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SURFACE WATER SUPPLY OF THE UNITED STATES

1909

PART VIII. WESTERN GULF OF MEXICO

PREPARED UNDER THE DIRECTION OF M. O. LEIGHTON

BY

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SURFACE WATER SUPPLY OF THE WESTERN GULF OF MEXICO, 1909.

By W. B. FREEMAN and R. H. BOLSTER.

INTRODUCTION.

AUTHORITY FOR INVESTIGATIONS.

This volume contains results of flow measurements made on certain streams in the United States. The work was performed by the water-resources branch of the United States Geological Survey, either independently or in cooperation with organizations mentioned herein. These investigations are authorized by the organic law of the Geological Survey (Stat. L., vol. 20, p. 394), which provides, among other things, as follows:

> 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.

Inasmuch as water is the most abundant and most valuable mineral in nature the investigation of water resources is included under the above provision for investigating mineral resources. The work has been supported since the fiscal year ending June 30, 1895, by appropriations in successive sundry civil bills passed by Congress under the following item:

> For gauging 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.

The various appropriations that have been made for this purpose are as follows:

Annual appropriations for the fiscal year ending June 30—

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	150,000

SCOPE OF INVESTIGATIONS.

These investigations are not complete nor do they include all the river systems or parts thereof that might purposefully be studied. The scope of the work is limited by the appropriations available. The field covered is the widest and the character of the work is believed to be the best possible under the controlling conditions. The work would undoubtedly have greater scientific importance and ultimately be of more practical value if the money now expended for wide areas were concentrated on a few small drainage basins; but such a course is impossible because general appropriations made by Congress are applicable to all parts of the country. Each part demands its proportionate share of the benefits.

It is essential that records of stream flow shall be kept during a period of years long enough to determine within reasonable limits the entire range of flow from the absolute maximum to the absolute minimum. The length of such a period manifestly differs for different streams. Experience has shown that the records for some streams should cover from five to ten years, and for other streams twenty years or even more, the limit being determined by the relative importance of the stream and the interdependence of the results with other long-time records on adjacent streams.

In the performance of this work an effort is made to reach the highest degree of precision possible with a rational expenditure of time and a judicious expenditure of a small amount of money. In all engineering work there is a point beyond which refinement is needless and wasteful, and this statement applies with especial force to stream-flow measurements. It is confidently believed that the stream-flow data presented in the publications of the survey are in general sufficiently accurate for all practical purposes. Many of the records are, however, of insufficient length, owing to the unforeseen reduction of appropriations and consequent abandonment of stations. All persons are cautioned to exercise the greatest care in using such incomplete records.

Records have been obtained at more than 1,550 different points in the United States, and in addition the surface water supply of small areas in Seward Peninsula and the Yukon-Tanana region, Alaska, has been investigated. During 1909 regular gaging stations were maintained by the survey and cooperating organizations at about 850 points in the United States, and many miscellaneous measurements were made at other points. Data were also obtained 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 surface water-supply papers and in special papers from time to time.

PURPOSES OF THE WORK.

The results contained in this volume are requisite to meet the immediate demands of many public interests, including navigation, irrigation, domestic water supply, water power, swamp and overflow land drainage, and flood prevention.

Navigation.—The Federal Government has expended more than $250,000,000 for the improvement of inland navigation, and prospective expenditures will approximate several times this amount. It is obvious that the determination of stream flow is necessary to the intelligent solution of the many problems involved.

Irrigation.—The United States is now expending $51,000,000 on federal irrigation systems, and this amount is far exceeded by the private expenditures of this nature in the arid West. The integrity of any irrigation system depends absolutely on the amount of water available. Therefore investigations of stream flow in that portion of the country are not only of first importance in the redemption of the lands but constitute an insurance of federal and private investments.

Domestic water supply.—The highest use of water is for domestic supply, and although this branch of the subject is of less direct federal interest than the branches already named, it nevertheless has so broad a significance with respect to the general welfare that the Federal Government is ultimately and intimately concerned.

Water power.—The development of the water power of the country is an economic necessity. Our stock of coal is being rapidly depleted and the cost of steam power is increasing accordingly. Industrial growth and, as a consequence, the progress of the United States as a nation will cease if cheap power is not available. Water power affords the only avenue now open. When the electric transmission of power was accomplished the relation of our water powers to national economy changed entirely. Before the day of electric transmission water power was important only at the locality at which it was generated, but it has now become a public utility in which the individual citizen is vitally interested. Inasmuch as the amount of water power that may be made available depends on the flow of rivers, the investigation of flow becomes a prerequisite in the judicious management of this source of energy.

Drainage of swamp and overflowed lands.—More than 70,000,000 acres of the richest land in this country are now practically worthless or of precarious value by reason of overflow and swamp conditions. When this land is drained it becomes exceedingly productive and its value increases many fold. Such reclamation would add to the national assets at least $700,000,000. The study of run-off is the first consideration in connection with drainage projects. If by the drainage of a large area into any particular channel that channel

becomes so gorged with water which it had not hitherto been called upon to convey that overflow conditions are created in places where previously the land was not subject to inundation, then drainage results merely in an exchange of land values. This is not the purpose of drainage improvement.

Flood prevention.—The damage from floods in the United States probably exceeds on the average $100,000,000 annually, and in the year 1908, according to estimates based on reliable data, the aggregate damage approximated $250,000,000. Such an annual tax on the property of great regions should be reduced in the orderly progress of government. It goes without saying that any consideration of flood prevention must be based on a thorough knowledge of stream flow, both in the contributing areas which furnish the water and along the great lowland rivers.

PUBLICATIONS.

The data on stream flow collected by the United States Geological Survey since its inception have appeared in the annual reports, bulletins, and water-supply papers. Owing to natural processes of evolution and to changes in governmental requirements, the character of the work and the territory covered by these different publications has varied greatly. For the purpose of uniformity in the presentation of reports a general plan has been agreed upon by the United States Reclamation Service, the United States Forest Service, the United States Weather Bureau, and the United States Geological Survey, according to which the area of the United States has been divided into twelve parts, whose boundaries coincide with certain natural drainage lines. The areas so described are indicated by the following list of papers on surface water supply for 1909. The dividing line between the North Atlantic and South Atlantic drainage areas lies between York and James rivers.

Papers on surface water supply of the United States, 1909.

Part.	No.	Title.	Part.	No.	Title.
I	261	North Atlantic coast.	VI	266	Missouri River Basin.
II	262	South Atlantic coast and eastern Gulf of Mexico.	VII	267	Lower Mississippi River Basin.
III	263	Ohio River Basin.	VIII	268	Western Gulf of Mexico.
IV	264	St. Lawrence River Basin.	IX	269	Colorado River Basin.
V	265	Upper Mississippi River and Hudson Bay basins.	X	270	Great Basin.
			XI	271	California.
			XII	272	North Pacific coast.

The following table gives the character of data regarding stream flow at regular stations to be found in the various publications of the United States Geological Survey exclusive of all special papers. Numbers of reports are inclusive, and dates also are inclusive so far as the data are available.

Stream-flow data in reports of the United States Geological Survey.

[Ann.=Annual Report; B.=Bulletin; W. S.=Water-Supply Paper.]

Report.	Character of data.	Year.
10th Ann., pt. 2	Descriptive information only	
11th Ann., pt. 2	Monthly discharge	1884 to Sept., 1890.
12th Ann., pt. 2	do	1884 to June 30, 1891.
13th Ann., pt. 3	Mean discharge in second-feet	1884 to Dec. 31, 1892.
14th Ann, 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 Ann., pt. 2	Descriptive information only	
B. 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
W. S. 11	Gage heights (also gage heights for earlier years)	1896.
18th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for some earlier years).	1895 and 1896.
W. S. 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.
W. S. 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
W. S. 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1898.
W. S. 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th Ann., pt. 4	Monthly discharge (also for many earlier years)	1898.
W. S. 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.
21st Ann., pt. 4	Monthly discharge	1899.
W. S. 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.
22d Ann., pt. 4	Monthly discharge	1900.
W. S. 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
W. S. 75	Monthly discharge	1901.
W. S. 82 to 85	Complete data	1902.
W. S. 97 to 100	do	1903.
W. S. 124 to 135	do	1904.
W. S. 165 to 178	do	1905.
W. S. 201 to 214	Complete data, except descriptions	1906.
W. S. 241 to 252	Complete data	1907–8.
W. S. 261 to 272	do	1909.

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. An index of the reports containing records prior to 1904 has been published in Water-Supply Paper 119. The first table which follows gives, by years and drainage basins, the numbers of the papers on surface water supply published from 1899 to 1909. Wherever the data for a drainage basin appear in two papers the number of one is placed in parentheses and the portion of the basin covered by that paper is indicated in the second table. For example, in 1904 the data for Missouri River were published in Water-Supply Papers 130 and 131, and the portion of the records contained in Water-Supply Paper 131, as indicated by the second table, is that relating to Platte and Kansas rivers.

Numbers of water-supply papers containing results of stream measurements, 1899–1909.

	1899.[a]	1900.[b]	1901.	1902.	1903.	1904.	1905.	1906.	1907–8.	1909.
Atlantic coast and eastern Gulf of Mexico:										
New England rivers	35	47	65, 75	82	97	124	165	201	241	261
Hudson River to Delaware River, inclusive	35	47, (48)	65, 75	82	97	125	166	202	241	261
Susquehanna River to York River, inclusive	35	48	65, 75	82	97	126	167	203	241	261
James River to Yadkin River, inclusive	(35), 36	48	65, 75	(82), 83	(97), 98	126	167	203	242	262
Santee River to Pearl River, inclusive	36	48	65, 75	83	98	127	168	204	242	262
St. Lawrence River	36	49	65, 75	(82), 83	97	129	170	206	244	264
Hudson Bay	.....	.....	66, 75	85	100	130	171	207	245	265
Mississippi River:										
Ohio River	36	48, (49)	65, 75	83	98	128	169	205	243	263
Upper Mississippi River	36	49	65, 75	83	98, (99)	128, (130)	171	207	245	265
Missouri River	(36), 37	49, (50)	66, 75	84	99	130, (131)	172	208	246	266
Lower Mississippi River	37	50	(65), 66, 75	(83), 84	(98), 99	(128), 131	(169), 173	(205), 209	247	267
Western Gulf of Mexico	37	50	66, 75	84	99	132	174	210	248	268
Pacific coast and Great Basin:										
Colorado River	(37), 38	50	66, 75	85	100	133, (134)	175, (177)	211, (213)	249, (251)	269, (271)
Great Basin	38, (39)	51	66, 75	85	100	133, (134)	176, (177)	212, (213)	250, (251)	270, (271)
South Pacific coast to Klamath River, inclusive	(38), 39	51	66, 75	85	100	134	177	213	251	271
North Pacific coast	38	51	66, 75	85	100	135	(177), 178	214	252	272

[a] Rating tables and index to Water-Supply Papers 35-39 contained in Water-Supply Paper 39.
[b] 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.

Numbers of water-supply papers containing data covering portions of drainage basins.

No.	River basin.	Tributaries included.
35	James	
36	Missouri	Gallatin.
37	Colorado	Green, Gunnison, Grand above junction with Gunnison.
38	Sacramento	Except Kings and Kern.
39	Great Basin	Mohave.
48	Delaware	Wissahickon and Schuylkill.
49	Ohio	Scioto.
50	Missouri	Loup and Platte near Columbus, Nebr. All tributaries below junction with Platte.
65	Lower Mississippi	Yazoo.
82	James	
	St. Lawrence	Lake Ontario, tributaries to St. Lawrence River proper.
83	Lower Mississippi	Yazoo.
97	James	
98	Lower Mississippi	Do.
99	Upper Mississippi	Tributaries from the west.
128	Lower Mississippi	Yazoo.
130	Upper Mississippi	Tributaries from the west.
131	Missouri	Platte, Kansas.
134	Colorado	Data near Yuma, Ariz., repeated.
	Great Basin	Susan, Owens, Mohave.
169	Lower Mississippi	Yazoo.
177	Colorado	Below junction with Gila.
	Great Basin	Susan repeated, Owens, Mohave.
	North Pacific coast	Rogue, Umpqua, Siletz.
205	Lower Mississippi	Yazoo, Homochitto.
213	Colorado	Data at Hardyville repeated; at Yuma, Salton Sea.
	Great Basin	Owens, Mohave.
251	Colorado	Yuma and Salton Sea stations repeated.
271	Great Basin	Owens River basin.

The order of treatment of stations in any basin in these papers is downstream. The main stem of any river is determined on the basis of drainage area, local changes in name and lake surface being disregarded. After all stations from the source to the mouth of the main stem of the river have been given, the tributaries are taken up in regular order from source to mouth. The tributaries are treated the same as the main stream, all stations in each tributary basin being given before taking up the next one below.

The exceptions to this rule occur in the records for Mississippi River, which are given in four parts, as indicated above, and in the records for large lakes, where it is often clearer to take up the streams in regular order around the rim of the lake than to cross back and forth over the lake surface.

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 which represent a rate of flow, as second-feet, gallons per minute, miner's inches, and run-off in second-feet per square mile, and (2) those which represent the actual quantity of water, as run-off in depth in inches and acre-feet. They may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second and is the rate of discharge of water flowing in a stream 1 foot wide, 1 foot deep, at a rate 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 following table of equivalents:

"Gallons per minute" is generally used in connection with pumping and city water supply.

The "miner's inch" is the rate of discharge of water that passes through an orifice 1 inch square under a head which varies locally. It is commonly used by miners and irrigators throughout the West and is defined by statute in each State in which it is used.

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

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

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

CONVENIENT EQUIVALENTS.

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

1 second-foot equals 40 California miner's inches (law of March 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 646,272 gallons for one day.
1 second-foot equals 6.23 British imperial gallons per second.
1 second-foot for one year covers 1 square mile 1.131 feet or 13.572 inches deep.
1 second-foot for one year equals 31,536,000 cubic feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot for one day covers 1 square mile 0.03719 inch deep.
1 second-foot for one 28-day month covers 1 square mile 1.041 inches deep.
1 second-foot for one 29-day month covers 1 square mile 1.079 inches deep.
1 second-foot for one 30-day month covers 1 square mile 1.116 inches deep.
1 second-foot for one 31-day month covers 1 square mile 1.153 inches deep.
1 second-foot for one day equals 1.983 acre-feet.
1 second-foot for one 28-day month equals 55.54 acre-feet.
1 second-foot for one 29-day month equals 57.52 acre-feet.
1 second-foot for one 30-day month equals 59.50 acre-feet.
1 second-foot for one 31-day month equals 61.49 acre-feet.
100 California miner's inches equal 18.7 United States gallons per second.
100 California miner's inches equal 96 Colorado miner's inches.
100 California miner's inches for one day equal 4.96 acre-feet.
100 Colorado miner's inches equal 2.60 second-feet.
100 Colorado miner's inches equal 19.5 United States gallons per second.
100 Colorado miner's inches equal 104 California miner's inches.
100 Colorado miner's inches for one day equal 5.17 acre-feet.
100 United States gallons per minute equal 0.223 second-foot.
100 United States gallons per minute for one day equal 0.442 acre-foot.
1,000,000 United States gallons per day equal 1.55 second-feet.
1,000,000 United States gallons equal 3.07 acre-feet.
1,000,000 cubic feet equal 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 equals 7.48 gallons.
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 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
1⅓ horsepower equal about 1 kilowatt.

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

EXPLANATION OF TABLES.

For each drainage basin there is given a brief description of general conditions covering such features as area, source, tributaries, topography, geology, conditions of forestation, rainfall, ice conditions, irrigation, storage, power possibilities, and other special features of importance or interest.

For each regular current-meter gaging station are given in general, and so far available, the following data: Description of station, list of discharge measurements, table of daily gage heights, table of daily discharges, table of monthly and yearly discharges and run-off. For stations located at weirs or dams the gage-height table is omitted.

In addition to statements regarding the location and installation of current-meter stations, the descriptions give information in regard to any conditions which may affect the constancy of the relation of gage height to discharge, covering such points as ice, logging, shifting conditions of flow, and backwater; also information regarding diversions which decrease the total flow at the measuring section. Statements are also made regarding the accuracy and reliability of the data.

The discharge-measurement table gives the results of the discharge measurements made during the year, including the date, name of hydrographer, width and area of cross section, gage height, and discharge in second-feet.

The table of daily gage heights gives the daily fluctuations of the surface of the river as found from the mean of the gage readings taken each day. At most stations the gage is read in the morning and in the evening. The gage height given in the table represents the elevation of the surface of the water above the zero of the gage. All gage heights during ice conditions, backwater from obstructions, etc., are published as recorded, with suitable footnotes. The rating is not applicable for such periods unless the proper corrections to the gage heights are known and applied. Attention is called to the fact that the zero of the gage is placed at an arbitrary datum and has no relation to zero flow or the bottom of the river. In general, the zero is located somewhat below the lowest known flow, so that negative readings shall not occur.

The discharge measurements and gage heights are the base data from which rating tables, daily discharge tables, and monthly discharge tables are computed.

The rating table gives, either directly or by interpolation, the discharge in second-feet corresponding to every stage of the river recorded during the period for which it is applicable. It is not published in this report, but can be determined from the daily gage heights and daily discharges for the purpose of verifying the published results as follows:

First plot the discharge measurements for the current and earlier years on cross-section paper with gage heights in feet as ordinates and discharge in second-feet as abscissas. Then tabulate a number of gage heights taken from the daily gage height table for the complete range of stage given and the corresponding discharges for the days selected from the daily discharge table and plot the values on cross-section paper. The last points plotted will define the rating curve used and will lie among the plotted discharge measurements. After drawing the rating curve, a table can be developed by scaling off the discharge in second-feet for each tenth foot of gage height. These values should be so adjusted that the first differences shall always be increasing or constant, except for known backwater conditions.

The table of daily discharges gives the discharges in second-feet corresponding to the observed gage heights as determined from the rating tables.

In the table of monthly discharge the column headed "Maximum" gives the mean flow, as determined from the rating table, 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 consequently larger than given in the maximum column. Likewise, in the column of "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 the computations for the remaining columns, which are defined on page 11, are based.

FIELD METHODS OF MEASURING STREAM FLOW.

There are three distinct methods of determining the flow of open-channel streams: (1) By measurements of slope and cross section and the use of Chezy's and Kutter's formulas; (2) by means of a weir or dam; (3) by measurements of the velocity of the current and of the area of the cross section. The method chosen depends on the local physical conditions, the degree of accuracy desired, the funds available, and the length of time that the record is to be continued.

Slope method.—Much information has been collected relative to the coefficients to be used in the Chezy formula, $v=c\sqrt{Rs}$. This has been utilized by Kutter, both in developing his formula for c and in determining the values of the coefficient n which appears therein. The results obtained by the slope method are in general only roughly approximate, owing to the difficulty in obtaining accurate data and the uncertainty of the value for n to be used in Kutter's formula. The most common use of this method is in estimating the flood discharge of a stream when the only data available are the cross section, the slope as shown by marks along the bank, and a knowledge of the general conditions. It is seldom used by the United States Geological Survey. For full information regarding this method the reader is referred to the various text-books on hydraulics.

Weir method.—Relatively few stations are maintained at weirs or dams by the United States Geological Survey. Standard types of sharp-crested and broad-crested weirs, within the limits for which accurate coefficients have been experimentally obtained, give very accurate records of discharge if properly maintained. At practically all broad-crested weirs, however, there is a diversion of water either through or around the dam, usually for the purpose of development of water power. The flow is often complicated and the records are subject to errors from such sources as leakage through the dam, backwater at high stages, uncertainty regarding coefficient, irregularity of crest, obstructions from logs or ice, use of flashboards, old turbines with imperfect ratings, and many others, depending on the type of development and the uses of the diverted water.

In general, records of discharge at dams are usually accurate enough for practical use if no others are available. It has been the general experience of the United States Geological Survey, however, that records at current-meter gaging stations under unobstructed-channel conditions are more accurate than those collected at dams and where the conditions are reasonably favorable are practically as good as those obtained at sharp-crested weirs.[1]

Velocity method.—Streams in general present throughout their courses to a greater or less extent all conditions of permanent, semipermanent, and varying conditions of flow. In accordance with the location of the measuring section with respect to these physical conditions current-meter gaging stations may in general be divided into four classes—(1) those with permanent conditions of flow; (2) those with beds which change only during extreme high water;

[1] The determination of discharge over the different types of weirs and dams is treated fully in "Weir experiments, coefficients, and formulas" (Water-Supply Paper 200) and in the various text-books on hydraulics. "Turbine water-wheel tests and power tables" (Water-Supply Paper 180) treats of the discharge through turbines when used as meters. The edition of the latter water-supply paper is nearly exhausted. The paper can, however, be consulted at most of the larger libraries of the country or it can be obtained from the Superintendent of Documents, Washington, D. C., at a cost of 20 cents.

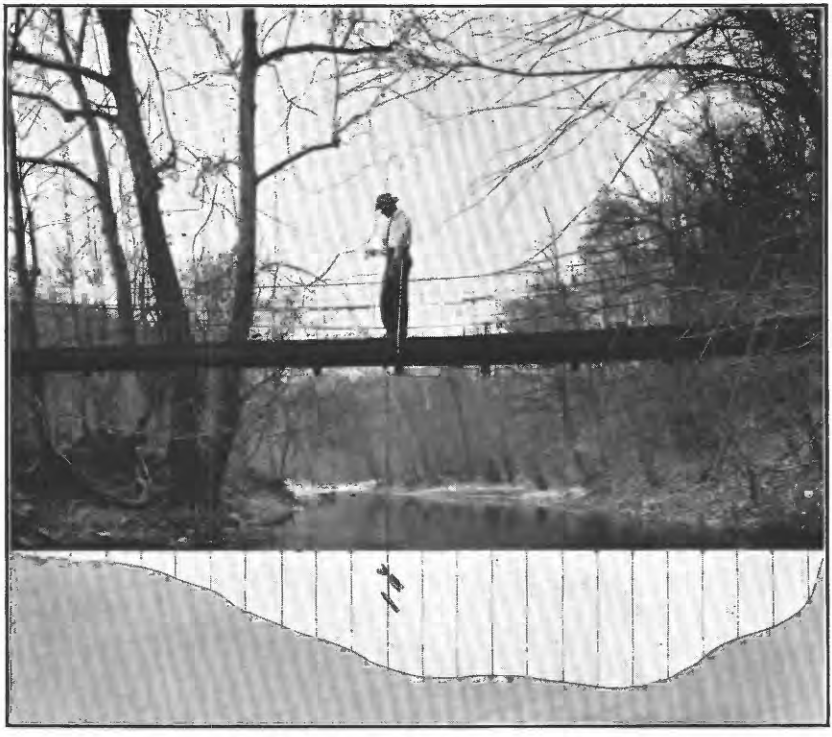
(3) those with beds which change frequently but which do not cause a variation of more than about 5 per cent of the discharge curves from year to year; and (4) those with constantly shifting beds. In determining the daily flow different office methods are necessary for each class. The field data on which the determinations are based and the methods of collecting them are, however, in general the same.

Great care is taken in the selection and equipment of gaging stations for determining discharge by velocity measurements in order that the data may have the required degree of accuracy. They are located, as far as possible, at such points that the relation between gage height and discharge will always remain constant for any given stage. The experience of engineers of the Geological Survey has been that permanency of conditions of flow is the prime requisite of any current-meter gaging station when maintained for several years, unless funds are available to cover all changes in conditions of flow. A straight, smooth section, without cross currents, backwater, boils, etc., at any stage is highly desirable, but on most streams is not attainable except at the expense of a cable equipment. Rough, permanent sections, if measurements are properly made by experienced engineers, taking measuring points at a distance apart of 5 per cent or less of the total width, will within reasonable limits yield better results for a given outlay of money than semipermanent or shifting sections with smooth, uniform current. So far as possible, stations are located where the banks are high and not subject to overflow at high stages and out of the influence of tributary streams, dams, or other artificial obstructions which might affect the relation between gage height and discharge.

A gaging station consists essentially of a gage for determining the daily fluctuations of stage of the river and some structure or apparatus from which discharge measurements are made, usually a bridge or cable.

The two factors required to determine the discharge of a stream past a section perpendicualr to the mean direction of the current are the area of the cross section and the mean velocity of flow normal to that section.

In making a measurement with a current meter a number of points, called measuring points, are measured off above and in the plane of the measuring section at which observations of depth and velocity are taken. (See Pl. I, *A*.) These points are spaced equally for those parts of the section where the flow is uniform and smooth, and are spaced unequally for other parts, according to the discretion and judgment of the engineer. In general, the points should not be spaced farther apart than 5 per cent of the channel width, nor farther apart than the approximate mean depth of the section at the time of measurement.



A. FOR BRIDGE MEASUREMENT.

B. FOR WADING MEASUREMENT.

TYPICAL GAGING STATIONS.

The measuring points divide the total cross section into elementary strips, at each end of which observations of depth and velocity are made. The discharge of any elementary strip is the product of the average of the depths at the two ends times the width of the strip times the average of the mean velocities at the two ends of the strip. The sum of the discharges of the elementary strips is the total discharge of the stream.[1]

Depths for the determination of the area are usually obtained by sounding with the current meter and cable. In rough sections or swift current an ordinary weight and cable are used, particular care being taken that all observations shall be in the plane of the cross section.

Two methods of determining the velocity of flow of a stream are in general use—the float method and the current-meter method.

The float method, with its various modifications of surface, subsurface, and tube or rod floats, is now considered obsolete in the ordinary practice of the United States Geological Survey. The use of this method is limited to special conditions where it is impracticable to use the current meter, such as in places where large quantities of ice or débris which may damage the meter are flowing with the current, and for miscellaneous measurements or other work where a high degree of accuracy is not necessary. Tube floats are very satisfactory for use in canals with regular bottoms and even flow of current. Measurements by the float method are made as follows: The velocity of flow of the stream is obtained by observing the time which it takes floats set free at different points across the stream to pass between two range lines about 200 feet apart. The area used is the mean value obtained from several cross sections measured between the two range lines. The chief disadvantages of this method are difficulty in obtaining the correct value of mean area for the course used and uncertainty regarding the proper coefficient to apply to the observed velocity.[2]

The Price current meter is now used almost to the exclusion of other types of meters by the United States Geological Survey in the determination of the velocity of flow of water in open channels, a use for which it is adapted under practically all conditions.[3]

Plate II shows in the center the new type of penta-recording current meter equipped for measurements at bridge and cable stations; on the left the same type of meter is shown equipped for wading measure-

[1] For a discussion of methods of computing the discharge of a stream see Engineering News, June 25, 1908.

[2] Further information regarding this method is given in Water-Supply Paper 95 and in the various textbooks covering the general subject of stream flow. The edition of this paper is nearly exhausted. It can, however, be consulted at most of the larger libraries of the country, or can be obtained from the Superintendent of Documents, Washington, D. C., at a cost of 15 cents.

[3] See Hoyt, J. C., and others, use and care of the current meter as practiced by the United States Geological Survey: Trans. Am. Soc. C. E., vol. 66, 1910, p. 70.

ments, to record by the acoustic method; the meter shown on the right is equipped to record electrically. (See Pl. I, *B*.) Briefly, the meter consists of six cups attached to a vertical shaft which revolves on a conical hardened-steel point when immersed in moving water. The revolutions are indicated electrically. The rating or relation between the velocity of the moving water and the revolutions of the wheel is determined for each meter by drawing it through still water for a given distance at different speeds and noting the number of revolutions for each run. From these data a rating table is prepared which gives the velocity per second of moving water for any number of revolutions in a given time interval. The ratio of revolutions per second to velocity of flow in feet per second is very nearly a constant for all speeds, and is approximately 0.45.

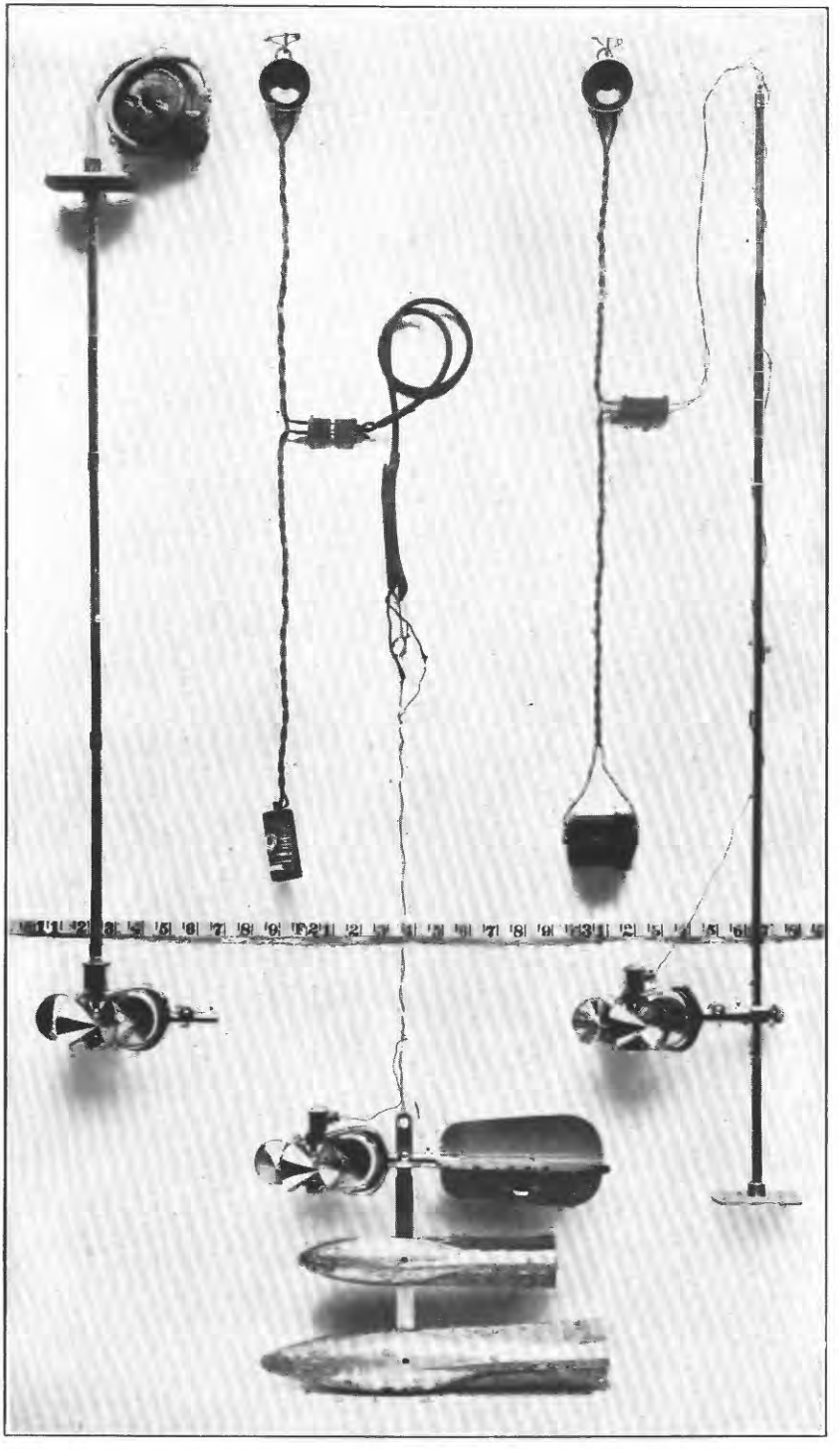
Three classes of methods of measuring velocity with current meters are in general use—multiple-point, single-point, and integration.

The two principal multiple-point methods in general use are the vertical velocity curve and 0.2 and 0.8 depth.

In the vertical velocity curve method a series of velocity determinations are made in each vertical at regular intervals, usually about 10 to 20 per cent of the depth apart. By plotting these velocities as abscissas and their depths as ordinates and drawing a smooth curve among the resulting points, the vertical velocity curve is developed. This curve shows graphically the magnitude and changes in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the area bounded by this velocity curve and its axis by the depth. This method of obtaining the mean velocity in the vertical is probably the best known, but on account of the length of time required to make a complete measurement its use is largely limited to the determination of coefficients for purposes of comparison and to measurements under ice.

In the second multiple-point method the meter is held successively at 0.2 and 0.8 depth, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. (See Pl. I, *A*.) On the assumption that the vertical velocity curve is a common parabola with horizontal axis, the mean of the velocities at 0.22 and 0.79 depth will give (closely) the mean velocity in the vertical. Actual observations under a wide range of conditions show that this multiple-point method gives the mean velocity very closely for open-water conditions and that in a completed measurement it seldom varies as much as 1 per cent from the value given by the vertical velocity curve method. Moreover, the indications are that it holds nearly as well for ice-covered rivers. It is very extensively used in the regular practice of the United States Geological Survey.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity or at an arbitrary depth



SMALL PRICE CURRENT METERS.

for which the coefficient for reducing to mean velocity has been determined or must be assumed.

Extensive experiments by means of vertical velocity curves show that the thread of mean velocity generally occurs between 0.5 and 0.7 total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and at this point the meter is held in most of the measurements made by the single-point method. A large number of vertical velocity curve measurements, taken on many streams and under varying conditions, show that the average coefficient for reducing the velocity obtained at 0.6 depth to mean velocity is practically unity. The variation of the coefficient from unity in individual cases is, however, greater than in the 0.2 and 0.8 method and the general results are not as satisfactory.

In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the effect of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocity taken at the subsurface to the mean has been found to be in general from about 0.85 to 0.95, depending on the stage, velocity, and channel conditions. The higher the stage the larger the coefficient. This method is especially adapted for flood measurements or when the velocity is so great that the meter can not be kept in the correct position for the other methods.

The vertical-integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface and noting the number of revolutions and the time taken in the operation. This method has the advantage that the velocity at each point of the vertical is measured twice. It is useful as a check on the point methods. In using the Price meter great care should be taken that the vertical movement of the meter is not rapid enough to vitiate the accuracy of the resulting velocity.

The determination of the flow of an ice-covered stream is difficult, owing to diversity and instability of conditions during the winter period and also to lack of definite information in regard to the laws of flow of water under ice. The method now employed is to make frequent discharge measurements during the frozen periods by the 0.2 and 0.8 and the vertical velocity curve methods, and to keep an accurate record of the conditions, such as the gage height to the surface of the water as it rises in a hole cut in the ice, and the thickness and character of the ice. From these data an approximate estimate of the daily flow can be made by constructing a rating curve (really a series of curves) similar to that used for open channels, but considering, in addition to gage heights and discharge, the varying thickness of ice.[1]

[1] For information in regard to flow under ice cover see Water-Supply Paper U. S. Geol. Survey No. 187, 1907.

OFFICE METHODS OF COMPUTING AND STUDYING DISCHARGE AND RUN-OFF.

At the end of each year the field or base data for current-meter gaging stations, consisting of daily gage heights, discharge measurements, and full notes, are assembled. The measurements are plotted on cross-section paper and rating curves are drawn wherever feasible. The rating tables prepared from these curves are then applied to the tables of daily gage heights to obtain the daily discharges, and from these applications the tables of monthly discharge and run-off are computed.

Rating curves are drawn and studied with special reference to the class of channel conditions which they represent. The discharge measurements for all classes of stations when plotted with gage heights in feet as ordinates and discharges in second-feet as abscissas define rating curves which are generally more or less parabolic in form. In many cases curves of area in square feet and mean velocity in feet per second are also constructed to the same scale of ordinates as the discharge curve. These are used mainly to extend the discharge curves beyond the limits of the plotted discharge measurements and for checking purposes to avoid errors in the form of the discharge curve and to determine and eliminate erroneous measurements.

For every rating table the following assumptions are made for the period of application of the table: (*a*) That the discharge is a function of and increases gradually with the stage; (*b*) that the discharge is the same whenever the stream is at a given stage, and hence such changes in conditions of flow as may have occurred during the period of application are either compensating or negligible, except that the rating is not applicable for known conditions of ice, log jams, or other similar obstructions; (*c*) that the increased and decreased discharge due to change of slope on rising and falling stages is either negligible or compensating.

As already stated, the gaging stations may be divided into several classes, as indicated in the following paragraphs:

The stations of class 1 represent the most favorable conditions for an accurate rating and are also the most economical to maintain. The bed of the stream is usually composed of rock and is not subject to the deposit of sediment and loose material. This class includes also many stations located in a pool below which is a permanent rocky riffle that controls the flow like a weir. Provided the control is sufficiently high and close to the gage to prevent cut and fill at the gaging point from materially affecting the slope of the water surface, the gage height will for all practical purposes be a true index of the discharge. Discharge measurements made at such stations usually

plot within 2 or 3 per cent of the mean discharge curve, and the rating developed from that curve represents a very high degree of accuracy. Stations of this type are found in the north Atlantic coast drainage basins.

Class 2 is confined mainly to stations on rough mountainous streams with steep slope. The beds of such streams are, as a rule, comparatively permanent during low and medium stages, and when the flow is sufficiently well defined by an adequate number of discharge measurements before and after each flood the stations of this class give nearly as good results as those of class 1. As it is seldom possible to make measurements covering the time of change at flood stage, the assumption is often made that the curves before and after the flood converged to a common point at the highest gage height recorded during the flood. Hence the only uncertain period occurs during the few days of highest gage heights covering the period of actual change in conditions of flow. Stations of this type are found in the upper Missouri River drainage basin.

Class 3 includes most of the current-meter gaging stations maintained by the United States Geological Survey. If sufficient measurements could be made at stations of this class results would be obtained nearly equaling those of class 1, but owing to the limited funds at the disposal of the Survey this is manifestly impossible, nor is it necessary for the uses to which discharge data are applied. The critical points are as a rule at relatively high or low stages. The percentage error, however, is greater at low stages. No absolute rule can be laid down for stations of this class. Each rating curve must be constructed mainly on the basis of the measurements of the current year, the engineer being guided largely by the past history of the station and the following general law. If all measurements ever made at a station of this class are plotted on cross-section paper, they will define a mean curve which may be called a "standard curve." It has been found in practice that if after a change caused by high stage a relatively constant condition of flow occurs at medium and low stages, all measurements made after the change will plot on a smooth curve which is practically parallel to the standard curve with respect to ordinates, or gage heights. This law of the parallelism of ratings is the fundamental basis of all ratings and estimates at stations with semipermanent and shifting channels. It is not absolutely correct, but, with few exceptions, answers all the practical requirements of estimates made at low and medium stages after a change at a high stage. This law appears to hold equally true whether the change occurs at the measuring section or at some controlling point below. The change is, of course, fundamentally due to change in the channel caused by cut or fill, or both, at or near the measuring section. For all except small streams the changes in

section usually occur at the bottom. The following simple but typical examples illustrate this law:

(*a*) If 0.5 foot of planking were to be nailed on the bottom of a well-rated wooden flume of rectangular section, there would result, other conditions of flow being equal, new curves of discharge, area, and velocity, each plotting 0.5 foot above the original curves when referred to the original gage. In other words, this condition would be analogous to a uniform fill or cut in a river channel which either reduces or increases all three values of discharge, area, and velocity for any given gage height. In practice, however, such ideal conditions rarely exist.

(*b*) In the case of a cut or fill at the measuring section there is a marked tendency toward decrease or increase, respectively, of the velocity. In other words, the velocity has a compensating effect, and if the compensation is exact at all stages the discharge at a given stage will be the same under both the new and the old conditions.

(*c*) In the case of uniform change along the crest of a weir or rocky control, the area curve will remain the same as before the change, and it can be shown that here again the change in velocity curve is such that it will produce a new discharge curve essentially parallel to the original discharge curve with respect to their ordinates.

Of course, in actual practice such simple changes of section do not occur. The changes are complicated and lack uniformity, a cut at one place being largely offset by a fill at another, and vice versa. If these changes are very radical and involve large percentages of the total area—as, for example, on small streams—there may result a wide departure from the law of parallelism of ratings. In complicated changes of section the corresponding changes in velocity which tend to produce a new parallel discharge curve may interfere with each other materially, causing eddies, boils, backwater, and radical changes in slope. In such extreme conditions, however, the measuring section would more properly fall under class 4 and would require very frequent measurements of discharge. Special stress is laid on the fact that, in the lack of other data to the contrary, the utilization of this law will yield the most probable results.

Slight changes at low or medium stages of an oscillating character are usually averaged by a mean curve drawn among them parallel to the standard curve, and if the individual measurements do not vary more than 5 per cent from the rating curve the results are considered good for stations of this class. Stations of this type are found in the south Atlantic coast and eastern Gulf of Mexico drainage basins.

Class 4 comprises stations that have soft, muddy, or sandy beds. Good results can be obtained from such sections only by frequent discharge measurements, the frequency varying from a measure-

ment every two or three weeks to a measurement every day, according to the rate of diurnal change in conditions of flow. These measurements are plotted and a mean or standard curve drawn among them. It is assumed that there is a different rating curve for every day of the year and that this rating is parallel to the standard curve with respect to their ordinates. On the day of a measurement the rating curve for that day passes through that measurement. For days between successive measurements it is assumed that the rate of change is uniform, and hence the ratings for the intervening days are equally spaced between the ratings passing through the two measurements. This method must be modified or abandoned altogether under special conditions. Personal judgment and a knowledge of the conditions involved can alone dictate the course to pursue in such cases. Stations of this type are found in the Platte, Arkansas, Rio Grande, and lower Colorado drainage basins.

