Water-Supply and Irrigation Paper No. 172 Series P, Hydrographic Progress Reports, 48

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1905

PREPARED UNDER THE DIRECTION OF F. H. NEWELL

PART VIII.—Missouri River Drainage

BY

CYRUS C. BABB, M. C. HINDERLIDER, and JOHN C. HOYT

WASHINGTON
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PROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1905.

PART VIII.

By C. C. Babb, M. C. Hinderlider, and J. C. Hoyt.

INTRODUCTION.

ORGANIZATION AND SCOPE OF WORK.

The hydrographic work of the United States Geological Survey includes the collection of facts concerning and the study of conditions affecting the behavior of water from the time it reaches the earth as rain or snow until it joins the oceans or the great navigable rivers. These investigations became a distinct feature of the work of the Survey in the fall of 1888, when an instruction camp was established at Embudo, N. Mex. The first specific appropriation for gaging streams was made by the act of August 18, 1894, which contained an item of $12,500 "for gauging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and semiarid sections." (28 Stat L., p. 398.)

Since that time the appropriations have been gradually increased, as shown by the following table:

Annual appropriations for hydrographic surveys, fiscal years ending June 30, 1895-1906.

1895	$12,500	1901	100,000
1896	30,000	1902	100,000
1897	50,000	1903	200,000
1898	50,000	1904	200,000
1899	50,000	1905	200,000
1900	50,000	1906	200,000

As a result of the increased appropriations the work has been greatly extended and at the same time it has been more thoroughly systemized by the adoption of standard methods and by grouping the States into districts, in each of which a district hydrographer and a corps of assistants carry on a comprehensive study of the hydrographic resources.

The chief features of the hydrographic work are the collection of data relating to the flow of the surface waters and the study of the conditions affecting this flow. Information is also collected concerning river profiles, duration and magnitude of floods, water power, etc., which may be of use in hydrographic studies. This work includes the study of the hydrography of every important river basin in the United States and is of direct value in the commercial and agricultural development of the country.

In order to collect the material from which estimates of daily flow are made, gaging stations are established. The selection of a site for a gaging station and the length of time it is maintained depend largely on the physical features and the needs of each locality. If the water is to be used for power, special effort is made to obtain information concerning the minimum flow; if water is to be stored, the maximum flow receives special attention. In all sections of the country permanent gaging stations are maintained for general statistical

purposes, to show the conditions existing through long periods. They are also used as primary stations, and their records in connection with short series of measurements, serve as bases for estimating the flow at other points in the drainage basin.

During the calendar year 1905 the division of hydrography has continued measuring the flow of streams on the same general lines as in previous years. Many new and improved methods have been introduced, by which the accuracy and value of the results have been increased. Approximately 800 regular gaging stations were maintained during the year, and an exceptionally large number of miscellaneous measurements and special investigations were made. The "Report of Progress of Stream Measurements," which contains the results of this work, is published in a series of fourteen Water-Supply and Irrigation Papers, Nos. 165 to 178, as follows:

No. 165. Atlantic coast of New England drainage.
No. 166. Hudson, Passaic, Raritan, and Delaware river drainages.
No. 167. Susquehanna, Gunpowder, Patapsco, Potomac, James, Roanoke, and Yadkin river drainages.
No. 168. Santee, Savannah, Ogeechee, and Altamaha rivers and eastern Gulf of Mexico drainages.
No. 169. Ohio and lower eastern Mississippi river drainages.
No. 170. Great Lakes and St. Lawrence River drainages.
No. 171. Hudson Bay and upper eastern. and western Mississippi River drainages.
No. 172. Missouri River drainage.
No. 173. Meramec, Arkansas, Red, and lower western Mississippi river drainages.
No. 174. Western Gulf of Mexico and Rio Grande drainages.
No. 175. Colorado River drainage.
No. 176. The Great Basin drainage.
No. 177. The Great Basin and Pacific Ocean drainages in California.
No. 178. Columbia River and Puget Sound drainages.

These papers embody the data collected at the regular gaging stations, the results of the computations based on the observations, and such other information as may have a direct bearing on the study of the subject, and include, as far as practicable, descriptions of the basins and the streams draining them.

For the purpose of introducing uniformity into the reports for the various years the drainages of the United States have been divided into eleven grand divisions, which have been again divided into secondary divisions, as shown in the following list. The Progress Report has been made to conform to this arrangement, each part containing the data for one or more of the secondary divisions. The secondary divisions have in most cases been redivided, and the facts have been arranged, so far as practicable, geographically.

List of drainage basins in the United States.

NORTHERN ATLANTIC DRAINAGE BASINS.

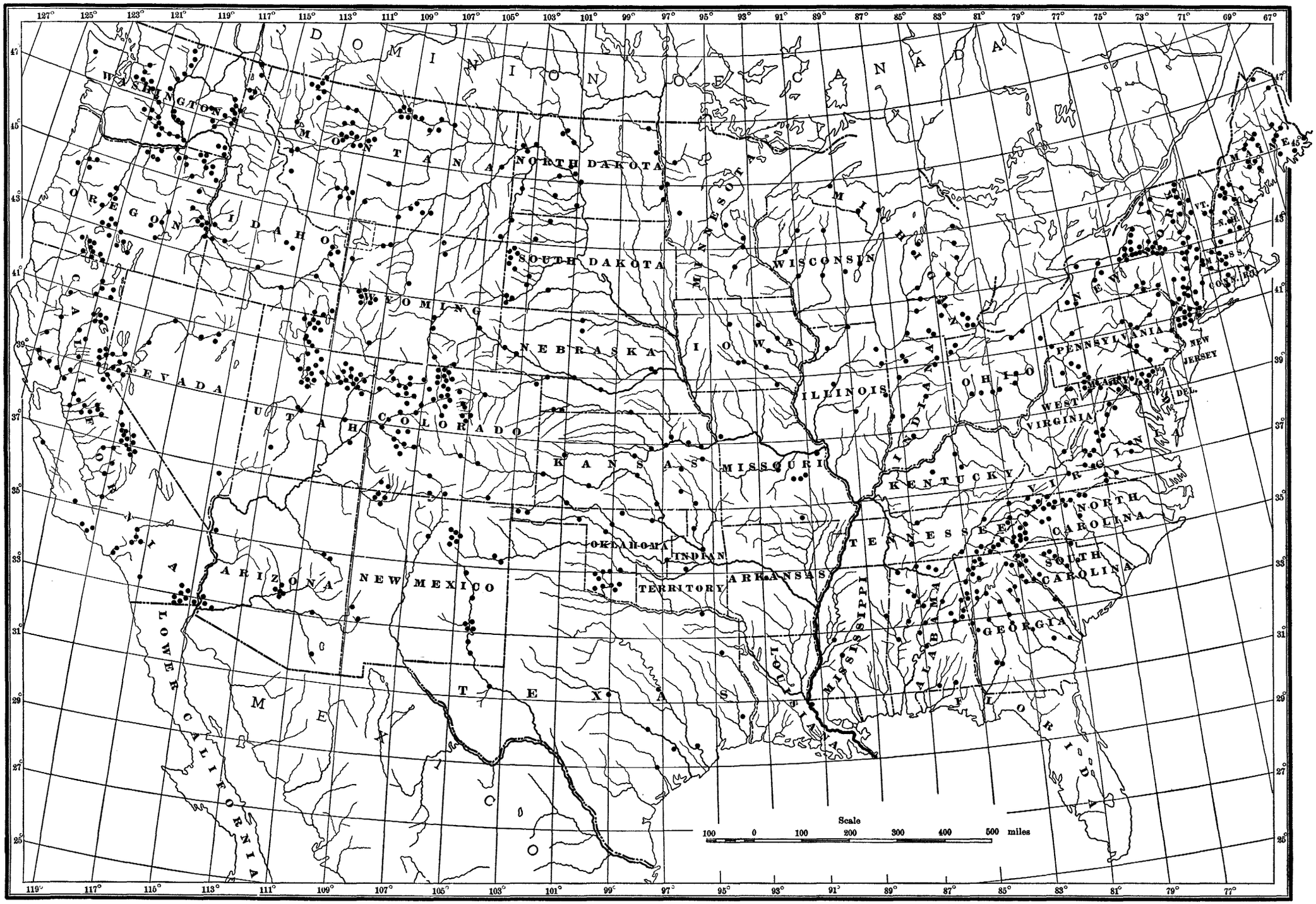
St. John.	Thames.
St. Croix.	Housatonic.
Penobscot.	Hudson.
Kennebec.	Passaic.
Androscoggin.	Raritan.
Presumpscot.	Delaware.
Saco.	Susquehanna.
Merrimac.	Potomac.
Connecticut.	Minor Chesapeake Bay.
Blackstone.	Minor northern Atlantic.

SOUTHERN ATLANTIC DRAINAGE BASINS.

James.	Great Pedee (Yadkin).
Chowan.	Santee.
Roanoke.	Savannah.
Tar.	Ogeechee.
Neuse.	Altamaha.
Cape Fear.	Minor southern Atlantic.

EASTERN GULF OF MEXICO DRAINAGE BASINS.

Suwanee.	Pearl.
Apalachicola.	Minor eastern Gulf of Mexico.
Mobile.	



MAP OF THE UNITED STATES, SHOWING LOCATION OF PRINCIPAL RIVER STATIONS MAINTAINED DURING 1905.

EASTERN MISSISSIPPI RIVER DRAINAGE BASINS.

Lower eastern Mississippi.
Ohio.
Upper eastern Mississippi.

ST. LAWRENCE RIVER DRAINAGE BASINS.

Lake Superior.
Lake Michigan.
Lake Huron.
Lake St. Clair.
Lake Erie.
Niagara River.
Lake Ontario.
Lake Champlain (Richelieu River).
Minor St. Lawrence.

WESTERN MISSISSIPPI RIVER DRAINAGE BASINS.

Upper western Mississippi.
Missouri.
Meramec.
Lower western Mississippi.
Arkansas.
Red.

WESTERN GULF OF MEXICO DRAINAGE BASINS.

Sabine.
Neches.
Trinity.
Brazos.
Colorado (of Texas).
Guadelupe.
San Antonio.
Nueces.
Rio Grande.
Minor western Gulf of Mexico.

COLORADO RIVER DRAINAGE BASIN.

THE GREAT BASIN.

Wasatch Mountains.
Humboldt.
Sierra Nevada.
Minor streams in Great Basin.

PACIFIC COAST DRAINAGE BASINS.

Southern Pacific.
San Francisco Bay.
Northern Pacific.
Columbia.
Puget Sound.

HUDSON BAY DRAINAGE BASINS.

DEFINITIONS.

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 inch, 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.

"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 has been commonly used by miners and irrigators throughout the West, and is defined by statute in each State in which it is used. In most States the California miner's inch is used, which is the fiftieth part of a second-foot.

"Second-feet per square mile" is applied to 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. There is a convenient relation between the second-foot and the acre-foot. One second-foot flowing for twenty-four hours will deliver 86,400 cubic feet or approximately 2 acre-feet.

EXPLANATION OF TABLES.

For each regular gaging station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage-height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off, based on all the facts obtained to date.

The descriptions of stations give such general information about the locality and equipment as would enable the reader to find and use the station. They also give, as far as possible, a complete history of all the changes that have occurred since the establishment of the station that would be factors in using the data collected.

The discharge-measurement table gives the results of the discharge measurements made during the year, including the date, the name of the hydrographer, the gage height, the area of cross section, the mean velocity, and the 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. The gage height given in the table represents the elevation of the surface of the water above the zero of the gage. At most stations the gage is read in the morning and in the evening.

The rating table gives discharges in second-feet corresponding to each stage of the river as given by the gage heights.

In the table of estimated monthly discharge, the column headed "Maximum" gives the mean flow for the day when the mean gage height was highest. This is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge larger than given in this 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 for each second during the month. On this are based the computations for the three remaining columns, which are defined on page 3.

In the computations for the tables of this report the following general and special rules have been used:

Fundamental rules for computation.

1. The highest degree of precision consistent with the rational use of time and money is imperative.
2. All items of computation should be expressed by at least two and not more than four significant figures.
3. Any measurement in a vertical velocity, mean velocity, or discharge curve whose per cent of error is five times the average per cent of error of all the other measurements should be rejected.
4. In reducing the number of significant figures, or the number of decimal places, by dropping the last figure, the following rules apply:

(*a*) When the figure in the place to be rejected is less than 5, drop it without changing the preceding figure. Example: 1,827.4 becomes 1,827.

(*b*) When the figure in the place to be rejected is greater than 5, drop it and increase the preceding figure by 1. Example: 1,827.6 becomes 1,828.

(*c*) When the figure in the place to be rejected is 5, and it is preceded by an even figure, drop the 5. Example: 1,828.5 becomes 1,828.

(*d*) When the figure in the place to be rejected is 5, and it is preceded by an odd figure, drop the 5 and increase the preceding figure by 1. Example: 1,827.5 becomes 1,828.

Special rules for computation.

1. Rating tables are to be constructed as closely as the data on which they are based will warrant No decimals are to be used when the discharge is over 50 second-feet.
2. Daily discharges shall be applied directly to the gage heights as they are tabulated.
3. Monthly means are to be carried out to one decimal place when the quantities are below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in the monthly mean shall be a significant figure. This also applies to the yearly mean.
4. Second-feet per square mile and depth in inches for the individual months shall be carried out to at least three significant figures, except in the case of decimals where the first significant figure is preceded by one or more naughts (0), when the quantity shall be carried out to two significant figures. Example: 1.25; .125, .012, .0012. The yearly means for these quantities are always to be expressed in three significant figures and at least two decimals places.

CONVENIENT EQUIVALENTS.

1 second-foot equals 50 California miner's inches.
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 deep, or 13.572 inches deep.
1 second-foot for one year equals 0.000214 cubic mile; equals 31,536,000 cubic feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot falling 10 feet equals 1.136 horsepower.
100 California miner's inches equals 15 United States gallons per second.
100 California miner's inches equal 77 Colorado miner's inches.
100 California miner's inches for one day equal 4 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 130 California miner's inches.
100 Colorado miner's inches for one day equal 5.2 acre-feet.
100 United States gallons per minute equal 0.223 second-foot.
100 United States gallons per minute for one day equal 0.44 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 inch equals 2.54 centimeters.
1 foot equals 0.3048 meter.
1 yard equals 0.9144 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 1,760 yards; equals 5,280 feet; equals 63,360 inches.
1 square yard equals 0.836 square meter.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet; equals 4,840 square yards.
1 acre equals 209 feet square, nearly.
1 square mile equals 259 hectares.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot equals 7.48 gallons; equals 0.804 bushel.
1 cubic foot of water weighs 62.5 pounds.
1 cubic yard equals 0.7646 cubic meter.
1 cubic mile equals 147,198,000,000 cubic feet.
1 cubic mile equals 4,667 second-feet for one year.
1 gallon equals 3.7854 liters.
1 gallon equals 8.36 pounds of water.
1 gallon equals 231 cubic inches (liquid measure).
1 pound equals 0.4536 kilogram.
1 avoirdupois pound equals 7,000 grains.
1 troy pound equals 5,760 grams.
1 meter equals 39.37 inches. Log. 1.5951654.
1 meter equals 3.280833 feet. Log. 0.5159842.
1 meter equals 1.093611 yards. Log. 0.0388629.
1 kilometer equals 3,281 feet; equals five-eighths mile, nearly.
1 square meter equals 10.764 square feet; equals 1.196 square yards.
1 hectare equals 2.471 acres.
1 cubic meter equals 35.314 cubic feet; equals 1.308 cubic yards.
1 liter equals 1.0567 quarts.
1 gram equals 15.43 grains.
1 kilogram equals 2.2046 pounds.
1 tonneau equals 2,204.6 pounds.
1 foot per second equals 1.097 kilometers per hour.
1 foot per second equals 0.68 mile per hour.
1 cubic meter per minute equals 0.5886 second-foot.
1 atmosphere equals 15 pounds per square inch; equals 1 ton per square foot; equals 1 kilogram per square centimeter.
Acceleration of gravity equals 32.16 feet per second every second.
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 8.8 feet.
1⅓ horsepowers 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 the theoretical power.
Quick formula for computing discharge over weirs: Cubic feet per minute equals $0.4025\, l\sqrt{h^3}\, l$ = length of weir in inches; h=head in inches flowing over weir, measured from surface of still water.
To change miles to inches on map:
Scale 1 : 125000, 1 mile=0.50688 inch.
Scale 1 : 90000, 1 mile=0.70400 inch.
Scale 1 : 62500, 1 mile=1.01376 inches.
Scale 1 : 45000, 1 mile=1.40800 inches.

FIELD METHODS OF MEASURING STREAM FLOW.

The methods used in collecting these data and in preparing them for publication are given in detail in Water-Supply Papers No. 94 (Hydrographic Manual, U. S. Geological Survey) and No. 95 (Accuracy of Stream Measurements). In order that those who use this report may readily become acquainted with the general methods employed, the following brief description is given:

Streams may be divided, with respect to their physical conditions, into three classes—(1) those with permanent beds; (2) those with beds which change only during extreme low or high water; (3) those with constantly shifting beds. In estimating the daily flow special methods are necessary for each class. The data on which these estimates are based and the methods of collecting them are, however, in general the same.

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; (3) by measurements of the velocity of the current and of the area of the cross section. The method chosen for any case 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.

Weir method.—When funds are available and the conditions are such that sharp-crested weirs can be erected, these offer the best facilities for determining flow. If dams are suitably situated and constructed they may be utilized for obtaining reliable estimates of flow. The conditions necessary to insure good results may be divided into two classes—(1) those relating to the physical characteristics of the dam itself, and (2) those relating to the diversion and use of water around and through the dam.

The physical requirements are as follows: (*a*) Sufficient height of dam, so that backwater will not interfere with free fall over it; (*b*) absence of leaks of appreciable magnitude; (*c*) topography or abutments which confine the flow over the dam at high stages; (*d*) level crests, which are kept free from obstructions caused by floating logs or ice; (*e*) crests of a type for which the coefficients to be used in $Q = c\, b\, h^{\frac{3}{2}}$, or some similar standard weir formula, are known (see Water-Supply Paper No. 150); (*f*) either no flash boards or exceptional care in reducing leakage through them and in recording their condition.

Preferably there should be no diversion of water through or around the dam. Generally, however, a dam is built for purposes of power or navigation, and part or all of the water flowing past it is diverted for such uses. This water must be measured and added to that passing over the dam. To insure accuracy in such estimates the amount of water diverted

should be reasonably constant. Furthermore, it should be so diverted that it can be measured, either by a weir, by a current meter, or by a simple system of water wheels which are of standard make or which have been rated as meters under working conditions and so installed that the gate openings, the heads under which they work, and their angular velocities may be accurately observed.

The combination of physical conditions and uses of the water should be such that the estimates of flow will not involve, for a critical stage of considerable duration, the use of a head, on a broad-crested dam, of less than 6 inches. Moreover, when all other conditions are good, the cooperation of the owners or operators of the plant is still essential if reliable results are to be obtained.

A gaging station at a weir or dam has the general advantage of continuity of record through the periods of ice and floods, and the disadvantages of uncertainty of coefficient to be used in the weir formula and of complications in the diversion and use of the water.

Velocity method.—The determination of the quantity of water flowing past a certain section of a stream at a given time is termed a discharge measurement. This quantity is the product of two factors—the mean velocity and the area of the cross section. The mean velocity is a function of surface slope, wetted perimeter, roughness of bed, and the channel conditions at, above, and below the gaging section. The area depends on the contour of the bed and the fluctuations of the surface. The two principal ways of measuring the velocity of a stream are by floats and current meters.

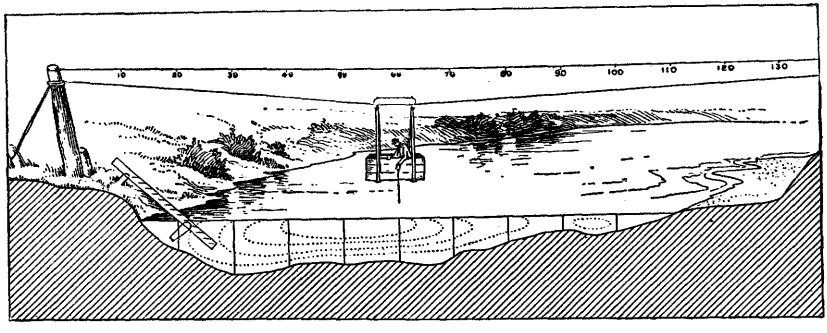


FIG. 1.—Cable station, showing section of river, car, gage, etc.

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. Their essential requirements are practically the same, whether the velocity is determined by meters or floats. They are located as far as possible where the channel is straight both above and below the gaging section; where there are no cross currents, backwater, or boils; where the bed of the stream is reasonably free from large projections of a permanent character; and where the banks are high and subject to overflow only at flood stages. The station must be so far removed from the effects of tributary streams and dams or other artificial obstructions that the gage height shall be an index of the discharge.

Certain permanent or semipermanent structures, usually referred to as "equipment," are generally appurtenant to a gaging station. These are a gage for determining the fluctuations of the water surface, bench marks to which the datum of the gage is referred, permanent marks on a bridge or a tagged line indicating the points of measurement, and, where the current is swift, some appliance (generally a secondary cable) to hold the meter in position in the water. As a rule the stations are located at bridges if the channel conditions are satisfactory, as from them observations can more readily be made and the cost of equipment is small.

The floats in common use are the surface, subsurface, and tube or rod floats. A corked bottle with a flag in the top and weighted at the bottom makes one of the most satisfactory

surface floats, as it is affected but little by wind. In case of flood measurements, good results can be obtained by observing the velocity of floating cakes of ice or débris. In all surface float measurements coefficients must be used to reduce the observed velocity to the mean velocity. The subsurface and tube or rod floats are intended to give directly the mean velocity in the vertical. Tubes give excellent results when the channel conditions are good, as in canals.

In measuring velocity by a float, observation is made of the time taken by the float to pass over the "run," a selected stretch of river from 50 to 200 feet long. In each discharge measurement a large number of velocity determinations are made at different points across the stream, and from these observations the mean velocity for the whole section is determined. This may be done by plotting the mean positions of the floats as indicated by the distances from the bank as ordinates and the corresponding times as abscissas. A curve through these points shows the mean time of run at any point across the stream, and the mean time for the whole stream is obtained by dividing the area bounded by this curve and its axis by the width. The length of the run divided by the mean time gives the mean velocity.

The area used in float measurements is the mean of the area at the two ends of the run and at several intermediate sections.

The essential parts of the current meters in use are a wheel of some type, so constructed that the impact of flowing water causes it to revolve, and a device for recording or indicating the number of revolutions. The relation between the velocity of the moving water and the revolutions of the wheel is determined for each meter. This rating is done by drawing the meter 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 for any number of revolutions.

Many kinds of current meters have been constructed. They may, however, be classed in two general types—those in which the wheel is made up of a series of cups, as the Price, and those having a screw-propeller wheel, as the Haskell. Each meter has been developed for use under some special condition. In the case of the small Price meter, which has been largely developed and extensively used by the United States Geological Survey, an attempt has been made to get an instrument which could be used under practically all conditions.

Current-meter measurements may be made from a bridge, cable, or boat or by wading, and gaging stations may be classified in accordance with such use. Fig. 1 shows a typical cable station.

In making the measurement an arbitrary number of points are laid off on a line perpendicular to the thread of the stream. The points at which the velocity and depth are observed are known as measuring points, and are usually fixed at regular intervals, varying from 2 to 20 feet, depending on the size and condition of the stream. Perpendiculars dropped from the measuring points divide the gaging section into strips. For each strip or pair of strips the mean velocity, area, and discharge are determined independently, so that conditions existing in one part of the stream may not be extended to parts where they do not apply.

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

The three principal multiple-point methods in general use are the vertical velocity-curve, 0.2 and 0.8 depth, and top, bottom, and mid depth.

In the vertical velocity-curve method a series of velocity determinations are made in each vertical at regular intervals, usually from 0.5 to 1 foot 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. On account of the length of time required to make a complete

measurement by this method its use is 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 of the depth and the mean of the velocities at these two points is taken as the mean velocity for that vertical. This method is based on the assumption that the vertical velocity-curve is a common parabola, in which the mean ordinate equals the mean of the ordinates at 0.2211 depth and at 0.7886 depth. Actual observations show that this law holds very closely.

In the third multiple-point method the meter is held at mid depth at 0.5 foot below the surface and at 0.5 foot above the bottom, and the mean velocity is determined by dividing by 6 the sum of the top velocity, four times the mid depth velocity, and the bottom velocity. This method may be modified by observing at 0.2, 0.6, and 0.8 depth.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity or at an arbitrary depth for which the coefficient for reducing the mean velocity has been determined.

Extensive experiments by vertical velocity-curves show that the thread of mean velocity generally occurs at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, at which point the meter is held in a majority of the measurements. A large number of vertical velocity-curve measurements taken on many streams under varying conditions show that the average coefficient for reducing the velocity obtained at 0.6 depth to mean velocity is practically unity.

In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be unaffected by 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 from 0.85 to 0.95, depending on the stage, velocity, and channel conditions. The higher the stage the larger the coefficient. This method is specially adapted for flood measurements or when the velocity is so great that the meter can not be kept at 0.6 depth.

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 well adapted for measurements under ice and as a check on the point methods.

The area, which is the other factor in the velocity method of determining the discharge of a stream, depends on the stage of the river, which is observed on the gage, and on the general contour of the bed of the stream, which is determined by soundings. The soundings are usually taken at each measuring point at the time of the discharge measurement, either by using the meter and cable or by a special sounding line or rod. For streams with permanent beds standard cross sections are usually taken during low water. These sections serve to check the soundings which are taken at the time of the measurements and from them any change which may have taken place in the bed of the stream can be detected. They are also of value in obtaining the area for use in computations of high-water measurements, as accurate soundings are hard to obtain at high stages.

In computing the discharge measurements from the observed velocities and depths at various points of measurement the measuring section is divided into elementary strips, as shown in fig. 1, and the mean velocity, area, and discharge are determined separately for either a single or a double strip. The total discharge and the area are the sums of those for the various strips, and the mean velocity is obtained by dividing the total discharge by the total area.

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 the 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 vertical velocity-curve method, 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, the thickness and character of the ice, etc.

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, varying thickness of ice. Such data as are available in regard to this subject are published in Water-Supply Paper No. 146, pp. 141-148.

OFFICE METHODS OF COMPUTING RUN-OFF.

There are two principal methods of estimating run-off, depending on whether or not the bed of the stream is permanent.

For stations on streams with permanent beds the first step in computing the run-off is the construction of the rating table, which shows the discharge corresponding to any stage of the stream. This rating table is applied to the record of stage to determine the amount of water flowing. The construction of the rating table depends on the method used in measuring flow.

For a station at a weir or dam, the basis for the rating table is some standard weir formula. The coefficients to be used in its application depend on the type of dam and other conditions near its crest. After inserting in the weir formula the measured length of crest and assumed coefficient, the discharge is computed for various heads, and the rating table considered.

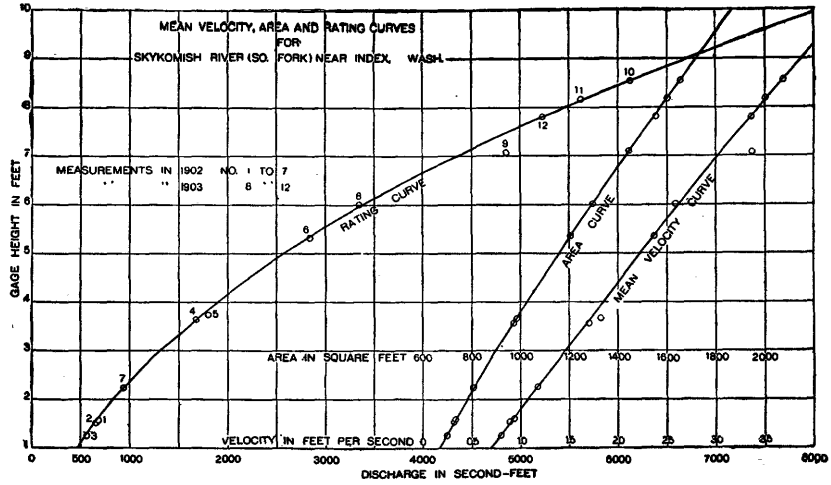


FIG. 2.—Discharge, mean-velocity, and area curves for South Fork of Skykomish River near Index, Wash.

The data necessary for the construction of a rating table for a velocity-area station are the results of the discharge measurements, which include the record of stage of the river at the time of measurement, the area of the cross section, the mean velocity of the current, and the quantity of water flowing. A thorough knowledge of the conditions at and in the vicinity of the station is also necessary.

The construction of the rating table depends on the following laws of flow for open permanent channels: (1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant. (2) The discharge will be the same whenever the stream is at a given stage, if the change of slope due to the rise and fall of the stream be neglected. (3) The discharge is a function of and increases gradually with the stage.

The plotting of results of the various discharge measurements using gage heights as ordinates, and discharge, mean velocity, and area as abscissas, will define curves which show the discharge, mean velocity, and area corresponding to any gage height. For the development of these curves there should be therefore a sufficient number of discharge measurements to cover the range of the stage of the stream. Fig. 2 shows a typical rating curve with its corresponding mean velocity and area curves.

As the discharge is the product of two factors, the area and the mean velocity, any change in either factor will produce a corresponding change in the discharge. Their curves are therefore constructed in order to study each independently of the other.

The area curve can be definitely determined from accurate soundings extending to the limits of high water. It is always concave toward the horizontal axis or on a straight line, unless the banks of the stream are overhanging.

The form of the mean velocity-curve depends chiefly on the surface slope, the roughness of the bed, and the cross section of the stream. Of these, the slope is the principal factor. In accordance with the relative change of these factors the curve may be a straight line, convex or concave toward either axis, or a combination of the three. From a careful study of the conditions at any gaging station the form which the vertical velocity-curve will take can be predicted, and it may be extended with reasonable certainty to stages beyond the limits of actual measurements. Its principal use is in connection with the area curve in locating errors in discharge measurements and in constructing the rating table.

The discharge curve is defined primarily by the measurements of discharge, which are studied and weighted in accordance with the local conditions existing at the time of each measurement. The curve may, however, best be located between and beyond the measurements by means of curves of area and mean velocity. The discharge curve under normal conditions is concave toward the horizontal axis and is generally parabolic in form.

In the preparation of the rating table the discharge for each tenth or half tenth on the gage is taken from the curve. The differences between successive discharges are then taken and adjusted according to the law that they shall either be constant or increasing.

The determination of daily discharge of streams with changeable beds is a difficult problem. In case there is a weir or dam available, a condition which seldom exists on streams of this class, estimates can be obtained by its use. In case of velocity-area stations frequent discharge measurements must be made if the estimates are to be other than rough approximations. For stations with beds which shift slowly or are materially changed only during floods, rating tables can be prepared for periods between such changes and satisfactory results obtained with a limited number of measurements, provided that some of them are taken soon after the change occurs. For streams with continually shifting beds, such as the Colorado and Rio Grande, discharge measurements should be made every two or three days, and the discharges for intervening days obtained either by interpolation modified by gage height, or by Professor Stout's method, which has been described in full in the Nineteenth Annual Report, Part IV, page 323, and in Engineering News of April 21, 1904. This method, or a graphic application of it, is also much used in estimating flow at stations where the bed shifts but slowly.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is extended to other persons and corporations who have assisted these hydrographers or have cooperated in any way, either by furnishing records of the height of water or by assisting in transportation.

The following list, arranged geographically by States, gives the names of the hydrographers and others who have assisted in furnishing and preparing the data contained in this report:

Colorado.—District and resident hydrographer, M. C. Hinderlider,[a] assisted by R. I. Meeker, Wm. A. Lamb, A. A. Weiland, Melvin Beeson, Thomas E. Brick, and F. L. Meeker. Acknowledgments are due the Colorado and Southern, Burlington and Missouri River, Union Pacific, and Chicago, Burlington and Quincy railroads for transportation furnished the district and local hydrographers.

[a] Office of district hydrographer for Colorado, Kansas, northern New Mexico, and southern Wyoming, Chamber of Commerce Building, Denver, Colo.

Kansas.—District hydrographer, M. C. Hinderlider; resident hydrographer, W. G. Russell. Acknowledgments are due the Atchison, Topeka and Santa Fe, Union Pacific, Missouri, Kansas and Texas, Missouri Pacific, and Chicago, Rock Island and Pacific railways for annual passes issued to Mr. Russell.

Missouri.—District hydrographer, F. W. Hanna,[a] assisted by M. S. Brennan and S. K. Clapp. Acknowledgment is due the St. Louis and San Francisco Railroad for transportation furnished to Messrs. Hanna and Brennan.

Nebraska.—District hydrographer, M. C. Hinderlider [b] assisted by J. C. Stevens and by H. C. Gardner. and F. S. Dobson, assistants to the State engineer. Valuable assistance was rendered by Prof. O. V. P. Stout, of the University of Nebraska, in the way of free use by J. C. Stevens of office facilities and suggestions in the methods for the collection of field data. Acknowledgments are also due the Chicago, Burlington and Quincy, Chicago and Northwestern, and Fremont, Elkhorn and Missouri Valley railroads for annual passes issued in favor of Messrs. Stevens and Gardner.

Montana.—District engineer, C. C. Babb,[c] assisted by C. T. Prall, L. R. Stockman, H. M. Morse, W. B. Freeman, J. H. Sloan, A. P. Porter, and Gordon Edson. Acknowledgments are due the Great Northern and Northern Pacific railways for transportation and to Mr. J. W. Shields, of Choteau, Mont., for voluntary observations of Teton River.

North Dakota.—District hydrographer, F. W. Hanna, assisted by E. F. Chandler, of the engineering department of the University of North Dakota.

South Dakota.—Resident hydrographer, R. F. Walter.[d]

Wyoming.—The hydrographic work in the State has been carried on under the direction of the district hydrographer, M. C. Hinderlider, and by the resident hydrographer, A. J. Parshall. Acknowledgments are due for annual passes over all their lines in Wyoming to the Union Pacific, Chicago, Burington and Quincy, Colorado and Southern, Colorado and Wyoming, and Fremont, Elkhorn and Missouri Valley railroads.

GENERAL FEATURES OF THE MISSOURI RIVER DRAINAGE.

Missouri River and its innumerable tributaries drain an immense area in the northern and western section of the United States. The northern boundary of this area is approximately the fiftieth parallel, the southern the thirty-ninth; its western limit is the Rocky Mountain region, while to the east the divide between this basin and that of the upper Mississippi crosses eastern North and South Dakota, western Iowa, and northeastern Missouri. Its extent east and west is about 900 miles; north and south it is 600 miles; the basin comprises a total of 492,000 square miles.

The topography of the basin is of the most varied character, ranging from the mountainous regions of Montana, Wyoming, and Colorado to the rolling prairies of the Dakotas, Nebraska, and Kansas. The upper tributaries drain a forested region, but the main stream flows through a country almost wholly devoid of forests. The precipitation in the mountainous portion of the basin is mainly in the form of heavy snowfall, but a great part of the area lies within the arid and semiarid regions, and it is probable that the average annual precipitation throughout the entire basin is less than 20 inches.

The tributaries are mostly in the upper course of the river and from the western side of the basin. The most important of these tributaries are Mussellshell, Marias, Milk, Yellowstone, Cheyenne, Platte, and Kansas rivers.

The work of the United States Geological Survey in this drainage area during 1905 is set forth in the following pages:

MISSOURI RIVER.

DESCRIPTION OF BASIN.

Missouri River proper is formed in southwestern Montana by the union of three streams which were discovered by Lewis and Clark in 1806 and named by them Jefferson, Madison, and Gallatin rivers. Jefferson and Madison forks come together first, and within 2 miles they are joined by the Gallatin. The head of the Missouri thus formed lies in about latitude 45° 56′ north and longitude 111° 32′ west. Each of the three headwater rivers is about 90

[a] District hydrographer for Missouri during 1906, A. H. Horton, 876 Federal Building, Chicago, Ill.
[b] District hydrographer for 1906, Adna Dobson, State engineer, Lincoln, Nebr.
[c] District hydrographer for Montana, northwestern Minnesota, North Dakota, and northern Wyoming, 1906, H. M. Morse, Huntley, Mont.
[d] District hydrographer for 1906, J. E. Stewart, Belle Fourche, S. Dak.

feet wide, flows with great velocity, and discharges large quantities of water. The Gallatin is the most rapid of the three. The beds of all are formed of smooth pebbles and gravel and the waters are perfectly transparent.

From the junction of the three forks the course of the Missouri lies through mountain valleys and deep canyons, from which it finally issues through a gorge in a range of rocks, called by Lewis and Clark the "gates of the Rocky Mountains." Thirty-five miles above Fort Benton the river pours over Great Falls and from that point onward it is a navigable stream. For miles below the falls the river flows in a deep canyon, with banks ranging from 100 to 160 feet in height. Below the mouth of Marias River, which enters from the north, the banks are less abrupt and rise with gentle slopes to the bluffs. The high-water width of the river, which in the vicinity of Fort Benton is 500 to 1,000 feet, increases to 1,500 feet at the mouth of Milk River and to 2,000 feet near the mouth of the Yellowstone. Below the Yellowstone the width gradually increases from 2,000 to 3,000 feet, and this remains approximately the average width for 600 miles of its course.

From the mouth of the Yellowstone the Missouri follows a winding but on the whole southeasterly course until it is joined by the Kansas; thence it flows more to the east across the State of Missouri, and empties into the Mississippi 16 miles above St. Louis, 189 miles above the mouth of the Ohio, and 2,824 miles below the junction of its three upper forks.

For the first 350 miles below the union of the three forks the Missouri is a comparatively clear stream, but approximately midway between the forks and the mouth of the Yellowstone its character gradually changes and it becomes turbid. Although a large amount of the sediment carried by the Missouri is undoubtedly brought in by the drainage of its tributaries, the greater part is derived from the caving of its banks.

The volume of the Missouri is subject to great variations, the ordinary high-water discharge at the mouth being about 28 times the low-water discharge. The freshets are caused by melting snow and heavy summer rains. The amount of snow falling on the prairies is usually small, but among the Rocky Mountains the snows begin early, continue late, and accumulate to great depths. The regular floods occur in May and June, the June rise being as a rule higher and lasting longer. Thereafter the river steadily decreases in volume, the minimum being reached during the winter months.

Except in the mountain canyons the Missouri flows through an alluvial bottom land of the most fertile character, varying in width from 1½ miles near the mouth to 17 miles in the vicinity of Sioux City. Through this flood plain the river winds back and forth, leaving tongues of land alternately on either side, stretching out from one bluff to within a few thousand feet of the other. In the vicinity of St. Joseph the Missouri is said to make eight complete crossings within a distance of 30 miles, measured in the direction of its general course.

Irrigation is practiced on various tributaries of the stream and agriculture has been extensively developed in several of the valleys. The Missouri itself has not been used for irrigation, owing to its high banks and the consequent difficulty of diversion.

Information in regard to this basin is contained in the following publications of the United States Geological Survey (Ann = Annual Report; WS = Water-Supply Paper):

Description: Ann 11, ii, pp 42–43; 12, ii, pp 236–237; 13, iii, pp 34–35; 22, iv, p 280; WS 84, pp 13–14; 99, pp 34–36; 130, pp 68–69.
Irrigation surveys in, engineering features: Ann 11, ii, pp 114–133; 13, iii, pp 34–63, 53–54.
Rainfall data: Ann 13, iii, pp 39–41; 20, iv, p 235; WS 75, pp 114–116.
Rainfall and run-off relation: Ann 20, iv, pp 232–235; WS 75, pp 117–118.

JEFFERSON RIVER NEAR SAPPINGTON, MONT.

This station was established November 13, 1894, and was discontinued December 31, 1905. It is located 1 mile north of the railroad station at Sappington, Mont., and 7 miles above Willow Creek.

The channel is straight for 500 feet above and below the station. Both banks are composed of clay and are covered with willows and underbrush; the right bank may overflow at extremely high water. The bed is smooth and regular and is covered with gravel. The current is swift and entirely free from eddies. The section is an excellent one.

Until June 15, 1904, discharge measurements were made by means of a cable situated about 300 feet above the old wooden bridge of the Northern Pacific Railway. On that date the cable station was destroyed and for a time measurements were made from the lower side of the railroad bridge. The new cable put in November 1, 1904, was placed about 500 feet above the old one, on account of the building of a new railroad bridge at the former site.

During 1905 the gage was read twice daily up to April 1 by John Fraser and from April 1 to November 11 by L. T. Hare, the agent of the Northern Pacific Railway at Sappington; after the latter date observations were taken once each day. The original gage was a vertical staff fastened to the middle pier of the Northern Pacific Railway bridge. November 3, 1897, the gage datum was lowered 0.80 foot. Readings for the subsequent years were adjusted to the new datum, but those for the rest of 1897 were corrected to agree with the old datum. Later a chain gage was fastened to the upstream side of the old railroad bridge; the length of the chain was 16.30 feet. June 14, 1905, the gage was moved to the downstream side of the new railroad bridge, 200 feet above; the new chain length is 24.31 feet. The same datum was used for the new gage, and as the water surface is 0.03 foot higher at this point, there was an increase of 0.03 foot in the gage readings. All readings, however, have been referred to the old datum. Bench marks Nos. 1, 2, and 3 are unreliable and two additional bench marks have been established, as follows: (4) A cross on top of the coping at the northwest corner of a small concrete culvert 800 feet east of the old railroad bridge; elevation, 11.57 feet. (5) A flat notch cut in the sloping surface on the lower wing wall of the east abutment of the Northern Pacific Railway bridge, about 4 feet from the lower corner, marked "U. S. G. S. B. M.;" elevation, 11.62 feet. Elevations are above the zero of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Description: Ann 18, iv, pp 134–135; 19, iv, p 281; Bull 131, p 22; 140, pp 92–93; WS 15, pp 70–71; 27, p 68; 37, pp 206–207; 49, p 264; 66, p 19; 84, pp 47–48; 99, p 133; 130, pp 85–86.

Discharge: Ann 18, iv, p 135; Bull 131, pp 22, 92; 140, p 93; WS 15, p 71; 27, pp 74–75; 37, p 207; 49, p 264; 66, p 20; 84, p 48; 99, p 133; 130, p 86.

Discharge, monthly: Ann 18, iv, p 136; 19, iv, p 282; 20, iv, pp 234, 238; 22, iv, p 285; WS 75, pp 117, 120; 84, p 49; 99, p 135; 130, p 88.

Discharge, yearly: Ann 20, iv, p 53.

Gage heights: WS 11, p 49; 15, p 71; 27, p 71; 37, p 207; 49, p 264; 66, p 20; 84, p 48; 99, p 134; 130, p 87.

Hydrographs: Ann 19, iv, p 283; 20, iv, p 238; 22, iv, pp 286, 287; WS 75, p 120.

Rainfall and run-off relation: Ann 20, iv, p 235; WS 75, p 118.

Rating tables: Ann 18, iv, p 135; 19, iv, p 282; WS 27, p 75; 52, p 516; 66, p 170; 84, p 48; 99, p 134; 130, p 87.

Discharge measurements of Jefferson River near Sappington, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 3	L. R. Stockman	250	631	2.01	2.20	1,267
May 4	J. H. Sloan	250	705	2.06	2.32	1,454
May 19	do	250	581	2.11	2.05	1,224
June 14	do	252	1,172	3.52	4.02	4,122
July 8	do	255	887	2.38	2.82	2,112
August 4	do	248	558	1.76	1.92	983
September 7	do	237	377	1.56	1.50	588
September 21	do	247	363	1.33	1.37	484
October 27	H. M. Morse	250	583	1.99	2.15	1,159
November 16	J. H. Sloan	250	646	2.03	2.25	1,312

Daily gage height, in feet, of Jefferson River near Sappington, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.35	4.35	5.2	2.2	2.4	2.15	3.7	1.95	1.5	1.5	1.95	2.6
2	5.3	4.3	5.2	2.2	2.45	2.35	3.6	1.9	1.5	1.5	2.1	2.6
3	5.4	4.3	5.3	2.1	2.4	2.4	3.6	1.9	1.5	1.5	2.15	2.6
4	5.3	4.3	5.3	2.1	2.35	2.6	3.55	1.85	1.5	1.5	2.15	2.6
5	5.3	4.55	3.35	2.1	2.3	2.8	3.4	1.8	1.5	1.6	2.15	2.6
6	5.15	4.7	2.65	2.1	2.3	3.15	3.2	1.75	1.5	1.6	2.15	2.5
7	5.25	4.8	2.5	2.15	2.2	3.35	3.0	1.7	1.5	1.6	2.15	2.5
8	5.3	4.8	2.3	2.2	2.1	3.4	2.75	1.6	1.5	1.6	2.25	2.5
9	5.3	4.9	2.3	2.45	2.1	3.5	2.65	1.6	1.4	1.6	2.25	2.5
10	5.05	4.9	2.3	2.55	2.2	3.55	2.55	1.6	1.4	1.6	2.25	2.5
11	4.95	4.9	2.3	2.6	2.2	3.6	2.45	1.55	1.4	1.6	2.15	2.6
12	2.95	4.8	2.15	2.5	2.2	3.7	2.35	1.6	1.4	1.6	2.15	2.6
13	2.7	4.8	2.2	2.5	2.15	3.8	2.25	1.5	1.4	1.65	2.15	2.7
14	2.7	4.55	2.2	2.4	2.1	3.9	2.1	1.5	1.4	1.7	2.25	2.8
15	2.85	4.5	2.35	2.4	2.05	3.95	2.1	1.5	1.4	1.7	2.25	3.0
16	3.2	4.6	2.4	2.4	2.0	3.8	2.2	1.5	1.4	1.7	2.25	3.2
17	3.85	4.6	2.45	2.5	1.95	3.6	2.3	1.5	1.4	1.7	2.4	3.3
18	4.75	4.6	2.5	2.5	2.0	3.3	2.3	1.5	1.4	1.8	2.4	3.4
19	5.35	4.85	2.5	2.5	2.1	3.25	2.3	1.5	1.4	1.8	2.4	3.1
20	5.3	4.9	2.5	2.5	2.1	3.2	2.3	1.5	1.3	1.8	2.4	3.0
21	5.2	5.0	2.55	2.55	2.15	3.1	2.25	1.4	1.3	1.85	2.4	2.8
22	5.2	5.15	2.45	2.7	2.25	3.0	2.1	1.4	1.3	1.85	2.4	2.8
23	5.2	5.2	2.4	2.7	2.3	3.0	2.1	1.4	1.3	1.9	2.4	2.7
24	5.25	5.1	2.4	2.7	2.3	3.45	1.95	1.4	1.3	1.95	2.4	2.7
25	5.3	5.15	2.3	2.7	2.2	3.65	1.75	1.3	1.4	2.05	2.4	2.7
26	5.3	5.15	2.3	2.7	2.15	4.15	1.75	1.35	1.4	2.05	2.4	2.8
27	5.35	5.2	2.35	2.7	2.15	4.65	1.75	1.35	1.35	2.1	2.4	3.0
28	5.4	5.2	2.2	2.75	2.05	4.7	1.85	1.55	1.3	2.15	2.4	3.2
29	5.4	.....	2.2	2.6	2.1	4.45	2.0	1.6	1.35	2.05	2.5	3.3
30	5.4	.....	2.2	2.55	2.0	3.95	2.0	1.55	1.5	1.95	2.5	3.2
31	4.8	.....	2.2	.....	2.0	.....	2.0	1.5	.....	1.95	.....	3.0

NOTE.—River partly gorged January 1 to March 6; probably also gorged somewhat during December.

Station rating table for Jefferson River near Sappington, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.20	405	2.40	1,485	3.60	3,425	4.80	5,675
1.30	465	2.50	1,625	3.70	3,605	4.90	5,865
1.40	530	2.60	1,775	3.80	3,785	5.00	6,055
1.50	600	2.70	1,925	3.90	3,965	5.20	6,445
1.60	675	2.80	2,085	4.00	4,155	5.40	6,845
1.70	755	2.90	2,245	4.10	4,345	5.60	7,255
1.80	840	3.00	2,405	4.20	4,535	5.80	7,675
1.90	930	3.10	2,565	4.30	4,725	6.00	8,095
2.00	1,025	3.20	2,735	4.40	4,915	6.20	8,535
2.10	1,125	3.30	2,905	4.50	5,105	6.40	8,975
2.20	1,235	3.40	3,075	4.60	5,295		
2.30	1,355	3.50	3,245	4.70	5,485		

The above table is applicable only for open-channel conditions. It is based on 17 discharge measurements made during 1904–5, and is well defined throughout.

Estimated monthly discharge of Jefferson River near Sappington, Mont., for 1905.

[Drainage area, 8,984 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 7-31	1,700	1,180	1,413	70,070	0.157	0.146
April	2,005	1,125	1,578	93,900	.176	.196
May	1,555	978	1,214	74,650	.135	.156
June	5,485	1,180	3,206	190,800	.357	.398
July	3,605	798	1,665	102,400	.185	.213
August	978	498	658	40,460	.073	.084
September	600	465	536	31,890	.060	.067
October	1,180	600	814	50,050	.091	.105
November	1,625	978	1,346	80,090	.150	.167
The period				734,300		

NOTE.—No estimate for ice period.

MADISON RIVER (INCLUDING CHERRY CREEK) NEAR NORRIS, MONT.

This station was established May 2, 1897, when the old station at Three Forks was discontinued. The gage is situated at Black's ranch, 12 miles north of Norris and 25 miles west of Bozeman; the measuring section is located at the point where the river emerges from the canyon, about 4 miles above the gage.

The channel is curved both above and below the measuring section, but the bridge is at a right angle to the current. Both banks are high and rocky and do not overflow. The bed of the stream is rocky and the current is swift.

Discharge measurements are made from the lower side of the steel highway bridge. The initial point for soundings is at the left abutment.

The gage at Black's ranch, which is observed twice daily by Mrs. S. A. Black, is a vertical rod fastened to a post firmly set in the bed of the river at the right bank and braced with cross-pieces from the bank. It is about 125 yards west of the house of the observer. The gage is referred to bench marks as follows: (1) Top of large granite bowlder, marked with a spot of black paint, 20 feet south of the gage rod and 8 feet east of the river bank; elevation, 6.86 feet. (2) Top of white granite bowlder, marked with black paint, on the river bank 250 feet west of the gage; elevation, 8.82 feet. Elevations are above the zero of the gage.

Between the bridge and the gage, about 1½ miles above the latter, Cherry Creek enters the river from the right. In order to determine the total amount of water flowing past the gage, measurements of this creek are always made when the river is measured, and the result is added to that at the bridge above. The gaging station on Cherry Creek is at the wooden highway bridge 100 yards above its mouth.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Descripton: 99, p 130–131; 130, p 77.
Discharge: 99, p 131; 130, p 77.
Discharge, monthly: 99, p 132; 130, p 79.
Gage heights: 99, pp 131–132; 130, p 78.
Rating table: 99, p 132; 130, p 78.

Discharge measurements of Madison River (including Cherry Creek) near Norris, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.	Discharge (Cherry Creek included).
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*	*Sec.-ft.*
April 1	L. R. Stockman	216	376	3.54	1.32	1,330	1,346
May 2	J. H. Sloan	234	340	3.52	1.30	1,335	1,358
May 17	do	232	371	4.22	1.43	1,576	1,612
June 13	do	246	556	6.00	2.21	3,333	3,488
July 5	do	243	505	5.36	1.88	2,714	2,752
August 3	do	232	349	3.55	1.21	1,239	1,250
September 2	do	231	316	3.55	1.23	1,121	1,135
September 26	do	233	320	3.45	1.22	1,104	1,118
October 22	do	232	327	3.46	1.22	1,131	1,146
November 18	do	232	332	3.45	1.22	1,148	1,157

Daily gage height, in feet, of Madison River (including Cherry Creek) near Norris, Mont., for 1905.

	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.4	1.4	1.85	1.9	1.25	1.2	1.2	1.2
2	.....	1.4	1.4	1.95	1.9	1.25	1.2	1.2	1.2
3	.....	1.4	1.4	2.2	2.0	1.25	1.2	1.2	1.2
4	.....	1.4	1.4	2.2	2.0	1.25	1.2	1.2	1.2
5	.....	1.4	1.4	2.3	2.0	1.25	1.2	1.2	1.2
6	.....	1.4	1.4	2.34	2.0	1.25	1.2	1.2	1.2
7	.....	1.4	1.4	2.3	2.0	1.25	1.2	1.2	1.2
8	.....	1.4	1.4	2.3	2.0	1.28	1.2	1.2	1.2
9	.....	1.4	1.45	2.3	2.0	1.3	1.2	1.2	1.2
10	.....	1.4	1.5	2.3	1.6	1.3	1.2	1.2	1.2
11	.....	1.4	1.5	2.3	1.05	1.3	1.22	1.2	1.2
12	1.3	1.4	1.45	2.3	1.15	1.3	1.25	1.2	1.2
13	1.3	1.4	1.45	2.25	1.35	1.3	1.25	1.2	1.2
14	1.4	1.4	1.45	2.2	1.5	1.3	1.25	1.2	1.2
15	1.4	1.4	1.45	2.2	1.5	1.25	1.25	1.2	1.2
16	1.4	1.4	1.5	2.2	1.4	1.2	1.25	1.2	1.2
17	1.4	1.4	1.55	2.2	1.4	1.2	1.25	1.2	1.2
18	1.4	1.4	1.6	2.1	1.4	1.2	1.25	1.2	1.2
19	1.4	1.4	1.65	2.05	1.4	1.2	1.25	1.2	1.2
20	1.4	1.4	1.65	2.0	1.35	1.2	1.25	1.2	1.2
21	1.4	1.4	1.65	1.9	1.35	1.2	1.25	1.2	1.2
22	1.4	1.4	1.3	1.9	1.35	1.2	1.25	1.2	1.2
23	1.4	1.4	1.25	1.9	1.3	1.2	1.25	1.2	1.2
24	1.4	1.4	1.2	1.9	1.3	1.2	1.25	1.2	1.2
25	1.4	1.4	1.2	1.9	1.3	1.2	1.25	1.2	1.2
26	1.4	1.4	1.2	1.8	1.22	1.2	1.25	1.2	.....
27	1.3	1.4	1.1	1.7	1.28	1.2	1.25	1.2	.....
28	1.3	1.4	1.1	1.6	1.3	1.2	1.25	1.2	.....
29	1.3	1.4	1.2	1.6	1.3	1.2	1.25	1.2	.....
30	1.3	1.4	1.5	1.8	1.25	1.2	1.25	1.2	.....
31	1.3	.....	1.6	.....	1.25	1.2	1.25	1.2	.....

NOTE.—River frozen January 1 to March 11 and November 26 to December 31, inclusive.

Station rating table for Madison River (including Cherry Creek), near Norris, Mont., from March 12 to November 25, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.10	900	1.50	1,770	1.80	2,500	2.10	3,275
1.20	1,100	1.60	2,000	1.90	2,750	2.20	3,550
1.30	1,320	1.70	2,250	2.00	3,000	2.30	3,850
1.40	1,540						

The above table is applicable only for open-channel conditions. It is based on 16 discharge measurements made during 1904–5 and is fairly well defined throughout.

Estimated monthly discharge of Madison River (including Cherry Creek), near Norris, Mont., for 1905.

[Drainage area, 2,085 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 12–31	1,540	1,320	1,463	58,040	0.702	0.522
April	1,540	1,540	1,540	91,640	.739	.824
May	2,125	900	1,570	96,540	.753	.868
June	3,974	2,000	3,195	190,100	1.53	1.71
July	3,000	800	1,844	113,400	.884	1.02
August	1,320	1,100	1,177	72,370	.565	.651
September	1,210	1,100	1,171	69,680	.562	.627
October	1,100	1,100	1,100	67,640	.528	.609
November 1–25	1,100	1,100	1,100	54,540	.528	.491
The period				814,000		

GALLATIN RIVER AT LOGAN, MONT.

Gallatin River is formed by two chief upper branches, known as East and West Gallatin rivers, which rise on the western slopes of the Gallatin Range and unite a few miles east of Logan, whence the main stream flows northward to its point of junction with Jefferson and Madison rivers near Three Forks, Mont.

A gaging station was established at Logan August 24, 1893. The present station is located 200 yards northwest of the Logan railroad depot.

The channel is straight for 200 feet above and below the station. The right bank is high and rocky. The left is comparatively low and might overflow in the highest floods. Both banks are covered with bushes. The bed of the stream is sandy, with a small amount of vegetation. There is but one channel at all stages, and the current is moderate.

Discharge measurements are made by means of a cable, car, tagged wire, and stay wire just below the gage. The initial point for soundings is at the left cable support.

During 1905 gage readings were taken once each day up to October 27 by N. A. Smith. After that date the gage was read by S. M. Kirkbridge. The original gage was a rod fastened to the cribbing at the intake pipe of the pump at the railroad pump house immediately below the old Northern Pacific Railway bridge; but this was washed out, together with the crib, March 10, 1894, before any discharge measurements had been made. November 16, 1894, a new gage rod was installed under the northeast corner of the bridge, and measurements of the river were thereafter made by means of a cable 100 yards above. This gage was replaced September 16, 1896, by a wire gage fastened to the upstream hand rail of the

bridge in the east span. Bench mark No. 2 of this gage answered to the description of bench mark No. 1 of the previous gage. This gage was destroyed in April, 1901, when the old railroad bridge was being replaced. A temporary gage was established for the summer, and July 26, 1901, the datum of this gage was raised 1.23 feet. October 20, 1901, a new wire gage was established on the site of the present station, 150 yards upstream from the bridge, but the readings on this gage had no relation to those of the previous gages. April 16, 1905, the wire was replaced by a standard chain gage, but owing to unreliable descriptions of old bench marks there was probably a slight change in the gage datum at that time. The length of the chain from the end of the weight to the outside of the handle ring is 21.21 feet. The bench marks in present use are as follows: (1) A railroad spike in the west side of the rear post of the gage frame, 3.6 feet from the top of the horizontal bar; elevation above the zero of the gage, 8.02 feet. (2) A point halfway down on the beveled edge at the top of the concrete just below the roller bearing on the northeast abutment of the Northern Pacific Railway bridge; elevation above the zero of the gage, 11.71 feet.

This station was discontinued December 31, 1905.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Description: Ann 18, iv, p 128–129; 19, iv, p 277; Bull 131, pp 16–17; 140, p 89; WS 15, p 68; 27, p 68; 36, pp 197–198; 49, p 262; 66, pp 17–18; 84, pp 38–39; 99, pp 123–124; 130, pp 82–83.

Discharge: Ann 18, iv, p 129; Bull 131, pp 17, 92; 140, p 90; WS 15, p 68; 27, p 74; 36, p 198; 49, p 262; 66, p 18; 84, p 39; 99, p 124; 130, p 84.

Discharge, monthly: Ann 18, iv, p 130; 19, iv, p 278; 20, iv, pp 234, 240; 22, iv, p 282; Bull 140, p 91; WS 75, p 116; 84, p 40; 99, p 126; 130, p 85.

Discharge, yearly: Ann 20, iv, p 53.

Gage heights: Bull 131, p 18; 140, p 90; WS 11, p 48; 15, p 68; 27, p 70; 36, p 198; 49, p 263; 66, p 18; 84, p 39; 99, pp 124–125; 130, p 84.

Hydrographs: Ann 18, iv, p 130; 19, iv, p 278; 20, iv, p 240; 22, iv, p 282.

Rainfall and run-off relation: Ann 20, iv, p 235; WS 75, p 118.

Rating tables: Ann 18, iv, p 129; 19, iv, p 277; Bull 140, p 90; WS 27, p 75; 52, p 516; 84, p 40; 99, p 125; 130, p 85.

Discharge measurements of Gallatin River at Logan, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 3	L. R. Stockman	138	380	1.42	1.20	540
May 4	J. H. Sloan	.....	397	1.55	1.35	614
May 19	do	.....	508	2.21	1.94	1,125
June 14	do	150	670	3.64	2.70	2,438
July 8	do	140	340	1.04	.68	353
August 5	do	130	272	.73	.40	200
September 7	do	130	299	.78	.70	235
September 21	do	130	303	.87	.77	263
October 20	do	142	375	1.47	1.28	552
October 27	H. M. Morse	142	392	1.57	1.41	614
November 16	J. H. Sloan	143	391	1.60	1.42	623

Daily gage height, in feet, of Gallatin River at Logan, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.85	1.2	1.45	.....	1.3	2.1	2.5	0.4	0.6	1.1	1.3	2.1
2	2.55	1.15	1.45	.....	1.3	2.4	2.6	.3	.6	1.1	1.4	2.1
3	2.4	1.5	1.4	.....	1.3	2.65	2.45	.4	.6	1.1	1.5	1.8
4	1.85	3.9	1.4	.....	1.3	2.7	[a]2.35	.4	.6	1.1	1.5	1.6
5	1.6	3.9	1.4	1.2	1.3	3.1	2.25	.4	.6	1.1	1.4	1.9
6	1.5	3.9	1.4	1.15	1.3	3.0	1.8	[a]4	.7	1.1	1.4	2.1
7	1.6	3.9	1.4	1.1	1.25	2.9	1.3	.4	.7	1.1	1.4	1.7
8	1.8	3.9	1.4	1.1	1.25	2.85	.8	.4	.7	1.1	1.4	1.5
9	1.8	3.9	1.35	1.2	1.4	3.25	.6	.45	.7	1.1	1.4	1.5
10	1.6	3.9	1.35	1.3	1.7	3.25	.5	.5	.7	1.15	1.4	1.9
11	1.5	3.9	1.35	1.3	1.65	3.0	[a].45	.5	.7	[a]1.18	1.4	1.9
12	1.5	3.8	1.35	1.3	1.6	2.9	.4	.6	.65	1.2	1.4	2.0
13	1.5	3.8	1.35	1.2	1.5	2.8	.4	.6	[a].65	1.2	1.4	2.0
14	1.5	3.85	1.35	1.2	1.35	2.7	.4	.6	.65	1.2	1.4	2.0
15	1.8	3.85	1.35	1.25	1.35	2.6	.45	.6	.65	1.2	1.4	2.2
16	2.0	3.85	1.35	1.25	1.4	2.5	.45	.6	.7	1.2	1.4	2.4
17	2.2	3.85	1.4	1.3	1.35	2.5	.4	.7	.65	1.2	1.4	1.9
18	1.8	3.85	1.4	1.25	1.7	2.6	.4	.7	.7	1.2	1.4	1.9
19	1.8	3.85	1.35	1.25	1.8	2.8	.4	.7	.75	1.25	1.4	1.8
20	1.7	3.9	1.35	1.25	1.85	2.9	.4	.7	.8	1.25	1.4	1.8
21	1.5	3.9	1.35	1.25	1.9	2.0	.35	.7	.8	1.25	1.5	1.8
22	1.5	3.85	1.35	1.2	2.0	2.1	.3	.6	.8	1.3	1.4	1.8
23	1.5	3.8	1.3	1.25	1.9	2.2	.3	.6	.8	1.3	1.4	1.8
24	1.45	3.7	1.3	1.25	1.8	2.3	.4	.7	.8	1.4	1.4	2.5
25	1.45	3.0	1.3	1.3	1.7	2.4	.4	.7	.8	1.4	1.4	2.7
26	1.4	2.0	.....	1.3	1.7	2.55	.4	.7	.85	1.4	1.5	3.0
27	1.4	1.55	.....	1.3	1.75	2.4	.4	.6	.9	1.4	1.5	3.8
28	1.4	1.5	.....	1.3	2.65	2.3	.4	.6	.95	1.4	1.5	4.5
29	1.4	.....	.....	1.3	2.65	2.1	.4	.6	1.0	1.3	1.2	4.2
30	1.3	.....	.....	1.3	2.9	2.25	.4	.6	1.1	1.3	2.1	3.8
31	1.25	.....	.....	.....	2.7	.....	.4	.6	.....	1.2	.....	3.8

[a] Gage heights interpolated.

NOTE.—January 1–10, ice gorge below station, also February 4–26, inclusive. January 30 to February 3, inclusive, December 28–31, inclusive; readings to top of ice; drift ice floating in the river. November 29 to December 27, inclusive, ice floating in the river and probably gorge below for part of the time. River open January 11–29 and February 27 to November 28, inclusive. Gage destroyed March 26; replaced April 4.

Station rating table for Gallatin River at Logan, Mont., from January 1, 1904, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.30	178	1.30	545	2.20	1,210	3.20	2,205
.40	192	1.40	605	2.30	1,300	3.40	2,445
.50	210	1.50	670	2.40	1,390	3.60	2,685
.60	230	1.60	740	2.50	1,480	3.80	2,950
.70	260	1.70	810	2.60	1,570	4.00	3,240
.80	300	1.80	880	2.70	1,670	4.20	3,540
.90	340	1.90	955	2.80	1,770	4.40	3,870
1.00	385	2.00	1,035	2.90	1,870	4.60	4,230
1.10	435	2.10	1,120	3.00	1,980	4.80	4,620
1.20	485						

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1904–5, and is not well defined.

Estimated monthly discharge of Gallatin River at Logan, Mont., for 1905.

[Drainage area, 1,805 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January 11–29	1,210	605	741	27,930	0.411	0.290
March 1–25	635	545	586	29,060	.324	.302
April 5–30	545	435	512	26,400	.284	.275
May	1,870	515	836	51,400	.463	.534
June	2,265	1,035	1,592	94,730	.882	.984
July	1,570	178	428	26,320	.237	.273
August	260	178	225	13,840	.125	.144
September	435	230	279	16,600	.155	.173
October	605	435	499	30,680	.276	.318
November 1–28	670	545	617	34,270	.342	.356
The period				351,200		

NOTE.—No estimate for ice period.

WEST GALLATIN RIVER NEAR SALESVILLE, MONT.

West Gallatin River joins the East Gallatin a few miles east of Logan, Mont.

The gaging station was established in July, 1895. It is located at the Williams highway bridge, 16 miles southwest of Bozeman, Mont., from which point it is reached by driving. The nearest post-office is Salesville, 4 miles below the station.

The channel is nearly straight, with slight curves above and below the station. The banks are high and not liable to overflow. The bed of the stream is composed of bowlders and is fairly permanent. At flood stages water flows behind the bridge abutment near the right bank; at other times it is all confined in one channel. The bridge is not quite at a right angle to the direction of the current. During high water discharge measurements are frequently rendered impossible by the logs and ties which are floated down the river from the canyon to the Northern Pacific Railway. On account of the velocity of the current a stay wire is needed for the meter at nearly all stages of the river.

Discharge measurements are made from the lower side of the highway bridge. The initial point for soundings is on the guard rail over the left pier.

The gage was read until June 30, 1905, by Mrs. Alvin DeLong, who lived near the bridge; on that date gage readings were discontinued on account of difficulty in procuring an observer. The gage record was begun August 1, 1895. The gage first installed was a rod firmly spiked to a tree above the bridge, near the right bank. May 31, 1896, the datum was lowered 5 feet, and the rod was regraduated so as to correspond to the new datum. This gage is still in place, and is frequently used at high stages, as it stands in less turbulent water. In September, 1896, a wire gage was placed on the upstream side of the bridge and made to read the same as the rod gage. This was replaced April 20, 1904, by a standard chain gage, approximately the same datum being maintained. The present chain length is 17.43 feet. August 22, 1904, the rod gage was found to read 0.16 foot low as compared with the chain-gage datum. The new gage is referred to bench marks as follows: (1) The head of the westernmost rivet holding the angle irons on the top of the southwest cylindrical pier; elevation, 13.86 feet. (2) A large bowlder firmly set in the ground on the south side of the wagon road near the fence and 123 feet east of the southeast pier; elevation, 13.69 feet. Elevations are above the datum of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Description: Ann 14, ii, p 101; 18, iv, p 124; 19, iv, p 275; Bull 140, pp 86–87; WS 15, p 66; 27, p 68; 36, pp 195–196; 49, pp 260–261; 66, pp 16–17; 84, pp 40–41; 99, pp 126–127; 130, pp 79–80.

Discharge: Ann 18, iv, p 125; Bull 131, p 90; 140, p 86; WS 15, p 66; 27, pp 68, 74; 36, p 196; 49, p 261; 66, p 17; 84, p 41; 99, p 127; 130, p 80.

Discharge, monthly: Ann 14, ii, p 102; 18, iv, p 126; 19, iv, p 276; 20, iv, pp 234, 241; 21, iv, p 184; 22, iv, p 280; Bull 140, p 88; WS 75, pp 117, 118; 84, p 43; 99, p 129; 130, p 82.

Discharge, yearly: Ann 20, iv, p 52.

Gage heights: Bull 140, p 87; WS 11, p 47; 15, p 66; 27, p 69; 36, p 196; 49, p 261; 66, p 17; 84, p 42; 99, pp 127–128; 130, p 81.

Hydrographs: Ann 18, iv, p 126; 19, iv, p 277; 20, iv, p 241; 21, iv, p 185; 22, iv, p 281; WS 75, p 119.

Rainfall and run-off relation: Ann 20, iv, p 235; WS 75, p 118.

Rating tables: Ann 18, iv, p 125; 19, iv, p 276; Bull 140, p 87; WS 27, p 75; 39, p 446; 52, p 516; 66, p 170; 84, p 42; 99, p 128; 130, p 81.

Discharge measurements of West Gallatin River near Salesville, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 31	L. R. Stockman	83	183	1.88	2.90	343
May 1	J. H. Sloan	87	217	2.48	3.30	538
May 17	do	90	234	3.06	3.59	718
June 12	do	130	416	6.45	5.30	2,681
August 2	do	87	201	2.30	3.10	463
September 1	do	85	181	2.15	2.95	390
September 25	do	83	178	1.92	2.96	343
October 21	do	86	196	2.23	3.05	438
November 17	do	85	190	2.24	3.04	426

Daily gage height, in feet, of West Gallatin River near Salesville, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Aug.	Sept.	Oct.	Nov.
1	2.8	2.9	2.9	2.8	3.4	4.6		2.95		
2	2.9	2.9	2.9	2.9	3.2	4.9	3.10			
3	2.9	2.9	2.9	2.9	3.2	5.1				
4	2.9	2.9	2.9	2.9	3.1	5.2				
5	3.0	2.9	2.9	2.9	3.1	5.2				
6	3.0	3.0	2.9	2.9	3.1	5.1				
7	3.0	3.0	2.9	2.9	3.1	5.1				
8	2.9	3.0	2.9	2.9	3.4	5.3				
9	2.9	3.0	2.9	2.9	3.5	4.9				
10	3.0	3.0	3.0	2.9	3.3	4.8				
11	2.8	3.0	3.0	2.9	3.2	5.2				
12	2.8	3.0	3.0	2.9	3.2	5.3				
13	2.9	3.0	3.0	3.0	3.2	5.3				
14	2.9	3.1	3.0	3.0	3.3	5.3				
15	2.9	3.1	2.9	3.0	3.3	5.3				
16	2.9	3.2	2.9	3.0	3.3	5.2				
17	2.9	3.4	2.9	3.0	3.4	5.2				3.04
18	2.9	3.5	2.9	3.1	3.6	5.0				
19	2.9	3.3	2.9	3.1	3.9	4.8				
20	2.9	3.3	2.9	3.1	3.7	4.4				
21	2.9	3.1	2.8	3.1	3.7	4.5			3.05	
22	2.9	3.0	2.8	3.1	3.8	4.8				
23	2.9	3.0	2.9	3.1	3.8	4.8				
24	2.9	2.9	2.9	3.1	3.8	4.9				
25	2.9	2.9	2.9	3.2	3.8	4.7				
26	2.9	2.9	2.9	3.4	3.8	4.7		2.96		
27	2.9	2.9	2.9	3.4	3.7	4.8				
28	2.9	2.9	2.9	3.3	3.7	4.6				
29	2.9		2.9	3.2	3.7	4.4				
30	2.9		2.8	3.2	3.9	4.4				
31	2.9		2.8		4.2					

NOTE.—No observer July 1 to December 31, inclusive. Open-channel conditions assumed during winter months. Gage heights interpolated March 1–4, inclusive, and April 8.

Station rating table for West Gallatin River near Salesville, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.80	310	3.50	670	4.20	1,265	4.90	2,105
2.90	350	3.60	740	4.30	1,370	5.00	2,245
3.00	395	3.70	815	4.40	1,480	5.10	2,390
3.10	440	3.80	895	4.50	1,595	5.20	2,545
3.20	490	3.90	980	4.60	1,715	5.30	2,700
3.30	545	4.00	1,070	4.70	1,840	5.40	2,865
3.40	605	4.10	1,165	4.80	1,970	5.50	3,040

The above table is applicable only for open-channel conditions. It is based on 16 discharge measurements made during 1904–5, and is fairly well defined between gage heights 3 feet and 5 feet.

Estimated monthly discharge of West Gallatin River near Salesville, Mont., for 1905.

[Drainage area, 860 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	395	310	352	21,640	0.409	0.472
February	670	350	415	23,050	.483	.503
March	395	310	352	21,640	.409	.472
April	605	310	415	24,690	.483	.539
May	1,265	440	690	42,430	.802	.925
June	2,700	1,480	2,155	128,200	2.51	2.80
The period				261,600		

MISSOURI RIVER AT CASCADE, MONT.

This station was established July 20, 1902. It is located at the highway bridge at the east end of the town of Cascade, Mont., about one-fourth mile from the railroad.

The channel is straight 600 feet above the station to the island in the center of the stream; another island, 200 feet below the bridge, divides the river into two channels and causes a rather sudden change in the direction of the current. A fall of about 1 foot at this island produces rapids in the river below the station. The left bank is high, but the right may overflow at extreme flood stages. The central pier of the bridge is protected by an ice breaker, which extends about 125 feet upstream and has considerable effect on the current to the left, especially in low water.

Discharge measurements are made from the upstream side of the bridge. The initial point for soundings is near the left bank; it is a notch on the guard rail 2 feet to the left of the center of the southwest pier.

A standard chain gage, which is read twice each day by H. W. Ludwig, has replaced the chain gage first installed. It is located on the upstream side of the left span and is fastened to the floor of the bridge. The length of the chain is 31.99 feet. The gage is referred to bench marks as follows: (1) The top of an old iron bolt which secures the bed plate on the southwest iron bridge pier; it is painted in black "U.S.G.S.B.M." and has an elevation of 28.54 feet above gage datum. (2) A standard iron bench mark of the Missouri River Commission, situated 200 feet south of the Great Northern Railway station; elevation above the zero of the gage, 36.58 feet.

Information in regard to this station is contained in the following Water-Supply Paper of the United States Geological Survey:

Description: 84, p 35; 99, p 117; 130, p 72.
Discharge: 84, p 35; 99, p 117; 130, p 73.
Discharge, monthly: 99, p 119; 130, p 74.
Gage heights: 84, p 36; 99, p 118; 130, p 73.
Rating table: 99, p 118; 130, p 74.

Discharge measurements of Missouri River at Cascade, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage. height.	Dis-charge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 5	L. R. Stockman	349	2,537	1.37	4.20	3,484
May 12	H. M. Morse	.....	2,643	1.77	4.59	4,696
June 13	do	371	3,355	2.88	6.44	9,669
July 12	W. B. Freeman	356	2,618	1.53	4.60	4,013
August 8	H. M. Morse	348	2,443	.72	3.74	1,769
September 12	W. B. Freeman	350	2,253	.91	3.58	2,043
November 21	do	354	2,525	1.35	4.31	3,412

Daily gage height, in feet, of Missouri River at Cascade, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.6	4.1	4.55	4.4	4.6	4.6	6.55	4.1	3.6	3.3	3.95	5.5
2	4.6	4.1	4.45	4.4	4.6	4.6	6.35	4.05	3.6	3.3	4.0	5.5
3	4.6	4.1	4.35	4.4	4.6	4.65	6.15	3.98	3.6	3.3	4.0	5.5
4	4.6	4.2	4.3	4.38	4.5	4.72	5.9	3.88	3.6	3.3	4.0	5.5
5	4.6	4.2	4.3	4.35	4.5	4.8	5.8	3.85	3.6	3.3	4.0	5.5
6	4.6	4.2	4.4	4.3	4.5	5.15	5.75	3.75	3.6	3.4	4.05	5.5
7	4.6	4.2	4.4	4.3	4.5	5.95	5.45	3.75	3.6	3.4	4.08	5.5
8	4.6	4 2	4 4	4.25	4 5	6.22	5.32	3.75	3 6	3.4	4.1	5.5
9	4.6	4.3	4.5	4.2	4.5	6.45	5.25	3.75	3.6	3.4	4.15	5.5
10	4.7	4.3	4.5	4.2	4.5	6.6	5.2	3.75	3.6	3.4	4.18	5.4
11	4.7	4.3	4.5	4.2	4.5	6.6	4.75	3.75	3.6	3.45	4.2	5.3
12	4.8	4.28	4.5	4.25	4.6	6.58	4.58	3.75	3.6	3.5	4.2	5.2
13	4.8	4.32	4.5	4.28	4.65	6.45	4.5	3.75	3.6	3.6	4.2	4.95
14	4.8	5.25	4.5	4.3	4.65	6.4	4.48	3.75	3.6	3.6	4.2	4.75
15	4.8	5.75	4.5	4.35	4.65	6.65	4.38	3.75	3.6	3.63	4.23	4.65
16	4.8	5.9	4.5	4.4	4.65	6.6	4.3	3.78	3.6	3.7	4.25	4.55
17	4.7	5.92	4.5	4.4	4.7	6.55	4.25	3.65	3.6	3.75	4.25	4.5
18	4.7	5.95	4.5	4.45	4.7	6.35	4.2	3.5	3.55	3.8	4.28	4.6
19	4.6	5.95	4.5	4.45	4.68	6.2	4.12	3.5	3.52	3.85	4.3	4.6
20	4.6	5.95	4.5	4.48	4.65	6.15	4.05	3.5	3.5	3.87	4.3	4.7
21	4.5	5.72	4.5	4.5	4.62	5.98	4.0	3.5	3.45	3.9	4.3	4.7
22	4.5	5.55	4.5	4.5	4.6	5.88	4.0	3.45	3.42	3.9	4.35	4.7
23	4.4	5.3	4.5	4.5	4.58	5.75	3.95	3.45	3.4	3.9	4.35	4.7
24	4.4	5.05	4.5	4.55	4.52	5.5	3.95	3.45	3.4	3.9	4.4	4.7
25	4.3	4.9	4.5	4.6	4.48	5.25	3.95	3.48	3.4	3.9	4.43	4.7
26	4.3	4.85	4.5	4.6	4.42	5.12	4.05	3.52	3.4	3.9	4.48	4.7
27	4.2	4.75	4.5	4.65	4.35	6.28	4.0	3.55	3.3	3.9	4.55	4.7
28	4.2	4.65	4.5	4.7	4.38	6.42	4.0	3.4	3.3	3.95	4.75	4.7
29	4.1	.....	4.45	4.7	4.45	6.55	3.95	3.5	3.3	3.95	5.5	4.7
30	4.1	.....	4.45	4.7	4.5	6.65	4.0	3.5	3.3	3.95	5.5	4.7
31	4.1	.....	4.4	.....	4.55	.....	4.0	3.6	.....	3.95	.....	4.7

NOTE.—River frozen and readings taken to the surface of the ice January 1 to February 28, inclusive, and November 28 to December 19, inclusive.

Station rating table for Missouri River at Cascade, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
3.30	1,720	4.20	3,120	5.10	5,500	6.00	8,260
3.40	1,800	4.30	3,340	5.20	5,800	6.10	8,580
3.50	1,900	4.40	3,560	5.30	6,100	6.20	8,900
3.60	2,020	4.50	3,800	5.40	6,400	6.30	9,220
3.70	2,160	4.60	4,060	5.50	6,700	6.40	9,560
3.80	2,320	4.70	4,320	5.60	7,000	6.50	9,900
3.90	2,500	4.80	4,600	5.70	7,300	6.60	10,240
4.00	2,700	4.90	4,900	5.80	7,620		
4.10	2,900	5.00	5,200	5.90	7,940		

The above table is applicable only for open channel conditions. It is based on 15 discharge measurements made during 1904-5, and is well defined between gage heights 3.5 feet and 6.5 feet.

Estimated monthly discharge of Missouri River at Cascade, Mont., for 1905.

[Drainage area, 18,295 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March	3,930	3,340	3,721	228,800	0.203	0.234
April	4,320	3,120	3,635	216,300	.199	.222
May	4,320	3,450	3,944	242,500	.216	.249
June	10,410	4,060	8,081	480,900	.442	.493
July	10,070	2,600	4,518	277,800	.247	.285
August	2,900	1,800	2,147	132,000	.117	.135
September	2,020	1,720	1,929	114,800	.105	.117
October	2,600	1,720	2,159	132,800	.118	.136
November 1-27	3,930	2,600	3,158	169,100	.173	.174
The period				1,995,000		

MISSOURI RIVER AT GREAT FALLS, MONT.

The flow of Missouri River at Great Falls, Mont., is divided into four parts:

1. Water flowing over Black Eagle Falls dam.
2. Water leaking through the dam.
3. Water used on the north side of the river by the Boston and Montana smelter.
4. Water used on the south side of the river by the electric light and power company and the Royal Milling Company.

Black Eagle Falls dam was begun April 15, 1890, and completed March 15, 1891.[a] The total cost of the dam from the inception of the enterprise to November 30, 1891, was $175,000. Originally the crest of the dam stood 40 feet above the surface of the water below the falls in the tailrace; but September 1, 1904, additional flashboards were erected, and the crest has since been 41 feet above the water in the tailrace. The original elevation of the flashboards on the crest was 3,282.05 feet above sea level. The present elevation is 3,282.18 feet. The wooden crest was sharp, but is now slightly worn by water and ice. The length of the dam is 745 feet. The amount of water flowing over it can be computed by using the dam as a weir.

[a] Parker, M. S., Black Eagle Falls dam: Trans. Am. Soc. Civ. Eng., vol. 27, 1892, p. 56.

The Boston and Montana smelter has a gage above the dam which is read four times daily. The difference between gage readings and the elevation of the crest gives the head on the crest. Records of gage heights have been kept since April 13, 1897. The zero of the gage stands at an elevation of 3,200 feet above sea level.

October 5, 1905, the water leaking through the dam was measured and found to be 72 second-feet. The water was low at the time (gage height, 3,280.80 feet), and it is probable that a greater head would increase the amount of leakage.

The water power is owned by the Great Falls Water Power and Townsite Company and is sold to various corporations. A record is kept of the horsepower developed, the computations being based on gate openings and heads, using an efficiency of 80 per cent for the turbines. From the monthly average of horsepower and head computation has been made of the monthly average of water used by the Boston and Montana smelter from 1897 to 1905, and the results are shown in the accompanying table.

On the south side of the river the Royal Milling Company pays for 300 horsepower delivered at the top of the bank. No regular record is kept of the amount of water used, but occasional tests are made to determine whether the required horsepower is developed. The electric-light and power company contracts for 1,000 horsepower, and as it is used for lighting and traction purposes the required amount is constantly changing and hourly records are kept. The average total horsepower used on the south side of the river is 1,300. Based on an efficiency of 80 per cent and a head of 41 feet, the flow required to develop this power is 349 second-feet.

An approximate idea of the quantity of water in the Missouri at Great Falls could be obtained by combining the various parts noted above.

Water from Missouri River used by Boston and Montana smelter at Great Falls, Mont., 1897–1905.

Month.	Second-feet.	Acre-feet.	Month.	Second-feet.	Acre-feet.
1897.			1899.		
April	1,400	83,310	January	1,764	108,500
July	1,343	82,580	February	1,795	99,690
August	1,359	83,560	March	1,804	110,900
September	1,484	88,300	April	1,763	104,900
October	1,469	90,310	May	1,783	109,600
November	1,462	87,000	June	1,792	106,600
December	1,441	88,600	July	1,803	110,900
			August	1,838	113,000
The period		603,700	September	1,791	106,600
			October	1,684	103,500
1898.			November	1,839	109,400
January	1,531	94,140	December	1,831	112,600
February	1,332	73,980			
March	953	58,600	The year	1,791	1,296,000
April	984	58,550			
May	1,277	78,520	1900.		
June	1,530	91,040	January	1,760	108,200
July	1,449	89,100	February	1,839	102,100
August	1,729	106,300	March	1,881	115,700
September	1,663	98,960	April	1,884	112,100
October	1,711	105,200	May	1,722	105,900
November	1,711	101,800	June	1,832	109,000
December	1,753	107,800	July	1,844	113,400
			August	1,898	116,700
The year	1,469	1,064,000	September	1,786	106,300
			October	1,752	107,700

Water from Missouri River used by Boston and Montana smelter at Great Falls, Mont., 1897–1905—Continued.

Month.	Second feet.	Acre-feet.
1900—Continued.		
November	1,708	101,600
December	1,849	113,700
The year	1,813	1,312,000
1901.		
January	1,375	84,550
February	1,579	87,690
March	1,688	103,800
April	2,028	120,700
May	2,077	127,700
June	2,121	126,200
July	1,983	121,900
August	1,874	115,200
September	1,806	107,500
October 1–24	1,773	84,400
The period	.....	1,080,000
1902.		
January 13–31	1,355	51,070
February	1,780	98,860
March	2,202	135,400
April	2,222	132,200
May	2,226	136,900
June	2,375	141,300
July	2,243	137,900
August	1,980	121,800
September	1,782	106,000
October	2,161	132,900
November	2,020	120,200
December	1,794	110,300
The period	.....	1,425,000
1903.		
January	2,200	135,300
February	1,962	109,000
March	2,087	128,300
April	2,239	133,200
1903—Continued.		
May	2,128	130,800
June	2,196	130,700
July	2,252	138,500
August	2,216	136,300
September	1,707	101,600
October	1,912	117,600
November	1,183	70,390
December	2,036	125,200
The year	2,010	1,457,000
1904.		
January	2,016	124,000
February	1,953	112,300
March	2,216	136,300
April	2,321	138,100
May	2,341	143,900
June	2,114	125,800
July	2,225	136,800
August	2,153	132,400
September	1,737	103,400
October	2,143	131,800
November	2,199	130,800
December	2,027	124,600
The year	2,120	1,540,000
1905.		
January	1,955	120,200
February	1,882	104,500
March	2,304	141,700
April	2,297	136,700
May	2,243	137,900
June	2,300	136,800
July	2,231	137,200
August	1,669	102,600
September	1,214	72,240
October	1,402	86,200
The period	.....	1,176,000

MISSOURI RIVER NEAR WILLISTON, N. DAK.

This station was established April 24, 1905. It is located at Bakers Ferry, 10 miles down the river from Williston, N. Dak., and 13½ miles southeast by the main traveled road on the east side of the river from Williston ferry landing.

The channel is straight for about 1,750 feet both above and below the station. The right bank consists of stiff clay and rises to an elevation of 25 feet above gage zero; the left bank is composed of loose sand and slopes upward to an elevation of 22 feet above gage zero; neither bank is subject to overflow. The bed of the stream is of sand and is shifting.

Discharge measurements are made from a cable ferry boat. The initial point for soundings is the face of the cut bank on the right shore.

A standard chain gage, which was read during 1905 by George E. Baker, is located on a projecting timber extending 20 feet from the bank of the river. The length of the chain

from the end of the weight to the marker is 37.80 feet. The gage is referred to bench marks as follows: (1) An aluminum tablet set in the top of a 6 by 6 inch square post about 20 feet west of the gage; elevation, 26.92 feet. (2) A cross of staples in the flat top of a large post, 4 feet high, about 3 rods southeast of the gage and 2 feet northwest of the supporting pole at the right end of the ferry cable; elevation, 30.00 feet. Elevations are above the datum of the gage.

Discharge measurements of Missouri River near Williston, N. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 22	Chandler and Richards	507	4,543	2.78	6.58	12,640
April 24	E. F. Chandler	525	4,480	2.32	5.26	10,390
June 21	P. M. Churchill	787	13,280	5.24	12.20	69,510
July 10	do	770	11,710	4.95	11.10	58,030
August 14	do	753	5,925	2.51	6.70	14,880
September 19	Chandler and Fellows	435	2,705	2.51	4.41	6,781

Daily gage height, in feet, of Missouri River near Williston, N. Dak., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	9.3	12.1	9.8	4.9	4.9	5.0
2	.....	9.4	12.6	9.0	4.8	4.8	5.0
3	.....	10.4	12.3	9.5	4.9	5.1	5.2
4	.....	11.0	12.0	9.8	4.9	5.6	5.2
5	.....	11.3	12.6	9.1	4.9	5.3	5.1
6	.....	11.8	11.9	9.1	4.9	5.0	4.9
7	.....	13.0	11.6	8.8	4.9	5.5	4.9
8	.....	13.6	11.5	8.2	4.8	5.2	4.9
9	.....	13.2	11.2	7.9	4.8	4.9	4.9
10	.....	13.2	11.1	7.8	4.8	4.5	5.0
11	.....	12.9	11.2	7.5	4.7	4.5	5.0
12	.....	13.5	11.2	7.3	4.7	4.4	5.1
13	.....	13.4	11.1	7.1	4.7	4.3	5.0
14	.....	12.8	11.1	6.8	4.6	4.3	5.0
15	.....	12.4	11.0	6.7	4.6	4.2	5.0
16	.....	12.4	11.1	6.5	4.6	4.2	5.1
17	.....	12.9	11.0	6.4	4.6	4.4	5.0
18	.....	12.8	11.0	6.5	4.5	4.4	5.0
19	.....	12.5	11.2	6.3	4.4	4.5	4.9
20	.....	12.3	11.0	6.1	4.4	4.7	4.9
21	.....	12.2	10.6	6.0	4.4	4.8	4.9
22	.....	12.3	10.2	5.9	4.4	4.9	5.0
23	6.7	11.8	9.9	5.8	4.3	4.9	5.0
24	7.6	11.5	9.8	5.7	4.3	4.9	5.0
25	8.0	11.5	9.4	5.5	4.2	5.0	4.9
26	7.9	11.8	9.0	5.4	4.1	5.0	5.0
27	8.4	12.2	8.9	5.3	4.0	5.0	5.1
28	9.3	12.1	8.9	5.2	4.0	4.9	[a] 2.1
29	9.5	11.8	9.2	5.1	4.0	4.9	4.6
30	9.3	11.9	9.5	5.0	4.0	4.9	4.9
31	9.2	.....	10.9	4.9	.....	4.9	.....

[a] Ice gorge above held water back.

NOTE.—River frozen over November 30.

MISSOURI RIVER AT WASHBURN, N. DAK.

This station was established June 28, 1905, and was discontinued November 30, 1905.

A record of river stages only was desired, and no discharge measurements were made. A staff gage is attached to the piling foundation of the "Soo" Railroad grain elevator on the left bank of the river. During 1905 the gage was read by Charles W. Blunt. Bench marks were established as follows: (1) A horizontal line of brass-head nails and spikes driven into the pile to which the gage is fastened; elevation, 14.00 feet. (2) A similar line of nails driven into the pile at the east end of the retaining wall below the elevator; elevation, 14.00 feet. Elevations refer to the datum of the gage.

Daily gage height, in feet, of Missouri River near Washburn, N. Dak., for 1905.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	8.65	6.35	3.9	3.0	3.3	17	.....	7.8	5.1	3.55	2.9	3.0
2	.....	8.9	7.0	3.9	3.0	3.05	18	.....	7.75	5.05	3.5	2.9	3.0
3	.....	9.25	7.35	3.8	3.0	3.1	19	.....	7.75	4.9	3.45	2.85	3.0
4	.....	9.45	6.85	3.8	3.0	3.0	20	.....	7.45	4.9	3.4	2.8	3.0
5	.....	9.05	6.65	3.8	3.0	3.0	21	.....	7.4	4.9	3.35	2.8	3.0
6	.....	9.2	6.65	3.8	3.0	3.1	22	.....	7.45	4.9	3.25	2.8	3.0
7	.....	9.3	6.7	3.75	3.0	3.15	23	.....	7.3	4.7	3.2	2.9	2.9
8	.....	9.1	6.55	3.6	3.0	3.2	24	.....	7.25	4.5	3.15	2.9	2.9
9	.....	8.95	6.45	3.6	3.25	3.2	25	.....	7.05	4.45	3.1	2.95	3.0
10	.....	8.75	6.1	3.6	3.35	3.1	26	.....	6.9	4.4	3.05	3.0	3.0
11	.....	8.65	5.85	3.6	3.5	3.1	27	.....	6.85	4.3	3.0	3.0	3.0
12	.....	8.55	5.7	3.6	3.45	3.1	28	9.05	6.65	4.3	3.0	3.05	3.0
13	.....	8.4	5.55	3.6	3.2	3.0	29	8.95	6.5	4.25	3.0	3.1	.....
14	.....	8.25	5.35	3.6	3.15	3.0	30	8.55	6.45	4.15	3.0	3.05	.....
15	.....	8.05	5.4	3.6	3.0	3.0	31	.....	6.3	4.0	.....	3.2	.....
16	.....	7.85	5.3	3.6	2.95	3.0							

MISSOURI RIVER NEAR BISMARCK, N. DAK.

This station was established September 28, 1904. It is located near the town of Bismarck, N. Dak.

The channel is straight for one-half mile both above and below the station. The right bank is high and not subject to overflow; the left bank consists of sandy slopes and wooded bottoms and is overflowed at extreme flood stages. The bed is sandy and shifts considerably. At ordinary stages the velocity of the current is moderate.

Discharge measurements are made by means of a cable ferryboat at Fort Lincoln ferry, about 5 miles southwest of Bismarck. The initial point for soundings is the face of the perpendicular bank on the right side of the river. Distances from the initial point are obtained by stadia sights from the boat on rods placed on each shore.

A braided-wire gage, which was read during 1905 by Mrs. J. S. Plants, is located on the Northern Pacific Railway bridge, about 2 miles west of Bismarck, near the middle of the second span of the bridge from the left bank. The bench mark is the top of the railroad track on the Northern Pacific Railway bridge at the gage; elevation above the datum of the gage, 73.90 feet. The zero of the gage is 1,617.9 feet above sea level.

Information in regard to this station is contained in Water-Supply Paper No. 130, of the United States Geological Survey, page 76.

Discharge measurements of Missouri River near Bismarck, N. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 23	Chandler and Richards	848	9,400	5.23	6.80	49,200
July 10	do	808	9,035	5.45	6.70	49,220
August 9	R. Richards	820	7,592	3.81	4.20	28,940
August 30	do	780	4,144	3.20	1.30	13,250
October 18	E. F. Chandler	715	2,903	2.77	—.60	8,042

Daily gage height, in feet, of Missouri River near Bismarck, N. Dak., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec
1	3.8	1.6	2.5	0.8	0.2	3.35	6.8	3.65	0.9	—0.9	—0.3	—0.9
2	3.6	2.0	2.5	.8	.2	3.9	6.95	4.0	.7	— .9	— .6	— .6
3	3.4	2.2	2.7	.8	.4	3.9	7.4	4.65	.6	— .9	— .25	— .6
4	3.4	2.2	2.8	.8	.4	3.7	7.8	4.8	.5	— .9	— .4	— .3
5	3.2	2.5	2.95	.8	.1	3.8	7.75	4.45	.5	— .9	— .5	— .7
6	3.05	2.6	3.2	.8	.2	4.35	7.4	4.1	.4	— .9	— .5	— .7
7	2.75	2.6	3.45	.7	.2	4.8	7.4	4.15	.3	— .8	— .2	— .5
8	2.5	2.6	3.65	.6	.25	5.9	7.15	4.25	.3	— .2	— .1	— .5
9	2.4	2.6	4.1	.6	.5	7.7	6.95	4.2	.2	.1	+ .1	— .5
10	2.1	2.6	4.5	.5	.6	7.9	6.7	4.05	.2	.4	.1	— .6
11	1.85	2.5	4.6	.5	.7	7.2	6.55	3.7	.2	.3	.0	— .4
12	1.5	2.4	4.5	.3	.8	6.95	6.35	3.4	.2	.4	.0	— .4
13	1.4	2.4	4.2	.1	.9	7.4	6.15	3.2	.0	.2	.0	— .4
14	1.4	2.2	4.0	.1	1.25	7.8	6.0	3.1	.1	.2	— .2	— .5
15	1.75	2.1	4.0	.1	1.35	7.5	5.9	2.85	.3	— .2	— .2	— .5
16	2.0	1.8	4.15	.0	1.6	7.0	5.6	2.7	.4	— .4	— .3	— .5
17	2.1	1.8	4.45	.0	1.7	6.8	5.4	2.6	.3	— .5	— .3	— .7
18	2.45	1.7	4.6	.0	1.8	7.0	5.3	2.5	.3	— .6	— .3	— .8
19	2.5	1.6	4.95	.0	1.95	7.45	5.3	2.3	.3	— .7	— .3	— .8
20	2.6	1.5	5.15	.0	2.2	7.35	5.1	2.2	.1	— .8	— .3	— .7
21	2.6	1.6	5.05	.0	2.4	7.05	4.9	2.2	.1	— .8	— .3	— .1
22	2.6	1.8	5.7	.0	2.35	6.8	4.9	2.2	.0	— .8	— .3	.0
23	2.4	2.0	8.6	.2	2.1	6.8	4.85	2.2	— .1	— .8	— .3	.3
24	2.4	2.1	5.1	.2	1.7	7.0	4.7	1.95	— .2	— .8	— .3	.5
25	2.3	2.1	3.05	.1	1.55	6.7	4.6	1.8	— .2	— .6	— .3	.6
26	2.05	2.1	2.0	.1	1.4	6.5	4.35	1.8	— .4	— .6	— .3	.7
27	1.75	2.5	1.45	.1	1.5	5.9	4.05	1.6	— .5	— .6	— .3	.9
28	1.7	2.5	1.1	.2	1.8	6.6	4.0	1.5	— .7	— .5	— .6	1.1
29	1.7	.....	.6	.2	2.2	7.3	3.9	1.5	— .7	— .5	— .6	1.1
30	1.5	.....	.6	.2	2.55	7.2	3.75	1.3	— .8	— .4	— .9	1.1
31	1.6	.....	.7	.....	2.9	.....	3.6	1.2	.....	— .3	.....	1.5

NOTE.—River frozen entirely across January 4 to March 6; ice gradually broke up March 7–22; river clear of ice March 24. Gage heights January 1 to March 7 are to top of ice; after that date to water surface. The following comparative readings were also made:

Date.	Water surface.	Top of ice.	Thickness of ice.
	Feet.	*Feet.*	*Feet.*
February 15	2.0	2.1	2.6
February 18	1.6	1.7	2.8
February 23	1.9	2.0	2.8
February 27	2.4	2.5	2.0

River frozen November 30 to December 31. Average thickness of ice, 1 foot. Gage heights are to top of ice.

Station rating table for Missouri River near Bismarck, N. Dak., from September 28, 1904, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
−0.90	7,680	0.50	10,660	1.90	15,780	4.60	31,800
−0.80	7,810	0.60	10,960	2.00	16,240	4.80	33,260
−0.70	7,950	0.70	11,260	2.20	17,180	5.00	34,760
−0.60	8,110	0.80	11,580	2.40	18,160	5.20	36,280
−0.50	8,280	0.90	11,900	2.60	19,200	5.40	37,840
−0.40	8,460	1.00	12,240	2.80	20,280	5.60	39,440
−0.30	8,660	1.10	12,580	3.00	21,400	5.80	41,060
−0.20	8,880	1.20	12,940	3.20	22,560	6.00	42,700
−0.10	9,100	1.30	13,320	3.40	23,760	6.50	46,940
0.00	9,340	1.40	13,700	3.60	25,000	7.00	51,300
0.10	9,580	1.50	14,100	3.80	26,280	7.50	55,780
0.20	9,840	1.60	14,500	4.00	27,600	8.00	60,320
0.30	10,100	1.70	14,920	4.20	28,960		
0.40	10,380	1.80	15,340	4.40	30,360		

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during 1905 and one in 1904, and is fairly well defined between gage heights −0.6 foot and 7 feet.

Estimated monthly discharge of Missouri River near Bismarck, N. Dak., in 1904 and 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1904				
October	10,660	9,340	10,160	624,700
November	12,240	9,340	10,400	618,800
December	28,280	9,340	16,730	1,029,000
1905				
March 24–31	35,520	10,960	16,640	264,000
April	11,580	9,340	10,200	606,900
May	20,840	9,580	13,640	838,700
June	59,440	23,460	46,030	2,739,000
July	58,520	25,000	41,020	2,522,000
August	33,260	12,940	21,490	1,321,000
September	11,900	7,810	9,696	577,000
October	10,380	7,680	8,440	519,000
November	9,580	7,680	8,710	518,300
The period				9,906,000

MISSOURI RIVER AT KANSAS CITY, MO.

This station was established April 13, 1905. It is located at the Hannibal Railway bridge at the foot of Broadway street, Kansas City, Mo.

The channel is slightly curved for one-half mile or more above and below the station. The right bank is high, is covered with railroad tracks and buildings, and does not overflow at this point; the left bank is low, sandy, somewhat timbered, and is liable to overflow. The bed of the stream is composed of sand and is clean except for stones around the piers and some drift lodged in the bed next to the south bank. The drift does not greatly affect the accuracy of measurements; the piers are the principal disturbing influence. The velocity is medium, becoming sluggish toward the north bank. It is very difficult to secure discharge measurements at this point at high stages on account of the great velocity of the current.

Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is at the south end on the downstream side of the bridge.

The gage was read from April 13 to June, 1905, by Charles Sprikle; on the latter date arrangements were made under which the readings are furnished by the United States Weather Bureau. The gage is the Missouri River Commission gage, located 280 feet north of the south end of the bridge, on the downstream side. It is graduated in feet and tenths from 303.5 to 332.0 feet, this being elevation above St. Louis, Mo. To obtain gage heights 303.5 feet must be deducted from all readings on this gage.[a]

Discharge measurements of Missouri River at Kansas City, Mo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage. height.[b]	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 13	W. G. Russell	704	11,900	3.80	8.6	45,200
May 29	do	856	17,170	4.67	12.2	80,240
June 2	Murphy and Russell	983	20,220	6.48	14.9	130,900
June 29	W. G. Russell	945	23,960	5.75	16.5	137,800
July 8	J. C. Stevens	992	23,840	7.54	19.4	179,800
October 8	W. G. Russell	679	13,610	2.49	7.4	33,830
October 27	do	679	13,750	2.50	7.6	34,360

[a] This was the amount used by the Missouri River Commission. The Weather Bureau deducts 303.3 feet, and this amount has been used since July 1, in order to avoid much unnecessary work and the danger of mistakes. The difference seems to occur from a difference in elevation given by two lines of levels run from St. Louis to this point.

Tuttle & Pike, civil engineers, of Kansas City, give the slope of the Missouri at the Hannibal bridge as 0.80 foot per mile. In 1881 a survey from Leavenworth to Lexington, 76 miles, gave 0.78 foot per mile. In 1903 a survey from the Great Western Railway bridge, just above the mouth of Kansas River, to Hannibal bridge, gave 1.62 feet per mile. In 1904 this slope was 1.22 feet per mile. Tuttle & Pike consider the last two abnormal and 0.80 foot per mile correct at Hannibal bridge.

[b] Gage heights obtained by subtracting 303.5 from gage readings.

Daily gage height, in feet, of Missouri River at Kansas City, Mo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	12.55	10.0	14.42	17.2	14.2	8.5	9.25	7.2	8.45
2	11.8	9.8	14.9	18.0	14.2	8.5	9.0	7.1	8.1
3	10.87	9.35	14.65	19.7	13.9	8.3	8.7	7.05	7.45
4	10.32	9.18	14.0	20.0	13.5	7.7	8.5	6.95	6.4
5	9.82	9.78	13.42	19.5	13.0	7.6	8.25	7.0	4.7
6	9.42	8.7	13.28	18.8	12.7	7.4	8.05	7.3	4.65
7	9.15	8.82	13.18	18.8	13.4	7.6	7.7	7.85	4.85
8	8.8	8.85	13.08	19.2	13.2	7.5	7.65	9.3	5.75
9	8.72	9.2	13.8	20.4	13.5	7.3	7.35	9.75	6.25
10	8.65	9.45	12.35	22.0	13.5	7.4	7.25	9.3	5.9
11	8.58	9.55	12.3	22.8	12.7	7.3	7.1	8.85	5.6
12	8.52	11.12	11.9	23.0	11.9	7.2	7.1	8.55	5.8
13	8.58	12.65	11.6	22.1	11.4	7.0	7.0	8.35	6.05
14	8.3	13.6	11.8	20.2	11.1	7.2	6.9	8.15	6.25
15	8.25	13.5	12.4	18.7	10.8	11.1	6.75	7.95	6.2
16	8.07	15.6	15.2	17.9	10.9	14.7	6.65	7.65	6.05
17	8.02	16.55	15.5	17.1	11.3	16.6	6.75	7.5	6.2
18	7.85	15.78	15.7	16.5	11.1	17.3	6.8	7.5	6.15
19	8.65	14.78	15.1	15.7	11.7	18.6	7.05	7.45	6.35
20	7.5	13.98	15.0	15.5	12.5	17.1	7.1	7.65	6.4
21	7.48	13.5	15.8	15.2	12.4	15.9	7.45	7.7	6.4
22	7.4	13.15	16.3	14.7	12.1	14.8	8.05	7.45	6.4
23	8.15	12.68	16.1	14.3	11.9	15.1	8.1	7.2	6.4
24	8.72	12.2	16.1	14.1	12.0	13.8	8.0	7.65	6.45
25	9.42	12.88	16.4	13.7	11.6	12.5	8.05	8.15	6.65
26	9.52	14.95	16.5	13.6	10.8	11.7	8.1	8.65	6.4
27	9.58	14.2	17.3	13.7	10.1	11.0	7.8	8.55	6.3
28	9.85	12.65	17.2	13.2	9.6	10.3	7.55	8.35	6.4
29	10.45	12.32	16.7	13.1	9.2	9.8	7.35	8.45	6.25
30	10.45	12.55	16.7	14.0	9.0	9.2	7.3	8.55	6.3
31	.....	12.52	.....	14.5	8.75	.....	7.3	.....	6.25

Station rating table for Missouri River near Kansas City, Mo., from April 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
4.60	16,000	6.70	28,600	8.80	45,600	12.80	87,800
4.70	16,500	6.80	29,300	8.90	46,500	13.00	90,300
4.80	17,000	6.90	30,000	9.00	47,400	13.50	96,700
4.90	17,500	7.00	30,700	9.20	49,200	14.00	103,200
5.00	18,000	7.10	31,400	9.40	51,100	14.50	109,750
5.10	18,550	7.20	32,100	9.60	53,000	15.00	116,600
5.20	19,100	7.30	32,850	9.80	55,000	15.50	123,600
5.30	19,650	7.40	33,600	10.00	57,000	16.00	130,600
5.40	20,200	7.50	34,400	10.20	59,000	16.50	137,600
5.50	20,750	7.60	35,200	10.40	61,000	17.00	144,600
5.60	21,300	7.70	36,000	10.60	63,000	17.50	151,600
5.70	21,900	7.80	36,800	10.80	65,000	18.00	159,000
5.80	22,500	7.90	37,650	11.00	67,100	18.50	166,500
5.90	23,150	8.00	38,500	11.20	69,200	19.00	174,000
6.00	23,800	8.10	39,350	11.40	71,400	19.50	181,500
6.10	24,450	8.20	40,200	11.60	73,700	20.00	189,000
6.20	25,100	8.30	41,100	11.80	76,000	21.00	204,400
6.30	25,800	8.40	42,000	12.00	78,300	22.00	220,000
6.40	26.500	8.50	42,900	12.20	80,600	23.00	236,000
6.50	27.200	8.60	43,800	12.40	83,000		
6.60	27,900	8.70	44,700	12.60	85,400		

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made durin ▾ 1905, and is fairly well defined between gage heights 7 feet and 20 feet.

Estimated monthly discharge of Missouri River near Kansas City, Mo., for 1905.

[Drainage area, 492,000 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
April	84,800	33,600	48,990	2,915,000	0.100	0.112
May	138,300	44,700	81,170	4,991,000	.165	.190
June	148,800	73,700	111,800	6,653,000	.227	.253
July	236,000	91,550	150,800	9,272,000	.307	.354
August	105,800	45,150	77,740	4,780,000	.158	.182
September	168,000	30,700	71,000	4,225,000	.144	.161
October	49,680	28,250	35,560	2,185,000	.072	.083
November	54,500	30,350	38,520	2,292,000	.078	.087
December	42,450	16,250	25,750	1,583,000	.052	.060
The period				38,900,000		

MISCELLANEOUS MEASUREMENTS.

The following miscellaneous discharge measurements were made in the Missouri River basin in 1905:

Miscellaneous discharge measurements made in Missouri River drainage basin in 1904 and 1905.

Date.	Stream.	Locality.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1904.			*Feet.*	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 5	Little Sioux	Cherokee, Iowa	137	1,232	2.07	.....	2,558
1905.							
June 25	Missouri	Mannhaven, N.Dak.	1,435	9,200	5.65	7.68	52,000
May 30	.....do	Great Falls, Mont.	.....	1,876	3.24	.....	6,100
June 15	.....do	.....do	961	2,645	4.66	.....	12,330
October 7	.....do	.....do	961	1,082	1.80	.....	1,951
June 19	Sixteenmile Creek	Lombard, Mont.	.....	50	1.07	.....	53
August 16	.....do	.....do	.....	23	.85	.....	19
September 22	.....do	.....do	.....	17	.93	.....	16

SMITH RIVER DRAINAGE BASIN.

SMITH RIVER AT TRULY, MONT.

Smith River rises in the Castle Mountains, in southern Meagher County, Mont., flows northwestward, and enters the Missouri about 15 miles southwest of Great Falls.

The gaging station was established March 7, 1905. It is located at a steel highway bridge on the county road running up Smith River valley, in the center of sec. 35, T. 19 N., R. 2 E., Montana prime meridian, near the discontinued post-office of Truly, and about 20 miles southwest of Great Falls, Mont., whence it is reached by driving.

The channel is straight for 200 feet above and 1,200 feet below the station. Both banks are high, but the left may overflow in extremely high water. The bed of the stream is composed of gravel and flat pieces of sandstone, is free from vegetation, and is permanent. There is but one channel at all stages and the current is fairly swift.

Discharge measurements are made from the downstream side of the bridge, which has but one span, though there is a trestle approach at the left bank. The initial point for soundings is marked with white paint on the end post of the truss on the left side of the bridge just above the hand rail.

The gage, which is read twice each day by Henry V. Evans, was originally a vertical rod set into the bed of the stream and braced to the downstream side of the bridge. This was replaced May 11, 1905, by a standard chain gage fastened to the upstream hand rail of the bridge, the same datum being used. The length of the chain is 20.40 feet. The gage is referred to bench marks as follows: (1) A point marked in black paint on the southwest corner of the stone abutment, at the north end of the bridge; its elevation is 12.61 feet above the zero of the gage and approximately 3,400 feet above sea level. (2) A nail in the trunk of a large cottonwood tree at the end of the southwest approach to the bridge, 70 feet back from the initial point for soundings on the downstream side of the road; elevation above gage zero, 13.36 feet.

Discharge measurements of Smith River at Truly, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec. ft.*
March 7	Porter and Bird	87	119	1.37	1.80	163
May 11	Stockman and Porter	81	101	1.24	1.62	125
September 1	A. P. Porter	.....	40	.76	1.20	31

Daily gage height, in feet, of Smith River at Truly, Mont., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.58	1.6	1.9	2.15	1.7	1.25	1.28	1.43	1.38
2	.....	1.58	1.55	1.9	2.15	1.75	1.28	1.3	1.45	1.4
3	.....	1.6	1.6	1.88	2.1	1.8	1.23	1.3	1.45	1.4
4	.....	1.55	1.6	1.95	2.05	1.65	1.25	1.35	1.53	1.58
5	.....	1.58	1.6	2.05	2.0	1.6	1.23	1.32	1.53	1.6
6	.....	1.55	1.5	2.15	1.92	1.6	1.23	1.3	1.55	1.62
7	1.8	1.58	1.5	2.2	1.88	1.55	1.2	1.3	1.55	1.55
8	1.78	1.6	1.55	2.2	1.85	1.5	1.22	1.3	1.55	1.58
9	1.8	1.7	1.5	2.15	1.85	1.5	1.2	1.3	1.55	1.6
10	1.8	1.55	1.58	2.35	1.75	1.48	1.2	1.3	1.55	1.58
11	1.65	1.55	1.68	2.55	1.72	1.4	1.2	1.32	1.55	1.52
12	1.65	1.6	1.75	2.65	1.65	1.4	1.2	1.35	1.55	1.52
13	1.52	1.5	1.65	2.45	1.6	1.4	1.18	1.4	1.55	1.5
14	1.45	1.58	1.65	2.35	1.6	1.4	1.18	1.4	1.55	1.5
15	1.75	1.6	1.6	2.3	1.6	1.4	1.18	1.4	1.55	1.52
16	1.75	1.6	1.6	2.28	1.6	1.4	1.2	1.4	1.55	1.5
17	1.75	1.6	1.58	2.17	1.68	1.4	1.18	1.42	1.55	1.5
18	1.75	1.6	1.6	2.2	1.6	1.4	1.18	1.45	1.55	1.4
19	1.75	1.6	1.8	2.12	1.6	1.4	1.18	1.45	1.55	1.4
20	1.72	1.6	1.88	2.0	1.62	1.32	1.18	1.32	1.55	1.48
21	1.72	1.6	1.85	2.0	1.6	1.3	1.18	1.4	1.55	1.55
22	1.7	1.6	1.85	2.0	1.6	1.3	1.15	1.4	1.55	1.7
23	1.68	1.6	1.95	2.25	1.58	1.3	1.15	1.5	1.45	1.6
24	1.65	1.6	1.9	2.35	1.52	1.3	1.15	1.5	1.3	1.5
25	1.65	1.6	1.9	2.4	1.5	1.3	1.15	1.53	1.33	1.4
26	1.52	1.6	1.9	2.48	1.5	1.3	1.15	1.5	1.35	1.45
27	1.62	1.6	1.9	2.52	1.52	1.3	1.15	1.53	1.3	1.45
28	1.62	1.6	1.9	2.4	1.85	1.3	1.15	1.5	1.38	1.35
29	1.65	1.6	1.9	2.28	1.72	1.3	1.18	1.53	1.25	1.45
30	1.62	1.6	1.9	2.2	1.65	1.28	1.25	1.65	1.28	1.4
31	1.55	.....	1.9	.....	1.6	1.25	.....	1.5	.....	1.35

NOTE.—Practically open-channel conditions during December.

SUN RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Sun River rises on the eastern slope of the Rocky Mountains in northwestern Montana, flows southward for about 60 miles, then, turning abruptly, flows eastward through a canyon in the confining mountains, emerging on a level plain through which it runs for 75 miles to its junction with the Missouri at Great Falls. The basin lies between Teton River on the north, the Dearborn on the south, the Missouri on the east, and the crest of the main range of the Rockies on the west.

Along its entire course through the plain the river has eroded a broad, level bottom, which averages about 1 mile in width and is from 5 to 25 feet above the surface of the water in the river. This bottom is bordered by a steeply sloping bluff, ranging in height from 300 to 500 feet, the top being the level surface of the plain, which extends north and south as a generally flat bench to the next river channel, where a similar bluff and bottom appear.

A project for reclaiming the bench lands between Sun and Teton rivers is under consideration by the United States Reclamation Service, and for that reason gaging stations have been maintained by the United States Geological Survey during 1905.

Information in regard to this basin is contained in the Annual Reports of the Reclamation Service and in the Annual Reports of the United States Geological Survey as follows:

Description: 11, ii, pp 43.
Irrigation surveys: 11, ii, pp 120–133; 13, iii, pp 56–57, 371–386.

NORTH FORK OF SUN RIVER NEAR AUGUSTA, MONT.

This station was established October 31, 1903. It is located below the head of the Kilraven ditch, near Christian's ranch, 14 miles northwest of Augusta and 21 miles southwest of Choteau, Mont.

The channel is straight for about 200 feet below and 300 feet above the station. The right bank is low and may overflow at flood stages; the left bank is high and rocky. The bed of the stream is of solid rock. The current is sluggish.

Discharge measurements are made by means of a cable, car, tagged wire, and stay wire. The initial point for soundings is the left cable support.

A standard chain gage, which, since March 1, 1905, has been read daily by G. B. Christian, who lives about one-half mile from the gage, is located on the left bank about 250 feet below the cable. The horizontal scale board is painted white and is fastened to three posts set in the ground. The length of the chain is 13.02 feet. The distance from the outside edge of the pulley to the zero of the scale is 4.00 feet. The gage is referred to bench marks as follows: (1) The highest point on a rock in the river, 12 feet upstream from the gage; size of the rock, 4 cubic yards; elevation of bench mark above gage zero, 3.96 feet. (2) A nail in the root of a cottonwood tree 15 feet east of the gage; elevation, 14.47 feet above gage zero. (3) A nail in the post which supports the inshore end of the gage; elevation, 10.69 feet above gage zero.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; WS=Water-Supply Paper):

Description: WS 99, pp 116–117; 130, p 90.
Discharge monthly: Ann 11, ii, p 94; 12, ii, pp 347, 360; 13, iii, p 93; 130, p 90.
Discharge, yearly: Ann 13, iii, p 98; 20, iv, p 53.
Gage heights: WS 130, p 90.
Hydrograph: Ann 12, ii, p 234.

Discharge measurements of North Fork of Sun River near Augusta, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 7	L. R. Stockman	115	357	1.41	1.34	502
May 24	Porter and Robbins	135	508	2.63	2.36	1,335
June 6	A. P. Porter	143	769	5.00	3.99	3,842
June 7	do	143	772	5.01	4.01	3,860
September 25	Gordon Edson	86	92	2.21	.70	205

Daily gage height, in feet, of North Fork of Sun River near Augusta, Mont., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.7	0.5	1.2	3.4	2.2	1.4	0.8	0.7	0.7	1.0
2	.65	.5	1.2	3.9	2.4	1.3	.8	,7	,7	1.0
3	.65	.5	1.3	4.0	2.4	1.3	.8	.7	.7	1.0
4	.6	.5	1.3	4.0	2.4	1.3	.8	.7	.6	1.0
5	.6	.5	1.3	3.9	2.4	1.3	.8	.7	.6	1.0
6	.65	.5	1.3	4.1	2.3	1.3	.8	.7	.6	1.0
7	.65	.5	1.3	4.0	2.3	1.2	.8	.7	.6	1.0
8	.65	.5	1.7	3.9	2.3	1.2	.8	.7	.6	1.0
9	.7	.7	2.2	3.9	2.0	1.2	.8	.7	.6	1.0
10	.7	.9	2.1	3.5	1.9	1.2	.8	.7	.6	1.0
11	.65	.9	1.9	3.4	1.9	1.2	.8	.7	.6	1.0
12	.6	.8	1.8	3.5	1.8	1.1	.8	.7	.6	1.0
13	.6	.8	1.8	3.5	1.7	1.1	.8	.7	.6	1.0
14	.6	.8	2.0	3.2	1.8	1.1	.8	.7	.6	1.0
15	.6	.8	2.0	3.0	1.9	1.1	.8	.7	.6	1.0
16	.6	.7	2.2	2.8	1.6	1.1	.8	.7	.6	1.0
17	.6	.7	2.2	2.6	1.6	1.0	.8	.7	.6	1.0
18	.6	.8	2.4	2.4	1.5	1.0	.8	.7	.6	1.0
19	.6	.8	2.5	2.3	1.5	1.0	.8	.7	.6	1.0
20	.6	.8	2.7	2.2	1.5	.9	.8	.7	.6	1.0
21	.6	.8	2.9	2.3	1.4	.9	.8	.7	.6	1.0
22	.6	.9	2.7	2.3	1.4	.9	.8	.7	.6	1.0
23	.6	1.0	2.5	2.3	1.4	.9	.8	.7	.6	1.0
24	.6	1.3	2.4	2.3	1.4	.9	.7	.7	.6	.9
25	.6	1.5	2.4	2.3	1.4	.9	.7	.7	.6	.9
26	.6	1.6	2.4	2.3	1.3	.9	.7	.7	.6	.9
27	.6	1.5	2.4	2.3	1.3	.8	.7	.7	1.0	.9
28	.6	1.3	2.3	2.3	1.3	.8	.7	.7	1.0	.9
29	.6	1.3	2.4	2.3	1.4	.8	.7	.7	1.0	.9
30	.7	1.3	2.5	2.2	1.3	.8	.7	.7	1.0	.9
31	.6	.....	3.0	.....	1.4	.8	.....	.7	.....	.9

NOTE.—Readings to top of ice November 27 to December 23.

Station rating table for North Fork of Sun River near Augusta, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.50	125	1.40	537	2.30	1,280	3.20	2,410
0.60	161	1.50	602	2.40	1,380	3.30	2,570
0.70	199	1.60	672	2.50	1,485	3.40	2,740
0.80	239	1.70	747	2.60	1,595	3.50	2,920
0.90	281	1.80	827	2.70	1,710	3.60	3,100
1.00	325	1.90	912	2.80	1,830	3.70	3,280
1.10	372	2.00	1,002	2.90	1,960	3.80	3,470
1.20	422	2.10	1,092	3.00	2,100	3.90	3,670
1.30	477	2.20	1,185	3.10	2,250	4.00	3,870

The above table is applicable only for open-channel conditions. It is based on ten discharge measurements made during 1904–5. It is well defined between gage heights 0.6 foot and 2.5 feet, and above 2.5 feet is based on two flood measurements at 10 feet.

Estimated monthly discharge of North Fork of Sun River near Augusta, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March	199	161	170	10,450
April	672	125	282	16,780
May	2,100	422	1,119	68,800
June	4,070	1,185	2,303	137,000
July	1,380	477	823	50,600
August	537	239	356	21,890
September	239	199	230	13,690
October	199	199	199	12,240
November 1–26	199	161	165	9,818
December 24–31	281	281	281	4,459
The period				345,700

NOTE.—No estimate for ice period.

SOUTH FORK OF SUN RIVER, AT AUGUSTA, MONT.

This station was established December 2, 1904. It is located at the highway bridge on the road from Augusta to Craig, Mont., about one-half mile from Augusta.

The channel above the station is straight for 20 feet and then turns to the right; below the station it is straight for 30 feet and then forks into two branches. Both banks are high and not liable to overflow. The bed of the stream is composed of coar e gravel and cobble-stone. The current is sluggish. Two sloughs on the east side and an irrigation ditch on the west side of the bridge carry water past the point of measurement.

Discharge measurements are made from the upstream side of the single-span bridge. The initial point for soundings is at the east end of the hand rail, directly over the face of the right abutment.

The gage, which is read daily by Richard Auchard, is a vertical rod spiked to the crib work of the east or right abutment on the downstream side. The gage is referred to bench marks as follows: (1) The head of a spike surrounded by a ring of nails in the top of the east abutment on the downstream side; elevation, 4.89 feet. (2) A spike in the root of a large cottonwood tree 75 feet west of the west end of the bridge on the north side of the road; elevation, 4.63 feet. Elevations are above zero of gage.

A description of this station, with gage-height and discharge data, is contained in Water Supply Paper No. 130 of the United States Geological Survey, page 90.

Discharge measurements of South Fork of Sun River at Augusta, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 6	Stockman and Porter	26	33	0.47	0.72	16
May 26	A. P. Porter	32	52	1.25	1.27	66
June 5	do	70	107	3.51	2.14	375
August 25	Porter and Edson	31	20	.63	.59	13
November 1	Gordon Edson	18	7.9	.70	.45	5.5

Daily gage height, in feet, of South Fork of Sun River at Augusta, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.3	1.6	1.1	1.0	1.0	1.8	1.9	1.9	0.5	0.6	0.4	1.6
2	1.3	1.8	1.1	1.0	.9	1.7	1.9	1.5	.5	.6	.5	1.6
3	1.2	1.8	1.1	1.0	1.0	1.7	1.8	1.4	.55	.6	.6	1.6
4	1.15	1.8	1.0	1.0	1.0	1.7	1.7	1.3	.6	.7	.6	1.6
5	1.3	1.8	1.0	.9	1.0	2.0	1.7	1.3	.65	.7	.6	1.6
6	1.15	1.9	1.0	.9	1.0	2.1	1.7	1.3	.6	.7	.6	1.6
7	1.2	1.9	1.0	.9	1.0	2.35	1.6	1.2	.6	.8	.7	1.6
8	1.3	1.9	1.0	.9	.6	2.1	1.6	1.2	.6	.8	.7	1.6
9	.....	1.9	1.0	.9	.8	2.45	1.5	1.1	.6	.8	.7	1.6
10	.....	1.9	1.0	.9	1.0	2.4	1.4	1.1	.6	.8	.7	1.6
11	.....	1.9	1.0	.9	1.0	2.4	1.4	1.1	.6	.8	.7	1.6
12	.....	1.9	1.0	.9	1.0	2.25	1.4	1.0	.6	.8	.7	1.6
13	.....	1.9	.9	.9	1.0	2.1	1.35	1.0	.6	.8	.7	1.6
14	.....	1.9	1.1	1.0	1.0	2.1	1.2	1.0	.6	.8	.7	1.4
15	.....	1.9	1.05	.95	1.1	2.0	1.2	1.0	.6	.8	.8	1.4
16	.....	1.9	1.05	.95	1.1	1.9	1.2	.9	.6	.8	.8	1.4
17	.....	2.0	1.05	1.0	1.2	1.78	1.1	.9	.5	.9	.8	1.2
18	.....	2.0	1.05	1.0	1.3	1.7	1.1	.9	.5	.9	.8	1.2
19	.....	2.1	1.1	1.0	1.2	1.65	1.1	.9	.5	.9	.8	1.2
20	.....	2.1	1.1	1.05	1.2	1.6	1.1	.9	.5	.7	.9	.9
21	.....	2.1	1.0	1.0	1.2	1.55	1.1	.8	.5	.8	.9	1.3
22	.....	2.1	1.1	1.0	1.2	1.55	1.0	.8	.5	.8	1.2	1.4
23	.....	2.1	1.0	1.0	1.2	1.62	1.0	.6	.5	.8	1.2	1.4
24	1.6	2.0	1.0	1.0	1.2	1.68	1.0	.6	.5	.7	1.3	1.5
25	.....	1.9	1.0	1.0	1.2	1.78	.9	.6	.5	.7	1.3	1.5
26	.....	1.9	1.0	1.0	1.2	2.2	.9	.6	.5	.6	1.3	1.5
27	.....	1.9	1.0	1.0	1.3	2.2	.9	.6	.6	.6	1.3	1.5
28	.....	1.1	1.0	1.0	1.4	2.05	1.0	.55	.6	.6	1.4	1.5
29	.....	.....	1.0	.9	1.5	2.0	1.0	.5	.6	.6	1.4	1.5
30	.....	.....	1.0	1.0	1.7	1.98	1.0	.5	.6	.4	1.4	1.5
31	.....	.....	1.0	.....	1.7	.....	1.0	.5	.....	.5	.....	1.5

NOTE.—River frozen and readings to surface of ice January 9 to February 27, inclusive, and November 22 to December 31, inclusive.

Station rating table for South Fork of Sun River at Augusta, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.40	4	1.00	37	1.60	130	2.10	370
0.50	7	1.10	46	1.70	160	2.20	430
0.60	11	1.20	58	1.80	200	2.30	490
0.70	16	1.30	73	1.90	250	2.40	550
0.80	22	1.40	90	2.00	310	2.50	620
0.90	29	1.50	110				

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during 1904–5. It is fairly well defined between gage heights 0.5 foot and 1.2 feet; above this point it is based on one measurement at 2.14 feet.

Estimated monthly discharge of South Fork of Sun River at Augusta, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March	46	29	39.4	2,423
April	42	29	34.2	2,035
May	160	11	56.4	3,468
June	585	120	295	17,550
July	250	29	85.5	5,257
August	250	7	43.4	2,669
September	14	7	9.4	559
October	29	4	18.0	1,107
November 1–21	29	4	16.7	696
The period				35,760

NOTE.—No estimate for ice period.

SUN RIVER AT SUN RIVER, MONT.

This station was established July 31, 1905. It is located at the highway bridge at Sun River, Mont., 21 miles west of Great Falls, and is used for the purpose of checking the measurements of the river and the ditches above.

The channel is slightly curved above the station and straight for 100 yards below. Both banks are high and will overflow only at extreme flood stages. The bed of the stream is composed of loose and coarse gravel. The flow is comparatively swift, but there is some backwater effect near the left bank.

Discharge measurements are made from the lower side of the bridge, which has two spans of 100 feet each. The initial point for soundings is the hand rail over the downstream pier at the left bank. Low-water measurements are made by wading at a point 100 feet above the bridge.

Until September 27, 1905, the gage was read occasionally by different employees of the United States Reclamation Service; on the latter date R. A. Lange was employed as a temporary observer, and observations were made daily to the end of the year. The first gage consisted of a strip of galvanized iron nailed to a pile near the left bank of the river 150 feet above the bridge. August 16, 1905, this was replaced by a vertical rod gage fastened to the same pile, and the datum of the gage was lowered 1.52 feet. The gage is referred to bench marks as follows: (1) A nail on the corner of the house nearest the gage; elevation, 14.16 feet. (2) The bottom of the outer eyebar in the lower chord of the bridge, 3 feet from the first panel point from the left (north) end of the bridge, on the upstream side; elevation, 13.90 feet. Elevations are above the datum of the gage.

Discharge measurements of Sun River at Sun River, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
July 31	A. P. Porter	91	180	2.38	2.52	427
August 14	do	60	85	3.42	2.10	289
September 27	Gordon Edson	53	43	2.15	1.44	92

Daily gage height, in feet, of Sun River at Sun River, Mont., for 1905.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1				1.45	2.0	2.05	17			1.6	1.85	2.05	2.0
2				1.4	2.0	2.05	18		1.9	1.6	1.9	2.05	2.0
3				1.55	2.0	2.05	19			1.6	1.7	2.0	2.0
4				1.82	2.0	2.05	20			1.5	2.0	2.0	2.0
5				1.82	2.0	2.05	21			1.5	2.1	2.0	2.0
6				1.85	2.0	2.05	22			1.5	2.1	2.0	1.9
7				1.85	2.0	2.05	23			1.4	2.1	2.0	1.9
8				1.85	2.0	2.05	24			1.5	2.0	2.0	2.0
9				1.82	2.0	2.05	25			1.5	2.1	2.0	2.0
10		2.21		1.9	2.0	2.05	26		1.8	1.5	2.0	2.0	2.0
11				1.9	2.0	2.0	27			1.5	2.0	2.0	2.0
12				1.85	2.0	2.0	28		1.8	1.5	2.1	2.05	2.0
13				1.9	2.0	2.0	29			1.45	2.0	2.05	2.0
14		2.1		1.9	2.0	2.0	30		1.75	1.45	2.0	2.05	2.0
15				1.9	2.0	2.0	31	2.52			2.1		2.0
16		2.03		1.9	2.05	2.0							

NOTE.—Gage heights all referred to datum established August 16, 1905. River frozen December 2–16; readings to water surface. Ice 4 inches thick December 11.

Estimated monthly discharge of Sun River at Sun River, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
August (7 days)	323	180	239	14,700
September (17–30)	137	80	110	6,545
October	288	80	224	13,770
November	272	256	259	15,410
December	272	225	259	15,920
The period				66,340

NOTE.—These estimates are only approximate owing to lack of measurements.

WILLOW CREEK NEAR AUGUSTA, MONT.

Willow Creek rises in the northern part of Lewis and Clarke County, and flows northeastward into North Fork of Sun River.

The gaging station was established June 8, 1905. It is located at Jordan's ranch, just below the junction of Willow Creek with Little Willow Creek, about 8 miles northwest of Augusta, Mont., in sec. 27, T. 21 N., R. 7 W., from which it is reached by driving.

The channel is straight for 200 feet above and 40 feet below the station. Both banks are fairly high and the left is thickly wooded. The bed of the stream is composed of clean, hard gravel, with an occasional bowlder. There is but one channel at all stages.

Discharge measurements are made from the upstream side of the old wooden footbridge, having a span of 19 feet. The initial point for soundings is directly over the face of the left abutment of the bridge. Low-water measurements are made by wading just above the gage.

Daily gage readings are taken by S. N. Jordan, who lives about 200 yards away. The original gage was a rod located on the left bank of the stream 30 feet above the measuring bridge. August 22, 1905, a standard chain gage was installed on the bank near the rod gage and made to read the same as the latter. The horizontal arm is fastened to three posts set in the bank. The length of the chain is 14.03 feet. The gage is referred to bench

marks as follows: (1) A nail in the head of a 2 by 4 inch stake driven nearly flush with the ground on the top of a little hill on the left side of the path leading from the gage reader's house to the gage; elevation, 9.25 feet. (2) A point on a log on the left abutment, downstream side of the bridge; elevation, 2.86 feet. (3) The zero of the old gage rod, which is just level with the zero of the chain gage. Elevations are above the datum of the gage.

Discharge measurements of Willow Creek near Augusta, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 8	Porter and Casen	13	38	1.55	2.12	58
July 13	H. P. Porter	17	12	1.95	1.19	23
August 22	Porter and Edson	16	8	1.43	.95	12
November 2	Gordon Edson	14	4	.77	.61	3

Daily gage height, in feet, of Willow Creek near Augusta, Mont., for 1905.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.45	2.0	0.9	0.6	0.7	0.65
2	.....	2 3	1.52	.9	.6	.7	.65
3	.....	2.25	1.4	.88	.58	.7	.65
4	.....	2.12	1.38	.88	.58	.7	.65
5	.....	1.95	1.3	.87	.58	.7	.68
6	.....	1.85	1.28	.87	.55	.7	.68
7	.....	1.7	1.2	.85	.55	.7	.7
8	2.15	1.65	1.2	.85	.58	.7	.7
9	2.78	1.6	1.18	.8	.62	.7	.7
10	2.43	1.32	1.12	.78	.62	.8	.7
11	2.22	1.2	1.1	.78	.65	.7	.7
12	2.1	1.18	1.08	.77	.65	.73	.7
13	2.0	1.15	1.08	.77	.65	.75	.7
14	1.9	1.12	1.02	.77	.65	.75	.72
15	1.85	1.05	1.0	.75	.65	.75	.7
16	1.68	1.05	.98	.75	.65	.73	.72
17	1.62	.95	1.0	.75	.65	.73	.75
18	1.5	.92	1.0	.75	.65	.73	.75
19	1.48	.9	1.0	.72	.68	.73	.78
20	1.4	.8	.98	.72	.72	.68	.75
21	1.32	.8	.95	.72	.75	.7	.75
22	1.78	.8	.95	.7	.78	.7	.72
23	2.15	.8	.9	.7	.75	.7	.7
24	2.22	.8	.9	.68	.72	.73	.7
25	2.6	.8	.95	.68	.72	.7	.68
26	3.15	.8	.95	.65	.73	.7	.65
27	2.77	.9	.95	.65	.73	.68	.65
28	2.55	.92	.9	.62	.7	.62	.65
29	2.43	1.08	.92	.62	.7	.6	.6
30	2.32	1.1	.9	.6	.7	.6	.6
31	.....	1.18	.9	.....	.7	.....	.6

NOTE.—Practically open-channel conditions during December.

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements made in Sun River drainage basin, Montana, in 1905.

Date.	Stream.	Locality.	Width.	Area of section.	Mean velocity.	Discharge.
			Feet.	*Sq. ft.*	*Ft. per sec.*	*Sec.-ft.*
May 30	B. E. and T. Irrigation Ditch.[a]	Augusta		2.8	1.57	4.4
November 7	Ford Creek		14.5	8.7	1.15	10
November 9	North Fork of North Fork of Sun River.	Dam site, reservoir No. 3.	20	36	1.29	47
November 10	South Fork of North Fork of Sun River.	do	47	67	.89	59
November 10	Bear Creek	1 mile above mouth	7	3.1	1.24	3.8

[a] This ditch takes water out of South Fork of Sun River just above the gaging station.

BELT CREEK DRAINAGE BASIN.

BELT CREEK NEAR BELT, MONT.

Belt Creek rises in Little Belt Mountains, flows in a general northerly direction, and enters the Missouri about 15 miles northeast of Great Falls.

The gaging station was established March 18, 1905. It is located at the highway bridge near Belt, Mont., in the NW ¼, NE ¼, sec. 18, T. 20 N., R. 7 E., 20 miles east of Great Falls, from which it is reached by driving.

The channel is straight for 50 feet above and below the station and curves to the right above. Both banks are high and the right bank is slightly wooded above the station. The bed of the stream is composed of rock, is free from vegetation, and is permanent. There is but one channel at all stages. The current is very sluggish, the velocity at low water being so small that current-meter measurements can not be taken.

Discharge measurements are made from the upstream side of the bridge, which consists of a single span. The initial point for soundings is marked with white paint on the upstream side of the bridge just over the face of the right abutment.

The gage is read once each day by Mrs. Anna Epperson. The gage first established was a vertical rod bolted to the second floor beam from the east end of the bridge on the upstream side. May 12, 1905, a standard chain gage was placed on the upstream side of the bridge and made to read the same as the old gage. The length of the chain is 16.86 feet. The gage is referred to bench marks as follows: (1) A black cross painted on top of a stone in the top of the upstream side of the left abutment; elevation, 19.19 feet. (2) A nail in the root of a 14-inch cottonwood tree, 25 feet east of the initial point for soundings, and 20 feet north of the center of the highway; elevation, 10.82 feet. Elevations are above the datum of the gage.

Discharge measurements of Belt Creek near Belt, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 17	Porter and Bird	40	45	0.18	1.59	8.0
May 12	L. R. Stockman	40	47	.17	1.61	7.8
June 11	A. P. Porter	55	160	3.61	3.85	578

Daily gage height in feet, of Belt Creek near Belt, Mont., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Nov.	Dec.
1	.....	1.6	1.6	2.5	3.0	1.9	.....	1.1
2	.....	1.55	1.6	2.6	3.0	2.0	.....	1.1
3	.....	1.55	1.6	2.6	3.0	2.0	.....	1.1
4	.....	1.6	1.6	3.1	2.9	2.0	.....	1.1
5	.....	1.6	1.6	3.15	2.9	2.0	.....	1.1
6	.....	1.6	1.6	3.3	2.8	1.9	.....	1.1
7	.....	1.6	1.6	3.35	2.8	1.8	.....	1.1
8	.....	1.6	1.6	3.5	2.8	1.7	.....	1.1
9	.....	1.6	1.6	3.85	2.5	1.5	.....	1.1
10	.....	1.6	1.6	4.1	2.5	1.45	.....	1.1
11	.....	1.6	1.6	4.05	2.5	1.4	.....	1.1
12	.....	1.6	1.6	3.6	2.5	1.4	.....	1.1
13	.....	1.6	1.6	3.6	2.5	1.4	.....	1.1
14	.....	1.65	1.65	3.6	2.5	1.4	.....	1.1
15	.....	1.65	1.65	3.5	2.5	1.5	.....	1.1
16	.....	1.65	1.65	3.35	2.6	1.4	.....	1.1
17	.....	1.65	1.65	3.3	2.5	1.4	.....	1.1
18	1.6	1.6	1.65	3.2	2.4	1.4	.....	1.1
19	1.6	1.6	1.65	3.1	2.3	1.3	.....	1.1
20	1.6	1.6	1.65	3.0	2.3	1.1	.....	1.1
21	1.6	1.6	1.7	3.0	2.3	(a)	.....	1.1
22	1.6	1.6	1.7	3.0	2.3	.....	.....	1.1
23	1.57	1.6	1.7	3.0	2.0	.....	.....	1.1
24	1.55	1.6	2.0	3.2	2.0	.....	.....	1.1
25	1.55	1.6	2.1	3.5	2.0	.....	.....	1.1
26	1.55	1.6	2.3	3.2	2.0	.....	.....	1.1
27	1.55	1.6	2.3	3.0	2.0	.....	.....	1.1
28	1.55	1.6	2.3	3.1	2.0	.....	.....	1.1
29	1.55	1.6	2.4	3.0	2.0	.....	(a)	1.1
30	1.6	1.6	2.4	3.0	2.0	.....	1.1	1.1
31	1.6	.....	2.4	.....	1.9	.....	.....	1.1

a Dry, August 21 to November 29.

NOTE.—Gage height for December, estimated.

HIGHWOOD CREEK DRAINAGE BASIN.

HIGHWOOD CREEK NEAR HIGHWOOD, MONT.

Highwood Creek rises in the Highwood Mountains, flows northwestward, and enters Missouri River about 30 miles below Great Falls.

The gaging station was established March 19, 1905. It is located at a highway bridge leading up Highwood Creek Valley, at Smith's ranch near Highwood, in sec. 5, T. 20 N., R. 8 E., Montana prime meridian, and 30 miles east of Great Falls, from which it is reached by driving.

The channel is straight for 40 feet above and 30 feet below the station; beyond these limits there are curves and rapids. Both banks are high and the right bank is wooded; neither bank is liable to overflow. The bed of the stream is composed of rocks, is free from vegetation, and is permanent. There is but one channel at all stages and the current is rather swift.

Discharge measurements are made from the upstream side of the two-span pile bridge to which the gage is attached. The initial point for soundings is on the upstream side of the bridge directly over the face of the left abutment.

The gage, which is read twice each day by Richard Smith, consists of a vertical rod, spiked to the cap on the piles at the northwest end of the bridge, upstream side. The gage is

referred to bench marks as follows: (1) The head of a 30-penny spike driven in the end of the pile cap on the center bent of the bridge and marked with a cross in black paint; elevation, 5.83 feet. (2) The underside of the end plank on top of the stringer at the northwest end of the bridge, upstream side; elevation, 7.00 feet. Elevations are above the datum of the gage.

Discharge measurements of Highwood Creek near Highwood, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 19	Porter and Bird	16	9	0.85	0.75	8.0
May 13	Stockman and Porter	16	9	.95	.84	8.0
June 11	A. P. Porter	25	28	3.21	1.78	91.

Daily gage height in feet, of Highwood Creek near Highwood, Mont., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Nov.	Dec.
1	.....	0.75	0.7	1.0	1.15	0.66	.....	0.55	0.6
2	.....	.75	.7	.98	1.1	.65	.....	.56	.59
3	.....	.75	.7	.94	1.08	.52	.....	.58	.6
4	.....	.75	.69	1.0	1.05	.45	.....	.6	.6
5	.....	.75	.7	1.25	1.02	.35	.....	.62	.6
6	.....	.78	.66	1.7	1.02	.32	.....	.61	.61
7	.....	.78	.68	1.65	.98	.41	.....	.6	.62
8	.....	.79	.7	1.58	1.05	.5	.....	.6	.62
9	.....	.82	.75	2.3	1.02	.48	.....	.6	.65
10	.....	.83	.8	2.2	.92	.48	.....	.6	.64
11	.....	.8	.82	1.77	.82	.28	.....	.6	.65
12	.....	.8	.82	1.6	.82	.35	.....	.6	.65
13	.....	.82	.85	1.5	.75	.18	.....	.6	.65
14	.....	.83	.86	1.3	.78	.32	.....	.6	.65
15	.....	.82	.88	1.2	.75	.08	.....	.6	.65
16	.....	.78	.86	1.18	.72	.1	.....	.6	.66
17	.....	.75	.88	1.2	.9	.15	.....	.62	.68
18	.....	.75	.92	1.18	.82	.06	.....	.61	.66
19	0.78	.75	.95	1.1	.8	.....	.....	.62	.68
20	.8	.75	.98	1.1	.78	.....	.....	.61	.66
21	.78	.74	.99	1.05	.75	.....	.....	.62	.65
22	.75	.78	1.02	1.17	.74	.....	.....	.61	.64
23	.75	.8	1.02	1.33	.72	.....	.....	.62	.62
24	.75	.78	1.04	1.3	.7	.....	.....	.61	.61
25	.75	.8	1.05	1.25	.7	.....	.....	.62	.62
26	.75	.81	1.01	1.25	.69	.....	.....	.61	.61
27	.72	.85	1.01	1.28	.7	.....	.....	.62	.62
28	.73	.84	1.01	1.25	.69	.....	.....	.61	.61
29	.72	.72	1.02	1.22	.7	.....	0.2	.62	.62
30	.73	.69	1.04	1.2	.68	.....	.4	.59	.61
31	.75	.....	1.05	.....	.7	.....	.52	.....	.6

NOTE.—No flow August 19 to October 28. Practically open-channel conditions during December.