The computations have, as a rule, been carried to three significant figures. Computation machines, Crelle's tables, and the 20-inch slide rule have been generally used. All computations are carefully checked.

After the computations have been completed they are entered in tables and carefully studied and intercompared to eliminate or account for all gross errors so far as possible. Missing periods are filled in, so far as is feasible, by means of comparison with adjacent streams. The attempt is made to complete years or periods of discharge, thus eliminating fragmentary and disjointed records. Full notes accompanying such estimates follow the daily and monthly discharge tables.

For most of the northern stations estimates have been made of the monthly discharge during frozen periods. These are based on measurements under ice conditions whenever available, daily records of temperature and precipitation obtained from the United States Weather Bureau, climate and crop reports, observers' notes of conditions, and a careful and thorough intercomparison of results with adjacent streams. Although every care possible is used in making these estimates, they are often very rough, the data for some of them being so poor that the estimates are liable to as much as 25 to 50 per cent error. It is believed, however, that estimates of this character are better than none at all, and serve the purpose of indicating in a relative way the proportionate amount of flow during the frozen period. These estimates are, as a rule, included in the annual discharge. The large error of the individual months has a relatively small effect on the annual total, and it is for many purposes desirable to have the yearly discharge computed, even though some error is involved in doing so.

ACCURACY AND RELIABILITY OF FIELD DATA AND COMPARATIVE RESULTS.

Practically all discharge measurements made under fair conditions are well within 5 per cent of the true discharge at the time of observation. Inasmuch as the errors of meter measurements are largely compensating, the mean rating curve, when well defined, is much more accurate than the individual measurements. Numerous tests and experiments have been made to test the accuracy of current-meter work. These show that it compares very favorably with the results from standard weirs and, owing to simplicity of methods, usually gives results that are much more reliable than those from stations at dams, where uncertainty regarding the coefficient and complicated conditions of flow prevail.

The work is, of course, dependent on the reliability of the observers. With relatively few exceptions, the observers perform their work honestly. Care is taken, however, to watch them closely and to inquire into any discrepancies. It is, of course, obvious that one gage reading a day does not always give the mean height for that day. As an almost invariable rule, however, errors from this source are compensating and virtually negligible in a period of one month, although a single day's reading may, when taken by itself, be considerably in error.

The effort is made to visit every station at least once each year for the purpose of making a measurement to determine the constancy of conditions of flow since the last measurement made during the preceding year, and also to check the elevation of the gage. On account of lack of funds or for other causes some stations were not visited during the current year. If conditions of flow have been reasonably permanent up to the time of the last preceding measurement, it is considered best to publish values of discharge on the basis of the latest verified rating curve rather than to omit them altogether, although it should be distinctly understood that such records are at times subject to considerable error. This is also true, although to a less degree, of the period of records since the date of the last measurement of the current year. As a rule, the accuracy notes are based on the assumption that the rating curve used is strictly applicable to the current year.

In order to give engineers and others information regarding the probable accuracy of the computed results, footnotes are added to the daily discharge tables, stating 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" or "approximate," within 15 to 25 per cent. These notes are very general and are based

on the plotting of the individual measurements with reference to the mean rating curve.

The accuracy column in the monthly discharge table does not apply to the maximum or minimum nor to any individual day, but to the monthly mean. It is based on the accuracy of the rating, the probable reliability of the observer, and knowledge of local conditions. In this column, A indicates that the 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.

USE OF THE DATA.

In general, the policy is followed of making available for the public the base data which are collected in the field each year by the Survey engineers. This is done to comply with the law, and also for the express purpose of giving to any engineer the opportunity of examining the computed results and of changing and adjusting them as may seem best to him. Although it is believed that the rating tables and computed monthly discharges are as good as the base data up to and including the current year will warrant, it should always be borne in mind that the additional data collected at each station from year to year nearly always throw new light on data already collected and published, and hence allow more or less improvement in the computed results of earlier years. It is therefore expected that the engineer who makes serious use of the data given in these papers will verify all ratings and make such adjustments in earlier years as may seem necessary. The work of compiling, studying, revising, and republishing data for different drainage basins for five or ten year periods or more is carried on by the United States Geological Survey so far as the funds for such work are available.

The values in the table of monthly discharge are so arranged as to give only a general idea of the conditions of flow at the station, and it is not expected that they will be used for other than preliminary estimates.

The daily discharges are published to allow a more detailed study of the variation in flow and to determine the periods of deficient flow.

COOPERATIVE DATA.

Cooperative data of various kinds and data regarding the run-off at many stations maintained wholly by private funds are incorporated in the surface water-supply reports of the United States Geological Survey.

Many stations throughout the country are maintained for specific purposes by private parties who supply the records gratuitously to the United States Geological Survey for publication. When such

records are supplied by responsible parties and appear to be reasonably accurate, they are verified, so far as possible, and estimated values of accuracy are given. Records clearly known to be worthless or misleading are not published. As it is, however, impossible to completely verify all such records furnished—because of lack of funds or for other causes—they are published for what they are worth, as they are of value as a matter of record and afford at least approximate information regarding stream flow at the particular localities. The Survey does not, however, assume any responsibility for inaccuracies found in such records, although most of them are believed to be reasonably good.

COOPERATION AND ACKNOWLEDGMENTS.

Special acknowledgments are due the following parties for assistance rendered and records furnished:

The International Boundary Commission—Gen. Anson Mills, commissioner on the part of the United States; Señor Dŏn Jacobo Blanco, commissioner on the part of Mexico; and W. W. Follett, consulting engineer on the part of the United States.

The Territorial engineer of New Mexico, Mr. V. L. Sullivan, who has taken great interest in this work and done everything possible to promote cooperation. During 1909 the Territory spent $2,500, which was set aside specifically for the work throughout New Mexico, in addition to some other funds of the Territorial engineer's office.

The State engineer of Colorado, Mr. Charles W. Comstock, who paid the salaries of the observers and the expenses of the hydrographers at a number of stations in Colorado.

The Atchison, Topeka & Santa Fe Railway Co., which donated $1,000 to be spent in New Mexico in 1909 by the Territorial engineer in cooperation with the United States Geological Survey.

The Farmers Union Irrigation Co., which paid the expense of obtaining a record on the Rio Grande at the Thirty Mile Bridge, under the direction of their engineers.

The Rio Mimbres Irrigation Co., which donated $250 toward the installation and maintenance of an automatic gage on Mimbres River.

The United States Reclamation Service, which furnished the records on the lower Pecos River in New Mexico.

The United States Weather Bureau, the United States Forest Service, and many engineers and companies.

DIVISION OF WORK.

The field data in the Rio Grande drainage basin, except for those stations maintained by the International Boundary Commission, were collected under the direction of W. B. Freeman, district engineer,

assisted by J. B. Stewart, G. H. Russell, and W. H. Sutton. The New Mexico work has been handled under the more immediate direction of Vernon L. Sullivan, Territorial engineer, assisted by C. D. Miller and others.

The data furnished by the International Water Commission were computed under the direction of W. W. Follett from the discharge measurements.

The data, ratings, and special studies of the completed data of the stations maintained by the United States Geological Survey were prepared by W. B. Freeman and R. H. Bolster. The computations and the preparation of the completed data for publication were made by G. C. Stevens, R. C. Rice, J. G. Mathers, H. D. Padgett, M. I. Walters, M. E. McChristie, and L. T. King.

The entire report was edited by Mrs. B. D. Wood.

GAGING STATIONS MAINTAINED IN WESTERN GULF OF MEXICO DRAINAGE BASINS.

The following list comprises the gaging stations regularly maintained in western Gulf of Mexico drainage basins by the United States Geological Survey and cooperative parties. Data for these stations have appeared in the published reports as shown in tables on pages 8–10. The stations are arranged by river basins, appear in downstream order, tributaries of main streams being indicated by indention. (See p. 11.)

Sabine River near Longview, Tex., 1904–1906.
Sabine River at Logansport, La., 1903–1906.
  Neches River at Evadale, Tex., 1904–1906.
Trinity River at Dallas, Tex., 1903–1906.
Trinity River at Riverside, Tex., 1903–1906.
Brazos River at Waco, Tex., 1898–1906.
Brazos River at Richmond, Tex., 1903–1906.
Colorado River at Austin, Tex., 1895–1906.
Colorado River at Columbus, Tex., 1902–1906.
  San Saba River near San Saba, Tex., 1904–1906.
Guadalupe River near Cuero, Tex., 1903–1906.
Rio Grande:
  Rio Grande at Thirtymile Bridge, near Creede, Colo., 1909.
  Rio Grande near Creede (Wason), Colo., 1907–1909.
  Rio Grande near Del Norte, Colo., 1889–1909, except 1907.
  Rio Grande near Lobatos (Cenicero), Colo., 1899–1909.
  Rio Grande near Alamosa, Colo., 1894, 1895, 1903.
  Rio Grande near Embudo, N. Mex., 1889–1903.
  Rio Grande near Buckman, N. Mex. (Rio Grande near San Ildefonso), 1895–1905 and 1909.
  Rio Grande near San Marcial, N. Mex., 1895–1909.
  Rio Grande near El Paso, Tex., 1889–1893, 1897–1909.
  Rio Grande near Fort Hancock, Tex., 1900–1903.
  Rio Grande above and below Presidio, Tex., 1900–1909.

Rio Grande—Continued.
Rio Grande near Langtry, Tex., 1900–1909.
Rio Grande near Devils River (below mouth), Tex., 1900–1909.
Rio Grande near Eagle Pass, Tex., 1900–1909.
Rio Grande near Nuevo Laredo, Tamaulipas, Mexico, 1900–1903.
Rio Grande near Laredo, Tex., 1903–1909.
Rio Grande near Roma, Tex., 1900–1909.
Rio Grande near Brownsville, Tex., 1900–1909.
Conejos River near Mogote, Colo., 1899, 1900, 1903–1909.
Chama River near Abiquia, N. Mex., 1895–1897.
Santa Fe Creek at Santa Fe, N. Mex., 1907–1909.
Mimbres River near Faywood, N. Mex., 1908–1909.
Cameron Creek at Fort Bayard, N. Mex., 1907–1909.
Stephens Creek at Fort Bayard, N. Mex., 1907–1909.
Pecos River at Santa Rosa, N. Mex., 1903–1906.
Pecos River near Fort Sumner, N. Mex., 1904–1909.
Pecos River near Roswell, N. Mex., 1903–1906.
Pecos River near Dayton, N. Mex., 1905–1909.
Pecos River near Lakewood, N. Mex., 1906–1909.
Pecos River at Avalon, N. Mex., 1906–1907.
Pecos River at Carlsbad, N. Mex., 1903–1908.
Pecos River near Pecos, Tex., 1898–1907.
Marguerreta flume near Pecos, Tex., 1898, 1900–1908.
Pecos River near Moorhead, Tex., 1900–1909.
Pecos River at High Bridge, near Lozier, Tex., 1898.
Gallinas River near Las Vegas, N. Mex., 1903–1909.
Taylor Moore ditch near Roswell, N. Mex., 1905.
Hondo River below Hondo reservoir, N. Mex., 1903–1906.
Hondo reservoir inlet near Hondo reservoir, N. Mex., 1906–1908.
Hondo reservoir scour gage No. 1 near Hondo reservoir, N. Mex., 1906.
Hondo River near Roswell, N. Mex., 1903–1906.
Penasco River near Dayton, N. Mex., 1905–1908.
Lake McMillan at Lakewood, N. Mex., 1906–1907 and 1909.
Devils River near Devils River, Tex., 1900–1909.
Rio Salado at Guerrero, Tamaulipas, Mexico, 1900–1909.
Rio San Juan at La Quemada, Tamaulipas, Mexico, 1900–1902.
Rio San Juan at Santa Rosalia Ranch, Tamaulipas, Mexico, 1902–1909.

RIO GRANDE DRAINAGE BASIN.

GENERAL FEATURES.

The Rio Grande basin is a long, narrow strip of country extending from the southern part of Colorado southeastward to the Gulf of Mexico. The perennial supply of water for the upper third of this basin comes principally from a comparatively small area of about 2,000 square miles of lofty mountains in Colorado and the extreme northern part of New Mexico. The Conchos enters the river from the Mexican side some 200 miles below El Paso and brings a good perennial flow as well as enormous floods in the summer and fall. Pecos and Devils rivers and springs also substantially augment the perennial supply, and other tributaries frequently furnish flood discharges, so that the "lower river" is not dependent on the moun-

tain area for its perennial flow. The flood season above the Conchos is May and June; below it is August and September. Frequently the river is dry at El Paso when the lower river country is inundated. In addition to the areas contributing a perennial supply of water and a spasmodic supply, a vast area of "lost river" basins which supply no water at any time, may, from topographic considerations, be included within this great catchment basin.

The Rio Grande rises in the mountainous area to the south and east of the Continental Divide in southwestern Colorado, flows eastward for a time as a mountain stream, and enters the San Luis Valley about 80 miles below its source. In this valley it receives from the north the waters of Saguache and San Luis rivers, by seepage, if at all; from the west, near the lower end of the valley, Alamos, La Jara, and Conejos rivers; and from the east the Trinchera, Culebra, and Rio Costilla. About 4 miles north of the Colorado State line it enters a long canyon locally known as the Rio Grande Canyon. From the east there enter this canyon two tributaries, Red River and Rio Hondo.

The general slope of the valley is still toward the south, the river descending, however, more rapidly than the surface of the country. This canyon is 300 or 400 feet deep in places, appearing from above as a gash in an otherwise level mesa. Its south end is 3 miles above Embudo, N. Mex., where the walls open and the river enters the Espanola Valley. While in the valley above Embudo the river receives from the east Taos River, Embudo Creek, and other small streams, and in the Espanola Valley it is increased by the Chama, flowing in from the west, and by a number of streams from the east.

At the lower end of Espanola Valley the river passes through White Rock Canyon, a gorge in a range of hills stretching from the Jemez to the Santa Fe Mountains. From Pena Blanca, near the lower end of this canyon, nearly to Socorro, the river flows in a valley from 1 to 3 miles wide, bounded on each side by mesas from 300 to 600 feet above the river. About 20 miles below Pena Blanca the Jemez enters from the west, and 60 miles or more below Albuquerque the Puerco comes in from the same side. The latter is a torrential stream with no perennial flow. Below these streams the Rio Grande has no tributaries of note until the Pecos comes in about 400 miles by river below El Paso.

At and below Socorro the valley contracts until it becomes too narrow for agriculture, but from San Antonio to San Marcial its width ranges from 1 to 2 miles. Below San Marcial the river swings to the west around the Cristobal and Caballos mountains, which lie along the west edge of the Jornada del Muerto, the valley from San Marcial to Rincon being narrow, low, and marshy. At Rincon the river enters a canyon which extends to Fort Selden, a distance of 15

miles. The Mesilla Valley, the most fertile valley in New Mexico, begins below Fort Selden and extends to the pass above El Paso, a distance of over 50 miles. Above El Paso the banks of the river again assume the canyon-like character for 3 miles, and the river passing this enters the Ysleta Valley, now commonly called the El Paso Valley.

The canyons above these valleys are not cut into hard, indurated rocks, but are bordered in many places by steep walls of comparatively soft, friable sandstones, alternating with conglomerates or beds of clay, the whole series in the northern part of New Mexico, at least, being capped by a vesicular lava. The fall through these canyons being great, the down-cutting is rapid, and thus the waters are supplied constantly with fresh detritus, part of which is deposited in turn in the valley below.

From El Paso to the Gulf the river forms the boundary between Mexico and the United States.

From source to mouth the Rio Grande is nearly 2,000 miles long, and its drainage area comprises about 248,000 square miles.

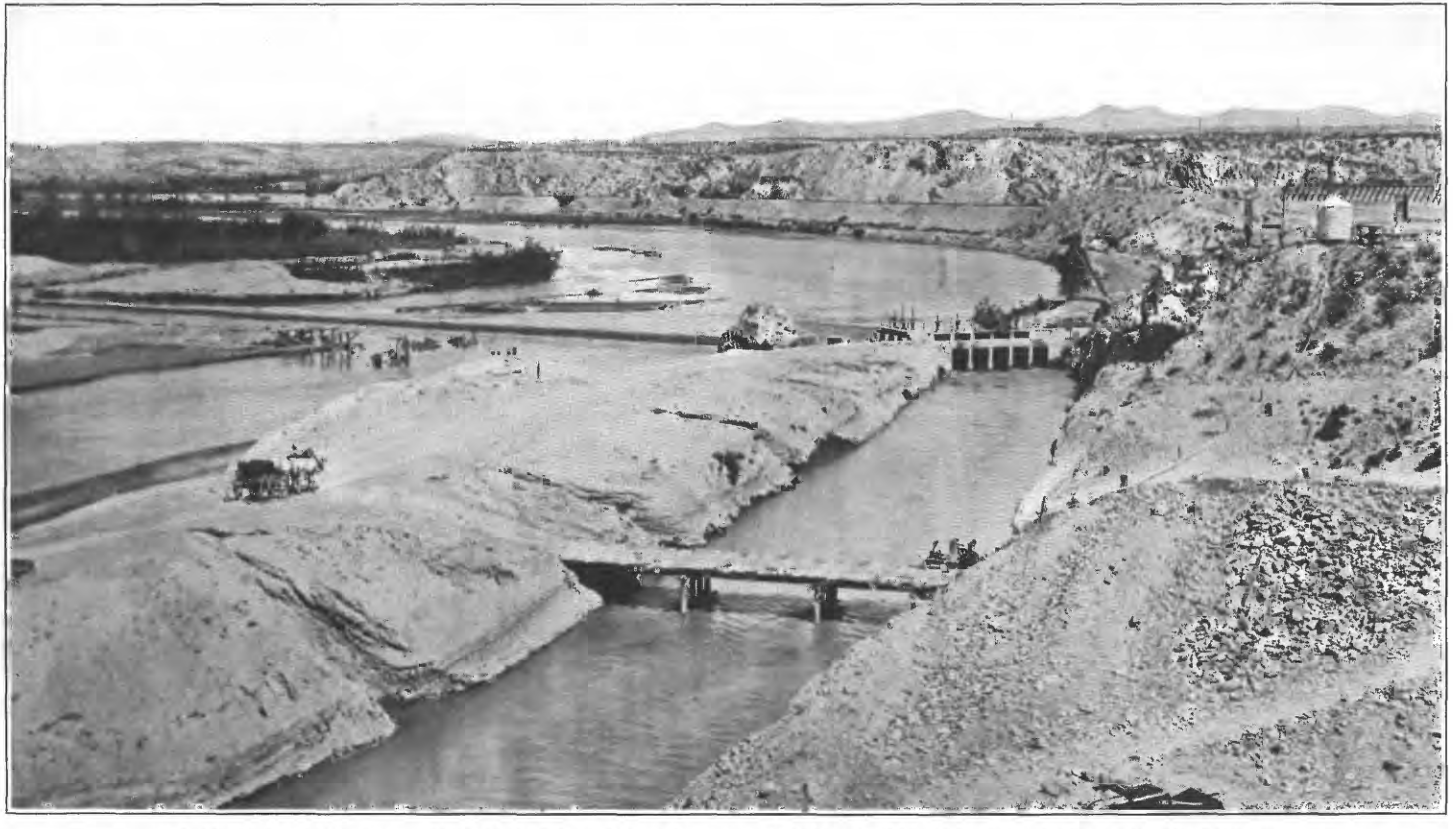
Many national forests have been established on the headwaters of the Rio Grande and its tributaries, both in Colorado and New Mexico. The drainage basin of the Rio Grande, exclusive of the Pecos, includes between 5,000 and 6,000 square miles of merchantable-timber land, 6,000 square miles of woodland and sparsely timbered land, and 2,000 square miles of burned and cut-over land, the remainder being sagebrush and open land.

The largest tributaries are the Conchos, which enters from the Mexico side, 200 miles below El Paso; the Conejos, which joins the Rio Grande just above the Colorado-New Mexico line; the Chama, which enters it in the Espanola Valley; the Pecos, which joins it in the southwestern part of Texas; and Devils River, about 50 miles below the Pecos. Most of the remaining tributaries are intermittent in character.

The mountains at the headwaters reach altitudes up to 14,000 feet above sea level. At Albuquerque, N. Mex., the elevation of the river is 5,000 feet and it leaves the Territory at an elevation of about 4,000 feet.

The rainfall varies greatly from year to year and from source to mouth, its irregularity making it very difficult to give averages. The annual precipitation in the mountainous district of Colorado—that is, along the upper Rio Grande—ranges from 15 to 25 inches. In the northern part of New Mexico it ranges from 10 to 15 inches and in the southern part from 5 to 12 inches.

In the mountains of Colorado the river is covered with a foot or more of ice from early in the winter until late in the spring. During severe winters the river is frozen over at times in northern New Mexico,



LEASBURG DIVERSION DAM AND HEADGATES OF RIO GRANDE CANAL, RIO GRANDE PROJECT, NEW MEXICO, LOOKING UPSTREAM.

A. THE LARGEST CONCRETE DROP IN MAIN RIO GRANDE CANAL, RIO GRANDE PROJECT, NEW MEXICO.

B. CONCRETE FLUME ACROSS PECOS RIVER, CARLSBAD PROJECT, NEW MEXICO.

and the snowfall is often very heavy. From the melting of the snows in Colorado and New Mexico comes the spring floods.

Irrigation is now practiced extensively in the following valleys along the Rio Grande and its smaller tributaries:

1. *San Luis Valley,* beginning a short distance above Del Norte and extending to the mouth of Conejos River. This district contains probably the largest cultivated area along the Rio Grande, aggregating nearly half a million acres.

2. *Valleys of the Taos district,* lying on the east side of the river below the Colorado line and including the valleys of Red River, Arroyo Hondo, and Taos. The Taos Valley surpasses the others both in water facilities and in area cultivated.

3. *Espanola Valley,* located south of the Taos district and Tres Piedras Mesa. It lies along the river, and, as in the Taos country, agriculture has been engaged in for years.

4. *Albuquerque district,* including the valley from Pena Blanco to San Marcial. The system of irrigation is practically the same as the old Pueblo Indian system. In the last few years, however, new settlers have adopted progressive methods and have greatly increased the duty of water.

5. *Mesilla Valley,* next to San Luis, is the most important agricultural area along the Rio Grande. The valley broadens just below Selden and continues generally broad and fertile for a distance of 35 miles or beyond the Texas line. A view of the Leasburg diversion dam of the United States Reclamation Service's Rio Grande project is presented in Plate III. The main canal of the same project is shown in Plate IV, *A*.

Along the Rio Grande and its tributaries in Colorado and New Mexico are available reservoir sites equal to storing of all flood waters. The largest reservoir in the country is about to be built near Engle, N. Mex. It will impound 2,500,000 acre-feet of water for the irrigation of nearly 200,000 acres of land in New Mexico, Texas, and Mexico.

The estimated power available on the Rio Grande and its tributaries, from its source to El Paso, Tex., is theoretically as follows:

Minimum horsepower	123,500
Minimum horsepower, six high months	241,000
Horsepower from storage, six months period	405,000

Developments will, however, be made chiefly on the upper tributaries in Colorado and a few of the mountain streams in New Mexico, and will not amount to more than 100,000 horsepower. At present very few water-power plants of any importance are operated in the drainage basin. The waters of the Rio Grande have been used only for irrigation and domestic purposes, but some of the tributaries have also been used in mining.

The wettest years on the upper Rio Grande appear to be 1906 and 1907; 1902 and 1908 are low-water years.

The determination of the amount of water in the Rio Grande is of importance, both on account of its use in irrigation and from its bearing upon interstate and international distribution of water. Most of the New Mexico and all of the Texas stations down to Eagle Pass are maintained by the United States section of the International Boundary Commission. The data used for the following stations have been collected by W. W. Follett, consulting engineer for the commission, and have been furnished through the courtesy of Gen. Anson Mills, commissioner:

Rio Grande near San Marcial, N. Mex.
Rio Grande near El Paso, Tex.
Rio Grande above Presidio, Tex.
Rio Grande below Presidio, Tex.
Rio Grande near Langtry, Tex.
Rio Grande at Eagle Pass, Tex.
Pecos River near Moorhead, Tex.
Devils River near Devils River Station, Tex.

On account of the shifting character of the river beds at the international water stations, no rating tables have been prepared. The estimated monthly discharges are from daily discharges computed by Mr. Follett directly from the discharge measurements.

The five stations from Laredo down (Laredo, Roma, Brownsville, Salado near Guerrero, and San Juan at Santa Rosalia ranch) are maintained by the Mexican section of the commission.

RIO GRANDE PROPER.

RIO GRANDE AT THIRTYMILE BRIDGE, NEAR CREEDE, COLO.

This station, which was established June 18, 1909, is about 30 miles west of Creede, Colo., and about 200 feet above the mouth of Big Squaw Creek at an elevation of about 9,200 feet above sea level.

No water is diverted above the station and none of any importance for many miles below except a little water used for meadow irrigation. The station is about one-half mile downstream from the proposed reservoir of the Farmers Union Irrigation Company, which will store flood water to be used in the irrigation of land in the valley 70 miles downstream. The records at this station have been taken at the expense of the company by their engineers under the general direction of the United States Geological Survey.

The chain gage, the datum of which has remained constant, is on the right bank 200 feet upstream from the Thirtymile Bridge, and discharge measurements have been made from a cable 30 yards below the gage.

This stream is frozen over for a number of months each year and there is also a large snowfall in that locality.

Discharge measurements of Rio Grande at Thirtymile Bridge, near Creede, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 19	Freeman and Pennock	60	255	5.90	1,440
June 21	O. P. Pennock	59	232	5.50	1,220
June 24	do	58	222	5.30	1,050
June 26	do	57	196	5.05	910
June 29	do	56	195	4.90	880
June 30	do	55	191	4.78	806
July 4	do	55	194	4.75	840
July 8	do	54	159	4.12	494
July 11	do	52	135	3.70	366
July 15	Pennock and Vandemoer	52	121	3.48	315
July 18	do	51	111	3.20	241
July 21	do	52	119	3.45	303
July 22	do	53	155	4.12	531
July 29	do	51	117	3.38	285
August 8 [a]	do	49	100	3.00	205
August 10	do	48	96	2.90	179
August 25	do	50	105	3.12	250

[a] Measurement not satisfactory, meter not working well.

Daily gage height, in feet, of Rio Grande at Thirtymile Bridge, near Creede, Colo., for 1909.

[O. P. Pennock, observer.]

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1		4.7	3.15	3.5	16		3.35	3.4	3.8
2		4.55	3.25	3.4	17		3.3	3.1	3.7
3		4.55	3.1	3.4	18	6.2	3.25	3.1	3.6
4		4.7	3.2	3.6	19	5.9	3.2	3.2	3.5
5		4.85	3.1	6.15	20	5.65	3.2	3.6	3.45
6		4.6	3.2	5.75	21	5.5	3.55	3.4	3.35
7		4.4	3.05	5.2	22		4.3	3.3	3.25
8		4.15	3.0	4.8	23		3.6	3.35	3.2
9		4.1	3.0	4.5	24	5.3	3.85	3.25	3.15
10		3.85	2.9	4.3	25	5.15	3.55	3.15	3.1
11		3.8	3.2	4.2	26	5.05	3.8	3.15	3.05
12		3.7	3.25	4.4	27	4.9	3.9	3.3	3.0
13		3.6	3.15	4.2	28	4.9	3.55	3.2	2.9
14		3.5	3.1	4.05	29	5.0	3.4	3.6	2.85
15		3.45	3.05	3.9	30	4.8	3.3	3.5	2.85
					31		3.2	3.5	

Daily discharge, in second-feet, of Rio Grande at Thirtymile Bridge, near Creede, Colo., for 1909.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1		788	230	316	16		276	289	409
2		717	252	289	17		264	220	376
3		717	220	289	18	1,640	252	220	345
4		788	241	345	19	1,450	241	241	316
5		861	220	1,610	20	1,300	241	345	302
6		740	241	1,360	21	1,210	330	289	276
7		648	210	1,040	22	[a] 1,170	604	264	252
8		540	201	836	23	[a] 1,130	345	276	241
9		520	201	694	24	1,100	426	252	230
10		426	184	604	25	1,010	330	230	220
11		409	241	561	26	962	409	230	210
12		376	252	648	27	886	444	264	201
13		345	230	561	28	886	330	241	184
14		316	220	500	29	936	289	345	176
15		302	210	444	30	836	264	316	176
					31		241	316	

[a] Interpolated.

NOTE.—These discharges are based on a rating curve that is well defined between 169 and 1,510 second-feet.

Monthly discharge of Rio Grande River at Thirtymile Bridge, near Creede, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
June (18-30)	1,640	836	1,120	28,900	A.
July	861	241	444	27,300	A.
August	345	184	248	15,200	A.
September	1,610	176	467	27,800	A.

RIO GRANDE NEAR CREEDE, COLO.

The station, which was established April 24, 1907, to obtain information concerning the quantity of run-off of the upper Rio Grande available for storage, is located at the three-span highway bridge one-quarter mile south of Wason siding, on the Creede branch of the Denver & Rio Grande Railroad, about 3 miles from Creede, the terminus of the line, and is a few miles above the site of a proposed dam and reservoir. The chain gage is fastened to the downstream side of left span, and discharge measurements are also made from the same side.

Willow Creek (or Goblin Creek) enters the river a short distance upstream from Wason, and Goose Creek comes in at Wagon-wheel Gap, about 5 miles below. The drainage area above the station is about 700 square miles.

Except for a little meadow irrigation, no water is diverted above this station. Two or three reservoirs are about to be constructed on the upper waters of the Rio Grande and its tributaries above Wason. Among others may be mentioned the Farmers' Union Irrigation Co.'s reservoir on the main stream, about 35 miles above. The proposed reservoir near Wason will have a capacity almost equal to the normal annual flow of the river.

The winters are long and very severe in this locality, and the stream has a heavy ice cover for several months. The bridge piers cause eddies, which materially affect the accuracy of measurements. The river channel is rough and the velocity high at flood stages, so that results obtained at this station are only fair.

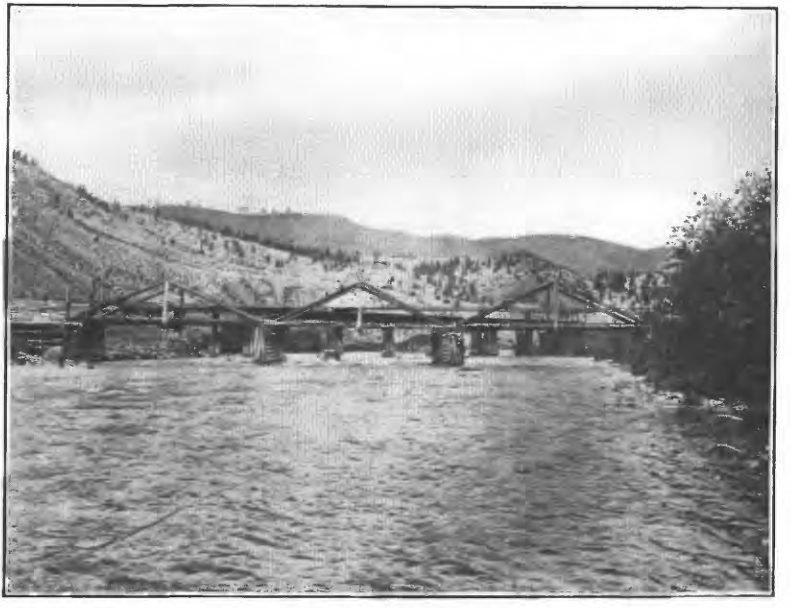
The datum of the gage has not been changed since the station was established.

A view of the river at this station is shown in Plate V, *A*.

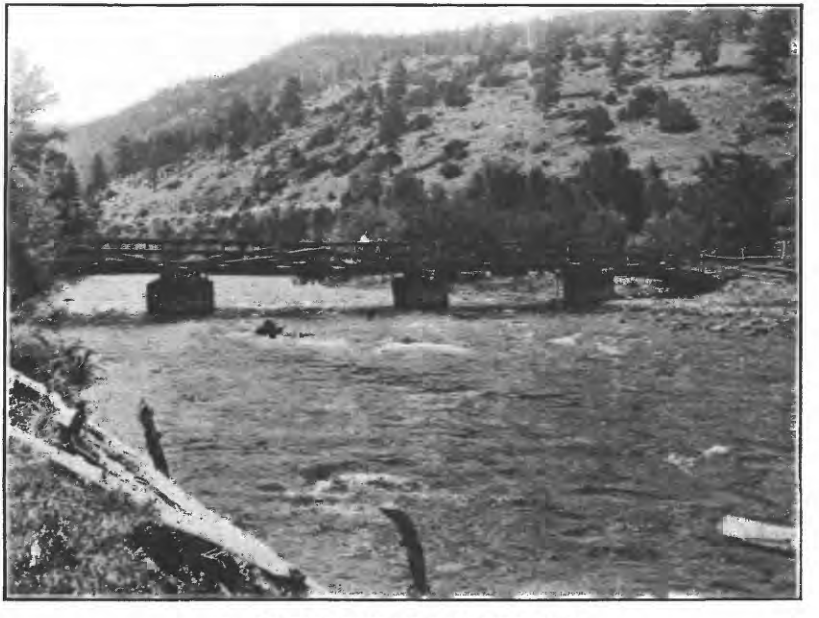
Discharge measurements of Rio Grande near Creede, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 18	W. B. Freeman	116	485	3.39	2,800
June 17	do	116	547	3.90	3,260
June 20	do	116	537	4.13	3,400
Aug. 5	G. H. Russell	107	238	1.22	588
Oct. 6	do	105	243	1.05	546
Dec. 10 [a]	do	65	146	.88	233

[a] Made by wading; ice along edges.



A. RIO GRANDE NEAR CREEDE, COLO.



B. CONEJOS RIVER NEAR MOGOTE, COLO.

Daily gage height, in feet, of Rio Grande near Creede, Colo., for 1909.

[Henry H. Wason, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.45	2.45	2.7	1.15	1.35	0.95	0.85
2	0.25	1.65	3.0	2.6	1.35	1.35	.95	.85
3	.25	1.7	4.15	2.65	1.25	1.5	.95	.85
4	.25	1.95	5.15	2.55	1.25	1.65	1.0	.9
5	.25	2.5	5.65	2.95	1.25	2.85	1.05	.85
6	.35	2.85	5.75	2.75	1.25	3.95	1.05	.8
7	.35	3.05	4.95	2.45	1.2	3.65	1.0	.85
8	.35	3.15	4.95	2.2	1.15	3.7	1.0	.85
9	.55	3.0	4.8	2.05	1.15	3.7	1.0	.8
10	.55	2.95	4.6	1.95	1.35	3.05	1.0	.8
11	.55	2.95	4.5	1.85	1.25	2.75	1.0	.8
12	.55	2.75	4.5	1.65	1.25	2.6	.95	.75
13	.55	3.0	4.5	1.65	1.25	2.25	.95	.75
14	.7	3.0	4.0	1.5	1.2	2.25	.9	.7
15	.75	3.1	4.3	1.45	1.25	2.05	.95	.6
16	.75	3.15	4.45	1.35	1.3	1.9	.95	.6
17	.75	3.3	4.25	1.25	1.2	1.8	.95	.55
18	.75	3.55	4.35	1.25	1.2	1.65	.95	.5
19	2.35	3.55	4.2	1.25	1.25	1.55	.9	.5
20	2.15	3.6	4.15	1.25	1.35	1.55	.9	.5
21	1.7	3.65	3.95	1.85	1.4	1.45	.9	.4
22	1.4	3.15	3.7	2.35	1.25	1 35	.9	.4
23	1.5	2.85	3.65	2.4	1.35	1.35	.9	.4
24	1.5	2.7	3.4	2.25	1.35	1.35	.9	.3
25	.....	2.9	3.25	1.7	1.25	1.25	.9	.3
26	.....	2.85	3.25	1.7	1.15	1.15	.9	.3
27	1.45	3.35	.....	1.75	1.15	1.05	.9	.....
28	1.75	3.6	2.85	1.65	1.45	1.05	.9	.2
29	1.65	3.45	2.85	1.45	1.45	1.05	.85	.2
30	1.45	2.9	2.75	1.35	1.45	1.05	.8	.....
31	.....	.....	.....	1.25	1.35	.....	.....	.....

NOTE.—Ice conditions during December.

Daily discharge, in second-feet, of Rio Grande near Creede, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	a 161	742	1,610	1,880	555	678	442	390
2	161	882	2,240	1,770	678	678	442	390
3	161	920	3,770	1,820	615	775	442	390
4	161	1,120	5,290	1,720	615	882	470	415
5	161	1,660	6,090	2,180	615	2,060	498	390
6	190	2,060	6,250	1,940	615	3,490	498	365
7	190	2,300	4,970	1,610	585	3,080	470	390
8	190	2,420	4,970	1,350	555	3,150	470	390
9	260	2,240	4,740	1,210	555	3,150	470	365
10	260	2,180	4,430	1,120	678	2,300	470	365
11	260	2,180	4,280	1,040	615	1,940	470	365
12	260	1,940	4,280	882	615	1,770	442	342
13	260	2,240	4,280	882	615	1,400	442	342
14	320	2,240	3,560	775	585	1,400	415	320
15	342	2,360	3,980	742	615	1,210	442	280
16	342	2,420	4,200	678	645	1,080	442	280
17	342	2,620	3,910	615	585	1,000	442	260
18	342	2,950	4,060	615	585	882	442	240
19	1,500	2,950	3,840	615	615	810	415	240
20	1,300	3,020	3,770	615	678	810	415	240
21	920	3,080	3,490	1,040	710	742	415	205
22	710	2,420	3,150	1,500	615	678	415	205
23	775	2,060	3,080	1,560	678	678	415	205
24	775	1,880	2,740	1,400	678	678	415	175
25	a 764	2,120	2,550	920	615	615	415	175
26	a 753	2,060	2,550	920	555	555	415	175
27	742	2,680	a 2,300	960	555	498	415	a 161
28	960	3,020	2,060	882	742	498	415	147
29	882	2,810	2,060	742	742	498	390	147
30	742	2,120	1,940	678	742	498	365	a 147
31	.....	a 1,860	.....	615	678	.....	a 378	.....

a Interpolated.

NOTE.—These discharges are based on a rating curve that is well defined below 2,880 second-feet.

Monthly discharge of Rio Grande near Creede, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April	1,500	161	506	30,100	A.
May	3,080	742	2,180	134,000	A.
June	6,250	1,610	3,680	219,000	B.
July	2,180	615	1,140	70,100	A.
August	742	555	630	38,700	A.
September	3,490	498	1,280	76,200	A.
October	498	365	435	26,700	A.
November	415	147	283	16,800	A.
The period				612,000	

RIO GRANDE NEAR DEL NORTE, COLO.

This station, which was established in the fall of 1889, was originally located about 2 miles above Del Norte, and records were taken more or less continuously until May 16, 1908, when a new station was established at the new state highway bridge about 6 miles above Del Norte, near the upper edge of the San Luis Valley. Some inflow takes place between the two points at certain seasons of the year, so that the mean annual flow at the state bridge is somewhat less than that at the old station.

As the station is above all the important diversions, the records show the amount of water available for irrigation and also the run-off from a drainage area of 1,400 square miles.

The new station is about 4 miles above the mouth of Los Pinos Creek, below the mouth of Wolf Creek, and about 10 miles below the mouth of the South Fork of the Rio Grande. The old station is just above the mouth of Los Pinos Creek.

The diversions from the Rio Grande and its tributaries above this point are all small and are used chiefly for meadow irrigation. They represent a very small percentage of the total flow of the stream. The largest ditch takes water out at Del Norte, about 2 miles below the original station. From this canal and many others diverted at various points nearly 300,000 acres of land in Colorado are now being irrigated from the Rio Grande.

Numerous small storage reservoirs under construction or in contemplation on the tributaries of the Rio Grande will store a large proportion of flood waters, but all the waters of the upper Rio Grande have been filed upon.

The flow of the stream is affected by ice for three or four months during the winter.

Practically no change was made in the datum of the gage at the old station during its maintenance, and this old gage is still being used by the water commissioner in that irrigation district of the State. The present chain gage is located on the highway bridge,

and the readings have no determined relation to those taken at the old gage. Discharge measurements are made from the downstream side of the bridge.

Very good results can be obtained at the present station except when ice conditions prevail.

Discharge measurements of Rio Grande near Del Norte, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 17	W. B. Freeman	181	733	3.58	3,730
June 21	do	193	878	4.27	4,960
Aug. 4	G. H. Russell	166	393	1.60	840
Oct. 1	do	167	383	1.40	752

Daily gage height, in feet, of Rio Grande near Del Norte, Colo., for 1909.