MARIAS RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Marias River rises on the eastern slope of the main divide of the Rocky Mountains and flows in a general southeasterly direction to its junction with the Missouri. Throughout its entire length the river flows in a canyon and has a fall not exceeding 5 feet per mile. Its principal tributaries are Cutbank Creek, Willow Creek, and Cottonwood Creek, which enter from the north, and Two Medicine Creek, Birch Creek, and Teton River from the south. The most important of these is the Teton, which has its source in the Rocky Mountains, flows eastward in a course approximately parallel to that of Sun River, crossing and recrossing the sixth standard parallel north, and emptying into Marias River about a mile above the point where the latter joins the Missouri.

The United States Reclamation Service has under consideration a project for diverting water from the head of St. Mary River across both North and South forks of Milk River to Cutbank Creek, allowing it to flow down this creek and Marias River for 100 miles or more, and then taking it out of the Marias by a canal to Big Sandy Creek, a tributary of Milk River.

Information in regard to stations in this basin is contained in the Annual Reports of the Reclamation Service and in the Thirteenth Annual Report of the United States Geological Survey, Part III, pages 59–60.

MARIAS RIVER NEAR SHELBY, MONT.

This station was established April 4, 1902. It is located at the highway bridge near James A. Johnson's ranch, 7 miles south of Shelby, Mont.

The channel is straight for 100 yards above and 200 yards below the station. The right bank is sandy, sloping, and liable to overflow; the left bank is high and is protected by sheet piling and a plank wall. The bed of the stream is composed of sand and gravel, with some cobblestones, and is liable to shift after freshets. There is but one channel and the current flows toward the left bank as it rounds a sharp curve some distance above. The velocity of the current is moderate.

Discharge measurements are made from the highway bridge, the lower chord of which is about 15 feet above low water. The initial point for soundings is the east end of the bridge pier on the lower side of the bridge at the left bank.

A standard chain gage, which has been read during 1905 by Mr. Johnson, is fastened to the upstream guard rail of the bridge. The length of the chain is 21.98 feet. The gage is referred to bench marks as follows: (1) A rivet head in the footplate at the foot of the batter post on the top of the southeast pier; the plate is marked "B. M. 17.54," which is the elevation above gage datum. (2) A spike in the southwest side of a cottonwood stump, 25 feet southeast of the southeast pier; elevation above gage datum, 11.26 feet.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, p 32; 99, pp 112–113; 130, p 91.
Discharge: 66, p 23; 84, p 33; 99, p 113; 130, p 91.
Discharge, monthly: 84, p 34; 99, p 115; 130, p 93.
Gage heights: 84, p 33; 99, pp 113–114; 130, p 92.
Rating tables: 84, p 34; 99, p 114; 130, p 92.

Discharge measurements of Marias River near Shelby, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 30	Stockman and Morse	155	362	2.87	2.88	1,040
May 21	H. M. Morse	165	435	3.35	3.42	1,455
June 1	do	166	460	3.50	3.53	1,610
July 11	W. B. Freeman	152	258	2.90	2.92	1,037
August 7	H. M. Morse	135	252	1.46	2.22	369
September 9	W. B. Freeman	122	181	.88	1.78	159
October 17	Freeman and Morse	134	238	1.53	2.22	363
November 20	W. B. Freeman	127	189	1.08	1.88	204

Daily gage height, in feet, of Marias River near Shelby, Mont., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.8	3.5	3.4	2.5	.....	.....	2.3	2.0
2	3.9	3.6	3.6	2.4	.....	.....	2.3	2.05
3	4.1	3.5	3.6	2.4	1.85	.....	2.3	2.05
4	4.1	3.6	3.5	2.3	.....	.....	2.25	2.05
5	4.1	3.6	3.4	2.3	.....	.....	2.25	2.0
6	4.0	3.5	3.4	2.3	.....	.....	2.2	2.0
7	3.9	3.4	3.3	2.3	.....	.....	2.2	2.05
8	3.8	3.7	3.2	2.2	.....	.....	2.18	2.05
9	3.7	3.9	3.2	2.2	1.83	.....	2.15	2.07
10	3.7	4.0	3.1	2.2	.....	.....	2.15	2.07
11	3.6	3.7	2.9	2.1	.....	.....	2.1	2.07
12	3.4	3.6	2.9	2.1	.....	.....	2.1	2.07
13	3.4	3.6	2.8	2.1	.....	.....	2.05	2.07
14	3.7	3.7	2.8	2.1	.....	.....	2.05	2.07
15	3.8	3.5	2.7	2.1	.....	.....	2.05	2.1
16	3.8	3.5	2.7	2.0	.....	.....	2.0	2.1
17	3.7	3.6	2.6	2.0	.....	2.22	2.0	2.1
18	3.7	3.5	2.5	2.0	.....	.....	2.0	2.1
19	3.8	3.4	2.5	1.95	.....	.....	2.0	2.1
20	3.6	3.25	2.5	1.9	.....	.....	2.0	2.1
21	3.8	3.3	2.5	1.9	.....	.....	1.95	2.07
22	3.9	3.25	2.5	1.85	.....	.....	1.95	2.07
23	4.1	3.2	2.4	.....	.....	.....	1.9	2.07
24	4.2	3.3	2.4	.....	.....	.....	1.9	2.05
25	4.8	3.4	2.4	.....	.....	.....	1.9	2.05
26	4.9	3.5	2.9	.....	.....	.....	1.9	2.07
27	4.7	3.6	2.5	.....	.....	.....	1.9	2.07
28	3.6	3.5	2.5	.....	.....	.....	1.9	2.07
29	3.5	3.5	3.0	.....	.....	2.4	1.9	2.07
30	3.4	3.4	2.7	.....	.....	2.35	1.95	2.07
31	3.4	.....	2.5	.....	.....	2.35	.....	2.05

NOTE.—No observations from January 1 to April 30 or from August 23 to October 28. Practically open-channel conditions during December.

Station rating table for Marias River near Shelby, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.70	150	2.60	590	3.50	1,550	4.40	2,970
1.80	180	2.70	670	3.60	1,690	4.50	3,160
1.90	215	2.80	760	3.70	1,830	4.60	3,350
2.00	250	2.90	850	3.80	1,970	4.70	3,540
2.10	290	3.00	950	3.90	2,130	4.80	3,740
2.20	340	3.10	1,050	4.00	2,290	4.90	3,940
2.30	390	3.20	1,170	4.10	2,450	5.00	4,160
2.40	450	3.30	1,290	4.20	2,610		
2.50	520	3.40	1,410	4.30	2,790		

The above table is applicable only for open-channel conditions. It is based on 16 discharge measurements made during 1904–5, and is well defined between gage heights 1.8 feet and 4.5 feet.

Estimated monthly discharge of Marias River near Shelby, Mont., for 1905.

[Drainage area 2,610 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
May	3,940	1,410	2,114	130,000	0.810	0.934
June	2,290	1,170	1,585	94,310	.607	.677
July	1,690	450	870	53,490	.333	.384
August 1-22	520	198	321	14,010	.123	.101
November	390	215	279	16,600	.107	.119
December	290	250	276	16,970	.106	.122
The period				325,400		

CUTBANK CREEK AT CUTBANK, MONT.

Cutbank Creek rises on the eastern slope of the Rocky Mountains, flows eastward and then southeastward, and enters Marias River near the town of Cutbank.

The gaging station was established August 4, 1905. It is located in the gorge just below the steel-trestle bridge of the Great Northern Railway, three-fourths of a mile west of Cutbank.

Except for a slight curve just above, the channel is straight for 500 feet or more above and below the cable. At the cable support the right bank is 3 feet higher than the left, which might overflow at the highest stages; both banks are free from brush and vegetation. The bed of the stream is composed of gravel with an occasional bowlder, and the sides are of sandy soil. Fairly accurate results should be obtained, though the current is rather swift and the bottom somewhat rough. Owing to the distance between the gage and the cable the slope of the water surface at the two points is probably somewhat different.

Discharge measurements are made by means of a cable with tag wire, which was established September 18, 1905, 300 yards below the gage. The initial point for soundings is on the tag wire 5 feet out from the cable support on the left bank.

The gage is read twice each day by Frank Mason. The first gage was a rod placed on the left (east) bank of the creek and nailed to the cribbing at the intake of the railroad pumping plant. This was replaced August 31, 1905, by a standard chain gage, located on the left bank 200 feet below the rod gage and made to read the same as the latter. The

horizontal arm is graduated from 1.5 feet to 10 feet and is supported by posts set in the bank. The distance from the center of the standard gage pulley to the zero of the gage scale is 4.98 feet. The length of the chain is 17.35 feet. The gage is referred to bench marks as follows: (1) A black cross painted on the southwest corner of the yellow sandstone block at the foot of the bedplate on the top of the upstream masonry pier nearest the water's edge at the left bank, of the Great Northern Railway steel-trestle bridge over the creek; elevation, 16.64 feet. (2) A cross chiseled on the highest point of a large outcropping rock at the southeast corner of Frank Mason's house, 75 feet north of the gage; elevation, 15.11 feet. (3) A railroad spike driven in the north side of the rear post of the gage 2 feet above ground; elevation, 11.04 feet. Elevations are above the datum of the gage.

Discharge measurements of Cutbank Creek at Cutbank, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
August 31	W. B. Freeman	31	18	1.24	2.81	22
September 27	H. M. Morse	26	12	1.04	2.77	12
October 19	Freeman and Morse	48	44	1.33	3.30	58
November 19	W. B. Freeman	42	22	2.14	3.11	47

Daily gage height, in feet, of Cutbank Creek at Cutbank, Mont., for 1905.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.8	2.85	3.2	2.4	17	3.1	2.8	3.25	3.1	3.7
2	.....	2.8	2.9	3.25	2.45	18	3.1	2.8	3.1	3.1	3.7
3	.....	2.8	2.8	3.2	2.55	19	3.1	2.8	3.3	3.1	3.75
4	3.3	2.8	2.85	3.2	3.35	20	3.0	2.75	3.25	3.1	3.7
5	3.3	2.8	3.15	3.25	2.9	21	3.0	2.7	3.25	3.1	3.55
6	3.3	2.8	3.6	3.25	2.8	22	3.0	2.7	3.25	2.9	3.5
7	3.25	2.8	3.5	3.2	2.8	23	3.0	2.7	3.2	3.0	3.4
8	3.2	2.8	3.5	3.2	2.65	24	3.0	2.7	3.2	3.05	3.35
9	3.2	2.75	3.4	3.2	.95	25	2.9	2.8	3.2	3.1	3.45
10	3.1	2.7	3.4	3.2	3.95	26	2.9	2.7	3.25	2.95	3.45
11	3.25	2.7	3.4	3.15	4.0	27	2.9	2.8	3.25	2.8	3.65
12	3.2	2.7	3.3	3.1	4.0	28	2.9	2.8	3.3	2.6	3.7
13	3.15	2.7	3.3	3.1	4.0	29	2.8	2.8	3.3	2.5	3.4
14	3.1	2.7	3.3	3.1	3.9	30	2.8	2.85	3.25	2.5	3.3
15	3.1	2.7	3.3	3.1	3.9	31	2.8	.....	3.2	.....	3.4
16	3.1	2.7	3.2	3.1	3.8						

NOTE.—November 26 to December 31 readings were taken through a hole cut in the ice.

TETON RIVER NEAR BELLEVIEW, MONT.

This station was established November 26, 1904. It is located in sec. 35, T. 25 N., R. 35 W., Montana prime meridian, about 16 miles above Choteau, Mont. The nearest post-office is Belleview, Mont.

The channel above the station is straight for about 200 feet at low water, but at high water the river curves gradually from the left; below the station the channel is straight for 75 feet. Both banks are low and covered with thick underbrush and a few scattered trees. The bed of the stream consists of coarse gravel and cobblestones and is free from vegetation. A bar divides the channel at low water. The current is swift and there are some small rapids down the stream.

Discharge measurements are made by means of a cable, car, and tagged wire a short distance upstream from the gage. The initial point for soundings is the zero of the tagged wire at the left bank.

The gage is read daily by Julius Bjornstad, who lives near. The first gage was spiked to a post on the left bank, about 40 feet above the head of Kroff's irrigation ditch. March 9, 1905, it was moved by the observer 250 feet upstream on account of the dam erected at the head of the ditch below. There is no connection between the gage readings before and after that date, probably on account of the difference in slope of the water surface at the two points. May 8, 1905, the gage, which is a rod, was referred to the bench marks, and it was found that the datum had been raised 0.78 foot in moving, while the difference in the level of the water surface at the old and new locations was but 0.10 foot. The gage datum was then lowered 0.20 foot, and it is now 0.58 foot above the original datum. The gage is referred to bench marks as follows: (1) A nail in a 10-inch cottonwood tree 8 feet west of the road and 50 feet from the left bank of the river; elevation, 4.85 feet. (2) A nail in a 5-inch cottonwood tree 2 feet east of the road and 50 feet from the left bank; elevation, 4.45 feet. (3) A nail in a 20-inch cottonwood tree serving as a post in Bjornstad's small corral; elevation, 2.51 feet.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 93–94.

Discharge measurements of Teton River near Belleview, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 8	Stockman and Porter	38	34	1.41	0.40	48
October 12	Gordon Edson	.....	38	1.46	.39	56
November 4	do	36	37	1.38	.38	51

Daily gage height, in feet, of Teton River near Belleview, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.4	0.3	0.15	0.35	0.4	1.3	1.2	0.65	.....	0.4	0.35	0.25
2	.4	.3	.2	.3	.45	1.55	1.2	.7	0.5	.4	.35	.25
3	.4	.3	.2	.3	.4	1.85	1.2	.7	.5	.4	.35	.15
4	.4	.3	.15	.35	.4	1.8	1.2	.7	.....	.35	.4	.0
5	.4	.3	.15	.35	.4	1.8	1.15	.7	.4	.....	.35	.0
6	.4	.3	.15	.35	.4	2.0	1.1	.6	.55	.4	.35	.0
7	.4	.3	.15	.35	.4	2.2	1.1	.65	.45	.4	.35	.0
8	.4	.3	.15	.35	.4	2.2	1.1	.6	.45	.4	.35	.0
9	.4	.3	.35	.3	.5	2.2	1.0	.6	.45	.4	.35	.05
10	.....	.3	.35	.25	.6	2.0	1.0	.6	.4	.4	.35	.05
11	.....	.3	.35	.25	.6	1.8	1.0	.55	.4	.4	.35	.1
12	.....	.3	.35	.25	.6	1.7	1.0	.6	.4	.45	.35	.1
13	.....	.3	.35	.3	.6	1.7	1.0	.6	.4	.5	.35	.1
14	.....	.3	.35	.3	.6	1.6	.95	.6	.4	.45	.35	.1
15	.4	.3	.35	.3	.55	1.45	.9	.6	.4	.45	.35	.1
16	.4	.3	.35	.3	.55	1.4	.9	.....	.4	.45	.35	.05
17	.3	.3	.35	.3	.65	1.4	.85	.....	.4	.45	.35	.05
18	.3	.3	.35	.3	.7	1.3	.8	.5	.4	.45	.35	.05
19	.3	.3	.35	.3	.8	1.2	.8	.5	.4	.3	.35	.05
20	.3	.3	.35	.3	.85	1.15	.75	.5	.4	.35	.35	.05
21	.3	.3	.35	.3	1.0	1.1	.75	.....	.4	.35	.3	.05
22	.3	.3	.3	.3	1.05	1.15	.8	.....	.4	.35	.3	.05
23	.....	.3	.3	.3	1.0	1.2	7	.....	.4	.35	.3	.4
24	.....	.3	.3	.3	.95	1.15	.75	.5	.35	.35	.3	.05
25	.....	.3	.3	.3	.95	1.15	.7	.5	.25	.35	.3	.05
26	.3	.3	.3	.4	.9	1.2	.7	.5	.....	.4	.3	.05
27	.3	.3	.3	.4	.9	1.15	.7	.....	.4	.4	2.3	.0
28	.3	.1	.3	.4	.9	1.15	.7	.5	.4	.4	.25	.0
29	.3	.....	.3	.4	.95	1.15	.7	.....	.4	.4	.25	.0
30	.3	.....	.35	.4	1.0	1.1	.7	.....	.4	.35	.25	.0
31	.3	.....	.35	.....	1.1	.....	.7	.....	.....	.4	.....	.0

NOTE.—Readings from March 9 to December 31 have been referred to the datum of May 8, 1905. The readings prior to March 9 refer to a different datum, there being no connection with the later readings. River partly frozen January 1–22, inclusive; readings to the surface of the ice January 26 to February 27, inclusive. River open after February 28. River blocked with ice November 27 and December 23.

TETON RIVER NEAR CHOTEAU, MONT.

This station was established November 30, 1904. It is located at the highway bridge on the road from Choteau to Augusta, Mont., and is about 1½ miles from the town of Choteau.

The channel is straight for about 200 feet above the station; below it curves slightly to the right. The right bank is high; the left is low and is subject to overflow at high stages. The bed of the stream is covered with rocks and coarse gravel and is free from vegetation. The current is swift.

Discharge measurements are made from the upstream side of the bridge, which is a wooden structure resting on pile bents. The initial point for soundings is at the left side of the bridge.

The gage is read occasionally by J. W. Shields, a surveyor, who performs this service gratuitously. The original chain gage was fastened to the upstream hand rail of the bridge. This was replaced May 9, 1905, by a standard chain gage, fastened to the floor of the bridge near the former gage, the same datum being maintained; the chain length is 12.33 feet. The gage is referred to bench marks as follows: (1) A nail in a 3-inch plank just back of the floor beam at the west end of the bridge; elevation above zero of gage, 9.08 feet. (2) A

nail, 2 feet above ground, in the trunk of a cottonwood tree 100 feet from the east end of the bridge and in the fence on the south side of the road; elevation above gage zero 6.87 feet.

Information in regard to this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 94–95.

Discharge measurements of Teton River near Choteau, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 9	Stockman and Porter	15	5.0	1.54	1.70	8
October 13	Gordon Edson		3.9	.76	1.63	3

Daily gage height, in feet, of Teton River near Choteau, Mont., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		1.6					
2		1.65		1.55	1.6		
3		1.7	1.8	1.55			
4		1.75					1.75
5		1.95					1.75
6		2.2					
7		2.2				1.6	
8		2.45	1.85			1.6	
9	1.7	2.55		1.5			
10		2.45					
11		2.45		1.6			
12	1.7	2.6					
13	1.65	2.7				1.63	
14	1.65						
15	1.6		1.5	1.55			
16	1.65	2.1					
17	1.7	2.1					
18	1.7	2.05					
19	1.7	1.95					
20	1.7	1.9					
21	1.7	1.9				1.7	
22	1.7	1.9	1.45			1.7	
23	1.7	1.9					
24	1.65	1.9					
25	1.65	1.85					
26	1.65	1.85		1.5			
27	1.65			1.5	1.6		
28	1.7	1.9	1.5				
29	1.7					1.7	
30	1.7						
31	1.7						

MILK RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Milk River rises in the undulating foothills of the Rocky Mountains in northwestern Montana, near the boundary line between the United States and Canada. Its headwaters flow northeastward into Canada, and for about 100 miles its course is eastward, parallel with

the international boundary; it then turns to the southeast, passes across the northern part of Montana, and empties into the Missouri.

The valley through which Milk River flows is broad and contains many thousand acres of irrigable land. The summer flow of the stream is not sufficient for the irrigation of any considerable part of this area, and it has been proposed to augment the supply by turning into the headwaters of Milk River the abundant waters of the St. Mary basin, which lies immediately adjacent to the sources of the Milk.

Information in regard to the basin is contained in the Annual Reports of the Reclamation Service and in the following publications of the United States Geological Survey (Ann= Annual Report; WS=Water-Supply Paper):

Description: Ann 19, iv, pp 286–287; 21, iv, p 188; 22, iv, pp 271–273; 22, iv, pp 287–288.
Irrigation surveys: Ann 13, iii, pp 62–63.
See page measurements: WS 130, pp 102–103.

SOUTH FORK OF MILK RIVER NEAR BROWNING, MONT.

This station was established April 28, 1905. It is located at Croff's ranch, about 40 miles northeast of Browning, Mont.

The channel is straight for about 100 yards above and below the station. Both banks are composed of gravel, and the right bank is liable to overflow at extreme high water. The bed of the stream is made up of rocks from 6 to 18 inches in diameter, is free from vegetation, and is fairly permanent. There is but one channel at all stages. The current is sluggish at the wading section and swift about 200 feet above. The depth at ordinary stages is about 2 feet.

High-water discharge measurements are made by means of a cable, car, and tagged wire about 200 feet above the gage. The initial point for soundings is the first marker on the tagged wire at the left bank. Low-water measurements are made by wading between the gage and the cable.

The gage, which was observed twice daily by R. J. Croff, was originally a temporary rod installed on the left bank 200 yards from the observer's house. This was replaced May 8, 1905, by a standard chain gage, located at the same place and fastened to supports in the left bank. The length of the chain is 13.66 feet. The gage is referred to bench marks as follows: (1) A stake driven into the bank above the gage; elevation, 8.00 feet. (2) A nail driven into the southeast corner of the log hen house belowing to Mr. Croff; elevation, 12.80 feet. Elevations are above the datum of the gage.

Discharge measurements of South Fork of Milk River near Browning, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 28	Stockman and Morse	45	55	0.93	3.60	51
May 28	H. M. Morse	46	54	.78	3.52	42
July 21	do	14	7	1.35	3.13	10
August 30	C. C. Babb				2.80	[a]2

[a] Estimated.

Daily gage height, in feet, of South Fork of Milk River near Browning, Mont., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	3.5	3.4	3.55	3.4	2.85	3.15
2	.....	3.5	3.4	3.55	3.4	2.85	3.15
3	.....	3.5	3.5	3.6	3.4	2.8	3.15
4	.....	3.5	3.5	3.6	3.3	2.8	3.15
5	.....	3.5	3.4	3.5	3.25	3.0	3.2
6	.....	3.5	3.5	3.5	3.2	3.0	3.2
7	.....	3.5	3.5	3.4	3.2	3.0	3.25
8	.....	3.4	3.55	3.4	3.1	3.0	3.28
9	.....	3.5	3.5	3.35	3.1	2.9	3.32
10	.....	3.7	3.5	3.35	3.1	2.95	3.3
11	.....	3.7	3.5	3.3	3.1	3.0	3.28
12	.....	3.7	3.5	3.2	3.0	2.98	3.25
13	.....	3.7	3.4	3.2	3.0	3.0	3.2
14	.....	3.75	3.4	3.2	3.0	3.0	3.25
15	.....	3.7	3.4	3.2	3.0	2.9	3.3
16	.....	3.65	3.5	3.2	3.0	2.9	3.32
17	.....	3.6	3.5	3.2	3.0	2.9	3.32
18	.....	3.6	3.5	3.2	2.95	2.9	.....
19	.....	3.6	3.45	3.2	2.9	2.9	.....
20	.....	3.6	3.6	3.15	2.9	2.9	.....
21	.....	3.75	3.6	3.1	2.85	2.9	.....
22	.....	3.8	3.6	3.1	2.8	2.8	.....
23	.....	3.75	3.6	3.1	2.8	2.8	.....
24	.....	3.65	3.6	3.1	2.8	2.8	.....
25	.....	3.6	3.65	3.1	2.8	2.8	.....
26	.....	3.55	4.0	3.2	2.8	2.8	.....
27	.....	3.5	4.2	3.3	2.8	2.82	.....
28	3.6	3.5	3.85	3.3	2.8	3.0	.....
29	3.55	3.5	3.75	3.4	2.8	3.08	.....
30	3.5	3.45	3.55	3.45	2.8	3.1	.....
31	.....	3.5	.....	3.4	2.82	.....	.....

NOTE.—Creek frozen over October 18.

Estimated monthly discharge of South Fork of Milk River near Browning, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
May	78	30	51	3,117
June	144	30	49	2,916
July	51	9	24	1,445
August	30	2	8.5	523
September	9	2	4.4	262
October 1–17	23	12	17	587
The period	.....	.....	.....	8,850

NOTE.—These estimates are only a rough approximation.

MILK RIVER AT HAVRE, MONT.

This station was established May 15, 1898. It is located at the highway bridge at Havre, Mont.

The channel is straight below the station and for a short distance above, when a sharp curve occurs. Both banks are high, being above ordinary floods, and are slightly wooded. The bed of the stream is liable to change with every freshet. The current is sluggish at ordinary stages.

Discharge measurements were originally made by means of a cable stretched across the river not far from the highway bridge. November 4, 1902, the cable was taken out, and discharge measurements have since been made from the downstream side of the bridge to which the gage is attached. The bridge makes an angle of 20° with the normal to the current at the measuring section. The initial point for soundings is marked on the downstream guard rail at the right bank.

The gage is read daily by L. H. Lng, the United States Weather Bureau observer at Havre. January 12, 1904, the old wire gage was replaced by a standard chain gage, which was made to read the same as the old gage, and was located on the downstream side of the bridge. The length of the chain is 25.21 feet. The gage pulley is located at a point which corresponds to a reading of 2.0 feet on the scale. The gage is referred to bench marks as follows: (1) The top of the highest bolt securing the bedplate to cement on top of the southwest pier of the bridge; elevation, 2,486.51 feet above datum. (2) A 20-penny nail in a cottonwood tree 100 feet southwest of the southwest pier of the bridge; elevation, 2,477.44 feet above datum. (3) A standard United States Geological Survey tablet in the stone pier of a column supporting the Great Northern Railway water tank, one-half mile southeast of the gage and near the roundhouse; elevation, 2,482.46 feet. The elevation of the zero of the gage is 2,461.25 feet above datum. The datum used in the establishment of the bench marks is that of the city of Havre, deduced from a temporary bench mark of the United States Geological Survey, which has since been destroyed.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; WS=Water-Supply Paper):

Description: Ann 20, iv, p 245; WS 27, pp 68–69; 37, p 209; 49, p 267; 66, pp 15–16; 84, p 28; 99, pp 108–109; 130, pp 95–96.

Discharge: WS 27, p 75; 37, p 209; 49, p 267; 66, p 16; 84, p 29; 99, pp 109–110; 130, p 96.

Discharge, monthly: Ann 20, iv, p 245; 21, iv, p 189; 22, iv, p 288; WS 75, p 122; 84, p 31; 99, p 111; 130, p 98.

Discharge, yearly: Ann 20, iv, p 53.

Gage heights: WS 27, p 72; 37, p 210; 49, p 267; 66, p 16; 84, p. 30; 99, p 110; 130, pp 96–97.

Hydrographs: Ann 20, iv, p 246; 21, iv, p 189; 22, iv, p 288.

Rating tables: WS 27, p 76; 39, p 447; 52, p 516; 66, p. 170; 84, pp 30–31; 99, p 111; 130, p 97.

Discharge measurements of Milk River at Havre, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 7	L. R. Stockman	74	45	1.09	3.30	49
May 2	H. M. Morse	86	67	1.27	3.85	85
May 6	do	85	58	1.22	3.59	71
June 5	do	77	43	1.04	3.44	45
July 11[a]	W. B. Freeman	39	22	.76	3.15	17
July 31	H. M. Morse	82	83	1.36	3.85	113
August 1	do	75	71	.78	3.68	55

[a] Made by wading.

Daily gage height, in feet, of Milk River at Havre, Mont., for 1905.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	.....	4.4	3.4	3.8	3.55	3.65	3.7
2	.....	4.4	3.5	3.7	3.55	3.45	3.7
3	.....	4.4	3.4	3.6	3.45	3.45	3.6
4	.....	4.35	3.4	3.6	3.45	3.45	3.6
5	.....	4.4	3.4	3.6	3.45	3.35	3.6
6	.....	4.4	3.4	3.6	3.45	3.55	3.8
7	.....	4.3	3.4	3.6	3.45	3.55	3.4
8	.....	4.6	3.3	3.6	3.25	3.55	3.4
9	.....	4.5	3.3	3.5	3.25	3.45	3.4
10	.....	4.3	3.3	3.5	3.25	3.45	3.2
11	.....	4.3	3.2	3.5	3.25	3.25	3.0
12	.....	3.7	3.3	3.6	3.25	3.15	3.0
13	.....	3.6	3.3	3.6	3.25	3.15	3.0
14	.....	3.6	3.3	3.5	3.25	3.25	2.8
15	.....	3.9	3.4	3.5	3.25	3.25	2.7
16	.....	4.0	3.3	3.45	3.15	3.15	2.7
17	.....	4.0	3.4	3.45	3.25	3.05	2.7
18	.....	3.95	3.4	3.35	3.25	2.95	2.6
19	.....	3.9	3.5	3.45	3.25	2.95	2.4
20	.....	4.2	3.4	3.45	3.25	2.95	2.4
21	.....	4.0	3.5	3.35	3.25	2.8	2.4
22	.....	4.0	3.5	3.35	3.15	2.8	2.4
23	.....	3.9	3.5	3.75	3.15	2.7	2.4
24	.....	3.9	3.5	3.65	3.15	2.7	2.3
25	.....	3.8	3.5	3.65	3.05	2.6	2.3
26	3.5	3.8	3.5	3.55	3.25	2.8	2.3
27	4.7	3.6	3.5	3.55	3.35	2.9	.....
28	4.7	3.7	3.6	3.55	3.55	4.9	.....
29	.....	3.6	3.7	3.45	3.65	5.0	.....
30	.....	3.5	3.8	3.45	3.75	4.1	.....
31	.....	3.4	.....	3.45	.....	3.9	.....

NOTE.—River frozen solid to bottom January 15 to February 26; in the first part of March water was flowing over the ice, which was frozen to the bottom.

Station rating table for Milk River at Havre, Mont., from January 1 to May 5, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
3.20	46	3.40	55	3.60	73	3.80	102
3.30	50	3.50	63	3.70	85		

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during the first part of 1905, and is not well defined.

Station rating table for Milk River at Havre, Mont., from May 6, to Agwust 26, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.80	2	3.40	42	4.00	139	4.60	266
2.90	4	3.50	55	4.10	158	4.70	290
3.00	7	3.60	69	4.20	178	4.80	315
3.10	12	3.70	85	1.30	199	4.90	340
3.20	20	3.80	102	4.40	221	5.00	366
3.30	30	3.90	120	4.50	243	5.10	392

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during the latter part of 1905, and is not well defined.

Estimated monthly discharge of Milk River at Havre, Mont., for 1905.

[Drainage area, 7,300 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January			[a]5	307	0.00068	0.00078
February			[a]5	278	.00068	.00071
March			[a]40	2,460	.0055	.0063
April	102	46	59	3,511	.0081	.0090
May	102	36	62	3,812	.0085	.0098
June	94	10	35	2,083	.0048	.0054
July	366	0	54	3,320	.0074	.0085
August	102	0	25	1,290	.0034	.0033
The period				17,060		

[a] Estimated by C. C. Babb.

MILK RIVER AT MALTA, MONT.

This station was established July 31, 1902. It is located at the highway bridge on the main road one-fourth mile east of the railroad station at Malta, Mont.

The channel is straight for 700 feet above and 250 feet below the station. Both banks are high and sandy and not subject to overflow. The bed of the stream is composed of sand and gravel and shifts considerably during floods. All of the water passes between the two abutments of the bridge at all stages, and the velocity of the current is moderate.

Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings, marked zero, is a spike on the downstream guard rail at the right bank.

The gage is read once each day by S. C. Loyd. The original wire gage has been replaced by a standard chain gage having the same datum as the old one, fastened to the lower downstream guard rail of the bridge. The length of the chain is 28.61 feet. The bench mark is marked in paint "B.M.U.S.G.S." on the east end of a plank spiked to the south abutment; elevation above gage datum, 13.66 feet. The elevation of the gage datum above sea level is 2,241.4 feet. The datum bench mark is the United States Geological Survey tablet at the Malta schoolhouse and is 37.80 feet above gage datum.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, pp 26–27; 99, p 103; 130, pp 98–99.
Discharge: 84, p 27; 99, p 104; 130, p 99.
Discharge, monthly: 84, p 28; 99, p 106; 130, p 102.
Gage heights: 84, p 27; 99, pp 104–105; 130, p 100.
Rating tables: 84, p 28; 99, p 105; 130, p 101.

Discharge measurements of Milk River at Malta, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 11	H. M. Morse	20	8.9	0.52	0.73	4.6
June 28	C. T. Prall	69	56	.94	1.25	52
July 24	W. B. Freeman	.....	.....	.....	.80	[a] 5.0
July 29	do	22	28	1.45	1.19	40
August 26	do	9	2.6	.88	.72	2.0
August 26	do	9	2.4	.78	.71	2.0

[a] Estimated.

Daily gage height, in feet, of Milk River at Malta, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1.1	1.1	2.2	1.1	0.6	1.0	1.95	2.95	0.55
2	1.1	1.1	2.2	1.1	.6	.9	1.45	2.75	.55
3	1.1	1.1	2.4	1.1	.6	.8	1.05	2.25	[a]
4	1.1	1.1	2.4	1.0	.6	.9	.95	1.95	.....
5	1.1	1.1	2.6	1.1	.6	.9	.95	1.95	.....
6	1.1	1.1	2.8	1.1	.6	.9	.95	1.75	.....
7	1.1	1.1	2.5	1.0	.6	.9	.85	1.55	.....
8	1.1	1.1	2.3	.9	.6	.9	.85	1.35	.....
9	1.1	1.1	2.1	.9	.7	1.0	1.05	1.45	.....
10	1.1	1.1	2.5	.8	.7	1.1	1.65	1.45	.....
11	1.1	1.1	2.0	.8	.7	1.1	1.45	1.45	.....
12	1.1	1.1	2.1	.7	.7	1.1	1.15	1.25	.....
13	1.1	1.1	2.0	.7	.7	1.1	1.65	1.25	.....
14	1.1	1.1	2.0	.7	.7	1.0	1.45	1.15	.....
15	1.1	1.1	2.0	.7	.7	1.0	1.15	1.15	.....
16	1.1	1.1	1.9	.7	.7	1.0	1.05	1.15	.....
17	1.1	1.1	1.9	.7	.7	1.0	1.05	1.05	.....
18	1.1	1.1	2.0	.7	.7	1.0	1.05	1.05	.....
19	1.1	1.1	2.1	.7	.7	1.0	1.05	1.05	.....
20	1.1	1.1	1.8	.7	.7	1.0	1.05	.75	.....
21	1.1	1.1	1.8	.7	.7	1.0	.95	.75	.....
22	1.1	1.1	1.8	.7	.7	1.0	.95	.75	.....
23	1.1	1.2	1.8	.7	.7	1.0	.95	.75	.....
24	1.1	1.3	1.7	.6	.8	1.0	.85	.65	.....
25	1.1	1.3	1.7	.6	.8	.9	.85	.65	.....
26	1.1	1.2	1.5	.6	.8	.8	.85	.65	.....
27	1.1	1.7	1.4	.6	.9	1.0	1.05	.65	.....
28	1.1	1.7	1.4	.6	1.0	1.8	1.05	.65	.....
29	.....	.....	1.3	.6	1.0	1.3	1.25	.65	.....
30	.....	.....	1.3	.6	1.0	1.9	1.15	.55	.....
31	.....	.....	1.1	.....	1.0	.....	3.05	.55	.....

[a] River dry remainder of year.

NOTE.—Ice conditions January 1 to March 3.

Station rating table for Milk River at Malta, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.70	1	1.40	74	2.10	294	2.80	618
.80	6	1.50	96	2.20	336	2.90	670
.90	12	1.60	122	2.30	380	3.00	722
1.00	19	1.70	151	2.40	424	3.10	778
1.10	29	1.80	183	2.50	472		
1.20	41	1.90	217	2.60	520		
1.30	56	2.00	254	2.70	568		

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1904-5. It is well defined throughout; above 2 feet the curve is the same as for 1904.

Estimated monthly discharge of Milk River at Malta, Mont., for 1905.

[Drainage area, 14,040 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January			[a]5	307	0.00036	0.00042
February			[a]5	278	.00036	.00037
March	618	29	258	15,860	.018	.021
April	29	0	8	476	.00057	.00064
May	19	0	34	2,091	.0024	.0028
June	217	6	27	1,607	.0019	.0021
July	750	9	65	2,828	.0046	.0053
August	696		97	5,964	.0069	.0080
The period				29,410		

[a] Estimated by C. C. Babb.

NORTH FORK OF MILK RIVER NEAR CHINOOK, MONT.

This station was established April 22, 1905. It is located at Snedecor's ranch, about 4½ miles north of Chinook, Mont.

The channel is straight for 100 yards above and below the station. The banks are composed of sandy soil, covered with brush and cottonwood trees; they are high and do not overflow. The right bank has a slope of about 45°, and the left of about 30°. The bed of the stream is of sand, with a little vegetation near the left bank, and probably shifts slightly after the highest floods. There is but one channel at all stages and the current is moderate.

Discharge measurements are made by means of a cable, car, and tagged wire just above the gage or by wading at low water. The initial point for soundings is a nail driven into the end of one of the timbers supporting the cable at the left bank.

The gage, which is read once each day by Mrs. R. B. Snedecor, is an inclined rod, which was erected May 22, 1905, to take the place of the temporary rod gage first established. The new gage is nailed in two sections to posts driven into the left bank. The gage is referred to bench-marks as follows: (1) A spike driven in a post just east of the gage; elevation, 11.26 feet. (2) A 20-penny spike in the root of a 10-inch cottonwood tree 20 feet east of the upper end of the gage; elevation, 13.92 feet. (3) A 20-penny spike driven into the root of a 5-inch cottonwood tree 40 feet northeast of the tree to which the east end of the cable is fastened; elevation, 16.12 feet. Elevations are above the datum of the gage.

Discharge measurements of North Fork of Milk River near Chinook, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 22	H. M. Morse	56	37	0.95	1.06	36
June 2	do	32	31	1.13	1.05	35
June 16	Stockman and Prall	55	35	.88	1.00	31
July 3	Babb and Prall	55	45	1.49	1.35	67
July 18[a]	W. B. Freeman	29	19	.49	.73	9.5
August 10[a]	do	25	14	.80	.80	11.1
August 23	C. T. Prall	.....	.....	.....	.55	[b]1.0

[a] Wading. [b] Estimated.

Daily gage height, in feet, of North Fork of Milk River near Chinook, Mont., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct	Nov.
1	.....	1.28	1.15	1.25	0.92	0.45	.....	0.8
2	.....	1.3	1.05	1.32	1.35	.45	.....	8
3	.....	1.3	1.0	1.35	1.05	.43	.....	.8
4	.....	1.25	1.0	1.32	1.0	.35	.....	.8
5	.....	1.25	1.0	1.25	1.5	.35	.....	.8
6	.....	1.25	1.0	1.18	1.25	.32	.....	.8
7	.....	1.21	1.0	1.25	.98	.3	.....	.8
8	.....	1.2	1.0	1.15	.92	.3	.....	.8
9	.....	1.22	.95	1.1	.82	.25	.....	.85
10	.....	1.25	.9	.98	.8	.25	.....	.93
11	.....	1.2	.9	.9	.78	.25	.....	.95
12	.....	1.18	.9	.92	.75	.....	.....	.93
13	.....	1.15	.9	.95	.72	.....	.....	.85
14	.....	1.1	.95	.95	.65	.....	.....	.85
15	.....	1.1	1.02	.9	.65	.....	.....	.88
16	.....	1.1	1.0	.82	.65	.....	.....	.9
17	.....	1.1	1.0	.78	.65	.....	.....	.9
18	.....	1.1	.98	.75	.65	.....	.....	.95
19	.....	1.1	.95	.75	.65	.....	.....	.95
20	.....	1.1	1.02	.72	.6	.....	.....	.95
21	.....	1.05	1.15	.68	.55	.....	.....	.95
22	1.2	1.08	1.15	.65	.52	.....	.....	.95
23	1.2	1.08	1.05	.65	.5	.....	0.7	.93
24	1.18	1.05	1.05	.65	.55	.....	.7	.9
25	1.15	1.05	1.05	.6	.6	.....	.7	.9
26	1.18	1.05	1.06	2.7	.58	.....	.7	.9
27	1.22	1.05	1.22	1.45	.52	.....	.7	.9
28	1.28	1.05	1.22	1.35	.5	.....	.7	.....
29	1.28	1.05	1.28	1.0	.5	.....	.7	.....
30	1.25	1.08	1.3	1.5	.45	.....	.8	.....
31	.....	1.12	.....	1.05	.45	.....	.8	.....

NOTE.—September 3 to October 22, no flow. November 28 to December 31, frozen.

Station rating table for North Fork of Milk River near Chinook, Mont., from April 23 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.50	1	1.10	43	1.70	127	2.30	272
.60	3	1.20	53	1.80	147	2.40	302
.70	8	1.30	65	1.90	172	2.50	332
.80	13	1.40	77	2.00	197	2.60	362
.90	23	1.50	92	2.10	222	2.70	392
1.00	33	1.60	107	2.20	247	2.80	422

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during 1905. It is poorly defined and is a basis for only a rough estimate.

Estimated monthly discharge of North Fork of Milk River near Chinook, Mont., for 1905.

[Drainage area, 1,422 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
April 22–30	63	48	55	984	0.039	0.013
May	65	38	48	2,933	.034	.039
June	65	23	37	2,208	.026	.029
July	392	3	48	2,927	.033	.038
August	92	1	16	972	.011	.013
September	1	0	0	0	.000	.000
October	13	0	2.6	160	.0018	.0021
November 1–27	28	13	21	1,119	.015	.015
The period				11,300		

BEAVER CREEK NEAR ASHFIELD, MONT.

Beaver Creek rises in the Little Rocky Mountains, flows to the northeast and east, and enters Milk River near Hinsdale, Mont.

The gaging station was established July 5, 1903, at bridge No. 455 of the Great Northern Railway, one-half mile west of Ashfield, Mont. It was abandoned December 31, 1903, because the results were affected by backwater from a dam erected a mile below about a month after the establishment of the station. A new station was established at a point 2½ miles farther upstream and beyond the influence of the dam. It is near the ranch house of R. H. Thomas, about 18 miles from Malta and 3 miles south of Ashfield, Mont., the nearest post-office.

The channel is straight for 100 yards above and below the cable. Both banks are high and covered with willows. The left bank is steep and the right is sloping. The bottom of the stream is of mud. There is but one channel at all stages and the flow is very sluggish, the velocity being comparatively low even in the highest floods. The stream carries little water except at the time of spring floods or heavy rains, and during the summer the channel is overgrown with weeds and willows, which have to be cleared out occasionally.

Discharge measurements are made from a cable about 225 feet above the gage. The cable has a span of 100 feet between supports, and a tagged wire marked at 5-foot intervals is stretched above. The initial point for soundings is a nail in the cable support at the left bank.

The gage, which is read daily by Mr. Thomas, is an inclined plank on the right bank, securely fastened to posts set in the ground at each end, and has a vertical extension, which

gives minus readings at very low water. Early in 1905 the gage was referred to the bench marks and was found to have settled, so that the zero mark on the gage read 0.08 foot too high. It has not been corrected. The gage was also found to read 0.01 foot too great per foot vertical. The gage is referred to bench marks as follows: (1) A nail driven flush in the top of a 2 by 4-inch stake, 12 feet south of the gage; elevation, 11.43 feet above gage datum. (2) The top of a railroad spike driven in the northwest corner of Mr. Thomas's house, 1 foot above ground; elevation, 13.35 feet above gage datum.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 100; 130, pp 108-109.
Discharge: 99, p 100; 130, p. 109.
Discharge, monthly, 130, p 111.
Gage heights: 99, p 101; 130, p 110.
Rating table: 130, p 110.

Discharge measurements of Beaver Creek near Ashfield, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 28	C. T. Prall	53	169	1.00	4.55	169
July 29	W. B. Freeman	7	5	1.42	.17	7
July 30	do	20	39	1.16	1.78	46
July 30	do	20	36	1.15	1.69	42
July 30	do	20	41	1.20	1.86	49

Daily gage height, in feet, of Beaver Creek near Ashfield, Mont., for 1905.

Day.	Mar.	June.	July.	Aug.	Day.	Mar.	June.	July.	Aug.
1			2.70	2.9	17	0.6	1.7	0.6	
2			2.1	1.15	18	.5	1.5	.4	
3			1.7	1.15	19	.5	1.3	.3	
4			1.3	.95	20	.4	1.1	.2	
5			1.0	1.7	21	.2	1.0	.1	
6			.9	1.55	22	.1	.8	.0	
7			.7	.9	23	.05	.8	.0	
8			.5	.3	24	—.1	1.1	.0	
9			.3	.2	25	—.2	2.0	.2	
10			.2	.1	26	—.2	2.5	1.5	
11			.2	.0	27	—.2	2.3	1.8	
12	2.0	0.8	.6	.0	28	—.25	4.6	1.9	
13	1.3	1.2	1.0	.1	29		4.0	.4	
14	1.15	1.2	1.1	.1	30		4.3	1.92	
15	.9	1.4	1.0	.15	31			3.1	
16	.7	1.8	.8	.2					

NOTE.—Creek dry for missing days.

Station rating table for Beaver Creek near Ashfield, Mont., from March 12 to August 16, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.00	4	1.00	22	2.00	54	3.00	94
0.10	5	1.10	25	2.10	58	3.20	102
0.20	6	1.20	28	2.20	62	3.40	110
0.30	7	1.30	31	2.30	66	3.60	120
0.40	9	1.40	34	2.40	70	3.80	130
0.50	11	1.50	37	2.50	74	4.00	140
0.60	13	1.60	40	2.60	78	4.20	150
0.70	15	1.70	43	2.70	82	4.40	160
0.80	17	1.80	46	2.80	86	4.60	170
0.90	19	1.90	50	2.90	90		

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during 1905. It is fairly well defined between gage heights 0 and 2 feet, and has been extended beyond these limits, being based on one measurement at 4.55 feet.

Estimated monthly discharge of Beaver Creek near Ashfield, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March	54	0	7.2	428
June	170	0	34.3	2,041
July	98	4	24.1	1,482
August	90	0	10.0	615
The period				4,566

BEAVER CREEK OVERFLOW NEAR BOWDOIN, MONT.

This station was established June 29, 1903. It is located on an overflow channel of Beaver Creek, about 4 miles southeast of the Great Northern Railway section house at Bowdoin, Mont., and is best reached by team from Malta, Mont., 14 miles distant. The water supply is derived partly from the natural drainage of irrigated lands and partly from water wasted over the spillway at a dam on Beaver Creek above.

The channel is straight for 200 feet above and 100 feet below the station. During extreme floods both banks are submerged and the whole valley is covered with water. The bed of the stream at the station forms a small bar, covered with weeds and swamp grass. The current is sluggish, and measurements are affected by a check which is frequently erected at the gates of a lateral about 1 mile below.

Discharge measurements are made by means of a cable, car, and tagged wire, and also by wading. The initial point for soundings is the east side of a post on the west or left bank.

The gage is read daily by John Turmell, who lives about 300 yards distant. It is a vertical board nailed to a cottonwood tree on the right bank about 100 feet above the cable. All the old bench marks have been destroyed, but the zero of the gage is at an elevation of 2,207.84 feet above sea level, as determined from the datum bench mark at the Malta school house. This is based on the elevation of the rail in front of the Great Northern Railway station at Malta, Mont. September 15, 1905, two new bench marks were established from the gage on the assumption that the readings were at that time correct. These bench marks are as follows: (3) The head of a railroad spike driven vertically in a projecting log at the southwest corner of Mr. Turmell's house, 800 feet southwest of the gage; elevation, 21.44 feet above gage zero. (4) The head of a 20-penny spike driven horizontally in the northwest corner of Mr. Turmell's house, 2 feet above the ground; elevation, 19.48 feet above gage zero.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, pp 101–102; 130, p 111.
Discharge: 99, p 102; 130, p 112.
Discharge, daily: 130, p 112.
Discharge, monthly: 130, p 113.
Gage heights: 99, pp 102–103; 130, p 112.

Discharge measurements of Beaver Creek overflow near Bowdoin, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 28	C. T. Prall	89	215	0.55	6.4	118
July 30 [a]	W. B. Freeman	56	77	.2	4.8	15

[a] Float measurement.

Daily gage heights, in feet, and discharge, in second-feet, of Beaver Creek overflow near Bowdoin, Mont., for 1905.

Day.	March.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1					4.8	16	4.4	7
2					4.9	19	4.2	5
3	5.4	43			4.8	16	4.1	4
4	5.3	37			4.7	13	4.0	3
5	5.15	29			4.6	11	3.9	2
6	4.85	18	6.65	138	4.4	7	3.8	2
7	4.85	18	5.0	23	4.3	6	3.7	2
8	4.05	4	4.4	7	4.1	4	3.6	1
9			4.3	6	4.0	3		
10			4.3	6	4.0	3		
11			5.3	37	3.9	2		
12			5.0	23	3.8	2		
13			6.7	143	3.8	2		
14			5.0	23	3.7	2		
15			4.9	19	3.7	2		
16			4.7	13	3.6	1		
17			4.6	11	3.6	1		
18			4.5	9				
19			4.4	7				
20			4.3	6				
21			4.2	5				
22			4.1	4				
23			4.1	4				
24	3.9	2	4.0	3				
25	3.8	2	4.0	3				
26	3.7	2	6.0	83				
27	3.6	1	5.7	61				
28			6.4	116				
29			5.5	49	5.2	31		
30			5.0	23	4.8	16		
31					4.6	11		

NOTE.—No flow on missing days.

Estimated monthly discharge of Beaver Creek overflow near Bowdoin, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum	Minimum.	Mean.	
March 3–8, 24–27	43	1	16	309
June 6–30	138	3	33	1,631
July 1–17, 29–31	31	1	8	333
August 1–8	7	1	3	51
The period				2,324

PRIVATE CANALS IN MILK RIVER VALLEY.

DESCRIPTION OF CANALS.

During 1905 a number of stations were maintained on private canals in Milk River Valley, mainly for the purpose of ascertaining the extent of the private water rights. With one exception—the Rock Creek canal near Hinsdale, in Valley County—these canals are located in Choteau County and are used for the irrigation of lands in the vicinity of Harlem and Chinook.

The canals are all built on small grades and in soil which is easily eroded. In many of them deposition of silt has taken place, and in nearly all there is a growth of weeds and moss. At low stages the water is uniformly sluggish. In order to divert water into the laterals checks are erected in the main channels, and these checks often produce backwater effects for long distances above. They were put up under a great variety of conditions, and as a result many different velocities are found to exist at the same gage height during the season; in order to establish the correct relation between gage height and discharge it has been found necessary to make several rating curves for the same canal station. All the canals except the Rock Creek canal at Hinsdale and the Cook canal at Chinook have more than one station rating curve.

In July, 1905, an injunction suit was brought by the United States Office of Indian Affairs against later appropriators of water on Milk River and its tributaries above, to determine the rights pertaining to the agency ditch which supplies the Fort Belknap Indian Reservation. For that reason the water was shut off from some of the ditches, including the Matheson and Cook canals, during part of the irrigation season.

The gaging stations maintained were as follows:

Paradise Valley canal near Chinook, Mont.
Cook canal near Chinook, Mont.
Matheson canal near Chinook, Mont.
Harlem canal near Zurich, Mont.
Agency ditch near Harlem, Mont.
Fort Belknap canal near Chinook, Mont.

In addition to the canal stations regularly maintained, temporary gaging stations were established on Reser and West Fork ditches, taken from West Fork of Milk River, and miscellaneous information was collected in regard to the Dowen & Buckley, Rokita, and Corregan ditches from North Fork of Milk River; the Winter-Anderson canal from Milk River; and ditches from Parallel Creek. The water rights pertaining to these canals are to be adjudicated in the general lawsuit recently instituted.

PARADISE VALLEY CANAL NEAR CHINOOK, MONT.

This canal is used for the irrigation of bottom lands several miles east of Chinook, Mont. It diverts water from the south side of Milk River about 7 miles below Chinook, and its general course is easterly.

The station was established in June, 1903. It is reached by driving along the south river road from Chinook, Mont.

The channel is straight and the section at the station is semicircular. The bed of the canal is composed of mud and sand and the banks are covered with brush and weeds.

Discharge measurements are made from a footbridge. The initial point for soundings is the zero on the bridge at the left bank.

The gage was read once each day during the irrigation season of 1905 by Rudolph Friede, who lives 300 yards distant. It is a vertical board driven into the bed of the canal about 500 feet below the head gates and just at the footbridge from which the discharge measurements are made. The gage is referred to bench marks as follows: (1) A spike driven in the top of a 6 by 6 inch post on the left side of the downstream end of the head gates; elevation, 7.29 feet. (2) A spike in the southwest side of a 12-inch post 40 feet south of the south end of the dam and 28 paces east of bench mark No. 1; elevation, 7.38 feet. Elevations are above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 107; 130, p 105.
Discharge: 99, p 107; 130, p 105.
Discharge, daily: 130, p 106.
Discharge, monthly: 130, p 106.
Gage heights: 99, p 107.

Discharge measurements of Paradise Valley canal near Chinook, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 8	L. R. Stockman	11	5.0	0.70	0.45	3.5
April 24	Stockman and Morse	20	11.5	.87	.76	10.1
May 17	H. M. Morse	18	9.3	.71	.81	6.6
June 3	do	20	14.6	.54	1.08	7.8
June 17	Stockman and Prall	18	11.0	.43	.98	4.8
June 24	C. T. Prall	18	11.3	.48	1.01	5.4
June 24	do	18	13.0	.39	1.02	5.0
July 8	Freeman and Morse	18	12.5	.38	1.09	4.8
July 15	C. T. Prall	17	11.0	.31	.98	3.4
July 21	W. B. Freeman	18	11.6	.44	1.01	5.1
July 27	H. M. Morse	19	20.0	.53	1.37	10.0
August 5	W. B. Freeman	9	2.6	.26	.50	.7

Daily gage height, in feet, and discharge, in second feet, of Paradise Valley canal near Chinook Mont., for 1905.

Day.	March.		April.		May.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1			0.17	1	0.47	4	1.14	8	1.24	8	0.57	1.0
2			.15	.5	.56	6	1.17	8	1.30	9	.50	.5
3			.15	.5	.67	8	1.12	8	1.21	7	.49	.5
4			.40	3	.78	10	1.05	7	1.21	7	.44	.5
5			.46	4	.92	13	1.11	8	1.20	7	.50	.5
6			.47	4	1.17	19	1.15	10	1.19	7	.48	.5
7			.47	4	1.09	17	1.20	11	1.22	7	.45	.5
8			.42	3	1.08	17	1.50	16	.92	4	.45	.5
9			.42	3	1.11	17	1.20	11	1.54	15	.44	.5
10			.54	5	1.08	17	1.03	6	1.14	6	.43	.5
11			.75	10	1.13	18	1.08	8	.68	2	.41	.5
12			1.08	17	1.09	17	1.11	8	.89	3	.40	.3
13			1.10	17	1.10	17	1.19	11	.90	3	.39	.3
14			1.02	15	1.17	19	1.04	7	.95	4	.35	.2
15			.98	15	.84	7	1.07	7	.97	4	.30	.2
16			.92	13	.81	6.5	1.02	6	1.10	6	.20	.1
17			.86	12	.78	6.5	.98	5	1.13	6	.10	
18			1.08	17	.82	6.5	.98	5	1.13	6		
19			1.08	17	.80	6.5	.96	4	1.05	5		
20			1.11	17	.80	6.5	1.01	5	1.06	5		
21			1.01	15	.80	6.5	.96	4	1.05	5		
22			.84	12	.82	6.5	.94	4	.94	4		
23			.83	11	.90	7	.94	4	.81	3		
24			.78	10	1.12	8	1.00	5	.73	2		
25			.71	9	1.09	8	1.09	6	.66	2		
26	0.21	1	.64	8	1.11	8	1.09	6	.65	2		
27	.23	1	.49	4	1.07	8	1.15	6	1.60	17		
28	.42	3	.48	4	1.10	8	1.36	10	1.40	11		
29	.48	4	.45	4	1.09	8	1.22	7	1.33	9		
30	.30	2	.41	3	1.10	8	1.25	8	.85	3		
31	.24	1			1.11	8			.69	2		

Estimated monthly discharge of Paradise Valley canal near Chinook, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March 26–31	4	1	2	24
April	17	.5	9	536
May	19	4	10	615
June	16	4	7	417
July	17	2	6	369
August	1	.1	.4	13
The period				1,974

COOK CANAL NEAR CHINOOK, MONT.

This canal diverts water from North Fork of Milk River, one of the most constant tributaries of that stream. The head-gates are situated about 3 miles east of Chinook, Mont., and the course of the canal is nearly due south for about 2 miles, beyond which it turns to the east and crosses to the south side of the river, where the greater part of the lands irrigated by the canal are situated.

The station was established April 10, 1905. It is located at a small wooden highway bridge on the road running parallel to the Great Northern Railway about 3 miles east of Chinook.

The channel is straight for 25 feet above and 300 feet below the station, there being a right-angled turn directly above the bridge. The banks are of earth fill and are above the level of the surrounding lands. The bed of the stream is composed of soft mud covered with vegetation, and is permanent. The water has a depth of about 3 feet at ordinary stages and the velocity is low.

Discharge measurements are made from the lower side of the bridge. The initial point for soundings is a paint mark on the floor of the bridge, directly over the right abutment on the downstream side.

The gage, which was read once each day during the irrigation season of 1905 by George W. Hartman, is a vertical rod driven into the bed of the canal near the left bank about one-fourth mile above the bridge. The bench mark is a spike in the west side of a post in the fence just east of the canal; elevation, 4.61 feet above the datum of the gage.

Discharge measurements of Cook canal near Chinook, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec. ft.*
April 10	L. R. Stockman	14	32.8	1.15	3.4	37.7
April 24	Stockman and Morse	13	30.4	1.16	3.28	35.5
May 17	H. M. Morse	13	29.0	.92	3.18	26.7
June 3	do	14	28.2	.72	3.02	20.6
June 17	Stockman and Prall	14	27.0	.80	2.98	21.5
June 24	C. T. Prall	14	30.2	1.01	3.26	30.6
July 3	Babb and Prall	14	17.3	.17	2.39	3.0
July 7	W B. Freeman	14	17.9	.13	2.22	2.3
July 15	C. T. Prall	14	25.0	.54	2.80	13.4
August 5	W. B. Freeman	14	27.0	.64	2.93	17.0
August 11	H. M. Morse	14	19.0	.30	2.45	6.0

Daily gage heights, in feet, and discharge, in second-feet, of Cook canal near Chinook, Mont., for 1905.

Day.	April.		May.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1	.....	.....	3.7	50	1.9	0	.....	0	2.95	19
2	.....	.....	3.7	50	1.9	0	.....	0	3.0	21
3	.....	.....	3.65	47	3.02	21	2.39	4	2.9	17
4	.....	.....	3.6	45	1.8	0	.....	4	2.4	4
5	.....	.....	.....	0	1.8	0	.....	3	2.93	17
6	.....	.....	.....	0	1.7	0	.....	2	2.3	3
7	.....	.....	.....	0	2.0	0	2.22	2	2.4	4
8	.....	.....	.....	0	3.2	29	2.15	1	2.4	4
9	.....	.....	.....	0	3.1	25	3.1	25	2.4	4
10	3.4	38	.....	0	3.1	25	3.0	21	2.3	3
11	.....	.....	2.75	12	3.1	25	2.9	17	2.45	5
12	.....	.....	2.8	13	3.2	29	2.1	0	2.4	4
13	.....	.....	2.95	19	3.2	29	1.2	0	2.0	0
14	.....	.....	3.0	21	3.1	25	1.3	0	1.75	0
15	.....	.....	3.1	25	3.0	21	2.8	13	1.7	0
16	.....	.....	3.15	27	3.1	25	1.3	0	1.7	0
17	.....	.....	3.2	29	3.0	21	1.3	0	1.5	0
18	.....	.....	3.15	27	3.0	21	1.3	0	1.55	0
19	.....	.....	3.2	29	2.9	17	1.25	0	1.82	0
20	.....	.....	3.1	25	2.9	17	1.2	0	1.4	0
21	.....	.....	3.15	27	2.9	17	1.9	0	1.4	0
22	.....	.....	3.1	25	2.9	17	1.25	0	1.35	0
23	.....	.....	2.6	8	3.0	21	1.2	0	1.35	0
24	3.28	36	2.0	0	3.1	25	1.2	0	1 3	0
25	.....	.....	2.0	0	3.3	33	1.2	0	1.25	0
26	.....	.....	2.0	0	2.9	17	1.3	0	.....	.....
27	.....	.....	2.0	0	2.9	17	2.4	4	.....	.....
28	.....	.....	2.0	0	2.9	17	2.6	8	.....	.....
29	.....	.....	1.95	0	2.2	2	2.8	13	.....	.....
30	.....	.....	1.9	0	.....	0	2.8	13	.....	.....
31	.....	.....	1.9	0	.....	.....	2.7	10	.....	.....

Estimated monthly discharge of Cook canal near Chinook, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	.....	.....	[a] 37.0	2,202
May	50	0	15.5	953
June	33	0	16.5	982
July	25	0	4.5	277
August 1–12	21	0	9.0	214
The period	.....	.....	.....	4,628

[a] Estimated.

MATHESON CANAL NEAR CHINOOK, MONT.

This canal diverts water from the south side of North Fork of Milk River. The head-gates are situated about 3½ miles east of Chinook, Mont., and about three-fourths of a mile below the head of the Cook canal. The general course of the canal is easterly and the irrigated lands under it lie along the Great Northern Railway.

The station was established April 10, 1905. It is located at a footbridge 200 feet below the head-gates.

The channel is straight for 200 feet above and below the station. The canal is in a cut and the banks are high; the right is covered with willows and the left with brush. The bed is composed of sand and is covered with vegetation. The velocity is about 1.4 feet per second when the canal is running full.

Discharge measurements are made from the bridge. The initial point for soundings is at the extreme end of the bridge timbers on the right bank.

The gage, which was read once each day during the irrigation season by H. C. Reynolds, is a vertical rod driven into the bed of the canal immediately below the bridge. The gage is referred to bench marks as follows: (1) A 60-penny nail in the root of a 5-inch willow tree, 180 feet south of the head-gates of the canal; elevation, 9.58 feet above the datum of the gage. (2) A nail in a 3-inch willow tree, 180 feet south of the head of the canal, east of bench mark No. 1 and across the road from it; elevation, 9.34 feet above the datum of the gage.

Discharge measurements of Matheson canal near Chinook, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 10	L. R. Stockman	11.0	18.3	1.42	3.15	25.9
April 24	Stockman and Morse	9.3	8.2	.83	2.1	6.8
May 17	H. M. Morse	7.5	5.0	.58	1.76	2.9
June 3	do	9.5	11.8	.68	2.52	8.0
June 17	Stockman and Prall	10.0	15.2	.60	2.85	9.1
June 23	C. T. Prall	10.0	18.6	.68	3.17	12.7
June 23	do	10.0	17.0	.68	3.05	11.5
July 8	Freeman and Morse	.....	5.6	.13	1.85	.7
July 15	C. T. Prall	9.2	10.0	.42	2.29	4.0
July 21	W. B. Freeman	8.0	4.0	.11	1.76	.5
July 27	H. M. Morse	10.0	13.0	.63	2.72	8.0
August 11	do	8.0	4.8	.24	1.79	1.0
August 19	C. T. Prall	.....	.....	.....	1.45	.25

NOTE.—Grass removed from canal bed after June 23.

Daily gage height, in feet, and discharge, in second-feet, of Matheson canal near Chinook, Mont., for 1905.

Day.	April.		May.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1	.....	26	3.25	28	2.8	9	.....	7	1.6	0.5
2	.....	26	2.88	20	2.7	8.5	.....	7	1.55	.4
3	.....	26	3.2	27	2.7	8.5	2.38	5	1.5	.3
4	.....	26	2.88	20	2.7	8.5	2.5	6	1.5	.3
5	.....	26	2.8	18	2.7	8.5	2.0	2	1.5	.3
6	.....	26	2.8	18	2.65	8.5	2.0	2	1.5	.3
7	.....	26	2.7	16	2.65	8.5	1.9	1	1.3	.0
8	.....	26	2.62	15	2.65	8.5	1.8	1	1.2	.0
9	.....	26	2.6	14	2.65	8.5	2.3	4	1.7	.0
10	3.2	27	2.45	12	2.65	8.5	2.85	9	1.8	1.0
11	3.2	27	2.28	9	2.6	8	2.8	9	1.8	1.0
12	3.15	26	2.25	9	2.6	8	2.6	7	1.7	.7
13	3.12	25	.....	7.5	2.6	8	2.5	6	1.65	.5
14	2.95	21	.....	6	2.65	8	2.3	4	1.5	.3
15	2.7	16	.....	5	2.65	8	2.25	4	1.5	.3
16	2.65	15	.....	4	2.6	8	2.45	5	1.5	.3
17	2.6	14	1.76	3	2.85	9	2.4	5	1.7	.7
18	2.58	14	2.1	7	2.6	7	1.8	1	1.7	.7
19	2.55	13	2.22	8	2.5	6	1.8	1	1.6	.5
20	2.55	13	2.72	8.5	2.5	6	1.85	1	1.5	.3
21	2.55	13	2.8	9	2.7	8	1.8	1	1.5	.3
22	2.9	20	2.92	9	2.7	8	2.2	3	1.65	.6
23	3.0	22	2.6	8	3.1	12	1.8	1	.....	.....
24	2.1	7	2.55	8	3.0	11	1.8	1	.....	.....
25	2.0	6	2.62	8	3.0	11	1.8	1	.....	.....
26	2.05	6	2.6	8	2.9	10	2.45	5	.....	.....
27	2.05	6	2.7	8.5	2.8	9	2.72	8	.....	.....
28	2.1	7	2.75	9	2.85	9	1.85	1	.....	.....
29	3.05	23	2.8	9	2.6	7	1.7	1	.....	.....
30	3.18	27	2.8	9	3.0	11	1.6	.5	.....	.....
31	.....	.....	2.8	9	.....	.....	1.6	.5	.....	.....

NOTE.—Discharge April 1-9 estimated.

Estimated monthly discharge of Matheson canal near Chinook, Mont., in 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	27	6.0	19.0	1,131
May	28	3.0	11.0	676
June	12	6.0	9.0	536
July	9	.5	3.5	215
August 1-22	1	0	.4	17
The period	.....	.....	.....	2,575

HARLEM CANAL NEAR ZURICH, MONT.

The Harlem canal is owned by a corporation composed of farmers and is used to irrigate a considerable area of bottom lands near Harlem. It diverts water from the north side of Milk River about 10½ miles below Chinook and flows eastward about 12 miles.

The station was established in June, 1903. It is located about 500 feet below the head-gates of the canal, which are 1½ miles southeast of the Great Northern Railway section house at Zurich and is best reached by driving from Harlem or Chinook.

Discharge measurements are made by wading at the gage. The initial point for soundings is a stake driven into the left bank, near the gage. Flood measurements can be made from a small highway bridge 2 miles below.

The gage was read daily during the irrigation season of 1905 by John Palm, who lives about one-half mile below. It is a vertical board driven into the bed of the canal. The bench-mark is a spike in the downstream face of a 6 by 8 inch post at the left bank, on the downstream side of the head-gate. The spike is 0.8 foot below the top of the cross piece and has an elevation of 11.89 feet above the gage datum.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 106; 130, pp 106–107.
Discharge: 99, pp 106, 136; 130, p 107.
Discharge, monthly, 130, p 108.
Gage heights: 130, p 107.
Rating table: 130, p 108.

Discharge measurements of Harlem canal near Zurich, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 8	L. R. Stockman	16	26	0.4	1.35	10.5
April 24	Stockman and Morse	17	27	.54	1.12	15.0
May 17	H. M. Morse	20	36	.52	1.38	19.0
June 3	do	16	24	.81	1.58	19.0
June 17	Stockman and Prall	19	32	.23	.98	7.3
June 24	C. T. Prall	13	10	.25	.68	2.5
July 8	Freeman and Morse		35	.74	2.21	26.0
July 15	C. T. Prall		20	.51	1.35	10.0
July 21	W. B. Freeman		15	.35	1.05	5.3
July 27	H. M. Morse		52	.97	2.96	51.0
August 5	W. B. Freeman		7	.15	.45	[a]1.2
August 11	H. M. Morse		20	.67	1.37	14.0

[a] Leakage through gates.

Daily gage heights, in feet, and discharge, in second-feet, of Harlem canal near Zurich, Mont., for 1905.

Day.	March.		April.		May.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1			1.93	21	1.0	12	1.6	19	1.4	15	1.35	18
2			1.93	21	.9	10	1.6	19	1.6	19		0
3			1.93	21	.9	10	1.6	19	1.98	22		0
4			1.53	14	.8	8	1.5	17		25		0
5	2.33	28	1.43	12	.8	8	1.3	13	2.3	28	.45	1
6	2.33	28	1.43	12	1.1	14	1.0	8	2.1	24	1.4	15
7	2.43	30	1.33	10		17	.9	6	2.28	28	1.2	11
8	2.43	30	1.33	10	1.5	21	1.1	10	2.41	30	1.2	11
9	2.53	32	1.10	6	1.7	25	1.3	13	2.4	30	1.4	15
10	2.43	30	1.10	6	1.8	27	1.6	19	2.45	31	1.5	1.
11	2.33	30	1.65	16	1.8	27	1.4	15	2.12	24	1.35	14
12	2.73	36	2.50	32	1.75	26	1.2	11	1.96	21	1.25	12
13	2.83	38	2.50	32	1.7	25	1.15	10	1.78	18	1.2	11
14	2.63	34	2.50	32	1.6	23	1.3	13	1.5	13	1.1	10
15		0	2.40	30	1.6	23	1.1	10	1.4	11	.95	7
16	2.13	25	2.40	30	1.35	18	1.05	9	1.22	8	.85	5
17		0	2.40	30	1.2	15	.98	7	1.17	7	.8	4
18		0	1.80	27	1.1	14	.9	6	1.1	6	2.0	26
19	2.33	28	1.60	23	1.1	14	.8	4	1.05	5	.85	5
20	2.33	28	1.45	20	.85	9	.78	4	1.05	5		0
21	2.43	30	1.40	19	.75	7	.75	4	1.0	5		
22	2.63	34	1.30	17	.8	8	.74	4	1.0	5		
23	2.33	28	1.20	15	.9	10	.70	3	.98	4		
24	2.33	28	1.10	14	1.0	12	.68	3	.9	3		
25	2.23	27	1.10	14	1.15	14	.68	3	.87	3		
26	2.03	23	1.20	15	1.3	13	.65	2	1.6	15		
27	2.03	23	1.20	15	1.4	15	.65	2	2.83	48		
28	2.03	23	1.10	14		16	.85	5	4.05	73		
29	2.13	25	1.00	12	1.5	17	1.10	10	3.2	56		
30	2.13	25	1.00	12	1.6	19	1.29	13	1.75	26		
31	2.13	25			1.6	19			1.5	21		

Estimated monthly discharge of Harlem canal near Zurich, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March 5–31	38	0	25.5	1,366
April	32	6	18	1,071
May	27	7	16	984
June	19	2	9	536
July	73	3	20	1,230
August 1–19	26	0	10	377
The period				5,564

AGENCY DITCH NEAR HARLEM, MONT.

This canal was built by the United States Indian Office and is used for the irrigation of land on the Fort Belknap Indian Reservation. It diverts water from the south side of Milk River, flows southward and eastward for about 11 miles, and has several laterals of considerable size. The head gates are situated near the agency buildings, about 4 miles south of Harlem, Mont.

The station was established July 14, 1905. It is located at the highway bridge about one-fourth of a mile below the head gates.

The channel is straight for 300 feet above and below the station. Both banks are high and have slopes of about 1½ to 1. The bed of the canal is composed of firm earth, comparatively free from vegetation, and is permanent.

Discharge measurements are made from the downstream side of the wooden-truss bridge, which has a span of 45 feet. The initial point for soundings is a nail at the end of the downstream lower chord of the bridge at the right bank.

The gage, which was read gratuitously once each day during the irrigation season by C. M. Zeibach, chief clerk of the agency, is a vertical rod driven into the bed of the canal 15 feet below the bridge and 5 feet from the right bank. The gage is referred to bench marks as follows: (1) The head of a 60-penny spike driven vertically into an 8 by 8 inch timber on the south end and lower side of the bridge; elevation, 12.68 feet above the zero of the gage. (2) The highest point on a large granite bowlder at the north end and lower side of the bridge; elevation above the zero of the gage, 14.51 feet.

Discharge measurements of Agency ditch near Harlem, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
July 14	Prall and Freeman	20	30	0.81	3.24	24
July 28	W. B. Freeman	24	67	.77	4.82	[a] 52
July 28	do	24	60	1.04	4.53	63
August 4	C. T. Prall	24	54	.55	4.3	[a] 29
August 17	do	22	44	.33	3.8	[a] 14
August 25	do	18	18	1.01	2.5	18
September 5	W. B. Freeman	14	4	.4	1.75	2

[a] Backwater.

Daily gage height, in feet, and discharge, in second feet, of Agency ditch near Harlem, Mont., in 1905.

Day.	July.		August.		September.		Day.	July.		August.		September.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.		Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1	.....	0	4.4	33	1.9	5	17	3.1	21	3.8	14	.....	.....
2	.....	0	4.3	29	.....	4	18	2.9	16	3.7	12	.....	.....
3	.....	0	4.3	29	.....	3	19	2.7	12	3.6	11	.....	.....
4	.....	0	4.3	29	1.8	3	20	2.6	10	3.5	9	.....	.....
5	.....	0	4.2	25	1.75	2	21	2.5	8	3.4	8	.....	.....
6	.....	0	4.2	25	.....	2	22	2.5	8	3.3	8	.....	.....
7	.....	0	4.2	25	.....	1	23	2.5	8	3.2	7	.....	.....
8	.....	0	4.2	25	.....	1	24	2.0	2	3.15	6	.....	.....
9	.....	32	4.2	25	.....	0	25	1.8	1	2.5	18	.....	.....
10	.....	32	4.2	25	.....	0	26	1.7	1	.....	16	.....	.....
11	.....	32	4.1	22	.....	0	27	1.6	0	.....	14	.....	.....
12	.....	32	4.1	22	.....	.....	28	4.8	63	.....	11	.....	.....
13	.....	29	4.1	22	.....	.....	29	5.2	52	.....	9	.....	.....
14	3.32	27	4.0	19	.....	.....	30	5.3	52	.....	7	.....	.....
15	2.9	16	3.95	18	.....	.....	31	4.8	51	.....	5	.....	.....
16	3.1	21	3.9	16	.....	.....							

Estimated monthly discharge of Agency ditch near Harlem, Mont., in 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
July 8–31	63	0	23	1,049
August	33	5	18	1,107
September 1–8	5	1	3	48
The period				2,204

FORT BELKNAP CANAL NEAR CHINOOK, MONT.

The Fort Belknap canal is owned by a corporation composed of farmers and is used for the irrigation of extensive areas of bottom lands near Chinook, Mont. It diverts water from the north side of Milk River about 8 miles above Chinook.

The station was established June 21, 1903. It is located at the highway crossing 1 mile below the head gates of the canal and is reached by driving.

The channel is curved above and straight below the station. Both banks are sloping, and the bed is composed of sand and gravel.

Discharge measurements are made from the wooden highway bridge, to which the gage is attached. The initial point for soundings is a spike 15 feet from the gage on the downstream hand rail.

The gage was read daily until August 12, 1905, by D. E. Martin, and from that date to the end of the irrigation season by Morris Jones. The original gage was a vertical board fastened to the downstream chord of the highway bridge. This was replaced July 28, 1905, by a rod gage driven into the bed of the canal just below the bridge, the same datum being used. The gage is referred to bench marks as follows: (1) A nail at the base of a large cottonwood tree 300 feet southeast of the gage; elevation, 3.91 feet above the zero of the gage and 2,427.80 feet above sea level. (2) A nail in a telephone pole 30 feet northeast of the bridge; elevation, 7.57 feet above gage datum and 2,431.46 feet above sea level. This gage datum is 0.15 foot higher than that of 1903.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description; 99, pp 107-108; 130, p 103.
Discharge; 99, p 108; 130, p 104.
Discharge, monthly; 130, p 105.
Gage heights; 99, p. 108; 130, p. 104.
Rating table; 130, p 104.

Discharge measurements of Fort Belknap canal near Chinook, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 10	L. R. Stockman	30.0	51	1.00	2.83	51
April 22	do	33.5	55	1.17	2.92	64
May 19	H. M. Morse	28.0	46	1.01	2.70	46
June 16	Stockman and Prall	27.5	42	.67	2.60	28
July 1	H. M. Morse	36.0	63	1.08	3.18	68
July 12	C. T. Prall	28.0	42	.52	2.57	22
July 20	W. B. Freeman		14	.35	1.50	5
July 28	H. M. Morse		86	1.51	3.62	130
July 29	do		37	1.49	2.35	55
August 3	C. T. Prall		42	1.49	2.68	63
August 3[a]	do		56	1.22	3.00	68
August 8	W. B. Freeman		60	.98	3.16	59
August 15	H. M. Morse		41	.37	2.62	15
August 23	C. T. Prall				.65	[b] 1

[a] Affected by backwater from check in canal. [b] Estimated.

Daily gage heights, in feet, and discharge, in second-feet, of Fort Belknap canal near Chinook, Mont., for 1905.

Day.	March.		April.		May.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1			3.25	82	3.1	73	2.7	48	3.18	68	2.5	64
2			3.15	76	3.1	73	2.9	60		55	2.5	64
3			3.05	70	3.0	66	2.9	60	2.8	39	3.0	65
4			3.05	70	3.0	66	2.7	48	2.8	39	3.0	64
5			2.95	63	2.9	60	2.6	46	2.8	39	3.3	63
6			2.95	63	2.9	60	2.7	44	2.9	47	3.3	62
7			2.95	63	3.0	66	2.7	42	3.0	54	3.3	61
8			2.85	57	2.9	60	2.7	40	3.1	62	3.2	59
9			2.95	63	2.9	60	2.7	38	3.0	54	3.1	54
10			3.05	56	2.9	60	2.7	36	2.9	47	3.0	46
11			2.8	54	2.9	60	2.7	34	2.8	39	2.9	38
12			2.9	60	2.9	60	2.7	32	2.7	32	2.8	30
13			2.9	60	2.8	54		31	2.6	24		25
14			2.9	60	2.9	60		30	2.5	20		20
15			3.0	66	2.8	54		29	2.4	18	2.6	15
16			3.0	66	2.8	54	2.6	28		14	2.4	9
17			3.0	66	2.7	48		27		11	2.0	5
18			3.0	66	2.7	48		26		8	1.5	3
19			3.0	66	2.7	48	2.6	25		7	1.1	2
20			3.1	73	2.7	48	2.5	24	1.5	5	1.0	2
21			3.0	66	2.5	36	2.5	23		5	.9	2
22			2.92	64	2.7	48	2.5	22		4	.8	1
23			3.0	66	3.0	66	2.45	21		4	.7	1
24			3.0	66	3.1	73	2.45	20		4	.6	1
25			3.0	66	3.2	79		19		3	.6	1
26			3.0	66	3.1	73		18		3	.6	1
27	3.55	100	3.0	66	3.0	66		17		3	.6	1
28	3.45	94	2.9	60	2.9	60		16	3.62	130	.6	1
29	3.35	88	3.1	73	2.9	60		30	2.35	55	.6	1
30	3.25	82	3.2	79	2.8	54		40	2.6	70	.6	1
31	3.25	82			2.8	54			2.6	70	.6	1

Estimated monthly discharge of Fort Belknap canal near Chinook, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March 27–31	100	82	89	883
April	82	54	66	3,927
May	79	36	60	3,689
June	60	16	32	1,904
July	130	3	33	2,029
August	65	1	25	1,537
The period				13,970

RESER DITCH NEAR CHINOOK, MONT.

The Reser ditch diverts water from West Fork of Milk River at a point about 12 miles northwest of Chinook. The original dam and some dikes were constructed in 1900, but were destroyed by floods the same year. The present dam was built in 1904 and the ditch was completed and first used in April, 1905. It is designed to serve about 400 acres of land owned by A. H. and E. T. Reser.

A temporary gaging station was established July 10, 1905. It is located about 1 mile below the head-gates of the ditch.

A gage rod, which was observed by A. H. Reser, who furnished the records gratuitously, was driven into the bottom of the ditch about 10 feet above the measuring section. A bench mark was established on the chipped point of a large granite bowlder 75 feet south of the ditch and 250 feet west of the station; elevation of bench mark above the datum of the gage, 3.82 feet.

The ditch was dry during a considerable part of the irrigation season, and for this reason but two measurements of discharge were secured. It was visited five times between June 21 and August 2 by various employees of the Reclamation Service.

Discharge measurements of Reser ditch near Chinook, Mont., in 1905.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. ft.	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
July 10	C. T. Prall	8.6	0.69	2.50	5.9
August 2	W. B. Freeman	8.1	.79	2.53	6.4

Daily gage height, in feet, and discharge in second-feet of Reser ditch near Chinook, Mont., for 1905.

Day.	April.		May.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1	.....	.....	.....	3	.....	3	.....	0	2.6	7
2	.....	.....	.....	3	.....	3	.....	0	2.6	7
3	.....	.....	.....	3	.....	3	.....	0	2.6	7
4	.....	.....	.....	3	.....	3	.....	0	2.6	7
5	.....	.....	.....	3	.....	3	.....	0	2.6	6
6	.....	.....	.....	3	.....	3	.....	0	.....	6
7	.....	.....	.....	3	.....	3	.....	0	2.5	6
8	.....	.....	.....	3	.....	3	.....	0	2.5	6
9	.....	[a]3	.....	3	.....	3	.....	0	2.5	6
10	.....	3	.....	3	.....	3	2.5	6	.....	0
11	.....	3	.....	3	.....	3	.....	6	.....	0
12	.....	3	.....	3	.....	3	2.5	6	.....	0
13	.....	3	.....	3	.....	3	2.4	5	.....	0
14	.....	3	.....	3	.....	3	2.7	8	.....	0
15	.....	3	.....	3	.....	3	2.4	5	.....	0
16	.....	3	.....	3	.....	.....	2.3	4	.....	0
17	.....	3	.....	3	.....	.....	.....	0	.....	0
18	.....	3	.....	3	.....	.....	.....	0	.....	0
19	.....	3	.....	3	.....	.....	.....	0	.....	0
20	.....	3	.....	3	.....	.....	.....	0	.....	0
21	.....	3	.....	3	.....	0	.....	0	.....	0
22	.....	3	.....	3	.....	0	.....	0	.....	0
23	.....	3	.....	3	.....	0	.....	0	.....	0
24	.....	3	.....	3	.....	0	.....	0	.....	0
25	.....	3	.....	3	.....	0	.....	0	.....	0
26	.....	3	.....	3	.....	0	.....	0	.....	0
27	.....	3	.....	3	.....	0	.....	0	.....	0
28	.....	3	.....	3	.....	0	.....	0	.....	0
29	.....	3	.....	3	.....	0	.....	0	.....	0
30	.....	3	.....	3	.....	0	.....	0	.....	0
31	.....	.....	.....	3	.....	0	2.5	6	.....	0

[a] Estimated April 9–June 15.

Estimated monthly discharge of Reser ditch near Chinook, Mont., in 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 9–30	.....	.....	[a]3.0	131
May	.....	.....	[a]3.0	184
June 1–15	.....	.....	[a]3.0	90
July	8	0	1.5	92
August	7	0	1.9	114
The period	8	0	.....	611

[a] Estimated.

WEST FORK DITCH NEAR CHINOOK, MONT.

The West Fork ditch diverts water from West Fork of Milk River about 4 miles north of Chinook, Mont. In 1898 a dam was constructed at this point and a ditch which irrigated about 75 acres. The ditch was extended in subsequent years and now serves, it is claimed, several hundred acres of land. A new dam was constructed in 1904 near the original location. Several individuals were at first interested in the West Fork ditch, but it is now controlled exclusively by the Empire Cattle Company.

A temporary gaging station was established on this ditch June 16, 1905, about 200 feet below the head-gates.

A gage rod was driven into the bottom of the ditch at the measuring section. It was referred to a bench mark consisting of a 20-penny nail driven vertically into a 6 by 12 inch timber on the lower side of the head-gates at left bank; elevation above the datum of the gage, 5.50 feet.

An injunction was served on the owners of this ditch in the latter part of June and the water was turned off until July 11. Several measurements of discharge were made, the results of which are given below:

Discharge measurements of West Fork ditch near Chinook, Mont., in 1905.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. ft.	*Ft. per. sec.*	*Feet.*	*Sec.-ft.*
June 16	Prall and Stockman	7	0.84	2.80	5.9
July 11	Prall and Morse	14	.90	3.43	12.6
July 18	W. B. Freeman	.....	.....	1.70	[a]1
August 2	do	11.5	1.03	3.55	12.0
August 10	do	12.8	1.03	3.50	13.0
August 15	H. M. Morse	6.8	.97	2.90	6.6

[a] Estimated.

Daily gage heights, in feet, and discharge, in second-feet, of West Fork ditch near Chinook, Mont., for 1905.

Day.	June.		July.		August.	
	Gage height.	Dis-charge.	Gage height.	Dis-charge.	Gage height.	Dis-charge.
1	.....	a8.5	.....	0	.....	a12
2	.....	a8.5	.....	0	3.35	12.7
3	.....	a8.5	.....	0	.....	a12
4	.....	a8.0	.....	0	.....	a12
5	.....	a8.0	.....	0	.....	a12
6	.....	a8.0	.....	0	.....	a12
7	.....	a7.5	.....	0	.....	a13
8	.....	a7.5	.....	0	.....	a13
9	.....	a7.5	0	0	.....	a13
10	.....	a7.0	.....	a13	3.5	13
11	.....	a7.0	3.43	12	.....	a13
12	.....	a7.0	.....	a13	.....	a12
13	.....	a6.0	.....	a13	.....	a10
14	.....	a6.0	.....	a11	.....	a8.6
15	.....	a6.0	.....	a9	2.9	6
16	2.8	5.9	.....	a7	.....	a5
17	.....	4.3	.....	a0	.....	a4
18	.....	3.0	1.7	0.1	.....	0
19	.....	2.0	.....	0	.....	0
20	.....	1.0	.....	0	.....	0
21	0	0	.....	0	.....	0
22	.....	0	.....	0	.....	0
23	.....	0	.....	0	.0	0
24	.....	0	.....	0	.....	0
25	.....	0	.....	0	.....	0
26	.....	0	.....	0	.....	0
27	.....	0	.....	0	.....	0
28	.....	0	.....	0	.....	0
29	.....	0	.0	0	.....	0
30	.....	0	.....	0	.....	0
31	.....	.....	.....	12	.....	0

a Estimated.

Estimated monthly discharge of West Fork ditch near Chinook, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
June	8.5	0	4.2	250
July	13.0	0	2.9	179
August	13.0	0	5.9	364

DOWEN & BUCKLEY DITCH NEAR CHINOOK, MONT.

This ditch, which heads in Canada about 150 feet north of the international boundary, diverts water from North Fork of Milk River at a point about 30 miles north of Chinook, Mont.

Construction was begun on the dam and ditch in 1902, and the works now consist of an earth and rock dam, three flumes, and about 2 miles of ditch. About 40 acres of land were irrigated from the ditch in 1905, and it is probable that 150 acres will ultimately be reclaimed. The water filing attaching to this ditch is for a flow of 12 second-feet, but the

owners testified in a lawsuit that only 50 miner's inches, or 1.25 second-feet, have ever been diverted. September 20, 1905, the ditch was visited and a cross section and the slope were determined, from which the capacity of the ditch was estimated at 7.5 second-feet.

ROKITA DITCH NEAR CHINOOK, MONT.

The Rokita ditch diverts water from North Fork of Milk River at a point about 27 miles north of Chinook, Mont. The dam is well constructed of earth and rock, and the ditch is about 2 miles long. About 40 acres are irrigated at present, but more land will soon be brought under the ditch. Information is lacking in regard to the date and amount of water filing, as well as the date on which construction was commenced.

This ditch was visited September 20, 1905, and a cross section and the slope were measured, from which the capacity is estimated at 6 second-feet.

CORREGAN DITCH NEAR CHINOOK, MONT.

The Corregan dam is located in North Fork of Milk River at a point about 22 miles north of Chinook, Mont., and 8 miles below the Dowen & Buckley dam. The head-gates are 5 feet wide and 2.5 high, and the ditch is completed for 2 miles. The upper 1,500 feet are located in a slough, and the ditch is carried across North Fork in a flume about 150 feet long. An appropriation of 20 second-feet was made in October, 1901, and construction was begun on the ditch in 1902. About 55 acres of land are being served at present and probably 150 acres will eventually be irrigated from this ditch. Henry Corregan testified in court that he has used about 100 miner's inches, or 2.5 second-feet, since 1902.

The ditch was visited September 20, 1905, and cross sections and slopes were taken at two different points, from which the capacity of the ditch is estimated at 6 second-feet.

WINTER-ANDERSON CANAL NEAR CHINOOK, MONT.

This canal diverts water from the south side of Milk River at a point about 3 miles southeast of Chinook, Mont. Construction was begun in October, 1900, and a filing was made at that time for 100 second-feet of water. An appropriation of 12 second-feet, dating back to March, 1896, is also claimed for this ditch by Henry Winter. This appropriation was originally made by other parties, whose rights were acquired by Winter in September, 1896. Probably 2,500 acres could be irrigated from the Winter-Anderson canal, but it carried no water during 1905.

This canal was visited October 11, 1905, and from the cross section and slope which were then taken the capacity of the canal was estimated at 45 second-feet.

PARALLEL CREEK DITCHES NEAR HARLEM, MONT.

In the vicinity of Harlem, Mont., are a number of ditches used to divert water from Parallel Creek, a stream which usually discharges a large amount of water in March and April, but goes dry early in the season. A considerable body of land is irrigated from this creek.

The principal ditches are the Nystrom, Fox, Everett & Smith Company, and Forbes.

ROCK CREEK CANAL NEAR HINSDALE, MONT.

This canal is owned by a corporation composed of farmers in the lower Milk River Valley. It diverts water from the east side of Rock Creek, a tributary of Milk River from the north. The head-gates are situated about 7 miles north of Hinsdale, Mont , and the general course of the canal is southerly. The canal is used to irrigate extensive areas north of the river and east of Rock Creek.

The gaging station was established July 5, 1905. It is located about 300 feet below the head-gates of the canal.

The channel is straight for 100 yards above and 200 yards below the section. Both banks are nearly vertical and are composed of earth. The bed is composed of soft mud, with a

very small amount of vegetation, and probably shifts slightly. The current has a velocity of about 1 foot per second in ordinary stages.

Discharge measurements are made by wading about 10 feet below the gage. The initial point for soundings is a stake set in the west bank about 2 feet from the water's edge.

The gage, which was read twice each day by F. E. Halbert from the time of its establishment to the end of the irrigation season, is a vertical rod driven into the bed of the canal near the left bank. The gage is referred to bench marks as follows: (1) The head of a 10-penny nail driven into a notch cut in a large cottonwood tree 100 feet east of the gage; elevation, 8.43 feet above the datum of the gage. (2) The head of a 10-penny nail driven into a notch cut in a large cottonwood tree 150 feet northeast of the gage; elevation, 8.74 feet above the datum of the gage.

Discharge measurements of Rock Creek canal near Hinsdale, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
July 5	C. T. Prall	24.5	30.1	1.02	1.0	30.7
July 24	W. B. Freeman	21.5	9.4	.26	.19	2.5
August 12	do	21.5	13.1	.51	.3	6.7

Daily gage heights, in feet, and discharge, in second-feet, of Rock Creek canal, near Hinsdale, Mont., for 1905.

Day.	July.		August.		Day.	July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.		Gage height.	Discharge.	Gage height.	Discharge.
1	.....	31	1.25	41	17	0.68	18	0.2	0
2	.....	31	.95	29	18	.5	12	.....	0
3	.....	31	.9	27	19	.4	9	.....	0
4	.....	31	.8	23	20	.38	8	.....	0
5	1.0	31	.7	19	21	.3	6	.....	0
6	.95	29	.65	17	22	.25	5	.....	0
7	1.0	31	.58	15	23	.25	5	.....	0
8	.95	29	.5	12	24	.2	3	.....	0
9	.85	25	.42	9	25	.1	1	.....	0
10	.7	19	.4	9	26	1.4	48	.....	0
11	.65	17	.35	7	27	1.4	48	.....	0
12	.62	16	.3	6	28	1.25	41	.....	0
13	.5	12	.25	5	29	1.3	44	.....	0
14	.42	9	.2	3	30	1.3	44	.....	0
15	.4	9	.12	2	31	1.2	39	.....	0
16	.48	11	.08	1					

Estimated monthly discharge of Rock Creek canal near Hinsdale, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
July	48	1	22	1,353
August	41	0	7.3	438

SEEPAGE MEASUREMENTS.

MILK RIVER, MONTANA.

During the week beginning June 4, 1905, a series of measurements were made by L. R. Stockman, assistant engineer, along Milk River from the head-gates of the Milk River canal, located about 20 miles northwest of Sweet Grass, down the river to a point 2 miles below the Canadian police station. This distance is approximately 50 miles. Other measurements were made from the point where Milk River enters Montana as far down as Havre. This distance is about 60 miles.

Seepage measurements of Milk River, Montana, June, 1905.

Day.	Location.	Distance.[a]	Discharge.	Gain or loss.	
				Total.	Per mile.
		Miles.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
9	Head-gates	0	49.0	.....	.....
9	Milk River	10	56.5	+7.5	+0.75
10	Logan's ranch	16	51.4	−5.1	− .32
10	Young's ranch	10	47.2	−4.2	− .42
10	Sickler's ranch	14	43.9	−3.3	− .24
6	Canadian line	75	39.9	−4.0	− .053
6	Simpson's ranch	15	37.0	−2.9	− .20
5	Dam site	19	33.3	−3.7	− .20
5	Deserted ranch	15	41.6	+8.3	+ .55
5	Havre	10	44.6	+3.0	+ .30

[a] Distances from point to point, measured along the river.

CUTBANK CREEK, MONTANA.

August 21 and 22, 1905, a series of measurements were made by H. M. Morse, engineering aid, along Cutbank Creek, for the purpose of determining the seepage loss, from a point about 20 miles above the town of Cutbank, near the ranch of John Bird, to Cutbank.

Seepage measurements of Cutbank Creek, Montana, August, 1905.

Day.	Location.	Distance from Cutbank.	Discharge.	Gain or loss.	
				Total.	Per mile.
		Miles.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
21	John Bird's ranch	20	42.5	.....	.....
21	Gilham's ranch	15	37.0	−5.5	−1.1
21	Stockman's camp, 1 mile above Bud Ellison's ranch	11	40.6	+3.6	+ .9
22	2 miles below Bud Ellison's ranch	8	35.6	−5.0	−1.4
22	5 miles from Cutbank and 1 mile above point where reservation fence crosses creek	5	34.2	−1.4	− .47
22	Cutbank	0	33.0	−1.2	− .27

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements made in Milk River drainage basin in 1905.

Date.	Stream.	Locality.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
			Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 16	Milk River [a]	Yantic, Mont					[b] 1.0
July 1	do.[a]	do					[b] .2
July 12	do.[a]	do					[b] .2
July 20	do[a]	do					[b] .3
July 28	do.[a]	do					[b] .5
July 29	do.[a]	do					[b] 60
August 3	do.[a]	do					[b] 4.0
August 8	do.[a]	do					[b] 1.0
August 15	do.[a]	do					[b] .2
August 23	do.[a]	do					[b] .0
June 17	Milk River [c]	Chinook, Mont					[b] 3.0
June 24	do.[c]	do					[b] 3.0
July 8	do.[c]	do		127.0	1.07		136
July 15	do.[c]	do		7.4	.93		8.0
July 21	do.[c]	do					[b] 7.0
July 27	do.[c]	do					[b] 450
August 5	do.[c]	do					[b] 200
August 11	do.[c]	do		38.0	1.38		53
August 19	do.[c]	do					[b] 8.0
June 17	Milk River [d]	Zurich, Mont					[b] 1.5
June 24	do.[d]	do					[b] 2.0
July 8	do.[d]	do	108	184.0	.98		180
July 15	do.[d]	do					[b] 5.0
July 21	do.[d]	do					[b] 4.0
July 27	do.[d]	do					[b] 350
August 5	do.[d]	do	68	90.0	2.32		209
August 11	do.[d]	do	24	19.0	1.88		35
August 19	do.[d]	do					[b] 6.0
August 25	Agency ditch [e]	Fort Belknap Agency, Mont.		21.0	.68		15.0
July 14	Milk River [f]	Harlem, Mont					[b] 4.0
July 28	do.[f]	do	75	380.0	1.08		409
August 4	do.[f]	do					[b] 50
August 17	do.[f]	do					[b] 5.0
August 25	do.[f]	do					[b] 1.0
September 5	do.[f]	do					[b] 2.0
July 24	Milk River	Hinsdale, Mont					[b] 40
August 12	do	do					[b] 65
July 5	Rock Creek [g]	do		23.5	.62	2.0	14.0
July 24	do.[g]	do				1.58	[b] .5
August 12	do.[g]	do				1.6	[b] .5
July 18	West Fork of Milk River.[h]	Chinook, Mont					[b] 9.0
July 11	West Fork of Milk River.[i]	do					[b] 1.0
July 18	do.[i]	do					[b] 7.0

[a] Estimated just below the head of the Fort Belknap canal.
[b] Estimated.
[c] Measured just below the head of the Paradise Valley canal.
[d] Measured just below the head of the Harlem canal.
[e] Measured 1½ miles below head-gates.
[f] Measured just below head of the agency ditch.
[g] Measured just below head of the Rock Creek canal.
[h] Measured below head of the Reservation ditch.
[i] Measured below all diversions.

Miscellaneous discharge measurements made in Milk River drainage basin in 1905—Continued.

Date.	Stream.	Locality.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
			Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
July 28-29	West Fork of Milk River.[a]	Chinook, Mont					[b] 200.0
August 2	do.[a]	do		36.0	0.67		24.0
August 8	do.[a]	do		87.0	.44		38.0
August 10	do.[a]	do		33.0	.60		20.0
August 11	do.[a]	do					[b] 15.0
August 15	do.[a]	do					[b] 5
August 23	do.[a]	do					[b] 5

[a] Measured below all diversions. [b] Estimated.

MUSSELSHELL RIVER DRAINAGE BASIN.

MUSSELSHELL RIVER AT SHAWMUT, MONT.

Musselshell River heads in the Little Belt Mountains, not far from White Sulphur Springs, Meagher County, Mont., runs eastward between the Big Snowy Mountains and the Bull Mountains in a course approximately parallel to that of the Yellowstone to about 107° 30′ west longitude, and then turns northward to the Missouri.

The gaging station was established August 12, 1902, for the purpose of determining the amount of water available for irrigation and storage. It is located at Crawford's ranch, one-eighth mile from the post-office at Shawmut, Mont., and 25 miles east of Harlowtown.

The channel is straight for 150 feet above and below the station. The right bank is high and steep and covered with brush; the left is comparatively high and but slightly wooded; both banks may overflow at extreme high water. There is but one channel at all stages.

Discharge measurements are made by means of a cable and car at the new gage. The initial point for soundings is the center of the post supporting the right end of the cable.

The gage is read once each day by Dwight E. Crawford. The original gage was a vertical rod spiked to a cottonwood stump on the right bank of the river, about 200 feet north of Mr. Crawford's house. April 22, 1905, a new rod gage was set into the right bank 400 feet below the old gage, the datum being 1.01 feet below that of the original gage. As the fall of the river is only 0.72 foot between the two points, the new gage reads 0.29 foot greater than the old one; readings for years previous to 1905, to be referred to the new datum, must therefore be increased by that amount. The gage is referred to bench marks as follows: (1) A 30-penny spike below a blaze in an 18-inch cotton wood tree, which stands at the corral fence 75 feet northeast of the old gage rod; elevation, 5.91 feet above zero of the old gage and 6.92 feet above zero of the new gage. (2) A 10-penny spike in a 6-inch cottonwood tree 60 feet southeast of the old gage rod; elevation, 6.14 feet above zero of the old gage and 7.15 feet above zero of the new gage. (3) A bolt in the post supporting the measuring cable at the right bank, established April 22, 1905; elevation, 4.87 feet above zero of the new gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey.

Description: 84, p 31; 99, pp 111-112; 130, p 113.
Discharge: 130, p 114.
Gage heights: 84, p 32; 99, p 112; 130, p 114.

Discharge measurements of Musselshell River at Shawmut, Mont., 1904–5.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1904.		*Feet.*	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec. ft.*
November 8	L. R. Stockman	.....	53	1.38	[a] 1.44	74
1905.						
April 23	J. H. Sloan	55	69	.95	1.01	66
May 15	do	55	70	1.18	1.20	83
June 20	do	72	159	2.35	2.25	376
August 7	do	63	61	.98	1.00	60
September 22 [b]	do	.....	1.6	1.10	.40	1.8

[a] Referred to new datum. [b] Made at different section.

Daily gage height, in feet, of Musselshell River at Shawmut, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.45	1.6	1.9	1.2	0.95	1.6	2.5	2.4	0.55	0.45	0.95	1.1
2	1.45	1.6	1.6	1.2	.9	1.9	2.3	2.0	.55	.45	1.0	1.1
3	1.45	1.6	1.6	1.2	.9	2.3	2.1	1.85	.55	.45	1.1	1.1
4	1.45	1.6	1.55	1.2	1.0	2.6	1.9	1.5	.55	.45	1.05	1.1
5	1.45	1.6	1.5	1.2	1.05	4.58	1.8	1.3	.55	.45	1.05	1.1
6	1.45	1.6	1.5	1.2	1.05	3.78	1.7	1.15	.55	.45	1.05	1.1
7	1.45	1.65	1.55	1.2	1.05	3.4	1.5	1.1	.55	.45	1.05	1.1
8	1.45	1.7	1.5	1.2	1.0	3.4	1.3	.95	.55	.45	1.05	1.1
9	1.45	1.7	1.4	1.3	1.0	4.13	1.3	.85	.5	.45	1.05	1.1
10	1.45	1.7	1.4	1.3	1.0	3.2	1.2	.8	.5	.45	1.05	1.1
11	1.45	1.7	1.3	1.3	1.55	3.6	1.05	.75	.5	.5	1.05	1.1
12	1.45	1.7	1.2	1.3	1.5	3.3	.9	.75	.5	.5	1.05	1.1
13	1.45	1.7	1.2	1.3	1.4	3.3	.8	.7	.45	.5	1.05	1.1
14	1.45	1.7	1.1	1.25	1.3	3.25	.7	.7	.45	.6	1.04	1.1
15	1.45	1.7	1.4	1.25	1.2	3.1	.65	.65	.45	.6	1.04	1.1
16	1.45	1.7	1.3	1.25	1.15	2.75	.6	.65	.45	.6	1.04	1.1
17	1.45	1.7	1.3	1.25	1.1	2.7	1.9	.65	.45	.6	1.0	1.1
18	1.45	1.7	1.3	1.2	1.1	2.6	.8	.65	.45	.7	1.0	1.1
19	1.45	1.7	1.3	1.2	1.2	2.4	.65	.6	.45	.8	1.01	1.1
20	1.45	1.7	1.3	1.2	1.3	2.2	.6	.6	.45	.8	1.01	1.1
21	1.45	1.7	1.25	1.15	1.3	2.1	.6	.6	.45	1.0	1.0	1.1
22	1.5	1.7	1.25	1.15	1.3	2.2	.55	.6	.45	1.1	1.0	1.1
23	1.5	1.75	1.2	.95	1.3	2.3	.55	.6	.4	1.0	.9	1.1
24	1.5	1.8	1.2	1.0	1.3	2.35	.55	.6	.4	1.05	.9	1.05
25	1.5	1.8	1.2	1.0	1.3	2.4	.55	.6	.4	1.05	.9	1.0
26	1.5	1.8	1.2	1.0	1.3	2.4	.85	.6	.4	1.0	1.0	1.0
27	1.5	1.9	1.2	1.0	1.3	2.6	.7	.6	.4	1.0	1.1	1.0
28	1.5	2.05	1.2	.95	1.3	2.45	.7	.6	.4	1.0	1.1	1.0
29	1.6	.....	1.2	.95	1.5	2.25	.9	.55	.4	.9	1.1	1.0
30	1.6	.....	1.2	.95	1.5	2.1	.9	.55	.4	.9	1.1	1.0
31	1.6	.....	1.2	.....	1.5	.....	4.18	.55	.....	.8	.....	1.0

NOTE.—All gage heights refer to the datum established April 22, 1905.
From January 1 to February 12 the river was frozen entirely across; from February 13 to February 28 there was an open channel; the river was clear on March 1. Average thickness of ice, 0.8 foot. The river was frozen also from November 27 to December 31. Thickness of ice, 0.6 foot, approximately. During frozen period gage heights are to the top of the ice.

LITTLE MUDDY RIVER DRAINAGE BASIN.

LITTLE MUDDY RIVER NEAR WILLISTON, N. DAK.

Little Muddy River rises in the northwestern part of Williams County, N. Dak., and flows southward into Missouri River at Williston.

The gaging station was established February 4, 1904. It is located in sec. 19, T. 155 N., R. 100 W., the gage in the southwest quarter and the cable in the northeast quarter, about 7 miles by road from Williston, N. Dak.

The channel is straight for about 200 feet above and 1,700 feet below the station. Both banks are high and clean and do not overflow. The bed of the stream is composed of silt and is fairly permanent. There is but one channel at all stages, and the current is sluggish.

Discharge measurements are made at high stage by means of a cable, car, and tagged wire. The initial point for soundings is a point 0.5 foot behind the top of the cable support at the right bank. At low stages measurements are made by wading a few rods below the gage.

A standard chain gage, which was read during 1905 by W. O. Hollar, is attached to a timber projecting horizontally over the stream near the house of the observer. The length of the chain is 22.23 feet. The gage is referred to bench marks as follows: (1) A post driven flush with the surface of the ground under the projecting timber of the gage and marked with a brass-headed nail in the top; elevation above the datum of the gage, 2.92 feet. (2) A horizontal line of four medium-sized spikes driven into the end of a log in the wall of the log house about 4 rods west of the chain gage at the corner nearest to it and about 3 feet above ground; elevation above gage datum, 13.00 feet.

An inclined rod gage reading from 1.8 to 10.3 feet was established about 6 rods above the chain gage.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No 130 of the United States Geological Survey, pages 114–117.

Discharge measurements of Little Muddy River near Williston, N. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 5	F. C. Davis	8.0	6.9	2.32	2.60	16.0
April 25[a]	Chandler and Turner	22	9.8	0.97	2.50	9.5
April 25	do	7.8	5.3	1.72	2.45	9.1
April 25[a]	do	15.5	6.2	1.47	2.45	9.1
May 23	R. Richards	8.5	7.2	2.43	2.54	17.5
June 22	F. C. Davis	8.0	7.2	2.12	2.50	15.3
July 25	Hanna and Chandler	8.0	6.8	1.71	2.57	11.6
September 20	E. F. Chandler	7.5	4.5	1.32	2.39	5.9

[a] Made at different section.

Daily gage height, in feet, of Little Muddy River near Williston, N. Dak., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	3.9	2.6	2.5	2.5	2.6	2.5	2.4	2.6	2.5
2	3.9	2.6	2.5	2.5	2.6	2.5	2.5	2.6	2.5
3	3.9	2.6	2.5	2.5	2.6	2.5	2.5	2.6	2.5
4	3.9	2.5	2.5	2.55	2.6	2.5	2.5	2.5	2.5
5	3.8	2.5	2.5	3.2	2.6	2.5	2.4	2.5	2.5
6	3.6	2.5	2.5	3.45	2.6	2.5	2.4	2.5	2.5
7	3.5	2.5	2.5	3.2	2.6	2.5	2.4	2.5	2.5
8	3.2	2.5	2.5	3.1	2.6	2.5	2.4	2.5	2.5
9	3.0	2.5	2.5	2.95	2.6	2.5	2.4	2.5	2.5
10	3.0	2.4	2.5	2.8	2.6	2.5	2.4	2.5	2.5
11	2.9	2.4	2.5	2.8	2.6	2.4	2.4	2.5	2.5
12	2.9	2.4	2.5	2.7	2.6	2.4	2.4	2.5	2.5
13	2.9	2.4	2.5	2.6	2.6	2.4	2.4	2.5	2.5
14	2.9	2.4	2.5	2.6	2.6	2.4	2.4	2.5	2.5
15	2.8	2.4	2.5	2.6	2.6	2.4	2.4	2.5	2.5
16	2.8	2.4	2.5	2.6	2.6	2.4	2.4	2.5	2.5
17	2.8	2.4	2.5	2.6	2.6	2.4	2.4	2.5	2.5
18	2.7	2.4	2.5	2.6	2.6	2.4	2.4	2.5	2.5
19	2.8	2.5	2.5	2.5	2.6	2.4	2.4	2.5	2.5
20	2.7	2.5	2.5	2.6	2.6	2.4	2.4	2.5	2.5
21	2.7	2.5	2.5	2.6	2.6	2.4	2.4	2.5	2.5
22	2.7	2.5	2.5	2.5	2.6	2.4	2.4	2.5	2.5
23	2.7	2.5	2.5	2.5	2.6	2.4	2.4	2.5	2.6
24	2.6	2.5	2.5	2.5	2.5	2.4	2.4	2.5	2.6
25	2.6	2.5	2.5	2.5	2.6	2.4	2.4	2.5	2.6
26	2.6	2.5	2.5	2.5	2.6	2.4	2.4	2.5	2.6
27	2.6	2.5	2.5	2.5	2.6	2.4	2.4	2.5	2.6
28	2.6	2.5	2.5	2.65	2.5	2.4	2.4	2.5	2.5
29	2.6	2.5	2.5	2.65	2.5	2.4	2.4	2.5	2.5
30	2.6	2.5	2.5	2.6	2.5	2.4	2.4	2.5	.....
31	2.6	.....	2.5	.....	2.5	2.4	.....	2.5	.....

NOTE.—River frozen over January 1 to February 28; also November 30 to December 31.

Station rating table for Little Muddy River near Williston, N. Dak., from February 1, 1904, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.40	6	3.40	137	4.30	423	5.20	794
2.50	10	3.50	162	4.40	461	5.30	839
2.60	16	3.60	189	4.50	500	5.40	885
2.70	23	3.70	218	4.60	539	5.50	932
2.80	32	3.80	249	4.70	579	5.60	980
2.90	43	3.90	281	4.80	620	5.70	1,030
3.00	57	4.00	315	4.90	662	5.80	1,082
3.10	74	4.10	359	5.00	705	5.90	1,135
3.20	93	4.20	386	5.10	749	6.00	1,189
3.30	114						

The above table is applicable only for open-channel conditions. It is based on 13 discharge measurements made during 1904-5. It is fairly well defined between gage heights 2.4 feet and 5.4 feet; above 6 feet it is estimated.

Estimated monthly discharge of Little Muddy River near Williston, N. Dak., for 1905.

[Drainage area, 800 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March	200	16	58.8	3,615	0.074	0.085
April	16	6	9.4	559	.012	.013
May	10	10	10.0	615	.012	.014
June	150	10	28.1	1,672	.035	.039
July	16	10	15.0	922	.019	.022
August	10	6	7.3	448	.0091	.010
September	10	6	6.4	381	.0080	.0089
October	16	10	10.6	652	.013	.015
November	16	10	11.0	633	.014	.015
The period				9,500		

YELLOWSTONE RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

The upper Yellowstone rises in the Shoshone Mountains, in northwestern Wyoming, near the southeast corner of the Yellowstone National Park, flows northwestward for 40 or 50 miles, and then enters Yellowstone Lake, which may be considered the great source of the main river. This lake is about 15 miles long by 20 miles wide, lies at an elevation of 7,778 feet above the sea, and is hemmed in on every side by lofty mountains from whose snow-covered slopes its chief supply of water must come, since it receives no important streams. Issuing from the lake at the north end, the stream flows northwestward for 10 or 15 miles, plunges over the Great Falls of the Yellowstone, and for the next 20 miles runs through the Grand Canyon, which is impassable throughout. About 80 miles from the lake it emerges from the Snow Mountains, and thence runs eastward and northeastward until it joins the Missouri at Fort Buford, N. Dak.

As it leaves the mountains the river is about 600 feet wide and 6 feet deep; thence to Clark Fork, which enters from the south about 15 miles above Billings, Mont., it is characterized by bold, sweeping curves and many islands. Between Clark Fork and the mouth of the Bighorn it is from 1,500 to 1,800 feet wide, is free from rapids, and has a current of 3 to 4 miles an hour. Between the Bighorn and the Powder the main stream increases in width to from 2,400 to 2,700 feet, and becomes turbid like the Missouri. Below the mouth of the Powder the banks are low and caving, and the stream contains some rapids and shoals and numerous densely timbered islands.

The length of the Yellowstone is about 500 miles; the area of the basin is approximately 67,500 square miles.

Of the tributaries of the Yellowstone the most important is the Bighorn, which has its source in the many small streams draining the intersecting slopes of the Wind River and Shoshone mountains in northwestern Wyoming, about 30 miles southeast of Yellowstone National Park. For approximately 75 miles it flows southeastward, its volume being constantly augmented by small streams from the south heading well back in the Wind River Range, but receiving no important additions from the north. In this portion of its course it is called Wind River; but at its southernmost point it is joined by Little Wind River, turns abruptly to the northeast, and is below known as the Bighorn. Continuing in a winding course for about 15 miles, it then turns directly north, passes through a deep canyon in the Owl Creek Range, crosses Bighorn County, Wyo., into Montana, and joins the Yellowstone about 30 miles north of Fort Custer. The basin is almost surrounded by high mountain

ranges, including the Shoshone and Owl Creek mountains on the north of Wind River, the Wind River, Sweetwater, and Granite ranges on the west and south, and to the east a low range of broken hills which extend to the high plateau forming the divide between the Bighorn and the Powder and North Platte river basins. The reduced Shoshone Indian Reservation is drained by Wind River, while the Crow Reservation is located near the mouth of the Bighorn. On the Indian lands several large canals are being constructed and the science of irrigation is being taught. The soil on the Rocky Mountain slopes is generally a sandy loam, but in the narrow tributary valleys the soil is deeper and of an alluvial character.

The principal tributaries of the Bighorn are, first, Wind, Little Wind, and Popo Agie rivers, which combined carry the great perennial discharge and become the head waters; below the mouth of the Little Wind are Muskrat, Poison, and Badwater creeks, which drain the sand hills to the east, Muddy Creek, which follows the foothills of the Owl Creek Range, Gooseberry Creek, Gray Bull Creek, No Wood Creek, and Shoshone and Little Bighorn rivers.

The Shoshone rises on the eastern slope of the Shoshone Mountains, east of the Yellowstone National Park. It has two chief upper branches, North and South forks, which unite just before entering Shoshone Canyon, at a point about 12 miles southwest of Cody. From the junction of the forks the course of the main river is a little east of northeast to the Bighorn. The head-water region is very mountainous, many of the peaks, which are never entirely free from snow, rising to elevations of nearly 11,000 feet. The valley of North Fork is very narrow and the area of agricultural land in its lower reaches comprises but a few hundred acres. The valley of South Fork is perhaps 2 miles wide at its mouth, gradually narrowing for 10 or 15 miles until it becomes a gulch or canyon. There are 2,000 or 3,000 acres of land under some stage of cultivation. From these two forks the Shoshone receives 99 per cent of all the run-off carried by the stream at any point. The lower basin, on the north of the river, soon flattens out to a low plain with a gentle slope to the southeast; to the south there is a small level bench immediately below Cody, which is soon closed in by a broken headland, spreading out again farther downstream, where another large tract of irrigable land is to be found. Throughout its length the Shoshone is a rapid stream, the fall being very great. On the first benches the soil is a sandy loam resting upon gravel. Salt sage and an extremely light growth of grasses cover the valleys. The site of the Shoshone storage dam, one of the projects of the Reclamation Service, is in Shoshone Canyon about 6 miles west of Cody.

Information in regard to this basin is contained in Annual Reports of the United States Reclamation Service and in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin):

Description: Ann 11, ii, pp 36-38; 12, ii, pp 237-238; 20, iv, pp 246-247; 21, iv, p 190; Bull 131, p 26.
Irrigation surveys: Ann 13, iii, pp 63-73.
Rainfall data: Ann 13, iii, pp 67-68.

YELLOWSTONE RIVER NEAR LIVINGSTON, MONT.

This station was established May 2, 1897. It is located at Carter's bridge, 5 miles south of Livingston, Mont., at the mouth of the lower canyon.

The channel is straight for 100 yards above and below the station. The right bank is low and in flood season a part of the water escapes through a slough on that side, beginning at gage height 4.65 feet. This water is measured separately at the bridge over the slough 125 yards away. The left bank is high and will not overflow. The current is swift.

Discharge measurements are made from the downstream side of the bridge. At high water a stay line is necessary to keep the meter submerged. The initial point for soundings is marked on the guard rail 2 feet east of the center of the northwest pier, which is at the left bank.

Gage readings are taken once each day by Mrs. W. O. Cowan. A vertical rod was first installed, but was replaced by a wire gage located on the lower side of the east span. January 1, 1903, the gage datum was lowered 3 feet, increasing all subsequent readings by that

amount. In April, 1904, the wire gage was replaced by a standard chain gage having the same datum. The length of the chain is 20.77 feet. The gage is referred to bench marks as follows: (1) The head of a 2-inch nut on the center pin at the foot of the end diagonal of the upstream truss of the east pier; elevation, 17.60 feet above the new datum. (2) A white paint mark on the corner of the top of the shoe at the foot of the batter post on the east end of the upstream side of the bridge; the batter post is marked in white paint "B. M. 14.20," it is also marked in red paint "17.20;" elevation above the new gage datum, 17.20 feet.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann = Annual Report; WS = Water-Supply Paper):

Description: WS 15, p 74; 27, p 69; 37, pp 210–211; 49, p 268; 66, p 22; 84, pp 24–25; 99, p 97; 130, p 117.
Discharge: Ann 20, iv, p 247; WS 15, p 74; 37, p 211; 49, p 268; 66, p 22; 84, p 25; 99, p 98; 130, p 118.
Discharge: monthly; Ann 19, iv, p 289; 20, iv, p 248; 22, iv, p 289; WS 75, p 122; 84, p 26; 99, p 99; 130, p 119.
Discharge, yearly: Ann 20, iv, p 53.
Gage heights: WS 15, p 74; 27, p 73; 37, p 211; 49, p 268; 66, p 22; 84, p 25; 99, p 98; 130, p 118.
Hydrographs: Ann 19, iv, p 289; 20, iv, p 248; 22, iv, p 290; WS 75, p 123.
Rating tables: Ann 19, iv, p 288; WS 27, p 76; 52, p 516; 66, p 170; 84, p 26; 99, p 99; 130, p 119.

Discharge measurements of Yellowstone River near Livingston, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 29	L. R. Stockman	160	426	2.56	1.80	1,089
April 29	J. H. Sloan	179	567	3.68	2.56	2,082
May 13	do	178	543	3.50	2.50	1,900
June 6	do		1,478	6.93	6.41	10,250
July 3	do	235	1,440	6.63	6.20	9,548
August 1	do	188	842	5.05	4.12	4,252
August 30	do	182	784	3.94	3.05	3,090
September 20	do	179	540	3.49	2.52	1,884
October 28	do		490	3.13	2.19	1,536

Daily gage height, in feet, of Yellowstone River near Livingston, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.7	1.3	1.9	1.8	2.35	5.85	6.2	3.95	2.9	2.5	1.95	1.85
2	1.7	5.35	1.8	1.8	2.5	6.35	6.2	3.95	2.8	2.45	1.95	1.85
3	1.7	4.9	1.8	1.8	2.6	6.8	6.1	3.85	2.8	2.45	1.95	1.85
4	1.85	4.25	1.85	1.8	2.45	7.15	6.0	3.85	2.75	2.45	1.95	1.95
5	1.7	4.1	1.85	1.8	2.35	7.4	5.9	3.85	2.75	2.4	1.95	1.9
6	1.7	2.3	1.85	1.8	2.25	6.4	5.7	3.8	2.7	2.4	1.95	1.95
7	1.7	2.0	1.9	1.9	2.35	6.2	5.7	3.75	2.7	2.35	2.0	1.9
8	1.7	1.8	1.9	2.0	2.5	6.85	5.5	3.5	2.7	2.35	2.0	1.9
9	1.5	1.7	1.9	2.1	2.85	7.25	5.3	3.5	2.7	2.35	2.0	1.7
10	1.6	1.5	1.85	2.1	2.8	6.7	5.3	3.5	2.65	2.3	2.0	1.6
11	1.5	1.25	1.8	1.9	2.6	6.4	5.25	3.5	2.6	2.2	2.0	1.6
12	1.2	1.25	1.8	1.9	2.5	6.6	5.2	3.5	2.6	2.2	1.95	1.7
13	1.2	1.25	1.8	1.9	2.5	7.0	5.15	3.5	2.6	2.2	1.95	1.7
14	1.7	1.5	1.9	1.9	2.4	7.2	5.0	3.45	2.6	2.2	1.9	1.6
15	1.9	1.6	1.9	1.95	2.45	6.85	4.9	3.4	2.6	2.2	1.9	1.7
16	1.9	1.6	1.8	1.95	2.5	6.4	5.0	3.35	2.55	2.25	1.8	1.7
17	1.8	1.6	1.85	1.95	2.65	6.2	4.9	3.3	2.5	2.2	1.8	1.8
18	1.9	1.6	1.85	1.95	3.5	6.2	4.7	3.3	2.5	2.2	1.8	1.8
19	1.75	1.65	1.9	2.0	3.4	6.0	4.65	3.2	2.5	2.1	1.8	1.85
20	1.9	1.75	1.95	2.0	3.4	5.8	4.6	3.15	2.5	2.1	1.8	1.9
21	1.9	1.8	1.95	2.1	3.4	5.75	4.55	3.1	2.45	2.2	1.8	1.7
22	1.9	1.8	1.8	2.1	3.5	6.5	4.45	3.1	2.45	2.15	1.8	1.65
23	1.9	1.7	1.85	2.1	3.6	6.2	4.4	3.0	2.35	2.15	1.8	1.4
24	1.9	1.75	1.7	2.2	3.6	6.4	4.3	3.0	2.35	2.15	1.85	1.3
25	1.9	1.85	1.7	2.4	3.6	6.3	4.25	3.0	2.4	2.2	2.00	1.4
36	1.85	1.95	1.7	2.5	3.8	6.5	4.2	3.0	2.4	2.2	1.95	1.65
27	1.85	1.85	1.7	2.75	3.9	6.75	4.15	3.0	2.35	2.2	1.9	1.6
28	1.85	1.85	1.8	2.75	3.85	6.85	4.1	3.0	2.35	2.2	1.75	1.5
29	1.8	.....	1.8	2.5	4.25	6.5	4.05	2.95	2.35	2.1	1.45	1.6
20	1.75	.....	1.85	2.45	4.55	6.4	4.0	2.9	2.5	2.1	1.6	1.55
31	1.5	.....	1.8	.....	4.95	.....	3.95	2.9	.....	2.0	.....	1.6

NOTE.—Ice conditions February 2-14 Gage heights are to the top of the ice.

Station rating table for Yellowstone River near Livingston, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	500	2.40	1,760	3.80	3,720	5.40	7,120
1.10	560	2.50	1,890	3.90	3,880	5.60	7,680
1.20	630	2.60	2,020	4.00	4,060	5.80	8,280
1.30	700	2.70	2,150	4.10	4,240	6.00	8,900
1.40	770	2.80	2,280	4.20	4,420	6.20	9,540
1.50	850	2.90	2,410	4.30	4,600	6.40	10,200
1.60	930	3.00	2,550	4.40	4,800	6.60	10,880
1.70	1,020	3.10	2,690	4.50	5,000	6.80	11,580
1.80	1,110	3.20	2,830	4.60	5,200	7.00	12,300
1.90	1,200	3.30	2,970	4.70	5,420	7.20	13,060
2.00	1,300	3.40	3,110	4.80	5,640	7.40	13,820
2.10	1,400	3.50	3,250	4.90	5,860		
2.20	1,520	3.60	3,400	5.00	6,100		
2.30	1,640	3.70	3,560	5.20	6,600		

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1904-5, and is well defined throughout.

Estimated monthly discharge of Yellowstone River near Livingston, Mont., for 1905.

[Drainage area, 3,580 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	1,200	630	1,054	64,810	0.294	0.339
February (15 days)	1,250	700	1,032	30,700	.288	.161
March	1,250	1,020	1,139	70,040	.318	.367
April	2,215	1,110	1,396	83,070	.390	.435
May	5,980	1,580	2,752	169,200	.769	.887
June	13,820	8,130	10,670	634,900	2.98	.332
July	9,540	3,970	6,180	380,000	1.73	1.99
August	3,970	2,410	3,068	188,600	.857	.988
September	2,410	1,700	1,975	117,500	.552	.616
October	1,890	1,300	1,572	96,660	.439	.506
November	1,300	930	1,190	70,810	.332	.370
December	1,250	700	1,025	63,030	.286	.330
The period				1,969,000		

NOTE.—No estimate for ice period.

YELLOWSTONE RIVER NEAR BILLINGS, MONT.

This station was established May 29, 1904. It is located at the county highway bridge about 2 miles east of Billings and 200 feet below the Northern Pacific Railway bridge. A river gage is also maintained by the Department of Agriculture at the second highway bridge above, about 4 miles west of the Geological Survey station.

The channel is straight for 200 feet above and 400 feet below the station. The right bank is of gravel, slopes gradually back from the channel, and is not subject to overflow. The left bank is low and sandy, overflowing in extremely high water. The bed of the stream is composed of gravel and is free from vegetation. There is but one channel at all stages, and the current is swift. The masonry piers of the railway bridge, 200 feet above, and an island, 400 feet below, have considerable effect on the direction of the current.

Discharge measurements are made from the lower side of the bridge, which has three spans resting on steel-jacketed concrete piers. The initial point for soundings is on the left side of the bridge.

A standard chain gage, which is read twice each day by James E. Dickie, is attached to the bridge near the middle of the first span from the west bank. The length of the chain is 27.95 feet. The gage is referred to bench marks as follows: (1) The top of the third course of stone in the left abutment of the Northern Pacific Railway bridge; elevation above the datum of the gage, 18.99 feet. (2) The top of a nail on the end of the second bent from the west end of the highway bridge on the downstream end of the bent sill; elevation, 18.21 feet above the datum of the gage.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 120–122.

Discharge measurements of Yellowstone River near Billings, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 25	L. R. Stockman	282	1,627	1.45	1.30	2,357
April 27	J. H. Sloan	318	1,842	1.95	2.00	3,603
May 12	do	325	2,099	2.48	3.10	5,217
June 8	do	455	4,177	5.43	8.26	22,680
June 28	do	458	4,554	6.25	9.19	28,450
July 20	do	391	2,618	3.95	4.90	10,340
August 14	do	324	2,240	3.06	3.40	6,856
September 12	do	319	1,771	2.32	2.38	4,107
October 11	do	287	1,666	1.77	1.83	2,944
October 20	Morse and Sloan	318	1,762	2.12	2.10	3,733

Daily gage height, in feet, of Yellowstone River near Billings, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.1	4.1	5.0	0.9	2.0	6.2	8.6	4.25	2.6	2.3	2.0	2.0
2	1.1	4.1	4.95	.85	2.3	6.75	8.35	4.4	2.6	2.3	2.0	2.0
3	1.1	4.1	4.9	.8	2.3	7.2	8.05	4.15	2.6	2.3	2.0	2.0
4	1.1	4.1	4.7	.9	2.5	8.4	8.0	4.15	2.6	2.2	2.0	2.0
5	1.1	4.1	4.55	1.0	2.5	9.6	8.0	4.15	2.5	2.2	2.0	2.0
6	1.1	4.1	4.05	1.0	2.5	9.4	7.75	4.0	2.5	2.1	2.0	2.0
7	1.1	4.1	3.8	1.1	2.5	8.1	7.3	4.15	2.5	2.1	2.0	2.0
8	1.1	4.1	3.4	1.1	2.5	8.25	7.15	3.95	2.4	2.2	2.0	2.0
9	1.1	4.1	2.9	1.5	2.5	9.6	7.0	3.55	2.3	2.25	2.0	2.0
10	1.1	4.1	2.6	1.8	3.25	9.7	6.7	3.5	2.25	2.2	2.0	2.0
11	4.4	4.1	2.2	1.8	3.25	8.7	6.8	3.5	2.2	2.0	1.95	2.0
12	4.4	4.1	1.8	1.8	3.0	8.55	6.55	3.4	2.2	2.05	1.9	2.0
13	4.4	4.1	1.8	1.7	3.2	9.7	6.55	3.45	2.2	2.1	1.9	2.0
14	4.4	4.1	1.8	1.5	3.05	9.8	6.1	3.4	2.2	2.0	1.9	2.0
15	4.4	4.1	1.8	1.5	2.8	9.6	6.0	3.25	2.2	2.0	1.9	2.0
16	4.4	4.5	1.8	1.5	2.5	8.8	6.15	3.15	2.2	2.0	1.9	2.0
17	4.1	5.0	1.8	1.6	2.1	8.55	6.25	3.1	2.2	2.05	1.8	1.9
18	4.1	5.3	1.8	1.7	2.0	8.25	5.65	3.1	2.2	2.2	1.8	1.9
19	4.1	5.5	1.8	1.8	3.7	7.65	5.3	3.2	2.2	2.2	1.8	1.9
20	4.1	5.5	1.6	1.8	4.1	7.1	5.35	3.0	2.2	2.2	1.8	1.8
21	4.1	5.5	1.6	1.8	2.75	7.1	5.5	2.85	2.2	2.1	1.9	1.8
22	4.1	5.5	1.45	1.85	2.6	7.4	5.6	2.7	2.0	2.0	1.9	1.6
23	4.1	5.5	1.4	1.9	3.45	8.15	5.5	2.7	2.0	2.0	1.9	1.6
24	4.1	5.5	1.4	1.95	4.2	8.5	4.6	2.65	2.0	2.0	1.9	1.5
25	4.1	5.5	1.4	1.8	4.05	8.4	4.5	2.7	2.0	2.0	1.9	1.5
26	4.1	5.5	1.4	1.8	3.8	8.4	4.5	2.7	2.0	2.0	1.9	1.45
27	4.1	5.5	1.4	2.0	3.95	8.9	4.45	2.6	2.0	2.0	1.9	1.4
28	4.1	5.5	1.3	2.2	4.2	9.4	4.45	2.6	2.0	2.0	2.0	1.3
29	4.1	.....	1.2	2.5	4.1	8.85	4.25	2.6	2.25	2.0	2.0	1.3
30	4.1	.....	1.0	2.25	4.6	8.65	4.25	2.65	2.4	2.0	2.0	1.3
31	4.1	.....	1.0	.....	5.5	.....	4.2	2.7	.....	2.0	.....	1.3

NOTE.—Ice conditions January 1 to March 11; readings to the top of the ice. January 11 to February 22 the river was gorged below the station; thickness of ice increased from 0.2 foot to 1.8 feet. River frozen November 29 to December 31.

Station rating table for Yellowstone River near Billings, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	1,800	2.70	4,860	4.40	8,790	7.20	18,470
1.10	1,940	2.80	5,085	4.50	9,050	7.40	19,340
1.20	2,085	2.90	5,310	4.60	9,320	7.60	20,250
1.30	2,235	3.00	5,535	4.70	9,600	7.80	21,200
1.40	2,390	3.10	5,760	4.80	9,890	8.00	22,190
1.50	2,550	3.20	5,985	4.90	10,190	8.20	23,190
1.60	2,715	3.30	6,210	5.00	10,500	8.40	24,190
1.70	2,885	3.40	6,435	5.20	11,140	8.60	25,190
1.80	3,060	3.50	6,660	5.40	11,810	8.80	26,200
1.90	3,240	3.60	6,885	5.60	12,490	9.00	27,260
2.00	3,425	3.70	7,110	5.80	13,190	9.20	28,360
2.10	3,615	3.80	7,335	6.00	13,890	9.40	29,490
2.20	3,810	3.90	7,565	6.20	14,590	9.60	30,660
2.30	4,010	4.00	7,800	6.40	15,300	9.80	31,860
2.40	4,215	4.10	8,040	6.60	16,050	10.00	33,060
2.50	4,425	4.20	8,285	6.80	16,840		
2.60	4,640	4.30	8,535	7.00	17,640		

The above table is applicable only for open-channel conditions. It is based on 14 discharge measurements made during 1904–5. It is fairly well defined between gage heights 1 foot and 5 feet, being based on two flood measurements above 5 feet.

Estimated monthly discharge of Yellowstone River near Billings, Mont., for 1905.

[Drainage area, 11,180 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 12–31	3,060	1,800	2,612	103,600	0.234	0.174
April	4,425	1,535	2,747	163,500	.246	.274
May	12,150	3,425	5,943	365,400	.532	.613
June	31,860	14,590	24,700	1,470,000	2.21	2.47
July	25,190	8,285	14,740	906,300	1.32	1.52
August	8,790	4,640	6,218	382,300	.556	.641
September	4,640	3,425	3,933	234,000	.352	.393
October	4,010	3,425	3,615	222,300	.323	.372
November 1–28	3,425	3,060	3,290	182,700	.294	.306
The period				4,030,000		

NOTE.—No estimate for ice period.

YELLOWSTONE RIVER AT GLENDIVE, MONT.

This station, established in 1893 by the United States War Department, was transferred to the Department of Agriculture, which has kept daily records of river height. When a study of the lower Yellowstone Valley was begun in 1903, this station was taken up by the United States Geological Survey, whose records begin August 1, 1903. The station is located at the steel highway bridge leading northward from Glendive, about one-fourth mile from the post-office.

The channel is straight for about 500 feet above and below the bridge. The right bank is composed of clay and gravel, is high, and is riprapped for some distance above and below the bridge; the left bank is low and bordered by sandy flats, covered with trees and brush, extending to the hills, 1 mile distant; these flats are liable to be submerged at high water. The bed of the stream is of clay and sand and shifts at every flood. At low water an island becomes visible between the third and fourth spans from the right, and at flood stages water finds its way through a slough traversing the flats on the left. The water at high stages is very deep and swift. Old piling and cribwork, remains of a former bridge, obstruct the channel on the upstream side.

Discharge measurements are made from the downstream hand rail of the bridge, which spans the channel in four spans of 300 feet each. The initial point for soundings is over the southeast pier at the right bank.

During 1905 the gage was read daily until August 31 by H. A. Sample; after that date the daily observations were taken by the local office of the United States Reclamation Service. The original United States Geological Survey gage was of the wire type, fastened to the upstream hand rail of the first span, about 200 feet from the right bank, the scale graduations being marked on the hand rail. This gage was destroyed October 24, 1904, and one month later a standard chain having the same datum was put in its place. The length of the chain is 39.48 feet. The gage is referred to bench marks as follows: (1) A point on the surface of the cement at the northwest corner of the girder on the pier under station "0;" elevation, 26.26 feet above gage datum and 2,060.6 feet above sea level. (2) The top of the west rail of the Northern Pacific Railway track at the right end of the bridge; elevation, 30.19 feet above gage datum. The elevation of the bench marks above sea level was determined from the Northern Pacific elevation of the datum rail at Terry, Mont.; this is 2,242 feet above sea level. The gage readings from 1897 until the establishment of the United States Geological Survey wire gage were referred to a "T" on the top of the southeast anchor bolt in the southeast caisson at the east end of the bridge; its elevation was 25.08 feet above gage datum. The old gage was carried away by ice April 8, 1899, and gage heights during the remainder of that year were determined by measuring down to the water surface from this bench mark. A new bridge was erected in 1901, and it is not known whether this old bench mark was disturbed or not.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, pp 91–92; 130, pp 123–124.
Discharge: 99, p 92; 130, p 124.
Discharge, monthly: 130, p 126.
Gage heights, 99, pp 93–97; 130, pp 124–125.
Rating table: 130, p 25

Discharge measurements of Yellowstone River at Glendive, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 28	L. R. Stockman	705	2,038	2.19	0.73	4,471
April 25	J. H. Sloan	735	2,413	2.31	1.10	5,565
May 9	do	742	3,099	2.50	2.18	7,746
June 4	do	772	6,285	5.26	6.34	33,090
July 1	do	1,010	7,973	6.58	8.09	52,450
July 26	do	763	4,697	3.64	4.53	17,100
August 22	do	746	3,270	2.69	2.42	8,788
September 15	do	740	2,368	2.29	1.30	5,433
October 13	do	746	2,382	2.13	1.11	5,079

Daily gage height, in feet, of Yellowstone River at Glendive, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.4	2.75	6.1	0.7	1.1	4.6	8.3	4.8	1.8	2.1	1.4	2.0
2	4.4	2.85	6.1	.6	1.4	5.7	7.9	5.4	1.8	2.2	1.4	1.6
3	4.5	2.85	6.3	.6	1.4	5.8	8.1	4.6	1.8	1.8	1.2	1.3
4	4.5	2.85	6.4	.6	1.1	6.3	8.3	4.4	1.9	1.4	1.2	1.4
5	4.6	2.85	7.5	.5	1.2	7.0	7.7	4.3	1.9	2.3	1.2	1.4
6	4.6	2.85	6.7	.5	1.3	8.2	7.2	3.9	1.8	1.8	1.2	1.5
7	4.5	2.85	6.3	.5	1.9	9.2	7.1	3.7	1.8	1.6	1.2	1.7
8	4.5	2.85	5.9	.5	2.4	9.4	6.7	3.5	1.8	1.4	1.3	3.2
9	4.6	2.85	5.3	.5	2.4	8.3	6.6	3.3	1.8	1.3	1.3	3.8
10	4.6	2.85	5.2	.4	2.2	8.8	6.4	3.1	1.7	1.2	1.3	4.0
11	4.1	2.85	5.0	.4	2.2	9.3	6.2	3.1	1.7	1.2	1.2	4.0
12	3.6	2.85	5.0	.4	2.4	9.3	6.0	3.0	1.6	1.15	1.2	3.8
13	3.3	2.95	4.9	.4	2.8	8.8	5.9	3.0	1.5	1.15	1.2	3.6
14	3.1	3.25	4.8	.9	2.9	8.1	5.9	3.0	1.4	1.2	1.2	3.4
15	3.0	3.85	4.5	.9	2.6	8.2	5.9	3.0	1.3	1.2	1.2	3.0
16	2.85	3.5	4.1	.8	2.3	8.6	5.8	3.0	1.3	1.2	1.2	2.9
17	2.75	3.3	3.7	.8	2.2	8.5	5.7	3.0	1.2	1.3	1.1	2.9
18	2.75	3.0	3.6	.8	2.0	8.2	6.0	2.9	1.3	1.3	1.1	2.8
19	2.75	2.9	1.5	.9	1.8	7.8	5.4	2.8	1.2	1.4	1.1	2.7
20	2.75	2.9	1.1	.9	1.8	7.8	5.2	2.7	1.1	1.4	1.1	2.7
21	2.75	2.9	1.1	.9	1.9	7.8	5.0	2.7	1.0	1.4	1.1	2.7
22	2.75	3.3	1.0	.9	3.3	7.0	4.9	2.7	1.0	1.4	1.1	2.7
23	2.75	3.4	1.0	.9	3.3	7.0	4.4	2.5	1.0	1.4	1.1	2.6
24	2.75	3.4	1.0	.8	3.3	6.9	4.3	2.3	1.0	1.4	1.1	2.5
25	2.75	4.1	.9	1.1	3.6	7.8	4.3	2.1	.9	1.4	1.1	2.4
26	2.75	4.5	.9	1.1	4.1	8.0	4.5	2.0	.9	1.4	1.1	2.1
27	2.75	6.9	.8	.9	4.5	7.7	4.4	1.9	.8	1.4	1.2	2.0
28	2.75	6.1	.7	.8	4.4	7.7	5.2	1.9	.8	1.4	1.3	1.9
29	2.75	.....	.7	.9	4.2	7.9	5.2	1.8	.7	1.4	3.2	1.5
30	2.75	.....	.7	1.0	4.3	8.1	5.4	1.8	.....	1.4	2.5	1.5
31	2.75	.....	.7	.....	4.3	.....	4.7	1.8	.....	1.5	.....	1.5

NOTE.—Ice conditions January 1 to March 19; also November 29 to December 31, Readings are to the top of the ice.

Station rating table for Yellowstone River at Glendive, Mont., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec. ft.*	*Feet.*	*Sec. ft.*	*Feet.*	*Sec. ft.*	*Feet.*	*Sec. ft.*
.40	3,750	2.00	7,300	3.60	12,900	6.40	32,000
.50	3,930	2.10	7,580	3.70	13,350	6.60	34,000
.60	4,120	2.20	7,860	3.80	13,800	6.80	36,000
.70	4,310	2.30	8,160	3.90	14,300	7.00	38,000
.80	4,500	2.40	8,460	4.00	14,800	7.20	40,200
.90	4,700	2.50	8,780	4.20	15,800	7.40	42,400
1.00	4,900	2.60	9,100	4.40	16,900	7.60	44,700
1.10	5,100	2.70	9,450	4.60	18,000	7.80	47,100
1.20	5,300	2.80	9,800	4.80	19,200	8.00	49,500
1.30	5,530	2.90	10,150	5.00	20,400	8.20	52,000
1.40	5,760	3.00	10,500	5.20	21,750	8.40	54,600
1.50	5,990	3.10	10,850	5.40	23,200	8.60	57,200
1.60	6,240	3.20	11,250	5.60	24,750	8.80	59,800
1.70	6,490	3.30	11,650	5.80	26,400	9.00	62,400
1.80	6,740	3.40	12,050	6.00	28,200		
1.90	7,020	3.50	12,450	6.20	30,050		

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1904–5, and is fairly well defined throughout.

Estimated monthly discharge of Yellowstone River at Glendive, Mont., for 1905.

[Drainage area, 66,090 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 20–31	5,100	4,310	4,670	111,200	0.071	0.032
April	5,100	3,750	4,374	260,300	.066	.074
May	17,450	5,100	9,663	594,200	.146	.168
June	67,800	18,000	47,970	2,854,000	.726	.810
July	53,300	16,350	29,240	1,798,000	.442	.510
August	23,200	6,740	11,110	683,100	.168	.194
September 1–29	7,020	4,310	5,751	330,800	.087	.094
October	8,160	5,200	5,917	363,800	.090	.104
November 1–28	5,760	5,100	5,294	294,000	.080	.083
The period				7,289,000		

NOTE.—No estimate for ice period.

CLARK FORK AT FROMBERG, MONT.

Clark Fork enters Yellowstone River from the south, about 15 miles southwest of Billings, Mont.

The gaging station was established June 3, 1905. It is located on the highway bridge one-half mile east of the Northern Pacific Railway station at Fromberg, Mont. One small stream, Rock Creek, flows into the river between the gaging station and its mouth.

The channel is slightly curved for 100 yards above and 300 yards below the station. The right bank is high, is covered with brush and willows, and does not overflow. The left bank is low, is sparsely wooded, and overflows during extremely high water. The bed of the

stream is composed of rock and gravel and is free from vegetation and permanent. There is but one channel and the water flows uniformly with a good velocity.

Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is directly over the center of the pier on the right bank.

The gage, which is read twice daily by Mrs. J. S. Tuggle, was first a temporary rod spiked to the upstream side of the central pier of the bridge. This was replaced July 25, 1905, by a standard chain gage fastened to the upstream side of the bridge not far from the center of the stream. The length of the chain is 15.24 feet. The gage is referred to bench marks as follows: (1) The top of the west end of the cap on the piling on the west bent of the bridge, upstream side; elevation, 13.36 feet above gage zero. (2) The top of a 10-penny nail driven into the base of a large cottonwood tree 120 feet southwest of the west end of the bridge; elevation, 13.06 feet above the zero of the gage.