[James G. Duncan, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.8	2.85	3.05	1.55	1.85	1.4	1.0	0.95
2	.....	1.9.	3.2	2.95	1.5	1.75	1.35	1.05	1.0
3	.....	2.25	3.85	2.95	1.55	1.75	1.35	1.1	1.0
4	.....	2.65	4.4	2.9	1.55	1.85	1.35	1.05	1.0
5	.....	3.2	4.9	2.9	1.6	2.2	1.65	1.0	1.0
6	.....	3.5	5.15	3.15	1.5	4.3	1.7	1.0	.95
7	.....	3.65	5.0	2.9	1.5	4.25	1.7	1.0	.95
8	.....	4.0	4.9	2.6	1.4	3.45	1.65	1.0	1.0
9	.....	3.35	4.8	2.45	1.4	3.0	1.5	1.0	1.0
10	.....	3.3	4.7	2.3	1.35	2.75	1.5	1.05	1.05
11	.....	3.4	4.6	2.15	1.45	2.6	1.45	1.0	1.05
12	.....	3.35	4.4	2.05	1.4	2.45	1.45	.95	.95
13	.....	3.4	4.5	1.9	1.5	2.65	1.4	.95	1.0
14	.....	3.4	4.2	1.85	1.5	2.55	1.4	.9	1.0
15	.....	3.15	4.2	1.8	1.45	2.45	1.35	.9	1.0
16	.....	3.35	4.3	1.75	1.5	2.3	1.3	.8	.95
17	.....	3.55	4.25	1.7	1.5	2.2	1.3	.75	1.05
18	.....	3.95	4.3	1.65	1.45	2.1	1.3	.75	1.05
19	.....	4.05	4.25	1.6	1.45	2.0	1.25	.85	.....
20	.....	3.9	4.35	1.6	1.65	1.95	1.25	1.0	.....
21	.....	3.55	4.25	1.6	1.75	1.85	1.25	1.1	.....
22	.....	3.45	4.05	1.7	1.55	1.8	1.2	1.0	.....
23	.....	3.35	4.0	2.1	1.65	1.75	1.2	1.0	.....
24	.....	3.25	3.95	2.25	1.65	1.65	1.15	1.1	.....
25	1.7	3.1	3.8	2.05	1.8	1.6	1.15	1.1	.....
26	1.8	3.15	3.8	1.85	1.6	1.6	1.15	1.0	.....
27	2.1	3.55	3.5	2.1	1.65	1.55	1.1	1.0	.....
28	2.3	3.85	3 35	1.95	1.65	1.5	1.1	1.05	.....
29	2.25	3.4	3.2	1.75	2.05	1.45	1.1	1.0	.....
30	2.0	3.1	3.3	1.65	1.95	1.4	1.1	1.0	.....
31	.....	3.05	.....	1.6	1.9	.....	1.05	.....	.....

NOTE.—Probable ice conditions December 19–31.

Daily discharge, in second-feet, of Rio Grande near Del Norte, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1,060	2,420	2,720	832	1,110	710	425	398
2	.....	1,160	2,970	2,560	790	1,020	672	458	425
3	.....	1,560	4,140	2,560	832	1,020	672	490	425
4	.....	2,120	5,260	2,490	832	1,110	672	458	425
5	.....	2,970	6,320	2,490	875	1,490	920	425	425
6	.....	3,500	6,870	2,880	790	5,050	965	425	398
7	.....	3,770	6,540	2,490	790	4,940	965	425	398
8	.....	4,430	6,320	2,040	710	3,410	920	425	425
9	.....	3,230	6,100	1,830	710	2,640	790	425	425
10	.....	3,140	5,890	1,620	672	2,260	790	458	458
11	.....	3,320	5,680	1,430	750	2,040	750	425	458
12	.....	3,230	5,260	1,320	710	1,830	750	398	398
13	.....	3,320	5,470	1,160	790	2,120	710	398	425
14	.....	3,320	4,840	1,110	790	1,970	710	370	425
15	.....	2,880	4,840	1,060	750	1,830	672	370	425
16	.....	3,230	5,050	1,020	790	1,620	635	320	398
17	.....	3,590	4,940	965	790	1,490	635	295	458
18	.....	4,340	5,050	920	750	1,370	635	295	458
19	.....	4,530	4,940	875	750	1,260	598	345	400
20	.....	4,240	5,160	875	920	1,210	598	425	400
21	.....	3,590	4,940	875	1,020	1,110	598	490	350
22	.....	3,410	4,530	965	832	1,060	560	425	350
23	.....	3,230	4,430	1,370	920	1,020	560	425	350
24	.....	3,060	4,340	1,560	920	920	525	490	350
25	965	2,800	4,050	1,320	1,060	875	525	490	350
26	1,060	2,880	4,050	1,110	875	875	525	425	350
27	1,370	3,590	3,500	1,370	920	832	490	425	350
28	1,620	4,140	3,230	1,210	920	790	490	458	350
29	1,560	3,320	2,970	1,020	1,320	750	490	425	350
30	1,260	2,800	3,140	920	1,210	710	490	425	350
31	.....	2,720	.....	875	1,160	.....	458	.....	350

NOTE.—These discharges are based on a rating curve that is fairly well defined. Discharges December 19–31 estimated because of probable ice conditions.

Monthly discharge of Rio Grande near Del Norte, Colo., for 1909.

[Drainage area, 1,400 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
April 25–30	1,620	965	1,310	.936	0.21	15,600	A.
May	4,530	1,060	3,180	2.27	2.62	196,000	A.
June	6,870	2,420	4,770	3.41	3.80	284,000	A.
July	2,880	875	1,520	1.09	1.26	93,500	A.
August	1,320	672	864	.617	0.71	53,100	A.
September	5,050	710	1,660	1.19	1.33	98,800	A.
October	965	458	661	.472	.54	40,600	B.
November	490	295	418	.299	.33	24,900	B.
December	458	350	397	.284	.33	24,400	C.
The period	.....	.....	.....	.....	.....	831,000	

RIO GRANDE NEAR LOBATOS, COLO.

This station was established June 28, 1899, at the state bridge about 15 miles east of Antonito, in T. 33 N., R. 11 E.

The station is particularly important because it is located only a few miles above the Colorado-New Mexico line, and the records show

the amount of water passing from Colorado into New Mexico. The data are valuable also in connection with the proposed Engle reservoir of the United States Reclamation Service, and they will be used in the adjudication of all water rights along the Rio Grande which must eventually be made.

Conejos River enters about 7 miles above the station. A large part of the normal flow of the river is diverted above this station during the irrigation period. About 450,000 acres of land are irrigated, and more will be put under water in connection with some of the proposed reservoir systems above.

Ice usually forms on the river at this point for about three months during the winter, but occasionally open-water conditions prevail through part of this period.

The datum of the gage has not been changed since the station was established. The present chain gage is fastened to downstream handrail of bridge. Measurements are also made from downstream side of this bridge. Very good results have been obtained at this station. The river channel is quite permanent, being a gash cut in the lava rock. Occasionally during low water some sediment is deposited, but it is scoured out in times of flood.

Discharge measurements of Rio Grande near Lobatos, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 13[a]	J. B. Stewart	192	150	2.20	390
Mar. 26	do	224	402	1.90	480
May 16	Freeman and Stewart	251	990	4.60	3,960
June 22	W. B. Freeman	255	1,180	5.01	4,310
Aug. 2	G. H. Russell	196	256	1.40	170
Sept. 29	do	233	572	2.62	1,140
Nov. 12	J. B. Stewart	222	426	2.05	500
Dec. 19[1]	G. H. Russell	130	258	2.28	280

[a] Ice conditions.

Daily gage height, in feet, of Rio Grande near Lobatos, Colo., for 1909.

[Roman Mondragon, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.3	1.85	1.95	1.9	2.9	3.65	3.1	1.4	3.1	2.5	1.9	2.15
2	2.3	1.85	1.65	1.9	2.65	3.4	2.95	1.3	3.05	2.5	1.9	2.2
3	2.3	1.85	1.75	1.9	2.65	3.4	2.75	1.3	3.1	2.45	2.0	2.1
4	2.3	1.85	1.9	1.9	2.95	3.65	2.6	1.3	3.0	2.35	2.0	2.1
5	2.3	1.9	1.95	1.9	3.35	4.15	2.6	1.2	3.1	2.3	2.0	2.4
6	2.3	1.95	1.95	1.9	4.0	5.4	2.7	1.2	3.6	2.4	2.0	2.3
7	2.3	1.95	1.95	1.9	4.6	5.95	2.7	1.15	4.35	2.55	2.0	2.35
8	2.3	2.0	1.95	1.9	5.05	6.4	2.8	1.2	4.8	2.8	2.0	2.35
9	2.3	2.05	1.95	1.9	5.15	6.65	2.6	1.25	4.9	2.8	2.0	2.4
10	2.3	2.05	2.05	1.9	5.2	6.7	2.4	1.3	5.0	2.8	2.0	2.4
11	2.3	2.05	1.95	1.9	5.05	6.55	2.3	1.4	4.7	2.7	2.0	2.4
12	2.3	2.05	2.1	1.9	4.95	6.35	2.1	1.45	4.35	2.55	2.0	2.3
13	2.3	2.2	2.05	1.85	4.85	6.1	1.9	1.4	4.1	2.55	2.1	2.3
14	2.3	2.15	1.85	1.85	4.75	5.85	1.8	1.4	4.1	2.55	2.1	2.3
15	2.35	2.15	1.95	2.2	4.85	5.65	1.6	1.4	3.95	2.5	2.1	2.4

Daily gage height, in feet, of Rio Grande near Lobatos, Colo., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	2.35	2.15	2.05	2.2	4.8	5.35	1.5	1.4	3.9	2.4	2.1	2.3
17	2.35	2.05	2.05	2.2	4.4	4.9	1.4	1.4	3.75	2.4	2.0	2.15
18	2.35	1.95	1.95	2.45	4.5	5.0	1.3	1.6	3.6	2.35	1.95	2.3
19	2.35	1.95	1.95	3.4	4.85	5.1	1.3	1.7	3.5	2.25	1.9	2.3
20	2.3	1.95	1.95	4.0	5.0	5.2	1.3	1.8	3.4	2.25	1.85	2.1
21	2.3	1.95	1.95	4.05	5.1	5.15	1.1	1.9	3.25	2.2	1.95	2.3
22	2.3	2.05	1.95	3.65	5.0	5.0	1.1	1.9	3.15	2.2	2.1	2.15
23	2.25	2.05	1.95	3.35	4.55	4.85	1.1	2.5	3.0	2.2	2.1	2.35
24	2.2	2.05	1.95	3.0	4.3	4.55	1.1	2.2	2.85	2.15	2.2	2.15
25	2.1	2.05	1.95	2.8	3.95	4.35	1.15	2.25	2.85	2.1	2.2	2.05
26	2.0	2.05	1.95	2.7	3.7	4.2	1.8	2.4	2.8	2.1	2.2	2.3
27	2.0	2.05	1.95	2.6	3.65	4.0	2.0	2.4	2.7	2.1	2.2	2.2
28	1.9	2.05	1.95	2.65	3.85	3.85	1.75	2.5	2.7	2.1	2.1	2.3
29	1.85	.....	1.95	2.85	4.1	3.65	1.6	2.65	2.65	2.0	2.1	2.2
30	1.85	.....	1.95	3.15	4.1	3.45	1.6	2.9	2.6	1.95	2.2	2.2
31	1.85	.....	1.9	.....	3.75	.....	1.5	3.0	.....	1.95	.....	2.2

NOTE.—Probable ice conditions January 1 to March 1 and December 5–31.

Daily discharge, in second-feet, of Rio Grande near Lobatos, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	400	410	350	460	1,470	2,480	1,730	205	1,730	1,000	460	660
2	400	410	320	460	1,170	2,130	1,540	165	1,660	1,000	460	705
3	400	410	372	460	1,170	2,130	1,290	165	1,730	950	530	615
4	400	420	460	460	1,540	2,480	1,110	165	1,600	850	530	615
5	400	420	495	460	2,060	3,220	1,110	135	1,730	800	530	600
6	400	440	495	460	2,990	5,200	1,230	135	2,410	900	530	600
7	400	440	495	460	3,920	6,120	1,230	122	3,530	1,060	530	600
8	400	440	495	460	4,630	6,920	1,350	135	4,230	1,350	530	570
9	400	450	495	460	4,790	7,370	1,110	150	4,390	1,350	530	570
10	400	430	572	460	4,870	7,460	900	165	4,550	1,350	530	570
11	400	430	495	460	4,630	7,190	800	205	4,070	1,230	530	550
12	400	400	615	460	4,470	6,830	615	228	3,530	1,060	530	550
13	400	390	572	430	4,310	6,380	460	205	3,140	1,060	615	500
14	400	380	430	430	4,150	5,940	400	205	3,140	1,060	615	500
15	400	380	495	705	4,310	5,610	295	205	2,920	1,000	615	450
16	400	380	572	705	4,230	5,110	250	205	2,840	900	615	450
17	400	370	572	705	3,600	4,390	205	205	2,630	900	530	400
18	400	370	495	950	3,760	4,550	165	295	2,410	850	495	300
19	400	370	495	2,130	4,310	4,710	165	345	2,270	752	460	280
20	400	370	495	2,990	4,550	4,870	165	400	2,130	752	430	300
21	400	380	495	3,060	4,710	4,790	110	460	1,920	705	495	300
22	400	380	495	2,480	4,550	4,550	110	460	1,800	705	615	300
23	400	380	495	2,060	3,840	4,310	110	1,000	1,600	705	615	300
24	400	380	495	1,600	3,450	3,840	110	705	1,410	660	705	300
25	400	380	495	1,350	2,920	3,530	122	752	1,410	615	705	300
26	400	380	495	1,230	2,560	3,300	400	900	1,350	615	705	300
27	400	380	495	1,110	2,480	2,990	530	900	1,230	615	705	300
28	400	380	495	1,170	2,770	2,770	372	1,000	1,230	615	615	300
29	400	.....	495	1,410	3,140	2,480	295	1,170	1,170	530	615	300
30	400	.....	495	1,800	3,140	2,200	295	1,470	1,110	495	705	300
31	400	.....	460	.....	2,630	.....	250	1,600	.....	495	.....	300

NOTE.—These discharges are based on a rating curve that is well defined below 4,550 second-feet. Discharges estimated January 1 to March 1 and December 5–31, due to probable ice conditions.

Monthly discharge of Rio Grande near Lobatos, Colo., for 1909.

[Drainage area, 7,700 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	400	400	400	0.052	0.06	24,600	C.
February	450	370	398	.052	.05	22,100	C.
March	615	320	490	.064	.07	30,100	A.
April	3,060	430	1,060	.138	.15	63,100	A.
May	4,870	1,170	3,460	.449	.52	213,000	A.
June	7,460	2,130	4,520	.587	.65	269,000	A.
July	1,730	110	607	.079	.09	37,300	A.
August	1,600	122	466	.061	.07	28,700	A.
September	4,550	1,110	2,360	.306	.34	140,000	A.
October	1,350	495	869	.113	.13	53,400	A.
November	705	430	569	.074	.08	33,900	A.
December	705	300	441	.057	.07	27,100	C.
The year	7,460	110	1,300	.169	2.28	942,000	

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

This station was first established February 1, 1895, to obtain data for use in connection with irrigation enterprises. Since that date records have been obtained at various intervals. It is located at the Denver & Rio Grande Railroad bridge, which crosses the river one-eighth mile east of Rio Grande. The bridge is about 9 miles below Espanola, 2 miles below San Ildefonso, an Indian pueblo 3½ miles above Buckman lumber camp. No important tributaries enter in the immediate vicinity.

Beginning in the vicinity of Del Norte, Colo., many large and small ditches divert water for irrigation.

The original gage was located on the left bank, about 200 feet above the bridge, and measurements were made from a cable which was located just above the bridge. On March 30, 1904, a vertical rod gage was established at a new datum on the downstream side of the railroad pier. The station was discontinued December 31, 1905, and reestablished June 22, 1909, the same gage being used as in 1904. The cable had been removed, and measurements during 1909 were made from the bridge. Gage heights are not affected by ice. Since 1904 the datum has remained practically unchanged.

Discharge measurements of Rio Grande near Buckman, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 22	J. B. Stewart	158	1,160	5.75	6,860
Aug. 2	do	103	253	2.15	603
Aug. 27	do	.....	462	3.70	2,040

NOTE.—These measurements are liable to be considerably in error because of the skew of the bridge and cross currents.

[1] Formerly known as near San Ildefonso.

Daily gage height, in feet, of Rio Grande near Buckman, N. Mex., for 1909.

[Aaron Martinez, observer.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	4.7	2.2	4.0	3.35	2.3	2.05
2	.....	4.35	2.0	4.2	3.0	2.2	2.25
3	.....	4.2	2.2	4.1	2.9	2.25	2.25
4	.....	4.2	2.35	4.0	2.9	2.25	2.35
5	.....	4.0	2.75	4.75	2.8	2.1	2.5
6	.....	4.35	2.85	6.0	2.85	2.2	2.45
7	.....	4.1	2.40	5.85	3.55	2.1	2.35
8	.....	3.95	2.25	5.95	3.75	2.05	2.25
9	.....	4.05	2.1	6.15	3.25	2.0	2.15
10	.....	3.9	2.0	6.1	3.45	1.9	1.95
11	.....	3.5	2.05	6.3	3.65	1.8	2.0
12	.....	3.35	2.3	5.95	3.65	1.85	1.85
13	.....	3.25	2.4	5.75	3.50	1.75	2.05
14	.....	3.15	2.4	5.55	3.45	1.8	2.1
15	.....	3.0	2.5	5.35	3.35	1.7	2.0
16	.....	3.3	2.5	5.25	3.25	1.75	1.95
17	.....	3.1	2.6	5.15	3.25	1.75	1 85
18	.....	2.8	3.2	4.95	3.2	1.85	1.9
19	.....	2.6	3.75	4.75	2.95	1.8	1.95
20	.....	2.15	3.95	4.55	2.85	1.7	1.95
21	.....	2.05	5.8	4.45	2.8	1.75	2.05
22	.....	2.2	3.85	4.3	2.7	1.7	2.15
23	6.65	2.4	3.55	4.2	2.65	1.75	2.25
24	6.4	2.25	3.8	3.95	2.6	2.05	2.15
25	5.95	2.5	3.7	3.85	2.5	2.05	2.05
26	5.8	2.7	3.95	3.65	2.45	2.05	2.25
27	5.65	2.6	3.85	3.50	2.4	2.2	2.15
28	5.4	2.4	3.75	3.40	2.5	2.05	2.05
29	5.15	2.5	3.85	3.5	2.3	2.2	2.15
30	4.85	2.25	3.75	3.45	2.3	2.05	2.05
31	.....	2.15	4.15	.....	2.3	.....	1.95

Daily discharge, in second-feet, of Rio Grande near Buckman, N. Mex., for 1909.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3,210	636	2,370	1,670	709	533
2	.....	2,780	500	2,600	1,320	636	672
3	.....	2,600	636	2,480	1,220	672	672
4	.....	2,600	747	2,370	1,220	672	747
5	.....	2,370	1,080	3,280	1,130	566	865
6	.....	2,780	1,180	5,140	1,180	636	825
7	.....	2,480	785	4,880	1,880	566	747
8	.....	2,320	672	5,060	2,100	533	672
9	.....	2,420	566	5,400	1,570	500	601
10	.....	2,260	500	5,310	1,780	440	470
11	.....	1,830	533	5,670	1,990	386	500
12	.....	1,670	709	5,060	1,990	413	413
13	.....	1,570	785	4,720	1,830	362	533
14	.....	1,470	785	4,400	1,780	386	566
15	.....	1,320	865	4,100	1,670	337	500
16	.....	1,620	865	3,950	1,570	362	470
17	.....	1,420	950	3,810	1,570	362	413
18	.....	1,130	1,520	3,540	1,520	413	440
19	.....	950	2,100	3,280	1,270	386	470
20	.....	601	2,320	3,020	1,180	337	470
21	.....	533	4,800	2,900	1,130	362	533
22	.....	636	2,210	2,720	1,040	337	601
23	6,330	785	1,880	2,600	994	362	672
24	5,850	672	2,150	2,320	950	533	601
25	5,060	865	2,040	2,210	865	533	533
26	4,800	1,040	2,320	1,990	825	533	672
27	4,560	950	2,210	1,830	785	636	601
28	4,170	785	2,100	1,720	865	533	533
29	3,810	865	2,210	1,830	709	636	601
30	3,400	672	2,100	1,780	709	533	533
31	.....	601	2,540	.....	709	.....	470

NOTE.—These discharges are based on a rating curve that is fairly well defined between 100 and 4,500 second-feet.

Monthly discharge of Rio Grande near Buckman, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
June 23–30	6,330	3,400	4,750	75,400	B.
July	3,210	533	1,540	94,700	B.
August	4,800	500	1,460	89,800	B.
September	5,670	1,720	3,410	203,000	B.
October	2,100	709	1,320	81,200	B.
November	709	337	489	29,100	B.
December	865	413	578	35,500	B.
The period				609,000	

RIO GRANDE NEAR SAN MARCIAL, N. MEX.

On August 8, 1889, a station was established near San Marcial and a measurement made giving a discharge of 19 second-feet. Soon after this date the gage was destroyed and the station abandoned until January 29, 1895, when it was reestablished at the Atchison, Topeka & Santa Fe Railway bridge, which crosses the river 1 mile south of San Marcial, N. Mex. The inclined gage, installed in 1895, was carried away in 1896 and a wire gage put in its place at the same datum. This was soon abandoned and gage heights were obtained by measuring, by means of a graduated rod, the distance from the bridge deck to the water surface.

Since January 1, 1901, the station has been maintained by the United States section of the International Boundary Commission.

The channel is sandy and very shifting. During high stages bridge piers interfere with the accuracy of results.

No important tributaries enter in the immediate vicinity.

Discharge measurements of Rio Grande near San Marcial, N. Mex., in 1909.

[By Geo. W. King.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	181	10.5	564	Mar. 12	209	10.6	1,037
5	150	10.4	649	15	216	10.5	836
8	176	10.4	581	18	158	10.4	643
11	179	10.4	634	21	149	10.4	698
14	178	10.4	736	24	166	10.2	708
17	163	10.5	723	27	191	10.4	913
20	195	10.4	747	30	224	10.6	1,082
23	198	10.5	774	Apr. 2	151	10.5	752
26	155	10.5	686	6	193	10.6	854
29	136	10.3	634	9	241	10.6	1,127
31	158	10.5	753	12	230	10.4	847
Feb. 3	147	10.4	591	15	237	10.6	867
6	147	10.5	697	18	392	11.0	1,141
9	152	10.5	666	21	716	11.9	4,074
12	161	10.5	688	24	659	12.0	3,696
15	152	10.3	549	27	563	11.3	2,904
18	150	10.5	631	30	480	11.25	2,737
22	190	10.6	657	May 3	508	11.5	3,135
25	172	10.6	615	6	525	11.1	2,834
28	144	10.4	529	9	1,058	12.5	6,340
Mar. 3	126	10.5	495	12	1,360	12.2	6,976
6	259	10.8	1,205	15	1,266	12.4	7,242
9	200	10.6	942	18	1,082	12.1	6,503

Discharge measurements of Rio Grande near San Marcial, N. Mex., in 1909—Continued.

Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*
May 21	1,093	12.2	6,622
24	1,090	12.3	6,751
27	912	11.7	5,027
30	714	11.4	3,928
June 2	711	11.5	4,139
5	664	11.3	3,175
8	860	12.1	4,937
11	1,353	12.7	7,887
14	1,200	12.5	7,585
17	980	12.0	5,874
20	800	11.7	4,497
23	830	11.8	4,346
26	788	11.5	4,121
29	664	11.1	3,156
July 2	602	10.9	2,010
5	391	10.5	1,398
8	370	10.2	1,033
11	245	10.0	768
14	198	9.9	665
17	211	9.9	434
20	122	9.4	238
23	186	9.7	401
26	87	9.4	235
27	232	10.05	756
30	59	8.8	112
Aug. 3	80	9.0	290
6	48	8.8	146
9	56	8.9	185
12	64	9.2	241
15	205	10.2	736
18	68	9.0	232
21	222	10.3	995
23	480	11.1	2,688
26	363	10.4	1,708
30	458	10.6	1,759
Sept. 2	295	10.3	1,086
5	343	10.6	1,457
6	401	11.3	2,488
9	814	11.6	4,225
12	669	12.0	4,199
15	524	11.4	3,316
18	564	11.4	3,001
21	545	11.2	2,876
24	431	10.8	1,832
27	387	10.7	1,614
30	345	10.6	1,176
Oct. 3	271	10.5	914
7	198	10.4	764
10	507	11.1	2,029
13	251	10.8	1,317
16	431	10.7	1,280
19	334	10.7	1,138
22	215	10.6	806
25	231	10.6	738
28	198	10.6	689
31	192	10.5	616
Nov. 3	294	10.5	623
9	202	10.5	590
12	175	10.5	584
15	207	10.5	539
18	325	10.6	778
21	259	10.7	660
24	235	10.65	618
27	328	10.85	973
Dec. 1	267	10.9	883
4	253	10.65	875
7	245	10.85	936
10	197	10.7	582
13	203	10.7	515
16	209	10.85	604

NOTE.—River frozen over from December 18 to December 31, 1909.

Daily gage height, in feet, of Rio Grande near San Marcial, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.45	10.45	10.45	10.5	11.4	11.5	10.9	8.55	10.5	10.55	10.5	10.9
2	10.5	10.4	10.5	10.5	11.4	11.5	10.9	8.35	10.3	10.5	10.5	10.85
3	10.4	10.4	10.5	10.5	11.4	11.55	10.75	8.65	10.65	10.5	10.5	10.8
4	10.4	10.4	10.55	10.55	11.0	11.6	10.6	9.0	10.5	10.45	10.6	10.65
5	10.4	10.4	10.7	10.6	10.8	11.4	10.5	9.05	10.6	10.4	10.45	10.7
6	10.5	10.45	10.8	10.6	10.95	11.2	10.4	8.8	12.05	10.4	10.4	10.8
7	10.5	10.35	10.8	10.65	11.55	11.2	10.3	8.95	13.3	10.4	10.4	10.85
8	10.4	10.4	10.7	10.7	12.1	11.6	10.2	9.0	12.5	10.4	10.35	10.9
9	10.4	10.45	10.6	10.6	12.5	12.4	10.5	8.95	11.6	10.4	10.5	10.75
10	10.55	10.55	10.55	10.5	12.65	12.65	10.2	8.95	11.95	11.15	10.5	10.7
11	10.45	10.5	10.55	10.4	12.5	12.65	10.0	9.05	12.2	10.75	10.5	10.6
12	10.4	10.45	10.6	10.4	12.3	12.7	10.0	9.0	12.05	10.8	10.4	10.55
13	10.4	10.5	10.6	10.5	12.1	12.7	10.05	8.95	11.8	10.8	10.45	10.65
14	10.35	10.4	10.5	10.6	12.1	12.6	9.95	9.75	11.7	10.8	10.5	10.95
15	10.4	10.3	10.5	10.6	12.3	12.25	9.9	9.9	11.4	10.8	10.5	10.95
16	10.35	10.3	10.5	10.6	12.25	12.0	9.9	9.4	11.35	10.7	10.45	10.9
17	10.5	10.4	10.4	10.6	12.2	11.95	9.9	9.45	11.35	10.7	10.45	10.75
18	10.4	10.5	10.4	10.9	12.05	11.85	9.85	9.1	11.4	10.7	10.55	10.7
19	10.45	10.4	10.5	11.15	12.1	11.7	9.75	9.2	11.35	10.7	10.65	10.9
20	10.45	10.4	10.6	11.3	12.05	11.7	9.45	9.1	11.3	10.7	10.65	10.7
21	10.5	10.45	10.45	11.85	12.15	11.9	9.4	10.4	11.2	10.6	10.7	10.7
22	10.5	10.55	10.3	12.0	12.25	11.8	9.35	11.7	10.95	10.6	10.7	10.7
23	10.5	10.55	10.2	11.95	12.3	11.8	9.55	11.25	10.8	10.6	10.65	10.7
24	10.4	10.6	10.2	12.15	12.3	11.65	9.4	10.55	10.8	10.6	10.6	10.7
25	10.45	10.6	10.35	11.8	12.25	11.45	9.05	10.1	10.85	10.6	10.7	10.7
26	10.45	10.5	10.4	11.45	12.15	11.5	10.1	10.3	10.65	10.6	10.75	10.7
27	10.5	10.5	10.4	11.3	11.85	11.35	10.0	10.6	10.7	10.6	10.85	10.7
28	10.35	10.4	10.5	10.9	11.7	11.2	9.6	10.4	10.6	10.6	10.95	10.7
29	10.35	.....	10.5	10.7	11.3	11.1	9.1	10.35	10.6	10.6	11.05	10.85
30	10.35	.....	10.6	11.0	11.3	10.9	8.85	10.4	10.6	10.5	10.9	11.15
31	10.5	.....	10.6	.....	11.5	.....	8.8	10.5	.....	10.5	.....	11.4

NOTE.—River frozen over from December 18 to 31.

Daily discharge, in second-feet, of Rio Grande near San Marcial, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	555	685	525	870	2,980	4,130	2,260	60	1,550	1,060	620	a 885
2	a 565	620	525	a 750	2,980	a4,140	a2,010	20	a1,090	940	620	900
3	560	a 590	a 495	750	a2,980	4,050	1,780	a 145	1,520	a 915	a 625	915
4	605	605	680	800	2,760	3,960	1,550	290	1,330	840	680	a 875
5	a 650	620	970	855	2,610	a3,370	a1,400	325	a1,460	765	585	890
6	675	a 665	a1,200	a 855	a2,720	2,960	1,280	a 145	a5,110	765	550	920
7	655	595	1,200	995	3,960	2,960	1,150	205	9,490	a 765	545	a 935
8	a 580	615	1,070	1,140	5,340	a3,840	a1,030	225	7,010	765	510	880
9	580	a 635	a 940	a1,130	a6,340	6,220	1,420	a 205	a4,230	765	a 590	700
10	670	705	935	985	7,050	7,350	1,030	185	4,650	a2,150	590	a 580
11	a 645	680	965	845	7,160	a7,740	a 770	205	4,880	1,200	590	500
12	670	a 660	a1,040	a 845	a7,180	7,890	770	a 165	a4,300	1,320	a 555	450
13	700	690	1,000	885	6,840	7,890	820	165	3,900	a1,320	540	a 485
14	a 715	620	870	925	6,840	a7,730	a 715	515	3,760	1,320	555	665
15	720	a 550	a 835	a 865	a7,110	6,760	590	a 590	a3,320	1,320	a 540	665
16	680	550	805	865	6,870	5,940	510	400	3,140	a1,280	570	a 635
17	a 725	590	675	865	6,750	a5,720	a 435	420	3,030	1,230	630	545
18	705	a 630	a 645	a1,070	a6,380	5,260	415	a 275	a3,000	1,190	a 750	515
19	745	605	745	1,630	6,500	4,660	375	350	2,970	a1,140	750	635
20	a 765	605	845	2,120	6,440	a4,500	a 255	290	2,940	1,090	690	515
21	775	620	a 735	a3,910	a6,560	4,850	220	a1,050	a2,880	855	a 660	515
22	775	a 645	680	4,080	6,690	4,480	200	3,950	2,220	a 805	660	515
23	a 775	615	665	3,790	6,750	a4,350	a 315	a3,000	1,830	785	620	515
24	705	630	a 710	a4,000	a6,750	4,230	280	1,920	a1,830	760	a 575	515
25	695	a 615	825	3,470	6,610	4,080	140	1,290	1,940	a 740	680	515
26	a 665	570	885	3,070	6,320	a4,120	a 800	a1,570	1,510	720	745	515
27	685	570	a 915	a2,900	a5,460	3,760	a 700	1,760	a1,610	705	a 870	515
28	645	a 530	995	2,500	4,860	3,400	520	1,710	1,330	a 690	1,040	515
29	a 645	.....	995	2,300	3,890	a3,160	260	1,700	1,260	690	1,100	665
30	665	.....	a1,080	a2,540	a3,720	2,700	a 130	a1,710	a1,180	615	920	965
31	a 755	.....	1,080	.....	4,120	.....	110	1,710	.....	a 615	.....	1,210

a Date of measurement.

Monthly discharge of Rio Grande near San Marcial, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	775	555	676	41,554
February	705	530	618	34,334
March	1,200	495	856	52,622
April	4,080	750	1,753	104,340
May	7,180	2,610	5,468	336,238
June	7,890	2,700	4,873	289,983
July	2,260	110	782	48,080
August	3,950	20	856	52,661
September	9,490	1,090	3,009	179,048
October	2,150	615	972	59,742
November	1,100	510	665	39,580
December	1,210	450	679	41,752
The year	9,490	20	1,767	1,279,934

RIO GRANDE NEAR EL PASO, TEX.

This station was located at the pumping house of the smelter company, 3 miles north of El Paso, Tex. The bed of the stream at that point is composed of mud and is constantly shifting and changing. On May 1, 1897, the station was placed under the charge of W. W. Follett, consulting engineer, International Boundary Commission, and by him removed 1 mile farther up the river to Courchesne's limekiln.

Although the section is unstable and subject to overflow, it is still the best site for a station in the vicinity of El Paso, as the entire bed is constantly shifting for many miles above and below. On this account frequent discharge measurements are made in order to closely estimate the daily discharge.

River heights were measured at the masonry pump-foundation pier. As the pier was torn down in October, 1902, an inclined wooden gage was established some 60 feet upstream. This has since been moved about 300 feet downstream.

Discharge measurements of Rio Grande near El Paso, Tex., in 1909.

[By T. A. Stiles and W. L. Follett.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	204	7.9	443	June 28	604	10.4	3,175
5	197	7.9	418	30	488	9.9	2,170
9	150	7.7	276	July 19	47	6.9	76
14	172	8.0	370	22	33	6.4	28
16	214	8.1	509	25	30	6.05	15
19	161	8.0	359	Aug. 21	21	6.1	23
Feb. 5	192	8.25	363	24	16	6.0	14
9	159	8.1	390	25	402	9.35	1,864
12	187	8.3	476	28	219	8.25	741
15	176	8.2	392	31	250	8.5	1,070
18	116	7.8	224	Sept. 3	205	8.0	584
21	169	8.1	329	6	187	7.95	593
25	84	7.5	145	9	991	11.95	5,574
28	87	7.3	163	12	727	11.45	4,480
Mar. 3	94	7.4	159	15	577	10.5	3,289
6	22	7.1	33	18	463	10.0	2,360
9	180	8.1	470	22	364	9.4	1,674
13	325	9.15	1,084	24	258	8.9	1,107
16	274	8.8	858	27	265	8.75	1,059
20	108	7.6	230	30	237	8.2	690
24	143	8.1	433	Oct. 3	220	8.4	869
28	125	8.05	358	6	147	7.9	431
31	103	7.8	186	9	151	7.8	342
Apr. 3	107	7.8	200	12	309	9.2	1,573
6	75	7.4	113	16	207	8.3	754
9	42	6.85	49	18	218	8.4	604
12	226	8.6	721	21	221	8.4	705
15	114	7.8	267	24	153	8.2	516
18	130	7.9	260	27	152	8.1	481
21	92	7.6	129	29	151	8.1	486
24	657	11.25	3,834	31	124	8.0	416
27	605	10.55	3,089	Nov. 3	170	8.1	401
30	342	9.5	1,625	6	142	7.95	336
May 3	446	10.2	2,238	9	132	7.75	299
6	404	9.85	2,028	12	128	7.6	274
9	441	10.1	2,265	15	152	7.9	364
12	1,060	12.3	6,434	18	146	7.8	358
15	1,027	12.1	6,044	21	136	7.7	288
18	1,011	12.2	6,548	24	243	8.3	555
21	848	11.7	5,072	27	174	8.0	399
26	959	12.1	5,755	Dec. 1	225	8.2	506
30	652	10.7	3,580	5	243	8.4	779
June 3	641	10.6	3,194	9	217	8.4	463
6	492	10.0	2,461	12	176	8.2	364
9	525	10.1	2,710	15	127	7.8	233
12	980	11.9	5,531	19	230	8.3	475
15	967	12.1	6,168	24	111	7.5	191
19	886	11.7	5,118	28	85	7.2	146
22	642	10.7	3,670	31	58	6.95	101
25	665	10.9	3,599				

Daily gage height, in feet, of Rio Grande near El Paso, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.85	8.35	7.8	7.75	9.3	10.35	9.85	.....	8.3	8.2	8.0	8.1
2	7.9	8.35	7.75	7.7	9.5	10.5	9.6	.....	8.3	8.1	8.0	8.35
3	7.95	8.2	7.45	7.9	10.1	10.55	9.15	.....	8.05	8.15	8.05	8.45
4	7.9	8.25	7.25	7.8	10.3	10.5	9.3	.....	7.9	8.25	7.9	8.25
5	7.9	8.3	7.15	7.75	9.85	10.3	8.95	.....	7.85	8.05	7.8	8.45
6	7.9	8.05	7.1	7.4	9.8	10.0	9.0	.....	8.0	7.9	7.8	8.5
7	7.9	7.9	7.05	7.4	9.6	9.85	8.9	.....	8.1	7.75	7.95	8.3
8	7.85	7.8	6.95	7.2	9.6	9.6	8.45	.....	8.95	7.8	7.75	8.3
9	7.7	8.0	7.8	7.0	10.3	9.9	8.3	.....	11.75	7.85	7.7	8.35
10	7.5	8.1	8.4	8.15	11.1	10.6	8.25	.....	11.75	7.7	7.65	8.45
11	7.2	8.2	8.3	8.85	11.95	11.35	7.95	.....	11.15	7.85	7.7	8.5
12	7.85	8.25	8.85	8.5	12.2	11.9	7.8	.....	11.65	8.55	7.6	8.25
13	7.95	8.05	9.2	8.05	12.5	12.15	7.85	.....	11.05	8.75	7.65	8.2
14	8.0	8.1	9.0	7.85	12.5	12.15	7.7	.....	10.5	8.3	7.8	7.95
15	8.35	8.2	9.0	7.9	12.2	12.15	7.5	.....	10.5	8.3	7.9	7.8
16	8.1	8.2	8.85	7.8	11.85	12.15	8.0	.....	10.25	8.3	7.9	7.7
17	8.0	8.0	8.85	8.0	12.0	12.2	7.55	.....	10.1	8.3	7.8	7.65
18	8.15	7.85	8.55	7.95	12.1	11.8	7.3	.....	9.9	8.35	7.75	8.05
19	8.1	7.75	8.05	8.15	12.05	11.6	6.95	.....	9.8	8.3	7.7	8.3
20	7.95	7.7	7.8	7.8	11.8	11.5	6.5	.....	9.7	8.2	7.75	8.15
21	7.75	8.1	7.75	7.8	11.7	11.1	6.6	6.15	9.4	8.35	7.7	7.8
22	7.65	8.1	7.9	9.1	11.65	10.75	6.55	6.1	9.4	8.4	8.0	7.6
23	7.65	8.0	8.0	10.3	11.6	10.7	6.15	6.05	9.2	8.35	8.25	7.55
24	8.05	7.7	8.05	11.05	11.95	10.7	6.1	6.05	8.95	8.15	8.25	7.5
25	7.95	7.55	8.6	11.2	12.1	10.85	6.05	10.51	8.85	8.0	7.95	7.5
26	7.9	7.45	8.4	11.2	12.05	10.75	5.95	9.4	8.8	8.15	7.85	7.45
27	7.95	7.4	8.2	10.75	12.0	10.65	5.9	8.2	8.75	8.15	8.0	7.3
28	7.95	7.3	8.1	10.1	11.4	10.45	.....	8.05	8.35	8.05	7.75	7.2
29	7.95	.....	8.1	9.8	11.0	10.15	.....	8.8	8.25	8.05	7.8	7.15
30	7.9	.....	7.95	9.45	10.6	9.9	.....	8.65	8.2	8.15	7.85	7.1
31	8.05	.....	7.8	.....	10.4	.....	.....	8.45	.....	8.0	.....	7.0

NOTE.—No flow July 28 to August 20.

Daily discharge, in second-feet, of Rio Grande near El Paso, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	425	425	365	175	1,450	3,040	2,030	.....	875	690	400	a 460
2	a 445	425	340	165	1,620	3,130	1,710	.....	875	600	380	655
3	470	335	a 185	a 230	a2,150	a3,160	1,170	.....	a 635	a 645	a 380	760
4	425	365	95	200	2,300	3,070	1,350	.....	535	735	340	630
5	a 420	a 395	55	190	2,030	2,830	930	.....	520	560	310	a 820
6	420	305	a 35	a 115	a2,000	a2,460	990	.....	a 625	a 430	a 310	760
7	420	265	25	115	1,790	2,280	890	.....	780	300	335	560
8	380	250	10	90	1,790	1,980	530	.....	1,840	340	300	480
9	a 275	a 350	a 340	a 65	a2,640	a2,420	440	.....	a5,140	a 385	a 290	a 435
10	195	390	645	545	4,160	3,500	415	.....	5,140	255	280	490
11	75	435	590	810	5,770	4,670	295	.....	3,820	385	290	515
12	315	a 455	915	a 680	a6,240	a5,530	250	.....	a4,880	a1,000	a 275	a 390
13	350	360	a1,110	410	6,830	6,110	265	.....	3,980	1,160	290	365
14	a 370	365	985	295	6,830	6,190	220	.....	3,290	755	335	280
15	620	a 390	985	a 320	a6,250	a6,270	160	.....	a3,290	755	a 365	a 235
16	a 510	390	a 890	255	5,640	6,300	310	.....	2,820	a 755	375	215
17	420	310	885	305	6,040	6,430	175	.....	2,540	635	345	205
18	480	a 245	730	a 275	a6,350	5,380	125	.....	a2,250	a 560	a 330	375
19	a 420	205	465	370	6,090	a4,970	a 80	.....	2,130	550	310	a 475
20	345	190	a 335	215	5,430	4,830	30	.....	2,020	490	320	425
21	290	a 330	290	a 215	a5,070	4,250	40	a 30	1,670	660	a 290	300
22	260	330	350	1,640	4,990	a3,740	a 35	25	a1,670	705	420	225
23	260	300	395	2,880	4,900	3,550	20	20	1,450	660	530	210
24	350	205	a 415	a3,630	5,500	3,440	15	a 20	a1,170	a 500	a 535	a 190
25	330	a 160	735	3,780	5,750	a3,530	a 15	a2,680	1,090	450	375	190
26	320	155	600	3,780	a5,670	3,470	10	1,910	1,070	500	320	180
27	330	165	465	a3,300	5,600	3,380	5	690	a1,060	a 500	a 400	160
28	330	a 165	a 395	2,460	4,670	a3,210	.....	a 540	790	460	300	a 145
29	330	.....	395	2,050	4,050	2,670	.....	1,420	725	a 465	325	135
30	320	.....	290	a1,460	a3,430	a2,170	.....	1,250	a 690	520	345	130
31	355	.....	a 185	.....	3,120	.....	.....	a1,010	.....	a 415	.....	a 110

a Date of measurement.

NOTE.—No flow July 28 to August 20.

Monthly discharge of Rio Grande near El Paso, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	620	75	363	22,324
February	455	155	309	17,177
March	1,110	10	468	28,760
April	3,780	65	1,034	61,527
May	6,830	1,450	4,392	270,050
June	6,430	1,980	3,932	233,970
July	2,030	0	403	24,803
August	2,680	0	310	19,031
September	5,140	520	1,979	117,759
October	1,160	255	575	35,345
November	535	275	347	20,268
December	820	110	371	22,820
The year	6,830	0	1,207	873,834

RIO GRANDE ABOVE PRESIDIO, TEX.

This station was established April 4, 1900, by the International Boundary Commission. It was originally located 9 miles above Presidio and 18 miles above the mouth of Rio Conchos, one of the principal tributaries of the Rio Grande, and about 200 miles below El Paso. The station was in a straight stretch of the river, but in the bight of a long bend. In 1905 the river began to erode a cut-off across this bend, and the spring flood of 1905 deepened this channel to such an extent that more water passed through it than through the station, and it became necessary to abandon the location. In September, 1905, the station was moved 8 miles farther upstream and rebuilt. Its location was far enough above the mouth of Rio Conchos to be free from the effects of backwater from that stream. Caving banks necessitated the abandonment of this upper site, and the station was moved back to the original site, at the Haciendita, July 6, 1909. A new gage was established whose readings are not comparable with the old ones. Changes of river bed have closed the crevasse which threatened in 1905, and frequent discharge measurements are necessary to determine closely the daily discharge.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande above Presidio, Tex., in 1909.

[By W. T. Millington.]

Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*
Jan. 3	133	3.7	163
6	80	3.5	105
9	83	3.6	99
12	91	3.55	129
15	82	3.45	141
18	62	3.3	88
21	110	3.6	169
24	128	3.6	195
27	92	3.45	139
30	63	3.3	94
Feb. 3	63	3.2	86
6	62	3.2	77
9	70	3.35	103
12	97	3.6	115
15	73	3.3	99
18	77	3.3	96
21	72	3.4	101
24	70	3.3	95
27	71	3.25	90
Mar. 3	64	3.3	69
6	49	3.1	43
9	45	2.9	32
12	26	2.75	18
15	23	2.6	13
21	145	4.0	223
24	94	3.7	116
27	76	3.3	79
30	74	3.0	73
Apr. 2	34	2.6	28
5	69	3.0	78
8	43	2.8	56
11	38	2.8	42
14	21	2.6	12
29	526	5.7	2,308
May 2	478	5.6	1,157
5	333	4.6	547
8	436	5.2	992
11	307	4.5	493
14	572	5.8	2,586
16	760	6.3	3,474
19	968	6.9	5,158
22	1,035	7.0	4.399
26	1,040	6.4	4,076
30	1,049	6.5	3,815
June 2	941	6.0	2,539
5	870	5.5	1,920
8	798	5.3	1,559
11	976	5.9	3,250
14	856	6.3	3,007
17	1,052	6.9	4,832
20	968	6.9	3,160
23	1,099	6.9	5,514
26	906	6.1	3,607
29	842	5.9	2,483
July 2	733	5.5	1,631
July 6	446	8.6	1,736
9	435	8.4	1,495
12	285	7.4	625
15	201	6.7	289
18	73	5.4	56
21	159	6.3	171
24	120	5.9	97
27	126	6.0	106
30	173	6.35	189
Aug. 3	80	5.4	73
6	81	5.4	69
9	61	5.2	36
12	22	4.5	8
14	148	7.2	325
18	20	4.4	8
Sept. 2	75	5.5	41
5	152	6.5	162
8	129	6.3	119
11	133	6.4	139
14	842	10.95	5,763
17	623	9.75	2,840
20	535	9.3	1,859
23	422	8.8	1,138
26	338	8.2	691
29	278	7.55	392
Oct. 3	210	7.2	258
6	195	6.9	191
9	203	6.9	217
12	155	6.8	139
15	137	6.45	109
18	192	6.9	219
21	222	7.1	284
24	224	7.1	268
27	229	7.3	340
30	213	7.0	233
Nov. 2	175	7.1	187
5	173	7.0	180
8	148	6.9	128
11	129	6.8	101
14	121	6.7	86
17	107	6.6	79
20	92	6.6	65
23	118	6.8	91
26	121	6.8	109
29	121	6.6	109
Dec. 3	152	6.9	135
6	146	6.9	139
9	180	7.1	213
12	188	7.3	244
15	187	7.4	193
19	184	7.4	155
21	176	7.2	140
24	155	7.0	174
27	162	7.2	204
30	120	6.9	131

NOTE.—Gage heights, July 6 to December 30, taken on new gage, whose readings are not comparable with old gage.

Daily gage height, in feet, of Rio Grande above Presidio, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	3.2	3.1	2.6	6.15	6.3	5.7	5.65	5.25	7.5	7.1	7.05
2	3.7	3.3	3.1	2.6	5.5	5.95	5.45	5.55	5.45	7.35	7.05	7.0
3	3.65	3.25	3.3	3.2	4.85	5.75	5.2	5.4	5.5	7.15	6.95	6.9
4	3.6	3.25	3.2	3.1	4.7	5.65	5.05	5.65	6.7	7.0	6.95	6.85
5	3.6	3.2	3.1	3.0	4.55	5.55	5.0	5.45	6.45	6.9	6.95	6.9
6	3.5	3.2	3.1	2.9	4.7	5.5	8.6	5.45	6.85	6.9	6.9	6.8
7	3.6	3.2	2.95	2.8	5.0	5.4	8.95	5.3	6.9	6.85	6.9	6.9
8	3.6	3.2	2.9	2.8	5.25	5.35	10.4	5.2	6.2	6.8	6.9	6.8
9	3.6	3.35	2.9	2.8	5.05	5.85	7.8	5.1	5.85	6.85	6.85	7.15
10	3.65	3.5	2.85	2.8	4.7	5.9	7.85	4.85	6.35	6.85	6.8	7.2
11	3.6	3.6	2.85	2.8	4.55	5.9	8.15	4.65	6.3	6.95	6.8	7.2
12	3.6	3.6	2.8	2.7	4.8	5.95	7.3	4.45	6.55	6.8	6.7	7.3
13	3.6	3.45	2.7	2.7	5.3	6.05	6.95	6.8	10.25	6.7	6.7	7.35
14	3.5	3.3	2.65	2.6	5.8	6.3	6.7	8.7	11.0	6.55	6.75	7.3
15	3.45	3.3	2.6	2.6	6.0	6.55	6.7	5.45	11.15	6.45	6.7	7.3
16	3.4	3.3	2.6	.....	6.3	6.65	6.5	4.95	10.45	6.4	6.65	7.3
17	3.4	3.2	.....	.....	6.6	6.85	5.95	4.7	9.75	6.45	6.6	7.3
18	3.3	3.3	.....	.....	6.8	6.55	5.3	4.4	9.85	6.95	6.55	7.45
19	3.35	3.4	3.8	.....	6.85	6.9	6.3	4.55	9.45	7.1	6.6	7.4
20	3.5	3.4	4.0	.....	7.0	6.9	6.3	4.5	9.3	7.05	6.6	7.3
21	3.6	3.4	4.0	.....	7.05	6.9	6.25	4.3	9.5	7.15	6.6	7.2
22	3.6	3.25	3.9	.....	7.0	6.95	6.05	.....	8.8	7.2	6.6	7.0
23	3.6	3.3	3.75	.....	7.1	6.9	5.95	.....	8.8	7.15	6.8	7.0
24	3.6	3.3	3.7	.....	7.15	6.55	5.9	.....	8.5	7.15	6.8	6.95
25	3.5	3.35	3.6	.....	6.75	6.05	5.8	.....	8.35	7.2	6.8	6.9
26	3.5	3.2	3.45	.....	6.4	6.1	5.85	.....	8.15	7.1	6.8	7.15
27	3.45	3.25	3.3	.....	6.3	5.8	6.0	.....	7.9	7.25	6.8	7.1
28	3.4	3.1	3.2	3.9	6.45	5.85	7.4	.....	7.65	7.1	6.65	7.0
29	3.3	.....	3.1	5.7	6.5	5.9	7.6	.....	7.55	7.0	6.6	7.0
30	3.25	.....	3.0	5.7	6.5	5.7	6.5	.....	7.45	7.0	6.6	6.9
31	3.2	.....	2.9	.....	6.5	.....	5.95	.....	.....	7.1	.....	6.8

NOTE.—On July 6 station was moved back to "The Haciendita," 8 miles above mouth of Conchas, and a new gage established not comparable with old gage.
No flow March 17–18, April 16–27, August 22–31.

Daily discharge, in second-feet, of Rio Grande above Presidio, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	165	85	70	30	2,430	3,370	2,060	105	30	380	225	150
2	165	90	65	*a* 30	*a*1,100	*a*2,480	*a*1,580	95	*a* 40	320	*a* 185	145
3	*a* 150	*a* 90	*a* 70	100	700	2,230	1,330	*a* 75	40	*a* 245	175	*a* 135
4	135	90	55	90	610	2,100	1,180	110	190	215	175	125
5	135	80	45	*a* 80	*a* 510	*a*1,980	1,130	80	*a* 150	190	*a* 170	135
6	*a* 105	*a* 75	*a* 45	65	620	1,920	*a*1,740	*a* 80	265	*a* 190	150	*a* 120
7	120	80	35	55	845	1,740	2,440	55	280	185	140	140
8	110	85	30	*a* 55	*a*1,030	*a*1,650	5,340	35	*a* 110	180	*a* 130	120
9	*a* 100	*a* 105	*a* 30	50	885	3,110	*a* 975	*a* 30	75	*a* 200	115	*a* 220
10	120	110	25	45	635	3,250	1,020	20	135	185	100	230
11	125	115	25	*a* 40	*a* 530	*a*3,250	1,280	10	125	200	*a* 100	230
12	*a* 140	*a* 115	*a* 20	25	975	3,000	*a* 575	*a* 5	175	*a* 140	85	*a* 245
13	150	110	15	25	1,780	2,850	410	285	4,870	130	85	230
14	140	100	15	*a* 10	*a*2,590	*a*3,010	290	*a* 925	*a*5,830	115	*a* 90	195
15	*a* 140	*a* 100	*a* 15	10	2,940	3,770	*a* 290	130	6,060	*a* 110	90	*a* 175
16	125	100	10	0	*a*3,480	4,070	255	70	4,450	100	85	165
17	125	90	0	0	4,320	*a*4,680	155	40	*a*2,840	110	*a* 80	155
18	*a* 90	*a* 95	0	0	4,880	3,580	*a* 45	*a* 10	2,990	*a* 235	70	175
19	100	100	155	0	*a*5,020	3,720	170	20	2,170	285	70	*a* 155
20	140	100	225	0	5,000	*a*3,160	170	15	*a*1,860	265	*a* 65	145
21	*a* 170	*a* 100	*a* 225	0	4,770	3,950	*a* 160	5	2,150	*a* 300	65	*a* 140
22	180	90	185	0	*a*4,400	4,830	125	0	1,140	310	65	125
23	190	95	135	0	4,670	*a*5,510	105	0	*a*1,140	290	*a* 90	150
24	*a* 195	*a* 95	*a* 115	0	4,870	4,680	*a* 95	0	915	*a* 285	95	*a* 170
25	160	100	105	0	4,440	3,490	90	0	800	305	105	160
26	160	85	95	0	*a*4,080	*a*3,610	90	0	*a* 670	270	*a* 110	195
27	*a* 140	*a* 90	*a* 80	0	3,840	2,410	*a* 105	0	555	*a* 320	120	*a* 190
28	125	75	80	210	3,950	2,440	625	0	440	270	105	155
29	95	.....	75	*a*2,310	3,920	*a*2,480	725	0	*a* 390	235	*a* 110	155
30	*a* 85	.....	*a* 75	2,310	*a*3,920	2,060	*a* 250	0	360	*a* 235	110	*a* 130
31	80	.....	70	.....	3,920	.....	140	0	.....	265	.....	105

a Date of measurement.

Monthly discharge of Rio Grande above Presidio, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	195	80	134	8,251
February	115	75	94	5,246
March	225	0	71	4,344
April	2,310	0	185	10,988
May	5,020	510	2,828	173,871
June	5,510	1,650	3,146	187,200
July	5,340	45	805	49,478
August	925	0	71	4,364
September	6,060	30	1,375	81,808
October	380	100	228	14,103
November	225	65	112	6,664
December	245	105	163	10,046
The year	6,060	0	768	556,273

RIO GRANDE BELOW PRESIDIO, TEX.

The station was established April 8, 1900, by the International Boundary Commission. It is 6 miles below Presidio, 7 miles below the mouth of the Rio Conchos, and about 215 miles below El Paso. It is at the west end of the canyon section of the Rio Grande. The discharge at this station minus the discharge at the station above Presidio, Tex., is the discharge of Rio Conchos, except at rare intervals, when some rain water enters the Rio Grande from the north.

The river is fairly straight at the station and for one-fourth mile above and below. The right bank is a rocky bluff. The left bank is an alluvial deposit and overflows for 750 feet back from the river, where gravel hills are found. The bed is of shifting sand and is affected by a drainage line called Alamos Creek, which reaches the river one-fourth mile below the station. This creek is subject to torrential floods, which bring large quantities of bowlders and gravel into the Rio Grande, forming a temporary dam, which remains, throwing backwater onto the gage, until a flood in the river scours it out. The extreme floods come from the Rio Conchos, the highest recorded gage height being 26.35 feet on September 11, 1904. Frequent discharge measurements are made to determine closely the daily flow.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande below Presidio, Tex., in 1909.

[By W. T. Millington.]

Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*
Jan. 4	650	6.8	802
7	625	6.8	704
10	626	6.8	781
13	589	6.8	603
16	602	6.8	652
19	596	6.7	564
22	593	6.8	509
25	688	6.8	665
28	627	6.8	501
31	605	6.6	491
Feb. 4	659	6.8	900
7	626	6.7	616
10	623	6.8	617
14	612	6.75	591
16	617	6.7	569
19	561	6.6	481
22	547	6.55	446
25	506	6.6	358
28	495	6.6	357
Mar. 4	482	6.5	272
7	510	6.5	238
10	508	6.45	208
13	443	6.35	143
16	423	6.3	158
19	406	6.2	174
22	554	6.85	474
25	465	6.6	349
28	428	6.4	280
31	403	6.25	312
Apr. 3	425	6.3	393
6	433	6.35	405
9	379	6.2	307
12	382	6.1	351
15	352	6.0	320
18	324	5.95	276
21	305	5.9	197
24	329	5.9	190
27	338	5.9	202
30	1,127	7.4	1,128
May 1	1,236	8.0	2,740
4	1,145	7.7	2,054
7	1,203	7.8	2,548
10	1,172	7.7	2,085
13	904	7.9	1,470
17	1,116	8.6	3,719
20	1,256	8.9	5,983
24	1,359	9.05	5,452
27	1,350	9.1	5,338
31	1,338	9.1	4,509
June 3	894	8.6	1,500
6	805	8.4	1,286
9	753	8.3	1,036
12	666	8.0	719
15	1,791	10.7	6,958
18	1,505	10.2	5,242
21	1,512	10.1	4,361
24	1,242	10.35	6,059
27	1,013	9.5	3,565
30	1,117	9.7	4,327
July 7	2,137	11.9	10,407
10	2,434	12.8	14,819
13	2,201	12.15	10,396
16	1,769	10.7	5,945
19	1,269	9.5	2,467
22	1,217	9.4	2,530
25	1,139	9.0	1,993
28	1,419	10.15	4,030
31	1,555	10.3	4,466
Aug. 4	1,552	10.4	6,089
7	1,534	9.75	5,001
10	1,663	10.4	7,110
13	1,546	10.3	5,735
16	1,835	10.75	8,114
19	2,388	11.8	12,157
22	1,757	10.2	7,619
25	1,476	9.65	4,215
28	1,486	9.6	4,965
31	1,152	8.6	2,360
Sept. 3	2,448	12.7	14,222
6	1,619	9.9	6,380
9	1,385	9.0	4,011
12	1,740	9.8	7,578
15	2,305	11.2	10,796
18	2,406	11.4	12,633
21	2,087	10.5	7,534
24	1,763	9.8	5,298
27	1,320	9.2	3,564
30	1,188	8.6	2,480
Oct. 4	919	8.2	1,702
7	848	8.1	1,411
10	780	7.9	1,065
13	799	7.8	981
16	614	7.6	911
19	653	7.8	1,072
22	646	7.7	1,084
25	604	7.7	935
28	628	7.7	1,094
31	581	7.5	702
Nov. 3	580	7.4	755
6	561	7.3	644
9	564	7.3	625
12	558	7.2	595
15	550	7.2	580
18	526	7.1	529
21	509	7.1	462
24	511	7.1	506
27	512	7.1	466
30	514	7.0	478
Dec. 4	543	7.1	584
7	518	7.0	512
10	594	7.2	639
13	588	7.3	539
16	575	7.2	468
20	569	7.2	596
23	536	7.1	486
26	531	7.1	500
28	1,971	10.85	8,492
31	1,209	9.0	3,205

Daily gage height, in feet, of Rio Grande below Presidio, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.7	6.7	6.6	6.15	7.85	8.95	9.65	10.85	9.5	8.5	7.5	7.05
2	6.7	6.7	6.55	6.2	8.0	8.75	9.65	11.2	12.15	8.4	7.4	7.1
3	6.9	6.75	6.5	6.3	7.85	8.55	9.3	10.65	12.5	8.3	7.4	7.1
4	6.8	6.8	6.5	6.4	7.65	8.45	9.2	10.45	11.25	8.2	7.4	7.1
5	6.8	6.8	6.5	6.3	7.5	8.4	9.2	10.5	10.25	8.2	7.3	7.05
6	6.8	6.7	6.5	6.3	7.5	8.4	11.0	10.5	9.95	8.15	7.3	7.0
7	6.8	6.7	6.5	6.2	7.85	8.4	11.55	9.75	9.45	8.1	7.3	7.0
8	6.85	6.7	6.5	6.2	7.9	8.3	12.6	10.05	9.1	8.0	7.3	7.0
9	6.8	6.7	6.4	6.2	7.95	8.3	12.5	10.1	9.1	8.0	7.3	7.1
10	6.8	6.75	6.4	6.2	7.7	8.25	12.8	10.45	9.65	7.9	7.3	7.15
11	6.85	6.8	6.4	6.1	7.6	8.15	12.3	10.3	10.15	7.9	7.2	7.3
12	6.8	6.8	6.4	6.1	7.6	8.0	12.8	10.3	9.9	7.85	7.2	7.3
13	6.8	6.8	6.4	6.1	7.85	8.1	12.0	10.35	10.65	7.75	7.2	7.25
14	6.8	6.75	6.4	6.1	8.1	8.35	11.15	10.85	11.1	7.6	7.2	7.2
15	6.8	6.7	6.35	6.0	8.35	10.55	10.4	10.4	11.2	7.6	7.2	7.15
16	6.8	6.7	6.3	6.0	8.5	9.6	10.65	10.8	11.6	7.6	7.2	7.2
17	6.75	6.7	6.25	6.0	8.6	10.0	10.45	11.7	11.4	7.6	7.1	7.1
18	6.7	6.7	6.2	6.0	8.75	10.3	9.95	11.8	11.4	7.75	7.1	7.15
19	6.7	6.6	6.2	6.0	8.85	10.15	9.5	11.65	11.0	7.8	7.1	7.2
20	6.7	6.6	6.85	6.0	8.95	10.1	9.65	10.8	10.95	7.7	7.1	7.2
21	6.8	6.6	6.85	5.9	9.0	10.15	9.55	10.45	10.5	7.7	7.1	7.2
22	6.8	6.55	6.8	5.9	9.05	10.4	9.35	10.1	10.4	7.75	7.1	7.1
23	6.8	6.5	6.8	5.9	9.05	10.65	9.1	9.75	10.05	7.7	7.1	7.1
24	6.9	6.5	6.7	5.9	9.05	10.3	9.0	9.95	9.85	7.7	7.1	7.1
25	6.8	6.55	6.6	5.9	9.1	9.75	9.0	9.65	9.55	7.7	7.1	7.1
26	6.8	6.6	6.55	5.9	9.1	9.65	9.75	9.05	9.25	7.6	7.1	7.1
27	6.8	6.6	6.5	5.9	9.1	9.45	9.8	9.8	9.2	7.6	7.1	7.15
28	6.75	6.6	6.4	5.9	9.05	9.3	10.2	9.6	9.1	7.7	7.0	10.75
29	6.7	.....	6.4	7.4	9.15	9.5	10.5	9.6	8.7	7.6	7.0	9.9
30	6.7	.....	6.3	7.4	9.1	9.7	10.45	8.75	8.6	7.5	7.0	9.2
31	6.6	.....	6.2	.....	9.1	.....	10.35	8.6	.....	7.5	.....	9.0

Daily discharge, in second-feet, of Rio Grande below Presidio, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	640	635	355	290	a 2,340	3,610	4,190	6,670	4,910	2,280	740	530
2	675	695	310	330	2,740	2,400	4,190	8,070	12,630	2,090	710	585
3	815	795	270	a 395	2,400	a 1,450	3,220	6,710	a13,660	1,890	a 755	585
4	a 800	a 900	a 270	420	a 1,900	1,340	2,950	a 6,210	10,160	a 1,700	750	a 585
5	770	830	260	395	1,450	1,290	2,950	6,260	7,360	1,660	650	550
6	735	685	250	a 395	1,450	a 1,290	7,920	6,260	a 6,510	1,540	a 645	510
7	a 705	a 615	a 240	335	a 2,700	1,240	a 9,440	a 5,000	5,200	a 1,410	640	a 510
8	755	600	240	320	2,850	1,090	13,840	5,970	4,280	1,240	630	510
9	755	585	180	a 305	3,000	a 1,040	13,350	6,130	a 4,270	1,240	a 625	575
10	a 780	a 590	a 180	335	a 2,090	985	a14,820	a 7,260	6,200	a 1,070	625	a 605
11	745	615	180	325	1,380	875	11,420	6,450	7,990	1,060	595	645
12	665	615	175	a 350	980	a 720	14,820	6,090	a 7,810	1,020	a 595	595
13	a 605	615	a 165	350	a 1,320	950	a 9,940	a 5,880	9,530	a 965	590	a 505
14	620	a 590	175	350	2,110	1,530	7,330	7,730	10,570	910	585	470
15	635	570	165	a 320	2,910	a 6,610	5,020	6,720	a10,800	910	a 580	435
16	a 650	a 570	a 160	310	3,400	3,190	a 5,790	a 8,310	12,410	a 910	580	a 470
17	610	555	160	300	a 3,720	4,560	5,220	11,770	12,220	910	530	430
18	575	545	160	a 300	4,620	a 5,540	3,770	12,160	a12,630	1,030	a 530	495
19	a 565	a 480	a 175	275	5,380	4,900	a 2,470	a11,730	10,370	a 1,070	505	565
20	530	480	475	255	a 6,130	4,550	2,780	9,320	10,090	1,020	485	a 595
21	545	475	475	a 195	6,040	a 4,510	2,700	8,320	a 7,530	1,050	a 460	595
22	a 510	a 445	a 450	195	5,940	5,580	a 2,460	a 7,320	7,210	a 1,120	475	485
23	560	385	450	190	5,700	6,640	2,130	5,680	6,100	1,030	490	a 485
24	665	345	400	a 190	a 5,450	a 5,910	1,990	5,700	a 5,440	980	a 505	490
25	a 665	a 335	a 350	195	5,510	4,300	a 1,990	a 4,210	4,570	a 940	495	495
26	610	360	330	200	5,430	4,010	3,320	2,950	3,710	910	480	a 500
27	555	360	315	a 200	a 5,340	a 3,460	3,410	5,190	a 3,560	960	a 465	550
28	a 475	a 355	a 280	200	4,980	3,160	a 4,180	a 4,960	3,380	a 1,090	425	a8,200
29	480	.....	310	1,130	5,070	3,740	5,050	4,960	2,660	935	450	5,780
30	510	.....	300	a 1,130	4,720	a 4,330	4,900	2,750	a 2,480	780	a 480	3,770
31	a 490	.....	a 290	.....	a 4,510	.....	a 4,610	a 2,360	.....	a 700	.....	a3,200

a Date of measurement.

Monthly discharge of Rio Grande below Presidio, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	815	475	635	39,065
February	900	335	558	30,992
March	475	160	274	16,850
April	1,130	190	349	20,787
May	6,130	980	3,663	225,243
June	6,640	720	3,160	188,033
July	14,820	1,990	5,876	361,329
August	12,160	2,360	6,616	406,810
September	13,660	2,480	7,541	448,740
October	2,280	700	1,175	72,239
November	755	425	569	33,858
December	8,200	430	1,139	70,016
The year	14,820	160	2,630	1,913,962

RIO GRANDE NEAR LANGTRY, TEX.

This station was established in April, 1900, by the International Boundary Commission. It is located one-half mile south of Langtry station, on the Southern Pacific Railroad, and is about 440 miles below El Paso, Tex., at the east end of the canyon section of the Rio Grande, and a short distance to the west of the mouth of Pecos River, one of the principal tributaries of the Rio Grande.

The right (Mexican) bank is a rock bluff; the left bank is alluvial deposit for 200 feet back to a rock bluff. As the river is constantly shifting, because of alluvial deposits, frequent discharge measurements are made in order to determine closely the daily flow.

Observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande near Langtry, Tex., in 1909.

[By E. E. Winter.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	390	0.35	661	Apr. 17	298	0.0	420
7	413	.5	770	22	291	— .05	379
12	378	.35	655	27	294	— .05	387
18	388	.4	671	May 2	281	— .05	380
23	398	.4	694	6	605	1.6	1,596
28	403	.4	723	10	471	.95	1,088
Feb. 2	383	.4	684	14	568	1.5	1,379
7	371	.3	630	18	709	1.8	2,132
12	376	.3	626	23	941	2.8	3,991
17	371	.3	628	28	1,073	3.15	4,763
21	375	.35	655	June 2	989	3.0	4,486
25	370	.3	631	6	835	2.3	2,929
Mar. 2	348	.3	565	10	824	2.3	3,027
7	350	.3	573	15	658	1.8	2,063
13	337	.25	546	19	1,073	3.2	4,919
17	350	.25	549	23	1,048	3.1	4,548
22	310	.1	443	27	1,059	3.2	4,761
28	305	.05	416	July 2	922	2.7	3,858
Apr. 2	333	.15	511	8	1,056	3.5	5,316
7	318	.15	503	12	2,374	7.5	16,369
12	317	.05	466	16	1,577	5.1	9,501

Discharge measurements of Rio Grande near Langtry, Tex., in 1909—Continued.

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 20	1,305	3.9	6,472	Oct. 11	678	1.7	1,956
25	1,209	3.5	5,374	15	628	1.6	1,672
28	1,269	3.7	6,301	20	595	1.0	1,444
Aug. 3	1,455	4.45	7,924	24	595	1.0	1,440
7	1,474	4.7	8,952	28	594	1.0	1,421
12	1,385	4.05	7,027	Nov. 2	570	.9	1,298
16	1,463	4.7	9,189	7	535	.85	1,170
21	1,858	5.8	12,031	11	507	.8	1,074
24	1,336	3.9	6,869	15	509	.8	1,035
28	1,066	3.1	4,577	20	468	.7	985
Sept. 2	862	2.5	3,336	24	457	.7	941
6	1,754	5.35	11,319	28	442	.6	849
13	1,131	3.3	5,482	Dec. 2	444	.55	850
17	1,713	5.15	10,378	7	460	.6	912
21	1,642	5.4	11,112	11	458	.6	890
25	1,374	4.0	7,350	16	445	.5	839
27	1,199	3.4	5,783	22	450	.6	871
Oct. 2	895	2.45	3,280	28	438	.5	834
7	746	1.9	2,333				

Daily gage height, in feet, of Rio Grande near Langtry, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.4	0.4	0.3	0.2	−0.05	3.2	2.55	4.0	2.5	2.65	1.0	0.5
2	.35	.4	.3	.15	− .05	3.0	2.7	4.05	2.5	2.45	.9	.55
3	.35	.4	.3	.15	− .05	3.1	2.75	4.35	2.55	2.25	.9	.6
4	.4	.4	.3	.15	.8	2.9	2.7	4.95	6.95	2.1	.9	.6
5	.4	.4	.3	.15	1.85	2.65	2.55	4.45	6.75	2.0	.85	.6
6	.45	.35	.3	.15	1.6	2.4	2.5	4.55	5.25	2.0	.85	.6
7	.5	.3	.3	.15	1.45	2.3	2.6	4.65	4.15	1.9	.85	.6
8	.45	.3	.25	.1	1.25	2.25	3.3	4.45	3.7	1.8	.8	.6
9	.35	.3	.25	.1	1.05	2.3	5.75	4.15	3.45	1.8	.8	.6
10	.35	.3	.25	.1	.95	2.3	6.55	3.7	3.25	1.7	.8	.6
11	.35	.3	.25	.05	.9	2.25	6.7	3.75	2.9	1.7	.8	.6
12	.35	.3	.25	.05	1.05	2.25	7.55	4.1	2.65	1.65	.8	.6
13	.4	.3	.25	.05	1.55	2.35	7.3	4.25	3.05	1.6	.8	.6
14	.4	.35	.25	.0	1.5	2.1	7.2	4.2	3.65	1.6	.8	.6
15	.4	.3	.25	.0	1.3	1.7	6.25	3.95	3.8	1.55	.8	.55
16	.4	.3	.25	.0	1.15	1.15	5.15	4.55	4.65	1.4	.75	.5
17	.4	.3	.25	.0	1.55	1.55	5.1	4.55	5.15	1.3	.7	.55
18	.4	.35	.25	.0	1.85	3.15	4.5	4.75	6.0	1.25	.7	.6
19	.4	.35	.25	.0	2.05	3.2	3.95	5.85	6.0	1.15	.7	.6
20	.4	.35	.25	.0	2.3	3.2	3.8	5.95	5.65	1.0	.7	.6
21	.4	.35	.2	− .05	2.5	3.4	3.65	5.8	5.3	1.0	.7	.6
22	.4	.3	.1	− .05	2.65	3.05	3.6	4.8	4.8	1.0	.7	.6
23	.4	.3	.1	− .05	2.85	3.1	3.7	4.15	4.15	1.0	.7	.6
24	.4	.3	.1	− .05	2.9	3.3	3.75	3.65	4.0	1.0	.7	.6
25	.4	.3	.1	− .05	3.05	3.5	3.5	3.3	3.9	1.0	.6	.6
26	.4	.3	.1	− .05	3.05	3.45	3.3	3.1	3.65	1.0	.55	.55
27	.4	.3	.1	− .05	3.1	3.15	3.45	3.1	3.4	1.0	.55	.55
28	.4	.35	.05	− .05	3.15	3.05	3.7	3.15	3.25	1.0	.55	.5
29	.4	.....	.05	− .05	3.15	2.9	3.45	2.85	3.0	1.0	.55	.5
30	.4	.....	.05	− .05	3.1	2.6	3.6	2.55	2.8	1.0	.5	.5
31	.4	.....	.05	.....	3.05	.....	3.65	2.5	.....	1.0	.....	3.75

Daily discharge, in second-feet, of Rio Grande near Langtry, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	710	695	575	540	*a* 380	4,780	3,580	6,950	3,360	3,850	1,400	810
2	*a* 660	*a* 685	*a* 565	*a* 510	380	*a*4,490	*a*3,860	7,060	*a*3,340	*a*3,280	*a*1,300	*a* 850
3	660	685	565	510	380	4,710	3,950	*a*7,700	3,480	2,940	1,280	900
4	695	685	570	510	990	4,260	3,860	9,420	15,800	2,680	1,270	900
5	695	685	570	510	1,790	3,710	3,580	8,470	15,240	2,510	1,200	905
6	730	655	570	505	*a*1,600	*a*3,150	3,490	8,660	*a*11,030	2,510	1,180	905
7	*a* 770	*a* 630	*a* 575	*a* 505	1,480	2,950	3,680	*a*8,860	7,900	*a*2,330	*a*1,170	*a* 910
8	730	630	550	485	1,320	2,880	*a*4,950	8,210	6,620	2,140	1,100	905
9	655	630	550	485	1,170	3,000	11,530	7,320	5,900	2,140	1,090	900
10	655	625	550	485	*a*1,090	*a*3,030	13,750	5,990	5,330	1,960	1,080	895
11	655	625	545	465	1,060	2,930	14,170	6,140	4,330	*a*1,960	*a*1,070	*a* 890
12	*a* 655	*a* 625	545	*a* 465	1,140	2,930	*a*16,510	*a*7,190	3,620	1,850	1,060	890
13	670	625	*a* 545	465	1,410	3,120	15,800	7,690	*a*4,760	1,740	1,050	890
14	670	650	545	430	*a*1,380	2,640	15,520	7,520	6,410	1,710	1,040	890
15	670	630	545	425	1,180	*a*1,960	12,790	6,700	6,810	*a*1,650	*a*1,030	865
16	670	630	550	425	1,030	1,410	*a*9,650	*a*8,690	9,060	1,600	1,010	*a* 840
17	670	*a* 630	*a* 550	*a* 420	1,710	2,090	9,500	8,800	*a*10,380	1,560	985	855
18	*a* 670	655	545	415	*a*2,220	4,830	7,990	9,320	12,880	1,540	985	870
19	675	655	535	410	2,600	*a*4,920	6,600	12,160	12,880	1,500	985	870
20	680	655	530	405	3,060	4,880	*a*6,200	12,410	11,850	*a*1,440	*a* 985	870
21	685	*a* 655	500	385	3,430	5,230	5,790	*a*12,030	*a*10,840	1,440	975	870
22	690	630	*a* 445	*a* 380	3,710	4,490	5,650	9,310	9,500	1,440	965	*a* 870
23	*a* 695	630	445	380	*a*4,100	*a*4,550	5,920	7,540	7,750	1,440	950	870
24	700	630	440	380	4,210	4,970	6,060	*a*6,150	7,350	*a*1,440	*a* 940	870
25	705	*a* 630	435	385	4,540	5,400	*a*5,370	5,150	*a*7,090	1,440	875	870
26	710	620	430	385	4,540	5,290	4,990	4,580	6,440	1,430	835	850
27	715	605	430	*a* 385	4,650	*a*4,670	5,520	4,580	*a*5,780	1,430	825	850
28	*a* 720	615	*a* 415	385	*a*4,760	4,490	*a*6,300	*a*4,720	5,410	*a*1,420	*a* 820	*a* 835
29	715	.....	420	390	4,760	4,220	5,760	4,080	4,780	1,420	830	835
30	705	.....	425	390	4,660	3,680	6,080	3,480	4,280	1,410	805	835
31	700	.....	430	.....	4,560	.....	6,190	3,380	.....	1,400	.....	7,100

a Date of measurement.

Monthly discharge of Rio Grande near Langtry, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	770	655	690	42,417
February	695	605	643	35,702
March	575	415	513	31,517
April	540	380	440	26,212
May	4,760	380	2,429	149,336
June	5,400	1,410	3,855	229,408
July	16,510	3,490	7,567	465,302
August	12,410	3,380	7,428	456,714
September	15,800	3,340	7,673	456,595
October	3,850	1,400	1,890	116,231
November	1,400	805	1,036	61,666
December	7,100	810	1,073	65,980
The year	16,510	380	2,936	2,137,080

RIO GRANDE BELOW DEVILS RIVER, TEX.

The station was established in April, 1900, by the International Boundary Commission. It is alongside the Southern Pacific Railroad track, about a mile below the mouth of Devils River and the town of Devils River, and about 480 miles below El Paso.

The bed of the river is rock for a short distance from the left bank; the right bank is alluvial deposit, overflowing in extreme high water

for a distance of some 500 feet back from the river. The left bank is a loose rock fill, along which runs the Southern Pacific Railroad.

Frequent discharge measurements are made to determine closely the daily flow. The observations at this station during 1909 have been made under the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande below Devils River, Tex., in 1909.