Discharge measurements of Clark Fork at Fromberg, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet:*	*Sec.-ft.*
June 3	J. H. Sloan	209	845	4.87	6.42	4,118
June 27	do	210	970	5.91	7.25	5,730
July 25	do	185	518	3.00	4.95	1,657
August 19	do	135	370	1.98	3.98	734
September 16	do	122	309	1.34	3.53	416
October 17	do	122	289	1.30	3.47	372

Daily gage height, in feet, of Clark Fork at Fromberg, Mont., for 1905.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	6.6	4.72	3.82	3.5	3.5	3.5
2	.....	6.55	4.68	3.75	3.5	3.5	3.5
3	6.5	6.28	4.95	3.72	3.5	3.5	3.5
4	6.95	6.2	5.1	3.68	3.45	3.58	3.5
5	7.25	6.15	4.8	3.65	3.45	3.6	3.5
6	6.55	5.9	4.6	3.6	3.4	3.55	3.5
7	6.05	5.95	4.5	3.6	3.4	3.55	3.5
8	6.25	6.0	4.5	3.55	3.4	3.55	3.5
9	7.45	6.0	4.38	3.55	3.4	3.5	3.5
10	7.1	6.0	4.28	3.55	3.4	3.5	3.5
11	6.35	6.02	4.35	3.55	3.35	3.5	3.5
12	6.5	5.9	4.3	3.55	3.35	3.5	3.5
13	7.25	5.9	4.3	3.55	3.45	3.5	3.5
14	7.3	5.82	4.22	3.55	3.6	3.5	3.5
15	7.0	5.8	4.18	3.5	3.5	3.5	3.45
16	6.55	5.75	4.12	3.5	3.45	3.5	3.45
17	6.3	5.55	4.08	3.5	3.45	3.5	3.45
18	6.15	5.2	4.0	3.47	3.42	3.5	3.45
19	5.55	5.2	3.9	3.45	3.4	3.5	3.45
20	5.4	5.0	3.85	3.45	3.42	3.5	3.45
21	5.7	5.0	3.8	3.45	3.48	3.5	3.45
22	6.4	4.9	3.8	3.4	3.5	3.5	3.45
23	6.4	5.05	3.8	3.4	3.53	3.5	3.42
24	6.4	5.0	3.75	3.37	3.55	3.5	3.4
25	6.4	5.0	3.75	3.35	3.55	3.5	3.4
26	6.58	4.88	3.7	3.35	3.5	3.5	3.4
27	7.0	5.0	3.85	3.35	3.5	3.8	3.4
28	7.25	4.85	3.85	3.35	3.5	3.8	3.4
29	6.9	4.78	3.9	3.45	3.5	3.8	3.4
30	6.7	4.78	3.88	3.75	3.5	3.8	3.4
31	.....	4.72	3.85	.....	3.5	.....	3.4

NOTE.—November 27-30, rise caused by ice. River frozen November 27 to December 31; readings are to the water surface in a hole in the ice.

Station rating table for Clark Fork at Fromberg, Mont., from June 3 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
3.40	346	4.30	999	5.20	1,973	6.20	3,475
3.50	400	4.40	1,094	5.30	2,102	6.40	3,850
3.60	458	4.50	1,192	5.40	2,236	6.60	4,260
3.70	520	4.60	1,293	5.50	2,375	6.80	4,690
3.80	587	4.70	1,397	5.60	2,519	7.00	5,140
3.90	660	4.80	1,504	5.70	2,667	7.20	5,600
4.00	738	4.90	1,615	5.80	2,819	7.40	6,080
4.10	821	5.00	1,730	5.90	2,975		
4.20	908	5.10	1,849	6.00	3,135		

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1905 and is well defined between gage heights 3.5 feet and 7.2 feet.

Estimated monthly discharge of Clark Fork at Fromberg, Mont., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
June 3–30	6,200	2,236	4,294	238,500
July	4,260	1,418	2,511	154,400
August	1,849	520	924	56,820
September	602	321	421	25,050
October	458	321	381	23,430
November 1–26	458	400	407	20,990
The period				519,200

NOTE.—No estimate for ice period.

PRYOR CREEK AT HUNTLEY, MONT.

Pryor Creek rises in the Pryor Mountains, in southeastern Carbon County, Mont., flows northeastward, and enters Yellowstone River from the south about 15 miles northeast of Billings.

The station was established August 6, 1904. It is located at Huntley, the junction of the Northern Pacific and Burlington railroads, 13 miles from Billings, Mont.

No regular station for discharge measurements has yet been established; but low-water measurements have been made by wading above the gage and high-water measurements have been made from the Northern Pacific Railway bridge, 1¼ miles below.

The gage, which is read twice each day by J. W. Day, consists of a rod placed vertically at the right bank about 200 feet south of the Northern Pacific Railway station. The gage is referred to bench marks as follows: (1) The top of the rail of the Northern Pacific Railway track in front of the operator's window; elevation, 14.52 feet. (2) A nail in a pile at the foot of a large tree on the east side of the creek, opposite the station agent's house and the post-office; elevation, 11.46 feet. (3) A spike driven in a large tree 100 feet southwest of the water-tank, 150 feet north of the section house, and 40 feet east of the track; elevation, 12.79 feet. Elevations are above the zero of the gage, which is 3,014.48 feet above sea level.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 126–127.

Discharge measurements of Pryor Creek at Huntley, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 17	J. H. Sloan	12	20	1.25	1.45	26
May 12	do	16	25	2.35	1.96	59
June 5	do	40	271	7.31	14.93	1,982
June 26	do	17	26	2.66	2.20	68
July 2	do	34	148	6.34	10.52	936
August 15	do	18	16	1.21	1.20	13
September 14	do		10	1.19	1.18	12

Daily gage height, in feet, of Pryor Creek at Huntley, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.6	3.05	4.8	1.7	1.55	2.3	7.95	1.3	1.2	2.35	1.75	2.3
2	1.65	3.25	4.4	1.7	1.75	2.45	8.1	1.7	1.2	1.8	1.75	2.3
3	1.55	3.3	3.95	1.8	1.8	2.4	5.4	1.4	1.2	1.65	1.8	2.3
4	1.7	3.4	3.75	1.65	2.15	2.3	3.4	1.3	1.25	1.6	1.9	2.3
5	1.75	3.4	3.55	1.55	3.45	12.7	2.7	1.3	1.2	1.65	1.8	2.3
6	1.65	3.4	3.3	1.65	2.1	5.25	1.85	1.3	1.3	1.55	1.7	2.3
7	1.8	3.45	3.05	1.7	1.65	3.25	1.75	1.3	1.25	1.5	1.7	2.3
8	1.95	3.55	2.65	1.6	1.55	6.3	1.7	1.3	1.2	1.45	1.7	2.3
9	2.1	3.6	2.2	1.75	2.25	8.55	1.7	1.28	1.2	1.4	1.7	2.3
10	2.15	3.6	2.0	1.85	4.8	8.1	1.6	1.25	1.2	1.65	1.7	2.3
11	2.0	3.6	1.9	2.0	3.6	3.8	1.5	1.2	1.3	1.7	1.65	2.3
12	2.15	3.6	1.8	2.05	1.95	3.5	1.6	1.2	1.25	1.6	1.7	2.3
13	2.25	3.6	1.95	2.2	1.8	3.6	1.65	1.2	1.25	1.65	1.7	2.3
14	2.2	3.6	1.85	2.1	1.75	3.55	1.7	1.2	1.3	1.85	1.6	2.3
15	2.35	3.6	1.7	2.05	1.75	3.45	1.65	1.2	1.25	2.1	1.6	2.3
16	2.3	3.7	1.85	2.05	1.7	3.5	1.55	1.2	1.2	1.8	1.65	2.3
17	2.4	3.8	2.0	1.9	1.65	3.65	1.5	1.25	1.2	1.65	1.65	2.35
18	2.2	3.95	1.9	1.85	1.85	3.8	1.4	1.2	1.2	1.6	1.7	2.4
19	2.15	4.15	1.8	1.8	2.05	3.65	1.4	1.2	1.3	1.6	1.65	2.4
20	2.25	4.2	1.65	1.55	2.3	3.25	1.3	1.2	1.3	1.6	1.6	2.4
21	2.25	4.4	1.6	1.45	2.0	3.05	1.3	1.2	1.25	1.6	1.6	2.4
22	2.3	4.5	1.7	1.4	1.9	2.8	1.3	1.2	1.2	1.95	1.7	2.4
23	2.4	4.6	1.75	1.4	2.4	2.75	1.35	1.2	1.2	1.8	1.6	2.4
24	2.4	4.75	1.6	1.5	4.05	3.05	1.35	1.2	1.3	1.75	1.7	2.4
25	2.5	5.1	1.6	1.45	2.9	3.2	1.25	1.2	1.3	1.95	1.7	2.4
26	2.5	5.2	1.7	1.4	2.45	3.05	1.3	1.2	1.25	2.1	1.7	2.4
27	2.5	5.3	1.6	1.5	2.4	3.2	1.25	1.15	1.2	2.15	1.9	2.4
28	2.5	5.15	1.6	1.45	2.3	3.3	1.2	1.2	1.25	2.3	2.05	2.4
29	2.65	.....	1.65	1.4	2.4	3.3	1.35	1.08	1.3	2.4	2.1	2.4
30	2.85	.....	1.7	1.5	2.45	3.3	1.3	1.15	2.0	1.8	2.2	2.4
31	2.9	.....	1.65	.....	2.55	.....	1.3	1.2	.....	1.8	.....	2.5

NOTE.—River frozen and readings to the top of the ice from January 8 to February 14 inclusive and from November 28 to December 31 inclusive; water flowing over the top of the ice February 15 to March 8 inclusive.

Station rating table for Pryor Creek at Huntley, Mont., from August 7, 1904, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	6	2.60	96	4.10	203	6.20	388
1.10	9	2.70	102	4.20	211	6.40	408
1.20	13	2.80	109	4.30	219	6.60	428
1.30	18	2.90	115	4.40	227	6.80	448
1.40	23	3.00	122	4.50	235	7.00	470
1.50	28	3.10	128	4.60	243	7.20	492
1.60	33	3.20	135	4.70	251	7.40	514
1.70	39	3.30	142	4.80	259	7.60	536
1.80	45	3.40	149	4.90	268	7.80	558
1.90	51	3.50	156	5.00	277	8.00	582
2.00	57	3.60	163	5.20	295	8.20	606
2.10	63	3.70	171	5.40	313	8.40	631
2.20	70	3.80	179	5.60	331	8.60	657
2.30	76	3.90	187	5.80	349	8.80	683
2.40	83	4.00	195	6.00	368	9.00	710
2.50	89						

The above table is applicable only for open-channel conditions. It is based on nine discharge measurements made during 1904-5, and is well defined between gage heights 1 foot and 2 feet. The table has been extended beyond these limits, being based on two flood measurements, one at 10.52 feet and one at 14.93 feet.

Estimated monthly discharge of Pryor Creek at Huntley, Mont., for 1904-5.

[Drainage area, 800 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1904.						
August 7-31	16	6	8.9	441	0.011	0.010
September	18	13	16.1	958	.020	.022
October	33	16	24.7	1,519	.031	.036
November	54	18	30.8	1,833	.038	.042
December	51	25	34.1	2,097	.043	.050
The period				6,848		
1905.						
January 1-7	45	30	37.3	516	.047	.012
March 9-31	70	33	43.8	1,975	.054	.046
April	70	23	39.4	2,344	.049	.055
May	259	30	77.8	4,784	.097	.112
June	1,370	76	222	13,210	.278	.310
July	594	13	78.2	4,808	.098	.113
August	39	9	15.2	935	.019	.022
September	57	13	16.6	988	.021	.023
October	83	23	44.4	2,730	.056	.065
November 1-27	51	33	39.0	2,089	.049	.049
The period				34,380		

NOTE.—No estimate for ice period.

BIGHORN RIVER[a] AT THERMOPOLIS, WYO.

This station was established May 28, 1900. It was at first located near the hot springs on the "Mile Square, State Reservation," about half a mile northeast of Thermopolis, in T. 43 N., Rs. 94 and 95 W.; but in 1901 it was transferred to the new iron bridge 400 or 500 feet upstream from the former location.

The channel is straight for some distance above and below the station. The banks are high and do not overflow. The bed of the stream is composed of rock and gravel and is fairly permanent. At ordinary stages all of the water flows beneath the bridge proper, but at flood stages it rises under the approaches at each side. There are no obstructions in the channel above the station.

Discharge measurements are made from the bridge, which is a two-span truss structure, each span 125 feet long, with approaches on each side 15 feet long. Sounding points are marked at 10-foot intervals by brass-headed nails driven into the railing on the downstream side, beginning at the center pier, which is the initial point, and running toward either bank.

The gage is observed by William M. Neece, superintendent of the State reserve, who lives within 100 yards of the station. The gage used in 1900 was a horizontal rod extending out over the water and fastened to posts firmly set in the ground, with the usual wire and weight attachment. In 1901 a new gage, with relative heights the same as those in use in 1900, was painted on the lower center pier of the recently constructed iron bridge, 400 or 500 feet above the old gage. In March, 1903, another gage, serving as a bench mark and for the observer's use at times of high water, was painted on the lower pier of the bridge on the right bank of the river. This gage, which is not reached by the water until it stands 3 feet above datum, enables the observer to read heights of high water more accurately than they can be read on the regular gage, which is in the center of the stream and exposed to the force of the current, causing a rise and fall of several inches on the gage. In March, 1904, the regular gage was replaced by a new one, consisting of a vertical staff firmly fastened by iron bands to the pier on which the former gage was painted.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann = Annual Report; WS = Water-Supply Paper):

Description: WS 37, p 211; 49, p 269; 66, p 23; 84, pp 23-24; 99, p 89; 130, pp 127-128.
Discharge: WS 37, p 211; 49, p 269; 84, p 24; 99, p 90; 130, p 128.
Discharge, monthly: Ann 22, iv, p 291; WS 75, p 123; 99, p 91; 130, p 130.
Gage heights: WS 49, p 269; 66, p 23; 84, p 24; 99, p 90; 130, p 129.
Hydrograph: Ann 22, iv, p 291.
Rating tables: WS 52, p 516; 66, p 170; 99, p 91; 130, p 130.

Discharge measurements of Bighorn River at Thermopolis, Wyo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 9	A. J. Parshall	177	326	1.67	0.85	545
July 10	do	252	910	5.02	3.45	4,567
July 11	do	252	938	5.15	3.60	4,827
July 12	do	252	960	5.25	3.70	5,043
July 18	C. D. Farmer	252	862	4.72	3.30	4,065
July 23	do	244	787	4.54	3.00	3,572
August 1	do	244	687	4.12	2.60	2,830
August 4	do	220	585	3.83	2.30	2,240
August 18	do	220	510	3.30	1.90	1,683
September 9	do	198	476	3.05	1.50	1,454
September 20	do	170	401	2.27	1.20	910
October 12	do	166	339	2.25	1.00	761

[a] A description of this river is included in the general description of the Yellowstone River basin, p. 91.

Daily gage height, in feet, of Bighorn River at Thermopolis, Wyo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.3	1.1	3.9	4.85	2.65	1.6	1.35	0.8	[b] 0.3
2	.3	1.1	4.65	4.75	2.55	1.55	1.5	0.8	0.3
3	.5	1.2	4.35	4.55	2.5	2.0	1.4	0.8	0.3
4	.3	1.2	4.6	4.65	2.35	1.95	1.3	0.7	0.2
5	.3	1.3	5.75	4.55	2.2	1.8	1.25	0.9	0.25
6	.3	1.4	6.2	4.35	2.45	1.9	1.35	0.8	0.4
7	.2	1.45	6.1	4.05	2.45	1.85	1.25	0.95	0.35
8	.3	1.5	6.15	3.75	2.4	1.75	1.2	0.85	0.3
9	.4	1.4	4.5	3.6	2.25	1.55	1.1	0.85	0.2
10	.55	1.3	5.5	3.55	2.2	1.5	1.1	0.9	0.4
11	.75	1.2	4.8	3.4	2.75	1.4	1.0	0.95	0.4
12	.8	1.2	3.85	3.35	2.3	1.4	1.0	0.9	0.4
13	.65	1.25	4.15	3.5	2.3	1.45	1.1	0.8	0.5
14	.6	1.3	4.45	3.65	2.25	1.3	1.1	0.8	0.45
15	.8	1.1	4.8	3.6	2.1	1.3	1.2	0.7	0.4
16	.85	1.05	4.55	3.52	2.0	1.25	1.15	0.7	0.3
17	.7	1.2	4.3	3.7	2.0	1.2	1.3	0.75	0.3
18	.7	1.05	4.45	3.6	1.95	1.25	1.2	0.75	0.3
19	.8	1.05	4.6	3.25	1.9	1.2	1.1	0.9	0.2
20	.8	1.1	4.5	2.95	1.8	1.15	1.0	0.8	0.2
21	.8	1.25	4.6	2.95	1.8	1.2	0.95	0.85	0.2
22	.9	1.4	4.45	3.15	1.7	1.15	0.9	0.9	0.3
23	.95	1.9	4.25	3.05	1.7	1.1	0.9	0.85	0.25
24	.8	2.05	3.95	2.9	1.7	1.1	0.9	0.8	0.2
25	.85	1.85	3.9	2.85	1.8	1.0	0.85	0.7	0.2
26	1.0	1.9	4.3	2.8	1.8	.95	0.9	0.7	0.2
27	1.1	2.25	4.65	2.8	1.8	1.0	0.9	0.7	0.2
28	1.0	2.7	5.05	2.85	1.9	1.0	0.8	0.65	0.3
29	1.0	4.0	5.0	2.85	1.8	1.05	0.85	[a] 0.55	0.3
30	1.05	4.15	5.05	2.8	1.7	1.25	0.9	0.45	0.4
31	.....	3.3	.....	3.15	1.65	.....	0.8	.....	0.3

[a] River frozen over. [b] River full of ice.

Station rating table for Bighorn River at Thermopolis, Wyo., from April 1 to October 14, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
.20	150	1.50	1,255	2.80	3,205	4.00	5,615
.30	205	1.60	1,375	2.90	3,390	4.20	6,045
.40	265	1.70	1,500	3.00	3,580	4.40	6,475
.50	330	1.80	1,630	3.10	3,770	4.60	6,905
.60	400	1.90	1,765	3.20	3,965	4.80	7,340
.70	475	2.00	1,905	3.30	4,165	5.00	7,780
.80	555	2.10	2,050	3.40	4,365	5.20	8,220
.90	640	2.20	2,200	3.50	4,570	5.40	8,660
1.00	730	2.30	2,355	3.60	4,775	5.60	9,100
1.10	825	2.40	2,515	3.70	4,985	5.80	9,550
1.20	925	2.50	2,680	3.80	5,195	6.00	10,000
1.30	1,030	2.60	2,850	3.90	5,405	6.20	10,450
1.40	1,140	2.70	3,025				

The above table is applicable only for open-channel conditions. It is based on 11 discharge measurements made during 1905 and is well defined between gage heights 0.8 foot and 3.7 feet.

Estimated monthly discharge of Bighorn River at Thermopolis, Wyo., for 1905.

[Drainage area, 8,184 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
April	825	150	476	28,320	0.058	0.065
May	5,938	778	1,594	98,010	.195	.225
June	10,450	5,300	7,161	426,100	.875	.976
July	7,450	3,205	4,664	286,800	.570	.657
August	3,115	1,438	2,057	126,500	.251	.289
September	1,905	685	1,132	67,360	.138	.154
October	1,255	555	819	50,360	.100	.115
November	685	298	546	32,490	.067	.075
December	330	150	207	12,730	.025	.029
The period				1,129,000		

BIGHORN RIVER AT FORT CUSTER, MONT.

This station was established June 16, 1904. It is located at the bridge of the Burlington and Missouri River Railroad, about one-half mile above the junction of Bighorn and Little Bighorn rivers, near the section house at Fort Custer. The nearest post-office is 11 miles away, at Crow Agency, Mont. The nearest town is Billings, 60 miles distant.

The channel is straight for 100 hundred yards above and below the bridge. The right bank is high and does not overflow. The left is low and subject to overflow by extremely high water. The bed of the stream is of gravel and is free from vegetation. There is but one channel at ordinary stages, broken by the two piers of the bridge. The current is swift.

Discharge measurements are made from the upstream side of the three-span bridge, to which the gage is attached. The initial point for soundings is at the east or right abutment of the bridge.

During 1905 the gage has been read twice each day and four successive observers have been employed, namely, C. D. Hogue, N. N. Storm, J. R. Jahnson, and L. P. Roode. January 1, 1905, the gage datum was raised 5 feet above the 1904 datum and a standard chain gage was fastened near the middle of the first span from the east bank, the length of the chain from the bottom of the weight to the marker being 21.72 feet. October 10, 1905, the gage was moved to the west or left span of the bridge and the gage datum was lowered 2 feet. The new chain-gage length is 23.83 feet. All gage heights for 1905 are referred to the datum of January 1, 1905. The gage is referred to bench marks as follows: (1) On the top of the east concrete abutment at the south end on mark XXXIII; elevation, 16.90 feet above the datum of October 10, 1905. (2) On the top of the first concrete pier west of the east abutment on the south end of the pier on mark XXXVI; elevation, 16.85 feet above the datum of October 10, 1905. (3) On the top of the south end of the west concrete abutment on mark XXXIV; elevation, 16.88 feet above the datum of October 10, 1905. The elevation of this datum is given at 2,877.1 feet above sea level.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 131–132.

Discharge measurements of Bighorn River at Fort Custer, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 23	L. R. Stockman	418	1,295	1.17	0.55	1,510
April 26	J. H. Sloan	444	1,407	1.29	.68	1,823
May 11	do	442	1,620	2.11	1.50	3,424
June 10	do	455	3,370	7.12	5.55	24,000
June 26	do	456	2,960	5.23	4.45	15,490
July 19	do	431	2,362	3.39	2.90	8,012
August 18	do	446	1,680	2.23	1.58	3,748
September 13	do	443	1,261	1.55	.87	1,960
October 10	do	443	1,259	1.39	.73	1,747
October 31	Morse and Sloan	443	1,266	1.38	.74	1,743

Daily gage height, in feet, of Bighorn River at Fort Custer, Mont., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.7	1.55	1.8	0.4	0.73	3.9	4.48	2.2	1.1	.....	0.73	0.73
2	.65	1.55	1.82	.4	.7	3.92	4.52	2.2	1.12	2.1	.7	.78
3	.6	1.55	1.85	.4	.78	4.05	4.22	2.05	1.1	1.25	.73	.95
4	.6	1.55	1.8	.4	1.23	4.62	4.12	1.9	1.1	1.05	.73	1.0
5	.6	1.55	1.2	.35	1.58	5.0	3.98	1.9	1.1	1.0	.8	1.08
6	.6	1.6	1.2	.35	1.38	5.52	3.8	1.8	1.13	.9	.8	1.12
7	.55	1.6	1.1	.35	1.18	5.28	3.68	1.75	1.1	.88	.75	1.2
8	.55	1.6	1.1	.35	1.25	4.9	3.52	1.6	1.2	.78	.75	1.3
9	.5	1.6	1.0	.35	1.25	5.2	3.55	1.6	1.1	.7	.78	1.22
10	.5	1.6	1.0	.35	1.42	5.6	3.4	1.65	1.0	.78	.73	1.2
11	.5	1.6	.8	.35	1.52	5.28	3.38	1.62	1.0	.98	.68	1.22
12	.5	1.6	.8	.42	1.42	5.05	3.52	1.58	.9	.92	.7	1.2
13	,5	1.6	.9	.4	1.15	4.78	3.5	1.62	.93	.9	.7	1.2
14	.5	1.6	.7	.42	1.08	4.72	3.4	1.6	.87	.9	.7	1.2
15	.5	1.6	.7	.45	1.0	4.88	3.48	1.65	.85	.9	.7	1.2
16	.5	1.6	.8	.5	.9	4.85	3.4	1.68	.85	1.0	.7	1.28
17	.55	1.6	.9	.55	.85	4.82	3.2	1.55	.8	1.02	.7	1.35
18	.55	1.6	1.0	.55	.85	4.92	2.95	1.5	.8	1.0	.7	1.38
19	.6	1.6	1.0	.58	1.35	5.02	2.85	1.45	.75	.95	.7	1.35
20	.6	1.6	.9	.52	1.75	4.4	2.8	1.38	.7	.92	.7	1.42
21	.6	1.6	.9	.74	1.7	3.95	2.62	1.3	.7	.92	.7	1.48
22	1.55	1.6	.8	.78	1.78	3.75	2.48	1.28	.65	.92	.7	1.45
23	1.55	1.6	.7	.82	2.08	4.3	2.42	1.18	.63	.92	.7	1.38
24	1.55	1.6	.6	.62	3.05	4.68	2.45	1.15	.6	.93	.7	1.1
25	1.55	1.6	.52	.62	3.15	4.42	2.35	1.12	.55	.93	.7	1.1
26	1.55	1.6	.5	.62	2.62	4.35	2.3	1.1	.....	.93	.73	1.1
27	1.55	1.6	.45	.65	2.6	4.5	2.25	1.1	.....	.92	.75	1.1
28	1.55	1.7	.4	.78	2.6	4.82	2.2	1.1	.....	.98	.78	1.1
29	1.55	.....	.4	.78	2.6	4.9	2.4	1.15	.....	.93	.73	1.1
30	1.55	.....	.4	.78	3.35	4.62	2.38	1.15	.....	.88	.7	1.12
31	1.55	.....	.4	.....	4.22	.....	2.35	1.15	.....	.83	.....	1.12

NOTE.—Readings from January 22 to March 3, inclusive, and from November 28 to December 31 were taken to the surface of the ice. January 1–21, inclusive, gage height read to the water surface through a hole cut in the ice. River bed was dry under the gage September 26 to October 1, inclusive. For that reason gage was moved to deeper water. Ice thickness, January 22, 12 inches; February 20, 14 inches; February 25, 14.5 inches.

Station rating table for Bighorn River at Fort Custer, Mont., from June 16, 1904, to Decembe 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.40	1,260	1.60	3,660	2.80	7,460	4.00	12,780
.50	1,400	1.70	3,920	2.90	7,820	4.20	13,940
.60	1,540	1.80	4,200	3.00	8,200	4.40	15,180
.70	1,700	1.90	4,480	3.10	8,580	4.60	16,500
.80	1,860	2.00	4,780	3.20	8,980	4.80	17,900
.90	2,040	2.10	5,080	3.30	9,380	5.00	19,380
1.00	2,240	2.20	5,400	3.40	9,800	5.20	20,940
1.10	2,440	2.30	5,720	3.50	10,240	5.40	22,660
1.20	2,660	2.40	6,060	3.60	10,720	5.60	24,460
1.30	2,900	2.50	6,400	3.70	11,200	5.80	26,340
1.40	3,140	2.60	6,740	3.80	11,720		
1.50	3,400	2.70	7,100	3.90	12,240		

The above table is applicable only for open-channel conditions. It is based on fourteen discharg measurements made during 1904–5, and is fairly well defined between gage heights 0.5 foot and 4.5 feet The table has been extended beyond these limits, being based on one measurement at 5.55 feet.

Estimated monthly discharge of Bighorn River at Fort Custer, Mont., for 1904–5.

[Drainage area, 20,720 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1904.						
June 16–30	25,290	13,940	20,670	615,000	0.998	0.55
July	17,540	8,010	12,260	753,800	.592	.68
August	7,532	2,506	4,583	281,800	.221	.25
September	3,920	1,700	2,449	145,700	.118	.13
October	1,860	1,620	1,728	106,300	.083	.09
November	1,700	1,400	1,558	92,710	.075	.08
The period				1,995,000		
1905.						
January 1–21	1,700	1,400	1,485	61,850	.072	.05
March 4–31	4,200	1,260	1,957	108,700	.094	.09
April	1,896	1,200	1,440	85,690	.069	.07
May	14,060	1,700	4,318	265,500	.208	.24
June	24,460	11,460	17,420	1,037,000	.841	.93
July	15,960	5,400	9,143	562,200	.441	.50
August	5,400	2,440	3,486	214,300	.168	.19
September 1–25	2,660	1,470	2,077	103,000	.100	.09
October 2–31	5,080	1,700	2,202	131,000	.106	.11
November 1–27	1,860	1,668	1,732	92,750	.084	.08
The period				2,662,000		

NOTE.—No estimate for ice period.

LITTLE BIGHORN RIVER AT CROW AGENCY, MONT.

This station was established March 24, 1905. It is located at the Burlington and Missouri River Railroad bridge, one-fourth mile south of Crow Agency, Mont.

The channel is straight for 200 feet above and below the station. Both banks are high and unwooded. The bed of the stream is covered with rock and gravel, is free from vegetation, and is permanent. All of the water passes between the abutments of the bridge at all stages. The velocity of the current is moderate. There are a few large rocks in the river, and about 1,200 feet above the station, at the head of Crow Agency ditch, there is a stone and brush dam.

Discharge measurements are made from the upstream side of the single-span bridge to which the gage is attached. The initial point for soundings is a nail driven in the upstream guard rail directly over the inner face of the right abutment.

Daily gage readings have been taken since the establishment of the station by three successive observers—C. C. Hutton, J. A. Smith, and Thomas W. McHoes. The standard chain gage is attached to the upstream side of the bridge, near the center of the river. The length of the chain is 20.31 feet. The gage is referred to bench marks as follows: (1) A cross on the west end of the south abutment, directly below the figures "1903;" elevation, 12.87 feet. (2) A bolt head in the guard rail on the upstream side of the bridge, 7 feet south of the gage; elevation, 19.33 feet. (3) A nail in the east end of the cap on piles supporting the railroad track over Crow Agency ditch; elevation, 14.33 feet. Elevations are above the zero of the gage.

Discharge measurements of Little Bighorn River at Crow Agency, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 24	L. R. Stockman	114	85	1.43	2.00	122
April 26	J. H. Sloan	82	83	1.51	2.00	125
May 11	do	89	165	2.77	3.10	457
June 10	do	99	326	3.85	4.80	1,253
June 26	do	92	262	3.38	4.04	885
July 18	do	87	148	1.82	2.48	268
August 18	do	83	91	1.37	2.05	124
September 13	do	82	68	1.08	1.89	74
October 19	do	83	69	1.06	1.90	72
October 30	Morse and Sloan	82	83	1.38	2.06	115

Daily gage height, in feet, of Little Bighorn River at Crow Agency, Mont., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.0	2.0	3.3	3.6	2.2	1.9	2.0	1.9	2.
2	.....	2.0	2.0	3.4	3.6	2.2	1.9	2.0	2.0	2.
3	.....	2.0	2.1	3.7	3.7	2.2	1.9	2.0	2.1	2.
4	.....	2.0	2.4	3.9	.....	2.2	1.9	2.0	2.1	2.
5	.....	2.0	2.5	4.4	.....	2.2	1.9	2.0	2.1	2.
6	.....	2.0	2.5	5.2	.....	2.2	1.9	2.0	2.1	2.
7	.....	2.0	2.5	5.1	.....	2.2	1.9	1.9	2.1	2.
8	.....	1.9	2.4	5.2	.....	2.1	1.9	1.9	2.1	2.
9	.....	2.0	2.4	5.7	.....	2.1	1.9	1.9	2.1	2.
10	.....	2.1	2.4	4.8	.....	2.1	.....	1.9	2.1	2.
11	.....	2.2	3.1	4.8	.....	2.1	1.9	1.9	2.1	2.
12	.....	2.1	2.5	4.3	.....	2.1	1.9	1.9	2.1	2.
13	.....	2.1	2.4	4.4	.....	2.1	1.9	2.0	2.1	2.
14	.....	2.1	2.3	4.5	.....	2.1	1.9	2.0	2.1	2.
15	.....	2.1	2.3	4.7	.....	2.1	1.9	2.1	2.1	2.
16	.....	2.1	2.3	4.5	.....	2.1	1.9	2.1	2.1	2.
17	.....	2.1	2.3	4.3	.....	2.1	1.9	2.1	2.1	2.
18	.....	2.1	2.3	4.2	.....	2.1	1.9	2.1	2.1	2.
19	.....	2.1	2.2	4.0	2.4	2.1	1.9	2.1	2.0	2.
20	.....	2.1	2.3	3.9	2.4	2.1	1.9	2.0	2.0	2.
21	.....	2.1	2.4	3.7	2.3	2.1	1.9	2.0	2.1	2.
22	.....	2.1	2.3	3.7	2.3	2.0	1.9	2.1	2.1	2.
23	.....	2.1	2.5	3.8	2.3	2.0	1.9	2.1	2.1	2.
24	2.0	2.0	2.5	4.0	2.3	2.0	1.9	2.0	2.0	2.
25	2.0	2.0	2.6	4.1	2.3	2.0	1.8	2.0	2.1	2.
26	2.0	2.0	2.6	4.0	2.3	2.0	1.8	2.1	2.2	2.
27	2.0	2.0	2.6	3.9	2.4	2.0	1.8	2.1	2.1	2.
28	2.0	2.0	2.7	3.8	2.4	2.0	1.8	2.1	2.1	2.
29	2.0	2.0	2.7	3.7	2.3	1.9	1.8	2.1	2.0	2.
30	2.0	2.0	2.7	3.7	2.4	1.9	2.0	2.0	2.0	2.
31	2.0	.....	3.0	.....	2.3	1.9	.....	2.0	.....	2.

NOTE.—River partly frozen during December. Gage heights are to the water surface.

Station rating table for Little Bighorn River at Crow Agency, Mont., from March 24 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.80	60	2.70	320	3.60	675	4.50	1,110
1.90	80	2.80	355	3.70	720	4.60	1,160
2.00	105	2.90	390	3.80	765	4.70	1,210
2.10	130	3.00	430	3.90	810	4.80	1,260
2.20	155	3.10	470	4.00	860	4.90	1,310
2.30	185	3.20	510	4.10	910	5.00	1,360
2.40	215	3.30	550	4.20	960	5.20	1,465
2.50	250	3.40	590	4.30	1,010	5.40	1,575
2.60	285	3.50	630	4.40	1,060	5.60	1,685

The above table is applicable only for open-channel conditions. It is based on ten discharge measurements made during 1905 and is well defined between gage heights 2 feet and 5 feet.

Estimated monthly discharge of Little Bighorn River at Crow Agency, Mont., for 1905.

[Drainage area, 1,276 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 24–31	105	105	105	1,666	0.082	0.025
April	155	80	117	6,962	.092	.103
May	470	105	235	14,450	.184	.212
June	1,740	550	977	58,140	.766	.855
July 1–3, 19–31	720	185	289	9,161	.226	.134
August	155	80	125	7,686	.098	.113
September	105	60	78	4,612	.061	.068
October	130	80	109	6,702	.085	.098
November	155	80	124	7,379	.097	.108
December	.....	.....	130	7,993	.102	.118
The period	.....	.....	.....	124,800	.....	.....

NOTE.—A gage height of 2.1 feet has been assumed as representing the normal flow during December.

SHOSHONE RIVER[a] NEAR CODY, WYO.

This station was established April 26, 1902. It is located at the wagon bridge 1 mile northeast of Cody, Wyo., in sec. 29, T. 53 N., R. 101 W.

The channel is straight both above and below the station. The banks are high and not liable to overflow. The bed of the stream is composed of gravel and rock and is fairly permanent, but occasionally a small bar, which usually remains but a short time, forms at the lower end of the center pier of the bridge. There is but one channel at all stages, interrupted by the center pier or cribbing of the bridge. The current is swift and the river bed slopes to the left bank. At low water the stream is nearly confined to a channel under the left span of the bridge, but at higher stages it rises to the abutment on the right bank.

Discharge measurements are made from the wagon bridge, the points for soundings being indicated by numbers painted on the railing. The initial point is the face of the abutment on the left bank.

The gage, which is read daily by W. J. Kissick, consists of a staff fastened to the framework of the middle pier of the bridge, downstream side. The bench mark is a bolt in the bridge sleeper 1.15 feet above the 12-foot mark on the gage; it is indicated by a cross. The range of gage heights is about 6 feet.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, p 21; 99, p 83; 130, p 132.
Discharge: 84, p 22; 99, p 84; 130, p 133.
Discharge, monthly: 84, p 23; 99, p 85; 130, pp 135–136.
Gage heights: 84, p 22; 99, p 84; 130, p 134.
Rating tables: 84, p 23; 99, p 85; 130, p 134.

[a] A brief description of Shoshone River is included in the general description of the Yellowstone River basin.

Discharge measurements of Shoshone River near Cody, Wyo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 7	A. J. Parshall	128	359	1.98	2.70	710
June 4	J. Ahern	178	909	6.72	5.70	6,088
June 20	Brundage and Soper	158	647	4.69	4.20	3,034
June 26	do	185	909	7.19	5.70	6,536
June 28	do	193	965	7.82	5.95	7,550
July 8	do	168	784	6.02	5.05	4,716
July 14	A. J. Parshall	160	648	5.71	4.50	3,701
July 15	do	159	635	5.48	4.40	3,480
August 26	do	131	385	2.22	2.75	853
September 16	Brundage and Soper	123	294	1.46	2.27	432
December 1	do	90	202	1.09	1.79	223

[a] Made by wading above bridge.

Daily gage height, in feet, of Shoshone River near Cody, Wyo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	1.9	2.5	2.8	2.2	5.0	5.0	3.5	2.7	2.0	2.1	1.8
2	2.1	1.9	2.5	2.8	2.3	5.1	5.0	3.4	2.7	1.9	2.0	1.9
3	2.1	2.0	2.6	2.8	2.5	5.5	5.3	3.2	2.8	1.8	2.1	1.9
4	2.0	2.0	2.6	2.8	2.7	5.7	5.2	3.8	2.8	1.9	2.0	1.8
5	1.9	1.9	2.6	2.9	3.0	6.0	5.1	3.5	2.7	1.8	2.1	1.9
6	1.9	1.8	2.5	2.9	3.0	5.5	4.7	3.5	2.6	2.0	2.2	2.1
7	1.9	1.7	2.7	2.8	2.7	5.0	4.7	3.5	2.6	2.1	2.1	2.0
8	1.8	1.7	2.7	2.9	2.7	5.8	4.8	3.9	2.5	2.0	2.0	2.0
9	1.8	1.6	2.6	2.9	2.8	5.5	4.8	4.0	2.6	2.0	2.0	1.9
10	1.8	1.6	2.6	2.8	3.0	5.0	4.7	3.8	2.6	1.9	2.1	1.8
11	1.8	1.7	2.5	2.9	2.9	5.2	4.6	3.0	2.7	1.8	2.2	1.7
12	1.9	1.7	2.6	2.9	2.9	5.2	5.3	3.1	2.6	1.9	2.0	2.0
13	1.9	1.8	2.7	2.9	2.9	5.7	4.6	3.0	2.6	2.1	1.9	2.1
14	2.0	1.8	2.5	2.8	3.0	5.8	4.5	2.9	2.5	2.1	1.8	2.0
15	2.0	1.8	2.5	2.9	2.8	5.6	4.5	3.0	2.4	2.0	1.9	2.0
16	2.0	1.9	2.6	2.9	3.1	5.6	4.7	2.9	2.3	2.0	2.0	1.9
17	1.9	2.0	2.7	3.0	3.0	4.7	4.8	2.9	2.3	2.1	2.0	1.8
18	1.9	2.0	2.7	3.0	3.1	4.7	4.5	2.8	2.3	1.9	2.0	1.8
19	1.9	2.1	2.7	3.0	3.0	4.5	4.2	2.7	2.3	2.0	2.0	1.9
20	1.8	2.1	2.8	3.1	3.5	4.2	4.4	2.7	2.2	1.8	2.1	2.0
21	1.8	2.2	2.9	3.1	3.5	4.5	4.5	2.7	2.2	2.1	2.0	1.9
22	1.7	2.2	2.9	2.9	3.8	5.0	4.1	2.7	2.2	2.1	1.9	2.0
23	1.7	2.4	2.9	3.0	3.5	5.0	4.1	2.7	2.2	2.1	2.0	1.8
24	1.7	2.5	2.8	2.8	3.0	5.0	4.1	2.8	2.2	2.1	2.0	1.8
25	1.6	2.5	3.0	2.7	3.3	5.0	4.0	2.8	2.1	2.0	2.0	2.0
26	1.6	2.4	3.0	2.8	3.5	5.7	4.0	2.8	2.1	2.0	2.0	2.0
27	1.8	2.5	3.1	2.9	3.6	5.9	4.4	2.8	2.0	2.0	1.9	1.9
28	1.8	2.5	2.8	3.0	3.5	5.8	4.4	2.8	1.9	2.1	1.9	2.0
29	1.8	.....	2.9	2.5	4.0	5.8	4.4	2.7	1.9	1.9	1.8	2.0
30	1.9	.....	2.9	2.5	4.3	5.5	4.3	2.9	2.0	1.8	1.9	2.0
31	1.9	.....	3.0	.....	4.5	.....	3.6	3.0	.....	2.1	.....	2.0

NOTE.—The gage heights for this station as reported by the observer were greatly in error. They have been corrected and adjusted on the basis of 30 gage readings made during the year by hydrographers and by the use of the Marquette station gage heights. They are still liable to some error.

Estimated monthly discharge of Shoshone River near Cody, Wyo., for 1905.

[Drainage area, 1,480 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	365	190	270	16,600	0.182	0.210
February	630	190	351	19,490	.237	.247
March	1,230	630	833	51,220	.563	.649
April	1,230	630	972	57,840	.657	.733
May	3,705	420	1,401	86,140	.947	1.09
June	7,850	3,070	5,747	342,000	3.88	4.33
July	5,720	1,965	3,891	239,200	2.63	3.03
August	2,675	800	1,286	79,070	.869	1.00
September	900	255	559	33,260	.378	.422
October	350	220	295	18,140	.199	.229
November	410	220	303	18,030	.205	.229
December	350	190	270	16,600	.182	.210
The year	7,850	190	1,348	977,600	.911	12.38

NOTE.—The greater part of the published gage heights for December, 1904, are probably 1 foot too low, owing to inaccurate gage reading, thus causing great error in published estimates for that month. The 1905 estimates are based on two rating curves.

SOUTH FORK OF SHOSHONE RIVER AT MARQUETTE, WYO.

South Fork, which furnishes about 25 per cent of the discharge of Shoshone River, rises in the Shoshone Mountains, near the southeast corner of the Yellowstone National Park, and flows northeastward about 50 miles to the entrance of the canyon, where it joins North Fork. It receives numerous small tributaries which enter from both sides.

The gaging station was established April 26, 1903, but was discontinued during 1904. It is located at the county highway bridge at Marquette, Wyo., 12 miles west of Cody, in sec. 12, T. 52 N., R. 103 W.

The channel forms the arc of a long curve extending about 200 feet above and below the bridge. The banks do not overflow, but at highest stages the water rises a few feet against the bridge abutments on either side. The bed of the stream is rocky and stable. The river flows in a single channel under the bridge, the greatest depth being near the center. Large rocks near the left bank interfere somewhat with the accuracy of discharge measurements.

Discharge measurements are made from the bridge, sounding points being indicated by marks painted at 10-foot intervals on the lower railing. The initial point for sounding is at the abutment on the left bank.

The gage, which is read twice daily by C. P. MacGlashan, is a vertical timber set well out in the stream and fastened to a strong post placed 1 foot deep in the rocky bed of the channel and securely braced to the sleeper of the bridge. The bench mark is the lower surface of the iron plate at the bottom of the bridge stringer at the gage rod; elevation, 10.60 feet above the zero of the gage.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 99 of the United States Geological Survey, pages 85–87.

Discharge measurements of South Fork of Shoshone River at Marquette, Wyo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 25	J. Ahern	85	88	2.16	0.70	190
May 8	A. J. Parshall	118	113	2.52	1.00	285
June 6	J. Ahern	144	275	4.61	2.40	1,269
June 15	Brundage and Saunders	144	338	5.36	2.80	1,812
June 19	Brundage and Soper	144	228	4.14	1.95	943
June 27	do	144	430	5.95	3.35	2,559
July 1	do	144	343	5.42	2.75	1,860
July 15	A. J. Parshall	144	262	5.09	2.35	1,335
September 16	Brundage and Soper	85	67	1.94	.63	130
September 19 [a]	do	72	91	1.22	.62	112

[a] Made by wading 250 feet above usual point.

Daily gage height, in feet, of South Fork of Shoshone River at Marquette, Wyo., for 1905.

Day	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	0.7	2.65	3.0	1.45	0.8	0.7	0.5
2	.75	2.65	2.75	1.4	.8	.7	.6
3	.85	2.8	2.45	1.35	.85	.6	.6
4	.9	3.0	2.3	1.35	.85	.6	.6
5	.85	2.9	2.45	1.25	.8	.6	.6
6	.9	2.3	2.5	1.35	.75	.6	.6
7	.95	2.3	2.7	1.3	.75	.55	.6
8	1.0	2.8	2.6	1.3	.7	.5	.6
9	.9	2.8	2.6	1.15	.75	.55	.6
10	.9	2.85	2.35	1.15	.75	.6	.55
11	.9	2.4	2.7	1.1	.8	.5	.55
12	.8	2.3	2.4	1.1	.75	.5	.6
13	.8	2.7	2.45	.95	.75	.6	.7
14	.7	2.85	2.6	.9	.65	.6	.65
15	.8	2.9	2.5	.95	.65	.55	.7
16	.75	2.7	2.45	1.05	.7	.6	.7
17	1.1	2.15	2.6	.95	.7	.6	.7
18	1.7	2.15	2.45	1.0	.65	.6	.7
19	1.4	2.0	1.8	.85	.65	.65	.7
20	1.55	2.0	2.2	.85	.6	.7	.65
21	1.65	2.1	1.95	.8	.6	.6	.7
22	1.6	2.7	1.8	.85	.6	.5	.65
23	1.65	2.3	2.65	.8	.6	.6	.65
24	1.45	2.6	2.3	.85	.6	.6	.7
25	1.45	3.05	1.7	.8	.5	.6	.6
26	1.55	3.4	2.1	.9	.5	.6	.55
27	1.5	3.8	2.5	.85	.4	.6	.5
28	1.7	3.15	2.25	.9	.5	.5	.4
29	2.3	3.0	1.8	.9	.55	.5	.35
30	2.2	2.85	1.7	.85	.6	.5	.35
31	2.55	.....	1.5	.9	.....	.5	.....

Station rating table for South Fork of Shoshone River at Marquette, Wyo., from May 1 to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.40	63	1.30	460	2.20	1,180	3.10	2,235
.50	87	1.40	525	2.30	1,280	3.20	2,365
.60	115	1.50	590	2.40	1,385	3.30	2,500
.70	149	1.60	660	2.50	1,495	3.40	2,635
.80	189	1.70	735	2.60	1,610	3.50	2,775
.90	235	1.80	815	2.70	1,730	3.60	2,915
1.00	285	1.90	900	2.80	1,850	3.70	3,055
1.10	340	2.00	990	2.90	1,975	3.80	3,200
1.20	400	2.10	1,085	3.00	2,105		

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during 1905, and is well defined.

Estimated monthly discharge of South Fork of Shoshone River at Marquette, Wyo., for 1905.

[Drainage area, 500 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
May	1,552	149	474	29,140	0.948	1.09
June	3,200	990	1,724	102,600	3.45	3.85
July	2,105	590	1,335	82,090	2.67	3.08
August	558	189	314	19,310	.628	.724
September	212	63	143	8,509	.286	.319
October	149	87	110	6,764	.220	.254
November	149	53	117	6,962	.234	.261
The period				255,400		

PINEY CREEK AT KEARNEY, WYO.

Piney Creek rises on the eastern slope of the Bighorn Mountains, in the extreme northwestern part of Johnson County, Wyo., in the elevated plateau region east of Cloud Peak, and flows in a general northeasterly direction until it joins Clear Creek, a branch of Powder River. Its entire length is between 40 and 50 miles, and its total drainage area about 160 square miles. It receives a number of small tributaries, among which may be mentioned Little Piney Creek, which enters from the south near the gaging station at Kearney, and Boxelder Creek, which comes in a few miles above the junction of Piney and Clear creeks. Boxelder Creek probably obtains a part of its limited discharge by seepage from De Smet Lake, a small lake without outlet on the divide between this basin and that of Clear Creek to the south. The valley of Piney Creek is narrow, and is so largely composed of rock, bowlders, and cobblestones that little effort has been made to use it for agricultural purposes. The soil of the rolling uplands and side hills is a rich, deep, sandy loam, generally covered with a small growth of sagebrush and thick, luxuriant grasses. A few thousand acres, including several sidehill tracts, comprise the arable land within the Piney basin proper to which the water supply has been applied. Two large ditches, taken out at the point where the creek leaves the mountain slopes to enter the valley, have been carried from Piney Creek across the low divide to the Prairie Dog basin, where the soil conditions are similar. Near the

head of Piney Creek are several small lakes, at one of which—Piney Lake—an earthen dam was constructed some years ago to conserve waters for use on the northern slope of the northern Piney divide. This dam, which was not well planned or constructed, gave way when nearly filled and caused considerable destruction to properties below.

The gaging station was established September 6, 1902. It is located at the highway bridge about 100 yards south of the Kearney post-office, at the crossing of the stage road from Buffalo to Sheridan, on the water front of the Geier ranch. This ranch is one of the most productive properties on Piney Creek and is built on the site of old Fort Kearney.

The channel is straight for 600 feet above and below the station. The right bank is high and does not overflow; the left bank overflows at extreme flood stages, when a slough about 100 yards from the bank carries a small amount of water. The bed of the stream is composed of gravel. There is but one channel. The current is very swift during high water and sluggish at low-water periods. There are no obstructions in the channel, either above or below.

Discharge measurements are made from the bridge. The initial point is a zero painted on the floor of the bridge at the right bank.

The gage is read once daily at ordinary stages and twice daily during times of greatest fluctuations, by A. J. Sinsel, who lives one-fourth mile distant. The gage is a vertical staff, spiked to the lower abutment of the bridge on the right bank. The bench mark is the United States Geological Survey bench at Geier's ranch, about 60 feet south of the gage; it is marked "Sher. 4662," and its elevation is 4,661.77 feet above sea level. The elevation of the zero of the gage is 4,645.96 feet; the range of gage heights is about 2.5 feet.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, p 21; 99, p 77; 130, p 138.
Discharge: 84, p 21; 99, pp 77-78; 130, p 139.
Discharge, monthly: 99, p 79; 130, p 140.
Gage heights: 84, p 21; 99, p 78; 130, p 139.
Rating table: 99, p 79; 130, p 140.

Discharge measurements of Piney Creek at Kearney, Wyo., for 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 15	A. J. Parshall	40	57	0.54	1.40	31
May 10	do	41	81	1.32	2.00	107
May 11	do	41	80	1.18	1.92	94
June 5	do	42	137	7.33	3.40	1,004
June 6 [a]	do	42	95	5.36	2.80	509
July 6	do	41	89	1.66	1.95	148
July 6	do	41	91	1.46	1.90	133
July 7	do	41	88	1.39	1.85	122
July 18	do	40	80	1.21	1.70	97
August 24	do	40	62	.82	1.40	52
September 30	do	40	53	.45	1.10	24

[a] Measured above bridge.

Daily gage height, in feet, of Piney Creek at Kearney, Wyo., for 1905.

Day	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.4	1.8	2.88	2.35	1.6	1.25	1.15	1.4
2	1.4	1.9	3.1	2.3	1.6	1.25	1.2	1.4
3	1.4	1.8	3.3	2.3	1.55	1.2	1.15	1.4
4	1.4	1.7	3.7	2.2	1.4	1.2	1.15	1.4
5	1.4	1.7	3.5	2.15	1.2	1.2	1.15	1.4
6	1.45	1.8	2.78	2.05	1.2	1.2	1.15	1.4
7	1.45	1.85	2.88	1.9	1.2	1.2	1.15	1.4
8	1.5	1.85	3.25	1.9	1.1	1.2	1.15	1.4
9	1.5	1.9	3.25	1.9	1.1	1.2	1.15	1.4
10	1.5	1.9	2.88	1.9	1.1	1.15	1.1	1.35
11	1.5	1.95	2.75	1.9	1.2	1.15	1.1	1.35
12	1.5	2.0	2.72	1.9	1.3	1.15	1.1	1.35
13	1.55	1.95	2.82	1.9	1.3	1.15	1.1	1.35
14	1.55	1.95	2.75	1.9	1.2	1.15	1.1	1.35
15	1.55	2.0	2.68	2.1	1.2	1.15	1.15	1.35
16	1.5	2.0	2.62	2.0	1.2	1.15	1.15	1.35
17	1.5	2.1	2.45	1.95	1.2	1.15	1.15	1.35
18	1.5	2.2	2.35	1.8	1.2	1.15	1.15	1.35
19	1.5	2.3	2.30	1.7	1.2	1.15	1.15	1.3
20	1.5	2.2	2.35	1.9	1.2	1.15	1.2	1.3
21	1.5	2.3	2.38	1.85	1.3	1.15	1.25	1.3
22	1.5	2.35	2.38	1.75	1.3	1.2	1.3	1.3
23	1.5	2.75	2,38	1.7	1.4	1.2	1.35	1.3
24	1.55	2.55	2.3	1.7	1.45	1.15	1.4	1.3
25	1.6	2.5	2.3	1.7	1.4	1.15	1.4	1.3
26	1.7	2.5	2.42	1.7	1.4	1.15	1.45	1.3
27	1.85	2.45	2.45	1.8	1.3	1.15	1.4	1.3
28	1.75	2.5	2.45	1.75	1.3	1.15	1.4	1.3
29	1.7	2.65	2.25	1.65	1.3	1.15	1.4	1.3
30	1.75	2.75	2.3	1.65	1.3	1.15	1.4	1.3
31	.....	2.85	.....	1.6	1.25	.....	1.4	.....

Station rating table for Piney Creek at Kearney, Wyo., from January 1, 1904, to June 5, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.20	15	1.80	76	2.40	262	3.00	660
1.30	21	1.90	96	2.50	310	3.10	750
1.40	29	2.00	118	2.60	364	3.20	850
1.50	38	2.10	144	2.70	430	3.30	960
1.60	48	2.20	178	2.80	500	3.40	1,080
1.70	60	2.30	218	2.90	580	3.50	1,200

The above table is applicable only for open-channel conditions. It is based on nine discharge measurements made during 1904, and is well defined between gage heights 1.3 feet and 3 feet.

Station rating table for Piney Creek at Kearney, Wyo., from June 6 to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.10	24	1.70	94	2.30	262	2.90	595
1.20	32	1.80	113	2.40	302	3.00	675
1.30	41	1.90	136	2.50	347	3.10	765
1.40	52	2.00	162	2.60	400	3.20	860
1.50	64	2.10	192	2.70	460	3.30	960
1.60	78	2.20	225	2.80	525		

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made subsequent to June 5, 1905. It is well defined between gage heights 1.1 feet and 2 feet.

Estimated monthly discharge of Piney Creek at Kearney, Wyo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	86	29	42.2	2,511
May	540	60	196	12,050
June	1,450	244	510	30,350
July	282	78	142	8,731
August	78	24	41.3	2,539
September	36	28	29.7	1,767
October	58	24	35.3	2,170
November	52	41	45.8	2,725
The period				62,840

MISCELLANEOUS MEASUREMENT.

A measurement of Clark Fork at Bridger, Mont., made June 1, 1905, gave the following: Area of section, 755 square feet; mean velocity, 5.42 feet per second; discharge, 4,088 second-feet.

LITTLE MISSOURI RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

The Little Missouri rises in the central part of Crook County, in northeastern Wyoming, flows northeastward, crossing the southeast corner of Montana and the northwest corner of South Dakota, and empties into the Missouri in North Dakota, in the Fort Berthold Indian Reservation. The upper portion of the basin is mountainous, but the stream flows for the most part through a rolling country bounded in places by ranges of steep hills carrying some timber. The soil is partly a sandy loam and partly gumbo, and there is little land under cultivation. The stream receives numerous small tributaries, most of which are dry for the greater part of the year. The main floods occur during March, May, June, and July. During the rainy season some water is diverted from the tributaries and a small quantity is stored for irrigation.

LITTLE MISSOURI RIVER AT ALZADA, MONT.

This station was established April 3, 1904. It is located at the highway bridge on the old Spearfish and Miles City stage road, about one-half mile northwest of Alzada, Mont.

The channel is straight both above and below the station for about 200 feet. Both banks are high, but are liable to overflow at extreme high water. The bed of the stream is composed of fine silt and is fairly permanent. The current is moderately swift, except at low

water. There is but one channel, broken by the middle crib pier of the bridge. This pier and the ice breaker just above are the only obstructions in the channel at the station. Willows and brush on the banks tend to retard the flow during high water. Below the station the willows grow in some places so that their branches reach nearly across the channel. The stream is frozen from about December 20 to March 10, and observations are discontinued during that time.

Discharge measurements are made at high stages from the downstream side of the bridge. The initial point for soundings is a bolt in the downstream hand rail near the left end of the bridge. Low-water measurements are made by wading one-half mile above the gage.

The gage, which was read during 1905 once each day by Miss Elsie King, consists of a plain staff attached vertically to the downstream side of the crib pier supporting the middle of the bridge. The gage is referred to bench marks as follows: (1) A spike driven into the base of a tree about 50 feet west of the left end of the bridge; elevation above the zero of the gage, 16.33 feet. (2) A United States Geological Survey standard bench mark in front of the Alzada post-office, about 2,000 feet distant; elevation above sea level, 3,428 feet, and above the zero of the gage, 26.82 feet. The elevation of the gage zero above sea level is 3,401.18 feet.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 140 to 143.

Discharge measurements of Little Missouri River at Alzada, Mont., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 21	H. D. Comstock	6	1.5	1.0	1.10	1.5
June 7	do	6	2.1	2.14	1.24	4.5
July 24	do	21	13.0	2.29	1.90	3.0
August 24	do				1.10	3.0

Daily gage height, in feet, of Little Missouri River at Alzada, Mont., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.6	1.2	1.1	1.4	2.2	1.5	5.3	1.0
2	.....	1.6	1.5	1.1	3.6	1.9	2.8	4.0	1.0
3	.....	1.5	4.4	2.0	13.0	1.2	2.2	3.3	1.0
4	.....	1.5	11.4	2.0	13.1	1.0	1.8	2.3	1.0
5	.....	1.1	12.6	1.8	3.8	2.0	1.4	1.4	1.0
6	.....	1.1	9.95	1.4	3.7	1.2	1.2	1.2	1.0
7	.....	1.1	4.6	1.2	3.4	1.2	1.2	1.1	1.0
8	.....	1.1	2.9	1.2	3.2	1.2	1.2	1.0	1.0
9	.....	1.1	1.6	3.0	2.7	1.2	1.2	1.0	1.0
10	.....	1.1	1.6	2.2	2.6	1.2	1.2	1.0	1.0
11	.....	1.1	1.6	1.5	2.5	1.2	1.2	1.0	1.0
12	.....	1.1	1.5	1.3	2.4	3.0	1.2	1.0	1.0
13	.....	1.1	1.3	1.2	2.3	6.0	1.2	1.0	1.0
14	.....	1.1	1.3	1.1	3.0	4.0	1.0	1.0	1.0
15	1.4	1.1	1.3	8.5	3.5	2.0	1.0	1.0	1.0
16	1.4	1.4	1.2	3.0	2.2	1.5	1.0	1.0	1.0
17	1.4	1.4	1.2	9.7	4.0	1.2	1.0	1.0	1.0
18	1.4	1.4	1.1	14.0	3.2	1.2	1.0	1.0	1.0
19	1.4	1.3	1.1	12.6	2.0	1.2	1.0	1.0	1.0
20	1.4	1.2	1.2	11.5	7.0	1.2	1.0	1.0	1.0
21	1.4	1.2	1.2	4.0	6.5	1.0	1.0	1.0	1.0
22	1.4	1.2	1.2	2.2	4.5	1.0	1.0	1.4	1.0
23	1.4	1.2	1.3	2.5	3.0	1.0	1.0	3.8	1.0
24	1.4	1.2	1.1	2.7	2.0	1.0	1.0	2.4	1.0
25	1.4	1.2	1.1	3.0	3.0	1.0	1.0	1.2	1.0
26	1.4	1.2	1.2	3.2	4.3	1.0	1.0	1.2	1.0
27	1.4	1.2	1.2	2.0	5.0	1.0	1.0	1.0	1.0
28	1.7	1.2	1.1	1.6	4.0	1.2	1.0	1.0	1.0
29	1.7	1.2	1.1	1.5	7.0	1.0	1.0	1.0	1.0
30	1.7	1.2	1.1	1.4	3.9	1.0	6.0	1.0	1.0
31	1.7	.....	1.1	.....	2.6	10.0	.....	1.0	.....

Station rating table for Little Missouri River at Alzada, Mont., from March 15, to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	1	2.30	67	3.60	178	4.90	300
1.10	2	2.40	75	3.70	187	5.00	310
1.20	4	2.50	83	3.80	196	5.10	320
1.30	7	2.60	91	3.90	205	5.20	330
1.40	10	2.70	99	4.00	214	5.30	340
1.50	14	2.80	107	4.10	223	5.40	350
1.60	19	2.90	115	4.20	232	5.50	360
1.70	24	3.00	124	4.30	241	5.60	370
1.80	30	3.10	133	4.40	250	5.70	380
1.90	37	3.20	142	4.50	260	5.80	390
2.00	44	3.30	151	4.60	270	5.90	400
2.10	51	3.40	160	4.70	280	6.00	411
2.20	59	3.50	169	4.80	290		

The above table is applicable only for open-channel conditions. It is based on 12 discharge measurements made during 1904-5, and is well defined between gage heights 1 foot and 6 feet. Above 3 feet the table is the same as that for 1904. Above 6 feet the discharge is only approximate.

Estimated monthly discharge of Little Missouri River at Alzada, Mont., for 1905.

[Drainage area, 600 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 15–31	24	10	13.3	449	0.022	0.014
April	19	2	5.6	333	.0093	.010
May	1,173	2	124	7,624	.207	.239
June	1,354	2	212	12,620	.353	.394
July	1,237	10	245	15,060	.408	.470
August	861	1	60.2	3,702	.100	.115
September	411	1	22.6	1,345	.038	.042
October	340	1	35.4	2,177	.059	.068
November	1	1	1.0	60	.0017	.0019
The period				43,370		

LITTLE MISSOURI RIVER AT CAMP CROOK, S. DAK.

This station was established September 2, 1903. It is located near the old highway bridge on the road from Camp Crook to Belle Fourche, about one-half mile from Camp Crook, in T. 18 N., R. 1 E.

The channel is straight for 300 feet above and 400 feet below the station. Both banks are sparsely wooded, and the left bank overflows at high water. The bed is sandy and somewhat shifting. There is but one channel at all stages. The current is sluggish at low water. The river is frozen from about December 20 to March 10, and observations are discontinued during that time. Gage heights range from zero to 10 feet.

High-water measurements are made from a car and cable 200 feet above the old bridge. The cable is marked at 10-foot intervals with white paint. The initial point for soundings is the left cable support. Low-water measurements are made by wading near the cable. The gage was read once each day during 1905 by Paul A. Chuning. The original gage was destroyed by floods in the spring of 1904. The present temporary gage, established April 20, 1905, consists of three parts—a staff driven in the center of the channel, a staff driven on the left bank, and a timber spiked to the left abutment of the old bridge. This gage will be replaced by a permanent gage on the steel bridge now being erected. The gage is referred to bench marks as follows: (1) A spike driven in a blaze 6 inches above ground on a tree near the road, 100 feet from the right end of the bridge; elevation, 10.53 feet above the zero of the gage. (2) A spike driven in a blaze 6 inches above ground on a tree across the road from bench mark No. 1 and 175 feet farther downstream; elevation above the zero of the gage, 12.89 feet.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 73; 130, pp 143–144.
Discharge: 99, p 74; 130, p 144.
Discharge, monthly: 130, p 146.
Gage heights: 99, p 74; 130, p 145.
Rating table: 130, p 145.

Discharge measurements of Little Missouri River at Camp Crook, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage. height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 20	H. D. Comstock	64	24	1.00	0.45	24
June 4	do	28	17	.61	.34	10.3
June 6	do	21	5.5	1.42	.31	7.8
July 25	do	114	197	2.12	2.15	418
July 26	do	110	166	1.77	1.90	294
August 23	Stevens and Comstock	68	48	1.10	.69	53

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Little Missouri River at Camp Crook, S. Dak., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	0.3	0.4	1.1	4.0	5.0	0.4	0.9
2	.....	.3	.4	3.2	3.5	5.6	3.7	.8
3	.....	.3	.4	5.85	2.7	3.0	2.9	.7
4	.....	1.1	.4	6.7	1.9	2.25	2.7	.7
5	.....	3.0	.4	6.0	1.7	2.0	2.6	.6
6	.....	4.0	.4	5.1	1.7	1.8	2.4	.6
7	.....	4.0	.3	2.2	1.6	1.7	1.7	.6
8	.....	2.6	.3	1.9	1.4	1.7	1.2	.5
9	.....	1.6	.4	1.8	1.2	1.7	.7	.5
10	.....	1.3	.4	2.0	1.0	.7	.5	.5
11	.....	1.3	.4	2.0	.9	.6	.5	.5
12	.....	.9	.5	2.0	.8	.5	.5	.5
13	.....	.8	.9	1.8	.7	.5	.5	.4
14	.....	.8	.85	1.8	.7	.5	.5	.4
15	.....	.6	.8	1.4	2.0	.5	.5	.4
16	.....	.55	4.9	2.0	2.1	.5	.5	.4
17	.....	.5	5.6	6.8	1.7	.5	.5	.4
18	.....	.5	7.0	5.1	1.0	.5	.5	.4
19	.....	.5	7.6	3.0	.9	.4	.7	.4
20	0.45	.5	5.6	2.4	.7	.4	.7	.4
21	.5	.5	4.5	1.5	.7	.3	.9	.4
22	.5	.5	3.3	1.6	.7	.3	1.0	.5
23	.4	.4	2.5	2.6	.6	.3	1.5	.5
24	.4	.4	1.6	2.6	.6	.3	1.6	.5
25	.4	.3	1.4	2.1	.6	.3	1.9	.5
26	.35	.3	1.8	1.7	.6	.3	2.5	.5
27	.3	.4	1.7	.8	.6	.3	1.9	.4
28	.3	.4	1.7	1.8	.6	.3	1.8	.4
29	.3	.4	1.6	4.2	.5	.3	1.5	.4
30	.3	.4	1.5	6.0	.5	.4	1.4	.4
31	.....	.4	.....	6.15	.5	.....	1.0	.....

Station rating table for Little Missouri River at Camp Crook, S. Dak., from April to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.20	3	1.00	93	1.70	270	2.40	523
.30	7	1.10	111	1.80	302	2.50	565
.40	16	1.20	132	1.90	335	2.60	608
.50	26	1.30	156	2.00	370	2.70	652
.60	37	1.40	182	2.10	406	2.80	697
.70	49	1.50	210	2.20	444	2.90	743
.80	62	1.60	239	2.30	483	3.00	790
.90	77						

The above table is applicable only for open-channel conditions. It is based on sixteen discharge measurements made during 1903–1905, and is well defined between gage heights 0.3 foot and 2.6 feet. The discharge above 3 feet is only approximate.

Estimated monthly discharge of Little Missouri River at Camp Crook, S. Dak., for 1905.

[Drainage area, 1,900 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
April 20–30	26	7	14.6	319	0.0077	0.0032
May	1,320	7	170	10,450	.089	.103
June	3,480	7	608	36,180	.320	.357
July	3,000	62	961	59,090	.506	.583
August	1,320	26	208	12,790	.109	.126
September	2,280	7	244	14,520	.128	.143
October	1,147	16	229	14,080	.121	.140
November	77	16	27.2	1,618	.014	.016
The period				149,000		

LITTLE MISSOURI RIVER AT MEDORA, N. DAK.

This station was established May 12, 1903. It is located at the Northern Pacific Railway bridge, one-third mile west of the railroad station at Medora, N. Dak.

The channel is straight for 100 feet above the station and 300 feet below. The right bank is clean, low, and overflows at very high stages; the left bank is almost perpendicular and has a height of 30 feet above gage datum. The bed of the stream is of clay and sand, and sometimes scours from 5 to 8 feet during floods; at ordinary stages the bed changes only slightly. There is but one channel, broken by three piers, according to the stage of the river. In the latter part of 1903 the cross section at the bridge was temporarily changed during repairs to the bridge by the railroad company, continuing several months.

Discharge measurements are made from the railroad bridge to which the gage is attached. The initial point for soundings is the left end of the guard rail on the lower side of the bridge, 2.9 feet west of the east face of the concrete abutment.

The gage was read during 1905 by W. A. Brubaker and P. E. Anderson. A standard chain gage is located on the lower side of the railroad bridge at a point 91 feet from the initial point for soundings. There is also a vertical board gage reading from 1 foot to 9 feet, fastened to a pile in the river about 200 feet above the bridge. August 7, 1905, on account of the bridge having been changed by the railroad, a chain length of 30.92 feet was

established, which made the readings agree with the timber gage. The bench mark is the top of the southwest corner of the concrete abutment on the left bank; elevation above gage datum, 30.11 feet. The top of the gage pulley is 31.6 feet above the gage datum, which is about 2,230 feet above sea level, as determined by hand level from the railroad station at Medora, N. Dak.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, pp 70–71; 130, pp 146–147.
Discharge: 99, p 71; 130, p 147.
Discharge, monthly: 99, p 73; 130, p 149.
Gage heights: 99, pp 71–72; 130, pp 147–148.
Rating table: 99, p 72; 130, p 148.

Discharge measurements of Little Missouri River at Medora, N. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 26	E. F. Chandler	59	130	.95	3.60	123
July 7	Chandler and Richards	183	1,026	4.19	8.45	4,302
July 8	do	180	959	4.73	8.08	4,539
Do	E. F. Chandler	180	966	4.27	8.13	4,124
Do	R. Richards	181	975	4.30	8.18	4,195
August 6	do	143	456	2.75	5.96	1,256
August 7	do	135	398	2.61	5.61	1,038
August 24	do	88	173	1.55	4.01	269
October 16	do	74	186	.87	3.72	161

Daily gage height, in feet, of Little Missouri River at Medora, N. Dak., for 1905.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	7.2	3.3	2.6	3.2	9.8	5.8	3.5	4.0	3.6
2	.....	7.0	3.2	2.6	3.2	10.2	5.6	3.5	4.0	5.1
3	.....	6.5	3.2	2.6	3.1	9.8	6.8	3.4	4.0	5.0
4	.....	6.5	3.2	2.6	8.7	7.6	7.2	3.4	4.0	4.8
5	.....	6.3	3.2	2.6	9.4	8.8	7.3	3.4	4.0	5.0
6	.....	5.4	3.2	2.6	8.5	9.2	6.4	6.0	5.0	4.9
7	.....	4.2	3.2	2.6	9.3	8.6	5.1	5.6	5.0	4.7
8	.....	4.1	3.2	2.6	8.2	8.2	6.0	5.0	5.0	4.4
9	.....	4.0	3.1	2.8	7.3	7.9	6.1	4.7	4.9	4.2
10	.....	4.0	3.1	2.9	6.1	7.4	5.9	4.5	4.8	4.0
11	.....	4.0	3.0	3.5	6.0	7.2	5.5	4.3	4.6	3.8
12	.....	4.0	3.0	3.5	5.8	7.2	5.1	4.1	4.4	3.6
13	.....	4.0	3.0	3.8	5.2	6.7	4.9	4.0	4.2	3.6
14	.....	4.0	3.0	3.8	6.3	6.0	4.3	4.0	4.0	3.5
15	.....	3.9	3.0	3.7	5.8	5.3	4.0	4.0	4.0	3.5
16	.....	3.9	2.9	3.6	6.4	5.0	8.8	3.8	4.0	3.5
17	.....	3.9	2.9	3.6	5.4	4.7	4.0	3.6	3.9	3.5
18	.....	3.9	2.9	3.6	5.1	4.5	4.2	3.4	3.8	3.5
19	.....	3.8	2.9	3.6	4.6	5.2	4.0	3.4	3.8	3.4
20	.....	3.8	2.8	3.6	6.6	8.8	3.8	3.2	3.7	3.4
21	.....	3.8	2.8	3.6	7.8	8.5	3.7	3.0	3.6	3.4
22	.....	3.7	2.8	3.5	7.9	8.3	3.7	3.0	3.6	3.4
23	.....	3.6	2.7	3.5	9.2	8.8	3.7	2.8	3.6	3.4
24	.....	3.6	2.7	3.5	8.2	9.0	3.7	2.8	3.5	3.4
25	3.0	3.6	2.6	3.4	8.6	7.9	3.7	2.6	3.4	3.4
26	3.3	3.5	2.6	3.3	7.0	7.3	3.7	2.6	3.6	3.4
27	4.5	3.5	2.6	3.3	6.8	7.2	3.6	2.5	3.4	3.4
28	4.9	3.5	2.6	3.3	6.6	7.0	3.6	2.4	3.4	3.4
29	.....	3.4	2.6	3.2	6.5	7.7	3.6	4.5	3.4	.....
30	.....	3.4	2.6	3.2	6.3	6.1	3.5	4.0	3.3	.....
31	.....	3.3	.....	3.2	.....	6.1	3.5	.....	3.3	.....