[By E. E. Winter.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 5	905	3.7	1,592	July 15	2,499	7.5	16,198
10	918	3.7	1,619	19	2,091	6.0	9,212
15	924	3.7	1,729	23	5,221	14.6	42,532
21	934	3.7	1,789	27	1,700	5.5	6,623
26	948	3.7	1,770	31	2,055	6.2	9,476
31	938	3.7	1,734	Aug. 6	1,840	6.0	8,885
Feb. 5	919	3.6	1,686	11	1,635	5.6	7,115
10	928	3.6	1,690	15	1,662	5.7	7,486
15	911	3.6	1,655	20	2,212	7.0	13,055
20	911	3.6	1,645	23	1,755	6.0	8,875
24	901	3.6	1,604	27	1,542	5.3	6,231
28	1,006	3.75	1,879	31	1,328	4.8	4,574
Mar. 5	863	3.55	1,492	Sept. 5	1,347	5.1	5,363
10	858	3.55	1,469	9	1,730	5.7	7,771
15	866	3.55	1,433	16	1,851	6.05	9,588
20	836	3.5	1,359	20	2,060	6.55	12,012
26	833	3.5	1,330	24	1,740	5.9	8,453
31	829	3.45	1,282	26	1,681	5.65	7,243
Apr. 6	854	3.5	1,321	30	1,391	5.1	5,375
11	837	3.45	1,269	Oct. 6	1,195	4.5	3,602
16	826	3.4	1,193	10	1,112	4.3	2,943
20	828	3.4	1,156	14	1,102	4.3	2,939
25	829	3.4	1,175	19	1,031	4.0	2,342
30	856	3.5	1,302	23	1,067	4.0	2,355
May 5	871	3.55	1,393	27	1,066	4.0	2,347
9	1,062	4.0	2,272	31	1,072	4.0	2,304
13	1,082	4.0	2,229	Nov. 6	974	3.8	1,992
17	1,045	3.9	2,008	10	995	3.8	1,989
21	1,458	4.8	4,251	14	979	3.8	1,923
26	1,461	5.0	4,795	19	954	3.7	1,885
31	1,452	5.0	4,852	23	917	3.7	1,832
June 5	1,371	4.85	4,547	27	916	3.7	1,768
9	1,273	4.65	3,767	30	910	3.7	1,835
13	1,303	4.8	4,289	Dec. 4	926	3.7	1,694
18	1,395	5.0	4,741	9	915	3.7	1,692
22	1,358	5.0	4,901	14	912	3.7	1,677
26	1,560	5.3	6,166	18	934	3.7	1,687
30	1,321	4.9	4,694	24	939	3.8	1,709
July 7	1,341	4.8	4,607	30	957	3.7	1,716
11	2,511	7.8	16,693				

Daily gage height, in feet, of Rio Grande below Devils River, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.75	3.7	3.6	3.5	3.5	5.0	4.75	6.3	4.55	4.95	4.0	3.7
2	3.7	3.7	3.6	3.5	3.5	5.05	4.8	6.25	4.6	4.85	4.0	3.7
3	3.7	3.7	3.6	3.5	3.5	5.0	4.9	6.2	4.6	4.7	3.9	3.7
4	3.7	3.7	3.55	3.5	3.5	4.9	5.15	6.55	4.65	4.6	3.9	3.7
5	3.7	3.65	3.55	3.5	3.85	4.85	5.15	6.4	5.8	4.55	3.85	3.7
6	3.7	3.65	3.55	3.5	4.3	4.7	4.8	6.1	7.5	4.5	3.8	3.7
7	3.7	3.6	3.5	3.5	4.2	4.7	4.85	6.1	6.25	4.4	3.8	3.7
8	3.7	3.6	3.5	3.5	4.1	4.6	5.4	6.1	6.15	4.35	3.8	3.7
9	3.7	3.6	3.5	3.5	4.0	4.6	6.35	6.05	5.65	4.3	3.8	3.7
10	3.7	3.6	3.5	3.5	4.0	4.6	6.75	5.7	5.35	4.3	3.8	3.7
11	3.7	3.6	3.5	3.4	3.9	4.6	7.8	5.6	5.05	4.3	3.8	3.7
12	3.7	3.6	3.55	3.4	4.0	4.6	7.85	5.55	4.85	4.3	3.8	3.7
13	3.7	3.6	3.5	3.4	4.1	4.8	7.4	5.75	4.7	4.3	3.8	3.7
14	3.7	3.6	3.55	3.4	4.2	4.6	7.45	6.0	5.5	4.25	3.8	3.7
15	3.7	3.6	3.55	3.4	4.15	4.6	7.4	5.7	5.5	4.2	3.8	3.7

Daily gage height, in feet, of Rio Grande below Devils River, Tex., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	3.7	3.6	3.5	3.4	4.0	4.65	6.6	5.8	6.05	4.2	3.8	3.7
17	3.7	3.6	3.5	3.4	3.9	4.65	6.25	6.45	6.45	4.05	3.75	3.7
18	3.7	3.65	3.5	3.4	4.05	5.1	6.15	5.85	6.8	4.0	3.75	3.7
19	3.7	3.6	3.5	3.4	4.35	5.0	6.0	6.45	7.25	4.0	3.7	3.7
20	3.7	3.6	3.5	3.4	4.65	4.65	5.75	7.0	6.5	4.0	3.7	3.7
21	3.7	3.6	3.5	3.4	4.8	5.15	5.45	6.6	6.9	4.1	3.7	3.7
22	3.7	3.6	3.5	3.4	4.8	5.05	5.3	5.95	6.5	4.0	3.7	3.75
23	3.7	3.6	3.5	3.4	4.85	5.2	12.5	6.0	6.5	4.0	3.7	3.8
24	3.7	3.6	3.5	3.4	5.0	5.3	6.35	5.75	5.9	4.0	3.7	3.8
25	3.7	3.6	3.5	3.4	5.0	5.45	5.95	5.55	5.9	4.0	3.7	3.8
26	3.7	3.6	3.5	3.55	5.0	5.3	5.4	5.35	5.65	4.0	3.7	3.8
27	3.7	3.5	3.5	3.6	5.1	5.2	5.5	5.4	5.6	4.0	3.7	3.75
28	3.7	3.75	3.5	3.5	5.0	5.25	5.4	5.4	5.4	4.0	3.7	3.7
29	3.7	.....	3.5	3.5	5.15	5.05	5.65	5.15	5.2	4.0	3.7	3.7
30	3.7	.....	3.5	3.5	5.0	4.95	6.15	4.9	5.1	4.0	3.7	3.7
31	3.7	.....	3.45	.....	5.0	.....	6.3	4.8	.....	4.0	.....	3.7

Daily discharge, in second-feet, of Rio Grande below Devils River, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,810	1,730	1,690	1,320	1,300	4,850	4,270	9,880	3,910	4,930	2,300	1,800
2	1,720	1,730	1,650	1,320	1,300	4,950	4,450	9,680	4,040	4,630	2,300	1,760
3	1,680	1,730	1,620	1,320	1,300	4,850	4,780	9,480	4,040	4,190	2,150	1,730
4	1,640	1,730	1,530	1,320	1,300	4,650	5,560	10,880	4,180	3,900	2,150	a1,690
5	a1,590	a1,700	a1,490	1,320	a1,980	a4,550	5,590	10,280	a8,510	3,750	2,070	1,690
6	1,600	1,700	1,490	a1,320	2,860	3,960	4,580	a9,330	16,200	a3,600	a1,990	1,690
7	1,600	1,690	1,440	1,320	2,670	3,960	a4,810	9,330	10,350	3,270	1,990	1,690
8	1,610	1,690	1,430	1,310	2,470	3,570	7,030	9,330	9,880	3,110	1,990	1,690
9	1,610	1,690	1,430	1,310	a2,270	a3,590	10,860	9,110	a7,600	2,940	1,990	a1,690
10	a1,620	a1,690	a1,420	1,300	2,260	3,590	12,470	7,560	6,550	a2,940	a1,990	1,690
11	1,640	1,690	1,420	a1,240	2,050	3,590	a16,690	a7,120	5,500	2,940	1,970	1,690
12	1,660	1,680	1,460	1,230	2,240	3,590	17,070	6,930	4,800	2,940	1,960	1,680
13	1,680	1,670	1,410	1,220	a2,450	a4,290	15,450	7,670	4,270	2,940	1,940	1,680
14	1,700	1,660	1,440	1,210	2,670	3,840	15,820	8,600	7,420	a2,840	a1,920	a1,680
15	a1,730	a1,660	a1,430	1,200	2,560	3,840	a15,730	a7,490	7,420	2,740	1,920	1,680
16	1,740	1,660	1,380	a1,190	2,230	3,950	12,000	7,910	a9,590	2,740	1,920	1,680
17	1,750	1,650	1,380	1,190	a2,010	3,950	10,370	10,700	11,530	2,440	1,900	1,690
18	1,760	1,700	1,370	1,180	2,380	a5,040	9,910	8,130	13,220	2,340	1,900	a1,690
19	1,770	1,650	1,370	1,170	3,150	4,780	a9,210	10,700	15,400	a2,340	a1,880	1,690
20	1,780	a1,640	a1,360	a1,160	3,870	3,770	8,240	a13,050	a11,790	2,340	1,870	1,690
21	a1,790	1,630	1,360	1,160	a4,250	5,310	7,080	11,380	13,590	2,540	1,850	1,690
22	1,780	1,620	1,350	1,160	4,250	a5,050	6,500	8,670	11,540	2,350	1,840	1,700
23	1,780	1,610	1,350	1,170	4,390	5,740	a34,260	a8,870	11,540	a2,350	a1,830	1,710
24	1,770	a1,600	1,340	1,170	4,800	6,170	9,980	7,930	a8,450	2,350	1,820	a1,710
25	1,770	1,600	1,340	a1,180	4,800	6,800	8,400	7,170	8,450	2,350	1,800	1,720
26	a1,770	1,600	a1,330	1,360	a4,800	a6,170	6,230	6,420	a7,240	2,350	1,780	1,730
27	1,770	1,500	1,330	1,430	5,070	5,800	a6,620	a6,560	7,070	a2,350	a1,770	1,710
28	1,760	a1,880	1,330	1,300	4,820	5,980	6,220	6,560	6,390	2,340	1,790	1,700
29	1,750	.....	1,320	1,300	5,220	5,250	7,230	5,730	5,710	2,330	1,810	1,710
30	1,740	.....	1,320	a1,300	4,840	a4,880	9,270	4,900	5,370	2,320	a1,830	a1,720
31	a1,730	.....	a1,280	.....	a4,850	.....	a9,880	a4,570	.....	a2,300	.....	1,720

a Date of measurement.

Monthly discharge of Rio Grande below Devils River, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	1,810	1,590	1,713	105,322
February	1,880	1,500	1,671	92,787
March	1,690	1,280	1,415	86,995
April	1,430	1,160	1,256	74,737
May	5,220	1,300	3,142	193,210
June	6,800	3,570	4,677	278,301
July	34,260	4,270	9,889	608,053
August	13,050	4,570	8,449	519,511
September	16,200	3,910	8,385	498,942
October	4,930	2,300	2,896	178,096
November	2,300	1,770	1,941	115,478
December	1,800	1,680	1,703	104,707
The year	34,260	1,160	3,928	2,856,139

RIO GRANDE AT EAGLE PASS, TEX.

The station was established in April, 1900, by the International Boundary Commission. It is one-half mile above the highway bridge between Eagle Pass, Tex., and Ciudad Porfirio Diaz, Mexico, and about 540 miles below El Paso.

The right bank is alluvial deposit, with a bottom back of it about 1,500 feet wide, which begins to overflow at gage height 22 feet. The left bank is shale rock rising abruptly from the river. The bed of the stream is constantly shifting, and frequent discharge measurements are necessary to determine closely the daily discharge. The section is subject to overflow at high stages. At low water, the depth is considerable and the velocity slow.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande at Eagle Pass, Tex., in 1909.

[By J. K. Wilson.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 3	1,271	1.4	2,232	Mar. 9	1,076	1.1	1,768
6	1,296	1.4	2,252	12	1,250	1.4	2,274
9	1,275	1.4	2,240	16	1,099	1.1	1,843
12	1,337	1.4	2,316	19	1,065	1.0	1,748
16	1,346	1.4	2,351	22	1,046	1.0	1,665
18	1,252	1.4	2,236	25	1,112	1.1	1,873
21	1,228	1.4	2,195	28	1,084	.9	1,680
24	1,245	1.4	2,167	31	1,050	.9	1,727
27	1,243	1.4	2,191	Apr. 3	1,032	.9	1,670
31	1,235	1.4	2,144	6	1,043	.9	1,739
Feb. 3	1,232	1.4	2,181	9	1,027	.9	1,651
6	1,229	1.4	2,150	12	1,001	.8	1,536
9	1,202	1.3	2,102	16	994	.8	1,538
12	1,189	1.3	2,071	19	1,016	.8	1,538
16	1,194	1.4	2,040	22	1,005	.8	1,531
19	1,181	1.2	2,037	25	963	.8	1,458
22	1,178	1.2	2,030	28	1,396	1.8	2,545
25	1,136	1.2	1,904	30	1,012	.9	1,642
28	1,128	1.2	1,882	May 3	975	.7	1,488
Mar. 3	1,120	1.2	1,882	6	930	.7	1,413
6	1,079	1.1	1,784	9	1,315	1.6	2,204

Discharge measurements of Rio Grande at Eagle Pass, Tex., in 1909—Continued.

Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*
May 13	1,313	1.6	2,294
16	1,294	1.5	2,126
19	1,285	1.5	2,336
22	1,677	2.7	4,601
25	1,679	2.8	4,439
28	1,787	3.0	5,295
31	1,760	2.9	5,261
June 3	1,814	3.15	5,346
6	1,724	2.8	4,648
9	1,806	2.3	4,902
12	1,809	2.2	4,871
15	1,859	2.55	5,500
18	1,716	2.2	3,421
21	1,943	2.85	6,011
24	2,067	3.1	7,044
27	2,144	3.2	7,428
30	2,046	3.0	6,625
July 3	1,909	2.8	6,096
6	1,860	3.0	5,744
9	1,935	3.15	5,959
12	2,818	5.3	14,831
16	2,865	5.4	14,977
18	2,502	4.4	11,401
21	2,405	3.7	7,120
24	4,955	8.35	27,644
27	2,147	3.4	5,518
31	2,546	4.0	8,275
Aug. 3	2,730	4.4	12,644
6	2,423	4.35	11,106
9	2,657	4.3	8,639
13	2,125	3.7	9,106
16	2,094	3.8	8,517
19	2,135	3.9	8,921
22	2,684	4.9	13,329
25	2,086	3.75	8,502
28	1,829	3.3	6,160
31	1,931	2.7	5,781
Sept. 3	1,751	2.7	4,650
Sept. 7	2,491	4.5	11,873
10	2,018	3.6	7,836
13	1,924	2.8	6,122
16	1,919	3.4	7,121
19	2,562	4.3	8,571
22	2,785	5.05	14,533
25	2,180	4.0	8,872
28	2,186	3.5	8,469
30	1,983	3.0	6,414
Oct. 3	1,836	2.6	5,800
6	1,771	2.4	5,179
10	1,336	2.0	2,861
13	1,327	2.0	2,745
16	1,288	2.0	2,678
19	1,258	1.7	2,608
22	1,248	1.6	2,571
25	1,288	1.5	2,644
28	1,253	1.5	2,594
31	1,266	1.5	2,592
Nov. 3	1,237	1.5	2,493
6	1,226	1.4	2,393
9	1,195	1.3	2,321
12	1,194	1.3	2,344
15	1,250	1.3	2,378
18	1,213	1.4	2,340
21	1,229	1.4	2,327
24	1,177	1.4	2,188
27	1,111	1.4	2,089
30	1,086	1.4	1,913
Dec. 3	1,082	1.4	1,964
6	1,044	1.3	1,747
9	1,122	1.2	1,862
13	1,139	1.2	1,981
16	1,172	1.2	2,040
22	1,173	1.2	2,069
25	1,202	1.2	2,052
28	1,159	1.2	2,019
31	1,164	1.2	2,000

Daily gage height, in feet, of Rio Grande at Eagle Pass, Tex., for 1909.

Day.	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.4	1.4	1.2	0.9	0.9	2.9	2.9	4.6	2.45	3.0	1.5	1.4
2	1.4	1.4	1.2	.9	.7	3.1	2.8	4.4	2.4	2.6	1.5	1.4
3	1.4	1.4	1.2	.9	.7	3.15	2.8	4.3	2.6	2.6	1.5	1.4
4	1.4	1.4	1.2	.9	.7	2.9	2.9	4.3	2.55	2.55	1.5	1.35
5	1.4	1.4	1.1	.9	.7	2.95	2.9	4.8	4.25	2.45	1.4	1.35
6	1.4	1.4	1.1	.9	1.1	2.8	3.0	4.3	5.35	2.4	1.4	1.3
7	1.4	1.4	1.1	.9	1.9	2.4	3.7	4.0	4.4	2.35	1.3	1.3
8	1.4	1.35	1.1	.9	1.75	2.3	3.05	4.35	4.0	2.25	1.3	1.2
9	1.4	1.3	1.1	.9	1.55	2.25	3.1	4.25	3.5	2.2	1.3	1.2
10	1.4	1.3	1.1	.9	1 4	2.25	4.5	3.85	3.5	2.0	1.3	1.2
11	1.4	1.3	1.25	.9	1.4	2.2	5.45	3.65	3.25	2.0	1.3	1.2
12	1.4	1.3	1.4	.8	1.4	2.2	5.3	3.45	2.8	2.0	1.3	1.2
13	1.4	1.3	1.35	.8	1.6	2.2	5.35	3.75	2.7	2.0	1.35	1.2
14	1.4	1.4	1.3	.8	1.6	2.65	5.3	3.9	2.7	2.0	1.3	1.2
15	1.4	1.4	1.25	.8	1.55	2.45	5.6	4.0	5.55	2.0	1.3	1.2
16	1.4	1.35	1.1	.8	1.5	2.0	5.4	3.85	3.1	2.0	1.35	1.2
17	1.4	1.3	1.0	.8	1.5	2.1	4.7	4.1	4.1	1.7	1.4	1.2
18	1.4	1.25	1.0	.8	1.45	2.2	4.4	4.0	4.5	1.7	1.4	1.2
19	1.4	1.2	1.0	.8	1.55	2.7	4.3	4.0	4.5	1.7	1.4	1.2
20	1.4	1.2	1.05	.8	1.95	2.75	4.0	4.65	5.2	1.7	1.5	1.2
21	1.4	1.2	1.0	.8	2.35	2.95	3.7	4.9	4.35	1.65	1.4	1.2
22	1.4	1.2	1.0	.8	2.65	2.85	3.4	4.9	5.0	1.6	1.4	1.2
23	1.4	1.2	1.0	.8	2.7	2.95	5.9	4.2	4.8	1.5	1.4	1.2
24	1.4	1.2	1.4	.8	2.85	3.1	8.0	3.85	4.25	1.5	1.4	1.2
25	1.4	1.2	1.15	.8	2.8	3.4	4.5	3.65	4.0	1.5	1.4	1.2
26	1.4	1.2	1.05	.8	2.95	3.25	4.0	3.4	3.85	1.5	1.4	1.2
27	1.4	1.2	.95	1.55	2.9	3.2	3.4	3.15	3.6	1.5	1.4	1.2
28	1.4	1.2	.9	1.65	2.95	3.0	3.55	3.35	3.45	1.5	1.4	1.2
29	1.4	.....	.9	.9	2.9	3.05	3.6	3.2	3.35	1.5	1.4	1.2
30	1.4	.....	.9	.9	2.95	2.95	3.5	2.9	3.0	1.5	1.4	1.2
31	1.4	.....	.9	.....	2.9	.....	4.3	2.65	.....	1.5	.....	1.2

Daily discharge, in second-feet, of Rio Grande at Eagle Pass, Tex., for 1909.

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

a Date of measurement.

Monthly discharge of Rio Grande at Eagle Pass, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	2,350	2,150	2,233	137,276
February	2,180	1,880	2,053	114,030
March	2,270	1,660	1,841	113,217
April	2,390	1,460	1,644	97,805
May	5,280	1,440	3,042	187,061
June	8,200	3,420	5,535	329,375
July	26,100	5,520	10,001	614,955
August	13,840	5,700	9,423	579,372
September	16,500	4,350	8,859	527,127
October	6,410	2,570	3,392	208,542
November	2,560	1,910	2,305	137,137
December	2,070	1,750	1,974	121,349
The year	26,100	1,440	4,358	3,167,246

RIO GRANDE NEAR LAREDO, TEX.

The station was established near Nuevo Laredo, Mexico, in April, 1900, by the International Boundary Commission. It was intended to measure the river from the highway bridge connecting Laredo, Tex., with Nuevo Laredo, Tamaulipas, and the gage was established on the right bank just above the bridge. Measurements were kept up by

the Mexican section of the commission until September 24, 1900, and gage heights were read until February 28, 1903, but the results were so conflicting that the station was abandoned. In July, 1903, a cable station was established by the commission about 2 miles above Nuevo Laredo, and on August 1, 1903, regular meter measurements and gage heights were started. The new gage heights are not comparable with the old. The station is about 670 miles below El Paso.

The river bed at the new station is constantly shifting, and frequent discharge measurements are made to determine closely the daily discharge. The banks at the new station are not subject to overflow.

The observations at these stations have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights for the years 1900 to 1904, which had not hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio Grande near Laredo, Tex., in 1909.

[By L. Varela.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 6	1,424	2.5	2,333	July 12	1,751	4.7	4,403
10	1,438	2.6	2,388	16	3,397	7.0	18,433
16	1,531	2.8	2,845	23	1,623	4.0	3,789
21	1,419	2.4	2,328	24	4,004	8.8	29,931
26	1,340	2.0	1,933	25	3,809	8.1	21,319
31	1,440	2.5	2,229	31	1,637	3.0	3,335
Feb. 5	1,389	2.3	2,167	Aug. 3	1,676	4.4	4,020
9	1,464	2.5	2,349	9	1,766	4.3	3,873
14	1,453	2.5	2,308	14	1,716	4.3	3,827
20	1,441	2.2	2,239	19	1,545	3.5	3,210
25	1,418	2.1	2,232	22	1,883	5.1	6,270
Mar. 1	1,288	2.0	1,950	29	2,026	5.6	7,138
5	1,500	2.4	2,316	Sept. 3	1,432	3.3	2,809
10	1,453	2.2	2,284	7	1,869	6.5	8,312
13	2,409	4.4	6,598	14	1,571	3.7	3,497
18	1,260	2.0	1,731	16	2,104	6.7	9,768
26	1,472	2.2	2,278	21	2,642	6.3	11,758
31	1,285	2.1	1,817	27	2,307	5.8	8,078
Apr 5	1,324	2.2	2,001	30	1,937	4.9	5,776
12	1,468	2.3	2,258	Oct. 5	1,842	4.0	4,310
16	1,306	2.1	1,857	10	1,637	3.7	3,349
21	1,342	2.1	1,887	15	1,558	3.2	2,951
25	1,341	2.0	1,843	21	1,432	3.0	2,584
30	1,403	2.3	2,148	26	1,414	2.8	2,271
May 6	1,294	2.0	1,833	31	1,376	2.8	2,286
11	1,390	2.3	2,065	Nov. 5	1,349	2.7	2,036
15	1,414	2.5	2,144	11	1,323	2.6	1,983
22	2,449	4.6	6,752	17	1,334	2.5	2,024
27	2,816	5.6	9,691	21	1,442	2.4	2,151
31	2,543	4.5	5,997	26	1,427	2.4	2,055
June 6	1,787	4.0	3,756	30	1,383	2.35	2,028
11	1,602	3.4	3,281	Dec. 5	1,323	2.4	1,992
16	1,399	2.5	2,116	11	1,285	2.3	1,836
21	1,358	2.6	2,272	16	1,265	2.3	1,745
25	1,576	3.5	3,266	21	1,297	2.5	2,005
30	1,281	3.0	2,620	27	1,317	2.5	2,007
July 7	1,640	4.2	3,692	31	1,291	2.5	2,005
7	2,921	6.5	13,373				

Daily gage height, in feet, of Rio Grande near Laredo, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.5	2.5	2.0	2.2	2.2	4.5	2.8	3.1	3.6	4.6	2.7	2.35
2	2.55	2.6	2.1	2.2	2.1	5.45	2.8	3.75	3.4	4.7	2.55	2.4
3	2.5	2.5	2.1	2.15	2.05	4.6	2.5	4.3	3.4	4.4	2.5	2.4
4	2.5	2.4	2.3	2.1	2.0	4.75	2.8	3.6	3.6	4.05	2.7	2.4
5	2.4	2.3	2.4	2.2	2.0	4.1	3.15	3.95	3.3	3.95	2.7	2.4
6	2.45	2.3	2.3	2.2	2.0	4.1	3.7	4.55	3.9	3.9	2.6	2.3
7	2.5	2.3	2.3	2.15	2.0	4.1	4.95	4.3	6.05	3.55	2.5	2.3
8	2.4	2.4	2.15	2.15	2.1	3.7	5.4	3.7	5.6	3.45	2.4	2.3
9	2.45	2.5	2.1	2.2	2.2	3.5	3.65	4.4	5.0	3.6	2.5	2.25
10	2.6	2.5	2.2	2.2	2.3	3.4	3.1	4.1	4.6	3.7	2.6	2.2
11	2.6	2.45	2.2	2.1	2.3	3.4	4.1	3.6	4.3	3.6	2.55	2.3
12	2.5	2.3	2.5	2.2	2.2	2.95	5.0	3.85	4.3	3.9	2.45	2.3
13	2.4	2.3	4.45	2.3	2.2	2.65	5.7	3.45	4.1	3.7	2.2	2.3
14	2.6	2.45	3.3	2.3	2.1	2.5	6.65	4.15	3.85	3.4	2.1	2.3
15	2.75	2.3	2.45	2.2	2.5	2.5	5.6	3.2	5.85	3.35	2.3	2.3
16	2.8	2.3	2.2	2.1	2.4	2.5	7.15	3.35	6.5	3.35	2.35	2.3
17	2.75	2.4	2.05	2.1	2.5	2.4	5.9	3.8	5.0	3.2	2.45	2.3
18	2.65	2.3	2.0	2.2	2.6	2.4	5.05	3.4	5.5	3.75	2.4	2.3
19	2.6	2.2	2.1	2.2	2.75	2.2	5.15	3.55	5.8	3.7	2.4	2.3
20	2.4	2.2	2.1	2.1	2.4	2.45	5.6	3.45	6.4	3.2	2.4	2.45
21	2.4	2.15	2.1	2.1	3.5	2.55	4.85	3.75	6.15	3.0	2.4	2.5
22	2.3	2.1	2.1	2.1	4.3	2.4	4.25	5.25	5.6	2.95	2.4	2.5
23	2.3	2.2	2.25	2.1	3.25	2.75	4.15	5.0	4.8	2.6	2.4	2.5
24	2.2	2.1	2.6	2.0	3.25	2.8	9.2	4.3	5.15	2.9	2.4	2.5
25	2.15	2.1	2.35	2.0	3.2	3.25	6.65	3.85	4.3	2.95	2.4	2.5
26	2.0	2.05	2.2	2.0	4.25	3.15	4.4	4.5	4.9	2.8	2.4	2.5
27	2.0	2.0	2.2	2.0	5.4	3.25	3.5	4.5	5.65	2.45	2.4	2.5
28	2.0	2.0	2.2	2.05	4.45	3.3	2.75	4.8	5.6	2.2	2.4	2.5
29	2.1	.....	2.15	2.25	4.0	3.2	2.85	5.45	5.15	2.65	2.4	2.5
30	2.35	.....	2.1	2.25	4.0	3.0	2.55	4.85	4.9	2.8	2.35	2.5
31	2.5	.....	2.1	.....	4.1	.....	2.85	4.4	.....	2.8	.....	2.5

RIO GRANDE NEAR ROMA, TEX.

The station was established in 1900 by the International Boundary Commission. It is near Roma, Tex., 775 miles, by river, below El Paso.

The right bank is alluvial deposit, and overflows in high water for a width of 250 feet. The overflow section is thickly covered with mesquite brush. The left bank is of hard material, and does not overflow.

The river bed is constantly shifting, and frequent discharge measurements are necessary to determine closely the daily discharge. The section is subject to overflow at high water.

The highest recorded flood, September 16, 1904, marked 26 feet on the gage.

The observations at this section have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights for the years 1900 to 1904, which had not hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio Grande near Roma, Tex., in 1909.

[By H. P. Guerra.]

Date.	Area of section.	Gage height.	Discharge	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	1,486	2.9	2,286	July 2	5,745	12.7	32,157
6	1,349	2.8	2,101	6	8,502	18.3	53,442
10	1,357	2.8	2,068	10	3,945	8.4	18,380
14	1,357	2.8	2,097	14	4,242	9.1	19,390
18	1,314	2.7	2,008	18	4,068	8.7	18,841
22	1,319	2.7	2,010	22	3,849	8.2	17,394
26	1,317	2.7	2,021	25	4,594	10.2	22,162
30	1,317	2.5	2,020	30	3,099	6.6	11,482
Feb. 2	1,290	2.5	1,954	Aug. 2	3,102	6.6	11,493
6	1,202	2.4	1,862	6	3,194	6.8	12,435
10	1,204	2.4	1,851	10	3,535	7.6	16,066
14	1,206	2.4	1,857	13	4,320	9.4	19,870
18	1,117	2.0	1,721	17	3,580	7.6	16,198
23	1,121	2.0	1,729	22	3,112	6.6	11,840
27	1,119	2.0	1,726	26	3,112	6.6	11,854
Mar. 2	1,039	1.9	1,600	28	6,079	13.2	33,246
6	1,042	1.9	1,605	30	8,959	19.0	59,129
10	1,044	1.9	1,608	Sept. 2	5,326	11.6	26,809
14	2,053	4.3	3,372	6	3,553	7.6	16,168
18	1,118	2.0	1,701	10	3,408	7.3	15,007
22	1,116	2.0	1,707	14	3,061	6.4	10,838
26	1,276	2.5	1,918	18	3,063	6.4	10,859
30	1,044	1.9	1,618	22	3,758	8.0	16,921
Apr. 2	1,036	1.9	1,600	26	3,554	7.6	16,249
6	948	1.7	1,444	29	3,553	6.4	10,808
8	2,027	4.3	3,400	Oct. 2	3,013	6.3	10,665
12	1,281	2.5	1,934	6	2,350	4.9	5,013
17	949	1.7	1,458	10	2,204	4.5	4,151
22	845	1.0	1,184	14	2,028	4.0	3,230
26	841	1.0	1,177	18	1,922	3.8	3,049
29	841	1.0	1,186	22	1,950	3.9	3,160
May 2	1,269	2.5	1,924	26	1,897	3.7	3,005
6	847	1.0	1,215	30	1,549	3.0	2,444
10	851	1.0	1,221	Nov. 2	1,553	3.0	2,457
12	1,287	2.5	1,996	6	1,425	2.8	2,236
17	974	1.8	1,534	10	1,436	2.8	2,269
21	1,227	2.4	1,900	14	1,848	3.7	3,011
22	2,028	4.0	3,214	18	1,852	3.7	3,013
25	2,067	4.3	3,441	22	1,634	3.4	2,719
27	2,376	5.0	5,286	26	1,637	3.4	2,724
28	3,634	7.7	16,337	29	1,644	3.5	2,736
June 2	4,410	9.8	20,467	Dec. 2	1,644	3.5	2,738
6	2,147	4.4	3,731	6	1,640	3.5	2,734
10	1,704	3.7	3,011	10	1,644	3.5	2,739
14	1,673	3.4	2,794	14	1,486	3.4	2,637
18	1,625	3.3	2,698	18	1,494	3.4	2,666
22	2,113	4.3	3,605	22	1,490	3.4	2,662
26	2,421	5.4	6,604	26	1,517	3.7	2,905
29	2,468	5.4	6,929	30	1,525	3.7	2,953

Daily gage height, in feet, of Rio Grande near Roma, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.9	2.5	2.0	1.9	1.5	5.0	7.9	6.35	15.95	6.2	3.0	3.5
2	2.9	2.5	1.9	1.9	2.15	9.6	13.3	6.6	13.55	6.05	3.1	3.5
3	2.9	2.5	1.9	1.7	1.6	6.55	18.7	7.3	11.15	5.7	3.05	3.5
4	2.9	2.5	1.9	1.7	1.15	4.4	18.65	6.95	8.4	5.6	3.0	3.5
5	2.8	2.5	1.9	1.75	1.0	4.4	18.65	6.8	7.6	5.2	3.0	3.4
6	2.8	2.4	1.9	1.8	0.9	4.4	18.3	7.0	7.7	4.9	2.85	3.4
7	2.8	2.4	1.9	1.7	.9	4.25	14.4	7.5	8.95	4.8	2.85	3.5
8	2.8	2.4	1.9	4.05	.8	4.15	10.3	7.85	9.35	4.65	3.1	3.5
9	2.8	2.4	1.9	2.85	.8	4.0	9.35	7.65	8.55	4.5	3.6	3.5
10	2.8	2.4	1.9	2.45	.85	3.8	8.1	7.4	7.4	4.45	2.9	3.5
11	2.8	2.4	1.9	2.55	2.3	3.85	7.25	7.05	7.25	4.35	3.15	3.4
12	2.8	2.4	1.9	2.1	2.35	3.8	8.2	8.2	7.1	4.25	3.7	3.4
13	2.8	2.4	1.9	1.85	2.15	3.7	8.8	8.95	6.8	4.15	3.7	3.4
14	2.75	2.35	3.1	1.75	2.0	3.45	9.15	7.25	6.35	4.05	3.7	3.4
15	2.7	2.25	3.5	1.55	1.9	3.4	8.95	7.0	6.65	4.0	3.65	3.4
16	2.7	2.1	3.05	1.35	1.8	3.4	8.8	6.85	6.5	3.9	3.6	3.4
17	2.7	2.05	2.4	1.1	1.8	3.4	9.15	6.7	6.55	3.9	3.6	3.4
18	2.7	2.0	2.1	1.0	1.95	3.3	8.5	6.95	6.7	3.8	3.6	3.4
19	2.7	2.0	1.95	1.0	2.2	3.3	7.9	6.95	8.0	4.3	3.6	3.4
20	2.7	2.0	1.9	1.0	2.5	3.4	9.15	6.75	7.85	5.1	3.6	3.4
21	2.7	2.0	1.9	1.0	2.45	3.5	8.8	6.65	8.0	3.9	3.5	3.4
22	2.7	2.0	1.95	1.0	3.95	4.1	7.75	6.6	7.95	3.85	3.4	3.4
23	2.7	2.0	1.8	1.0	4.0	4.3	7.1	7.35	7.75	3.75	3.4	3.8
24	2.7	2.0	1.7	1.0	3.65	4.75	6.8	7.15	7.75	3.7	3.4	3.85
25	2.7	2.0	1.95	1.0	4.0	4.9	9.5	6.8	7.65	3.7	3.4	3.7
26	2.65	2.0	2.3	1.0	4.9	5.3	8.2	6.55	7.5	3.65	3.4	3.7
27	2.55	2.0	1.9	1.0	6.25	5.45	7.2	8.7	6.9	3.5	3.5	3.7
28	2.5	2.0	2.65	1.0	7.7	5.4	6.7	12.75	6.7	3.35	3.5	3.7
29	2.5	.....	2.05	1.0	5.5	5.4	6.65	16.95	6.5	3.3	3.5	3.7
30	2.5	.....	1.85	1.0	5.25	5.4	6.5	18.95	6.35	3.15	3.5	3.7
31	2.5	.....	1.8	.....	4.9	.....	6.35	17.05	.....	3.0	.....	3.7

RIO GRANDE NEAR BROWNSVILLE, TEX.

This station was established in 1900 by the International Boundary Commission. It is about one mile above Brownsville, Tex., and opposite Matamoros, Tamaulipas, Mex., and 900 miles by river below El Paso.

Between Roma and Brownsville there are many lagoons (old river beds) which take river water during moderate floods, and a large area overflows quite deeply in larger floods. Much of this water returns slowly to the river as the flood subsides, so that the flow passes Brownsville more uniformly than it does Roma. Large quantities of water also leave the river entirely, reaching the Gulf of Mexico through channels remote from the Rio Grande. Local run-off, however, keeps the total water at Brownsville well up toward the combined flow of the San Juan and the Rio Grande at Roma. Both banks are alluvial and are just about level with high water. The right bank is protected by piling.

As the bed of the river is constantly shifting, frequent discharge measurements are made to determine closely the daily flow.

The observations at this station have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights for the years 1900 to 1904, which had not hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio Grande near Brownsville, Tex., in 1909.

[By P. Guerra.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 3	1,492	1.5	1,825	July 3	4,946	12.4	25,488
7	1,488	1.5	1,815	7	5,514	13.4	28,999
11	1,494	1.5	1,831	11	5,612	13.8	30,235
15	1,480	1.4	1,789	15	4,739	11.4	17,249
19	1,488	1.4	1,815	19	4,633	11.1	16,282
23	1,478	1.3	1,790	23	3,853	8.9	11,847
27	1,478	1.3	1,782	27	4,909	12.3	23,385
31	1,474	1.2	1,756	31	2,871	7.0	8,549
Feb. 3	1,468	1.1	1,741	Aug. 3	2,822	6.7	8,219
7	1,464	1.1	1,722	7	3,354	8.1	10,373
11	1,460	1.1	1,715	11	3,500	8.6	11,331
15	1,289	.9	1,414	15	5,388	13.8	27,687
19	1,271	.5	1,404	19	3,855	9.5	12,782
23	1,261	.4	1,379	23	3,627	8.8	11,943
27	1,240	.3	1,340	27	4,870	12.0	21,087
Mar. 3	1,226	.2	1,314	31	5,512	13.9	29,543
7	1,206	.1	1,270	Sept. 3	5,550	14.0	30,188
11	1,216	.1	1,267	7	5,660	14.3	31,655
15	1,198	.0	1,228	11	5,402	13.6	28,331
19	1,484	1.0	1,697	15	4,542	11.2	18,707
23	1,282	.4	1,383	19	5,478	13.8	28,921
27	1,264	.2	1,354	23	5,112	12.8	25,470
30	1,180	— .1	1,227	26	5,364	13.5	27,742
Apr. 2	1,083	— .2	1,133	30	4,266	10.4	16,959
6	1,047	— .4	1,077	Oct. 3	4,039	9.2	12,195
10	1,103	— .2	1,192	7	3,698	8.0	10,396
14	1,784	2.0	2,759	11	3,491	7.4	7,839
18	1,425	.7	1,717	15	3,164	6.8	6,183
22	1,049	— .4	1,068	19	2,892	6.0	5,431
26	973	— .8	954	23	3,017	6.4	5,731
30	973	— .8	943	27	2,716	5.3	5,004
May 2	947	— .9	890	30	2,529	4.7	4,569
6	1,055	— .4	1,086	Nov. 3	2,403	4.4	4,820
10	1,034	— .7	1,036	7	2,292	4.1	4,357
14	1,066	— .6	1,089	11	2,256	4.0	4,229
18	1,264	.2	1,365	15	2,226	3.9	4,087
22	1,276	.3	1,386	19	2,044	3.3	3,731
26	1,840	2.6	2,983	23	1,992	3.1	3,574
30	3,750	9.2	10,959	28	1,936	2.9	3,396
June 3	3,416	8.2	9,643	Dec. 2	1,912	2.8	3,254
7	2,489	5.0	4,656	6	1,980	3.0	3,542
11	2,225	4.1	4,169	10	1,882	2.7	3,132
14	1,912	3.0	3,525	14	1,838	2.5	2,936
18	1,849	2.8	3,335	18	1,846	2.5	2,939
22	1,771	2.4	3,118	22	1,856	2.6	3,010
26	1,836	2.7	3,280	26	1,926	2.8	3,191
30	2,331	4.4	4,529	30	1,964	2.9	3,399

Daily gage height, in feet, of Rio Grande near Brownsville, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	1.1	0.3	−0.1	−0.8	6.35	6.3	6.6	14.0	9.8	4.5	2.85
2	1.5	1.1	.3	− .2	− .9	5.4	8.8	6.6	14.0	9.45	4.45	2.8
3	1.5	1.1	.2	− .2	− .75	7.6	11.85	6.75	14.0	9.25	4.4	2.75
4	1.5	1.1	.2	− .3	− .55	10.1	13.05	7.2	14.2	8.9	4.3	2.7
5	1.5	1.1	.2	− .4	− .4	9.3	13.2	8.0	14.2	8.65	4.2	2.7
6	1.5	1.1	.1	− .4	− .3	7.85	13.25	8.3	14.2	8.4	4.2	2.9
7	1.5	1.1	.1	− .45	− .4	5.0	13.45	8.15	14.3	8.05	4.0	2.9
8	1.5	1.1	.1	− .5	− .5	4.8	13.55	8.2	14.2	7.85	3.75	2.9
9	1.5	1.1	.1	− .45	− .6	4.5	13.75	8.55	14.15	7.75	3.55	2.8
10	1.5	1.1	.1	− .2	− .7	4.25	13.8	8.45	14.1	7.65	3.5	2.75
11	1.5	1.1	.1	.0	− .7	4.0	13.8	8.4	13.8	7.45	4.0	2.7
12	1.5	1.1	.1	1.9	− .7	3.7	13.8	10.15	13.1	7.25	4.15	2.65
13	1.5	1.0	.05	2.2	− .7	3.2	12.95	13.15	12.2	7.1	4.15	2.5
14	1.4	.95	.0	2.0	− .6	3.0	11.2	13.5	11.45	6.95	4.1	2.5
15	1.4	.9	.0	1.7	− .55	3.0	11.6	13.75	11.05	6.75	3.95	2.5
16	1.4	.8	.05	1.2	− .35	2.95	11.9	13.9	10.6	6.55	3.8	2.5
17	1.4	.6	.25	.95	.2	2.9	11.8	13.6	11.5	6.35	3.55	2.5
18	1.4	.6	.65	.75	.2	2.8	11.45	11.45	12.3	6.15	3.4	2.5
19	1.4	.5	1.2	.55	.2	2.75	11.2	9.7	13.9	6.5	3.3	2.5
20	1.4	.5	1.45	.15	.2	2.65	10.2	9.1	13.35	5.85	3.25	2.5
21	1.3	.5	1.2	− .2	.25	2.6	9.65	8.9	13.05	5.75	3.2	2.5
22	1.3	.4	.55	− .45	.3	2.45	11.05	8.8	12.9	6.05	3.15	2.55
23	1.3	.4	.4	− .6	.4	2.2	10.65	8.8	12.75	6.45	3.1	2.45
24	1.3	.4	.4	− .7	.6	2.2	8.75	9.75	12.65	6.25	3.0	2.55
25	1.3	.3	.35	− .7	1.2	2.35	7.95	10.05	12.9	5.85	3.0	2.75
26	1.3	.3	.3	− .8	2.3	2.6	8.35	10.45	13.55	5.45	3.0	2.8
27	1.3	.3	.2	− .8	2.95	3.2	12.1	11.85	12.4	5.25	3.0	2.9
28	1.2	.3	.1	− .8	3.35	3.6	11.05	12.35	11.1	5.05	2.9	2.9
29	1.2	.....	.0	− .8	7.3	3.95	8.3	13.15	10.55	4.85	2.9	2.9
30	1.2	.....	− .05	− .8	9.3	4.3	7.45	13.65	10.3	4.65	2.9	2.9
31	1.2	.....	− .1	.....	7.25	.....	6.65	13.9	.....	4.5	.....	2.9

CONEJOS RIVER BASIN.

CONEJOS RIVER NEAR MOGOTE, COLO.

Conejos River, the most important tributary of the Rio Grande in Colorado, rises on the eastern slope of the San Juan Range, which forms the western boundary of Conejos County. It first flows southeastward, but at the town of Conejos bends northeastward and enters the Rio Grande below the mouth of Trinchera Creek.

The gaging station, which was established March 21, 1907, replacing the station formerly maintained about 4 miles below, is located at a private highway bridge on Jacob's ranch, about 16 miles above Antonito, Colo., in T. 33 N., R. 6 E., New Mexico principal meridian. It is above every important diversion for irrigation and below all the principal tributaries except the San Antonio.

The datum of the chain gage, which is on the bridge, has not been changed since the station was established. This gage is at the same datum as the rod gage used by Antoine Jacob during 1905 and 1906. The gage heights for these years have been furnished to the United States Geological Survey by him from his private records. Discharge measurements are also made from the highway bridge.

The data obtained at this station show the amount of water available for irrigation.

Water taken from the Conejos by numerous ditches below the station is used to irrigate 70,000 to 80,000 acres of land. The basin above the station affords excellent opportunities for storage, none of which are utilized at the present time. It will be difficult to secure additional water rights for irrigation along this stream.

The river is covered with ice for three or four months during the winter season. The stream bed is strewn with cobblestones and bowlders, and the water has a comparatively high velocity at all stages, making conditions unfavorable for accurate measurement. Eddies around the crib piers of the bridge also introduce uncertainty in the results.

A view of the river at this station is shown in Plate V, *B*.

Discharge measurements of Conejos River near Mogote, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 15	W. B. Freeman	121	314	2.35	1,070
June 23	do	126	369	2.80	1,710
Aug. 3	G. H. Russell	90.5	153	1.00	272
Sept. 30	do	62	92.5	.65	124
Nov. 13 [a]	J. B. Stewart	59	76	.35	57
Dec. 20 [b]	G. H. Russell	46	33	.....	74

[a] Ice along edge of stream. [b] Made about 8 miles below station.

Daily gage height, in feet, of Conejos River near Mogote, Colo., for 1909.

[Francisque Jacob, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.4	2.5	2.2	0.95	1.35	0.60	0.5	0.45
2	.....	1.45	2.65	2.3	1.05	1.4	.6	.45	.45
3	.....	1.85	2.95	2.25	1.05	1.4	.6	.4	.5
4	.....	2.2	3.25	2.15	1.05	1.45	.7	.4	.5
5	.....	2.7	3.55	2.1	1.1	2.1	.85	.4	.4
6	.....	2.7	3.65	2.1	1.2	2.5	1.0	.4	.4
7	.....	2.8	3.55	2.05	1.25	2.45	1.0	.4	.4
8	.....	2.8	3.45	2.05	1.15	2.2	1.05	.4	.5
9	.....	2.4	3.4	1.95	1.1	1.9	.85	.4	.5
10	.....	2.45	3.35	1.85	1.15	1.8	.8	.4	.5
11	.....	2.4	3.25	1.8	1.0	1.7	.8	.4	.5
12	.....	2.45	3.3	1.7	1.0	1.55	.8	.5	.4
13	.....	2.4	3.2	1.55	1.2	1.6	.8	.4	.4
14	.....	2.5	3.05	1.4	1.05	1.5	.8	.4	.5
15	.....	2.45	2.95	1.35	1.0	1.5	.8	.5	.5
16	.....	2.6	2.95	1.3	1.1	1.4	.7	.5	.4
17	.....	2.7	2.95	1.25	1.0	1.3	.7	.5	.4
18	.....	2.8	3.1	1.25	1.05	1.25	.7	.5	.4
19	.....	2.9	3.0	1.25	1.0	1.2	.7	.5	.4
20	.....	2.7	3.05	1.25	1.0	1.1	.7	.5	.4
21	.....	2.7	3.05	1.2	1.0	1.1	.6	.5	.4
22	.....	2.7	2.95	1.25	.95	1.1	.6	.6	.4
23	.....	2.45	2.8	1.25	1.15	1.1	.6	.5	.4
24	.....	2.3	2.8	1.4	1.25	.95	.6	.4	.4
25	1.35	2.2	2.75	1.35	1.4	.95	.6	.4	.4
26	1.35	2.35	2.6	1.25	1.25	.85	.6	.4	.3
27	1.55	2.5	2.55	1.2	1.4	.85	.6	.4	.3
28	1.65	2.75	2.4	1.1	1.35	.7	.55	.4	.4
29	1.65	2.6	2.4	1.1	1.9	.7	.55	.45	.4
30	1.3	2.4	2.35	1.1	1.6	.65	.55	.5	.4
31	.....	2.4	.....	.95	1.45	.....	.55	.....	.4

NOTE.—Probable ice conditions December 1–31, but it is believed that the gage heights were affected but little.

Daily discharge, in second-feet, of Conejos River near Mogote, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	353	1,230	1,010	222	388	120	95	85
2	.....	378	1,430	1,120	259	413	120	85	85
3	.....	618	1,900	1,060	259	413	120	75	95
4	.....	900	2,420	960	259	440	147	75	95
5	.....	1,500	2,940	910	278	910	190	75	75
6	.....	1,500	3,120	910	319	1,360	240	75	75
7	.....	1,650	2,940	865	341	1,300	240	75	75
8	.....	1,650	2,770	865	298	1,010	259	75	95
9	.....	1,110	2,680	780	278	740	190	75	95
10	.....	1,170	2,590	701	298	662	175	75	95
11	.....	1,110	2,420	662	240	592	175	75	95
12	.....	1,170	2,500	592	240	498	175	95	75
13	.....	1,110	2,330	498	319	528	175	75	75
14	.....	1,230	2,070	413	259	468	175	75	95
15	.....	1,170	1,900	388	240	468	175	95	95
16	.....	1,360	1,900	363	278	413	147	95	75
17	.....	1,500	1,900	341	240	363	147	95	75
18	.....	1,650	2,160	341	259	341	147	95	75
19	.....	1,810	1,980	341	240	319	147	95	75
20	.....	1,500	2,070	341	240	278	147	95	75
21	.....	1,500	2,070	319	240	278	120	95	75
22	.....	1,500	1,900	341	222	278	120	120	75
23	.....	1,170	1,650	341	298	278	120	95	75
24	.....	1,000	1,650	413	341	222	120	75	75
25	330	900	1,580	388	413	222	120	75	75
26	330	1,060	1,360	341	341	190	120	75	60
27	430	1,230	1,300	319	413	190	120	75	60
28	488	1,580	1,110	278	388	147	108	75	75
29	488	1,360	1,110	278	740	147	108	85	75
30	308	1,110	1,060	278	528	134	108	95	75
31	.....	1,110	.....	222	440	.....	108	.....	75

NOTE.—The above discharges are based on a rating curve that is fairly well defined below 400 second-feet. Discharges December 1–31 may be slightly affected by ice.

Monthly discharge of Conejos River near Mogote, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April 25–30	488	308	396	4,710	B.
May	1,810	353	1,220	75,000	B.
June	3,120	1,060	2,000	119,000	B.
July	1,120	222	548	33,700	B.
August	740	222	314	19,300	B.
September	1,360	134	466	27,700	B.
October	259	108	151	9,280	C.
November	120	75	84.5	5,030	C.
December	95	60	79.8	4,910	D.
The period	.....	.....	.....	299,000	

SANTA FE CREEK BASIN.

SANTA FE CREEK AT SANTA FE, N. MEX.

Santa Fe Creek rises on the range east of Santa Fe and flows westward over high plains to join the Rio Grande south of the Espanola Valley.

The gaging station, which was established May 31, 1907, to determine the amount of water available for irrigation and storage, is located at the Don Gaspar Avenue Bridge in the city of Santa Fe.

The gage datum was changed on August 13, 1908, and again on August 22, 1908. Results obtained at this station have been very unsatisfactory owing to the torrential character of the stream, the shifting nature of the bed, and the inadequate number of discharge measurements.

Discharge measurements are made from the downstream side of the bridge.

No important tributaries except intermittent streams enter below the station. The drainage area at the station is about 40 square miles, and at the mouth of the river it is about 300 square miles.

The reservoir for the Santa Fe municipal supply is situated in the canyon above the station and a water-power plant of 100-horsepower capacity is used to develop power for lighting. Very little water is diverted for irrigation above the station. One small ditch takes water out just above. In the canyon 8 miles above Santa Fe is a reservoir site where 10,000 acre-feet can be stored.

Ice is usually to be found in the stream during the winter months, though the flow is very small during that period. The low-water flow is regulated to some extent by the waterworks reservoir above.

Discharge measurements of Santa Fe Creek at Santa Fe, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 8	J. B. Stewart	9	3	0.05	5.2
Aug. 25	Sullivan and Stewart	30	27	.55	169
Do	J. B. Stewart	27.5	18	.30	69
Oct. 5	W. B. Freeman	.....	.....	−.10	*a* .2

a Estimated.

NOTE.—Measurements made at various sections.

Daily gage height, in feet, of Santa Fe Creek at Santa Fe, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	−0.3	−0.25	−0.4	−0.3	−0.1	−0.4	−0.5	−0.6	−0.4	−0.1	−0.15	−0.1
2	−.3	−.2	−.3	−.3	−.3	−.4	−.5	−.6	−.45	−.1	−.15	−.1
3	−.5	−.2	−.3	−.3	−.3	−.3	−.5	−.5	−.3	−.1	−.15	−.1
4	−.3	−.35	−.4	−.4	−.3	−.3	−.5	−.35	−.45	−.1	−.15	−.1
5	−.4	−.25	−.4	−.4	−.2	−.2	−.4	−.4	+.25	−.1	−.15	−.1
6	−.3	−.2	−.4	−.4	−.2	.0	−.5	−.4	+.1	.0	−.15	−.1
7	−.3	−.3	−.3	−.4	−.1	.0	−.5	−.6	.4	+.05	−.15	−.1
8	−.3	−.4	−.3	−.4	−.1	−.2	−.5	−.6	.4	.0	−.15	−.1
9	−.3	−.4	−.3	−.4	−.05	−.2	−.5	−.5	.3	.0	−.15	−.1
10	−.3	−.3	−.4	−.4	−.05	−.25	−.5	−.4	.35	.0	−.15	−.1
11	−.25	−.3	−.35	−.4	−.05	−.1	−.5	−.5	.3	+.1	−.1	−.1
12	−.3	−.4	−.3	−.4	−.05	−.2	−.5	−.6	.3	.1	−.1	−.1
13	−.25	−.4	−.3	−.4	−.05	−.2	−.2	−.4	.4	.1	−.1	−.1
14	−.25	−.4	−.2	−.4	−.05	−.25	−.5	−.4	.0	+.1	−.1	−.1
15	−.3	−.45	−.2	−.4	−.05	−.3	−.5	−.15	.15	−.1	−.1	−.1
16	−.2	−.45	−.2	−.45	−.1	−.3	−.5	−.4	.2	−.1	−.1	−.1
17	−.2	−.45	−.3	−.45	−.1	−.4	−.5	.....	.1	−.1	−.1	−.1
18	−.3	−.45	−.35	−.45	−.1	−.4	−.5	.....	.15	−.1	−.1	−.1
19	−.3	−.45	−.35	−.4	−.25	−.15	−.5	.....	.15	−.1	−.1	−.1
20	−.25	−.4	−.4	−.5	+.1	−.15	−.5	.....	.1	−.1	−.1	−.1

Daily gage height, in feet, of Santa Fe Creek at Santa Fe, N. Mex., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	−0.2	−0.4	−0.45	−0.5	+0.2	−0.25	−0.5	.....	+0.05	−0.1	−0.1	−0.1
22	− .2	− .3	− .45	− .4	− .1	− .4	− .5	.....	.0	− .1	− .1	− .1
23	− .15	− .3	− .45	− .3	− .1	− .35	− .5	.....	.0	− .1	− .1	− .1
24	− .3	− .2	− .45	− .2	− .05	− .5	− .5	−0.1	.0	− .1	− .1	− .1
25	− .2	− .3	− .3	− .45	− .05	− .5	+ .1	− .1	.0	− .1	− .1	− .1
26	− .15	− .45	− .3	− .45	− .1	− .5	.0	.0	− .1	− .1	− .1	− .1
27	− .2	− .5	− .35	− .4	− .3	− .4	− .3	.....	− .1	− .1	+ .2	.0
28	− .2	− .5	− .3	− .3	− .4	− .5	− .4	.....	− .1	− .1	+ .2	.0
29	− .25	.....	− .3	− .15	− .4	− .3	− .4	.....	− .1	− .1	.0	.0
30	− .3	.....	− .3	− .4	− .4	− .5	− .4	.....	− .1	− .1	.0	.0
31	− .2	.....	− .3	.....	− .4	.....	− .4	− .4	.....	− .1	.....	.0

NOTE.—Ice conditions during January and February.

Daily discharge, in second-feet, of Santa Fe Creek at Santa Fe, N. Mex., for 1907–1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	.....	.....	.....	.....	.....	19	0.5	0.5	34	0.5	1.0	3.5
2	.....	.....	.....	.....	.....	20	.5	.5	20	.5	1.0	6.3
3	.....	.....	.....	.....	.....	20	.5	3.5	27	.5	1.0	1.5
4	.....	.....	.....	.....	.....	20	.5	1.5	20	.5	1.0	1.3
5	.....	.....	.....	.....	.....	20	.5	2.5	11	.5	1.0	1.5
6	.....	.....	.....	.....	.....	20	.5	.5	20	.5	1.3	2.5
7	.....	.....	.....	.....	.....	22	.5	.5	11	.5	1.3	3.5
8	.....	.....	.....	.....	.....	22	.5	.5	15	.5	1.3	3.5
9	.....	.....	.....	.....	.....	20	1.0	.5	13	.5	1.3	3.5
10	.....	.....	.....	.....	.....	20	.5	.5	11	.5	1.1	4.9
11	.....	.....	.....	.....	.....	18	1.0	.5	6.3	.5	1.1	3.5
12	.....	.....	.....	.....	.....	18	.5	.5	1.5	.5	1.0	3.5
13	.....	.....	.....	.....	.....	15	.5	.5	.5	.5	1.0	6.3
14	.....	.....	.....	.....	.....	15	.5	.5	.5	.5	1.0	6.3
15	.....	.....	.....	.....	.....	11	.5	.5	.5	.5	1.3	8.6
16	.....	.....	.....	.....	.....	14	.5	.5	1.5	.5	1.0	6.3
17	.....	.....	.....	.....	.....	14	.5	.5	.5	.5	1.0	6.3
18	.....	.....	.....	.....	.....	11	.5	.5	1.0	.5	1.0	6.3
19	.....	.....	.....	.....	.....	15	.5	1.0	.5	.5	1.1	8.6
20	.....	.....	.....	.....	.....	20	.5	1.0	1.0	.5	1.1	8.6
21	.....	.....	.....	.....	.....	11	.5	.5	.7	1.0	1.0	6.3
22	.....	.....	.....	.....	.....	11	.5	.5	.7	.5	1.0	4.9
23	.....	.....	.....	.....	.....	8.6	.5	.5	.5	.5	1.5	6.3
24	.....	.....	.....	.....	.....	8.6	.5	.5	.5	.5	2.5	4.9
25	.....	.....	.....	.....	.....	5.7	.5	.5	.5	.5	2.5	4.9
26	.....	.....	.....	.....	.....	3.5	.5	.5	.5	.5	2.5	4.9
27	.....	.....	.....	.....	.....	2.5	.5	.5	.5	.5	3.1	3.5
28	.....	.....	.....	.....	.....	2.5	1.0	.5	.5	.5	3.1	3.5
29	.....	.....	.....	.....	.....	1.5	1.0	.5	.5	.7	3.5	4.9
30	.....	.....	.....	.....	.....	1.0	.5	85	.5	.7	3.5	3.5
31	.....	.....	.....	.....	.....	.....	.5	34	.....	.7	.....	4.9
1908.												
1	6.2	1.0	0.9	0.0	0.5	8.5	.0	14	2.0	.4	.4	2.0
2	8.2	1.0	2.4	.0	.0	26	.0	90	1.1	.4	.4	2.0
3	6.2	1.8	1.6	.0	.8	5.2	.0	111	.4	.4	.4	2.0
4	4.5	1.0	1.6	.0	3.2	2.8	.0	111	.4	.4	.4	.4
5	6.2	1.0	2.4	.0	.0	3.8	.0	111	.4	.4	.4	.4
6	6.0	5.2	4.7	.0	.0	2.8	.0	111	.4	.4	.4	.4
7	6.0	5.2	2.4	.0	2.3	1.9	.0	111	.4	.4	.4	.1
8	6.0	3.8	.6	.0	.0	2.0	.0	111	.1	.4	.1	.1
9	6.0	2.6	3.4	.0	.0	2.0	.0	111	.1	.4	.4	.1
10	4.4	2.6	.6	.0	.0	.5	.0	111	.1	.4	.4	.1
11	4.4	2.6	3.4	.0	.0	9.8	.0	111	.1	.4	.4	.1
12	4.4	2.6	.8	.0	.8	5.8	.0	111	.1	.4	.4	.1
13	3.2	2.6	2.3	.0	2.1	4.4	.0	.....	.1	.4	.4	.1
14	4.2	2.6	1.6	.0	1.3	.5	.0	.....	.1	.4	.4	.1
15	4.2	3.7	.3	.0	.0	.5	.....	.....	.1	.4	.4	.1

Daily discharge, in second-feet, of Santa Fe Creek at Santa Fe, N. Mex., for 1907–1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
16	3.2	3.7	0.5	0.0	0.0	6.0	8.0	.....	0.1	0.4	0.4	0.1
17	3.2	.9	.8	.0	1.3	4.6	8.0	186	.1	.4	.4	.1
18	4.0	2.5	.4	.0	1.3	.5	.....	95	.1	.4	.4	.1
19	4.0	2.5	.2	.0	.7	.5	8.0	34	.1	.4	.4	.4
20	3.0	1.6	.2	.0	.0	.5	8.0	50	.1	.4	.4	1.1
21	3.0	2.5	.2	.0	.0	.4	14	22	.1	1.1	.4	1.1
22	2.9	3.5	.2	.5	6.0	.4	4.5	22	.1	5.5	.4	1.1
23	3.9	2.5	.2	.5	18	.4	8.0	32	.1	3.3	.4	1.1
24	2.8	2.5	.2	.5	8.0	.4	6.0	32	.1	1.1	1.1	.4
25	2.7	3.5	.2	.5	4.5	.4	8.0	22	.1	1.1	1.1	.4
26	1.0	2.5	.1	.8	1.3	.4	4.5	9.0	.1	2.0	1.1	.4
27	1.0	4.8	.1	1.5	.8	1.5	4.5	5.5	.1	2.0	1.1	.4
28	2.6	2.5	.1	2.2	1.5	.3	4.5	5.5	.1	1.1	2.0	.0
29	2.6	3.5	.1	.0	1.5	.3	2.0	2.0	.1	2.0	2.0	.1
30	2.6	.....	.1	.0	.4	.0	4.5	3.3	.1	1.1	2.0	.1
31	2.6	.....	.1	.....	.4	.....	10	3.3	.....	.8	.....	1.1
1909.												
1	1.1	1.6	.4	1.1	3.3	.4	.0	.0	.0	.2	.2	.2
2	1.1	2.0	1.1	1.1	1.1	.4	.0	.0	.0	.2	.2	.2
3	.1	2.0	1.1	1.1	1.1	1.1	.0	.0	.0	.2	.2	.2
4	1.1	.8	.4	.4	1.1	1.1	.0	.2	.0	.2	.2	.2
5	.4	1.6	.4	.4	2.0	2.0	.2	.2	47	.2	.2	.2
6	1.1	2.0	.4	.4	2.0	5.5	.0	.2	31	2.0	.2	.2
7	1.1	1.1	1.1	.4	3.3	5.5	.0	.0	72	2.0	.2	.2
8	1.1	.4	1.1	.4	3.3	2.0	.0	.0	72	2.0	.2	.2
9	1.1	.4	1.1	.4	4.4	2.0	.0	.0	53	2.0	.2	.2
10	1.1	1.1	.4	.4	4.4	1.6	.0	.2	62	2.0	.2	.2
11	1.6	1.1	.8	.4	4.4	3.3	.0	.0	53	2.0	.2	.2
12	1.1	.4	1.1	.4	4.4	2.0	.0	.0	53	2.0	.2	.2
13	1.6	.4	1.1	.4	4.4	2.0	6.0	.2	72	2.0	.2	.2
14	1.6	.4	2.0	.4	4.4	1.6	.0	.2	3.0	2.0	.2	.2
15	1.1	.2	2.0	.4	4.4	1.1	.0	2.0	14	.2	.2	.2
16	2.0	.2	2.0	.2	3.3	1.1	.0	.2	20	.2	.2	.2
17	2.0	.2	1.1	.2	3.3	.4	.0	2.0	9.0	.2	.2	.2
18	1.1	.2	.8	.2	3.3	.4	.0	5.0	14	.2	.2	.2
19	1.1	.2	.8	.4	1.6	2.6	.0	10	14	.2	.2	.2
20	1.6	.4	.4	.1	9.0	2.6	.0	3.0	9.0	.2	.2	.2
21	2.0	.4	.2	.1	14	1.6	.0	5.0	5.0	.2	.2	.2
22	2.0	1.1	.2	.4	3.3	.4	.0	5.0	3.0	.2	.2	.2
23	2.6	1.1	.2	1.1	3.3	.8	.0	2.0	3.0	.2	.2	.2
24	1.1	2.0	.2	2.0	4.4	.1	.0	4.0	3.0	.2	.2	.2
25	2.0	1.1	1.1	.2	4.4	.1	2.0	4.0	3.0	.2	.2	.2
26	2.6	.2	1.1	.2	3.3	.1	1.0	15	.2	.2	.2	.2
27	2.0	.1	.8	.4	1.1	.4	.4	12	.2	.2	4.0	.2
28	2.0	.1	1.1	1.1	.4	.1	.2	10	.2	.2	4.0	.2
29	1.6	.....	1.1	2.6	.4	1.1	.2	10	.2	.2	2.0	.2
30	1.1	.....	1.1	.4	.4	.1	.2	10	.2	.2	2.0	.2
31	2.0	.....	1.1	.....	.4	.....	.2	.0	.....	.2	.....	.2

NOTE.—Discharges June 1 to December 31, 1907, were obtained from a rating curve that is not well defined; January 1 to August 1, 1908, by the indirect method for shifting channels; August 2–12, 1908, estimated; August 17, 1908, to June 30, 1909, from a rating curve that is fairly well defined; July 1 to December 31, 1909, estimated by the hydrographer.

Monthly discharge of Santa Fe Creek at Santa Fe, N. Mex., for 1907–1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1907.					
June	22.0	1.0	13.7	815	D.
July	1.0	.5	.56	34	D.
August	85.0	.5	4.53	279	D.
September	34.0	.5	6.71	399	D.
October	1.0	.5	.54	33	D.
November	3.5	1.0	1.54	92	D.
December	8.6	1.3	4.80	295	D.
The period				1,950	
1908.					
January	8.2	1.0	4.04	248	D.
February	5.2	.9	2.70	155	D.
March	4.7	.1	1.05	65	D.
April	2.2	.0	.22	13	D.
May	18	.0	1.65	101	D.
June	26	.0	3.10	184	D.
July (29 days)	14	.0	3.53	203	D.
August (27 days)	186	2.0	64.4	3,450	D.
September	2.0	.1	.25	15	D.
October	5.5	.4	.94	58	D.
November	2.0	.1	.64	38	D.
December	2.0	.0	.52	32	D.
The period				4,560	
1909.					
January	2.6	0.1	1.45	89	D.
February	2.0	.1	.81	45	D.
March	2.0	.2	.90	55	D.
April	2.6	.1	.59	35	D.
May	14.0	.4	3.36	207	D.
June	5.5	.1	1.45	86	D.
July	6.0	.0	.34	21	D.
August	15.0	.0	3.24	199	D.
September	72.0	.0	20.5	1,220	D.
October	2.0	.2	.72	44	D.
November	4.0	.2	.57	34	D.
December	.2	.2	.20	12	D.
The year	72.0	.0	2.84	2,050	

FLOOD ON BLUEWATER CREEK, N. MEX., SEPTEMBER 6, 1909.

By W. B. FREEMAN, district engineer.

In the early part of September, 1909, there were very heavy rains in nearly every part of New Mexico, which caused great floods and did considerable damage. The storm from September 4 to 6 in the Zuni Mountains, following frequent and heavy rains in July and August, resulted in the failure of the Zuni dam at Blackrock and the Bluewater dam on Bluewater Creek, some distance above Bluewater station on the Santa Fe Railway, in Valencia County.

The flood on Zuni River and the failure of the Zuni dam are described in Water-Supply Paper 269, and also in the Engineering News of August 25, 1910.

The Bluewater dam, which had been completed about four years, was located in the canyon just below the junction of Azul Creek with Bluewater Creek, about 10 miles west of Bluewater. It might be termed an earth and rock fill dam, some 300 feet long on top and about 35 feet high. The slopes averaged probably 2½ to 1, or over,

and the dam was riprapped on the inside slope. The central portion of the dam was made up of stratified limestone, which from the section exposed by the failure appears to have been laid by hand. The dam did not rest on or go down to bedrock, but the foundation was only about 10 feet above bedrock, which is of limestone and fairly uniform in elevation across the canyon. Both the inner and outer slopes of the dam were of earth.

The capacity of the reservoir is not known. The cost of the dam is believed to have been about $35,000.

The approximate drainage area above the dam is 240 square miles, much of which is fairly well forested. The elevations range from 7,000 feet to about 9,200 feet on the tops of the mountanis which form the Continental Divide.

The dam site is a very good one. It was first surveyed by the United States Geological Survey, and is described as Reservoir No. 33, on page 195 of part 2 of the Twelfth Annual Report. According to that report the reservoir would have a capacity of 53,000 acre-feet and an area of 1,900 acres, with a dam 74.5 feet high.

Mr. R. M. Jones, an engineer of Denver, Colo., was at the dam a short time before its failure, making estimates for its enlargement, and was there also immediately after its failure. He had an opportunity to talk to the watchman at the dam, who was present when it failed. It appears that the particular storm which caused its destruction followed in a general way the crest of the Zuni Mountains and was what is commonly known as a cloudburst. Old residents in that vicinity stated that the rainfall was by far the heaviest that they had ever witnessed. The water in the reservoir did not rise gradually but rather by large increments, as the flood from each tributary arrived separately, the time depending largely on the distance the water had to travel—that is, the flood water from one stream would come down in a rush, causing a sudden rise in the reservoir, which would remain practically stationary for a few minutes, when the waters from another stream would come rushing down. The result was that the reservoir was soon filled and, the spillway being inadequate to take care of the excess waters, the dam was topped to a depth of about 1½ feet. It was then torn out by the flood waters, which cut a channel to bedrock and left only the ends of the dam standing. This violent storm was evidently only of short duration, but the run-off was tremendous. No estimate even can be made of its amount.

The dam failed on the afternoon of September 6, just a few minutes before the failure of the Zuni dam, which went out as a result of the same storm.

The Bluewater dam was owned by the Bluewater Development Company. A small dam at the same site was washed out several years ago.

A description of the flood and the failure of the dam, by C. E. Linney, section director, United States Weather Bureau, is to be found on page 639 of the Monthly Weather Review for September, 1909.

The accompanying tables show the rainfall at various points in that vicinity during August and the first part of September.

Daily precipitation in inches in the vicinity of Bluewater dam, New Mexico, from August 1 to September 6, 1909.

Day.	Blackrock.	Bluewater station.	Bluewater reservoir.	Fort Wingate.	San Rafael.	Manuelito.	Day.	Blackrock.	Bluewater station.	Bluewater reservoir.	Fort Wingate.	San Rafael.	Manuelito.
AUG.							AUG.—con.						
1	.....	0.30	0.71	0.10	0.51	0.15	21	.....	0.28	0.62	0.20	0.90	.....
2	0.35	.....	.....	Tr.	.....	1.05	22	Tr.	.....	.29	.....	.....	0.50
3	.29	.18	Tr.	.....	.29	.....	23	.63	.....	Tr.	.20	.....	3.00
4	.35	.....	.....	.20	.82	.10	24	.07	.....	.....	.....	.....	.....
5	.28	.13	.....	.20	.17	.....	25	Tr.	.37	Tr.	1.30	.....	.....
6	.....	.....	.....	.50	.....	Tr.	26	Tr.	.58	Tr.	.50	.44	.....
7	.09	.....	.20	.20	.....	.50	27	Tr.	.....	.03	.20	.....	.....
8	.....	.....	.....	.10	.....	.35	28	Tr.	.....	Tr.	Tr.	.45	.....
9	.13	.27	.....	.20	.....	.20	29	.13	.12	.....	.20	.96	.50
10	.10	.04	.....	.....	.....	.70	30	.20	.63	*	.20	.....	.30
11	.04	.05	Tr.	Tr.	1.52	.....	31	.....	.....	.66	.....	.....	.....
12	.....	.48	Tr.	Tr.	1.18	.20	Total for month	2.83	4.09	3.73	5.40	10.03	7.55
13	Tr.	.....	*	.....	.....	.....							
14	.08	.....	.50	.....	.50	.....	SEPT.						
15	Tr.	.....	.....	Tr.	.....	.....	1	0.03	.....	Tr.	0.40	0.18	0.50
16	Tr.	.....	.32	.50	.74	.....	2	.....	.....	.....	.....	.....	.....
17	.01	.28	.....	.10	.19	.....	3	.04	.....	.63	.32	.38	.....
18	.06	.....	.18	.20	.60	.....	4	.20	.....	.91	1.20	.....	.50
19	.02	.38	.22	Tr.	.76	.....	5	.60	.....	.42	.59	.88	.20
20	Tr.	.....	.....	.30	.....	.....	6	.46	.....	Tr.	1.20	.70	.01

MIMBRES RIVER BASIN.

MIMBRES RIVER NEAR FAYWOOD, N. MEX.

The station, which is located about 6 miles southeast of Faywood Hot Springs and 10 miles from Faywood station, on the Silver City branch of the Santa Fe Railway, was established April 23, 1908, to determine the amount of water available for storage.

No important tributaries enter in the vicinity of the station, though many intermittent tributaries come in both above and below. The drainage area is about 450 square miles.

Some water is used for irrigation in the Mimbres Valley below the station, but as this is primarily a flood stream and as storage has not been provided, such irrigation is uncertain. By storing the flood water and cutting off the underflow at the Rio Mimbres dam site, it will be possible to reclaim several thousand acres of land along this stream.

The gage is located about 400 feet below the proposed Rio Mimbres reservoir dam site. The gage datum was lowered 4 feet on July 8, 1909, and was afterwards raised 3 feet on August 13, 1909, when a Friez automatic gage was installed 200 feet above the chain gage on the right bank. (See Pl. VI, *A*.)

The flow of the stream at the gaging station is not usually affected by ice during the winter months. As the channel is very shifting in character, frequent measurements are necessary at high and medium stages to obtain the best results. Measurements during high stages are made from a cable 1,000 feet below the automatic gage.

Discharge measurements of Mimbres River near Faywood, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 6	J. B. Stewart	21.5	5.4	3.90	8.8
Feb. 3	do	8.8	3.8	3.60	5.2
Apr. 27	do	7.0	1.6	3.65	2.0
June 10	do	8.0	1.8	3.70	1.1
July 8	do	8.3	1.6	3.90	1.4
Aug. 13	do	79.5	44.3	4.70	164
Aug. 20	do	11.5	2.1	[a] 1.16	1.5
Sept. 1	do	17	3.2	[b] 1.30	3.5
Oct. 12	W. B. Freeman	11.6	2.8	[c] 1.18	3.8

[a] Chain gage read 4.15 feet. [b] Chain gage read 4.30 feet. [c] Chain gage read 4.20 feet.

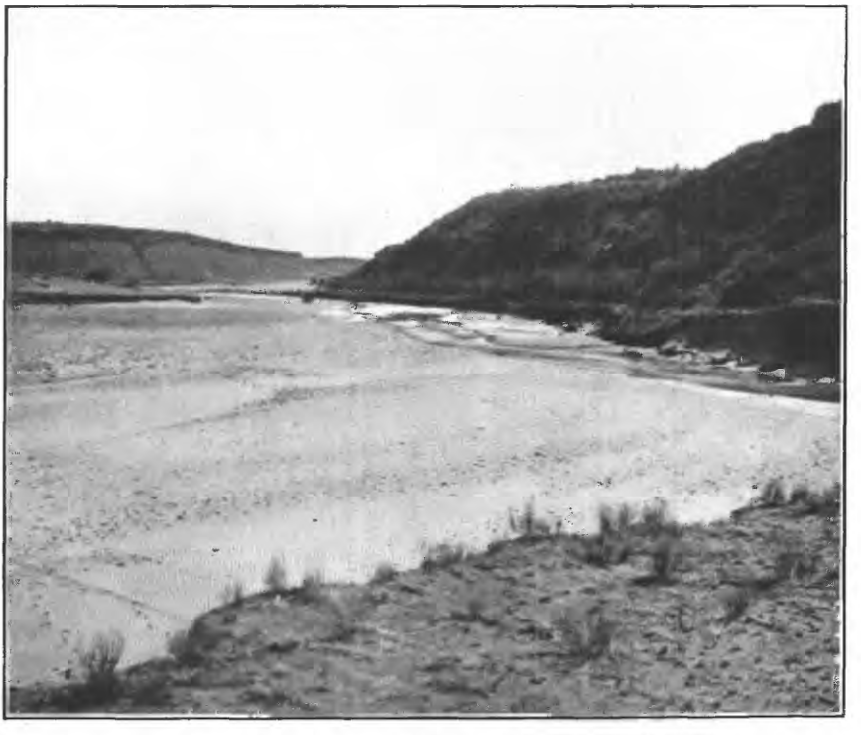
Daily gage height, in feet, of Mimbres River near Faywood, N. Mex., for 1909.

[Ralph C. Trujillo, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.2	3.8	3.7	3.7	3.7	3.7	3.75	3.85	1.3	1.15	1.2	1.05
2	4.2	3.8	3.7	3.7	3.65	3.7	3.85	3.85	1.25	1.15	1.2	1.05
3	4.1	3.6	3.7	3.7	3.65	3.7	4.05	3.85	1.3	1.15	1.2	1.05
4	4.0	3.6	3.7	3.6	3.65	3.7	3.8	3.9	1.3	1.15	1.2	1.05
5	4.0	3.7	3.7	3.6	3.7	3.7	3.75	3.9	1.5	1.15	1.2	1.0
6	3.9	3.8	3.7	3.6	3.7	3.7	3.9	3.95	1.2	1.15	1.2	1.0
7	3.9	3.7	3.7	3.6	3.65	3.7	4.1	3.95	1.1	1.15	1.2	1.0
8	3.9	3.7	3.7	3.6	3.7	3.7	3.9	3.95	1.05	1.15	1.2	1.0
9	3.8	3.7	3.7	3.7	3.7	3.7	3.9	3.9	1.05	1.15	1.2	1.0
10	3.8	3.7	3.7	3.7	3.7	3.7	3.9	3.95	1.15	1.2	1.2	.95
11	3.8	3.6	3.7	3.7	3.65	3.7	3.9	4.0	1.45	1.2	1.2	.95
12	3.8	3.6	3.7	3.7	3.65	3.7	3.9	4.1	1.35	1.2	1.2	.95
13	3.9	3.6	3.8	3.7	3.7	3.75	4.6	4.0	1.35	1.2	1.2	.95
14	3.9	3.6	3.9	3.7	3.7	3.75	3.95	4.55	1.3	1.2	1.2	.95
15	3.9	3.6	3 8	3.7	3.75	3.75	3.95	4.55	1.25	1.2	1.2	.9
16	3.9	3.6	3.7	3.7	3.75	3.75	3.9	1.3	1.25	1.2	1.2	.9
17	3.9	3.6	3.7	3.7	3.75	3.75	3.9	1.2	1.25	1.2	1.15	.9
18	3.9	3.6	3.7	3.7	3.75	3.7	3.9	1.1	1.25	1.2	1.2	.9
19	3.9	3.7	3.7	3.6	3.75	3.75	3.9	1.1	1.2	1.2	1.2	.9
20	3.9	3.7	3.7	3.6	3 75	3.75	4.0	1.15	1.2	1.2	1.2	.9
21	3.8	3.8	3.7	3.6	3.75	3.8	4.0	1.15	1.15	1.2	1.2	.9
22	3.8	3.8	3.7	3.6	3.75	3.8	3.95	1.2	1.15	1.2	1.15	.9
23	3.8	3.8	3.7	3.6	3.7	3.8	3.9	1.45	1.15	1.2	1.1	.9
24	3.8	3.7	3.7	3.6	3.7	3.8	3.95	1.35	1.15	1.2	1.1	.9
25	3.8	3.7	3.8	3.6	3.7	3.8	4.0	1.3	1.15	1.2	1.1	.9
26	3.8	3.7	3.9	3.65	3.65	3.75	4.0	1.2	1.15	1.2	1.1	.95
27	4.0	3.7	3.9	3.65	3.65	3.75	3.9	1.2	1.15	1.2	1.1	.95
28	3.9	3.7	3.8	3.7	3.65	3.75	3.9	1.2	1.15	1.2	1.1	.95
29	3.8	.....	3.8	3.7	3.7	3.85	3.9	1.2	1.15	1.2	1.1	1.0
30	3.8	.....	3.7	3.7	3.7	3.95	3.95	1.2	1.15	1.2	1.1	1.0
31	3.8	.....	3.7	.....	.....	.....	4.0	1.4	.....	1.2	.....	1.0

NOTE.—July 8 gage datum lowered 4.0 feet. All gage heights from January 1 to July 7 have been reduced to new datum. On August 16 a Friez automatic gage was installed about 200 feet above chain gage. The Freiz gage reads about 3 feet lower than the chain gage, but its zero is about 0.4 foot above that of the chain gage.

A. AUTOMATIC GAGE ON MIMBRES RIVER NEAR FAYWOOD, N. MEX.



B. PECOS RIVER VALLEY BETWEEN RIBERA AND FORT SUMNER, N. MEX.

Daily discharge, in second-feet, of Mimbres River near Faywood, N. Mex., for 1908–9.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
1908.												
1	.....	.....	.....	.....	13.4	15.5	10.1	39	41	42	28	28
2	.....	.....	.....	.....	13.4	15.6	10.2	143	41	42	16	28
3	.....	.....	.....	.....	25	15.7	10.3	108	520	61	16	28
4	.....	.....	.....	.....	25	15.8	10.3	56	112	61	16	17
5	.....	.....	.....	.....	13.4	7.8	10.3	39	41	42	16	17
6	.....	.....	.....	.....	13.4	7.8	10.4	24	41	61	16	17
7	.....	.....	.....	.....	13.4	7.9	10.4	39	41	61	16	17
8	.....	.....	.....	.....	13.4	7.9	10.5	39	41	61	16	17
9	.....	.....	.....	.....	13.4	8.0	21	39	41	42	28	17
10	.....	.....	.....	.....	13.4	8.0	35	39	41	61	28	17
11	.....	.....	.....	.....	13.4	8.1	35	39	41	61	28	17
12	.....	.....	.....	.....	6.3	8.2	21	24	41	61	28	17
13	.....	.....	.....	.....	6.3	8.3	10.8	24	41	61	44	30
14	.....	.....	.....	.....	6.4	8.4	345	24	41	61	44	46
15	.....	.....	.....	.....	6.5	8.5	34	220	41	61	28	46
16	.....	.....	.....	.....	6.6	8.6	72	108	41	42	16	65
17	.....	.....	.....	.....	6.8	8.7	435	57	59	42	16	46
18	.....	.....	.....	.....	6.9	8.8	53	39	59	42	28	46
19	.....	.....	.....	.....	7.0	8.9	53	39	41	42	28	16
20	.....	.....	.....	.....	14.6	9.0	53	345	59	42	16	30
21	.....	.....	.....	.....	14.7	9.1	36	79	41	42	16	30
22	.....	.....	.....	.....	14.8	9.2	22	39	59	42	16	30
23	.....	.....	.....	.....	14.9	9.3	10.6	39	41	42	16	30
24	.....	.....	.....	.....	15.0	9.4	10.6	39	41	42	28	30
25	.....	.....	.....	.....	15.1	9.5	515	39	41	61	28	46
26	.....	.....	.....	.....	7.4	9.6	345	57	59	61	28	46
27	.....	.....	.....	.....	7.5	9.7	630	910	59	61	28	46
28	.....	.....	.....	.....	7.6	9.8	515	56	41	44	28	30
29	.....	.....	.....	.....	7.7	9.9	435	39	42	44	28	30
30	.....	.....	.....	.....	7.8	10.0	106	1,000	42	44	28	30
31	.....	.....	.....	.....	7.8	.....	38	59	.....	28	.....	30
1909.												
1	46	21	7.8	5.0	3.0	1.6	0.1	1.7	3.5	2.0	7.0	3.5
2	46	21	7.8	5.0	1.8	1.5	1.1	1.7	2.0	2.0	7.0	3.5
3	30	5.2	7.8	5.0	1.8	1.5	7.8	1.7	4.0	2.0	7.0	3.5
4	17	4.6	7.8	2.0	1.8	1.4	.4	2.7	4.0	2.0	7.0	3.5
5	17	10	7.8	2.0	3.0	1.4	.1	3.5	18	2.0	7.0	2.0
6	8.8	20	7.8	2.0	3.0	1.3	1.7	5.4	2.5	2.0	7.5	2.0
7	8.5	10	6.7	1.6	1.5	1.2	9.1	5.4	1.0	2.0	7.5	2.0
8	8.5	10	6.7	1.6	2.4	1.1	1.4	5.4	.5	2.0	7.5	2.0
9	4.4	10	6.7	4.0	2.4	1.1	1.6	3.5	.5	2.0	7.5	2.0
10	5.0	10	6.7	4.0	2.4	1.1	1.6	5.4	1.0	4.0	7.5	2.0
11	6.0	4.6	6.7	4.0	1.5	.8	1.6	9.0	15	4.0	8.0	2.0
12	6.0	4.6	6.7	4.0	1.5	.8	1.6	18	8.0	4.0	8.0	2.0
13	13	4.6	14	4.0	2.4	1.6	93	9.0	8.0	4.5	8.0	2.0
14	13	4.6	25	4.0	2.4	1.6	2.7	108	5.5	4.5	8.0	2.0
15	15	4.0	14	4.0	3.2	1.3	2.7	108	4.0	5.0	8.0	1.5
16	15	4.0	6.7	4.0	3.2	1.3	1.6	7.0	4.0	5.0	8.0	1.5
17	15	4.0	6.7	3.5	3.2	1.3	1.6	3.0	4.0	5.0	6.0	1.5
18	15	4.0	4.8	3.5	3.2	.5	2.2	1.0	4.0	5.0	8.5	1.5
19	20	8.8	4.8	2.6	3.2	.7	2.2	1.0	2.0	5.0	8.5	1.5
20	20	8.8	4.8	2.6	3.2	.7	5.3	1.5	2.0	5.5	8.5	1.5
21	10.4	17.5	4.8	2.6	3.2	1.7	5.3	2.0	1.0	5.5	8.5	1.5
22	10.4	17.5	4.8	2.6	3.2	1.7	3.4	2.0	1.0	6.0	6.5	1.5
23	13.5	17.5	4.8	2.6	2.0	1.2	2.2	20	1.0	6.0	5.0	1.5
24	13.5	8.8	4.8	2.6	1.6	1.2	3.4	8.0	1.5	6.0	5.0	1.5
25	13.5	8.0	12.1	2.6	1.6	1.2	5.3	5.0	1.5	6.0	5.0	1.5
26	13.5	8.0	23	2.0	.7	.5	5.3	1.5	1.5	6.5	5.0	2.5
27	45	8.0	23	2.0	.7	.2	2.7	1.5	1.5	6.5	5.0	2.5
28	30	8.0	10.5	3.0	.7	.2	2.7	1.0	1.5	6.5	5.0	2.5
29	17	.....	10.5	3.0	1.6	1.6	2.7	1.0	1.5	6.5	5.0	4.0
30	17	.....	5.0	3.0	1.6	4.2	4.3	1.0	1.5	6.5	5.0	4.0
31	21	.....	5.0	.....	1.6	.....	6.7	8.5	.....	7.0	.....	4.0

NOTE.—The discharges for 1908–9 were obtained by the indirect method for shifting channels.