NOTE.—River frozen January 1 to February 28, during part of the time frozen to bottom in places, the discharge being very small. Also frozen November 28 to December 31.

Station rating table for Little Missouri River at Medora, N. Dak., from February 28 to November 28, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.40	1.9	3.90	223	5.30	870	7.40	2,405
2.50	2.2	4.00	260	5.40	925	7.60	2,600
2.60	2.7	4.10	298	5.50	980	7.80	2,805
2.70	3.3	4.20	338	5.60	1,035	8.00	3,015
2.80	4.1	4.30	380	5.70	1,095	8.20	3,230
2.90	5.2	4.40	424	5.80	1,155	8.40	3,450
3.00	6.8	4.50	470	5.90	1,215	8.60	3,675
3.10	9.8	4.60	520	6.00	1,280	8.80	3,905
3.20	15	4.70	570	6.20	1,410	9.00	4,140
3.30	29	4.80	620	6.40	1,555	9.20	4,380
3.40	54	4.90	670	6.60	1,710	9.40	4,620
3.50	85	5.00	720	6.80	1,870	9.60	4,860
3.60	118	5.10	770	7.00	2,040	9.80	5,100
3.70	152	5.20	820	7.20	2,220	10.00	5,340
3.80	187						

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1904–5, and is well defined between gage heights 3.2 feet and 6 feet. It has been extended beyond these limits, being based on three high-water measurements near 8 feet gage height. Above 6 feet the table can be considered as only approximate.

Estimated monthly discharge of Little Missouri River at Medora, N. Dak., for 1905.[a]

[Drainage area, 5,785[a] square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March	2,220	29	467	28,720	0.081	0.093
April	29	2.7	8.1	483	.0014	.0016
May	187	2.7	60.5	3,720	.010	.012
June	4,620	9.8	2,016	120,000	.349	.389
July	5,580	470	2,696	165,800	.467	.538
August	3,905	85	781	48,020	.135	.157
September	1,280	1.9	235	13,980	.041	.046
October	720	29	271	16,660	.047	.054
November 1–28	770	54	236	13,110	.041	.043
The period				410,500		

[a] Revised since 1904 report.

KNIFE RIVER DRAINAGE BASIN.

KNIFE RIVER AT BRONCHO, N. DAK.

Knife River rises in the northeastern part of Billings County, N. Dak., flows southeastward, then northeastward, and unites with the Missouri near Stanton, Mercer County, N. Dak.

The gaging station was established May 29, 1903. Its first location was at a point about 600 feet east of H. M. Haven's ranch house, where the Broncho post-office was situated at that time, and about 23 miles north of Hebron, N. Dak., on the Northern Pacific Railway. Owing to the abandonment of the Haven ranch and the removal of the post-office to the

house of F. M. Smith, in the SE. ¼ sec. 4, T. 142, R. 90 W., about 3 miles up the valley, the location was abandoned and a new station was established at the ranch of Mr. Smith. As no streams enter the river between the two points the run-off will be practically identical.

The channel is straight for 150 feet above the station and 400 feet below. Both banks are high and grassy and not subject to overflow. The bed of the stream is composed of firm clay and silt and may scour a little, but does not shift. The current at the cable is sluggish except at high stages.

Discharge measurements are made by means of a cable and car. The initial point for soundings is at the cable support on the right bank. Distances from the initial point are determined by a tagged line of heavy telegraph wires. Low-water measurements are made by wading a few rods below the gage.

The gage, which was read during 1905 by Sara J. Smith, is of the standard chain type, mounted on a projecting timber extending horizontally out over the water and substantially braced and guyed. The length of the chain is 32.65 feet. The distance from the center of the gage pulley to the zero of the scale is 11.7 feet, and the diameter of the pulley is 0.22 foot. The elevation of the center of the pulley, referred to the gage datum, is 20.86 feet, while that of the horizontal gage scale timber at the shore end is 21.03 feet. Supplementary to the chain gage are two rod gages driven into the left bank about 75 feet downstream from the chain gage, consisting of timbers braced to posts in the bank. The lower section reads from 2.6 to 9 feet; the upper reads from 9 to 13.9 feet. The chain gage is referred to bench marks as follows: (1) A cross on the top of a gray granite bowlder 1 foot in diameter, set flush with the ground in the line of the gage timber prolonged 5 feet behind the inner end of same; elevation above the zero of the gage, 21.15 feet. (2) A horizontal line of five nails driven into a joint of the stone foundation of the observer's house, 3 inches from the southeast corner; elevation above the gage datum, 31.25 feet.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 68; 130, pp 149–150.
Discharge: 99, p 69; 130, p 150.
Discharge, monthly: 99, p 70.
Gage heights: 99, p 69; 130, p 150.
Rating table: 99, p 70.

Discharge measurements of Knife River at Broncho, N. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 23	E. F. Chandler	10	8.6	2.12	3.89	18
July 3	Chandler and Richards	10	8.4	1.16	3.60	9.8
July 5	do	52	261	2.42	7.51	632
July 5	do	47	233	2.09	6.92	486
August 5	R. Richards	32	40	1.09	4.05	44
August 26	do	11	2.9	.70	3.35	2
October 17	do	9	6.3	.50	3.37	3.1

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Knife River at Broncho, N. Dak., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	3.7	3.4	3.5	3.6	3.35	3.2	3.45	3.3
2	.....	3.7	3.4	3.45	3.6	3.4	3.2	3.3	3.3
3	.....	3.65	3.4	3.4	3.6	5.8	3.2	3.35	3.4
4	.....	3.65	3.42	3.8	3.6	4.2	3.2	3.4	3.4
5	.....	3.6	3.6	6.1	7.2	3.95	3.15	3.3	3.4
6	.....	3.6	3.6	4.4	6.5	3.65	3.1	3.4	3.4
7	.....	3.6	3.6	7.4	4.8	3.6	3.1	3.3	3.4
8	.....	3.6	3.6	6.5	4.4	3.6	3.1	3.3	3.4
9	.....	3.55	3.6	6.0	4.2	3.5	3.2	3.3	3.45
10	.....	3.55	3.8	4.65	4.1	3.45	3.2	3.3	3.45
11	.....	3.55	3.7	4.3	3.9	3.45	3.2	3.3	3.4
12	.....	3.52	3.9	4.15	3.95	3.45	3.2	3.3	3.4
13	.....	3.5	3.8	4.1	3.9	3.4	3.2	3.3	3.4
14	.....	3.5	3.8	3.9	3.85	3.5	3.3	3.3	3.4
15	.....	3.5	3.8	3.9	3.7	3.5	3.25	3.3	3.5
16	.....	3.5	3.7	3.9	3.9	3.5	3.25	3.35	3.4
17	.....	3.5	3.7	3.9	5.0	3.5	3.2	3.35	3.4
18	.....	3.5	3.65	4.1	4.4	3.45	3.2	3.35	3.4
19	.....	3.5	3.6	4.1	4.0	3.45	3.3	3.35	3.4
20	.....	3.45	3.6	4.0	3.9	3.4	3.4	3.3	3.4
21	.....	3.45	3.55	4.05	3.8	3.4	3.3	3.3	3.4
22	.....	3.4	3.5	4.15	3.8	3.3	3.2	3.3	3.4
23	3.9	3.4	3.5	4.0	3.6	3.3	3.4	3.3	3.4
24	3.8	3.4	3.55	3.9	3.6	3.3	3.2	3.3	3.4
25	3.9	3.4	3.5	3.8	3.53	3.3	3.3	3.3	3.4
26	3.8	3.4	3.45	3.7	3.5	3.25	3.25	3.3	3.4
27	3.8	3.4	3.45	3.7	3.5	3.25	3.25	3.3	.....
28	3.75	3.4	3.4	3.7	3.5	3.25	3.25	3.3	.....
29	3.7	3.4	3.5	3.6	3.45	3.25	3.25	3.3	.....
30	3.7	3.4	3.55	3.6	3.45	3.2	3.4	3.3	.....
31	3.7	.....	3.65	.....	3.4	3.2	.....	3.3	.....

NOTE.—River frozen over November 27.

HEART RIVER DRAINAGE BASIN.

HEART RIVER NEAR RICHARDTON, N. DAK.

Heart River rises in eastern Billings County, N. Dak., flows eastward and southeastward for about 100 miles by general course, then turns abruptly to the north and northeast and enters the Missouri near Bismarck, N. Dak.

The gaging station was established May 18, 1903. It is located at the iron highway bridge 10 miles south of the Northern Pacific Railway station at Richardton, N. Dak.

The channel is straight for 150 feet above and below the station. Both banks are high and covered with brush. The bed of the stream is sandy and shifting. The velocity of the current is moderate.

Discharge measurements are made from the bridge to which the gage is attached. The initial point for soundings is the end of the guard rail on the lower side of the bridge, at the left bank.

A standard chain gage, which was read once each day during 1905 by W. F. Church, is located on the lower side of the bridge. The length of the chain is 24.34 feet. The gage is referred to bench marks as follows: (1) The top of the foot-guard rail at a distance of 45 feet from the initial point for soundings; elevation above gage datum, 25.58 feet. (2) On top of the iron flanges around the top of the downstream eastern edge of the concrete iron pier on the lower side of the bridge, on the left bank; elevation above gage datum, 24.79 feet.

The top of the gage pulley has the same elevation as bench mark No. 1. Gage datum is 2,150 feet above sea level, as determined by carrying an aneroid barometer six times between this point and the railroad station at Richardton.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 66; 130, p 151.
Discharge: 99, p 66; 130, p 151.
Discharge, monthly: 99, p 68; 130, p 153.
Gage heights: 99, p 67; 130, p 152.
Rating table: 99, p 67; 130, p 152.

Discharge measurements of Heart River near Richardton, N. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 25	E. F. Chandler	36	24	0.70	4.64	17
July 7	do	66	203	1.60	6.88	325
August 8	R. Richards	15.5	6.6	.75	4.24	5.0
August 24	do	4.6	1.3	.64	4.00	.9
October 16	do	7.0	4.5	.64	4.14	2.9

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Heart River near Richardton, N. Dak., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	6.6	4.5	4.1	4.2	4.4	4.3	3.8	4.1	4.2
2	7.25	4.5	4.1	4.2	4.4	4.3	3.8	4.1	4.2
3	6.8	4.5	4.1	4.2	4.4	4.3	3.8	4.1	4.2
4	6.1	4.4	4.2	4.2	4.4	4.3	3.8	3.9	4.2
5	6.1	4.4	4.3	6.7	9.1	4.3	3.8	3.9	4.2
6	6.1	4.4	4.3	5.4	9.1	4.3	3.8	3.9	4.2
7	5.6	4.3	4.3	5.1	7.4	4.3	3.8	3.9	4.3
8	5.5	4.3	4.3	5.5	6.2	4.2	3.8	3.9	4.3
9	5.5	4.3	4.3	5.7	5.6	4.2	3.8	4.2	4.3
10	5.5	4.3	4.4	5.1	5.3	4.2	3.8	4.3	4.3
11	5.5	4.3	4.4	4.9	5.1	4.2	3.8	4 3	4.3
12	5.4	4.3	4.4	4.9	5.0	4.2	3.8	4.2	4.3
13	5.1	4.3	4.3	4.7	4.9	4.2	3.8	4.2	4.3
14	5.0	4.3	4.3	4.6	4.8	4.2	3.8	4.1	4.3
15	4.9	4.3	4.3	4.6	5.55	4.2	3.8	4.1	4.3
16	4.9	4.3	4.3	4.5	7.05	4.2	3.8	4.1	4.3
17	4.8	4.2	4.3	4.5	6.6	4.1	3.8	4.0	4.3
18	4.8	4.2	4.3	4.6	6.0	4.1	3.8	4.0	4.3
19	4.8	4.2	4.3	4.7	5.7	4.1	3.8	4.0	4.3
20	4.8	4.2	4.3	4.7	5.0	4.1	4.5	4.0	4.4
21	4.7	4.2	4.3	4.6	5.1	4.1	4.5	4.0	4.4
22	4.7	4.2	4.3	4.6	4.6	4.0	4.4	4.0	4.4
23	4.7	4.2	4.3	4.7	4.6	4.0	4.3	4.0	4.4
24	4.6	4.2	4:3	4.8	4.6	4.0	4.3	4.0	.....
25	4.6	4.2	4.3	4.7	4.5	4.0	4.3	4.1	.....
26	4.6	4.2	4.3	4.7	4.5	4.0	4.2	4.1	.....
27	4.6	4.2	4.3	4.6	4.5	4.0	4.2	4.1	.....
28	4.6	4.1	4.2	4.5	4.4	4.0	4.1	4.1	.....
29	4.5	4.1	4.2	4.5	4.4	3.9	4.1	4.2	.....
30	4.5	4.1	4.2	4.4	4.4	3.9	4.1	4.2	.....
31	4.5	.....	4.2	.....	4.4	3.9	.....	4.2	.....

NOTE.—River frozen January 1 to February 26 and November 24 to December 31.

Station rating table for Heart River near Richardton, N. Dak., from March 1 to November 23, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
3.90	0.5	5.00	42	6.10	187	7.40	430
4.00	1	5.10	51	6.20	204	7.60	471
4.10	2	5.20	61	6.30	221	7.80	513
4.20	4	5.30	72	6.40	238	8.00	556
4.30	6	5.40	84	6.50	256	8.20	600
4.40	9	5.50	97	2.60	274	8.40	645
4.50	12	5.60	110	6.70	292	8.60	692
4.60	16	5.70	124	6.80	310	8.80	740
4.70	21	5.80	139	6.90	330	9.00	788
4.80	27	5.90	155	7.00	350		
4.90	34	6.00	171	7.20	390		

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during 1905 and one high-water measurement during 1904. It is well defined between gage heights 4 feet and 5 feet, and has been extended beyond these limits, being based on one measurement at 6.9 feet and one at 11 feet. Above 7 feet the estimate can be considered only approximate.

Estimated monthly discharge of Heart River near Richardton, N. Dak., for 1905.

[Drainage area, 1,250 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March	400	12	83.1	5,110	0.066	0.076
April	12	2	5.8	345	.0046	.0051
May	9	2	5.6	344	.0045	.0052
June	292	4	36.3	2,160	.029	.032
July	812	9	125	7,686	.100	.115
August	6	.5	3.1	191	.0025	.0029
September	12	.0	2.2	131	.0017	.0019
October	6	.5	2.2	135	.0017	.0020
November 1–23	9	4	6.0	274	.0048	.0041
The period				16,380		

APPLE CREEK DRAINAGE BASIN.

APPLE CREEK NEAR BISMARCK, N. DAK.

A temporary station was established on Apple Creek 6 miles east of Bismarck, N. Dak., at the bridge on the township line between sec. 3, T. 138, and sec. 34, T. 139. The gage was read by William S. Hedges.

Discharge measurements of Apple Creek near Bismarck, N. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 2	Walter Skelton	16	10.8	0.99	3.20	10.7
March 6	do	27	95	2.12	6.10	200
March 8	do	21	84	2.10	5.50	159
March 24	do	9.5	15.3	1.02	1.05	15.8
April 5	do	8.5	13.6	1.12	.90	15.2
April 19	do	6	7.0	.94	.35	6.6
May 29	do	6	7.3	.80	.50	5.8
June 6	do	18	52	1.19	2.90	62
June 7	do	18	38	1.06	2.30	40
June 9	do	35	159	1.53	6.65	243
June 10	do	24	90	1.44	4.60	130

Daily gage height, in feet, of Apple Creek near Bismarck, N. Dak., for 1905.

Day.	Feb.	Mar.	Apr.	May.	June.	Day.	Feb.	Mar.	Apr.	May.	June.
1	.....	3.4	0.95	0.3	0.5	17	.....	2.6	.3	1.0	1.5
2	.....	3.4	.8	.3	.5	18	.....	2.4	.3	1.0	1.4
3	.....	3.45	.8	.3	.5	19	.....	2.3	.35	.9	1.4
4	.....	3.75	.95	.3	.5	20	.....	2.2	.3	.7	1.3
5	.....	4.4	.9	.4	2.45	21	.....	2.15	.3	.6	1.3
6	.....	6.05	.9	.3	2.95	22	.....	.....	.3	.6	1.3
7	.....	6.45	.8	.3	2.35	23	.....	.....	.3	.6	1.3
8	.....	5.7	.7	.3	3.45	24	.....	1.05	.3	.6	1.3
9	.....	5.4	.7	.4	6.59	25	.....	1.1	.3	.6	1.3
10	.....	5.2	.6	.5	4.6	26	.....	1.1	.3	.5	1.4
11	.....	4.0	.5	.6	4.8	27	3.4	1.1	.3	.5	1.4
12	.....	3.75	.5	.7	4.0	28	3.4	1.1	.2	.5	2.1
13	.....	3.2	.5	.7	2.0	29	.....	1.05	.2	.5	.....
14	.....	3.0	.5	.8	1.5	30	.....	1.0	.2	.5	.....
15	.....	2.8	.5	.9	1.5	31	.....	1.0	.....	.5	.....
16	.....	2.6	.4	1.0	1.5						

NOTE.—Flow commenced February 27.

Estimated monthly discharge of Apple Creek near Bismarck, N. Dak., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March	307	10	54.7	3,363
April	15	5	8.8	524
May	16	5	9.0	553
June 1-21	244	6	50.0	2,082

NOTE.—These estimates are only approximate.

CANNON BALL RIVER DRAINAGE BASIN.

CANNON BALL RIVER AT STEVENSON, N. DAK.

Cannon Ball River is formed by two chief branches—North and South forks. North Fork rises in White Butte, in southern Billings County, N. Dak., flows northeastward for about 20 miles and then turns abruptly to the southeast; South Fork rises in Whetstone Butte, in the western part of Hettinger County, runs southeastward for approximately 40 miles and then turns northeastward; the two streams unite about 5 miles south of Three Buttes, in south-central Morton County, whence the main stream flows to the north and east, entering the Missouri about 25 miles southeast of Bismarck, N. Dak.

The gaging station was established June 10, 1903. It is located one-half mile west-northwest of the post-office at Stevenson, in sec. 20, T. 133 N., R. 82 W., and about 40 miles south of Mandan, N. Dak.

The channel is straight for 100 feet above the station and 400 feet below. The right bank is low, slopes gradually up from the water's edge, and is covered with timber and brush; the left bank is steep and about 25 feet high. The bed of the stream consists of clay, soft mud, and loose stones, and probably shifts somewhat. The depth varies from 2 to 5 feet at low stages. The current velocity is ordinarily sluggish.

Discharge measurements are made from a car and cable about 200 feet above the gage. A tagged wire is stretched above the cable. The initial point for soundings is a point 2 feet back from the cable support on the left bank.

The gage, which was read during 1905 by Donald Stevenson, is of the chain type and was put in June 30, 1905, to replace the old gage, which was in bad condition. The new gage has a chain length of 21.76 feet. The gage is supported by four solidly set posts on top of which is a horizontal timber, and is well braced and guyed. The pulley diameter is 0.31 foot and the distance from its center to the zero of the scale is 5.57 feet. The elevation of the highest point (marked with a cross), which is near the east corner of the flat top of a large granite rock, 4 by 9 feet, rising out of a pool to the right of its middle a few feet below the gage, is 4.84 feet above gage datum. The datum of the gage is about 1,700 feet above sea level, as determined by carrying an aneroid barometer six times between this station and Mandan, N. Dak.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 64; 130, pp 153-154.
Discharge: 99, p 65; 130, p 154.
Gage heights, 99, p 65; 130; p 154-155.

Discharge measurements of Cannon Ball River at Stevenson, N. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 28	E. F. Chandler	114	168	0.59	3.56	99
June 29[a]	do	40	56	2.19	3.45	123
June 30[a]		68	132	.87	3.49	114
August 3[a]	R. Richards	68	120	.85	3.52	102
August 28[a]	do	38	32	.62	2.88	20
August 29[a]	do	34	21	.92	2.85	19
October 17[a]	E. F. Chandler	14	9.6	.50	2.61	4.8

[a] Made by wading.

Daily gage height, in feet, of Cannon Ball River at Stevenson, N. Dak., for 1905.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	7.4	3.7	2.8	2.5	3.5	3.0	2.9	2.0	3.0
2	.....	7.2	3.5	2.9	2.7	3.5	3.3	2.9	1.8	3.0
3	.....	7.0	3.5	3.2	2.8	3.5	3.5	2.7	1.8	3.1
4	.....	6.9	3.4	4.1	2.8	4.1	3.2	2.7	1.9	3.2
5	.....	6.2	3.3	5.2	6.2	4.3	3.8	2.6	1.9	3.2
6	.....	6.2	3.3	5.7	6.2	4.5	3.3	2.5	1.9	3.2
7	.....	6.0	3.3	5.7	6.1	4.8	3.0	2.5	1.9	3.1
8	.....	3.9	3.2	5.6	7.1	5.2	2.8	2.4	1.5	3.1
9	.....	4.0	3.2	5.1	6.5	4.7	2.6	2.3	1.5	2.9
10	.....	4.1	3.2	4.8	3.6	4.5	2.6	2.6	1.5	2.7
11	.....	4.2	3.1	4.8	3.5	4.3	2.4	2.6	1.3	2.7
12	.....	4.2	3.1	4.3	3.5	5.2	2.6	2.5	1.0	2.7
13	.....	4.2	3.2	3.8	3.2	5.0	2.6	2.3	.8	2.7
14	.....	4.1	3.2	3.6	2.9	4.5	2.7	2.3	.8	2.8
15	.....	4.1	3.3	3.3	2.9	4.4	2.7	2.5	.8	2.8
16	.....	3.9	3.1	3.3	2.8	4.6	2.8	2.6	2.4	2.8
17	.....	3.9	3.1	3.2	2.6	5.3	2.9	2.8	2.6	2.9
18	.....	3.7	3.0	3.2	2.6	5.0	2.9	2.8	2.6	2.9
19	.....	3.7	3.0	3.0	2.4	4.7	3.9	2.7	2.6	2.9
20	.....	3.7	3.0	3.0	2.4	4.7	3.9	2.7	2.7	2.9
21	.....	3.8	2.9	3.0	2.9	3.5	3.8	2.5	2.7	2.8
22	.....	4.0	2.8	3.1	2.9	3.3	3.8	2.5	2.8	2.9
23	4.7	3.7	2.8	3.1	3.9	3.5	4.0	2.6	2.8	2.9
24	5.7	3.5	2.8	2.9	3.8	3.4	4.0	2.4	2.9	3.0
25	6.4	3.4	2.7	2.8	3.4	3.2	3.8	2.4	2.9	3.0
26	8.4	3.5	2.7	2.6	3.3	3.2	2.9	2.3	2.8	.....
27	8.9	3.4	2.7	2.6	3.3	3.0	3.0	2.2	2.8	.....
28	8.0	3.6	2.6	2.6	2.6	3.0	3.2	2.2	2.7	.....
29	.....	3.6	2.8	2.5	2.9	2.8	3.2	2.0	2.8	.....
30	.....	3.7	2.8	2.5	3.5	2.8	3.1	2.0	2.8	.....
31	.....	3.8	.....	2.5	.....	3.0	3.0	.....	2.9	.....

NOTE.—River frozen November 26.

GRAND RIVER DRAINAGE BASIN.

GRAND RIVER AT SEIM, S. DAK.

Grand River is formed by North and South forks, which rise in the hills of northwestern South Dakota and unite at Seim, whence the main stream flows eastward to its point of junction with the Missouri. The country drained is gently rolling and the soil is a sandy loam. There is very little land under cultivation. The only timber is along the banks of the river and its few tributaries. The main floods occur in March, May, June, and July.

The gaging station was established June 6, 1904. It is located just below the junction of North and South forks, about 800 feet east of the store at Seim. The channel is curved for about 200 feet above and 300 feet below the station. The right bank is low, somewhat wooded with scattered trees, and is subject to overflow; the left bank is high and clean and does not overflow. The bed is composed of sand and gravel and is free from vegetation and permanent. There is but one channel at high water, but during low stages there are three channels above the gage and one channel below. The current is swift. The flow ceases for a month or more in August and September. Gage heights range from 1.5 to 10 feet.

Discharge measurements are made by wading near the gage or, during high water, by floats. The initial point for soundings is the 3-foot mark of the gage.

The gage, which was read during 1905 once each day by James McGee, is inclined and in two sections. It is fastened to a tree and to posts set in the left bank. The gage is referred to bench marks as follows: (1) A railroad spike in the tree to which the upper section of the gage is attached; elevation, 9.10 feet above the zero of the gage. (2) A railroad spike driven into a cottonwood tree 125 feet from the left bank, opposite the gage; elevation, 14.08 feet above the zero of the gage.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 155-156.

Discharge measurements of Grand River at Seim, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage. height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 1	H. D. Comstock	18	5.4	1.07	1.64	5.8
May 1	do	18	6.0	1.05	1.64	6.3
July 16	do	56	57.0	2.21	2.45	126
August 21	Stevens and Comstock	50	38.0	1.53	2.09	58

Daily gage height, in feet, of Grand River at Seim, S. Dak., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Oct.	Nov.
1	.....	1.7	2.0	2.2	2.1	.....	1.7
2	2.0	1.7	2.0	2.2	2.0	.....	1.7
3	2.0	2.0	2.0	4.0	2.0	.....	1.6
4	2.0	3.0	2.0	3.6	2.1	1.8	1.6
5	2.0	3.0	2.0	3.5	2.1	1.8	1.6
6	2.0	2.8	2.6	3.0	2.0	1.7	1.6
7	2.0	1.6	2.6	2.7	1.9	1.6	1.7
8	2.0	1.6	2.5	2.5	1.9	1.6	1.7
9	2.0	1.6	9.4	2.5	1.8	1.6	1.6
10	1.9	1.6	3.2	2.4	1.8	1.6	1.6
11	1.9	1.6	3.2	2.4	1.8	1.6	1.6
12	1.8	1.6	3.2	2.2	1.8	1.6	1.6
13	1.8	1.6	3.6	2.2	1.8	1.6	(a)
14	1.8	1.5	3.6	2.2	1.8	1.6	.....
15	1.7	1.5	3.6	2.1	1.8	1.6	.....
16	1.7	1.5	3.6	2.4	1.8	1.7	1.7
17	1.7	1.5	3.6	2.5	4.5	1.7	1.6
18	1.7	1.5	4.0	2.6	3.2	1.7	1.7
19	1.7	1.5	4.9	2.6	2.6	1.6	1.6
20	1.7	1.5	4.6	2.8	2.3	1.6	1.6
21	1.7	1.6	4.5	2.9	2.3	1.7	1.6
22	1.7	1.7	3.0	2.7	2.0	1.7	1.7
23	1.7	1.7	2.8	2.5	1.8	1.7	1.6
24	1.7	2.0	2.5	2.3	1.6	1.7	.....
25	1.7	2.0	2.5	2.3	1.6	1.6	.....
26	1.7	1.8	2.5	2.3	1.6	1.6	.....
27	1.7	1.8	2.4	2.2	1.6	1.6	.....
28	1.7	1.8	2.4	2.1	1.6	1.6	.....
29	1.7	1.9	2.2	2.6	(a)	1.7	.....
30	1.7	1.9	2.2	2.4	.....	1.7	.....
31	.....	2.0	.....	2.1	.....	1.8	.....

a No flow; water standing in pools, August 29 to October 3, and November 13 to 15, inclusive.

Station rating table for Grand River at Seim, S. Dak., from June 6, 1904, to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.50	1	2.10	60	2.70	190	3.30	388
1.60	4	2.20	76	2.80	219	3.40	424
1.70	10	2.30	94	2.90	250	3.50	461
1.80	20	2.40	115	3.00	283		
1.90	32	2.50	138	3.10	317		
2.00	45	2.60	163	3.20	352		

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1904–5, and is well defined between gage heights 1.5 feet and 3.5 feet. The discharge above 3.5 feet is only approximate.

Estimated monthly discharge of Grand River near Seim, S. Dak., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
June 6–30	669	60	168	8,331
July 1–20	60	0	40.2	1,595

NOTE.—Dry after July 20.

Estimated monthly discharge of Grand River at Seim, S. Dak., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 2–30	45	10	22.2	1,277
May	283	1	37.7	2,318
June	3,500	45	423	25,170
July	669	60	167	10,270
August 1–28	909	4	79.9	4,913
October 4–31	20	4	7.9	439
November (1–12) (16–23)	10	4	6.1	242
The period				44,630

NOTE.—No flow August 29 to October 3 and November 13 to 15, inclusive. Water standing in pools.

MOREAU RIVER DRAINAGE BASIN.

MOREAU RIVER AT BIXBY, S. DAK.

Moreau River rises near the western boundary of South Dakota and flows eastward into the Missouri. The country drained is high and rolling and the soil is a sandy loam. There is very little land under cultivation. There is no timber except along the banks of the river and its tributaries, of which the chief are North and South Forks, Rabbit Creek, and Thunder Butte Creek. The principal floods occur in March, May, June, and July.

The gaging station was established June 4, 1904. It is located one-fourth mile southeast of Bixby, S. Dak., in T. 14 N., R. 13 E., about 1,000 feet below the ford.

The channel is straight for 1,000 feet above and below the gage. The left bank is high and clean and does not overflow; the right bank is timbered and is liable to overflow in extremely high water. The bed of the stream is composed of sandstone, contains much clay and fine sand, and is free from vegetation and permanent. There is but one channel at all stages. The current is swift at high water, but becomes sluggish at low water.

Gage heights range from 1 to 10 feet. The river is frozen from about December 1 to March 10, and observations are discontinued during that period.

High-water measurements are made by means of a car and cable 200 feet above the gage. The initial point for soundings is the right cable support. The cable is marked at 10-foot intervals with red paint. Low-water measurements are made by wading 100 feet below the gage.

A staff gage, which was read once each day during 1905 by J. A. Hudgins, is driven in an inclined position into the bed of the stream and is firmly spiked to two small trees on the right bank. In order that the gage heights may be read during floods, a second section is attached to a large cottonwood tree 50 feet from the bank. The gage is referred to bench marks as follows: (1) A railroad spike driven into the base of a cottonwood tree 75 feet from the gage on the right bank; elevation, 13.98 feet above the zero of the gage. (2) A railroad spike driven into the base of a cottonwood tree 100 feet from the gage and 75 feet downstream from the first bench mark; elevation, 13.95 feet above the zero of the gage.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 156–159, 192.

Discharge measurements of Moreau River at Bixby, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 28[a]	H. D. Comstock	32	4.8	0.96	1.35	4.6
May 3[a]	do	85	76	1.67	2.10	127
May 5[a]	do	82	124	2.00	2.60	249
May 6	do	82	211	3.10	3.54	654
May 6	do	82	228	3.16	3.72	721
May 7	do	90	300	3.90	4.47	1,170
May 7	do	91	331	4.12	4.85	1,365
July 15[a]	do	86	140	2.17	2.91	304
July 17[a]	do	91	191	2.56	3.32	489
August 19	Stevens and Comstock	84	212	2.78	3.65	589

[a] Made 100 feet below cable.

Daily gage height, in feet, of Moreau River at Bixby, S. Dak., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.5	1.3	1.5	1.7	1.7	4.6	1.5	1.7
2	.....	1.5	1.4	1.6	2.1	1.6	3.5	1.5	1.7
3	.....	1.5	2.1	2.0	6.1	1.55	2.4	1.5	1.6
4	.....	1.5	2.5	1.8	5.3	1.5	2.0	1.5	1.6
5	.....	1.4	2.65	1.6	4.1	1.5	1.8	1.5	1.6
6	.....	1.4	3.7	1.5	2.8	1.5	1.7	1.45	1.6
7	.....	1.4	4.6	1.5	2.35	1.5	1.6	1.45	1.6
8	.....	1.4	3.4	1.5	2.0	1.5	1.6	1.5	1.6
9	.....	1.3	3.0	1.5	1.9	1.5	1.6	1.5	1.6
10	.....	1.35	2.8	1.45	1.8	1.4	1.6	1.5	1.6
11	.....	1.4	2.5	1.45	1.7	1.4	1.6	1.5	1.6
12	.....	1.4	2.15	1.4	1.6	1.4	1.6	1.5	1.6
13	.....	1.4	1.9	1.4	6.9	1.6	1.6	1.5	1.6
14	1.5	1.4	1.9	1.5	3.9	1.5	1.6	1.5	1.6
15	1.5	1.4	1.85	1.9	2.5	1.5	1.6	1.5	1.6
16	1.5	1.5	1.7	2.9	2.4	4.8	1.6	1.5	1.6
17	1.5	1.5	1.6	3.0	3.3	7.0	1.5	1.5	1.6
18	1.5	1.5	1.5	6.75	2.5	5.5	1.5	1.5	1.6
19	1.5	1.7	1.5	6.4	3.3	3.7	1.5	1.7	1.6
20	1.5	1.7	1.5	4.8	3.1	2.8	1.5	1.7	1.6
21	1.5	1.5	1.5	3.4	2.15	2.0	1.5	1.7	1.6
22	1.5	1.5	1.5	3.0	1.9	1.8	1.5	1.7	1.6
23	1.5	1.5	1.4	2.15	1.8	1.6	1.5	1.7	1.6
24	1.5	1.4	1.4	2.0	1.7	1.6	1.5	1.7	1.6
25	1.5	1.4	1.4	1.9	1.7	1.6	1.5	1.7	1.6
26	1.45	1.4	1.4	1.85	1.7	1.6	1.5	1.7	.....
27	1.45	1.3	1.4	2.0	2.5	1.6	1.5	1.7	.....
28	1.45	1.35	1.4	1.9	2.25	1.5	1.5	1.7	.....
29	1.45	1.3	1.45	1.85	1.9	1.5	1.5	1.85	.....
30	1.5	1.3	1.45	1.6	1.8	1.5	1.5	1.75	.....
31	1.5	.....	1.4	.....	1.75	6.4	.....	1.7	.....

Station rating table for Moreau River at Bixby, S. Dak., from March 14 to November 25, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.30	0	2.30	158	3.30	490	4.20	958
1.40	5	2.40	184	3.40	534	4.30	1,020
1.50	12	2.50	211	3.50	580	4.40	1,084
1.60	23	2.60	240	3.60	628	4.50	1,151
1.70	37	2.70	271	3.70	678	4.60	1,220
1.80	53	2.80	303	3.80	730	4.70	1,292
1.90	71	2.90	337	3.90	784	4.80	1,366
2.00	91	3.00	372	4.00	840	4.90	1,442
2.10	112	3.10	409	4.10	898	5.00	1,520
2.20	134	3.20	448				

The above table is applicable only for open-channel conditions. It is based on 15 discharge measurements made during 1904–5, and is well defined between gage heights 1.3 feet and 5 feet. Above 5 feet the discharge is approximate.

Estimated monthly discharge of Moreau River at Bixby, S. Dak., for 1905.

[Drainage area, 1,600 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean		Second-feet per square mile.	Depth in inches.
March 14–31	12	8	11.1	398	0.0069	0.0046
April	37	0	8.6	512	.0054	.0060
May	1,220	0	142	8,731	.089	.103
June	3,044	5	323	19,220	.202	.225
July	3,196	23	415	25,520	.259	.299
August	3,300	5	348	21,400	.218	.251
September	1,220	12	85.4	5,082	.053	.059
October	62	8	23.3	1,433	.015	.017
November 1–25	37	23	24.1	1,195	.015	.014
The period				83,490		

CHEYENNE RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Cheyenne River rises in the eastern part of Wyoming, flows eastward around the southern border of the Black Hills, turns to the northeast, and unites with the Missouri in the central part of South Dakota. It drains a long narrow valley bordered by high table-lands and occasional low flats containing a few thousand acres each. In the Black Hills region, where many of the tributaries rise, extensive forests occur, and there is also considerable timber along the main stream. The soil is partly a sandy loam and partly gumbo, and there are many cultivated tracts.

The principal tributaries are Beaver and Hat creeks, Fall River, Battle, Spring, Rapid, and Boxelder creeks, Belle Fourche River, and Sulphur Creek. The chief tributaries of the Belle Fourche are Redwater River and Whitewood Creek, and the Redwater has one large tributary, Spearfish Creek.

The rainfall varies from 21 inches in the Black Hills region to 12 inches on the prairies. The main floods occur in March, May, June, and July. Many of the streams rising in the Black Hills are fed to a large extent by springs. Fall River, in particular, gets much of its water from hot springs and mineral springs.

There is considerable power development on the Black Hills tributaries, especially on Rapid and Whitewood creeks. Some water is diverted for irrigation from practically all the tributaries, and work is now in progress on the Belle Fourche project by the United States Reclamation Service, which proposes to divert and store nearly all the flow of the Belle Fourche at the town of Belle Fourche and to irrigate about 90,000 acres.

Information in regard to this basin is contained in the annual reports of the reclamation service and in the Fourth Annual Report of the United States Geological Survey, Part IV, pages 251–253.

CHEYENNE RIVER AT EDGEMONT, S. DAK.

This station was established June 19, 1903. It is located at the highway bridge just downstream from the Chicago, Burlington and Quincy Railway bridge, in the SE. ¼ sec. 36, T. 8 S., R. 2 E., just above the mouth of Cottonwood Creek.

The channel is straight above and below the station. The right bank is high and clean and does not overflow; the left bank is low, has a few scattered trees, and is liable to overflow. The bed of the stream is sandy and shifting. There is usually but one channel. The velocity is sluggish at low water. Gage heights range from 1 to 11 feet. The river is frozen from about December 1 to March 10.

Discharge measurements are made from the highway bridge. The initial point for soundings is a brass-headed tack surrounded by similar tacks in the first post of the lower hand rail on the south end of the bridge.

During 1905 the gage was read once each day by Hubert Wiedenfeld. The standard chain gage, installed May 17, 1905, is bolted to the lower chord of the downstream truss of the right span of the bridge, 50 feet from the right end. The length of the chain is 13.45 feet. The gage is referred to bench marks as follows: (1) A nail surrounded by a circle of brass tacks driven into a knot on the south side of a cottonwood tree 250 feet north of the north end of the highway bridge; elevation, 11.29 feet above the zero of the gage. (2) The corner of the abutment at the north end of the railroad bridge, on the fourth step of the abutment and on the corner on the east side away from the bridge; elevation above the zero of the gage, 20.23 feet.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, pp 55–56; 130, p 159.
Discharge: 49, p 272; 99, p 56; 130, p 160.
Gage heights: 99, p 56; 130, p 160.

Discharge measurements of Cheyenne River at Edgemont, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 28	F. M. Madden	57	20.0	1.50	1.80	30
April 7	H. D. Comstock	28	15.8	1.39	1.75	22
May 17[a]	do	15	4.7	1.32	2.28	6.2
June 14[a]	do	84	98	2.78	2.75	272
June 15[a]	do	72	77	2.23	2.50	172
June 15	do	150	382	3.50	4.20	1,336
June 16	do	148	247	2.43	3.30	599
June 16	do	147	206	2.28	3.10	469
June 18	do	300	1,652	5.60	9.75	9,259
June 19	do	154	575	4.31	4.62	2,477
June 19	do	154	474	3.53	4.00	1,674
August 4	do	162	578	3.34	4.23	1,930
August 5	do	162	274	2.46	2.95	674
August 6	do	270	1,285	5.62	8.00	7,222
August 6	do	250	1,157	5.09	7.55	5,893
August 6	do	220	968	4.96	6.80	4,803
August 7	do	175	730	4.77	5.60	3,485
August 8	do	162	359	2.82	3.64	1,014
September 6	Stevens and Comstock	94	45	1.44	2.35	65

[a] Made at different sections.

Daily gage height, in feet, of Cheyenne River at Edgemont, S. Dak., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.7	3.8	4.0	1.8	1.7	2.5	2.7	6.3	2.5	2.3	2.2	2.1
2	2.9	3.8	3.8	2.8	2.8	2.5	9.35	5.3	2.7	3.0	2.1	2.1
3	3.0	3.8	3.6	2.0	3.8	2.5	5.8	5.0	2.8	2.6	2.1	.....
4	3.0	3.8	3.5	2.0	2.5	2.5	5.0	4.0	2.6	2.6	2.2	.....
5	3.0	4.0	3.0	1.8	2.0	2.5	4.0	2.95	2.4	2.4	2.1	.....
6	3.0	4.0	2.5	1.8	2.0	2.5	3.0	7.95	2.2	2.4	2.1	.....
7	3.0	4.0	2.4	1.8	2.5	2.5	2.3	4.0	2.2	2.0	2.1	.....
8	3.0	4.0	2.4	1.8	2.5	2.6	3.4	3.7	2.2	2.3	2.1	.....
9	3.0	4.0	2.4	1.8	2.5	2.6	2.8	3.0	2.1	2.3	2.1	.....
10	3.0	4.0	2.4	1.8	2.3	2.6	2.8	2.2	2.1	2.3	2.1	.....
11	3.0	4.0	2.4	1.8	2.3	5.0	2.8	5.0	2.1	2.2	2.1	.....
12	3.0	4.0	2.4	1.8	2.3	4.2	2.7	8.4	2.1	2.3	2.1	.....
13	3.0	4.3	2.3	1.8	2.3	4.2	2.5	5.8	2.1	2.3	2.1	.....
14	3.0	4.3	2.3	2.2	2.3	5.0	2.8	4.0	2.1	2.4	2.1	.....
15	3.0	4.3	2.0	2.0	2.3	5.5	2.7	3.3	2.2	2.4	2.1	.....
16	3.0	4.3	2.0	2.0	2.2	3.8	2.6	3.0	2.2	2.4	2.1	.....
17	3.0	4.3	2.0	2.0	2.2	5.45	2.5	2.4	2.2	2.4	2.1	.....
18	3.0	4.3	2.0	2.0	2.3	9.65	2.3	2.3	2.1	2.3	2.1	.....
19	3.0	4.3	2.0	2.0	2.3	4.4	2.1	2.3	2.1	2.3	2.1	.....
20	3.0	4.3	2.0	2.0	2.4	3.4	7.7	2.2	2.1	2.1	2.1	.....
21	3.0	4.3	2.0	2.0	2.4	2.6	5.9	2.0	2.0	2.1	2.1	.....
22	3.3	4.5	1.9	2.0	2.4	2.6	4.8	2.6	2.0	2.1	2.1	.....
23	3.3	4.5	1.9	2.0	4.5	2.4	3.3	2.0	2.0	2.1	2.1	.....
24	3.3	5.0	1.9	2.0	4.8	3.0	2.8	1.9	2.0	2.1	2.1	.....
25	3.3	4.7	1.9	1.9	2.8	3.0	2.6	2.0	2.0	2.1	2.1	.....
26	3.3	4.5	1.9	1.9	2.8	2.7	2.4	2.6	2.0	2.1	2.1	.....
27	3.3	4.3	1.8	1.8	2.4	2.6	4.1	2.4	2.0	2.1	2.1	.....
28	3.3	4.2	1.8	1.7	2.4	2.4	6.0	2.3	2.0	2.1	2.1	.....
29	3.5	.....	1.8	1.7	2.3	2.0	10.7	2.3	2.0	2.0	2.1	.....
30	3.5	.....	1.8	1.7	2.3	2.6	9.7	2.3	2.0	2.0	2.1	.....
31	3.5	.....	1.8	.....	2.6	.....	6.0	2.3	.....	2.0	.....	.....

NOTE.—Ice conditions January 1 to February 22, inclusive.

Daily discharge, in second-feet, of Cheyenne River at Edgemont, S. Dak., 1903–1905.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.											
1	.....	.....	.....	.....	.....	375	1,685	318	10	4	57
2	.....	.....	.....	.....	.....	318	3,005	226	8	4	57
3	.....	.....	.....	.....	.....	23	1,795	130	8	4	57
4	.....	.....	.....	.....	.....	14	1,472	106	8	5	57
5	.....	.....	.....	.....	.....	10	1,092	75	8	5	57
6	.....	.....	.....	.....	.....	5	848	75	8	5	75
7	.....	.....	.....	.....	85	4	630	75	4	5	75
8	.....	.....	.....	.....	66	2	435	57	4	2	.....
9	.....	.....	.....	.....	269	2	246	117	4	2	.....
10	.....	.....	.....	.....	130	2	171	117	4	2	.....
11	.....	.....	.....	.....	75	4,290	95	106	4	2	.....
12	.....	.....	.....	.....	41	5,170	3,330	106	4	2	.....
13	.....	.....	.....	.....	34	1,740	1,320	5,720	5	2	.....
14	.....	.....	.....	.....	23	665	1,050	1,472	5	2	.....
15	.....	.....	.....	.....	18	405	665	925	5	2	.....
16	.....	.....	.....	.....	106	171	530	700	5	2	.....
17	.....	.....	.....	.....	171	6,680	345	405	5	2	.....
18	.....	.....	.....	.....	85	4,150	246	246	5	10	.....
19	.....	.....	.....	.....	49	1,320	171	171	5	28	.....
20	.....	.....	.....	.....	41	292	142	117	5	28	.....
21	.....	.....	.....	.....	34	206	75	75	5	28	.....
22	.....	.....	.....	.....	226	117	57	57	2	28	.....
23	.....	.....	.....	.....	66	66	57	57	2	28	.....
24	.....	.....	.....	.....	57	188	41	28	4	41	.....
25	.....	.....	.....	.....	49	1,472	885	18	4	41	.....
26	.....	.....	.....	.....	49	562	595	10	4	41	.....
27	.....	.....	.....	.....	49	925	1,050	10	4	41	.....
28	.....	.....	.....	.....	2,080	700	885	10	4	41	.....
29	.....	.....	.....	.....	1,850	435	735	10	4	75	.....
30	.....	.....	.....	.....	1,740	562	562	10	4	57	.....
31	.....	.....	.....	.....	.....	1,180	435	.....	4	.....	.....
1904.											
1	.....	.....	57	665	2,940	117	18	735	4	1	.....
2	.....	.....	57	562	2,080	3,730	18	246	4	1	.....
3	.....	.....	57	345	6,760	3,135	18	95	4	1	.....
4	.....	.....	57	772	4,010	925	18	292	4	1	.....
5	.....	.....	57	435	2,440	345	18	117	4	1	.....
6	.....	.....	57	206	1,180	2,565	18	57	4	1	.....
7	.....	.....	57	171	848	1,850	18	34	4	1	.....
8	.....	.....	41	130	665	1,525	18	34	4	1	.....
9	.....	.....	41	106	3,395	1,320	18	14	4	1	.....
10	.....	.....	41	85	1,472	1,135	10	8	4	1	.....
11	.....	.....	28	66	885	885	10	8	8	1	.....
12	.....	.....	28	49	562	735	10	8	14	1	.....
13	.....	.....	28	34	292	1,225	10	4	34	4	.....
14	.....	.....	18	34	142	665	10	1	156	8	.....
15	.....	.....	18	41	95	405	5	1	188	4	.....
16	.....	142	18	41	772	246	5	1	130	4	.....
17	.....	117	18	41	595	171	5	1	106	1	.....
18	.....	95	18	41	292	117	4	1	66	1	.....
19	.....	57	18	41	142	75	4	0	34	1	.....
20	.....	57	18	41	95	57	4	0	8	1	.....
21	.....	57	18	4,290	75	57	4	0	8	14	.....
22	.....	57	10	3,330	965	41	1	0	8	14	.....

Daily discharge, in second-feet, of Cheyenne River at Edgemont, S. Dak., 1903–1905—Cont'd.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.											
23	.....	57	10	2,200	665	57	1	0	4	34	.....
24	.....	57	8	1,050	405	41	1	0	4	66	.....
25	.....	57	4	848	292	28	1	0	4	85	.....
26	.....	57	4	700	142	28	1	0	4	85	.....
27	.....	57	4	595	345	18	1	0	4	.....	.....
28	.....	57	4	530	246	18	0	23	4	.....	.....
29	.....	57	4	465	206	18	0	23	4	.....	.....
30	.....	57	4	405	171	18	595	8	1	.....	.....
31	.....	57	.....	595	.....	18	1,320	.....	1	.....	.....
1905.											
1	.....	1,135	28	18	171	345	4,290	117	57	41	.....
2	.....	965	292	292	171	8,665	2,940	171	246	28	.....
3	.....	810	57	965	171	3,460	2,565	206	117	28	.....
4	.....	735	57	171	171	2,440	1,420	142	117	41	.....
5	.....	405	28	57	171	1,320	562	95	75	28	.....
6	.....	171	28	57	171	530	6,842	41	75	28	.....
7	.....	142	28	117	171	117	1,420	41	18	28	.....
8	.....	142	28	117	206	665	1,050	41	57	28	.....
9	.....	142	28	117	206	292	530	28	57	28	.....
10	.....	142	28	75	206	292	142	28	57	28	.....
11	.....	142	28	57	2,200	292	2,440	28	41	28	.....
12	.....	142	28	57	1,320	246	7,420	28	57	28	.....
13	.....	117	28	57	1,320	171	3,460	28	57	28	.....
14	.....	117	95	57	2,200	292	1,320	28	75	28	.....
15	.....	57	57	57	2,815	246	735	41	75	28	.....
16	.....	57	57	41	965	206	465	41	75	28	.....
17	.....	57	57	41	2,752	171	171	41	75	28	.....
18	.....	57	57	57	9,175	117	142	28	57	28	.....
19	.....	57	57	57	1,850	75	142	28	57	28	.....
20	.....	57	57	75	885	6,280	117	28	28	28	.....
21	.....	57	57	75	345	3,595	57	18	28	28	.....
22	.....	41	57	75	345	2,200	206	18	28	28	.....
23	.....	1,630	41	57	1,630	246	735	57	18	28	28	.....
24	.....	2,200	41	57	1,965	595	405	41	18	28	28	.....
25	.....	1,850	41	41	292	595	292	57	18	28	28	.....
26	.....	1,630	41	41	292	345	206	171	18	28	28	.....
27	.....	1,420	28	28	142	292	1,420	117	18	28	28	.....
28	.....	1,320	28	18	142	206	3,730	95	18	28	28	.....
29	.....	.....	28	18	117	95	10,960	95	18	18	28	.....
30	.....	.....	28	18	117	292	9,260	95	18	18	28	.....
31	.....	.....	28	.....	206	.....	3,730	95	.....	18	.....	.....

NOTE.—The daily discharge has been obtained by the indirect method.

Estimated monthly discharge of Cheyenne River at Edgemont, S. Dak., 1903–1905.

[Drainage area, 7,350 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1903.						
June 7–30	2,080	18	308	14,660	0.042	0.037
July	6,680	2	1,034	63,580	.141	.163
August	3,330	41	795	48,880	.108	.124
September	5,720	10	385	22,910	.524	.585
October	10	2	5.0	307	.00068	.00078
November	75	2	18.0	1,071	.0024	.0027
December 1–7	75	57	62.1	862	.0082	.0021
The period				152,300		
1904.						
March 16–31	142	57	68.4	2,171	.0093	.0055
April	57	4	26.7	1,589	.0036	.0040
May	4,290	34	610	37,510	.083	.096
June	6,760	75	1,106	65,810	.150	.167
July	3,730	18	696	42,800	.095	.110
August	1,320	0	69.8	4,292	.0095	.011
September	735	0	57.0	3,392	.0078	.0087
October	188	1	26.9	1,654	.0037	.0043
November 1–26	85	1	12.8	6,601	.0017	.0017
The period				165,800		
1905.						
February 23–28	2,200	1,320	1,675	19,930	.228	.051
March	1,135	28	195	11,990	.027	.031
April	292	18	50.5	3,005	.0069	.0077
May	1,965	18	245	15,060	.033	.038
June	9,175	95	1,022	60,810	.139	.155
July	10,960	75	2,024	124,400	.275	.317
August	7,420	41	1,266	77,840	.172	.198
September	206	18	47.0	2,797	.0064	.0071
October	246	18	56.5	3,474	.0077	.0089
November	41	28	28.9	1,720	.0039	.0044
The period				321,000		

NOTE.—No estimate for ice period.

BEAVER CREEK NEAR EDGEMONT, S. DAK.

Beaver Creek rises in the northern part of Weston County, Wyo., flows southeastward, and enters Cheyenne River in the northwestern part of Fall River County, S. Dak.

The gaging station was established April 7, 1905. It is located at Anderson's ranch, about 16 miles northwest of Edgemont, S. Dak., and about 2 miles west of the Argentine water tank on the Chicago, Burlington and Quincy Railroad, just below the mouth of Pass Creek, in the S. ½ sec. 16, T. 7 S., R. 1 E.

The channel is straight for 200 feet above and below the station. Both banks are low and are liable to overflow during high water. The bed of the stream at the measuring section is of gravel and cobblestones and is fairly permanent; at the gage the bed is composed of mud. At the measuring section there is one channel at high water, but at low water there are two channels; at the gage there is but one channel at all stages. The current is fairly swift. Gage heights range from 1 foot to 9 feet. The stream is frozen from about December 1 to March 10, and observations are discontinued during that time.

Discharge measurements are made by wading near a ford 1,000 feet below the gage. The initial point for soundings is a stake on the right bank in line with a crotched fence post and a dead tree.

The gage, which was read once each day during 1905 by H. Anderson, is a post supporting a plank step on the right bank, graduated from zero to 4 feet; a second post, higher up on the bank, about 30 yards from the house of the observer, is graduated from 4 to 8.5 feet. The bench mark is a spike driven 6 inches above the base of a cottonwood tree 100 feet above the gage; elevation, 9.59 feet above zero of gage.

Discharge measurements of Beaver Creek near Edgemont, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 7	H. D. Comstock	38	24.0	0.87	1.21	20
May 17	do	22	7.8	.59	.85	4.6
June 14	do	28	14.0	1.74	1.24	23
June 17	do	24	9.6	.98	.98	9.4
August 4	do	80	99.0	3.15	2.90	312
August 8	do	52	41.0	2.37	1.80	93
September 7	Stevens and Comstock	25	10.7	1.06	1.00	11.4

Daily gage height, in feet, of Beaver Creek near Edgemont, S. Dak., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.05	2.7	3.2	3.4	1.0	1.0	1.1
2	.....	1.55	2.0	8.4	6.9	1.2	2.0	1.2
3	.....	1.4	1.2	7.45	5.4	1.1	2.5	1.2
4	.....	1.2	1.0	5.8	3.5	1.0	1.6	1.15
5	.....	1.1	.9	3.1	2.2	1.0	1.4	1.1
6	.....	1.0	1.2	2.2	4.2	1.0	1.2	1.1
7	1.2	1.2	1.1	3.25	2.6	1.0	1.1	1.1
8	1.2	1.1	1.0	2.9	1.85	1.0	1.1	1.0
9	1.2	1.1	.9	1.8	1.7	1.0	1.0	1.0
10	1.3	1.1	2.9	1.4	1.8	1.0	1.0	1.0
11	1.25	1.0	3.35	1.4	1.85	1.0	1.0	1.0
12	1.2	.9	2.9	1.35	1.4	1.0	1.0	1.0
13	1.2	.8	1.5	1.3	1.4	1.0	1.0	1.0
14	1.2	.8	1.3	2.4	2.8	1.0	1.0	1.05
15	1.2	.8	1.2	1.65	2.1	1.0	1.0	1.05
16	1.2	.8	1.1	1.4	1.6	1.0	1.0	1.05
17	1.25	.8	1.0	1.25	1.4	1.0	1.0	1.1
18	1.2	.8	1.25	1.2	1.3	1.0	1.0	1.1
19	1.2	1.3	1.3	1.1	1.25	1.0	1.0	1.1
20	1.15	1.4	1.2	3.95	1.2	1.0	1.0	1.1
21	1.15	1.2	1.2	3.45	1.15	1.0	1.0	1.1
22	1.1	1.1	1.2	4.5	1.15	1.0	1.0	1.1
23	1.15	1.4	1.2	2.3	1.1	1.0	1.1	1.1
24	1.15	1.2	1.15	1.7	1.0	1.0	1.1	1.1
25	1.1	1.78	1.48	1.4	1.0	1.0	1.1	1.1
26	1.1	1.6	1.4	1.35	1.0	1.0	1.1	1.1
27	1.1	1.3	1.3	5.25	1.0	1.0	1.1	1.1
28	1.1	1.2	1.2	4.4	1.0	1.0	1.1	1.1
29	1.05	1.2	1.1	8.6	1.0	1.0	1.1	1.1
30	1.05	1.2	1.1	6.7	1.0	1.0	1.1	.....
31	.....	1.1	.....	4.4	1.0	.....	1.1	.....

HAT CREEK NEAR EDGEMONT, S. DAK.

Hat Creek enters Cheyenne River from the south in the central part of Fall River County, S. Dak.

The gaging station was established April 8, 1905. It is located at Brady's ranch, about 1 mile above the mouth of the creek, 13 miles east of Edgemont, S. Dak., in the SE. $\frac{1}{4}$ sec. 24, T. 9 S., R. 4 E.

The channel is straight for about 500 feet above and below the station. The right bank is medium high, is clean, and overflows at very high floods; the left bank is high and clean and does not overflow. The bed of the stream is composed of gravel and mud and is fairly permanent. There is but one channel at all stages and the current is swift. The stream is frozen over from about December 1 to March 10, and observations are discontinued during that period. Gage heights range from 0.5 foot to 11 feet.

Discharge measurements are made by wading 50 feet above the gage. The initial point for soundings is the bench mark.

The gage, which was read once each day during 1905 by Clarence Brady, consists of a vertical staff spiked to the crib work of an old pumping plant near the house of the observer. The bench mark is a spike in a cottonwood tree on the left bank, 50 feet above the gage and 35 feet from the water's edge; elevation above zero of gage, 10.22 feet.

Discharge measurements of Hat Creek near Edgemont, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 8	H. D. Comstock	15	7.6	1.55	0.71	11.8
May 18	do	23	12.3	1.01	.80	12.4
June 15	do	18	8.4	1.46	.73	12.3
August 7 [a]	do	115	408	4.80	5.10	1,958
August 9	do	32	34	2.50	1.70	85
September 6 [b]	Stevens and Comstock				1.10	8

[a] Float measurement.
[b] Bar below gage causes backwater; discharge estimated.

Daily gage height, in feet, of Hat Creek near Edgemont, S. Dak., for 1905.

Day.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	0.6	1.6	5.4	2.0	1.1	1.0	1.0
2	.....	1.68	1.15	2.8	1.9	1.1	1.0	1.0
3	.....	2.65	1.0	4.1	2.9	1.1	.95	1.0
4	.....	4.5	.9	2.5	1.9	1.1	.95	1.0
5	.....	2.9	.9	1.9	1.6	1.1	1.0	1.0
6	.....	1.9	.8	1.5	5.7	1.1	1.0	1.0
7	.....	1.45	.8	1.5	5.2	1.1	.95	1.0
8	.....	1.2	.75	1.4	2.45	1.1	.9	1.0
9	0.6	1.0	.7	1.9	1.75	1.1	.9	1.0
10	.7	1.0	2.72	1.55	2.0	1.1	.9	1.0
11	.7	.9	2.0	1.45	2.3	1.1	.95	1.0
12	.8	.85	1.2	1.3	11.0	1.1	.95	1.0
13	.8	.9	.9	1.2	8.0	1.1	1.0	1.0
14	1.6	.85	1.8	1.1	3.0	1.1	1.0	1.0
15	1.3	.8	.8	1.1	2.2	1.1	1.0	1.0
16	1.1	.8	2.45	1.0	1.8	1.1	1.0	1.0
17	1.2	.8	.8	1.0	1.6	1.1	1.25	1.0
18	1.1	.8	5.0	1.0	1.5	1.1	1.25	1.0
19	1.0	.8	6.3	1.0	1.5	1.1	1.15	1.0
20	1.0	.8	2.6	1.2	1.5	1.1	1.1	1.0
21	.9	1.8	2.3	1.1	1.5	1.1	1.1	1.0
22	.8	1.25	2.8	2.65	1.45	1.05	1.0	1.0
23	.75	1.0	7.0	2.5	1.3	1.05	1.0	1.0
24	.7	.9	3.4	1.2	1.3	1.0	1.0	1.0
25	.7	.9	3.5	1.0	1.2	1.0	1.0	1.0
26	.65	.75	2.3	1.0	1.2	1.0	1.0	1.0
27	.6	.75	1.85	1.0	1.2	.95	1.0	1.0
28	.7	.75	1.7	.9	1.2	.9	1.0	1.0
29	.7	.8	1.55	4.5	1.15	.95	1.0	1.0
30	.65	1.85	1.8	8.5	1.1	1.0	1.0	1.0
31	.....	2.5	.....	6.2	1.1	.....	1.0	.....

Estimated monthly discharge of Hat Creek near Edgemont, S. Dak., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 9–30	111	6	24.8	1,082
May	1,660	6	134	8,239
June	3,460	10	448	26,660
July	5,300	23	519	31,910
August	9,150	8	698	42,920
September	8	0	6.3	375
October	21	0	3.6	221
November	2	2	2.0	119
The period	.....	.....	.....	111,500

NOTE.—This estimate is only approximate.

SPRING CREEK NEAR RAPID, S. DAK.

Spring Creek has its source in the Black Hills in western South Dakota, flows southeastward and then northeastward and enters Cheyenne River near Creston, S. Dak.

The gaging station was established June 27, 1903. It is located on the highway from Rapid to Hermosa, on the property of Frank Blair, in the SE. ¼ sec. 3, T. 1 S., R. 7 E.

The channel is straight for 100 feet above and 75 feet below the station. Both banks are low and subject to overflow. At the station the bed of the stream is gravelly, but above and below this point the bottom is muddy. The current is sluggish above and below the footbridge, but is swift at the point where measurements are made. The stream is frozen from about December 1 to March 10, and observations are discontinued during that period. Gage heights range from 0.5 foot to 5 feet.

Discharge measurements are made from a small plank footbridge.

The gage, which was read once each day during 1905 by Lydia Blair, is a vertical timber, spiked to a tree at the water's edge, about 100 feet above the footbridge. The gage is referred to bench marks as follows: (1) A steel nail driven into the tree to which the gage is attached; elevation, 2.14 feet. (2) A nail driven into the base of a tree about 50 feet upstream from the gage; elevation, 4.14 feet. (3) A nail driven into the roots of a tree about 75 feet downstream from the gage; elevation, 3.36 feet. Elevations are above the zero of the gage. This station was discontinued December 1, 1905.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 53; 130, pp 160–161.
Discharge: 99, p 53; 130, p 161.
Discharge, monthly: 130, p 163.
Gage heights: 99, pp 53–54; 130, pp 161–162.
Rating table: 130, p 162.

Discharge measurements of Spring Creek near Rapid, S. Dak., for 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 20	H. D. Comstock	11	5.5	1.02	0.91	5.6
June 24	do	30	27	.72	1.15	19.4
July 3	do	23	34	2.08	1.89	70
August 14	do	22	34	2.27	1.80	78
September 4	Stevens and Comstock	24	29	.82	1.25	24

Daily gage height, in feet, of Spring Creek near Rapid, S. Dak., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.1	1.1	3.8	1.3	1.0	1.1
2	.....	1.2	1.4	2.2	1.3	1.0	1.1
3	.....	1.1	1.7	2.2	1.3	1.0	1.1
4	1.5	1.1	1.6	2.0	1.3	1.0	1.1
5	.8	1.1	1.6	1.8	1.3	1.0	1.1
6	.9	1.1	1.6	1.8	1.3	1.0	1.1
7	1.0	1.1	1.6	1.8	1.3	1.0	1.1
8	1.0	1.0	2.0	1.7	1.3	1.0	1.1
9	1.0	1.0	2.0	1.6	1.3	1.0	1.1
10	1.0	1.1	1.9	1.6	1.3	1.0	1.1
11	1.0	1.1	1.9	1.9	1.3	1.0	1.1
12	.9	1.2	1.9	1.9	1.3	1.0	1.1
13	.9	1.1	1.7	1.9	1.3	1.0	1.1
14	.9	1.0	1.6	1.8	1.2	1.0	1.1
15	.9	1.0	1.5	1.8	1.2	1.0	1.1
16	.9	1.1	1.4	1.8	1.2	1.0	1.1
17	.9	1.2	1.4	1.7	1.2	1.0	1.0
18	.9	1.2	1.4	1.7	1.2	1.0	1.0
19	.9	1.2	1.4	1.7	1.2	1.1	1.0
20	.9	1.2	1.7	1.6	1.2	1.2	1.0
21	.9	1.2	1.7	1.6	1.2	1.1	1.0
22	.9	1.2	2.25	1.5	1.1	1.1	1.0
23	.9	1.2	1.7	1.5	1.1	1.1	1.0
24	1.0	1.2	1.5	1.5	1.1	1.1	1.0
25	1.0	1.2	1.5	1.5	1.1	1.1	1.0
26	1.0	1.2	3.8	1.5	1.1	1.1	1.0
27	1.0	1.2	1.6	1.5	1.1	1.1	1.0
28	1.0	1.2	3.9	1.4	1.1	1.1	.9
29	1.2	1.1	1.8	1.3	1.0	1.1	.9
30	1.2	1.1	1.6	1.3	1.0	1.1	.9
31	1.1	.....	1.6	1.3	.....	1.1	.....

Station rating table for Spring Creek near Rapid, S. Dak., from May 4 to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.80	4	1.60	57	2.40	160	3.20	289
.90	6	1.70	67	2.50	175	3.30	307
1.00	10	1.80	79	2.60	190	3.40	325
1.10	15	1.90	91	2.70	206	3.50	343
1.20	21	2.00	103	2.80	222	3.60	361
1.30	29	2.10	117	2.90	238	3.70	379
1.40	37	2.20	131	3.00	255	3.80	397
1.50	47	2.30	145	3.10	272	3.90	415

The above table is applicable only for open-channel conditions. It is based on 15 discharge measurements made during 1903–1905, and is not well defined.

Estimated monthly discharge of Spring Creek near Rapid, S. Dak., for 1905.

[Drainage area, 205 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
May 4–31	47	4	10.2	566	0.050	0.052
June	21	10	17.1	1,018	.083	.093
July	415	15	85.2	5,239	.416	.480
August	397	29	77.8	4,784	.380	.438
September	29	10	22.3	1,327	.109	.122
October	21	10	12.3	756	.060	.069
November	15	6	12.3	732	.060	.067
The period				14,420		

RAPID CREEK AT RAPID, S. DAK.

Rapid Creek, which enters Cheyenne River near Creston, S. Dak., has its source in the Black Hills and flows southeastward.

The gaging station was established June 10, 1903. It is located at a highway bridge one-half mile downstream from the Rapid River Milling Company's mill, and one-fourth mile north of the Chicago and Northwestern Railway in the S. E. ¼ sec. 36, T. 2 N., R. 7 E.

The channel is straight for 150 feet above and 100 feet below the station. The banks are from 12 to 15 feet high and are liable to overflow only at extreme high water. The bed of the stream is composed of mud, with embedded bowlders. At high water there are two channels, one of which is very small. The velocity is good at all stages. The stream is subject to rapid fluctuations in height, owing to the opening and closing of the head-gates on a ditch above the station. Gage heights range from 1 foot to 5 feet. The stream is frozen from about December 20 to March 10, and observations are discontinued during that time.

Discharge measurements are made from the downstream side of the highway bridge. The initial point for soundings is the center one of a group of five brass-headed tacks driven into the downstream face of the end post at the south end of the bridge.

The gage, which was read twice each day during 1905 by John Merritt, is a timber securely spiked to a timber at the south abutment of the bridge. The gage is referred to bench marks as follows: (1) A railroad spike driven near the base of the second tree from the southeast corner of a dwelling across the street from the School of Mines dormitory; elevation, 13.92 feet above the zero of the gage. (2) A railroad spike driven near the base of the first tree from the corner south of the School of Mines dormitory; elevation, 12.81 feet above the zero of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, pp 50–51; 130, pp 163–164.
Discharge: 49, p 272; 99, p 51; 130, p 164.
Discharge, monthly: 99, p 52; 130, p 166.
Gage heights: 99, pp 51–52; 130, p 165.
Rating table: 99, p 52; 130, pp 165–166.

Discharge measurements of Rapid Creek at Rapid, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 10[a]	H. D. Comstock	33	38	2.48	1.70	95
May 19	do	30	77	2.31	2.10	178
May 26	do	30	72	1.99	1.95	143
June 26	do	30	70	1.91	1.91	134
July 3	do	32	104	5.38	2.95	559
July 5	do	32	102	5.08	2.9	518
August 12	do	32	115	2.15	2.21	247
September 2	do	35	106	1.10	1.69	117

[a] Made by wading.

Daily gage height, in feet, of Rapid Creek at Rapid, S. Dak., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.5	.....	1.48	1.6	1.38	2.0	2.42	2.22	1.72	1.5	1.62
2	1.6	.....	1.5	1.75	1.75	1.98	2.58	2.22	1.75	1.58	1.55
3	1.62	.....	.....	1.65	1.9	1.9	2.98	2.28	1.75	1.58	1.48
4	1.55	.....	.....	1.6	1.95	1.85	3.0	2.3	1.58	1.5	1.45
5	1.55	.....	.....	1.6	1.85	1.82	2.95	2.08	1.6	1.5	1.4
6	1.62	.....	.....	1.58	1.82	1.82	2.72	2.35	1.7	1.42	1.55
7	.....	.....	.....	1.58	1.85	1.8	2.18	2.2	1.62	1.58	1.5
8	.....	.....	.....	1.62	2.08	1.8	2.62	2.0	1.7	1.45	1.42
9	.....	.....	.....	1.65	2.22	1.78	2.68	2.18	1.55	1.48	1.48
10	.....	.....	.....	1.7	2.25	1.78	2.68	2.22	1.62	1.4	1.55
11	.....	.....	.....	1.65	2.3	1.92	2.58	2.08	1.65	1.45	1.42
12	.....	.....	.....	1.58	2.28	1.88	2.52	2.2	1.68	1.4	1.5
13	.....	.....	.....	1.75	2.25	1.78	2.45	2.2	1.6	1.35	1.38
14	.....	.....	.....	1.7	2.22	1.78	2.48	2.08	1.65	1.45	1.55
15	.....	.....	.....	1.5	2.25	2.12	2.45	2.05	1.68	1.42	1.42
16	.....	.....	1.48	1.6	2.22	1.85	2.32	2.05	1.75	1.42	1.35
17	.....	.....	1.62	1.6	2.15	1.85	2.32	2.0	1.52	1.4	1.45
18	.....	.....	1.6	1.6	2.18	1.98	2.28	2.0	1.58	1.4	1.52
19	.....	.....	1.5	1.6	2.15	2.35	2.2	2.0	1.5	1.48	1.52
20	.....	.....	1.55	1.58	2.1	1.95	2.3	1.88	1.55	1.52	1.55
21	.....	1.3	1.58	1.6	2.08	1.85	2.52	1.92	1.5	1.55	1.38
22	.....	1.4	1.6	1.6	2.02	1.95	2.45	1.85	1.52	1.58	1.45
23	.....	1.48	1.5	1.55	1.98	1.98	2.38	1.82	1.48	1.45	1.32
24	.....	1.48	1.4	1.58	2.02	1.95	2.25	1.82	1.52	1.5	1.42
25	.....	1.42	1.68	1.58	2.02	1.95	2.22	1.95	1.52	1.48	1.51
26	.....	1.48	1.58	1.52	1.98	1.85	3.18	1.88	1.45	1.45	1.48
27	.....	1.42	1.6	1.4	1.95	1.85	2.88	1.75	1.52	1.5	1.4
28	.....	1.5	1.52	1.58	2.02	1.82	3.38	1.85	1.62	1.45	.....
29	.....	.....	1.55	1.65	2.15	1.78	2.35	1.88	1.58	1.58	.....
30	.....	.....	1.4	1.58	2.2	1.72	2.2	1.65	1.55	1.58	.....
31	.....	.....	1.58	.....	2.12	.....	2.22	1.72	.....	1.55	.....

NOTE.—Ice conditions January 7 to February 20, inclusive.

Station rating table for Rapid Creek at Rapid, S. Dak., from January 1 to July 28, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.30	51	1.90	131	2.50	316	3.00	587
1.40	60	2.00	154	2.60	360	3.10	658
1.50	70	2.10	180	2.70	409	3.20	734
1.60	82	2.20	209	2.80	462	3.30	814
1.70	96	2.30	241	2.90	521	3.40	897
1.80	112	2.40	277				

The above table is applicable only for open-channel conditions. It is based on nine discharge measurements made during 1904–5, and is well defined between gage heights 1.5 feet and 3 feet.

Station rating table for Rapid Creek at Rapid, S. Dak., from July 29 to November 27, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.30	61	1.60	101	1.90	159	2.20	243
1.40	73	1.70	118	2.00	183	2.30	279
1.50	86	1.80	137	2.10	211	2.40	320

The above table is applicable only for open-channel conditions. It is based on two discharge measurements made during 1905.

Estimated monthly discharge of Rapid Creek at Rapid, S. Dak., for 1905.

[Drainage area, 410 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January 1–6	85	70	79.0	940	0.193	0.043
February 21–28	70	51	63.6	1,009	.155	.046
March	93	60	72.5	4,458	.177	.204
April	104	60	83.2	4,951	.203	.226
May	241	58	173	10,640	.422	.486
June	259	99	131	7,795	.320	.357
July	880	203	359	22,070	.876	1.01
August	299	110	195	11,990	.476	.549
September	128	80	102	6,069	.249	.278
October	98	67	84.2	5,177	.205	.236
November 1–27	104	64	82.3	4,407	.201	.202
The period				79,510		

NOTE.—Discharge interpolated March 3–15.

BOXELDER CREEK AT BLACKHAWK, S. DAK.

Boxelder Creek rises in the Black Hills in the southeastern part of Lawrence County, S. Dak., and flows southeastward into Cheyenne River.

The gaging station was established June 27, 1903. It is located at the bridge on the road leading past the church at Blackhawk, in the SE. ¼ sec. 9, T. 2 N., R. 7 E.

The channel is straight for 150 feet above and curved for 75 feet below the station. Both banks are high and cleared, but may overflow in extreme high water. The bed of the stream is stony, with soft mud near the edges, and there is considerable water grass just below the station. The bridge makes an angle of about 30° with the normal to the current. Gage heights range from 0.5 foot to 5 feet. The stream is frozen from about December 1 to March 10, and observations are discontinued during that period.

Discharge measurements are best made by wading, but at high water they may be made from the bridge. The initial point for soundings is a brass tack driven into the hand rail vertically above the gage.

The gage, which was read once each day during 1905 by R. H. Haedt, is a vertical timber securely spiked to a pile on the upstream side of the east end of the bridge. The gage is referred to bench marks as follows: (1) A spike driven about 6 inches above the base of a large fence post at the corner of the barnyard 300 feet east of the station; elevation, 16.84 feet. (2) A spike driven about 6 inches above the base of the south gatepost of a gate near a house about 500 feet from the station along the road toward Rapid; elevation, 16.81 feet. (3) A drift bolt driven in the base of a large cottonwood tree on the right bank, about 75 feet above the bridge; elevation, 4.34 feet. Elevations are above the zero of the gage. This station was discontinued December 1, 1905.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 49; 130, pp 166–167.
Discharge: 99, p 50; 130, p 167.
Discharge, monthly: 130, p 169.
Gage heights: 99, p 50; 130, pp 167–168.
Rating tables: 130, p 168.

Discharge measurements of Boxelder Creek at Blackhawk, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 20	H. D. Comstock	40	80	1.34	2.10	107
June 24[a]	do	22	18.5	2.22	1.49	41
July 3	do	48	225	2.43	4.60	546
August 14[a]	do	26	24	3.29	1.72	79
September 4[a]	Stevens and Comstock	26	29	1.07	1.11	31

[a] Made by wading.

Daily gage height, in feet, of Boxelder Creek at Blackhawk, S. Dak., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.6	1.1	3.3	1.2	0.9	0.7
2	.....	1.55	5.1	2.5	1.15	.9	.8
3	.....	1.55	4.7	2.3	1.2	.9	.75
4	.....	1.5	4.3	2.15	1.11	.9	.75
5	.....	1.4	3.7	2.1	1.08	.85	.8
6	.....	1.4	3.4	2.0	1.05	.85	.8
7	.....	1.4	3.0	1.95	1.1	.8	.8
8	.....	1.3	3.0	1.9	1.1	.85	.8
9	2.0	1.28	3.2	1.8	1.1	.85	.8
10	2.5	1.28	2.7	1.7	1.05	.85	.8
11	2.65	1.6	2.7	1.88	1.0	.88	.75
12	2.6	1.5	2.65	1.9	1.1	.9	.75
13	2.55	1.4	2.4	1.9	1.1	.9	.75
14	2.5	1.3	2.35	1.75	1.05	.9	.75
15	2.4	1.2	2.2	1.7	1.0	.9	.75
16	2.35	1.3	2.08	1.6	1.0	.9	.75
17	2.25	1.4	2.0	1.52	1.0	.9	.7
18	2.1	1.58	1.9	1.5	1.0	.9	.7
19	2.05	1.6	1.8	1.5	.95	.88	.7
20	2.05	1.55	2.1	1.45	.95	.85	.7
21	2.0	1.5	2.4	1.4	.9	.82	.7
22	1.9	1.55	2.05	1.35	.9	.8	.65
23	1.8	1.55	2.0	1.3	.85	.8	.7
24	1.9	1.5	1.8	1.3	.85	.8	.75
25	1.8	1.5	1.8	1.25	.85	.8	.7
26	1.8	1.4	2.2	1.22	.8	.8	.7
27	1.8	1.35	3.28	1.3	.9	.8	.7
28	1.8	1.25	2.7	1.3	.9	.8	.6
29	1.9	1.18	2.5	1.25	.9	.75	.55
30	1.9	1.05	1.9	1.2	.9	.7	.5
31	1.75	.....	1.8	1.2	.....	.7	.....

Station rating table for Boxelder Creek at Blackhawk, S. Dak., from May 9 to July 1, 1905

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	7	1.50	42	2.00	95	2.50	161
1.10	12	1.60	51	2.10	107	2.60	176
1.20	18	1.70	61	2.20	120	2.70	191
1.30	25	1.80	72	2.30	133		
1.40	33	1.90	83	2.40	147		

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during 1905, and is not well defined.

Station rating table for Boxelder Creek at Blackhawk, S. Dak., from July 2 to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
.50	2	1.30	42	2.10	128	2.90	241
.60	4	1.40	50	2.20	141	3.00	257
.70	7	1.50	59	2.30	154	3.10	273
.80	11	1.60	69	2.40	168	3.20	289
.90	16	1.70	80	2.50	182	3.30	306
1.00	21	1.80	91	2.60	196	3.40	323
1.10	27	1.90	103	2.70	211		
1.20	34	2.00	115	2.80	226		

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during the latter part of 1905, and is not well defined.

Estimated monthly discharge of Boxelder Creek at Blackhawk, S. Dak., for 1905.

[Drainage area, 157 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
May 9–31	184	66	109	4,972	0.694	0.594
June	51	9	35.4	2,106	.225	.251
July	650	27	210	12,910	1.34	1.54
August	306	34	84.5	5,196	.538	.620
September	34	11	21.6	1,285	.138	.154
October	60	7	19.0	1,168	.121	.140
November	11	2	8.1	482	.052	.058
The period				28,120		

BELLE FOURCHE RIVER AT BELLE FOURCHE, S. DAK.

Belle Fourche River, the largest tributary of the Cheyenne, rises near Middle Butte, in the western part of Weston County, Wyo., flows northeastward to a point near the Wyoming-Montana boundary line, then turns abruptly to the southeast, skirting the northern border of the Black Hills, and unites with the Cheyenne in the southeastern part of Meade County, S. Dak.

The gaging station was established May 26, 1903. It is located at the county highway bridge on the western outskirts of Belle Fourche, S. Dak., in the NW. ¼, sec. 10, T. 8 N., R. 2 E.

The channel is straight for 225 feet above the bridge and 300 feet below. The left bank is high, with a few scattered trees; the right bank is low, sparsely wooded, and subject to overflow at flood stages. The bed of the stream is of gravel and fairly permanent. The water flows in a single channel except at low stages, when it is divided by a gravel bar below the bridge. The current is swift. Gage heights range from 0.5 foot to 11 feet.

Discharge measurements are made from the lower side of the bridge. The initial point for soundings is the center of the north pile in the first bent on the east end.

The gage, which was read twice each day during 1905 by Raymond Giles, consists of a vertical timber spiked to a pile on the north side of the bridge on the third bent from the east end. The gage is referred to bench-marks as follows: (1) A spike in a cottonwood tree on the east bank 50 feet below the bridge; elevation, 8.05 feet above the zero of the

gage. (2) The top of the iron breakwater on the east pier of the railroad bridge 300 feet below the highway bridge; elevation, 8.13 feet above the zero of the gage. (3) A United States Geological Survey standard bench mark located in the Butte County court-house yard; elevation, 18.70 feet above the zero of the gage and 3,011.34 feet above sea level, making the elevation of gage datum above sea level 2,992.64 feet.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 57; 130, pp 169–170.
Discharge: 99, p 57; 130, p 170.
Discharge, monthly: 99, p 59; 130, p 172.
Gage heights: 99, p 58; 130, p 171.
Rating table: 99, p 58; 130, p 171.

Discharge measurements of Belle Fourche River at Belle Fourche, S. Dak., for 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 29[a]	F. M. Madden	54	65	1.45	1.80	94
April 13[a]	H. D. Comstock	62	57	1.25	1.68	71
June 1	do	70	89	1.64	2.00	146
Do	do	70	89	1.70	2.00	151
July 5	do	134	414	4.44	4.88	1,838
July 7	do	105	191	3.12	3.19	595
July 21	do	93	143	2.37	2.41	339
Do	do	93	143	2.40	2.41	343
August 2	do	120	261	3.89	3.79	1,015
August 16	J. C. Stevens	131	333	4.30	4.56	1,433

[a] Made by wading.

Daily gage height, in feet, of Belle Fourche River at Belle Fourche, S. Dak., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.68	4.25	4.95	1.7	1.58	1.85	1.95	4.85	2.1	1.6	1.7	1.6
2	1.55	5.0	4.35	1.72	2.08	1.9	1.92	3.32	2.1	1.6	1.7	1.6
3	1.35	5.75	3.95	1.65	3.15	1.85	4.3	2.78	2.1	1.6	1.7	.....
4	1.15	6.4	3.4	1.65	3.0	1.8	3.45	3.75	1.75	2.55	1.7	.....
5	.95	6.8	2.8	1.65	2.5	1.75	4.82	3.4	1.7	2.35	1.7	.....
6	.95	7.0	2.85	1.65	2.18	1.7	3.85	3.4	1.58	2.15	1.7	.....
7	.95	7.0	2.25	1.65	2.1	1.7	3.35	3.4	1.5	1.92	1.7	.....
8	1.0	7.0	2.25	1.65	2.18	1.7	3.48	2.15	1.5	1.82	1.7	.....
9	1.02	7.0	2.25	1.72	2.28	1.7	2.75	2.38	1.5	1.72	1.7	.....
10	1.05	6.7	2.25	1.82	2.68	1.75	3.52	3.2	1.45	1.7	1.7	.....
11	1.12	6.45	2.25	1.75	2.38	1.75	2.4	2.35	1.45	1.62	1.7	.....
12	1.3	6.2	2.05	1.7	2.25	1.75	2.6	2.35	1.45	1.65	1.7	.....
13	1.5	6.0	2.0	1.7	2.25	1.75	2.6	2.2	1.52	1.7	1.7	.....
14	1.72	5.9	2.0	1.75	2.2	1.75	2.3	6.38	1.55	1.7	1.7	.....
15	2.05	5.65	2.0	1.75	2.0	3.75	2.1	5.25	1.55	1.7	1.7	.....
16	2.22	5.35	2.0	1.75	1.95	3.15	2.6	4.35	1.55	1.7	1.7	.....
17	2.0	5.3	1.92	1.7	1.85	3.42	2.4	3.18	1.55	1.7	1.65	.....
18	2.0	5.15	1.82	1.7	1.85	.....	2.3	2.72	1.55	1.7	1.65	.....
19	3.0	4.98	1.72	1.7	1.85	2.85	2.05	2.5	1.55	1.7	1.65	.....
20	2.45	4.85	1.65	1.65	1.85	3.65	2.15	2.32	1.55	1.7	1.6	.....
21	2.38	4.8	1.65	1.65	1.85	3.32	2.4	2.2	1.55	1.7	1.6	.....
22	2.15	4.8	1.65	1.65	1.85	3.5	2.45	2.1	1.55	1.7	1.6	.....
23	1.08	4.8	1.6	1.65	1.85	2.85	3.45	2.02	1.55	1.7	1.6	.....
24	2.6	4.72	1.6	1.65	2.0	2.75	3.35	1.95	1.52	1.7	1.6	.....
25	3.0	4.7	1.6	1.65	2.82	2.8	3.35	1.9	1.5	1.7	1.6	.....
26	3.25	4.6	1.6	1.65	3.08	2.8	3.25	1.85	1.5	1.7	1.6	.....
27	3.45	4.6	1.6	1.65	2.38	2.35	4.32	1.8	1.5	1.7	1.6	.....
28	3.55	5.02	1.68	1.65	2.2	2.45	2.35	1.75	1.5	1.7	1.6	.....
29	3.38	.....	1.78	1.65	2.15	3.1	2.5	1.75	1.5	1.7	1.6	.....
30	3.18	.....	1.72	1.62	1.92	3.05	2.25	1.7	1.5	1.7	1.6	.....
31	3.0	.....	1.7	.....	1.9	.....	3.4	2.0	.....	1.7	.....	.....

NOTE.—Ice conditions January 1 to March 6, inclusive.

Station rating table for Belle Fourche River at Belle Fourche, S. Dak., from January 1 to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.40	50	2.50	290	3.60	850	4.70	1,630
1.50	60	2.60	330	3.70	920	4.80	1,705
1.60	75	2.70	370	3.80	990	4.90	1,780
1.70	90	2.80	410	3.90	1,060	5.00	1,855
1.80	110	2.90	450	4.00	1,130	5.20	2,005
1.90	130	3.00	500	4.10	1,200	5.40	2,155
2.00	150	3.10	550	4.20	1,270	5.60	2,305
2.10	175	3.20	610	4.30	1,340	5.80	2,455
2.20	200	3.30	670	4.40	1,410	6.00	2,610
2.30	230	3.40	730	4.50	1,480	6.20	2,770
2.40	260	3.50	790	4.60	1,555	6.40	2,930

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1904–5, and is well defined between gage heights 1 foot and 5.5 feet.

Estimated monthly discharge of Belle Fourche River at Belle Fourche, S. Dak., for 1905.

[Drainage area, 3,250 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 7–31	215	75	127	6,298	0.039	0.036
April	114	78	87.7	5,218	.027	.030
May	580	72	219	13,470	.067	.077
June	955	90	344	20,470	.106	.118
July	1,720	134	531	32,650	.163	.188
August	2,914	90	531	32,650	.163	.188
September	175	55	76.6	4,558	.024	.027
October	310	75	105	6,456	.032	.037
November	90	75	83.7	4,980	.026	.029
The period				126,800		

NOTE.—No estimate for ice period.

REDWATER RIVER AT BELLE FOURCHE, S. DAK.

Redwater River rises in the eastern part of Crook County, Wyo., flows eastward and unites with the Belle Fourche at Belle Fourche, S. Dak.

The gaging station was established July 20, 1903. It is located at the county highway bridge in the eastern limits of Belle Fourche, S. Dak., in the NW. ¼, sec. 11, T. 8 N., R. 2 E., 500 feet above the junction with Belle Fourche River.

The channel is straight for 50 feet above and below the station. The left bank is sufficiently high to prevent overflow, but the right bank is low and subject to overflow; there are trees along both banks. The bed of the stream is rocky and is fairly permanent. There is but one channel except at very high stages, and the current is swift. At very high stages the gage heights may be affected by backwater from Belle Fourche River. There is considerable "dead water" at low stages.

Discharge measurements are made from the north side of the bridge. The initial point for soundings is the center of the pile on the north side and at the east end of the bridge

The gage, which was read twice each day during 1905 by Raymond Giles, consists of a timber spiked to the north pile of the west bent of the bridge. The gage is referred to bench marks as follows: (1) The stone water table at the north corner of the public school building; elevation, 26.05 feet above the zero of the gage. (2) The top of the end of the iron waste pipe projecting from the northeast corner of the public school building; elevation, 22.97 feet above the zero of the gage. (3) The United States Geological Survey standard bench mark in the Butte County court-house yard; elevation, 18.46 feet above the zero of the gage and 3,011.34 feet above sea level, making the elevation of the gage datum above sea level 2,992.88 feet.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 59; 130, pp 172–173.
Discharge: 99, p 59; 130, p 173.
Discharge, monthly: 99, p 60; 130, p 175.
Gage heights: 99, p 60; 130, pp 173–174.
Rating table: 99, p 60; 130, p 174.

Discharge measurements of Redwater River at Belle Fourche, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 30	F. M. Madden	62	150	1.39	2.95	209
April 18	H. D. Comstock	62	152	1.32	2.95	200
May 11	do	65	251	3.76	4.50	945
May 13	do	63	220	3.12	4.05	686
June 9	do	60	111	1.28	2.80	142
July 7	do	62	172	2.22	3.80	382
August 16	J. C. Stevens	62	170	1.52	3.16	258

Daily gage height, in feet, of Redwater River at Belle Fourche, S. Dak., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	3.3	10.0	2.85	2.95	2.9	3.25	3.25	3.4	2.7	2.92	3.5
2	3.3	13.0	2.85	2.95	3.05	3.1	3.25	3.4	2.7	2.95	3.5
3	3.3	13.0	2.85	2.95	3.85	3.15	4.7	3.42	2.7	2.95	3.5
4	3.22	13.0	3.0	2.95	3.82	3.05	4.75	3.35	2.8	2.95	3.5
5	3.15	13.0	2.95	2.95	3.58	3.0	4.2	3.3	2.88	2.95	3.5
6	3.15	13.0	2.85	2.95	3.62	2.95	4.0	3.25	2.95	2.95	3.58
7	3.2	13.0	2.85	2.95	3.42	2.9	3.75	3.25	2.95	2.95	3.6
8	3.25	13.0	2.85	3.0	3.82	2.85	4.28	3.15	2.95	2.95	3.6
9	3.32	13.0	2.85	3.0	4.42	2.85	3.98	3.1	2.95	2.95	3.6
10	3.42	13.0	2.88	3.0	4.82	2.85	3.9	3.1	2.95	2.95	3.6
11	3.55	13.0	2.75	3.0	4.62	2.95	3.7	3.1	2.92	2.95	3.6
12	3.75	13.0	2.85	3.0	4.2	2.95	3.65	3.15	2.85	2.95	3.6
13	4.08	13.0	2.85	3.0	4.15	2.85	3.6	3.2	2.82	2.95	3.6
14	4.95	13.0	2.85	2.95	4.1	2.85	3.65	3.35	2.8	2.95	3.6
15	4.85	11.75	2.85	2.95	4.0	2.85	3.48	3.2	2.85	2.95	3.55
16	5.05	9.5	2.85	2.95	3.88	2.98	3.4	3.2	2.85	3.02	3.55
17	5.18	8.65	2.85	2.95	3.78	3.35	3.4	3.15	2.95	3.32	3.55
18	5.28	8.45	2.85	2.95	3.75	.....	3.4	3.15	2.92	3.5	3.55
19	5.45	8.25	2.85	2.95	3.75	3.5	3.25	3.15	2.9	3.5	3.55
20	5.28	7.35	2.85	2.92	3.72	3.48	3.25	3.08	2.95	3.5	3.6
21	4.9	5.9	2.85	2.9	3.7	3.4	3.75	3.0	2.92	3.5	3.6
22	4.55	4.9	2.85	2.9	3.65	3.4	3.72	2.95	2.9	3.5	3.6
23	4.5	4.5	2.85	2.9	4.0	3.4	3.75	2.95	2.9	3.5	3.6
24	4.65	3.75	2.85	2.9	3.85	3.4	3.5	2.92	2.88	3.5	3.6
25	4.88	3.35	2.9	2.9	3.72	2.9	3.45	2.9	2.85	3.5	3.6
26	5.15	3.05	2.9	2.9	3.65	3.0	3.4	2.85	2.9	3.5	3.6
27	5.32	2.95	2.9	2.9	3.55	3.25	3.7	2.8	2.88	3.5	3.6
28	5.42	2.88	3.0	2.95	3.5	3.0	3.45	2.75	2.85	3.5	3.6
29	5.52	.....	2.95	2.92	3.45	3.25	3.92	2.75	2.85	3.5	3.6
30	5.65	.....	2.95	2.9	3.35	3.25	3.95	2.75	2.9	3.5	3.6
31	5.95	.....	2.95	.....	3.3	.....	3.48	2.7	.....	3.5	.....

NOTE.—Ice conditions January 1 to February 24, inclusive.

Station rating table for Redwater River at Belle Fourche, S. Dak., from January 1 to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.70	120	3.30	323	3.90	607	4.50	942
2.80	148	3.40	365	4.00	660	4.60	1,002
2.90	178	3.50	410	4.10	714	4.70	1,064
3.00	210	3.60	457	4.20	769	4.80	1,130
3.10	245	3.70	505	4.30	825	4.90	1,200
3.20	283	3.80	555	4.40	883	5.00	1,265

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1905, and is well defined between gage heights 2.7 feet and 4.9 feet.

Estimated monthly discharge of Redwater River at Belle Fourche, S. Dak., for 1905.

[Drainage area, 1,015 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March	210	134	171	10,510	0.168	0.194
April	210	178	192	11,420	.189	.211
May	1,144	178	554	34,060	.546	.630
June	410	163	256	15,230	.252	.281
July	1,097	303	520	31,970	.512	.590
August	374	120	247	15,190	.243	.280
September	194	120	170	10,120	.167	.186
October	410	184	296	18,200	.292	.337
November	457	410	445	26,480	.438	.489
The period				173,200		

NOTE.—No estimate for ice period.

SPEARFISH CREEK NEAR SPEARFISH, S. DAK.

Spearfish Creek rises in the Black Hills in western Lawrence County, S. Dak., and flows northward into Redwater River.

The gaging station was established March 30, 1904. It is located at the Chicago, Burlington and Quincy Railroad bridge at Bradley's ranch, 1 mile above Spearfish, S. Dak., in the SW. ¼, sec. 14, T. 6 N., R. 2 E. It replaces the temporary station maintained during a part of 1903 at Toomey's ranch, 6 miles from Spearfish, and was placed at this point to get above the ditches which take water from Spearfish Creek in the town of Spearfish.

The channel is very crooked and the current is swift and full of rapids. Both banks are low, are covered with trees and brush, and overflow only when the stream freezes and the water runs over the ice. The bed is composed of coarse gravel and cobblestones and is not subject to much change. There is but one channel at all stages. Gage heights range from 0.8 foot to 7 feet.

Discharge measurements are made by wading at the gage. In high water they can be made from the bridge to which the gage is attached.

A staff gage, which was read during 1905 once each day by Bessie L. Bradley, is spiked vertically to a pile supporting the bridge near the right bank on the lower side. The gage is referred to bench marks as follows: (1) A drift bolt driven into the base of a cottonwood tree on the right bank, 50 feet below the gage; elevation, 4.02 feet above the zero of the gage. (2) The top of the head of a bolt in a pile in the first bent from the gage; the bolt is

marked by a spike driven through a flaw in the washer; elevation above the zero of the gage, 6.25 feet.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 175–177, 192.

Discharge measurements of Spearfish Creek near Spearfish, S. Dak., in 1905.

Date.	Hydrographer	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 6	H. D. Comstock	25	22	3.26	0.96	70
May 16	do	44	54	4.80	1.85	259
June 13	do	31	31	4.16	1.28	129
August 3	do	32	30	4.83	1.24	145
August 26	Stevens and Comstock	34	29	3.72	1.12	108

Daily gage height, in feet, of Spearfish Creek near Spearfish, S. Dak., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.95	1.3	0.85	0.95	1.15	1.25	1.3	1.25	1.1	1.05	1.05	1.05
2	.95	1.5	.85	.95	1.3	1.25	2.02	1.25	1.05	1.05	1.0	1.05
3	.95	2.65	.85	.95	1.3	1.25	2.5	1.25	1.05	1.05	1.0	.....
4	.95	3.05	.85	.9	1.3	1.25	2.05	1.2	1.05	1.05	1.0	.....
5	.9	3.3	.85	.9	1.3	1.35	1.75	1.2	1.05	1.05	1.0	.....
6	.9	3.15	.85	.95	1.3	1.25	1.75	1.2	1.05	1.05	1.0	.....
7	.85	3.4	.85	.95	1.45	1.25	1.65	1.2	1.1	1.05	1.0	.....
8	.85	3.1	.85	.95	1.7	1.25	1.65	1.2	1.1	1.05	1.05	.....
9	.95	2.9	.85	.95	2.25	1.3	1.55	1.2	1.1	1.05	1.05	.....
10	1.05	2.0	.85	.95	2.45	1.3	1.45	1.2	1.05	1.05	1.05	.....
11	2.45	1.0	.85	1.0	2.15	1.3	1.45	1.2	1.05	1.05	1.05	.....
12	2.45	1.0	.85	1.0	2.0	1.3	1.45	1.2	1.05	1.05	1.05	.....
13	2.45	2.0	.85	.95	2.0	1.3	1.4	1.2	1.05	1.05	1.05	.....
14	2.9	3.75	.85	.95	2.0	1.25	1.4	1.2	1.05	1.05	1.05	.....
15	3.7	3.75	.85	.95	1.95	1.25	1.3	1.15	1.05	1.05	1.05	.....
16	3.35	3.75	.85	.95	1.85	1.35	1.25	1.15	1.05	1.05	1.05	.....
17	3.3	3.5	.85	.95	1.75	1.35	1.25	1.15	1.05	1.05	1.05	.....
18	3.2	3.5	.85	.95	1.75	1.45	1.25	1.15	1.05	1.05	1.05	.....
19	3.2	3.5	.85	.95	1.75	1.45	1.25	1.15	1.05	1.05	1.05	.....
20	.85	3.4	.85	.95	1.75	1.45	1.55	1.15	1.05	1.05	1.05	.....
21	.85	3.35	.85	.95	1.75	1.45	1.45	1.15	1.05	1.05	1.05	.....
22	.9	2.85	.85	1.0	1.75	1.45	1.35	1.1	1.05	1.05	1.05	.....
23	.85	.85	.85	1.0	1.6	1.45	1.3	1.1	1.05	1.05	1.05	.....
24	.95	.85	.85	1.05	1.5	1.45	1.3	1.1	1.05	1.05	1.05	.....
25	1.0	.85	.85	1.1	1.5	1.45	1.25	1.1	1.05	1.05	1.05	.....
26	.85	.85	.85	1.15	1.45	1.45	1.25	1.1	1.05	1.05	1.05	.....
27	.85	.85	.85	1.15	1.4	1.45	1.25	1.1	1.05	1.05	1.05	.....
28	.85	.85	.9	1.15	1.4	1.4	1.25	1.1	1.05	1.05	1.05	.....
29	.85	.....	.9	1.15	1.35	1.4	1.25	1.1	1.05	1.05	1.05	.....
30	.65	.....	.95	1.15	1.35	1.35	1.25	1.1	1.05	1.05	1.05	.....
31	.85	.....	.95	.....	1.3	.....	1.25	1.1	.....	1.05	.....	.....

NOTE.—Ice conditions January 1 to February 22, inclusive.

Station rating table for Spearfish Creek near Spearfish, S. Dak., from February 23 to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.90	61	1.40	164	1.80	265	2.20	397
1.00	80	1.50	187	1.90	295	2.30	435
1.10	100	1.60	211	2.00	327	2.40	475
1.20	121	1.70	237	2.10	361	2.50	517
1.30	142						

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during 1904–5, and is not well defined.

Estimated monthly discharge of Spearfish Creek near Spearfish, S. Dak., for 1905

[Drainage area, 230 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
February 23–28	52	52	52.0	619	0.226	0.050
March	70	52	53.7	3,302	.233	.269
April	110	61	79.1	4,707	.344	.384
May	496	110	231	14,200	1.00	1.15
June	176	132	153	9,104	.665	.742
July	517	132	185	11,380	.804	.927
August	132	100	113	6,948	.491	.566
September	100	90	91.3	5,433	.397	.443
October	90	90	90.0	5,534	.391	.451
November	90	80	88.0	5,236	.383	.427
The period				66,460		

NOTE.—No estimate for ice period.

REDWATER CANAL AT MINNESELA, S. DAK.

This station was established May 7, 1904. It is located on the bridge across the canal in the town of Minnesela, 4 miles from Belle Fourche, S. Dak., in sec. 24, T. 8 N., R. 2 E.

The channel is straight for 200 feet above and below the station. The bed is composed of soft mud covered with water grass, which in the late summer lessens the flow of the canal considerably. There is but one channel at all stages, and the current is medium. Water is turned off the canal from about October 20 to May 20, and observations are discontinued during that period. Gage heights range from 1.5 to 3.5 feet.

Discharge measurements are made from the bridge to which the gage is attached. The initial point for soundings is a spike in the bridge over the edge of the canal at the right bank, downstream side.

The gage, which was read twice each day during 1905 by Robert H. Mitchell, is a vertical staff fastened to the bridge. The bench mark is a spike in a tree on the left bank about 100 feet from the gage; elevation, 4.00 feet above the zero of the gage.

A description of this station, with gage height and discharge data is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 178-179.

Discharge measurements of Redwater canal at Minnesela, S. Dak., for 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 30	H. D. Comstock	16	25	1.52	2.51	38
June 9	do	16	31	1.94	2.95	61
July 12	do	16	23	1.07	2.40	25
July 31	do	16	10	.10	1.60	[a]1

[a] Estimated.

Daily gage height, in feet, of Redwater canal at Minnesela, S. Dak., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.5	2.1	3.0	3.0	2.7	17	.....	0.95	2.5	3.0	2.9	1.9
2	.....	2.65	2.05	3.0	3.0	2.7	18	.....	1.0	2.2	3.0	2.9	1.8
3	.....	2.8	2.0	3.0	3.0	2.7	19	.....	1.3	1.9	3.0	2.95	1.8
4	.....	2.8	2.0	3.0	3.0	2.7	20	.....	2.0	1.9	3.0	2.9	1.8
5	.....	2.8	2.0	3.0	3.0	2.7	21	.....	2.0	1.9	3.0	2.9	1.8
6	.....	2.8	2.0	3.0	3.0	2.7	22	.....	2.0	2.0	3.0	2.75	1.75
7	.....	2.8	2.0	3.2	3.0	2.5	23	.....	2.4	2.5	3.0	2.6	1.7
8	.....	2.85	2.0	3.4	3.0	2.5	24	.....	2.55	2.5	3.0	2.6	.....
9	.....	2.95	2.05	3.4	3.0	2.5	25	.....	2.5	2.25	3.0	2.7	.....
10	.....	3.0	2.45	3.4	3.0	2.5	26	.....	2.4	2.0	3.0	2.7	.....
11	.....	3.0	2.45	3.4	3.0	2.5	27	.....	2.4	2.0	3.0	2.7	.....
12	.....	3.0	2.5	3.4	3.0	2.25	28	.....	2.0	2.95	3.0	2.7	.....
13	.....	3.05	2.5	3.2	3.0	2.0	29	.....	2.0	3.1	3.0	2.7	.....
14	.....	3.2	2.5	3.0	3.0	2.0	30	2.4	2.0	3.0	3.0	2.7	.....
15	.....	3.3	2.45	3.0	2.95	2.0	31	2.42	.....	3.0	3.0	.....	.....
16	.....	2.0	2.5	3.0	2.9	2.0							

Daily discharge, in second-feet, of Redwater canal at Minnesela, S. Dak., 1904–5.

Day.	1904.						1905.					
	May.	June.	July.	Aug.	Sept.	Oct.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	67	30	97	24	29	.....	37	12	60	55	36
2	.....	35	35	97	24	32	.....	46	0	60	55	36
3	.....	9	28	97	24	29	.....	56	9	60	55	36
4	.....	9	44	97	29	26	.....	56	9	60	55	36
5	.....	9	60	97	29	26	.....	51	9	60	55	36
6	.....	9	64	97	29	24	.....	51	9	60	55	36
7	.....	9	64	99	46	24	.....	51	9	74	55	26
8	44	9	64	81	66	24	.....	54	9	89	55	26
9	41	4	64	97	81	18	.....	62	10	89	55	26
10	41	2	64	97	46	16	.....	65	28	89	55	26
11	47	0	64	97	37	4	.....	65	28	89	55	26
12	47	0	64	97	32	.....	.....	65	30	89	55	26
13	38	0	64	97	29	.....	.....	68	30	74	55	7
14	35	0	64	97	26	.....	.....	79	30	60	55	7
15	41	0	64	97	26	.....	.....	87	28	60	52	7
16	38	0	64	81	40	.....	.....	11	30	55	48	7
17	35	0	64	81	34	.....	.....	0	30	55	48	4
18	41	2	60	81	29	.....	.....	0	16	55	48	2
19	41	38	56	70	1	.....	.....	0	6	55	52	2
20	41	47	50	59	1	.....	.....	11	6	55	48	2
21	35	47	60	59	0	.....	.....	11	6	55	48	2
22	53	47	74	59	0	.....	.....	11	9	55	39	1
23	67	44	74	59	5	.....	.....	28	30	55	31	0
24	67	41	67	59	6	.....	.....	36	30	55	31	.....
25	74	47	70	70	6	.....	.....	33	18	55	36	.....
26	74	47	67	81	9	.....	.....	25	9	55	36	.....
27	81	30	32	81	9	.....	.....	25	9	55	36	.....
28	67	30	35	81	10	.....	.....	9	56	55	36	.....
29	67	30	89	77	12	.....	.....	9	67	55	36	.....
30	67	30	89	73	20	.....	32	9	60	55	36	.....
31	67	.....	81	73	.....	.....	33	.....	60	55	.....	.....

NOTE.—The daily discharge is based on a series of parallel curves, each covering a short period of time.

Estimated monthly discharge of Redwater canal at Minnesela, S. Dak., 1904–5.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1904.				
May 8-31	81	35	52.0	2,475
June	67	0	21.4	1,273
July	89	28	60.3	3,708
August	97	59	83.3	5,122
September	81	0	24.3	1,446
October 1-11	32	4	22.9	500
The period				14,520
1905.				
June	87	0	37.0	2,202
July	67	6	22.6	1,390
August	89	55	63.0	3,874
September	55	31	47.7	2,838
October 1-23	36	0	18.0	821
The period				11,120

WHITE RIVER DRAINAGE BASIN.

WHITE RIVER AT INTERIOR, S. DAK.

White River rises in the northwestern part of Nebraska, flows northeastward, then eastward, and empties into the Missouri in southeastern Lyman County, S. Dak. The greater part of its course lies through the Bad Lands, which consist of white-clay cliffs and broken bottoms. There is little timber along the river and almost no land under cultivation. The main floods occur in March, May, June, and July.

The gaging station was established June 24, 1904. It is located at the ford about one-fourth mile northeast of Interior, S. Dak., in T. 3 S., R. 18 E.

The channel is curved for about 1,000 feet above and 500 feet below the station. Both banks are high and clean and overflow only at extreme high water. The bed is composed of sand and gravel and is shifting. There is but one channel at all stages except the very lowest, when there may be several channels. The slope at the station is about 3 feet per mile. The current is sluggish at low water. Gage heights range from 1 foot to 16 feet. The stream is frozen from about December 20 to March 10, and observations are discontinued during that period.

Discharge measurements are made by wading at the gage. The initial point for soundings is the top of the inclined gage.

The gage was read once each day during 1905 by George L. Johnson. Originally an inclined gage in two sections was attached to posts set in the bed and left bank of the stream. This gage and bench mark No. 1 were destroyed July 3, 1905. Records were referred to a temporary mark until August 31, 1905, when a new gage was established. It is inclined, consists of three sections, and is graduated to read direct. It is fastened to a post driven in the left bank, and a stump to a post driven near, both about 200 feet above the old gage, and to a post driven in the middle of the channel. Bench mark No. 1 is a spike driven in a blaze on a tree 50 feet above the old gage on the left bank; elevation, 10.26 feet above the zero of the gage. Bench mark No. 2 is a 60-penny spike in a 30-inch tree, blazed, 100 feet northeast of the new high-water gage; elevation, 14.83 feet above the zero of the gage.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 130 of the United States Geological Survey, pages 181–183.

Discharge measurements of White River at Interior, S. Dak., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 24	H. D. Comstock	112	60	1.47	1.80	88
June 29	do	133	214	2.24	3.06	479
August 31	do	105	59	1.49	2.03	88

Daily gage height, in feet, of White River at Interior, S. Dak., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	3.0	1.9	2.8	3.75	.....	2.05	1.8	2.1
2	.....	4.1	2.5	5.5	9.2	5.05	1.95	1.8	2.5
3	.....	4.9	4.2	5.3	13.5	4.35	1.95	1.9	2.0
4	.....	3.0	7.5	4.2	.....	4.05	2.3	1.9	2.0
5	.....	2.5	6.5	2.0	.....	3.35	2.25	1.9	2.0
6	.....	2.4	6.3	1.8	.....	3.05	2.15	1.9	2.0
7	.....	2.2	4.8	1.8	.....	2.85	1.95	1.9	2.0
8	.....	2.25	3.4	1.9	4.95	2.35	1.85	1.9	2.0
9	.....	2.2	2.9	1.8	4.65	2.25	1.85	1.9	2.0
10	.....	2.2	2.8	1.65	4.35	2.25	1.9	1.9	2.0
11	.....	2.2	2.5	1.6	5.0	2.15	1.9	1.95	2.0
12	.....	2.0	2.4	1.8	4.95	5.2	1.9	1.95	2.0
13	.....	2.6	2.3	1.6	4.25	5.15	1.9	1.95	2.0
14	.....	2.6	2.1	1.9	3.85	4.35	1.9	2.0	2.0
15	.....	3.5	2.1	2.3	3.05	4.45	1.9	2.0	2.0
16	.....	3.5	2.0	3.0	2.95	4.1	1.9	2.0	2.0
17	.....	3.0	1.9	4.2	2.75	3.95	1.9	1.95	2.0
18	.....	2.8	1.9	16.0	2.45	3.85	1.9	1.9	2.0
19	2.8	2.6	1.8	6.0	2.35	3.65	1.9	2.0	2.0
20	2.7	2.5	1.8	6.0	4.05	3.35	1.9	2.3	2.0
21	2.7	2.4	1.8	5.2	2.95	3.05	1.9	2.2	2.0
22	2.65	2.4	1.7	5.0	5.05	2.65	1.9	2.2	2.0
23	2.65	2.3	1.9	4.7	3.35	2.45	1.9	2.2	2.0
24	2.7	2.0	1.8	4.5	3.15	2.25	1.9	2.1	2.0
25	2.7	2.0	1.9	4.3	2.85	2.25	1.9	2.1	2.0
26	2.9	1.9	1.9	4.2	2.75	2.15	1.8	2.1	2.0
27	2.95	1.9	1.9	3.0	2.65	2.15	1.8	2.1	2.1
28	2.9	1.9	1.9	3.45	4.25	2.15	1.8	2.2	2.2
29	2.95	1.9	5.6	4.05	.....	2.15	1.7	2.2	2.2
30	2.2	1.9	3.3	3.95	.....	2.15	1.7	2.2	2.2
31	2.1	.....	3.0	.....	.....	2.15	.....	2.1	.....

NOTE.—Water over top of gage July 4–7 and July 29 to August 1.

NIOBRARA RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Niobrara River rises in the mountains of eastern Wyoming, flows eastward through the northern portion of Nebraska; and empties into the Missouri in Knox County at the city of Niobrara. Its drainage basin is narrow in the upper portion, but broadens considerably near the mouth; it comprises about 9,012 square miles.

Throughout the middle portion of its course the river runs in a deep canyon, varying in depth from 100 to 300 feet. Beyond the canyon are high, rolling, and sometimes broken

table-lands, traversed here and there by deep canyons cut by the numerous tributaries of the river. Large areas of rolling sand hills border these table-lands in portions of Sheridan, Cherry, Brown, Rock, and Holt counties. Formerly these sand hills were very shifting, but within recent years they have become overgrown with a comparatively luxuriant growth of grasses which serves to render them more permanent.

The soil throughout the region is generally sandy, and there is little or no timber except for a few pines on the bluffs of the canyons of the main stream and its tributaries. Lying generally in an east-west direction between the sand hills are extensive hay flats, and on the firmer soils considerable farming is done, for though the annual rainfall is small, most of it occurs during the growing months, and comparatively large quantities of corn, wheat, melons, etc., are produced. By far the greater part of the drainage area of the stream, however, is given over to range land for cattle. The Niobrara Forest Reserve, which lies between Niobrara and Snake rivers, consists almost wholly of sand hills, except along the borders.

Precipitation within the basin varies from 15 to 18 inches in the upper portion, from 18 to 21 inches in the middle portion, and from 21 to 24 inches in the lower portion. Evaporation is 6, 5, and 4½ feet in the upper, middle, and lower portions, respectively. Sixty-nine per cent of the precipitation falls during April, May, June, July, and August, and about one-half of the remainder is snowfall.

The river is not subject to periodic rises of any extent, owing to the fact that the sand hills which form so large a portion of its drainage area act as storage reservoirs for the rain and snow, which are afterwards fed to the stream in the form of spring water, thus equalizing the flow and making the constancy of the discharge almost phenomenal.

In the southern part of Cherry County are numerous small lakes which form the headwaters of tributaries. These lakes are subject to slight periodic rises which lag considerably behind the periods of greatest rainfall, and on one of them, Red Deer Lake, a gaging station was established in order that this characteristic might be studied.

The principal tributaries are Verdigris, Keya Paha, and Snake rivers, and Minnechaduza Creek. The drainage area of the Snake is similar in nearly all respects to that of the western part of the Niobrara.

The water resources of the Niobrara are at present almost wholly undeveloped, irrigation being limited to the low, narrow flood plains in the bottoms of the canyons. On Minnechaduza Creek, at Valentine, an artificial lake has been formed by a dam, and a power plant has been installed for lighting and for furnishing the city with water. On the lower portion of the Niobrara a number of mills are in operation, receiving their power from small tributaries. On Snake River possibilities for power development are phenomenal, but long transmission lines would be required to make it of practical value.

Detailed information in regard to this drainage basin is contained in the following reports:

A reconnaissance of Niobrara River and its tributaries, by J. C. Stevens: Third Ann. Rept. U. S. Recl. Service (2d ed.), 1905, pp. 338 et seq.

Preliminary report on the geology and water resources of Nebraska west of the 103d meridian, by N. H. Darton: Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 4, 1898, pp. 719 et seq.

NIOBRARA RIVER NEAR VALENTINE, NEBR.

This station was established July 22, 1897, and was known as the Fort Niobrara station. June 26, 1901, it was moved about 3 miles farther upstream to the Borman Bridge, in sec. 4, T. 34, R. 28, about 3 miles southeast of the town of Valentine.

At the gaging station the stream lies on an easy curve. The banks are heavily wooded and high and are not liable to overflow. The bed is composed of cobblestones and sand, which at times of high water scours out, leaving the rocks comparatively bare. The shifting of the sand renders the development of a good rating curve a difficult matter, and the method of applying a rating table indirectly has been largely used. There are no natural obstructions in the stream and the current is always swift. The range of gage heights seldom exceeds 2 feet except in the case of a "cloudburst," when the very lowest bottom

land has been flooded for a few hours. The river seldom freezes completely over, and during 1904 and 1905 records of gage heights were obtained throughout the winter.

Discharge measurements are made from a single-span steel bridge. The initial point for soundings is the zero mark on the upstream hand rail in line with the west face of the east pier.

The gage, which is observed by John Borman, is of the wire and weight type, and is located about 1,000 feet upstream from the bridge on the left bank. The length of the wire is 9.90 feet. The gage is referred to bench marks as follows: (1) The head of a nail driven in the stump of a boxelder tree—one of a clump of four—just east of Mr. Borman's house; elevation above the zero of the gage, 17.26 feet. (2) A 2 by 6 inch pine head block, on which the gate of Borman's fence rests when closed; elevation above the zero of the gage, 16.19 feet. As a check, the elevation of the water surface at the time of making the measurements is referred to the bottom of the upstream end of the second floor beam from the end of the bridge on the left bank.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; WS=Water-Supply Paper):

Description: Ann 20, iv, p 255; WS 66, p 25; 84, p 18; 99, p 46; 130, pp 183–184.
Discharge: Ann 18, iv, p 193; 20, iv, pp 255, 301; WS 66, p 25; 84, p 18; 99, p 46; 130, p 184.
Discharge, daily WS 130, p 185.
Discharge, monthly: WS 84, p 20; 99, p 48; 130, p 186.
Gage heights: WS 66, p 25; 84, p 19; 99, p 47; 130, p 184.
Rating tables: WS 84, p 19; 99, p 47.

Discharge measurements of Niobrara River near Valentine, Nebr., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 13	E. L. Thomas	117	220	4.13	1.64	910
May 31	H. C. Gardner	120	253	4.51	1.85	1,142
June 29	do	120	227	4.89	1.80	1,111
July 19	G. W. Bates	120	203	4.06	1.50	818
August 15	H. C. Gardner	105	204	4.78	1.65	978
October 15	do	120	228	3.65	1.55	834
November 15	G. W. Bates	115	207	4.28	1.65	886
December 27	do	110	208	4.53	1.75	940

Daily gage height, in feet, of Niobrara River near Valentine, Nebr., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.15	2.78	2.3	1.65	1.53	1.76	1.76	1.88	1.48	1.45	1.57	1.95
2	1.9	2.8	2.15	1.8	1.55	1.75	3.15	1.82	1.5	1.43	1.6	1.35
3	2.15	3.35	2.0	1.78	1.62	1.86	2.8	1.75	1.45	1.47	1.56	1.23
4	2.03	3.6	1.78	1.8	2.03	1.68	2 4	1.7	1.44	1.45	1.59	1.37
5	2.05	3.77	1.75	1.71	1.8	1.65	2.32	1.67	1.48	1.5	1.62	2.18
6	2.02	3.9	1.8	1.65	1.75	1.5	2.15	1.68	1.45	1.52	1.57	2.2
7	2.0	3.85	1.78	1.6	1.68	1.48	2.05	1.65	1.49	1.49	1.59	2.1
8	2.03	3.7	1.75	1.62	1.65	1.5	1.82	1.67	1.53	1.55	1.61	2.15
9	1.9	3.6	1.7	1.6	1.6	1.55	1.93	1.66	1.55	1.57	1.59	2.2
10	2.07	3.67	1.64	1.82	1.63	1.75	1.85	1.58	1.5	1.53	1.58	2.03
11	2.45	3.95	1.62	1.68	1.7	1.7	1.8	1.55	1.47	1.45	1.61	2.0
12	3.2	4.0	1.6	1.57	1.63	1.55	1.68	1.55	1.45	1.44	1.6	1.98
13	3.6	3.9	1.64	1.55	1.55	1.58	1.65	1.58	1.42	1.45	1.59	2.0
14	3.15	3.9	1.60	1.62	1.64	1.56	1.6	1.72	1 5	1.5	1.63	1.9
15	3.9	3.65	1.63	1.7	1.6	1.55	1.62	1.64	1.49	1.55	1.64	1.9
16	3.85	3.6	1.67	1.66	1.65	1.6	1.65	1.6	1.52	1.48	1.6	1.92
17	3.15	3.35	1.66	1.65	1.53	1.57	1.68	1.55	1.47	1.48	1.63	1.88
18	3.2	3.55	1.73	1.6	1.5	1.93	1.57	1.53	1.55	1.49	1.65	1.75
19	2.77	3.38	1.7	1.57	1.53	1.75	2.48	1.51	1.48	1.55	1.65	1.76
20	2.5	3.16	1.62	1.55	1.52	1.95	2.15	1.48	1.45	1.5	1.66	1.78
21	2.2	3.1	1.65	1.53	1.52	1.6	1.95	1.5	1.45	1.52	1.67	1.75
22	2.38	3.18	1.63	1.54	1.53	1.77	1.76	1.53	1.47	1.5	1.7	1.75
23	2.33	2.85	1.7	1.53	1.5	1.63	1.75	1.5	1.5	1.48	1.72	1.69
24	2.45	2.74	1.68	1.67	1.48	1.78	1.6	1.5	1,45	1.49	1.74	1.65
25	2.83	2.6	1.65	1.68	1.52	2.04	1.73	1.45	1.42	1.5	1.73	1.63
26	2.25	3.0	1.6	1.73	1.53	1.8	1.62	1.42	1.5	1.5	1.7	1.75
27	2.33	2.7	1.62	1.6	1.78	2.5	1.6	1.45	1.52	1.53	1.75	1.72
28	2.57	2.48	1.75	1.6	1.65	1.95	1.6	1.43	1.45	1.54	1.77	1.65
29	2.85	.....	1.65	1.55	2.2	1.72	1 61	1.49	1.5	1.58	1.56	1.58
30	1.9	.....	1.58	1.5	1.95	1.85	1.87	1.45	1.47	1.56	1.35	1.7
31	2.0	.....	1.61	.....	1.85	.....	1.8	1.48	.....	1.59	.....	1.56

Daily discharge, in second-feet, of Niobrara River near Valentine, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	905	740	1,005	1,065	1,375	760	725	820
2	.....	1,125	760	990	3,420	1,270	785	705	855
3	.....	1,095	835	1,160	2,845	1,150	730	745	805
4	.....	1,125	1,480	895	2,165	1,070	720	725	835
5	1,070	985	1,090	860	2,044	1,025	760	780	870
6	1,150	900	1,015	695	1,755	1,040	730	800	810
7	1,120	835	910	680	1,600	990	770	765	830
8	1,070	860	870	700	1,210	1,015	815	835	850
9	995	835	810	750	1,400	1,005	840	855	825
10	910	1,150	845	1,005	1,280	990	780	810	815
11	880	935	935	935	1,200	850	750	725	845
12	860	795	845	750	1,020	850	730	715	830
13	910	775	750	785	980	885	700	725	815
14	860	855	855	765	915	1,085	780	775	865
15	895	960	805	755	950	930	770	834	880
16	950	905	865	815	1,000	905	805	750	825
17	935	890	730	780	1,055	845	750	750	860
18	1,035	825	700	1,310	900	820	840	760	880
19	990	790	725	1,020	2,420	795	760	825	880
20	880	770	715	1,345	1,855	765	725	765	890
21	915	745	715	820	1,515	785	725	785	900
22	890	755	725	1,055	1,190	820	750	760	940
23	985	745	695	860	1,170	785	780	740	965
24	955	910	675	1,075	940	785	725	750	995
25	910	925	710	1,515	1,135	730	700	755	980
26	845	995	720	1,110	965	700	780	755	935
27	870	820	1,035	2,300	935	730	800	785	1,005
28	1,055	820	855	1,365	935	710	725	795	1,030
29	910	760	1,740	990	1,005	770	780	840	760
30	820	710	1,310	1,200	1,365	730	745	815	575
31	855	.....	1,140	.....	1,240	760	.....	845	.....

NOTE.—The daily discharge was obtained by the indirect method. Owing to the uncertainty of ice conditions and lack of high-water measurements no estimate was made January 1 to March 4 nor December 1–31.

Estimated monthly discharge of Niobrara River near Valentine, Nebr., for 1905.

[Drainage area, 6,070 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 5–31	1,150	820	945	50,610	0.156	0.157
April	1,150	710	883	52,540	.145	.162
May	1,740	675	890	54,720	.147	.170
June	2,300	680	1,010	60,100	.166	.185
July	3,420	900	1,402	86,200	.231	.266
August	1,375	700	902	55,460	.149	.172
September	840	700	760	45,220	.125	.140
October	855	705	774	47,590	.128	.148
November	1,030	575	866	51,530	.143	.160
The period	.....	.....	.....	504,000	.....	.....

RED DEER LAKE NEAR WOODLAKE, NEBR.

This station was established August 12, 1904. The lake is located in secs. 16, 17, 20, and 21, T. 30 N., R. 27 W., about 16 miles south of Woodlake post-office and about 30 miles south of Valentine, Nebr., and is representative of the numerous lakes of this region. The station was established for the purpose of determining the cause and amount of the periodic rise of these lakes, which, according to local authorities, is often several feet, beginning in April or May.

The lake covers about 1 square mile of surface and is merely a valley or flat in the sand hills, filled with water. The depth varies from 1 foot to 15 feet, the average being probably about 8 feet. The bed is entirely of sand, and the margin is thickly grown with rushes, etc.

The gage was observed by J. S. Brosius. It consists of a staff fastened to a post at the end of the boat landing 200 yards south of Cochran's ranch house near the east end of the lake. The bench mark is a group of three spikes driven horizontally near the base of a cottonwood tree 12 inches in diameter, located 40 feet south and 20 feet east of the southwest corner post of the large windmill tower just west of Cochran's house; elevation above the zero of the gage, 9.61 feet.

The station was discontinued October 31, 1905.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper of the United States Geological Survey No. 130, pages 186-187.

Daily gage height, in feet, of Red Deer Lake near Woodlake, Nebr., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1				4.39			4.75			
2									4.3	
3		4.46	4.36			4.55				
5					4.49			4.71		
6	4.4									
7				4.43						4.16
8							4.82			
9									4.32	
10			4.29			4.62				
11		4.5								
12								4.59		
13					4.52					
14	4.41						4.72			4.23
15				4.4						
16									4.3	
17		4.49	4.35			4.6				
19								4.5		
20	4.4				4.41					
21				4.36						
22							4.68			4.24
23									4.3	
24						4.7				
25		4.44	4.3							
26								4.4		
27					4.52					
28	4.41									
29				4.4			4.65			4.3
30									4.2	

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements made in Niobrara River drainage basin, Nebraska, in 1905.

Date.	Stream.	Locality.	Area of section.	Mean velocity.	Discharge.
			Sq. ft.	*Ft. per sec.*	*Sec.-ft.*
April 26	South Fork of Eagle Creek	Sec. 9, T. 30 N., R. 13 W	15	1.66	25
April 26	North Fork of Eagle Creek	Sec. 26, T. 31 N., R. 13 W	4.3	1.88	8.1
April 27	Beaver Creek	Sec. 19, T. 32 N., R. 16 W	18	1.12	20
July 18	Keya Paha River		58	2.34	136

PLATTE RIVER DRAINAGE BASIN.

GENERAL FEATURES.

Considered only with regard to the extent of area drained, the Platte is the most important tributary of the Missouri. It is formed by two forks, North Platte and South Platte, which rise, respectively, in northern and in central Colorado and unite a little southwest of the center of Nebraska. Its entire drainage basin comprises about 90,000 square miles, of which in round numbers 36,000 square miles belong to the North Platte and 24,000 to the South Platte. The lower course of the river is fairly well settled, but farther west the population is more scattered.

For convenience the description of the basin is divided, and the North Platte, South Platte, and Platte River proper are considered separately.

NORTH PLATTE RIVER.

DESCRIPTION OF BASIN.

The source of the North Platte is in North Park, Colorado, or rather in the mountains which, rising to elevations from 4,000 to 5,000 feet above its general level, hem it in on all sides. From the steep slopes of these mountains numerous small streams descend, unite below into large creeks, and flow outward to the center of the basin. The two which may be said to form the real head of the North Platte are Grizzly and Little Grizzly creeks, but within the park the river is joined by four large tributaries, Roaring Fork and North Fork from the west and Michigan and Canadian creeks from the east. Leaving the park, the river makes a bold curve northward into Wyoming, but near Caspar, on the north side of the Caspar Range, it turns abruptly to the east and southeast, maintaining the latter course to its point of junction with the South Platte in central Nebraska.

Within North Park the topographic features are diversified, including every degree of roughness from the snow-capped peaks of the Park and Medicine Bow ranges to the level prairie mesas along the lower portion of the stream. Dense forests occur in the mountain tracts, the heaviest being those on the east slope of the Park and the west slope of the Medicine Bow ranges. At an elevation of 8,500 feet above sea level the forests give way to the open prairie country, which, with the exception of the dense growth of willows along the river bottoms, is entirely free from forests of any description. The soil, composed principally of gravelly and sandy loam on the mesas and of sandy and black loam along the river bottoms, is in general fertile, but climatic conditions are such that the agricultural products are limited to wild hay, roots, and a few of the hardier grains.

In its northward course through Wyoming the stream receives many tributaries, the Snowy Range on the east contributing its drainage through Douglas, French, and Brush creeks, while the northeast slope of the Sierra Madre is drained by Beaver, Big Cow, and Spring creeks and Grand Encampment River. Medicine Bow and Sweetwater rivers are

added to the North Platte between Saratoga and Caspar, beyond which the only important tributary is the Laramie, which enters at old Fort Laramie.

The greater part of the region below Saratoga is a rolling, undulating prairie. The soil throughout Wyoming is a sandy loam of sufficient depth to produce meadows of rich grasses, even up to elevations of 7,000 feet. At lower elevations the soil becomes more friable and deeper.

Throughout its course in western Nebraska the valley of the North Platte is 10 to 15 miles wide. The present floor, consisting of sediments deposited in a former greater valley, is bordered by terraces and table-lands scarred by numerous tributaries and arroyos. The stream is broad and shallow, with a flood plain from 1 mile to 4 miles wide.

The character of the river bed at the Big Bend and at the Seminole Mountains, in Wyoming, seems to indicate a considerable underflow. A part of this is collected at the Big Bend, and probably the entire amount is brought to the surface as the river passes through the Seminole Range. In its lower course the bed of the stream is of fine quicksand, underlain at a depth of from 15 to 20 feet by a hard layer which seems to be clay.

Agricultural efforts in the basin of the North Platte have been largely confined to the valleys of the tributaries. No important work has been undertaken except on the Laramie, and this on the plains before that stream has passed through the Laramie Mountains and received the drainage of their eastern slope. On tributaries of the North Platte, however, the available lands are all occupied over the entire basin.

The stream is subject to periodic floods, which reach their maximum at the mouth some time during the latter part of June and are caused by the melting snow on the high ranges in which the headwater streams rise. The river runs lowest in winter, when it freezes thickly. High water prevails from the middle of April to the middle of July, when the river runs bank full.

In the mountain districts the precipitation, which is mostly in the form of snow during the winter and spring months, varies from 7 to 15 inches, the average being about 11 inches. Throughout the lower portion of the basin the precipitation is from 15 to 18 inches and the evaporation from water surface is from 5 to 6 feet.

Information in regard to the basin is contained in the Annual Reports of the Reclamation Service and in the Annual Reports of the United States Geological Survey, as follows: Thirteenth, pt. 3, pp. 78–82; Nineteenth, pt. 4, pp. 304–306, 772–774; Twenty-second, pt. 4, pp. 310–311.

GRIZZLY CREEK AT HEBRON, COLO.

Grizzly Creek rises on the northern slope of the Continental Divide in North Park, Colorado, flows northward, and unites with Little Grizzly Creek to form the North Platte. Its principal tributaries are Colorado, Arapahoe, and Buffalo creeks.

The gaging station was established May 13, 1904. It is located at the highway bridge at Hebron, Colo., about 2 miles above the junction with Little Grizzly Creek and 10 miles from Walden, Colo., in sec. 29, T. 8 N., R. 80 W.

The channel is straight for about 50 feet above and below the station. The banks are about 3 feet high and neither is liable to overflow. The current is at a right angle to the gaging section and is uniform and medium at all stages. The bed of the stream is composed of gravel, with cobblestones and mud on the left side. There is but one channel at all stages. Gage heights have a range of about 3 feet. The stream is frozen over during the greater part of the winter season, making gage readings impossible.

At very high stages discharge measurements are made from the downstream side of the two-span bridge to which the gage is attached. The initial point for soundings is the face of the left abutment at the zero marked on the hand rail. At low and ordinary stages discharge measurements are made by wading near the gage.

The gage, which is read once each day by James Peterson, is a vertical staff graduated from 2 to 9.5 feet spiked to the left downstream corner of the middle crib pier. The 2-foot mark rests on the bed of the stream. The gage is referred to bench marks as follows: (1) A 30-penny nail driven vertically into the top of the downstream end of the top timber

of the left abutment of the bridge; elevation, 9.76 feet above the zero of the gage. (2) A regulation iron bench-mark post 4 feet east of the fence on the west side of the road, 60 feet south of the river bank; elevation, 8.82 feet above the zero of the gage. The elevation above sea level is approximately 8,100 feet.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 53–55.

Discharge measurements of Grizzly Creek at Hebron, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 17	W. A. Lamb	54	173	1.73	5.70	299
June 17	do	53	76	2.71	.....	206
June 25	do	30	29	2.28	4.30	66
July 14	do	17	8.8	1.28	3.62	11
August 9	do	15	5.8	.86	3.50	5
August 24	do	8	1.7	.29	3.26	.5
September 26	do	9	2.5	.84	3.40	2.1

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Grizzly Creek at Hebron, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	5.35	5.55	3.9	3.5	3.3	3.3
2	.....	5.65	5.7	3.9	3.55	3.3	3.2
3	.....	5.55	5.75	3.98	3.6	3.45	3.45
4	.....	5.3	5.88	3.98	3.58	3.45	3.45
5	.....	5.02	5.9	3.98	3.6	3.45	3.45
6	.....	4.95	5.92	3.9	3.55	3.45	3.45
7	.....	4.7	5.75	4.0	3.55	3.45	3.45
8	.....	4.45	5.55	4.1	3.5	3.45	3.45
9	.....	5.95	5.8	4.18	3.5	3.45	3.45
10	.....	5.25	5.78	4.15	3.5	3.4	3.45
11	.....	4.9	5.95	4.22	3.5	3.4	3.45
12	.....	4.5	5.82	4.48	3.5	3.35	3.45
13	.....	4.55	5.7	4.5	3.5	3.35	3.45
14	.....	4.9	5.45	4.4	3.5	3.3	3.45
15	.....	4.8	5.55	4.38	3.5	3.3	3.45
16	.....	5.12	5.6	4.45	3.4	3.3	3.48
17	4.2	5.52	5.68	4.45	3.4	3.3	3.5
18	4.25	5.35	5.45	4.25	3.3	3.3	3.5
19	4.68	5.65	5.05	3.85	3.3	3.3	3.5
20	4.38	5.35	5.0	3.5	3.32	3.3	3.5
21	4.3	5.7	5.1	3.5	3.3	3.3	3.5
22	4.32	5.95	5.0	3.48	3.25	3.3	3.5
23	4.3	5.7	4.95	3.48	3.25	3.3	3.5
24	4.2	5.7	4.85	3.48	3.2	3.3	3.5
25	4.28	5.6	4.45	3.5	3.2	3.3	3.45
26	4.5	5.55	4.38	3.4	3.2	3.3	3.45
27	5.55	5.5	4.2	3.45	3.2	3.3	3.45
28	5.12	5.6	4.05	3.5	3.2	3.35	3.45
29	4.8	5.4	3.95	3.5	3.3	3.35	3.45
30	5.15	5.55	3.9	3.5	3.5	3.35	3.48
31	.....	5.5	.....	3.5	3.3	.....	3.48

Station rating table for Grizzly Creek at Hebron, Colo., from April 17 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-feet.*
3.20	1	4.00	35	4.80	131	5.60	281
3.30	2	4.10	43	4.90	147	5.70	303
3.40	4	4.20	52	5.00	164	5.80	325
3.50	7	4.30	62	5.10	182	5.90	347
3.60	11	4.40	74	5.20	200	6.00	370
3.70	16	4.50	87	5.30	219		
3.80	22	4.60	101	5.40	239		
3.90	28	4.70	116	5.50	260		

The above table is applicable only for open-channel conditions. It is based on 13 discharge measurements made during 1904–5, and is well defined between gage heights 3.3 and 5.6 feet.

Estimated monthly discharge of Grizzly Creek at Hebron, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April (14 days)	270	52	104	2,888
May	358	80	227	13,960
June	358	28	226	13,450
July	87	4	34.0	2,091
August	11	1	5.1	314
September	6	2	3.1	184
October	7	1	5.7	350
The period				33,240

LITTLE GRIZZLY CREEK AT HEBRON, COLO.

Little Grizzly Creek rises on the eastern slope of the Park Range in North Park, Colorado, flows eastward and unites with Grizzly Creek to form the North Platte.

The gaging station was established June 3, 1904. It is located at the wagon bridge on James Hill's ranch, one-half mile southwest of Hebron, Colo., and one-fourth mile west of the road from Hebron to Spicer, in sec. 32, T. 8 N., R. 80 W.

The channel is straight for 150 feet above and below the station. Both banks are low and liable to overflow. The bed of the stream is composed of gravel and small cobblestones and is firm. There is but one channel at all stages, broken by the middle pier of the bridge, and the current has a medium and uniform velocity. Gage heights have a range of about 3 feet. The creek is frozen over during the greater part of the winter.

High-water discharge measurements are made from the downstream side of the two-span bridge to which the gage is attached. The initial point for soundings is on the east edge of the pier at the left bank of the stream. Low-water measurements are made by wading 300 feet above the gage.

The gage is read once each day by John Peterson, who lives one-half mile distant. It is a staff nailed vertically to the northwest corner of the center pier of the bridge. The gage is referred to bench marks as follows: (1) A nail driven into the north end of the second log of the west abutment; elevation above the zero of the gage, 5.90 feet. (2) A nail driven into the north end of a log in the right abutment; elevation above the zero of the gage, 6.37 feet. (3) Top of regulation iron bench-mark post 80 feet east and 20 feet north of the gage; elevation above the zero of the gage, 6.79 feet. The elevation is approximately 8,100 feet above sea level.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 55–57.

Discharge measurements of Little Grizzly Creek at Hebron, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 17	W. A. Lamb	38	87	1.95	4.15	170
June 17	do	44	142	3.00	5.45	426
June 25	do	38	117	2.74	4.75	321
July 14	do	22	34	1.41	3.20	48
August 9	do	28	14	1.14	2.83	16
August 24	do	18	21	.33	2.68	6.9
September 26	do	18	54	.87	2.68	4.7

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Little Grizzly Creek at Hebron, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	4.25	4.55	3.95	2.9	2.6	2.8
2	.....	4.25	5.05	4.88	2.95	2.6	2.85
3	.....	4.25	5.15	4.88	2.82	2.6	2.82
4	.....	3.9	5.48	4.9	2.88	2.6	2.8
5	.....	3.88	5.45	4.95	2.92	2.6	2.8
6	.....	3.82	5.6	5.0	2.85	2.6	2.8
7	.....	3.65	5.45	4.88	2.85	2.6	2.8
8	.....	4.05	5.45	4.85	2.85	2.6	2.8
9	.....	3.4	5.55	4.82	2.85	2.6	2.8
10	.....	4.1	5.55	4.78	2.85	2.62	2.8
11	.....	3.5	5.92	4.78	2.85	2.65	2.8
12	.....	3.75	5.65	4.1	2.85	2.65	2.8
13	.....	3.6	5.45	3.3	2.85	2.65	2.8
14	.....	3.65	5.45	3.45	2.75	2.65	2.8
15	.....	3.65	5.4	3.55	2.65	2.65	2.82
16	.....	3.7	5.5	3.45	2.62	2.65	2.85
17	3.25	4.15	5.6	3.2	2.5	2.65	2.9
18	3.08	4.05	5.4	3.32	2.55	2.65	2.9
19	3.12	3.9	5.42	3.15	2.6	2.65	2.9
20	3.38	4.0	5.42	2.9	2.68	2.65	2.9
21	3.52	4.0	5.35	3.1	2.65	2.65	2.9
22	2.78	4.4	5.35	3.12	2.65	2.65	2.9
23	3.15	4.95	4.85	3.1	2.65	2.65	2.9
24	3.25	4.95	4.55	2.95	2.82	2.67	2.9
25	3.2	4.95	4.48	3.0	2.7	2.68	2.9
26	3.2	4.95	4.5	2.9	2.7	2.75	2.9
27	3.3	4.7	4.6	2.9	2.8	2.75	2.9
28	3.88	4.7	4.65	3.0	2.7	2.75	2.9
29	3.85	4.55	4.55	3.0	2.6	2.78	2.9
30	3.98	4.35	4.52	3.1	2.6	2.82	3.0
31	.....	4.8	.....	3.0	2.6	.....	3.0

Station rating table for Little Grizzly Creek at Hebron, Colo., from April 17 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.50	1	3.40	71	4.30	196	5.20	396
2.60	4	3.50	83	4.40	215	5.30	422
2.70	9	3.60	95	4.50	235	5.40	448
2.80	15	3.70	108	4.60	255	5.50	475
2.90	22	3.80	121	4.70	276	5.60	502
3.00	30	3.90	134	4.80	298	5.70	530
3.10	39	4.00	148	4.90	321	5.80	558
3.20	49	4.10	163	5.00	345	5.90	586
3.30	60	4.20	179	5.10	370	6.00	615

The above table is applicable only for open-channel conditions. It is based on 13 discharge measurements made during 1904–5 and is fairly well defined between gage heights 2.7 feet and 5 feet.

Estimated monthly discharge of Little Grizzly Creek at Hebron, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 17–30	145	14	68.6	1,905
May	333	71	182	11,190
June	592	231	401	23,860
July	345	22	138	8,485
August	26	1	12.3	756
September	16	4	6.9	411
October	30	15	19.2	1,181
The period				47,790

ROARING FORK OF NORTH PLATTE RIVER NEAR HEBRON, COLO.

Roaring Fork rises in the Park Range at the crest of the Continental Divide, flows eastward, and enters the North Platte about 3 miles below the junction of Grizzly and Little Grizzly creeks. The basin is very rugged, a large portion extending above the timber line and reaching an altitude of 13,000 feet above sea level. The headwaters consist of a number of branches, occupying small valleys separated by high, precipitous hills, and deriving their water supply from banks of perpetual snow and ice. The valley of the main stream is narrow, varying in width from a few hundred feet to half a mile, with bluffs on each side bounded by high, rolling mesa lands. The soil on the first bottom consists of black sandy loam and is generally very fertile. That on the mesas is of gravel and sandy loam. The forests about the headwaters comprise a heavy growth of white pine and spruce timber, with an abundance of underbrush and shrubbery. The bottom and first mesa land near the mouth are under cultivation, hay being practically the only crop.

The gaging station was established May 14, 1904. It is located at the highway bridge about 2 miles above J. E. Mallan's ranch house, 4 miles west of Hebron, Colo., and one-half mile above the mouth of the fork, in sec. 11, T. 8 N., R. 81 W.

The channel is straight for about 100 feet above and 50 feet below the station. The banks, which are about 5 feet high above and 3 feet high below the bridge, are lined with willows, and are not liable to overflow except at extremely high stages. The bed of the stream is composed of coarse gravel and cobblestones and is uniform and stable. There is but

one channel at all stages and the current is uniform and moderately swift. During an ordinary season gage heights have a range of about 3 feet. In the winter months the channel is obstructed by ice, and gage readings are unreliable.

Discharge measurements are made from the single-span bridge to which the gage is attached. The initial point for soundings is the south face of the north abutment, and is marked by a spike driven in the bridge floor. Low-water measurements are made by wading near the gage.

The gage was read twice each day during 1905 by Mrs. Stella Bohn, who lives 200 yards west of the station. A standard chain gage was established June 14, 1904. It is located on the east side of the bridge, 18 feet from the south face of the north abutment. The length of the chain is 7.70 feet. The gage is referred to bench marks as follows: (1) The top of a spike driven horizontally into the east end of the second timber from the top of the north abutment; elevation above gage datum, 2.86 feet. The head of a nail driven vertically into the north end of the gage rod is 2.55 feet above this bench mark. (2) Top of cast-iron rod 16 inches long, 1 inch square at the lower end and tapering to a point at the upper end, set on a bowlder sunk in the ground by the side of the lane fence, 50 feet northeast of the north pier of the bridge; elevation above gage datum, 7.14 feet. The elevation above sea level is approximately 8,100 feet.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 55–59.