Monthly discharge of Mimbres River near Faywood, N. Mex., for 1908–9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1908.					
May	25	6.3	11.6	713	C.
June	15.8	7.8	9.70	577	C.
July	630	10.1	126	7,750	C.
August	1,000	24	124	7,620	C.
September	520	41	63.0	3,750	C.
October	61	28	50.3	3,090	C.
November	44	16	23.9	1,420	D.
December	65	16	30.3	1,860	D.
The period				26,800	
1909.					
January	46	4.4	17.2	1,060	C.
February	21	4.0	9.54	530	C.
March	25	4.8	8.91	548	C.
April	5.0	1.6	3.15	187	C.
May	3.2	.7	2.21	136	C.
June	4.2	.2	1.25	74	C.
July	93	.1	5.92	364	C.
August	108	1.0	11.4	701	D.
September	18	.5	3.57	212	D.
October	7.0	2.0	4.47	275	D.
November	8.5	5.0	6.90	411	D.
December	4.0	1.5	2.26	139	D.
The year	108	.1	6.40	4,640	

CAMERON CREEK BASIN.

CAMERON CREEK AT FORT BAYARD, N. MEX.

This station, which was established on January 17, 1907, at the request of the United States Forest Service, to obtain data concerning flood run-off, is located near the pumping station at Fort Bayard, N. Mex., a United States Army post. The gage, a vertical rod, is a short distance above the crest of an old masonry dam, which was used to check the underflow of the creek.

For the greater part of the year the flow comes from springs, and amounts to less than 1 second-foot. Stephens Creek enters about 2 miles above this station.

The intake for the water supply of the post is above the station, and a little water is also diverted above for garden irrigation. The flood waters of this stream can probably be stored in natural depressions in the vicinity, which will make excellent reservoir sites. These can be supplied by feeder canals.

Ice does not appreciably affect the flow of the stream at this point. The channel has filled up with sediment above the dam, which probably has some effect on low-water measurements. The channel is probably permanent for measurements taken at higher stages. Unfortunately no high-water measurements have yet been made. Measurements are made by wading.

No change has been made in the datum of the gage during the maintenance of the station. Gage observations have been taken gratis by Sergt. T. J. McBurney, U. S. Army.

Discharge meaurements of Cameron Creek at Fort Bayard, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec-ft.*
Jan. 5	Jas. B. Stewart			1.65	[a] 0.6
Feb. 5	do	2.2	1.5	1.70	.3
Apr. 16	do				.5
June 4	do			1.62	.5
July 7	do			1.62	.5
Aug. 8	do			1.32	.5
Oct. 8	W. B. Freeman			1.35	[a] .2

[a] Estimated.

NOTE.—Gage heights are distorted by a dam below.

Daily gage height, in feet, and daily discharge, in second-feet, of Cameron Creek at Fort Bayard, N. Mex., for 1909.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
Jan. 1 to June 28	1.45	0.5	July 21–31	1.45	0.5
June 29	1.60	.5	Aug. 1	1.60	.5
June 30–July 2	1.45	.5	Aug. 2–10	1.35	.5
July 3	1.50	.5	Aug. 11	1.70	.5
July 4–12	1.45	.5	Aug. 12–13	1.35	.5
July 13	1.60	.5	Aug. 14	1.6	.5
July 14	1.55	.5	Aug. 15–16	1.35	.5
July 15	1.45	.5	Aug. 17	2.45	96
July 16	1.75	1.0	Aug. 18–20	1.35	.5
July 17	1.45	.5	Aug. 21	2.45	96
July 18	1.75	1.0	Aug. 22–26	1.35	.2
July 19	1.95	8.0	Aug. 27	1.65	.5
July 20	1.55	.5	Aug. 28–Dec. 31	1.35	.2

NOTE.—The gage heights for low stages are not a true index of the discharge.

Monthly discharge of Cameron Creek at Fort Bayard, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	0.5	0.5	0.5	31	D.
February	.5	.5	.5	28	D.
March	.5	.5	.5	31	D.
April	.5	.5	.5	30	D.
May	.5	.5	.5	31	D.
June	.5	.5	.5	30	D.
July	8.0	.5	.77	47	D.
August	96	.2	6.57	404	D.
September	.2	.2	.2	12	D.
October	.2	.2	.2	12	D.
November	.2	.2	.2	12	D.
December	.2	.2	.2	12	D.
The year	96	.2	.93	680	

STEPHENS CREEK NEAR FORT BAYARD, N. MEX.

This station, which was established January 17, 1907, at the request of the United States Forest Service, is located one-fourth mile above the Fort Bayard planting station of the Forest Service, 3 miles north of Fort Bayard.

The records furnish valuable information concerning normal and flood run-off. The station is situated about 2 miles above the junction of this stream with Cameron Creek.

The normal flow of this creek is very small, but for short periods during floods it occasionally carries a large flow, which can probably be stored. The intake for the water supply of the planting station is above the gage.

The records of this station are little, if any, affected by ice. The results obtained have not been very satisfactory, owing to the small number of discharge measurements, none of which were taken when there was any considerable flow in the stream.

No change has been made in the datum of the gage since the establishment of the station.

Discharge measurements of Stephens Creek near Fort Bayard, N. Mex., in 1909.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 5	J. B. Stewart	1.30	0.3
Feb. 5	do	1.32	.4
Apr. 16	do	1.35	.3
July 7	do	1.48	.1
Aug. 8	do	1.26	.1
Oct. 8	W. B. Freeman	1.25	.01

NOTE.—Discharges are estimated.

Daily gage height, in feet, of Stephens Creek near Fort Bayard, N. Mex., for 1909.

[H. C. Turner, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1								1.50	1.31	1.27		
2								1.60				1.38
3					1.30			1.20		1.25	1.35	
4		1.33	1.30									
5		1.33							1.90	1.25		1.39
6	1.30	1.33			1.30				1.40			
7	1.30						1.48	1.25		1.27		
8		1.33					1.47	1.26			1.35	
9								1.28	1.24			1.40
10					1.35				1.60	1.25		
11								1.60	1.31			
12		1.33	1.45					2.30	2.10	1.25		1.40
13					1.30		2.30					
14	1.30						2.10		1.30	(a)		
15								1.60			1.35	1.40

a Practically dry.

Daily gage height, in feet, of Stephens Creek near Fort Bayard, N. Mex., for 1909—Contd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16							1.90		1.30	1.27		
17								1.80	1.30	1.27		
18		1 34					1.70	1.25				1.40
19									1.30			
20	1.30									1.26	1.36	1.40
21		1.34					1.37	1.60	1.29			
22	1.30							1.40				
23									1.28			
24								1.32		1.26	1.36	1.40
25							1.28	1.32	1.29			
26	1.30	1 34					1.27	1.32				
27							1.27	1.40				1.40
28	1.30											
29					2.00			1.32	1.27	1.27	1.36	
30	1.30											
31										1.27		

PECOS RIVER DRAINAGE BASIN.

DESCRIPTION.

Pecos River, the largest tributary of the Rio Grande, rises on the east side of the Santa Fe Range in northern New Mexico, flows south through eastern New Mexico, then southeast through southwestern Texas, and unites with the Rio Grande about 400 miles (by river) below El Paso. Except for some of the upper tributaries, the branches of the Pecos are intermittent, carrying large floods at times. From source to mouth the river is about 800 miles long, and the total drainage area includes more than 32,000 square miles, of which 23,000 are in New Mexico and 9,000 in Texas.

The upper Pecos flows as a typical mountain stream through narrow valleys and deeply cut gorges, but below Fort Sumner the canyon-like walls are replaced by low rolling hills (see Pl. VI, *B*), and when the river reaches Roswell the gradation from the flood plains to the prairie is imperceptible. Arroyos and gulches are rare, and canyons are practically unknown. The mountain tributaries of the upper Pecos rise at elevations of about 11,000 feet; at Santa Rosa, N. Mex., the elevation is 4,600 feet; at Roswell, 3,500 feet; at Pecos, Tex., 2,550 feet; and at the mouth of the stream it is 1,000 feet.

The main Pecos may be said to be formed by the junction of the Gallinas with the upper Pecos at La Junta, N. Mex. The most important tributaries below this point and above Roswell are the Agua Negra and the Agua Negra Chiquita, which enter just above Puerto de Luna. Except for small springs, no important tributaries enter along this stretch, but some of the dry gulches and arroyos occasionally carry large quantities of flood water. Among the most

important of the lower tributaries are the Hondo, Rio Felix, the Penasco, Seven Rivers, and Black River.

It is rather a striking fact that the Pecos receives practically no tributaries from the east, probably because of the pervious character of the soil of the Staked Plains, upon which there is no surface drainage system. The water sinks into limestone rocks and establishes an underground drainage.

The condition of the Pecos basin may be characterized roughly as follows: Merchantable-timber land, 1,300 square miles; woodland, 2,400 square miles; 300 square miles of burnt and cut over land; and the remaining area of about 27,000 square miles is open and sage-brush land.

The rainfall along the Pecos in New Mexico ranges from 20 to 25 inches in the mountainous sections, as above Las Vegas and at Cloudcroft, to about 15 inches in the plains country, or in the vicinity of Roswell and Carlsbad. Through Texas the rainfall is light, the annual average being about 12 inches.

During the winter period the flow of the Pecos is supplied mainly by springs. The river has been known to go dry in the neighborhood of Colonias, N. Mex.

Considerable ice forms on the upper Pecos, and heavy snows are common. In the vicinity of Santa Rosa and Fort Sumner thin ice and slush ice are in evidence during a part of the winter. Lower down the valley there is an occasional light snow, which disappears very quickly, and at times there is thin ice along the edges of the river. In the lower end of the valley the climate is mild. The rainfall comes mainly in the summer months, in the form of showers, and is variable and uncertain.

Irrigation in New Mexico has reached its highest stage of development in the lower Pecos Valley, the irrigated district beginning a short distance above Roswell and continuing into Texas. Thousands of acres are under cultivation, and a wise and economical system of reservoirs and canals is in force. The surface waters have been greatly augmented during the past few years by numerous artesian wells. Above this fertile belt comparatively little farming is engaged in; below it irrigation is carried on only in a small way, as the return seepage water contains, unfortunately, a great percentage of alkali, which renders it undesirable for irrigation.

The recently completed Carlsbad and Hondo projects (Pl. IV, *B*) of the Reclamation Service provide for the irrigation of 20,000 and 10,000 acres, respectively, while the proposed Urton Lake project, which is to be relinquished by the Reclamation Service in favor of a Carey Act project, will result in the irrigation of about 60,000 acres in the vicinity of old Fort Sumner, N. Mex.

Numerous reservoir sites are to be found along the Pecos and its tributaries. Among the reservoirs now in operation may be mentioned Lake McMillan on the Pecos, and the Hondo reservoir on Hondo River. Urton Lake, a natural depression in the vicinity of Fort Sumner, will have a storage capacity of 190,000 acre-feet. It is to be supplied by a feeder canal from Pecos River. Because of the large amount of silt carried by this stream the prevention of its deposition must be taken into account and provided for in the construction of reservoirs.

On account of its long periods of low water, this stream does not offer many favorable opportunities for the development of power. At present there are no water-power plants of any importance in operation in the basin, except a public-utility plant of about 300 horsepower at Carlsbad, N. Mex. Later there may be some power development in connection with irrigation projects.

The records along this stream are very fragmentary, and most of them were taken within the last five or six years. From them it would appear that 1903 was a very low year and 1905 an unusually high one.

PECOS RIVER NEAR FORT SUMNER, N. MEX.

The station, which was established on June 12, 1904, to determine the amount of water available for the Urton Lake project of the United States Reclamation Service, is located at a place known as Arinosa, about 12 miles northwest of old Fort Sumner, N. Mex., and 4 miles upstream from Fort Sumner, a station on the Belen cut-off of the Atchison, Topeka & Santa Fe Railway, and is near the site of the proposed diversion dam and a few miles below Arroyo Salada. The nearest post-office is Fort Sumner.

All the tributaries for a long distance above and below the station are intermittent in character and only occasionally carry large amounts of water. The drainage area above the station is about 5,300 square miles.

Some irrigation is practiced along the bottom lands at various localities above the station, but not enough to materially affect the flow of the stream. The proposed Urton Lake project will divert a considerable portion of the stream flow at this point.

Slush ice sometimes forms at this station, and thin ice forms along the edges of the river, but results are not greatly affected by the ice conditions.

On July 5, 1905, the station was moved downstream and a new rod gage established at the present datum. Otherwise there had been no change in datum.

On account of the extremely shifting character of the channel, it is impossible to make reliable estimates of discharge unless very frequent measurements are made. High-water measurements are made from a cable.

Discharge measurements of Pecos River near Fort Sumner, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 29	J. B. Stewart	92	58	2.20	91
Apr. 14	do	46	38	2.25	70
June 1	do	72	59	2.52	126
June 30	do	96	55	2.33	66
July 20	W. H. Sutton	33	60	2.05	89
Aug. 25	do	220	177	2.45	389
Sept. 5	J. B. Stewart	209	161	2.70	400
Oct. 20	W. B. Freeman	106	63	2.46	95
Dec. 7	G. H. Russell	111	64	2.76	50

NOTE.—Measurements made at various sections.

Daily gage height, in feet, of Pecos River near Fort Sumner, N. Mex., for 1909.

[J. C. Pacheco, observer]

Day.	Jan.	Feb.	Mar	Apr.	May.	June.	July	Aug.	Sept	Oct.	Nov.	Dec.
1	2.35	2.3	2.25	2.35	2.3	2.5	2.7	2.2	2.7	2.3	2.4	2.5
2	2.3	2.35	2.25	2.3	2.3	2.5	2.4	2.3	2.5	2.3	2.4	2.5
3	2.35	2.3	2.25	2.3	2.35	2.4	2.4	2.2	2.5	2.3	2.45	2.5
4	2.3	2.35	2.3	2.3	2.4	2.45	2.3	2.3	2.55	2.35	2.4	2.5
5	2.3	2.3	2.2	2.3	2.4	2.35	2.4	2.3	2.6	2.35	2.45	2.55
6	2.3	2.35	2.25	2.35	2.35	2.4	2.4	2.25	3.2	2.3	2.45	2.5
7	2.3	2.3	2.25	2.35	2.3	2.4	2.4	2.3	3.3	2.4	2.5	2.75
8	2.25	2.3	2.25	2.35	2.3	2.4	2.45	2.55	3.05	2.5	2.5	2.7
9	2.25	2.35	2.2	2.35	2.4	2.55	2.6	2.4	2.9	2.4	2.45	2.6
10	2.3	2.35	2.35	2.3	2.5	2.5	2.7	2.4	2.75	2.5	2.5	2.55
11	2.25	2.35	2.5	2.35	2.5	2.5	2.5	2.3	2.8	2.5	2.45	2.5
12	2.35	2.3	2.45	2.3	2.4	2.5	2.4	2.65	2.8	2.4	2.4	2.55
13	2.45	2.3	2.4	2.3	2.4	2.7	2.35	3.00	2.8	2.4	2.4	2.5
14	2.5	2.35	2.3	2.3	2.4	2.5	2.3	2.50	2.6	2.45	2.45	2.55
15	2.4	2.5	2.3	2.2	2.35	2.5	3.25	2.4	2.6	2.4	2.45	2.55
16	2.3	2.4	2.3	2.3	2.3	2.55	2.7	2.95	2.5	2.4	2.45	2.6
17	2.3	2.3	2.3	2.3	2.4	2.6	2.3	2.8	2.6	2.4	2.4	2.6
18	2.2	2.3	2.25	2.35	2.5	2.5	2.25	2.5	2.55	2.4	2.4	2.6
19	2.25	2.3	2.25	2.3	2.4	2.5	2.1	2.5	2.6	2.4	2.45	2.6
20	2.2	2.3	2.25	2.3	2.5	2.5	2.2	2.5	2.6	2.45	2.45	2.6
21	2.25	2.3	2.3	2.5	2.65	2.4	2.1	2.9	2.5	2.5	2.45	2.6
22	2.3	2.35	2.3	2.4	2.65	2.4	2.0	3.2	2.5	2.45	2.45	2.85
23	2.25	2.3	2.25	2.4	2.7	2.4	2.0	2.6	2.45	2.4	2.45	2.9
24	2.35	2.35	2.2	2.4	2.45	2.5	2.8	2.5	2.4	2.4	2.45	2.9
25	2.3	2.3	2.3	2.45	2.4	2.4	2.6	2.6	2.4	2.45	2.45	2.85
26	2.25	2.3	2.3	2.45	2.5	2.3	2.7	2.6	2.4	2.4	2.5	2.7
27	2.25	2.3	2.3	2.45	2.5	2.35	2.3	2.7	2.4	2.4	2.45	2.8
28	2.2	2.3	2.3	2.4	2.5	2.35	2.	2.7	2.4	2.4	2.55	2.8
29	2.3	.....	2.35	2.35	2.4	2.4	2.2	2.8	2.3	2.4	2.5	2.7
30	2.3	.....	2.3	2.3	2.4	2.35	2.1	2.8	2.3	2.4	2.5	2.6
31	2.3	.....	2.35	.....	2.45	.....	2.2	2.8	.....	2.4	.....	2.3

Daily discharge, in second-feet, of Pecos River near Fort Sumner, N. Mex., for 1908–9.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
1	195	30	100	135	285	160	245	390	160	60	78	185
2	195	45	75	135	285	187	167	920	105	60	97	155
3	200	82	125	167	205	225	495	1,020	160	60	97	155
4	200	135	125	135	205	187	165	810	385	60	97	125
5	240	85	125	135	205	160	110	725	158	58	78	155
6	200	65	125	137	282	160	85	630	158	58	97	125
7	205	65	150	137	282	127	65	630	84	58	97	105
8	170	65	150	137	200	155	85	1,360	68	87	78	125
9	145	65	125	172	200	185	85	1,150	42	87	78	125
10	145	65	150	172	200	127	85	420	53	87	78	165
11	145	65	125	140	167	127	110	265	42	105	80	125
12	145	85	125	140	167	155	110	265	42	86	80	125
13	145	70	125	140	200	97	105	360	42	86	98	160
14	95	90	155	115	282	97	105	1,150	40	86	98	125
15	75	70	155	115	282	97	157	1,360	40	86	98	125
16	75	70	102	140	240	97	130	545	65	85	100	87
17	40	50	127	140	240	125	222	465	51	85	100	87
18	25	50	105	140	240	125	222	465	64	85	100	107
19	25	90	105	287	240	97	950	465	38	65	82	87
20	25	90	80	287	195	75	222	475	78	80	82	107
21	25	95	105	287	195	75	530	6,500	65	80	100	107
22	25	70	105	287	235	75	410	1,600	38	80	100	87
23	25	120	105	285	960	75	300	1,750	38	100	100	130
24	25	145	160	245	190	52	300	460	65	100	100	130
25	40	145	105	205	230	52	300	45	75	80	83	130
26	25	120	80	285	190	70	300	60	60	100	103	130
27	25	120	80	440	190	70	395	60	93	80	103	165
28	25	75	110	385	270	245	395	245	93	80	103	130
29	25	100	110	285	227	245	295	245	93	78	103	165
30	30	.....	110	285	187	245	735	340	60	78	125	165
31	30	.....	135	.....	187	.....	510	45	.....	78	.....	165
1909.												
1	165	137	95	115	75	116	295	168	485	63	48	14
2	130	170	95	95	72	118	92	246	250	63	42	14
3	165	137	95	95	87	78	110	168	230	60	53	12
4	130	170	120	95	107	95	72	246	245	75	37	12
5	130	137	73	92	105	68	130	246	295	73	48	15
6	135	170	90	110	83	77	130	204	1,240	55	46	11
7	135	135	90	110	69	77	145	246	1,480	85	58	50
8	110	135	90	110	67	80	190	514	920	127	53	37
9	110	168	73	110	97	148	345	340	660	85	38	20
10	137	168	135	90	150	127	500	340	440	127	48	15
11	110	168	250	108	150	127	285	246	510	127	35	12
12	170	130	205	88	95	127	215	662	500	80	28	16
13	250	130	162	88	95	280	183	1,370	495	80	25	13
14	310	168	110	87	95	127	175	452	265	103	29	17
15	210	290	110	55	75	127	1,620	340	265	80	27	18
16	137	205	105	85	60	161	660	1,250	180	77	27	25
17	137	135	105	85	90	195	210	934	260	76	19	26
18	90	128	84	102	130	127	190	452	200	75	17	27
19	112	128	84	85	85	127	108	452	255	75	22	28
20	90	125	84	82	127	127	175	452	250	90	20	29
21	112	125	103	190	237	85	110	1,140	170	112	19	30
22	137	150	103	122	237	85	73	1,860	165	85	17	100
23	112	125	80	120	280	85	73	587	133	65	16	120
24	170	150	65	117	105	133	934	452	105	65	15	120
25	137	120	100	147	85	87	587	587	103	75	13	103
26	112	120	100	147	120	65	750	555	103	60	20	55
27	112	118	100	143	120	70	246	670	100	57	12	88
28	91	118	100	115	120	70	73	635	100	55	23	87
29	137	.....	117	92	80	88	168	750	64	53	16	60
30	137	.....	95	75	80	72	110	705	64	50	15	37
31	137	.....	117	.....	95	.....	168	670	.....	48	.....	7

NOTE.—Discharges for 1908–9 were obtained by the indirect method for shifting channels.

Monthly discharge of Pecos River near Fort Sumner, N. Mex., for 1908–9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1908.				
January	240	25	96.5	5,930
February	145	30	83.5	4,800
March	160	75	121	7,440
April	440	115	203	12,100
May	960	167	247	15,200
June	245	52	132	7,860
July	950	65	271	16,700
August	a 6,500	45	814	50,100
September	385	38	85.2	5,070
October	105	58	79.3	4,880
November	125	78	93.8	5,580
December	185	87	131	8,060
The year	6,500	25	196	144,000
1909.				
January	310	91	141	8,670
February	290	118	149	8,280
March	250	65	108	6,640
April	190	55	105	6,250
May	280	60	112	6,890
June	280	65	112	6,660
July	1,620	72	294	18,100
August	1,860	168	579	35,600
September	1,480	64	351	20,900
October	127	48	77.5	4,770
November	58	12	29.5	1,760
December	120	7	39.3	2,420
The year	1,860	7	175	127,000

a Estimated.

NOTE.—The above estimates are in general only approximate.

PECOS RIVER NEAR DAYTON, N. MEX.

This station, which was established March 24, 1905, has been maintained in connection with the Carlsbad irrigation project in New Mexico to determine the amount of water supplied by the river to the McMillan reservoir, and is located about 3 miles east of Dayton, N. Mex., about 6 miles above the dam of the reservoir, and approximately 100 feet downstream from the mouth of Penasco River.

The original rod gage was washed out on September 6, 1905, and was relocated September 7, 1905, at a point about one-half mile upstream. Otherwise there has been no change in gage datum. Fair results can be obtained at this station if discharge measurements are taken at frequent intervals. This station was transferred March 31, 1908, to the United States Reclamation Service, and since then they have made the discharge measurements. Discharge measurements are made from a cable located about 100 yards below the new gage.

Considerable irrigation is practiced in the vicinity of Roswell, N. Mex., and opportunities for irrigation projects exist at various points above. The winters in this vicinity are comparatively mild and ice does not appreciably affect stream flow.

Discharge measurements of Pecos River near Dayton, N. Mex., in 1909.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
June 24	U. S. Reclamation Service	2.95	80
June 28	do	2.6	40
June 29	do	4.4	456
July 8	do	3.8	244
July 19	do	4.0	280
July 27	do	(a)	1,080
Aug. 3	do	2.6	100
Aug. 14	do	2.4	72
Nov. 3	do	2.75	112
Dec. 11	do	3.7	291

a Gage washed out.

Daily gage height, in feet, of Pecos River near Dayton, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	3.6	3.0	2.8	2.8	2.8	3.8	.....	3.9	2.6	2.7	3.0
2	3.7	3.9	3.0	2.8	2.8	2.7	3.6	.....	3.8	2.6	2.7	3.0
3	3.8	3.7	3.0	2.9	2.7	2.6	3.4	2.6	3.5	2.6	2.7	3.0
4	3.7	3.6	3.0	2.9	2.7	2.5	3.2	2.6	3.3	2.5	2.7	3.0
5	4.0	3.6	2.9	2.8	2.5	2.6	3.2	2.5	3.3	2.5	2.7	3.0
6	4.2	3.5	2.9	2.8	2.4	2.6	3.4	2.5	3.2	2.5	2.7	3.0
7	4.0	3.5	2.9	2.8	2.4	2.6	3.4	2.4	3.0	2.6	2.7	3.8
8	3.9	3.6	2.9	2.9	2.4	2.5	4.0	2.3	2.9	2.6	2.7	3.7
9	3.8	3.6	2.9	2.9	2.4	2.5	3.4	2.4	7.4	2.6	2.7	3.6
10	3.8	3.6	2.9	2.6	2.4	2.5	3.1	2.3	5.2	2.5	2.7	3.6
11	3.8	3.5	2.9	2.6	2.4	2.5	3.0	2.6	4.9	2.5	2.7	3.6
12	3.8	3.5	3.0	2.5	2.4	2.5	3.8	2.4	4.6	2.5	2.7	3.6
13	3.7	3.5	3.0	2.5	2.3	2.5	3.7	2.3	4.6	2.5	2.8	3.6
14	3.8	3.4	3.1	2.5	2.3	3.7	2.6	2.5	4.7	2.5	2.8	3.6
15	3.8	3.4	3.2	2.5	2.3	3.2	2.5	2.7	4.7	3.0	4.0	3.9
16	3.8	3.4	3.3	2.5	2.3	4.2	3.0	2.8	3.1	3.0	3.9	3.8
17	3.9	3.4	3.3	2.4	3.0	4.2	2.9	3.0	4.0	3.0	3.2	3.9
18	5.0	3.4	3.7	2.4	3.0	3.9	4.4	3.0	3.7	3.0	2.8	4.0
19	4.1	3.4	3.6	2.5	2.7	3.7	4.0	3.0	3.7	3.0	2.8	4.0
20	4.0	3.4	3.6	2.5	2.7	3.4	3.6	3.8	3.5	3.2	2.8	4.0
21	4.0	3.4	3.4	2.3	2.8	3.2	3.4	3.6	3.3	3.1	2.8	4.0
22	4.0	3.4	3.3	2.3	2.8	3.2	3.2	4.2	3.2	3.0	2.8	4.0
23	3.8	3.3	3.2	2.4	2.9	3.1	3.0	3.6	3.0	3.2	2.8	4.4
24	4.0	3.2	3.2	2.3	2.9	2.95	3.1	3.4	3.0	3.2	2.8	4.4
25	3.8	3.2	3.2	2.5	2.9	2.9	5.5	4.0	2.9	3.2	3.2	5.3
26	3.8	3.0	3.0	2.4	2.9	2.7	.....	3.7	2.8	3.0	3.0	3.9
27	3.9	3.0	2.9	2.4	2.3	2.5	.....	3.5	2.7	2.7	3.0	3.7
28	3.9	3.0	2.9	3.2	3.4	2.5	.....	3.4	2.8	2.7	3.0	3.7
29	3.6	.....	2.9	3.0	3.2	3.5	.....	3.7	2.8	2.7	3.0	3.6
30	3.6	.....	2.9	2.9	3.0	3.9	.....	3.7	2.6	2.6	3.0	4.4
31	3.6	.....	2.9	.....	2.9	.....	.....	3.9	.....	2.7	.....	4.1

NOTE.—Gage washed out July 26 and replaced August 3.

Daily discharge, in second-feet, of Pecos River near Dayton, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	260	230	85	60	60	60	236	.....	370	90	100	135
2	260	340	85	60	60	48	190	.....	330	90	100	135
3	300	260	85	72	48	40	151	90	230	90	100	135
4	260	230	85	72	48	36	115	90	186	82	100	135
5	385	230	70	60	36	40	115	82	186	82	100	135
6	490	200	70	60	32	40	151	82	167	82	100	135
7	385	200	70	60	32	40	151	74	135	90	100	330
8	340	230	70	72	32	36	290	67	122	90	100	290
9	300	230	70	72	32	36	151	74	4,200	90	100	260
10	300	230	70	40	32	36	99	67	1,340	82	100	260

Daily discharge, in second-feet, of Pecos River near Dayton, N. Mex., for 1909—Contd.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	300	200	70	40	32	36	85	90	1,040	82	100	260
12	300	230	85	36	32	36	236	74	790	82	100	260
13	260	230	85	36	30	36	212	67	790	82	110	260
14	300	170	105	36	30	212	40	82	870	82	110	260
15	300	170	125	36	30	115	36	100	870	135	420	370
16	300	170	145	36	30	360	85	110	150	135	370	330
17	340	170	145	32	85	360	72	135	420	135	167	370
18	1,080	170	260	32	85	262	450	135	290	135	110	420
19	440	170	230	36	48	212	290	135	290	135	110	420
20	385	170	230	36	48	151	190	330	230	167	110	420
21	385	170	170	30	60	115	151	260	186	150	110	420
22	385	170	145	30	60	115	115	530	167	135	110	420
23	300	145	125	32	72	99	85	260	135	167	110	650
24	385	125	125	30	72	78	99	207	135	167	110	650
25	300	125	125	36	72	72	1,290	420	122	167	167	1,440
26	300	85	85	32	72	48	.....	290	110	135	135	370
27	340	85	70	32	30	36	.....	230	100	100	135	290
28	340	85	70	115	151	36	.....	207	110	100	135	290
29	230	.....	70	85	115	170	.....	290	110	100	135	260
30	230	.....	70	72	85	262	.....	290	90	90	135	650
31	230	.....	70	.....	72	.....	.....	370	.....	100	.....	470

NOTE.—Discharges January 1 to March 31 obtained by indirect method for shifting channels. Discharges April 1 to July 25 are based on a rating curve that is well defined below 510 second-feet. Discharges August 3 to December 31 are based on a rating curve that is fairly well defined below 400 second-feet.

Monthly discharge of Pecos River near Dayton, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	1,080	230	345	21,200	C.
February	340	85	186	10,300	C.
March	260	70	109	6,700	C.
April	115	30	49.3	2,930	C.
May	151	30	55.6	3,420	C.
June	360	36	107	6,370	A.
July 1–25	1,290	36	203	10,100	A.
August 3–31	530	67	181	10,400	A.
September	4,200	90	476	28,300	B.
October	167	82	111	6,820	B.
November	420	100	133	7,910	B.
December	1,440	135	362	22,300	B.
The period	.....	.....	.....	137.000	

PECOS RIVER NEAR LAKEWOOD, N. MEX.

The station, which was established January 11, 1906, and transferred to the United States Reclamation Service March 31, 1908, is located 3 miles southeast of Lakewood and one-half mile below the McMillan reservoir dam.

The present inclined rod gage was established May 8, 1906. It had been previously moved from original location on February 8, 1906.

Fair results can be obtained at this station if occasional discharge measurements are made at different stages. Discharge measurements are made from a cable located about one-fourth mile above the railroad bridge of the Eastern Railway of New Mexico.

Discharge measurements of Pecos River near Lakewood, N. Mex., in 1909.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
July 12	U. S. Reclamation Service	1.0	97
Do	do	1.2	143
Do	do	1.55	209
July 27	do	3.0	625
Sept. 23	do	3.9	1,230
Do	do	1.9	381
Do	do	.8	89

Daily gage height, in feet, of Pecos River near Lakewood, N. Mex., for 1909.

[H. C. Holcomb, observer.]

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1		1.4	0.8	0.7	0.6	0.65	0.8	1.5	0.8
2		1.4	.8	.7	.6	.7	.8	1.5	.8
3		1.4	.8	.7	.6	.7	.8	1.5	.8
4		1.4	.8	.7	.6	.9	.8	1.5	.8
5			.8	1.2	.6	.9	.8	1.5	.8
6			.8	1.2	.6	.9	.8	1.5	.8
7			.8	1.2	.65	.9	.8	1.5	.8
8			.8	1.2	.5	.9	.8	1.5	.8
9			.8	1.2	.5	.9	.8	1.5	.8
10			.8	1.1	.5	.9	.8	1.5	.8
11			.8	.95	.5	1.0	.8	3.15	.8
12			.8	.8	.5	.8	.8	4.5	.8
13			.8	.8	.5	.8	.8	4.3	.7
14			.8	.75	.5	.8	.8	4.2	.6
15			.8	.7	.75	1.35	.8	1.95	.6
16			.8	.7	1.2	1.4	.8	1.5	2.7
17			.8	.7	.6	1.3	.8	1.5	4.0
18			.8	.7	.6	1.35	.8	1.5	.85
19			.75	.7	.6	1.3	.8	1.5	.85
20		1.4	.7	.7	.6	1.3	.8	1.25	
21		1.4	.7	.7	.6	1.3	.8	1.0	
22		1.4	.7	.7	.6	1.25	1.1	1.0	
23		1.4	.7	.7	.6	1.2	1.4	1.5	
24	1.4	1.4	.7	.7	.6	1.2	1.4	.8	
25	1.4	1.4	.7	.7	.6	2.7	1.4	.8	
26	1.4	1.4	.7	.95	.6	4.4	1.4	.8	
27	1.4	.8	.7	1.2	.6	3.1	1.4	.8	
28	1.4	.8	.7	1.2	.6	1.3	1.4	.8	
29		.8	.7	1.2	.6	.8	1.4	.8	
30		.8	.7	1.2	.6	.8	1.5	.8	
31		.8		.8		.8	1.5		

NOTE.—River probably dry January 1 to February 23 and October 20 to December 31.

Daily discharge, in second-feet, of Pecos River near Lakewood, N. Mex., for 1909.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	178	64	50	36	43	68	292	89
2	.....	178	64	50	36	50	69	295	89
3	.....	178	64	50	36	50	70	297	89
4	.....	178	64	50	36	80	71	300	89
5	.....	178	64	136	36	80	72	302	89
6	.....	178	64	136	36	80	74	305	89
7	.....	178	64	136	43	80	75	307	89
8	.....	178	64	136	24	80	77	310	89
9	.....	178	64	136	24	80	80	315	89
10	.....	178	64	116	24	80	82	318	89
11	.....	178	64	88	24	97	85	889	89
12	.....	178	64	64	24	64	87	1,520	89
13	.....	178	64	64	24	64	91	1,420	71
14	.....	178	64	57	24	64	94	1,380	54
15	.....	178	64	50	57	168	96	399	54
16	.....	178	64	50	136	178	99	250	690
17	.....	178	64	50	36	157	101	250	1,280
18	.....	178	64	50	36	168	104	250	98
19	.....	178	57	50	36	157	106	250	98
20	.....	178	50	50	36	157	109	184	.....
21	.....	178	50	50	36	157	111	128	.....
22	.....	178	50	50	36	146	180	128	.....
23	.....	178	50	50	36	136	241	250	.....
24	178	178	50	50	36	136	244	89	.....
25	178	178	50	50	36	524	247	89	.....
26	178	178	50	88	36	1,280	250	89	.....
27	178	64	50	136	36	662	252	89	.....
28	178	64	50	136	36	157	255	89	.....
29	.....	61	50	136	36	65	258	89	.....
30	.....	64	50	136	36	66	287	89	.....
31	.....	64	.....	64	.....	67	290	.....	.....

NOTE.—These discharges were obtained as follows:
February 24 to July 28 from a rating curve which is fairly well defined between 80 and 830 second-feet.
July 29 to September 10 by indirect method for shifting channels.
September 11 to October 19 from a rating curve which is fairly well defined.
March 5-19 interpolated.
Although the observer gives no definite dates, it is probable that the river was dry January 1 to February 23 and October 20 to December 31.

Monthly discharge of Pecos River near Lakewood, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	0	0	0	0	
February	178	0	31.8	1,770	C.
March	178	64	160	9,810	C.
April	64	50	58.6	3,490	C.
May	136	50	81.1	4,990	B.
June	136	24	37.5	2,230	C.
July	1,280	43	173	10,600	B.
August	290	68	140	8,610	B.
September	1,520	89	365	21,700	A.
October	1,280	0	110	6,760	B.
November	0	0	0	0	
December	0	0	0	0	
The year	1,520	0	96.4	70,000	

PECOS RIVER NEAR MOORHEAD, TEX.

The station, which was established by the International Boundary Commission in April, 1900, is near Moorhead, immediately above the high bridge of the Southern Pacific Railroad.

The station is in the bottom of a canyon about 300 feet deep. Both banks are of rock, but the bottom of the stream is mud. The river here consists of a series of pools connected by rapids. The best pool was chosen for the station. Frequent discharge measurements are made to determine closely the daily discharge. The highest known flood occurred April 6, 1900, about two weeks before this gage was established. The water marks showed that it reached 35.75 feet on the gage.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Pecos River near Moorhead, Tex., in 1909.

[By E. E. Winter.

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 3	701	1.0	417	July 9	675	0.5	178
8	713	1.0	433	13	676	.5	184
13	701	1.0	427	17	669	.4	185
19	707	1.1	447	21	684	.55	213
24	690	1.0	401	26	898	2.55	1,313
29	683	1.0	403	29	909	2.65	1,401
Feb. 3	689	1.0	384	Aug. 4	837	1.8	978
8	678	.95	355	9	702	.9	371
13	673	.95	342	13	733	1.0	395
18	686	.8	289	17	698	.8	359
22	686	.8	501	22	690	.65	266
26	683	.75	288	25	683	.6	256
Mar. 3	672	.85	306	29	698	.7	284
8	680	.85	318	Sept. 3	688	.5	229
13	672	.8	293	7	685	.5	229
18	654	.7	242	14	679	.5	247
23	672	.85	308	18	676	.5	235
29	649	.7	271	22	867	2.1	1,094
Apr. 4	671	.8	239	28	686	.75	329
9	637	.7	231	Oct. 4	691	.8	290
14	676	.8	276	8	687	.8	295
19	646	.7	239	12	671	.7	251
23	637	.65	224	16	669	.5	229
28	680	.8	293	21	695	.7	280
May 3	656	.6	246	25	696	.7	292
7	646	.6	258	29	702	.8	293
11	642	.5	228	Nov. 4	684	.7	269
15	654	.55	234	8	681	.7	273
19	656	.7	255	12	687	.8	322
24	736	1.1	431	16	688	.8	311
29	675	.5	228	21	700	.8	315
June 3	675	.5	229	25	705	.9	343
7	663	.4	178	28	704	.9	341
11	656	.4	181	Dec. 6	707	.9	361
16	674	.8	267	10	705	.9	381
20	681	.55	242	15	711	.9	377
24	836	1.7	822	20	720	1.0	391
28	692	.5	229	26	729	1.0	388
July 3	688	.55	196	31	739	1.05	426

Daily gage height, in feet, of Pecos River near Moorhead, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.0	1.0	0.85	0.7	0.7	0.55	0.65	3.4	0.7	0.9	0.85	0.9
2	1.0	1.0	.85	.75	.6	.75	.65	3.35	.6	.85	.8	.9
3	1.0	1.0	.85	.8	.6	.5	.55	2.4	.5	.8	.8	.9
4	1.0	1.0	.85	.8	.65	.65	.6	1.85	.5	.8	.7	.85
5	1.0	1.0	.8	.7	.7	.6	.7	1.6	.55	.8	.7	.9
6	1.0	.95	.8	.7	.6	.6	.65	1.4	.55	.8	.75	.9
7	1.0	.95	.85	.7	.6	.45	.6	1.0	.5	.8	.75	.9
8	1.0	.95	.85	.7	.6	.55	.55	.95	.5	.8	.7	.9
9	1.0	.95	.85	.7	.6	.4	.5	.9	.5	.8	.7	.9
10	1.0	.95	.9	.7	.6	.45	.45	.9	.5	.75	.7	.9
11	1.0	.95	.9	.7	.5	.4	.4	.95	.5	.75	.7	.9
12	1.0	.95	.8	.7	.5	.45	.5	1.0	.55	.7	.75	.9
13	1.0	.95	.8	.7	.55	.45	.5	1.0	.6	.7	.8	.9
14	1.0	.9	.8	.8	.55	.4	.45	1.1	.5	.6	.8	.9
15	1.0	.8	.8	.8	.55	1.5	.45	.85	.6	.55	.8	.9
16	1.05	.8	.8	.8	.6	.85	.4	.85	.6	.5	.8	.95
17	1.1	.8	.7	.8	.7	.75	.4	.8	.5	.5	.85	1.0
18	1.1	.8	.7	.75	.7	.7	.5	.7	.5	.6	.9	1.0
19	1.1	.85	.75	.7	.7	.7	.5	.8	.5	.6	.9	1.0
20	1.1	.9	.8	.7	.65	.55	.5	.7	1.0	.65	.8	1.0
21	1.1	.9	.8	.7	.65	.5	.5	.65	2.75	.7	.8	1.0
22	1.1	.8	.8	.65	.65	.4	.6	.7	2.2	.65	.8	1.0
23	1.1	.8	.85	.65	.9	.7	.7	.7	1.8	.65	.85	1.0
24	1.0	.8	.85	.6	1.05	1.5	.7	.7	1.25	.7	.85	1.0
25	1.1	.75	.8	.55	1.65	1.85	2.85	.65	1.0	.7	.9	1.0
26	1.1	.75	.8	.55	1.85	.9	2.6	.65	1.0	.7	.95	1.0
27	1.0	.85	.75	.8	1.35	.65	.75	.7	1.0	.75	.9	1.0
28	1.0	.85	.75	.8	.85	.55	.6	.7	.85	.8	.9	1.0
29	1.0	.....	.75	.75	.55	.55	2.0	.7	.8	.8	.95	1.0
30	1.0	.....	.7	.6	.5	.5	2.2	.8	.75	.8	.95	1.0
31	1.0	.....	.7	.....	.5	.....	3.0	.75	.....	.85	.....	1.05

Daily discharge, in second-feet, of Pecos River near Moorhead, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	380	395	305	255	270	245	245	1,780	285	375	310	350
2	400	390	305	255	240	305	235	1,750	260	340	295	350
3	a 415	a 385	a 305	255	a 245	a 230	a 195	1,280	a 230	305	295	355
4	420	380	310	a 240	265	305	215	a1,000	230	a 290	a 270	340
5	425	375	295	230	295	280	250	845	245	290	270	360
6	425	360	300	230	270	280	230	710	245	290	285	a 360
7	430	355	315	230	a 260	a 205	215	435	a 230	295	290	365
8	a 430	a 355	a 320	230	260	225	195	405	230	a 295	a 275	370
9	430	355	320	a 230	255	180	a 180	a 370	235	295	275	375
10	430	350	345	235	250	195	165	370	240	270	275	a 380
11	430	350	345	240	a 230	a 180	150	385	240	270	275	380
12	425	345	295	245	230	190	185	395	260	a 250	a 300	380
13	a 425	a 340	a 295	250	235	190	a 185	a 395	275	250	320	380
14	425	325	295	a 275	235	180	175	415	a 245	240	315	380
15	425	290	295	275	a 235	560	185	370	275	235	315	a 375
16	435	290	295	275	240	a 280	180	370	270	a 230	a 310	380
17	445	290	245	275	255	265	a 185	a 360	240	230	325	390
18	445	a 290	a 240	255	255	260	205	320	a 235	260	340	390
19	a 445	310	265	a 240	a 255	260	205	340	235	260	340	390
20	445	330	285	240	235	a 245	205	300	505	275	315	a 390
21	440	330	285	240	235	230	a 205	275	1,440	a 290	a 315	390
22	435	a 300	285	225	235	200	240	a 280	a1,140	275	315	390
23	430	300	a 310	a 225	345	345	295	275	925	275	330	390
24	a 400	300	310	210	a 410	a 730	295	275	610	290	330	390
25	440	290	295	195	620	895	1,480	a 265	470	a 290	a 345	390
26	440	a 290	295	195	685	430	a1,340	270	470	285	360	a 390
27	410	305	285	295	515	310	415	285	470	295	345	390
28	410	305	285	a 295	345	a 260	340	285	a 385	300	a 340	395
29	a 405	.....	a 285	280	a 245	235	a1,070	a 285	350	a 295	360	400
30	405	.....	270	235	230	210	1,180	315	330	295	360	405
31	405	.....	270	.....	230	.....	1,580	300	.....	310	.....	a 425

a Date of measurement.

Monthly discharge of Pecos River near Moorhead, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	445	380	424	26,083
February	395	290	331	18,407
March	345	240	295	18,149
April	295	195	245	14,588
May	685	230	294	18,069
June	895	180	297	17,663
July	1,580	150	401	24,645
August	1,780	265	507	31,150
September	1,440	230	393	23,405
October	375	230	282	17,346
November	360	270	313	18,634
December	425	340	380	23,395
The year	1,780	150	347	251,534

GALLINAS RIVER NEAR LAS VEGAS, N. MEX.

The station, which was established August 13, 1903, and maintained primarily for the purpose of determining the amount of water available for diversion and storage in the San Guyjella basin about 6 miles northwest of Las Vegas, is located at Los Vegas Hot Springs, 6 miles above Las Vegas, N. Mex.

The altitude of the station is about 6,700 feet. It is below all perennial tributaries. The drainage area above the station is about 90 square miles; the total drainage area exceeds 600 square miles.

Very little water is diverted above the station, though practically all of the ordinary flow is used for irrigation in the valley below. The reservoir mentioned above has a capacity of about 40,000 acre-feet, and is to be used for the irrigation of 10,000 acres of land. It will be filled from the Gallinas, the Sapello, and other small streams in that vicinity. The flow of the stream at this point is not usually affected by it.

The gage was washed out on September 29, 1904, and replaced by the present rod gage on October 19, 1904, which is located about 600 feet above the foot-bridge at the power house, from which high discharge measurements are made. Lower water measurements are made by wading. The zero of the new rod gage is 0.71 foot lower than that of the old one. Results at this station have been fairly satisfactory.

Discharge measurements of Gallinas River near Las Vegas, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 20	J. B. Stewart	17	7	1.75	3.1
Apr. 5	do	24	18.5	2.00	18.7
May 22	do	24	17	2.05	19.7
June 24	do	6	1.3	1.70	1.0
July 28	W. H. Sutton	22	22	1.88	14.1
Aug. 29	do	16	20.8	2.20	35.0
Oct. 26	W. B. Freeman	17	9.6	1.68	1.7
Nov. 29	G. H. Russell	18.5	11.4	1.77	4.3

Daily gage height, in feet, of Gallinas River near Las Vegas, N. Mex., for 1909.

[Wm. Prager, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.8	1.8	1.75	1.9	2.1	2.0	1.7	1.8	2.05	1.5	1.6	1.8
2	1.8	1.8	1.9	1.8	2.1	2.0	1.7	1.8	2.05	1.5	1.65	1.8
3	1.8	1.8	1.85	1.85	2.1	1.95	1.7	1.85	2.05	1.5	1.8	1.8
4	1.8	1.8	1.9	2.1	2.1	1.95	1.75	1.9	2.2	1.5	1.8	1.8
5	1.8	1.8	1.85	2.05	2.1	1.9	1.85	1.9	2.3	1.5	1.8	1.7
6	1.8	1.8	1.8	1.95	2.1	1.9	1.8	1.85	3.1	1.5	1.8	1.7
7	1.8	1.8	1.8	1.9	2.1	1.9	1.9	1.8	2.9	1.65	1.8	1.7
8	1.8	1.75	1.95	1.9	2.2	1.9	2.2	1.8	2.35	1.8	1.8	1.7
9	1.8	1.7	1.9	1.95	2.2	1.9	1.9	1.8	2.5	2.05	1.8	1.8
10	1.8	1.7	1.9	1.9	2.2	1.9	1.8	1.85	2.45	1.8	1.8	1.8
11	1.8	1.7	1.9	2.0	2.2	1.9	1.8	2.0	2.35	1.85	1.8	1.8
12	1.8	1.7	1.9	2.0	2.15	1.9	1.7	2.2	2.3	1.85	1.8	1.8
13	1.7	1.95	2.0	2.0	2.1	1.9	1.7	2.4	2.25	1.8	1.8	1.8
14	1.7	1.9	2.0	2.0	2.1	1.9	1.9	2.25	2.2	1.85	1.8	1.8
15	1.7	1.8	2.05	2.0	2.1	1.8	1.8	2.25	2.2	1.9	1.8	1.8
16	1.7	1.75	2.05	2.0	2.1	1.8	1.7	2.2	2.2	1.8	1.8	1.8
17	1.7	1.7	1.95	2.1	2.1	1.8	1.9	2.2	2.1	1.8	1.8	1.8
18	1.7	1.7	1.85	2.2	2.1	1.8	1.8	2.2	2.1	1.9	1.8	1.8
19	1.8	1.7	2.0	2.2	2.05	1.8	1.75	2.2	2.1	1.9	1.8	1.7
20	1.8	1.7	1.9	2.2	2.0	1.8	1.7	2.35	1.95	1.9	1.8	1.7
21	1.8	1.7	1.9	2.15	2.1	1.8	1.7	2.25	1.8	1.9	1.8	1.7
22	1.8	1.75	1.9	2.1	2.1	1.8	1.7	2.25	1.9	1.9	1.8	1.7
23	1.8	1.7	1.9	2.15	2.05	1.7	1.7	2.3	1.8	1.9	1.8	1.8
24	1.8	1.7	1.9	2.15	2.0	1.7	2.1	2.2	1.7	1.8	1.8	1.8
25	1.8	1.9	1.9	2.1	2.0	1.7	2.1	2.3	1.7	1.8	1.8	1.8
26	1.8	1.75	1.9	2.1	2.0	1.7	2.1	2.3	1.7	1.7	1.8	1.8
27	1.8	1.7	1.9	2.1	2.0	1.7	2.0	2.3	1.7	1.7	1.8	1.8
28	1.8	1.7	1.9	2.1	2.0	1.7	1.9	2.2	1.7	1.7	1.8	1.7
29	1.8	.....	1.9	2.1	2.0	1.7	1.85	2.2	1.7	1.95	1.8	1.7
30	1.8	.....	1.9	2.1	2.0	1.7	1.8	2.2	1.6	1.8	1.8	1.7
31	1.8	.....	1.9	.....	2.0	.....	1.8	2.2	.....	1.7	.....	1.7

Daily discharge, in second-feet, of Gallinas River near Las Vegas, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.0	5.0	3.4	10.5	27	16	2	8	19	0.0	0.3	5.0
2	5.0	5.0	10.5	5.0	27	16	2	7	20	.0	1.0	5.0
3	5.0	5.0	7.8	7.8	27	13	2	10	20	.0	5.0	5.0
4	5.0	5.0	10.5	29	27	13	3	14	37	.0	5.0	5.0
5	5.0	5.0	7.8	24	27	9	8	14	51	.0	5.0	1.8
6	5.0	5.0	5.0	14.8	27	9	6	10	280	.0	5.0	1.8
7	5.0	5.0	5.0	10.5	27	9	12	7	177	1.0	5.0	1.8
8	5.0	3.4	14.8	10.5	39	9	43	7	61	5.0	5.0	1.8
9	5.0	1.8	10.5	14.8	39	9	13	7	89	24.0	5.0	5.0
10	5.0	1.8	10.5	10.5	39	9	5	9	79	5.0	5.0	5.0
11	5.0	1.8	10.5	19	38	9	5	21	62	7.8	5.0	5.0
12	5.0	1.8	10.5	19	33	9	3	45	54	7.8	5.0	5.0
13	1.8	14.8	19	19	27	9	3	78	46	5.0	5.0	5.0
14	1.8	10.5	19	19	27	9	13	50	40	7.8	5.0	5.0
15	1.8	5.0	24	19	26	4	5	50	40	10.5	5.0	5.0
16	1.8	3.4	24	19	26	4	3	43	40	5.0	5.0	5.0
17	1.8	1.8	14.8	29	26	4	14	43	29	5.0	5.0	5.0
18	1.8	1.8	7.8	41	25	4	6	40	29	10.5	5.0	5.0
19	5.0	1.8	19	41	20	4	5	40	29	10.5	5.0	1.8
20	5.0	1.8	10.5	41	15	5	3	62	14.8	10.5	5.0	1.8
21	5.0	1.8	10.5	34	25	5	3	47	5.0	10.5	5.0	1.8
22	5.0	3.4	10.5	28	25	5	3	21	10.5	10.5	5.0	1.8
23	5.0	1.8	10.5	34	20	2	3	52	5.0	10.5	5.0	5.0
24	5.0	1.8	10.5	34	15	2	36	38	1.8	5.0	5.0	5.0
25	5.0	10.5	10.5	28	15	2	36	52	1.8	5.0	5.0	5.0
26	5.0	3.4	10.5	28	15	2	36	50	1.8	1.8	5.0	5.0
27	5.0	1.8	10.5	28	15	2	24	49	1.8	1.8	5.0	5.0
28	5.0	1.8	10.5	28	15	2	16	36	1.8	1.8	5.0	1.8
29	5.0	.....	10.5	28	16	2	11	35	1.8	14.8	5.0	1.8
30	5.0	.....	10.5	28	16	2	8	35	.3	5.0	5.0	1.8
31	5.0	.....	10.5	.....	16	.....	8	35	.....	1.8	.....	1.8

NOTE.—From January 1 to April 20 and September 17 to December 31 discharges are based on a well-defined rating curve. April 21 to September 16 discharges were obtained by the indirect method for shifting channels.

Monthly discharge of Gallinas River near Las Vegas, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	5.0	1.8	4.38	269	B.
February	14.8	1.8	4.03	224	B.
March	24	3.4	11.6	713	B.
April	41	5.0	23.4	1,390	B.
May	39	15	24.6	1,510	C.
June	16	2	6.6	393	C.
July	43	2	11.0	676	C.
August	78	7	32.7	2,010	C.
September	280	.3	41.6	2,480	B.
October	24	.0	5.93	365	B.
November	5.0	.3	4.71	280	B.
December	5.0	1.8	3.76	231	C.
The year	280	.0	14.5	10,500	

DEVILS RIVER DRAINAGE BASIN.

DEVILS RIVER AT DEVILS RIVER, TEX.

This station, which was established in April, 1900, by the International Boundary Commission, is opposite the Southern Pacific Railroad station at Devils River.

The river is about 50 miles long, has a perennial flow, and during flood periods is subject to great fluctuations. No good location for a gaging station exists on this stream where it would be accessible from the railroad station. The right bank is the talus of a cliff, the left bank is a bottom heavily timbered. At the site chosen the bed of the stream is nearly all a rock ledge, but seamed and faulted so as to be rough. The current changes in such a way as to give materially different discharges for the same gage height. It is therefore necessary to make frequent measurements to determine closely the daily flow.

The highest water on record occurred April 6, 1900, about two weeks before this gage was established. It reached a height of 25.4 feet on the gage, but this is 8 feet higher than any other known flood. Low water is 2 feet on the gage.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Devils River at Devils River, Tex., in 1909.

[By E. E. Winter.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 4	327	2.3	467	June 12	305	2.15	379
9	331	2.3	489	17	303	2.15	391
14	325	2.3	469	25	305	2.2	387
20	331	2.3	473	29	312	2.2	397
25	332	2.3	437	July 6	318	2.3	483
30	323	2.25	401	14	279	2.1	336
Feb. 4	325	2.25	408	23	545	3.0	1,254
9	316	2.25	396	30	427	2.6	671
14	332	2.3	480	Aug. 5	388	2.5	634
19	339	2.3	462	14	363	2.4	541
23	329	2.25	427	19	337	2.3	456
27	320	2.25	406	26	333	2.25	433
Mar. 4	325	2.25	417	30	342	2.3	457
9	320	2.25	412	Sept. 4	327	2.25	423
14	339	2.3	446	15	378	2.45	569
19	317	2.25	411	23	333	2.3	452
25	317	2.25	407	29	327	2.25	430
30	309	2.2	391	Oct. 5	323	2.25	421
Apr. 5	321	2.2	438	13	309	2.2	387
10	308	2.2	401	22	309	2.2	393
15	311	2.2	400	26	310	2.2	391
19	309	2.2	382	30	311	2.2	388
24	311	2.2	385	Nov. 5	306	2.2	395
29	317	2.25	418	13	310	2.2	399
May 4	312	2.2	397	22	311	2.2	411
12	297	2.15	380	29	319	2.25	427
20	308	2.2	395	Dec. 3	318	2.25	414
25	303	2.2	388	13	310	2.2	411
30	313	2.2	401	23	318	2.25	412
June 4	313	2.2	398	29	310	2.2	389

Daily gage height, in feet, of Devils River at Devils River, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.3	2.25	2.3	2.2	2.2	2.2	2.2	2.55	2.25	2.25	2.2	2.25
2	2.3	2.25	2.3	2.2	2.2	2.2	2.2	2.5	2.25	2.25	2.2	2.25
3	2.3	2.25	2.3	2.2	2.2	2.2	2.2	2.5	2.25	2.25	2.2	2.25
4	2.3	2.25	2.25	2.2	2.2	2.2	2.2	2.5	2.25	2.25	2.2	2.25
5	2.3	2.25	2.25	2.2	2.2	2.2	2.2	2.5	2.2	2.25	2.2	2.25
6	2.3	2.25	2.25	2.2	2.2	2.2	2.25	2.5	2.2	2.25	2.2	2.2
7	2.3	2.25	2.25	2.2	2.2	2.15	2.25	2.5	2.2	2.25	2.2	2.2
8	2.3	2.25	2.25	2.2	2.2	2.15	2.25	2.5	2.2	2.25	2.2	2.2
9	2.3	2.25	2.25	2.2	2.2	2.15	2.2	2.4	2.2	2.25	2.2	2.2
10	2.3	2.3	2.25	2.2	2.15	2.15	2.2	2.45	2.2	2.2	2.2	2.2
11	2.3	2.3	2.25	2.2	2.15	2.15	2.2	2.45	2.2	2.2	2.2	2.2
12	2.3	2.3	2.35	2.2	2.15	2.15	2.15	2.45	2.2	2.2	2.2	2.2
13	2.3	2.3	2.3	2.2	2.15	2.2	2.15	2.45	2.2	2.2	2.2	2.2
14	2.3	2.3	2.3	2.2	2.15	2.2	2.1	2.4	3.35	2.2	2.2	2.2
15	2.3	2.25	2.25	2.2	2.15	2.15	2.1	2.4	2.5	2.2	2.2	2.2
16	2.3	2.25	2.25	2.2	2.15	2.15	2.1	2.4	2.3	2.2	2.2	2.2
17	2.3	2.3	2.25	2.2	2.2	2.15	2.1	2.35	2.3	2.2	2.2	2.2
18	2.3	2.3	2.25	2.2	2.2	2.15	2.1	2.3	2.3	2.2	2.2	2.2
19	2.3	2.3	2.25	2.2	2.2	2.15	2.15	2.3	2.3	2.2	2.2	2.2
20	2.3	2.3	2.25	2.2	2.2	2.15	2.15	2.3	2.3	2.2	2.2	2.2
21	2.3	2.3	2.25	2.2	2.2	2.15	2.15	2.3	2.3	2.2	2.2	2.2
22	2.3	2.3	2.25	2.2	2.2	2.15	2.15	2.3	2.3	2.2	2.2	2.2
23	2.3	2.25	2.25	2.2	2.2	2.3	3.05	2.3	2.3	2.2	2.2	2.25
24	2.3	2.25	2.25	2.2	2.2	2.2	4.6	2.25	2.3	2.2	2.2	2.25
25	2.3	2.25	2.25	2.2	2.2	2.2	3.1	2.25	2.3	2.2	2.2	2.25
26	2.3	2.25	2.25	2.6	2.2	2.2	2.75	2.25	2.3	2.2	2.2	2.25
27	2.3	2.25	2.25	2.6	2.2	2.2	2.6	2.25	2.3	2.2	2.2	2.2
28	2.3	2.3	2.25	2.3	2.2	2.2	2.6	2.25	2.25	2.2	2.2	2.2
29	2.25	.....	2.25	2.25	2.2	2.2	2.6	2.3	2.25	2.2	2.25	2.2
30	2.25	.....	2.2	2.25	2.2	2.2	2.6	2.3	2.25	2.2	2.25	2.2
31	2.25	.....	2.2	.....	2.2	.....	2.6	2.25	.....	2.2	.....	2.2

Daily discharge, in second-feet, of Devils River at Devils River, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	475	400	440	400	395	400	405	650	430	430	390	420
2	470	405	440	410	395	400	415	635	430	425	390	415
3	470	405	440	420	395	400	420	635	425	425	390	a 415
4	a 465	a 405	a 415	430	a 395	a 400	430	635	a 425	420	395	415
5	470	405	415	a 440	395	400	435	a 635	410	a 420	a 395	415
6	475	405	415	430	395	400	a 460	630	410	420	395	410
7	480	400	415	420	395	380	455	620	405	420	395	410
8	485	400	410	410	395	380	445	615	405	415	395	410
9	a 490	a 395	a 410	405	395	380	420	610	400	415	395	410
10	485	440	410	a 400	380	380	410	585	400	390	400	410
11	480	450	410	400	380	380	405	580	400	390	400	410
12	475	460	475	400	a 380	a 380	375	570	400	390	400	410
13	470	470	445	400	380	400	365	565	400	a 385	a 400	a 410
14	a 470	a 480	a 445	400	380	405	a 335	a 540	1,560	385	400	410
15	470	430	440	a 400	380	385	335	530	a 625	390	400	410
16	470	430	430	395	380	385	340	525	480	390	405	410
17	470	460	425	390	395	a 390	340	495	475	390	405	410
18	470	460	420	385	395	390	340	465	470	390	405	405
19	475	a 460	a 410	a 380	395	385	360	a 455	465	390	405	405
20	a 475	460	410	380	a 395	380	360	455	460	390	410	405
21	470	455	410	385	395	380	360	455	455	395	410	400
22	460	450	410	385	390	375	360	455	455	a 395	a 410	400
23	455	a 425	410	385	390	435	a1,330	455	a 450	395	410	a 410
24	445	420	405	a 385	390	390	3,590	435	450	390	410	401
25	a 435	415	a 405	385	a 390	a 385	1,400	435	450	390	410	410
26	435	410	410	650	390	390	890	a 435	450	a 390	410	410
27	430	a 405	415	650	395	390	670	435	450	390	410	390
28	430	440	420	450	395	395	670	435	430	390	410	390
29	400	.....	420	a 420	400	a 395	670	455	a 430	390	a 425	a 390
30	a 400	.....	a 390	420	a 400	400	a 670	a 455	430	a 390	425	390
31	400	.....	390	.....	400	.....	670	435	.....	390	.....	395

a Date of measurement.

Monthly discharge of Devils River at Devils River, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	490	400	460	28,264
February	480	395	430	23,881
March	475	390	420	25,795
April	650	380	420	25,012
May	400	380	391	24,059
June	435	375	391	23,276
July	3,590	335	617	37,944
August	650	435	526	32,360
September	1,560	400	478	28,413
October	430	385	399	24,545
November	425	390	403	24,000
December	420	390	407	25,012
The year	3,590	335	445	322,561

RIO SALADO DRAINAGE BASIN.

RIO SALADO NEAR GUERRERO, TAMAULIPAS, MEXICO.

The Salado is a torrential stream, entering the Rio Grande from the Mexican side about 60 miles below Laredo, or 730 miles by river below El Paso. The town of Guerrero is located on the Salado

some 4 miles above its mouth, and the gaging station is 2 miles above the town. The gaging station was established in 1900 by the International Boundary Commission.

The river is a series of pools and rapids. The best pool available was chosen for the station. The banks are sandy clay, not subject to erosion. The bottom is mud. In low water the river is measured by wading among the rocks below the station. Frequent discharge measurements are made to determine closely the daily flow. The highest recorded flood, on June 16, 1903, gave 17.7 on the gage.

The observations at this station have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights for the years 1900 to 1904, which had not hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio Salado near Guerrero, Tamaulipas, Mexico, in 1909.

[By Lassaulx and Garcia.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 3	950	2.5	119	July 3	4,540	16.0	21,399
7[a]	137	2.3	130	5	5,152	19.0	29,565
11	136	2.2	117	7	3,976	14.0	16,928
15	137	2.1	115	11	3,196	6.5	3,736
19	136	2.1	112	15	2,929	5.0	3,132
23	137	2.1	116	19	2,738	4.2	1,364
27	134	2.0	102	20	2,926	6.0	3,178
30	133	2.0	96	23	2,734	4.4	1,411
Feb. 3	128	1.9	81	28	2,420	3.3	663
7	130	1.9	79	Aug. 3	2,346	2.9	448
11	127	1.8	74	7	2,387	3.2	570
15	126	1.7	70	11	2,353	3.5	609
19	124	1.6	64	13	2,886	6.1	3,339
23	122	1.5	60	15	2,505	4.0	1,120
27	119	1.4	59	19	2,377	3.4	652
Mar. 3	118	1.3	51	23	2,275	2.9	438
7	115	1.2	46	28	3,504	9.2	8,504
11	113	1.1	42	29	4,770	15.2	20,985
15	21	1.0	14	30	5,058	17.2	26,706
20	21	1.0	15	Sept. 3	3,960	11.5	12,465
24	21	1.0	15	7	3,230	7.0	4,067
28	21	.9	14	11	3,029	5.4	1,769
Apr. 1	131	1.9	92	15	2,959	5.1	1,621
3	125	1.8	81	19	2,932	5.0	1,538
7	116	1.2	43	23	2,847	4.6	1,348
8	1,580	4.5	1,138	28	2,789	4.3	1,256
11	142	2.4	137	Oct. 3	2,727	4.0	1,171
15	98	1.3	48	7	2,686	3.8	941
19	66	.9	40	11	2,645	3.6	825
23	63	.8	34	15	2,621	3.5	801
28	62	.7	29	19	2,623	3.5	801
May 3	33	.5	23	23	2,600	3.4	777
7	25	.3	15	28	2,561	3.2	747
11	23	.1	12	Nov. 3	2,561	3.2	744
15	21	.0	10	7	2,543	3.1	723
19	20	−.1	8	11	2,540	3.1	727
23	20	−.1	8	15	2,522	3.0	673
27	2,476	7.5	7,024	19	2,524	3.0	679
28	2,522	8.7	8,551	23	2,520	3.0	672
June 3	1,056	3.0	185	27	2,495	2.9	610
7	157	2.3	140	Dec. 3	2,520	3.0	667
11	119	1.8	103	7	2,519	3.0	675
15	117	1.7	86	11	2,496	2.9	601
19	119	1.7	90	15	2,493	2.9	595
23	160	2.4	155	19	2,495	2.9	593
28	116	1.4	73	23	2,515	3.0	643
July 2	3,137	10.6	13,622	28	2,514	3.0	643

[a] Rejected; too large.

Daily gage height, in feet, of Rio Salado near Guerrero, Tamaulipas, Mexico, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.4	1.9	1.3	1.85	0.6	3.7	1.65	3.0	16.45	4.0	3.2	3.0
2	2.45	1.9	1.3	1.65	.5	3.2	12.0	2.9	15.0	4.0	3.2	3.0
3	2.45	1.9	1.3	1.5	.5	2.9	16.75	2.9	10.9	3.9	3.2	3.0
4	2.4	1.9	1.2	1.4	.4	2.5	19.3	3.3	8.9	3.9	3.2	3.0
5	2.4	1.9	1.2	1.35	.4	2.4	18.5	3.3	7.7	3.9	3.2	3.0
6	2.3	1.9	1.2	1.25	.3	2.3	17.3	3.2	7.3	3.8	3.1	3.0
7	2.3	1.9	1.2	1.2	.3	2.25	11.75	3.2	6.95	3.8	3.1	2.9
8	2.3	1.8	1.2	3.85	.2	2.1	7.65	3.1	6.65	3.7	3.1	2.9
9	2.3	1.8	1.1	2.25	.2	2.0	8.25	3.05	6.1	3.7	3.1	2.9
10	2.2	1.8	1.1	2.55	.1	1.9	7.6	3.75	5.8	3.7	3.1	2.9
11	2.2	1.8	1.1	2.3	.1	1.75	6.25	3.65	5.35	3.6	3.1	2.9
12	2.2	1.8	1.1	1.8	.1	1.7	5.7	5.0	5.2	3.6	3.1	2.9
13	2.2	1.8	1.1	1.5	.0	1.6	5.35	5.9	5.1	3.6	3.1	2.9
14	2.1	1.8	1.0	1.4	.0	1.65	5.15	4.45	5.0	3.6	3.1	2.9
15	2.1	1.7	1.0	1.3	.0	1.65	4.95	3.95	5.1	3.5	3.0	2.9
16	2.1	1.7	1.0	1.2	.0	1.45	4.75	3.75	4.95	3.5	3.0	2.9
17	2.1	1.7	1.0	1.1	.0	1.25	4.55	3.5	5.0	3.5	3.0	2.9
18	2.1	1.6	1.0	.95	−.1	1.05	4.35	3.35	5.25	3.5	3.0	2.9
19	2.1	1.6	1.0	.9	−.1	1.7	4.15	3.35	5.3	3.95	3.0	2.9
20	2.1	1.5	1.0	.9	−.1	1.45	6.65	3.2	5.05	4.0	3.0	2.9
21	2.1	1.5	1.0	.9	−.1	1.3	5.4	3.1	4.6	3.75	3.0	2.9
22	2.1	1.5	1.0	.8	−.1	1.6	4.75	3.0	4.6	3.5	3.0	3.0
23	2.1	1.5	1.0	.8	−.1	2.35	4.2	2.9	4.55	3.4	3.0	3.0
24	2.0	1.4	1.0	.8	−.2	2.15	3.85	2.8	4.4	3.4	3.0	3.0
25	2.0	1.4	.9	.8	−.2	1.95	3.65	2.8	4.4	3.3	3.0	3.0
26	2.0	1.4	.9	.7	1.3	1.75	3.5	3.6	4.3	3.3	3.0	3.0
27	2.0	1.4	.9	.7	6.7	1.55	3.4	7.05	4.3	3.2	2.9	3.0
28	2.0	1.3	.9	.7	8.1	1.4	3.3	10.4	4.25	3.2	2.9	3.0
29	2.0	.....	.9	.6	6.25	1.4	3.2	15.7	4.2	3.2	2.9	2.9
30	2.0	.....	.9	.6	5.35	1.55	3.25	16.75	4.1	3.1	3.0	2.9
31	1.9	.....	.9	.....	4.2	.....	3.05	14.85	.....	3.1	.....	2.9

RIO SAN JUAN DRAINAGE BASIN.

RIO SAN JUAN NEAR SANTA ROSALIA RANCH, TAMAULIPAS, MEXICO.

The San Juan is a long torrential stream entering the Rio Grande 15 miles below Roma and 790 miles by river below El Paso. Six miles above its mouth is the town of Camargo.

The station was first established in 1900 near La Quemada, 12 miles above Camargo, by the International Boundary Commission, but in time of heavy flood in the Rio Grande backwater reached the station, and on July 14, 1902, it was moved 6 miles farther upstream to its present location near Santa Rosalia ranch, Tamaulipas, Mexico. It is now above backwater.

The river bed at both stations shifts constantly and frequent discharge measurements have been made to determine closely the daily flow. Both banks are of sandy clay which are above high water and do not erode. The bottom of the river is sand which erodes slightly in flood.

Low water (no flow) is approximately zero on the gage. The highest recorded flood, on September 16, 1904, reached 27 feet on the gage.

The observations at both stations have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights, 1900 to 1904, which had hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio San Juan near Santa Rosalia ranch, Tamaulipas, Mexico, in 1909.

[By S. Jaso.]

Date.	Area of section	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	100	1.0	20	June 27	71	.5	600
4	243	2.4	234	28	425	3.8	0
8	145	1.6	74	July 1	5,140	26.0	20,817
13	122	1.3	49	3	5,495	28.0	25,415
18	114	1.2	30	7	3,233	16.3	11,121
24	109	1.1	25	Aug. 10	620	1.2	264
28	98	1.0	22	11	4,315	22.0	17,476
Feb. 3	104	1.0	22	12	5,478	28.0	29,552
8	86	0.9	18	13	3,120	16.0	9,199
12	86	.9	7	17	1,519	5.5	3,930
17	81	.8	4	23	1,149	3.4	1,166
24	73	.75	2	28	6,600	32.5	42,768
27	77	.7	3	29	10,884	53.5	88,160
Mar. 3	76	.7	3	Sept. 2	3,181	16.3	10,306
9	72	.6	3	4	3,210	16.2	10,400
14	62	.6	2	9	3,180	16.0	10,303
19	56	.5	0	13	2,283	6.5	6,158
24	58	.4	0	16	4,793	13.5	19,412
30	45	.2	0	19	2,589	7.3	4,194
Apr. 4	35	.1	0	24	3,106	8.9	8,378
10	658	5.3	1,435	28	1,419	4.4	1,529
12	224	2.15	178	Oct. 4	1,866	3.0	1,806
16	122	1.2	41	10	1,743	1.9	1,437
21	88	.9	8	14	1,666	1.4	1,302
25	79	.7	3	25	1,719	.5	1,105
28	81	.6	3	28	1,255	.3	810
May 4	69	.5	0	Nov. 5	1,976	.55	1,327
9	61	.3	0	9	1,917	.2	1,248
14	51	.2	0	14	1,826	−.3	997
19	41	.1	0	18	1,717	−.9	802
23	71	.8	2	21	1,723	−1.0	752
27	130	1.2	48	24	1,683	−1.4	697
28	642	4.9	1,466	28	1,642	−1.7	575
June 2	216	2.0	126	Dec. 3	1,642	−1.5	881
3	524	4.2	855	8	1,606	−1.8	636
5	207	1.8	99	11	1,619	−1.7	716
10	128	1.0	27	16	1,593	−1.9	581
15	103	.8	5	22	1,613	−1.7	649
20	93	.7	3	25	1,614	−1.7	688
25	83	.5	0	28	1,590	−1.9	670

NOTE.—A new gage installed October 1, 1909. Readings are not comparable with old gage.

Daily gage height, in feet, of Rio San Juan near Santa Rosalia ranch, Tamaulipas, Mexico, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.0	1.0	0.7	.....	.....	1.5	19.9	1.35	23.25	3.75	0.1	−2.0
2	1.0	1.0	.7	.....	.....	3.2	24.5	1.25	18.4	3.5	.0	−1.5
3	1.0	1.0	.7	.....	.....	3.9	26.0	1.2	16.3	3.25	.0	−1.5
4	2.4	1.0	.7	.....	.....	2.1	21.0	1.35	16.2	2.95	.65	−1.5
5	2.1	.9	.7	.....	.....	1.75	12.0	1.2	16.2	2.75	.5	−1.6
6	1.85	.9	.7	.....	.....	1.55	13.15	1.15	16.1	2.55	.15	−1.7
7	1.75	.9	.7	.....	.....	1.35	14.75	1.7	16.1	2.35	.0	−1.8
8	1.6	.9	.7	.....	.....	1.3	15.65	1.6	16.0	2.2	.0	−1.75
9	1.5	.9	.6	.....	.....	1.15	10.85	1.35	15.65	2.05	.5	−1.8
10	1.45	.9	.6	5.05	.....	1.0	4.5	1.15	13.35	1.85	.2	−1.7

Daily gage height, in feet, of Rio San Juan near Santa Rosalia ranch, Tamaulipas, Mexico, for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	1.4	.9	.6	2.9	.....	.9	3.85	25.0	6.95	1.65	.05	−1.7
12	1.35	.9	.6	2.0	.....	.9	2.85	28.25	6.75	1.55	− .05	−1.6
13	1.3	.9	.6	1.6	.....	.9	2.7	20.0	6.5	1.5	− .15	−1.8
14	1.3	.9	.6	1.5	.....	.8	2.35	8.5	6.25	1.4	− .3	−1.9
15	1.3	.9	.....	1.35	.....	.8	2.2	7.0	6.7	1.4	− .45	−1.9
16	1.2	.9	.....	1.2	.....	.8	2.0	6.0	13.5	1.25	− .65	−1.9
17	1.2	.8	.....	1.1	.....	.7	1.9	5.5	10.3	1.1	− .8	−1.9
18	1.2	.8	.....	1.1	.....	.7	1.8	4.5	8.5	1.0	− .95	−1.9
19	1.2	.8	.....	1.0	.....	.7	1.7	3.95	6.2	0.95	−1.0	−1.9
20	1.2	.8	.....	1.0	.....	.7	1.7	3.7	6.75	.9	−1.0	−1.9
21	1.2	.8	.....	.95	.....	.6	5.25	3.55	6.4	.8	−1.0	−1.8
22	1.2	.8	.....	.9	.....	.6	3.65	3.45	6.1	.7	−1.1	−1.7
23	1.2	.8	.....	.8	.....	.6	3.15	4.95	5.85	.7	−1.25	−1.65
24	1.15	.8	.....	.8	.....	.5	2.7	6.5	8.1	.55	−1.4	−1.65
25	1.05	.7	.....	.7	1.25	.5	2.3	6.8	6.2	.45	−1.45	−1.7
26	1.0	.7	.....	.7	1.25	.5	1.85	7.0	5.3	.4	−1.5	−1.7
27	1.0	.7	.....	.7	6.25	.5	1.75	12.6	4.9	.4	−1.6	−1.8
28	1.0	.7	.....	.6	5.7	3.4	1.65	28.75	4.45	.3	−1.7	−1.9
29	1.0	.....	.....	.6	4.3	2.15	1.5	51.75	4.15	.2	−1.85	−1.9
30	1.0	.....	.....	.6	2.55	1.7	1.5	60.0	3.9	.1	−2.0	−2.0
31	1.0	.....	.....	.....	1.95	.....	1.4	43.5	.....	.1	.....	−2.0

NOTE.—No flow March 15 to April 9, and May 1–24, 1909.

MISCELLANEOUS MEASUREMENTS IN RIO GRANDE DRAINAGE BASIN.

The following miscellaneous discharge measurements were made in the Rio Grande drainage basin in 1909:

Miscellaneous discharge measurements in Rio Grande basin in 1909.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
May 18	Goose Creek	Rio Grande	Wagon Wheel Gap, Colo.	.....	[1] 30
May 17	South Fork of Rio Grande.	do	South Fork, Colo.	3.34	932
June 21	do	do	do	3.77	1,140
Aug. 4	do	do	do	1.67	142
Oct. 1	do	do	do	1.52	111
May 17	Willow Creek	do	1 mile below South Fork, Colo.	.....	[a] 50
Do	Shaw Creek	do	4 miles below South Fork, Colo.	.....	[a] 15
Do	Los Pinos Creek	do	2 miles above Del Norte, Colo.	.....	[a] 60
May 15	San Antonio Creek	Conejos River	1 mile south of Antonito, Colo.	[b] 11.0	814
June 22	do	do	do	[b] 12.45	.....
June 23	do	do	do	[b] 12.55	234
Oct. 1	do	do	do	.....	[c] 20
Sept. 30	Chama River	Rio Grande	Chamita, N. Mex.	.....	[a] 20
Oct. 1	do	do	do	.....	[a] 30
June 2	Rio Puerco	do	Rio Puerco, N. Mex.	.....	[a] 8

[a] Estimated. [b] Distance from reference point to water surface. [c] Float measurement.

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