Discharge measurements of Roaring Fork of North Platte River near Hebron, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 18	W. A. Lamb	24	22	1.77	1.63	39
June 18	do	41	81	4.58	3.59	371
June 24	do	41	75	4.44	3.30	333
July 15	do	34	38	2.34	2.02	89
August 8	do	25	24	1.71	1.70	41
August 23	do	20	17	1.29	1.48	22
September 25	do	15	7.4	1.07	1.25	7.9

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Roaring Fork of North Platte River near Hebron, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	1.35	2.35	2.55	1.88	1.35	1.25
2	.....	.....	2.65	2.48	1.85	1.3	1.25
3	.....	.....	3.02	2.4	1.85	1.3	1.25
4	.....	1.4	3.05	2.25	1.78	1.3	1.25
5	.....	.....	3.82	2.02	1.72	1.3	1.25
6	.....	1.4	3.45	1.98	1.7	1.3	1.25
7	.....	.....	3.35	2.02	1.72	1.3	1.25
8	.....	1.35	3.7	2.08	1.7	1.3	1.25
9	.....	.....	3.92	2.08	1.7	1.25	1.25
10	.....	1.35	3.7	1.95	1.65	1.25	1.2
11	.....	.....	3.38	1.9	1.65	1.25	1.2
12	.....	.....	3.28	1.92	1.65	1.25	1.2
13	.....	1.35	3.38	2.15	1.62	1.25	1.25
14	.....	.....	3.42	2.0	1.58	1.2	1.25
15	.....	1.1	3.52	2.08	1.52	1.2	1.3
16	.....	.....	3.65	2.15	1.5	1.2	1.28
17	1.5	.....	3.52	2.1	1.5	1.2	1.2
18	.....	1.62	3.45	1.98	1.5	1.25	1.25
19	.....	1.72	3.3	1.98	1.45	1.25	1.25
20	1.6	1.65	3.22	1.92	1.45	1.25	1.32
21	.....	1.8	3.3	1.98	1.45	1.25	1.35
22	1.4	1.9	3.3	1.9	1.45	1.25	1.4
23	.....	2.05	3.55	1.88	1.48	1.25	1.48
24	1.3	2.08	3.8	1.8	1.4	1.25	1.48
25	.....	2.1	3.25	1.8	1.4	1.25	1.45
26	1.2	2.08	3.25	1.8	1.35	1.25	1.45
27	.....	2.12	3.12	1.9	1.35	1.2	1.48
28	.....	2.12	2.98	1.82	1.35	1.2	1.45
29	1.4	2.08	2.8	1.95	1.35	1.2	1.48
30	.....	1.98	2.65	1.92	1.35	1.25	1.48
31	.....	2.02	.....	1.92	1.35	.....	1.45

Station rating table for Roaring Fork of North Platte River near Hebron, Colo., from April 17 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.10	4	1.90	71	2.70	205	3.40	342
1.20	7	2.00	85	2.80	224	3.50	362
1.30	11	2.10	100	2.90	243	3.60	383
1.40	17	2.20	116	3.00	262	3.70	404
1.50	24	2.30	133	3.10	282	3.80	425
1.60	33	2.40	150	3.20	302	3.90	446
1.70	44	2.50	168	3.30	322	4.00	467
1.80	57	2.60	186				

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during 1905, and is not well defined.

Estimated monthly discharge of Roaring Fork of North Platte River near Hebron, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 17-30 [a]	33	7	17.6	489
May	103	4	43.6	2,681
June	450	142	327	19,460
July	177	57	89.5	5,503
August	68	14	31.5	1,937
September	14	7	9.2	547
October	23	7	13.0	799
The period				31,420

[a] Missing gage heights interpolated.

NORTH FORK OF NORTH PLATTE RIVER AT HIGHO, COLO.

North Fork of North Platte River rises in the Park Range near the Colorado-Wyoming line, flows southeastward to a point about 2 miles west of Higho, Colo., and thence eastward into the North Platte at a point about 4 miles below the mouth of Roaring Fork. The stream flows through a narrow valley separated from the open prairie land of North Park by a high bluff, which slopes up gradually from the east side and then descends rather abruptly on the west to the river bottoms. The basin is mountainous in character, and much of it is covered with a heavy forest, consisting of several varieties of white pine and spruce and much quaking aspen and underbrush. The tributaries head among the snow banks in the highest portions of the Park Range, and after descending through narrow, precipitous canyons, enter the more or less rolling country at the foot of the range. The soil along the river bottoms consists of a black sandy loam and is well adapted to the raising of hay.

The gaging station was established May 14, 1904. It is located at the footbridge at Higho post-office, 7 miles northwest of Hebron and 12 miles west of Walden, Colo., in T. 9 N., R. 81 W.

The channel is straight for about 150 feet above and 50 feet below the station, and the current is medium. The right bank is about 3 feet high above and for a short distance below the gage, beyond which point it rises to a height of about 10 feet; the left bank is lower than the right and consists of a low bar, covered with willows and sloping gradually out from the stream. There is but one channel at low-water stages, but at high stages a second channel begins about 100 yards above the bridge, flows through the low sand bar at a distance of 50 yards from the left end of the bridge, and enters the main stream 150 yards below. The stream does not overflow the banks of either channel, except at very high stages, when the low land between the two channels may be submerged. The bed of the stream is composed of gravel and small cobblestones, and is free from vegetation and permanent. The current is swift at high stages and medium during ordinary stages. High-water measurements are somewhat affected by eddying currents and backwater caused by the pier at the left end of the bridge. Gage heights have a range of 1.5 feet. Readings are discontinued during the winter months on account of ice forming around the gage rod.

Discharge measurements are made at high water from the single-span footbridge to which the gage is attached. The initial point for soundings is a nail driven into the walk-log at the left end of the bridge. Low-water measurements are made by wading near the bridge.

The gage was read twice each day during 1905 by Mrs. Esther Bergquist, who lives near the station. It consists of a vertical staff spiked to the southwest face of the left abutment on the downstream side. The gage is referred to bench marks as follows: (1) A nail

driven into the top of the east end of the bottom log of the north abutment; elevation above the zero of the gage, 1.76 feet. (2) A point on the foundation stone under the northeast corner of the house of Charles Bergquist, marked "B.M.U.S.G.S."; elevation above the zero of the gage, 12.42 feet. The elevation above sea level is approximately 8,025 feet.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 23-25.

Discharge measurements of North Fork of North Platte River at Higho, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 18	W. A. Lamb	28	38	1.45	1.50	55
June 18	do	29	57	3.26	2.05	186
June 24	do	29	59	3.19	2.05	188
July 15	do	34	56	2.12	1.85	119
August 8	do	34	44	1.57	1.70	69
August 23	do	30	35	1.37	1.50	48
September 25	do	26	20	.65	1.09	13

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of North Fork of North Platte River at Higho, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.42	1.95	1.7	1.95	1.8	1.45	1.15
2	1.48	1.95	1.75	1.95	1.8	1.45	1.15
3	1.45	1.8	1.8	1.9	1.75	1.4	1.2
4	1.38	1.55	2.01	1.8	1.7	1.4	1.2
5	1.32	1.62	2.05	1.75	1.74	1.4	1.2
6	1.38	1.65	1.91	1.72	1.71	1.48	1.2
7	1.6	1.62	1.92	1.78	1.7	1.5	1.25
8	1.7	1.62	2.3	2.0	1.68	1.42	1.3
9	1.82	1.7	2.18	1.92	1.68	1.4	1.3
10	1.78	1.52	2.15	1.75	1.72	1.4	1.28
11	1.65	1.32	2.05	1.7	1.7	1.4	1.25
12	1.52	1.25	2.0	1.78	1.78	1.4	1.25
13	1.6	1.22	1.98	1.72	1.7	1.4	1.3
14	1.65	1.2	2.02	1.75	1.6	1.32	1.3
15	1.65	1.22	2.02	1.78	1.6	1.28	1.3
16	1.6	1.22	2.1	1.72	1.62	1.2	1.35
17	1.6	1.3	2.05	1.72	1.6	1.18	1.3
18	1.65	1.5	2.25	1.7	1.55	1.1	1.3
19	1.78	1.52	2.25	1.64	1.5	1.1	1.22
20	1.72	1.55	1.98	1.75	1.5	1.1	1.2
21	1.52	1.52	1 92	2.0	1.48	1.1	1.25
22	1.65	1.6	1.95	2.0	1.47	1.1	1.22
23	1.75	1.65	2.05	1.85	1.47	1.38	1.2
24	1.7	1.72	2.05	1.85	1.47	1.38	1.2
25	1.62	1.65	2.02	1.82	1.5	1.1	1.15
26	1.68	1.67	2.02	1.8	1.47	1.1	1.18
27	1.95	1.68	1.98	1.88	1.47	1.1	1.2
28	2.0	1.58	1.95	1.88	1.45	1.1	1.25
29	1.9	1.52	1.95	1.8	1.45	1.1	1.3
30	1.9	1.52	1.92	1.85	1.45	1.2	1.3
31	.....	1.62	.....	1.8	1.45	.....	1.22

Station rating table for North Fork of North Platte River at Higho, Colo., from April 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-feet.*
1.10	15	1.50	50	1.80	100	2.10	195
1.20	22	1.60	64	1.90	126	2.20	235
1.30	30	1.70	80	2.00	158	2.30	280
1.40	39						

The above table is applicable only for open-channel conditions. It is based on 15 discharge measurements made during 1904–5, and is well defined between gage heights 1.4 feet and 2.2 feet.

Estimated monthly discharge of North Fork of North Platte River at Higho, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	158	32	76.3	4,540
May	142	22	61.9	3,806
June	280	80	162	9,640
July	158	70	107	6,579
August	100	44	65.8	4,046
September	50	15	29.6	1,761
October	34	18	25.3	1,556
The period				31,930

NORTH PLATTE RIVER NEAR HEBRON, COLO.

This station was established May 13, 1904. It is located at a highway bridge below the junction of Grizzly and Little Grizzly creeks, about 4 miles northwest of Hebron, Colo., in T. 9 N., R. 80 W.

The bridge lies in a curve of about 150 feet radius. The banks are about 5 feet high, lined with willows, and not liable to overflow. The bed of the stream is composed of gravel, sand, and small cobblestones, and is uniform, permanent, and free from vegetation. There is but one channel at all stages. The current is very sluggish at low water, but medium at high stages. Gage heights have a range of about 4 feet. Discharge measurements are affected by dead water, by backwater caused by the wooden piers of the bridge, and by driftwood which collects at the upper side of the bridge. Gage readings are impracticable during the winter months on account of the formation of ice around the gage rod.

Discharge measurements are made from the downstream side of the three-span bridge to which the gage is attached. The initial point for soundings is the inner face of the left abutment, marked zero.

The gage is read each day by J. E. Mallon, who lives one-half mile distant. It consists of a vertical staff fastened to the northeast corner of the first pier from the left bank. The gage is referred to bench marks as follows: (1) A nail driven flush with the top of the cap timber on the west side of the crib pier to which the gage is fastened, just across the pier from the gage; elevation, 9.44 feet above the zero of the gage. (2) A cross cut on a ledge of rock in the cliff on the left bank of the river about 50 feet north of the west end of the bridge, marked "B.M.;" elevation, 17.80 feet above the zero of the gage. The elevation above sea level is about 8,025 feet.

A description of this station with gage height and discharge data is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 20–23.

Discharge measurements of North Platte River near Hebron, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 18	W. A. Lamb	83	284	1.38	5.30	392
June 17	do	84	390	2.53	6.60	986
June 25	do	88	365	1.94	5.95	708
July 14	do	66	68	2.29	4.45	156
August 8	do	58	32	1.91	3.90	61
August 24	do	32	27	.89	3.50	24
September 25	do	28	21	1.05	3.31	22

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of North Platte River near Hebron, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1		5.7	6.0	5.25	4.3	3.45	3.35
2		5.8	6.4	5.25	4.2	3.45	3.35
3		5.5	6.6	5.15	4.2	3.45	3.35
4		5.2	7.0	4.9	4.15	3.45	3.4
5		5.0	7.45	4.75	4.1	3.4	3.4
6		5.0	7.15	4.65	4.05	3.45	3.4
7		4.9	6.8	4.6	4.0	3.45	3.4
8		5.0	6.9	4.65	3.9	3.5	3.4
9	4.6	5.2	7.4	4.5	3.9	3.35	3.4
10	4.6	5.4	7.55	4.4	3.9	3.35	3.4
11	5.0	5.1	7.0	4.4	3.9	3.35	3.4
12	4.5	4.95	6.9	4.35	3.9	3.35	3.45
13	4.5	4.9	6.7	4.55	3.9	3.3	3.45
14	4.6	4.9	6.8	4.4	3.85	3.3	3.45
15	4.6	4.85	6.8	4.45	3.8	3.3	3.45
16	4.55	5.0	6.8	4.5	3.7	3.3	3.45
17	4.5	5.2	6.7	4.4	3.7	3.3	3.45
18	4.6	5.3	6.6	4.35	3.6	3.3	3.45
19	4.65	5.6	6.4	4.3	3.6	3.35	3.45
20	4.6	5.7	6.2	4.35	3.6	3.35	3.5
21	4.55	5.75	6.1	4.45	3.6	3.35	3.5
22	4.55	6.0	6.0	4.25	3.55	3.35	3.55
23	4.65	6.1	6.1	4.15	3.55	3.35	3.6
24	4.9	6.3	6.2	4.15	3.5	3.35	3.6
25	4.5	6.55	6.0	4.15	3.45	3.35	3.65
26	4.75	6.05	5.9	4.15	3.45	3.35	3.7
27	5.1	5.95	5.75	4.15	3.45	3.35	3.7
28	5.0	5.7	5.6	4.3	3.45	3.35	3.7
29	5.2	5.6	5.45	4.2	3.45	3.35	3.7
30	5.4	5.6	5.3	4.2	3.45	3.35	3.7
31		5.8		4.3	3.45		3.7

Station rating table for North Platte River near Hebron, Colo., from April 9 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec. ft.*	*Feet.*	*Sec. ft.*	*Feet.*	*Sec. ft.*	*Feet.*	*Sec. ft.*
3.30	15	4.20	110	5.10	315	6.00	705
3.40	20	4.30	125	5.20	355	6.20	800
3.50	25	4.40	140	5.30	395	6.40	900
3.60	35	4.50	160	5.40	435	6.60	1,000
3.70	45	4.60	180	5.50	480	6.80	1,100
3.80	55	4.70	200	5.60	525	7.00	1,200
3.90	65	4.80	225	5.70	570	7.20	1,310
4.00	80	4.90	250	5.80	615	7.40	1,420
4.10	95	5.00	280	5.90	660	7.60	1,530

The above table is applicable only for open-channel conditions. It is based on seven discharge measurements made during 1905, and is well defined between gage heights 3.3 feet and 6.5 feet.

Estimated monthly discharge of North Platte River near Hebron, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 9–30	435	160	215	9,382
May	975	238	479	29,450
June	1,502	395	950	56,530
July	375	102	164	10,080
August	125	22	54.3	3,339
September	25	15	18.5	1,101
October	45	18	27.4	1,685
The period				111,600

NORTH PLATTE RIVER NEAR COWDREY, COLO.

This station was established May 10, 1904. It is located at the wagon bridge about 2 miles northwest of Cowdrey, Colo., in T. 10 N., R. 80 W.

The channel is straight for 600 feet above and 900 feet below the station. Both banks are high and clean and are not subject to overflow. The bed of the stream is composed of coarse gravel and small cobblestones and is stable and uniform. There is but one channel at either high or low water. The current has a medium velocity at high and ordinary stages, but is sluggish at low stages. At the station the fall of the river is 4.2 feet per mile. During the winter months ice forms at the gage rod and gage readings are impracticable.

Discharge measurements are made by means of a car, cable, and tagged wire, one-fourth mile below the highway bridge. Soundings are marked on the tagged wire at 5-foot intervals, the initial point being the zero of the tagged wire near the left bank. At extreme low stages measurements are made by wading at convenient points near the bridge.

The gage, which was read twice each day during 1905 by C. M. Hendrickson, consists of a vertical staff spiked to the northeast corner of the first crib pier from the west end of the highway bridge above the cable. The foot marks are numbered from 2 to 12 feet, the 2-foot mark resting on the bed of the stream. The gage is referred to bench marks as follows: (1) The top of a 30-penny nail driven flush with the top of the cap timber on the north end of the right abutment of the bridge; elevation, 13.22 feet above gage datum. (2) An iron wagon skein set in the right bank 10 feet north of the bridge, the top of the hub being 2 inches above the surface of the ground, the base resting on a stone 1 foot below the surface;

a witness stake is beside the bench-mark post; elevation of bench mark, 10.89 feet above gage datum. The elevation above sea level is about 7,860 feet.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 25–28.

Discharge measurements of North Platte River near Cowdrey, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 19	W. A. Lamb	110	292	1.80	8.17	523
May 23	do	110	327	2.34	8.44	766
June 19	do	109	385	2.87	8.91	1,106
June 23	do	109	383	2.77	8.80	1,064
July 17	do	103	226	1.26	7.84	285
August 7	do	95	176	.84	7.59	148
Augus t22[a]	do	56	49	1.57	7.40	77
September 22[a]	do	26	29	.76	7.15	22

[a] Made at different section.

Daily gage height, in feet, of North Platte River near Cowdrey, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	8.6	8.1	8.4	8.42	7.75	7.45	7.35
2	8.65	8.2	8.7	8.25	7.75	7.42	7.35
3	8.6	8.15	8.85	8.2	7.7	7.4	7.35
4	8.6	7.95	9.05	8.18	7.72	7.45	7.35
5	8.5	7.8	9.3	8.12	7.72	7.5	7.35
6	7.85	7.7	9.5	7.98	7.72	7.75	7.38
7	7.85	7.7	9.25	7.88	7.7	7.82	7.45
8	7.8	7.7	9.0	7.82	7.7	7.75	7.45
9	7.95	7.8	9.6	7.75	7.72	7.65	7.45
10	8.05	7.95	9.6	7.82	7.7	7.65	7.45
11	7.65	8.05	9.45	7.75	7.7	7.5	7.42
12	7.6	7.95	9.2	7.75	7.7	7.45	7.38
13	7.65	7.85	9.05	7.75	7.65	7.45	7.32
14	7.55	7.85	9.1	7.75	7.6	7.05	7.3
15	7.75	7.85	9.05	7.78	7.6	7.08	7.3
16	7.6	7.85	9.05	7.75	7.6	7.12	7.3
17	7.7	7.95	9.15	8.02	7.55	7.2	7.3
18	7.6	8.1	8.85	7.8	7.55	7.2	7.3
19	7.7	8.15	8.9	7.8	7.55	7.2	7.3
20	7.7	8.2	8.75	7.8	7.5	7.2	7.3
21	7.6	8.3	8.65	7.85	7.52	7.2	7.3
22	7.55	8.35	8.7	7.9	7.48	7.18	7.3
23	7.65	8.45	8.7	7.92	7.45	7.15	7.3
24	7.7	8.55	8.7	7.75	7.45	7.15	7.3
25	7.6	8.65	8.7	7.7	7.55	7.15	7.3
26	7.7	8.55	8.7	7.7	7.5	7.18	7.3
27	7.8	8.55	8.65	7.75	7.5	7.2	7.3
28	7.95	8.45	8.68	7.72	7.5	7.22	7.3
29	8.0	8.45	8.52	7.72	7.48	7.35	7.3
30	8.05	8.5	8.52	7.72	7.4	7.35	7.35
31	.....	8.3	.....	7.72	7.4	.....	7.35

Station rating table for North Platte River near Cowdrey, Colo., from April 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
7.10	12	7.80	270	8.50	793	9.20	1,523
7.20	27	7.90	334	8.60	880	9.30	1,650
7.30	47	8.00	398	8.70	974	9.40	1,781
7.40	75	8.10	466	8.80	1,070	9.50	1,916
7.50	108	8.20	540	8.90	1,172	9.60	2,056
7.60	154	8.30	622	9.00	1,282		
7.70	208	8.40	707	9.10	1,400		

The above table is applicable only for open-channel conditions. It is based on nineteen discharge measurements made during 1904–5 and is well defined between gage heights 7.5 feet and 9 feet. It has been extended beyond these limits, being based on one measurement at 7.2 feet. Above 7.5 feet the table is the same as for 1904.

Estimated monthly discharge of North Platte River near Cowdrey, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	926	130	345	20,530
May	926	208	505	31,050
June	2,056	707	1,246	74,150
July	724	208	316	19,430
August	238	75	156	9,592
September	283	5	76.7	4,564
October	91	47	58.3	3,585
The period				162,900

CANADIAN RIVER AT COWDREY, COLO.

Canadian River rises in North Park, Colorado, among the highest peaks of the Medicine Bow Range, flows northwestward, and enters the North Platte about 1 mile below the mouth of Michigan Creek. The upper part of the drainage basin is exceedingly mountainous and the small tributaries find their way through canyons to the valley below. In its lower course the stream traverses a narrow valley which it has worn in the lake beds of the park and which extends some distance into the foothill region. This valley differs from the other river valleys of the park in the more uniform slope and regular shape of its sides, in the character of the mesa lands on the right, and in the sandy nature of its soil. The mesa on the right contains numerous sand dunes and in some places near the foothills extensive deposits of sand and coarse, disintegrated granite. The soil of the river bottom is principally a sandy loam. Hay is the only crop raised. The storage or diversion of the water of this stream is impracticable.

The gaging station was established May 10, 1904. It is located at the highway bridge one-half mile east of Cowdrey, Colo., in sec. 7, T. 10 N., R. 79 W.

The channel is straight for 150 feet above and 40 feet below the station. Each bank is about 2 feet high and is clean and well sodded; the left overflows during extreme high water. The bed of the stream is composed of sand and silt, with a few stones from the riprap at the west end of the bridge, and is shifting. As the changes occur at irregular intervals it is a difficult matter to obtain a good rating curve. There is but one channel at all stages, broken by four pile bents of the bridge, and the current has a medium velocity. The ordinary range of gage heights is about 1.6 feet. Gage readings are impracticable during the winter months on account of the formation of ice around the gage rod.

At all normal stages discharge measurements are made by wading a short distance above the pile bridge to which the gage is attached. At exceedingly high stages measurements are made from the bridge, the downstream guard rail of which is marked at 2-foot intervals. The initial point for soundings is a 20-penny nail driven into the floor of the bridge over the face of the left abutment on the downstream side.

The gage, which was read twice each day during 1905 by C. M. Hendrickson, consists of a vertical staff graduated from 2 to 8 feet, attached to the west face of the first pile from the left bank on the downstream side of the bridge. The 2-foot mark rests on the bed of the stream. The gage is referred to bench marks as follows: (1) A 30-penny nail driven flush with the top of the cap timber above the gage rod; elevation, 9.80 feet. (2) A 30-penny nail driven horizontally into the north face of a telephone pole 60 feet south of the left end of the bridge, 3 feet above the ground; elevation, 9.80 feet. (3) A regulation iron bench-mark post 3 feet south of the fence on the north side of the road, 40 feet west of the gage rod; elevation, 8.02 feet. Elevations of bench marks are above the datum of the gage. The elevation above sea level is about 7,860 feet.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 64–66.

Discharge measurements of Canadian River at Cowdrey, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 20	W. A. Lamb	34	56	1.41	4.85	79
June 20	do	35	56	2.23	5.10	125
June 23	do	53	65	1.95	5.05	127
July 17	do	28	26	1.58	4.47	41
August 7	do	31	25	1.36	4.43	34
August 22	do	15	13	1.23	4.10	16
September 22	do	14	9	1.11	4.05	10

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Canadian River at Cowdrey, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	5.5	4.8	4.9	4.68	4.55	4.05	4.2	4.35
2	5.6	4.9	5.05	4.65	4.45	4.05	4.2	.....
3	5.6	4.8	5.25	5.35	4.45	4.05	4.2	.....
4	5.75	4.7	5.6	5.15	4.45	4.02	4.2	.....
5	5.9	4.6	5.85	4.85	4.45	4.0	4.2	.....
6	5.8	4.5	5.9	4.7	4.45	4.1	4.2	.....
7	5.8	4.5	5.75	4.55	4.35	4.25	4.25	.....
8	5.75	4.4	5.8	4.4	4.3	4.18	4.25	.....
9	5.9	4.5	5.85	4.45	4.3	4.15	4.25	.....
10	5.9	4.55	6.15	4.48	4.3	4.15	4.25	.....
11	6.0	4.6	5.95	4.45	4.35	4.15	4.25	.....
12	5.7	4.6	5.6	4.45	4.4	4.15	4.25	.....
13	5.5	4.5	5.55	4.45	4.4	4.12	4.28	.....
14	5.25	4.4	5.65	4.5	4.4	4.1	4.35	.....
15	5.35	4.4	5.6	4.5	4.35	4.1	4.35	.....
16	5.05	4.4	5.6	4.5	4.35	4.1	4.35	.....
17	4.9	4.4	5.6	4.48	4.25	4.1	4.35	.....
18	4.65	4.7	5.3	4.48	4.1	4.1	4.32	.....
19	4.8	4.8	5.25	4.48	4.1	4.1	4.3	.....
20	4.7	4.9	5.1	4.45	4.1	4.05	4.3	.....
21	4.7	4.9	4.95	4.42	4.15	4.05	4.3	.....
22	4.75	4.9	4.95	4.42	4.1	4.08	4.3	.....
23	5.65	4.9	4.95	4.4	4.08	4.1	4.3	.....
24	4.65	4.9	4.98	4.25	4.02	4.1	4.3	.....
25	4.4	5.0	5.0	4.15	3.95	4.1	4.3	.....
26	4.6	5.0	4.92	4.2	3.85	4.05	4.3	.....
27	4.7	4.95	4.88	4.25	3.88	4.05	4.3	.....
28	4.9	4.9	4.85	4.25	3.95	4.05	4.3	.....
29	4.85	5.05	4.8	4.25	3.98	4.22	4.35	.....
30	4.75	5.1	4.7	4.4	4.05	4.22	4.35	.....
31	.....	4.95	.....	4.42	4.02	.....	4.35	.....

Station rating table for Canadian River at Cowdrey, Colo., from April 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
3.80	1	4.50	40	5.10	130	5.70	350
3.90	3	4.60	50	5.20	155	5.80	400
4.00	6	4.70	60	5.30	185	5.90	450
4.10	10	4.80	75	5.40	220	6.00	510
4.20	15	4.90	90	5.50	260	6.10	570
4.30	22	5.00	110	5.60	300	6.20	630
4.40	30						

The above table is applicable only for open-channel conditions. It is based on 15 discharge measurements made during 1904–5, and is well defined between gage heights 4 feet and 5.5 feet. It has been extended beyond these limits, being only approximate above 5.5 feet.

Estimated monthly discharge of Canadian River at Cowdrey, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	510	30	218	12,970
May	130	30	69.4	4,267
June	600	60	235	13,980
July	202	12	44.4	2,730
August	45	2	19.3	1,187
September	18	6	10.3	613
October	26	15	20.8	1,279
The period				37,030

MICHIGAN CREEK NEAR WALDEN, COLO.

Michigan Creek, the largest tributary of the North Platte in North Park from the east side, rises in the Rabbit Ears and Medicine Bow ranges, flows northwestward, and enters the main stream at a point 3 miles northwest of Cowdrey, Colo. The basin is rugged and mountainous, comprising the highest portion of the Medicine Bow Range in Colorado. The small tributaries of the creek extend far back into the range and interlace with tributaries of Grand and Cache la Poudre rivers. These small streams unite and emerge from the high mountainous areas into the more or less broken and rolling slopes and foothills which border the level prairie land of the park itself. The lower portion of the stream flows through a narrow valley, varying in width from one-fourth mile to 1 mile, bordered on either side by long bench-like ridges and rolling prairie land. The soil along the stream bottom is a black sandy loam and is very fertile, but on account of the great altitude practically the only crop grown is hay. The headwaters of the stream are well protected by heavy forests of white pine and spruce timber and a dense growth of quaking aspen and underbrush.

Illinois Creek, which joins Michigan Creek 2 miles below Walden, is the principal tributary stream. Its headwaters drain a low portion of the Rabbit Ears Range and its flow during the early part of the summer is large.

Water is being diverted from the headwaters of Michigan Creek to the Cache la Poudre on the eastern slope of the Rocky Mountains at a point known as Cameron Pass.

Two gaging stations were maintained on Michigan Creek during 1905, the first near Walden, the second at Cowdrey.

The Walden station was established May 9, 1904. It is located at the highway bridge 1½ miles north of Walden, Colo., in sec. 21, T. 9 N., R. 79 W., and is about 1 mile above the mouth of Illinois Creek.

The channel is straight for about 75 feet above and 50 feet below the station. The banks are about 3 feet high, are bordered with flat meadow lands, and do not overflow at this point. The bed of the stream is composed of sand and gravel and is free from vegetation and fairly permanent. There is but one channel at all stages, broken by the middle pier of the bridge. The current is swift at high stages and medium at low stages. High-water measurements are affected by backwater and eddies caused by the abutments and center pier of the bridge. Gage heights have a range of about 2 feet during an ordinary season. Gage readings in winter are impracticable owing to ice conditions.

High-water measurements are made from the downstream side of the two-span bridge to which the gage is attached. The initial point for soundings is a 30-penny nail driven into the floor at the west end of the bridge. At ordinary stages discharge measurements are made by wading a short distance above the bridge.

The gage, which was read twice each day during 1905 by H. E. Holdredge, consists of a staff graduated from 4 to 10 feet, fastened to the southwest corner of the center pier of the bridge, the 4-foot mark resting on the bed of the stream. The gage is referred to bench

..arks as follows: (1) The top of a nail driven into the left abutment of the bridge on the downstream side; elevation, 7.91 feet above gage datum. (2) The top of a 20-penny nail driven into the top of a sandstone bowlder under the cliff on the north side of the river, about 275 feet northeast of the north end of the bridge, marked "B. M. U. S. G. S.;" elevation above gage datum, 15.34 feet. Elevation above sea level is about 7,975 feet.

This station was discontinued October 31, 1905.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 131, of the United States Geological Survey, pages 59–61.

Discharge measurements of Michigan Creek near Walden, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 19	W. A. Lamb	48	42	2.95	4.95	124
June 19	do	48	113	3.47	5.65	392
June 24	do	49	106	2.97	5.50	315
July 16	do	40	36	2.69	4.91	97
August 8	do	36	21	2.05	4.56	43
August 22	do	24	15	1.47	4.40	22
September 23	do	16	14	.71	4.32	10

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Michigan Creek near Walden, Colo., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	5.22	5.25	4.7	4.25	4.32	17	.....	5.72	4.8	4.52	4.25	4.35
2	.....	5.32	5.35	4.7	4.3	4.32	18	.....	5.68	4.78	4.48	4.25	4.35
3	.....	5.42	5.28	4.68	4.22	4.32	19	4.98	5.6	4.78	4.48	4.25	4.32
4	.....	5.48	5.25	4.62	4.22	4.3	20	5.05	5.45	4.75	4.42	4.22	4.32
5	.....	5.7	5.12	4.62	4.28	4.3	21	5.05	5.4	4.72	4.4	4.22	4.35
6	.....	5.9	5.0	4.58	4.32	4.32	22	5.1	5.42	4.7	4.4	4.2	4.38
7	.....	5.8	4.92	4.58	4.4	4.32	23	5.18	5.38	4.68	4.38	4.2	4.38
8	.....	5.82	4.9	4.48	4.38	4.32	24	5.2	5.5	4.7	4.32	4.2	4.4
9	.....	5.92	4.88	4.5	4.38	4.32	25	5.15	5.48	4.7	4.32	4.28	4.4
10	.....	6.05	4.88	4.58	4.32	4.32	26	5.08	5.42	4.68	4.35	4.28	4.4
11	.....	6.08	4.85	4.6	4.3	4.32	27	5.12	5.45	4.68	4.3	4.28	4.42
12	.....	5.85	4.8	4.65	4.25	4.32	28	5.02	5.4	4.7	4.3	4.28	4.42
13	.....	5.8	4.82	4.68	4.25	4.32	29	5.12	5.38	4.7	4.28	4.28	4.42
14	.....	5.95	4.85	4.58	4.22	4.32	30	5.1	5.3	4.7	4.28	4.3	4.42
15	.....	5.88	4.8	4.48	4.22	4.32	31	5.1	.....	4.7	4.25	.....	4.42
16	.....	5.78	4.8	4.52	4.2	4.38							

Station rating table for Michigan Creek near Walden, Colo., from May 19, to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
4.20	5	4.70	60	5.20	190	5.70	410
4.30	10	4.80	80	5.30	225	5.80	465
4.40	20	4.90	100	5.40	265	5.90	520
4.50	30	5.00	125	5.50	310	6.00	580
4.60	45	5.10	155	5.60	360	6.10	640

The above table is applicable only for open-channel conditions. It is based on fourteen discharge measurements made during 1904-5, and is well defined between gage heights 4.3 feet and 5.8 feet.

Estimated monthly discharge of Michigan Creek near Walden, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
May (19–31)	190	120	155	3,997
June	628	197	377	22,430
July	245	57	97.5	5,995
August	60	8	31.2	1,918
September	20	5	8.9	530
October	22	10	15.1	928
The period				35,800

MICHIGAN CREEK[a] NEAR COWDREY, COLO.

This station was established May 9, 1904. It is located 100 feet above the wagon bridge 1½ miles west of Cowdrey, Colo., in sec. 11, T. 10 N., R. 80 W., and is below all tributaries.

The channel is straight for 50 feet above and 100 feet below the station. The right bank is a gradually sloping gravel bar which extends back about 80 feet; the left bank is about 5.5 feet high and is well sodded. At high stages the stream overflows the right bank for a distance of 75 feet from the main channel. The bed is composed of gravel and is free from vegetation, uniform, and permanent. There is but one channel at all stages. In some places the current is swift and uniform; in others backwater, eddies, and dead water occur. Near the bridge the channel is in poor condition, being obstructed by piles and ruined piers of the bridge. The ordinary range of gage heights is about 3 feet. The channel at the gage is almost entirely frozen over during the winter months, making gage readings impossible.

Discharge measurements are made at high stages from the downstream side of the wagon bridge. Low-water measurements are made by wading at convenient points above the bridge.

The gage, which was read twice each day during 1905 by C. M. Hendrickson, consists of an inclined staff spiked firmly to posts set into the left bank about 75 feet above the bridge. This gage was washed out during the high water of June, 1905, but was replaced in its original position and datum. The gage is referred to bench marks as follows: (1) A 30-penny nail driven into the top of the south end of the cap timber of the first pile bent at the east end of the bridge; a witness nail is driven in beside it; elevation of bench mark above the zero of the gage, 6.23 feet. (2) A standard iron-post bench mark, located 3 feet south of the fence on the south side of the road, 75 feet north of the gage rod and 50 feet west of the river bank; elevation above the zero of the gage, 6.26 feet. The elevation above sea level is about 7,870 feet.

This station was discontinued October 31, 1905.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 61–64.

[a] For description of creek see p. 190.

Discharge measurements of Michigan Creek near Cowdrey, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 19	W. A. Lamb	40	47	2.84	2.60	134
June 20	do	80	130	3.09	3.65	402
June 23	do	77	118	2.87	3.40	339
July 17	do	40	40	2.05	2.40	82
August 7	do	37	30	1.70	2.23	51
August 22	do	28	17	1.24	1.90	21
September 22	do	20	6.6	.98	1.67	6.5

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Michigan Creek near Cowdrey, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.5	3.0	3.4	3.2	2.45	1.7	1.8	2.0
2	2.55	3.15	3.6	3.1	2.4	1.7	1.8	.....
3	2.5	3.2	3.7	3.1	2.42	1.7	1.8	.....
4	3.15	2.85	4.0	2.98	2,42	1.75	1.8	.....
5	3.35	2.8	4.4	2.9	2.4	1.85	1.8	.....
6	3.2	2.6	4.6	2.85	2.42	1.9	1.8	.....
7	3.0	2.4	4.6	2.7	2.4	1.95	1.8	.....
8	2.65	2.4	4.6	2.68	2.32	1.88	1.8	.....
9	2.7	2.5	4.7	2.55	2.28	1.85	1.8	.....
10	2.7	2.6	4.5	2.52	2.35	1.85	1.8	.....
11	2.55	2.6	4.4	2.55	2.32	1.78	1.8	.....
12	2.55	2.5	4.3	2.5	2.3	1.75	1.8	.....
13	2.55	2.3	4.2	2.5	2.3	1.75	1.8	.....
14	2.55	2.3	4.1	2.5	2.3	1.75	1.85	.....
15	2.45	2.25	4.0	2.5	2.3	1.75	1.92	.....
16	2.4	2.2	3.9	2.48	2.25	1.75	1.95	.....
17	2.45	2.3	3.8	2.42	2.2	1.75	1.95	.....
18	2.4	2.5	3.7	2.38	2.08	1.75	1.95	.....
19	2.45	2.5	3.6	2.38	2.0	1.75	1.9	.....
20	2.45	2.55	3.5	2.38	2.0	1.72	1.9	.....
21	2.45	2.85	3.4	2.4	2.0	1.7	1.9	.....
22	2.4	2.95	3.4	2.38	1.9	1.7	1.9	.....
23	2.4	3.1	3.4	2.42	1.9	1.7	1.9	.....
24	2.4	3.3	3.38	2.42	1.88	1.7	1.9	.....
25	2.4	3.5	3.35	2.35	1.82	1.75	1.9	.....
26	2.4	3.4	3.3	2.35	1.82	1.72	1.9	.....
27	2.6	3.4	3.25	2.38	1.85	1.7	1.9	.....
28	2.75	3.3	3.28	2.4	1.82	1.72	1.9	.....
29	2.8	3.35	3.18	2.4	1.75	1.8	1.92	.....
30	2.85	3.5	3.15	2.5	1.65	1.8	1.95	.....
31	.....	3.35	.....	2.45	1.65	.....	1.98	.....

NOTE.—Gage heights estimated June 10–20, inclusive.

Station rating table for Michigan Creek near Cowdrey, Colo., from April 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.60	4	2.40	85	3.20	270	4.00	515
1.70	7	2.50	105	3.30	300	4.10	550
1.80	12	2.60	125	3.40	330	4.20	585
1.90	20	2.70	145	3.50	360	4.30	620
2.00	30	2.80	170	3.60	390	4.40	655
2.10	40	2.90	195	3.70	420	4.50	690
2.20	55	3.00	220	3.80	450	4.60	725
2.30	70	3.10	245	3.90	480	4.70	760

The above table is applicable only for open-channel conditions. It is based on 12 discharge measurements made during 1904–5. It is well defined between gage heights 1.7 feet and 2.6 feet and fairly well defined to 3.6 feet. It has been extended beyond these limits.

Estimated monthly discharge of Michigan Creek near Cowdrey, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	315	85	133	7,914
May	360	55	186	11,440
June	760	258	466	27,730
July	270	78	122	7,501
August	95	6	50.7	3,117
September	25	7	10.9	649
October	28	12	17.5	1,076
The period				59,430

NORTH PLATTE RIVER AT SARATOGA, WYO.

This station was established June 9, 1903. It is located at a point about 100 yards below the two-span iron-truss bridge which connects East and West Saratoga, in T. 17 N., R. 84 W.

The middle pier of the bridge divides the stream into two channels with almost equal capacity in high or low water periods. The banks are high and do not overflow. The bed of the stream is composed of rock and gravel and is subject to little change. The current is swift at ordinary stages, but at extreme low water a sort of basin is formed by the backing up of the water by the riffles below, and the undercurrent is very sluggish. There are no obstructions in the river above or below the station to interfere with the natural flow, but at certain seasons each year a "tie drive" blocks the stream for a few days. The range of gage readings is about 6 feet.

Discharge measurements are made from the bridge. The initial point for soundings during high water is at the pier on the east end of the bridge and at ordinary stages is at the center pier.

The gage was read twice daily during 1905 by J. M. Sterrett, who lives about one-fourth of a mile distant. It consists of a flexible Gurley rod fastened securely to a timber spiked to the cribwork at the northeast corner of what was formerly the Saratoga Club property. The bench mark is a spike driven into a cottonwood tree 7 inches in diameter standing 30 feet northwest of the gage; elevation, 9.84 feet above the zero of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey.

Description: 99, p 174, 131, pp 30–31.
Discharge: 84, p 94; 99, p 175; 131, p 31.
Discharge, monthly: 99, p 176; 131, p 33.
Gage heights: 99, p 175; 131, p 32.
Rating table: 99, p 176; 131, p 33.

Discharge measurements of North Platte River at Saratoga, Wyo., for 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 24	A. J. Parshall	203	487	0.85	1.91	416
April 17	do	221	610	1.37	2.40	835
April 28	J. M. Sterrett	226	721	2.15	2.90	1,550
April 29	do	232	776	2.43	3.10	1,885
May 2	do	234	850	3.06	3.50	2,604
May 19	do	243	936	3.53	3.80	3,308
May 20	do	244	1,010	4.30	4.10	4,344
May 22	do	248	1,138	4.93	4.60	5,603
May 24	do	250	1,212	5.54	4.95	6,717
June 3	do	251	1,304	5.72	5.25	7.455
June 4	do	251	1,385	6.22	5.55	8,610
June 5	do	251	1,524	7.32	6.10	11,153
June 6	do	251	1,442	6.78	5.80	9,790
September 9[a]	A. J. Parshall	105	126	2.35	1.70	296

[a] Made by wading one-fourth mile below station.

Daily gage height, in feet, of North Platte River at Saratoga, Wyo., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.72	2.02	3.25	4.72	3.68	2.35	1.55	1.68	1.54	1.79
2	1.72	2.05	3.45	4.92	3.58	2.32	1.52	1.68	1.68	1.87
3	1.72	2.02	3.45	5.18	3.78	2.28	1.52	1.66	1.82	1.85
4	1.78	2.02	3.28	5.6	3.6	2.22	1.52	1.66	1.94	1.87
5	1.78	2.0	3.08	6.0	3.38	2.2	1.55	1.66	1.95	1.82
6	1.85	2.1	2.95	5.68	3.22	2.15	1.62	1.62	1.89	1.7
7	2.02	2.18	2.88	5.65	3.08	2.08	1.7	1.6	1.88	1.62
8	1.8	2.32	2.9	5.65	3.0	1.95	1.78	1.57	1.83	1.78
9	1.75	2.6	3.12	6.1	3.0	1.9	1.72	1.6	1.8	1.69
10	1.75	2.72	3.2	6.05	2.95	1.9	1.66	1.58	1.7	.....
11	1.78	2.68	3.15	5.7	2.85	1.95	1.62	1.58	1.68	.....
12	1.8	2.45	3.05	5.58	2.7	2.18	1.56	1.62	1.66	.....
13	1.85	2.55	2.95	5.48	2.65	2.18	1.56	1.62	1.66	.....
14	1.85	2.68	2.9	5.3	2.6	2.08	1.51	1.7	1.68	.....
15	1.9	2.55	2.85	5.2	2.68	1.98	1.48	1.69	1.78	.....
16	1.92	2.48	2.9	5.18	2.6	1.92	1.44	1.68	1.8	.....
17	1.95	2.4	3.12	5.22	2.58	1.88	1.4	1.72	1.83	.....
18	1.98	2.38	3.5	4.95	2.52	1.82	1.42	1.72	1.86	.....
19	2.0	2.4	3.8	4.7	2.42	1.72	1.44	1.69	1.79	.....
20	1.98	2.55	4.05	4.55	2.6	1.7	1.46	1.68	1.64	.....
21	2.02	2.5	4.22	4.5	2.62	1.68	1.42	1.62	1.64	.....
22	2.05	2.42	4.52	4.5	2.6	1.62	1.41	1.72	1.6	.....
23	2.0	2.45	4.7	4.48	2.52	1.6	1.42	1.74	1.63	.....
24	2.02	2.5	4.82	4.5	2.38	1.6	1.4	1.78	1.7	.....
25	1.98	2.5	4.7	4.4	2.25	1.58	1.42	1.8	1.74	.....
26	2.02	2.48	4.7	4.32	2.2	1.55	1.44	1.82	1.7	.....
27	2.08	2.62	4.68	4.22	2.18	1.55	1.48	1.82	1.82	.....
28	2.02	2.88	4.7	4.1	2.18	1.55	1.47	1.81	1.78	.....
29	1.9	3.05	4.48	3.9	2.2	1.52	1.51	1.82	1.72	.....
30	2.02	3.05	4.38	3.8	2.2	1.5	1.59	1.82	1.53	.....
31	2.05	.....	4.48	.....	2.25	1.5	.....	1.68	.....	.....

NOTE.—Gage heights estimated March 1–4.

Station rating table for North Platte River at Saratoga, Wyo., from March 1 to December 9, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.40	180	2.50	970	3.60	2,905	4.70	5,945
1.50	215	2.60	1,095	3.70	3,145	4.80	6,265
1.60	255	2.70	1,230	3.80	3,390	4.90	6,590
1.70	300	2.80	1,375	3.90	3,645	5.00	6,920
1.80	355	2.90	1,530	4.00	3,905	5.20	7,590
1.90	415	3.00	1,695	4.10	4,175	5.40	8,270
2.00	485	3.10	1,870	4.20	4,455	5.60	8,960
2.10	565	3.20	2,055	4.30	4,740	5.80	9,660
2.20	655	3.30	2,250	4.40	5,030	6.00	10,360
2.30	750	3.40	2,455	4.50	5,325		
2.40	855	3.50	2,675	4.60	5,630		

The above table is applicable only for open-channel conditions. It is based on 14 discharge measurements made during 1905, and is well defined between gage heights 1.7 feet and 6 feet.

Estimated monthly discharge of North Platte River at Saratoga, Wyo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March	549	311	425	26,130
April	1,778	485	952	56,650
May	6,330	1,452	3,329	204,700
June	10,710	3,390	7,019	417,700
July	3,341	637	1,404	86,330
August	802	215	430	26,440
September	344	180	226	13,450
October	367	243	299	18,380
November	450	227	334	19,870
December 1–9	397	264	344	6,141
The period				875,800

NORTH PLATTE RIVER AT GUERNSEY, WYO.

This station was established June 14, 1900. It was originally located at the highway bridge about half a mile northwest of Guernsey, Wyo., in sec. 35, T. 27 N., R. 66 W., but at the opening of the season of 1902 the gage rod was removed to the railroad bridge 300 feet above the first location.

The channel is straight both above and below the station. The banks are high and not liable to overflow. The bed of the stream is sandy but fairly permanent. The channel is broken by two piers and six rows of piling, but no other obstructions above or below interfere with the flow. The ordinary range of gage heights is about 7 feet. At the highway bridge the bed of the channel is more changeable, but the velocity is more uniform.

Discharge measurements are still made from the highway bridge. The initial point for soundings is on the left bank.

The gage was observed during 1905 by W. F. Peterson, who lives about 100 yards distant. The 1902 gage was fastened to one of the piers of the railroad bridge and was placed 1 foot lower than the original gage had been. In the latter part of 1903 the 1902 gage was replaced by a new one with its zero at the same elevation as that of the old gage. The new rod was attached to the pile of the railroad bridge, which had been recently reconstructed.

The 1902 bench mark was a spike driven into the sleeper of the highway bridge at an elevation of 10.04 feet above gage datum. The 1903 bench mark is a United States Geological Survey monument 125 feet east of the gage rod; elevation above the zero of the gage, 13.72 feet. The elevation of the zero of the gage above sea level is 4,317 feet. The reconstruction of the bridge under which the gage was placed interfered somewhat with convenient reading, and in 1905 a secondary gage rod was placed nearer the bank for use during lower stages of water.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; WS=Water-Supply Paper):

Description: WS 49, p 275; 66, p 27; 84, pp 68–69; 99, pp 165–166; 131, pp 35–36.
Discharge: WS 49, p 275; 66, p 27; 84, p 69; 99, p 166; 131, p 36.
Discharge, monthly: Ann 22, iv, p 312; WS 75; p 125; 84, p 70; 99, p 167; 131, p 38.
Gage heights: WS 49, p 275; 66, p 27; 84, p 69; 99, p 166; 131, p 37.
Hydrograph: WS 75, p 126.
Rating tables: WS 52, p 516; 66, p 171; 84, p 70; 99, p 167; 131, p 38.

Discharge measurements of North Platte River at Guernsey, Wyo., for 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 22	A. J. Parshall	208	428	2.54	1.00	1,089
April 14	do	296	625	3.28	1.65	2,052
May 3	do	329	1,214	4.95	3.50	6,007
May 4	do	330	1,306	5.24	3.80	6,838
May 13	do	330	1,156	4.41	3.20	5,094
May 29	do	330	1,855	5.80	5.25	10,760
June 2	do	330	1,751	5.52	5.00	9,660
June 3	do	330	1,697	5.33	4.80	9,053
June 8	do	330	2,073	6.11	6.00	12,670
June 9	do	330	2,078	6.14	6.00	12,760
July 20	do	297	585	2.71	1.45	1,586
July 21	do	297	580	2.67	1.42	1,549
July 27	do	312	713	3.37	1.95	2,405
July 28	do	311	620	3.15	1.65	1,949
August 3	do	287	613	3.05	1.58	1,870
August 21	do	201	360	2.19	.85	788
August 22	do	200	354	2.12	.80	749
August 30	do	195	300	1.45	.38	434
September 5	do	189	263	1.29	.20	340
September 28	do	186	250	1.20	.10	300
October 7	do	196	307	1.55	.45	478

Daily gage height, in feet, of North Platte River at Guernsey, Wyo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.0	2.85	5.25	3.85	1.85	0.55	0.1	0.5
2	1.0	3.05	5.0	5.3	1.85	.25	.3	.5
3	1.0	3.5	4.88	3.75	1.45	.25	.38	.5
4	1.0	3.8	4.95	3.45	1.3	.25	.3	.5
5	1.0	3.7	5.05	3.25	1.1	.2	.32	.5
6	1.1	3.7	5.25	3.1	1.0	.2	.38	.5
7	1.12	3.75	5.6	3.25	1.0	.2	.45	.52
8	1.2	3.8	5.95	3.15	1.25	.25	.5	.55
9	1.2	3.9	6.0	2.85	1.0	.3	.45	.6
10	1.28	3.8	6.0	2.55	1.0	.4	.4	.6
11	1.38	3.6	6.0	2.35	1.0	.45	.35	.65
12	1.4	3.3	6.4	2.15	1.3	.5	.3	.65
13	1.45	3.2	6.3	2.05	1.8	.4	.3	.62
14	1.65	3.2	6.15	2.0	1.15	.48	.3	.6
15	1.9	3.1	6.05	2.0	1.0	.4	.3	.6
16	2.0	3.05	5.95	1.88	.9	.4	.35	.55
17	1.8	3.0	5.75	1.75	.8	.4	.32	.52
18	1.8	2.9	5.65	1.65	.8	.4	.35	.5
19	1.85	2.9	5.55	1.55	.95	.35	.35	.5
20	1.95	3.1	5.45	1.48	.9	.3	.35	.5
21	2.15	3.2	5.25	1.72	.85	.25	.35	.5
22	2.1	3.4	4.95	1.7	.8	.2	.4	.5
23	2.15	5.15	4.75	1.5	.7	.2	.4	.55
24	2.4	4.3	4.45	1.4	.62	.15	.4	.58
25	3.15	4.35	4.35	1.4	.55	.12	.4	.6
26	3.3	4.7	4.25	1.5	.5	.1	.45	.6
27	3.05	5.0	4.15	1.6	.48	.1	.45	.7
28	3.25	5.1	4.1	1.7	.5	.1	.5	.68
29	3.4	5.2	4.0	1.5	.48	.1	.5	.55
30	3.0	5.35	3.9	2.0	1.2	.1	.5	.50
31	.....	5.4	.....	1.65	1.0	.....	.5	.....

Station rating table for North Platte River at Guernsey, Wyo., from April 1 to June 12, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	1,090	2.10	2,795	3.20	5,125	4.60	8,770
1.10	1,225	2.20	2,970	3.30	5,370	4.80	9,310
1.20	1,365	2.30	3,150	3.40	5,620	5.00	9,860
1.30	1,510	2.40	3,340	3.50	5,870	5.20	10,410
1.40	1,660	2.50	3,540	3.60	6,125	5.40	10,970
1.50	1,815	2.60	3,750	3.70	6,385	5.60	11,540
1.60	1,970	2.70	3,965	3.80	6,645	5.80	12,120
1.70	2,130	2.80	4,185	3.90	6,905	6.00	12,700
1.80	2,290	2.90	4,410	4.00	7,170	6.20	13,300
1.90	2,455	3.00	4,640	4.20	7,700	6.40	13,900
2.00	2,625	3.10	4,880	4.40	8,230		

The above table is applicable only for open-channel conditions. It is based on ten discharge measurements made during the first part of 1905, and is fairly well defined. Owing to shifting conditions this table is not applicable subsequent to high water.

Station rating table for North Platte River at Guernsey, Wyo., from June 13, to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-ft.*
0.10	295	0.80	765	1.50	1,670	2.20	2,925
.20	335	.90	865	1.60	1,835	2.30	3,125
.30	385	1.00	975	1.70	2,005	2.40	3,330
.40	445	1.10	1,095	1.80	2,180	2.50	3,540
.50	515	1.20	1,225	1.90	2,360		
.60	590	1.30	1,365	2.00	2,545		
.70	675	1.40	1,515	2.10	2,730		

The above table is applicable only for open-channel conditions. It is based on eleven discharge measurements made during the latter part of 1905, and is fairly well defined. Above 2.5 feet the table is the same as the preceding one.

Estimated monthly discharge of North Platte River at Guernsey, Wyo., for 1905.

[Drainage area, 16,240 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
April	5,620	1,090	2,544	151,400	0.157	0.175
May	10,970	4,298	6,745	414,700	.415	.478
June	13,900	6,905	10,580	629,600	.651	.726
July	10,690	1,515	3,289	202,200	.203	.234
August	2,270	501	1,041	64,010	.064	.074
September	552	295	382	22,730	.024	.027
October	515	295	435	26,750	.027	.031
November	675	515	559	33,260	.034	.038
The period				1,545,000		

NORTH PLATTE RIVER AT ALCOVA, WYO.

This station was established February 19, 1904, by John E. Field. It is located at the highway bridge 1,000 feet southwest of the post-office at Alcova, Wyo. There are no running tributaries entering the river in this vicinity.

The channel is straight for 1,500 feet above and 800 feet below the station. The current is swift in the center and sluggish near the banks. Both banks are high, clean, and not liable to overflow. The bed of the stream is rocky, covered with small bowlders, and is permanent. The river is divided by the bridge piers into ten channels at low water and thirteen channels at high water. The bottom at the measuring section is rough and uneven, and this may affect the accuracy somewhat.

Measurements are made from the downstream side of the bridge. The initial point for soundings is the north end of the downstream hand rail.

The gage is a staff fastened to the northeast corner of the crib pier supporting the center of the bridge. During 1905 the gage was read twice a day by A. F. Hollebaugh. The bench mark is a standard United States Geological Survey iron post located at the west quarter corner of sec. 19, T. 30 N., R. 82 W. It is about 1,000 feet due north of the post-office. Its elevation is 5,366 feet above sea level and 36.67 feet above the gage datum.

July 20, 1905, a measurement was made by L. V. Branch with the following result: Area of section, 670 square feet; mean velocity, 1.68 feet per second; gage height, 5.42 feet; discharge, 1,126 second-feet.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 34–35.

Daily gage height, in feet, of North Platte River at Alcova, Wyo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.8	3.85	4.32	5.0	6.85	9.5	7.6	5.0	3.9	4.0	4.18	3.9
2	3.7	3.8	4.35	5.05	6.85	9.7	7.4	5.1	3.9	3.95	4.3	4.0
3	3.85	3.8	4.38	5.05	7.15	9.9	7.25	5.2	3.8	4.3	4.22	4.1
4	3.85	3.8	4.48	5.08	7.35	10.1	7.3	5.1	3.8	4.25	4.15	4.05
5	3.85	3.8	4.7	5.12	7.35	10.8	7.3	5.05	3.9	4.1	4.15	4.05
6	3.85	3.75	4.75	5.05	7.05	11.35	7.15	4.95	4.25	4.1	4.32	3.95
7	3.85	3.75	4.82	4.95	6.85	11.3	6.85	4.9	4.4	4.1	4.4	4.0
8	3.85	3.8	4.8	5.02	6.65	11.05	6.6	4.9	4.25	4.1	4.58	3.9
9	3.75	3.8	4.78	5.05	6.52	11.0	6.45	4.8	4.4	4.05	4.52	3.95
10	3.7	3.7	4.8	5.2	6.6	11.3	6.28	4.7	4.3	4.0	4.52	3.9
11	3.85	3.65	4.75	5.65	7.0	11.5	6.2	4.65	4.3	4.0	4.48	3.8
12	3.75	3.8	4.85	6.1	7.15	11.1	6.05	4.65	4.2	4.0	4.4	3.8
13	3.65	3.8	4.9	5.9	7.0	10.6	5.95	4.55	4.1	4.0	4.4	3.8
14	3.5	3.8	4.92	5.75	6.78	10.55	5.8	4.7	4.1	4.0	4.28	3.8
15	3.6	3.8	4.95	5.65	6.7	10.2	5.7	5.0	4.0	4.0	4.22	3.7
16	3.75	3.8	5.1	5.8	6.55	10.15	5.6	4.95	3.9	4.0	4.2	3.6
17	3.85	3.8	5.35	5.85	6.55	10.05	5.6	4.75	3.9	4.12	4.32	3.7
18	3.9	3.85	5.32	5.8	6.65	10.0	5.5	4.6	3.9	4.18	4.4	3.7
19	3.85	3.95	5.2	5.7	7.1	9.8	5.4	4.45	3.9	4.18	4.42	3.7
20	3.85	4.0	5.15	5.68	7.75	9.35	5.45	4.4	3.8	4.2	4.45	3.8
21	3.9	4.05	5.15	5.7	8.45	9.0	5.5	4.3	3.78	4.3	4.5	3.8
22	3.95	4.0	5.15	5.85	8.8	8.8	5.45	4.25	3.75	4.25	4.42	3.85
23	3.9	4.05	5.15	5.85	9.15	8.7	5.4	4.2	3.75	4.2	4.38	3.65
24	3.9	4.1	5.15	5.82	9.55	8.7	5.4	4.2	3.8	4.12	4.22	3.55
25	3.95	4.1	5.15	5.9	9.75	8.7	5.25	4.1	3.78	4.15	3.65	3.55
26	4.0	4.15	5.1	6.15	9.9	8.5	5.15	4.0	3.75	4.2	3.82	3.5
27	4.0	4.15	5.1	6.15	9.85	8.4	5.05	4.0	3.7	4.35	3.9	3.4
28	4.05	4.25	5.15	6.08	9.8	8.15	4.95	4.0	3.7	4.22	4.05	3.5
29	4.05	.....	5.12	6.28	9.95	8.05	4.9	3.9	3.7	4.32	4.25	3.4
30	4.05	.....	5.05	6.75	9.75	7.75	5.2	3.9	3.9	4.42	3.8	3.25
31	3.85	.....	5.05	.....	9.5	.....	5.1	3.9	.....	4.35	.....	3.45

NOTE.—Probable ice condition January, February, March, and December.

Station rating table for North Platte River at Alcova, Wyo., from February 21, 1904, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
3.40	110	4.90	760	6.40	2,200	8.80	6,325
3.50	130	5.00	830	6.50	2,330	9.00	6,770
3.60	155	5.10	900	6.60	2,465	9.20	7,225
3.70	180	5.20	975	6.70	2,600	9.40	7,685
3.80	210	5.30	1,055	6.80	2,740	9.60	8,155
3.90	245	5.40	1,140	6.90	2,885	9.80	8,635
4.00	285	5.50	1,230	7.00	3,030	10.00	9,120
4.10	325	5.60	1,320	7.20	3,330	10.20	9,630
4.20	370	5.70	1,415	7.40	3,645	10.40	10,160
4.30	415	5.80	1,515	7.60	3,980	10.60	10,720
4.40	465	5.90	1,620	7.80	4,335	10.80	11,300
4.50	520	6.00	1,730	8.00	4,700	11.00	11,900
4.60	575	6.10	1,840	8.20	5,080	11.20	12,150
4.70	635	6.20	1,955	8.40	5,475	11.40	13,130
4.80	695	6.30	2,075	8.60	5,890		

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during 1904–5, and is fairly well defined between gage heights 4.5 feet and 9.5 feet. Below 4.5 feet the table is uncertain.

Estimated monthly discharge of North Platte River at Alcova, Wyo., for 1904–5.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1904.				
April	2,958	747	1,729	102,900
May	11,450	3,210	5,900	362,800
June	8,395	3,485	6,758	402,100
July	3,517	695	1,808	111,200
August	816	440	582	35,790
September	1,302	210	389	23,150
October	647	361	482	29,640
November 1–19	465	110	307	11,570
The period				1,079,000
1905.				
April	2,670	795	1,394	82,950
May	8,998	2,357	4,707	289,400
June	13,440	4,245	8,855	526,900
July	3,980	760	1,817	111,700
August	975	245	574	35,290
September	465	180	273	16,240
October	476	265	347	21,340
November	564	168	406	24,160
The period				1,108,000

NOTE.—No estimate for ice period.

NORTH PLATTE RIVER NEAR MITCHELL, NEBR.

This station was established June 3, 1902. It is located at a highway bridge 1 mile south of Mitchell, Nebr., in sec. 27, T. 23 N., R. 56 W., and replaces the station at Gering, Nebr.

The channel is straight for 2,000 feet above and below the station. Both banks are low and sandy, but are not liable to overflow. The bed of the stream is composed entirely of shifting sand to a depth of 20 feet or more. At high stages there are three channels and at low stages there are from three to forty channels. The current is never sluggish, even at extreme low water. The river is frozen during the winter months. The range of gage heights is about 5.5 feet.

Discharge measurements are made from the upstream side of the highway bridge, which has a total span of 1,565 feet and is supported on pile bents 20 feet apart. The initial point for soundings is the zero mark at the north end of the bridge.

A standard chain gage, which was read during 1905 by B. H. Newbold, is fastened to the upstream end of the hand rail near the center of the bridge. The length of the chain is 10.60 feet. The gage is referred to bench marks as follows: (1) A cross cut in the floor of the bridge at the gage; elevation, 9.74 feet. (2) The head of a nail in the top of the west end of the cap of the first bent at the north end of the bridge; elevation, 8.56 feet. (3) A standard aluminum bench-mark cap, marked "U. S. G. S. B. M.," leaded into the top of a 2-inch gas pipe 4 feet long, located 138 feet north and 30 feet east of the north end of the downstream hand rail; elevation, 8.64 feet. Elevations are above gage datum.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 66, p 28; 84, p 66; 99, pp 162–163; 131, p 39.
Discharge: 66, p 28; 84, p 67; 99, p 163; 131, p 40.
Discharge, monthly: 75, p 126; 84, p 68; 99, p 165; 131, p 41.
Gage heights: 66, p 28; 84, p 67; 99, p 164; 131, p 40.
Rating tables: 84, p 68; 99, p 164; 131, p 41.

Discharge measurements of North Platte River near Mitchell, Nebr., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 29	H. C. Gardner	1,575	648	1.83	2.40	1,186
May 12	do	1,225	2,385	3.61	4.15	8,619
June 13	do	1,037	3,954	4.24	5.20	16,770
July 11	do	1,050	1,513	2.54	3.25	3,852
July 20	do	800	760	2.13	2.50	1,622
August 3	do	762	871	2.31	2.75	2,014
September 21	F. S. Dobson	450	215	1.77	1.92	383
September 7	H. C. Gardner	450	266	2.39	1.95	507

Daily gage height, in feet, of North Platte River near Mitchell, Nebr., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.87	1.67	2.72	2.5	4.1	5.0	4.1	2.7	2.1	1.9
2	1.79	.....	2.65	2.6	4.1	4.9	4.1	2.6	2.0	1.9
3	1.77	.....	2.4	2.6	4.2	4.8	4.1	2.7	2.0	1.9
4	1.8	.....	2.37	2.55	4.3	4.8	3.9	2.7	2.0	1.9
5	1.81	.....	2.35	2.5	4.4	4.8	3.8	2.6	2.0	1.9
6	1.76	.....	2.34	2.5	4.3	4.8	3.7	2.6	1.9	1.9
7	1.77	.....	2.32	2.5	4.4	4.8	3.6	2.6	1.9	1.9
8	1.78	.....	2.3	2.5	4.5	4.9	3.6	2.5	2.0	1.9
9	1.75	.....	2.34	2.5	4.4	5.1	3.5	2.5	2.0	1.9
10	1.74	.....	2.35	2.5	4.4	5.0	3.4	2.5	1.95	1.9
11	1.65	.....	2.34	2.6	4.3	5.0	3.2	2.5	1.9	1.9
12	1.64	.....	2.25	2.7	4.2	5.0	3.2	2.5	1.9	1.9
13	1.64	.....	2.3	2.7	4.2	5.2	3.1	2.65	1.9	1.9
14	1.65	.....	2.27	2.8	4.15	5.2	3.0	2.8	1.9	2.0
15	1.66	.....	2.35	2.8	4.1	5.0	2.9	2.6	1.9	2.0
16	1.76	.....	2.38	2.9	4.1	4.9	2.85	2.5	1.9	2.0
17	1.71	.....	2.41	3.0	4.1	4.8	2.8	2.4	1.9	1.9
18	1.82	.....	2.35	3.1	4.0	4.8	2.7	2.3	1.9	1.9
19	1.86	.....	2.4	3.1	3.9	4.8	2.6	2.3	1.9	1.9
20	1.88	.....	2.35	3.1	3.9	4.7	2.6	2.25	1.9	2.0
21	1.95	.....	2.4	3.1	4.0	4.7	2.5	2.2	1.9	2.0
22	2.0	2.1	2.45	3.3	4.1	4.6	2.5	2.3	1.9	2.0
23	2.05	2.15	2.5	3.4	4.2	4.4	2.55	2.3	1.9	2.0
24	2.1	2.25	2.45	3.5	4.9	4.3	2.6	2.2	1.9	2.0
25	1.87	2.3	2.35	3.6	4.7	4.25	2.6	2.2	1.9	2.0
26	2.07	2.53	2.42	4.1	4.6	4.2	2.5	2.2	1.9	2.0
27	2.09	2.55	2.4	4.2	4.6	4.1	2.7	2.15	1.9	2.0
28	2.01	2.6	2.36	4.1	4.7	4.0	2.8	2.1	1.9	2.0
29	1.8	.....	2.42	4.3	4.8	4.0	2.8	2.0	1.9	2.05
30	1.72	.....	2.45	4.2	4.9	4.0	2.75	2.0	1.9	2.1
31	1.69	.....	2.42	.....	4.9	.....	2.7	2.0	.....	2.1

NOTE.—Ice conditions during January and February.

Station rating table for North Platte River near Mitchell, Nebr., from January 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.90	380	2.80	2,260	3.70	6,050	4.60	11,900
2.00	520	2.90	2,570	3.80	6,600	4.70	12,700
2.10	670	3.00	2,900	3.90	7,150	4.80	13,500
2.20	840	3.10	3,260	4.00	7,700	4.90	14,300
2.30	1,030	3.20	3,650	4.10	8,300	5.00	15,100
2.40	1,250	3.30	4,070	4.20	8,900	5.10	15,900
2.50	1,480	3.40	4,520	4.30	9,600	5.20	16,800
2.60	1,720	3.50	5,000	4.40	10,300		
2.70	1,980	3.60	5,500	4.50	11,100		

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during 1905 and is fairly well defined.

Estimated monthly discharge of North Platte River near Mitchell, Nebr., for 1905.

[Drainage area, 24,400 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches
March	2,036	935	1,239	76,180	0.051	0.059
April	9,600	1,480	3,573	212,600	.146	.163
May	14,300	7,150	10,010	615,500	.410	.473
June	16,800	7,700	12,760	759,300	.523	.584
July	8,300	1,480	3,594	221,000	.147	.170
August	2,260	520	1,296	79,690	.053	.061
September	670	380	420	24,990	.017	.019
October	670	380	460	28,280	.019	.022
The period				2,018,000		

NOTE.—No estimate for ice period.

NORTH PLATTE RIVER AT BRIDGEPORT, NEBR.

This station was established May 4, 1902. It is located at the highway bridge on the public road about one-half mile north of Bridgeport, Nebr., in sec. 28, T. 20 N., R. 50 W.

At the gaging section the channel is narrowed by a dike built as a bridge approach, but is straight for a considerable distance both above and below. The banks are low, but are not liable to overflow. The bed is composed of shifting sand. There is but one channel at ordinary or high stages, but at low water the stream is divided into many winding channels. The water is never sluggish.

Discharge measurements are made from the upstream side of the highway bridge, which is supported by pile bents about 20 feet apart. The initial point for soundings is the zero mark on the hand rail at the south end of the bridge.

The gage, which was read during 1905 by Porter Hannawald, is of the wire and weight type and is fastened to the upstream hand rail of the bridge. The length of the wire is 12.80 feet. The gage is referred to bench marks as follows: (1) A 6 by 6 inch stone, marked "U. S. C. & G. S.," in the NE. ¼, sec. 32, T. 20 N., R. 50 W., of the sixth principal meridian, 130 feet east of the east gate of the stock yards and 300 feet northwest of the northwest corner of the public school building; elevation, 9.94 feet. (2) A standard aluminum United States Geological Survey bench-mark cap set in a 20 by 12 by 6 inch stone located about 50 feet south and a little east of the northeast corner of lot No. 4, block No. 2, of the Riverside addition to Bridgeport, Nebr.; elevation, 11.32 feet. (3) The head of a nail in the top of the west end of the cap of the south bent of the bridge; elevation, 10.14 feet. Elevations are above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, p 64; 99, pp 159–160; 131, p 42.
Discharge: 84, p 65; 99, pp 160–161; 131, p 43.
Discharge, monthly: 84, p 66; 99, p 162; 131, p 44.
Gage heights: 84, p 65; 131, p 43.
Rating tables: 84, p 66; 99, p 162; 131, p 44.

Discharge measurements of North Platte River at Bridgeport, Nebr., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 29	H. C. Gardner	2,200	845	1.67	5.10	1,417
May 12	do	2,200	4,150	2.66	6.30	11,040
June 14	do	2,190	4,904	3.57	7.00	17,550
July 12	do	2,190	2,089	2.26	5.65	4,608
July 21	do	1,960	1,287	1.84	5.40	2,367
August 4	do	2,060	1,298	1.92	5.45	2,504
September 13	A. Dobson	639	232	1.57	4.91	366

Daily gage height, in feet, of North Platte River at Bridgeport, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	5.5	6.45	6.83	6.25	5.46	4.8	4.86
2	.....	5.7	6.43	6.81	6.25	5.54	4.84	4.9
3	.....	5.52	6.4	6.75	6.25	5.37	4.93	4.92
4	.....	5.3	6.4	6.65	6.35	5.44	4.87	4.94
5	.....	5.27	6.37	6.62	6.2	5.48	4.94	4.95
6	.....	5.27	6.5	6.55	6.0	5.36	4.9	4.93
7	.....	5.25	6.41	6.57	5.95	5.35	4.87	4.9
8	.....	5.32	6.43	6.78	5.88	5.37	4.9	4.9
9	.....	5.35	6.45	6.86	5.85	5.31	4.9	4.9
10	.....	5.32	6.4	6.8	5.8	5.3	4.96	4.93
11	.....	5.43	6.46	6.9	5.75	5.33	4.94	4.95
12	.....	5.36	6.33	6.9	5.68	5.21	4.93	4.97
13	.....	5.42	6.3	6.95	5.6	5.27	4.91	4.98
14	.....	5.35	6.25	6.98	5.5	5.16	4.95	5.23
15	.....	5.37	6.25	7.0	5.35	5.3	4.9	5.15
16	.....	5.3	6.3	6.95	5.43	5.39	4.87	5.1
17	.....	5.38	6.25	6.8	5.43	5.13	4.87	5.1
18	.....	5.62	6.28	6.8	5.4	5.05	4.89	5.08
19	.....	5.6	6.25	6.8	5.34	5.0	4.97	5.03
20	.....	5.9	6.28	6.7	5.25	4.96	5.0	5.02
21	.....	5.57	6.15	6.6	5.37	4.9	4.95	5.07
22	.....	5.62	6.26	6.65	5.37	4.98	4.9	5.05
23	.....	5.8	6.25	6.6	5.05	4.95	4.9	5.1
24	.....	6.0	6.6	6.6	5.32	4.9	4.9	5.08
25	.....	6.0	6.53	6.5	5.16	4.86	4.92	5.08
26	.....	6.02	6.5	6.35	5.13	5.06	4.87	5.06
27	.....	6.2	6.52	6.3	5.43	5.07	4.88	5.08
28	.....	6.2	6.6	6.25	5.42	4.9	4.87	5.0
29	5.1	6.2	6.55	6.2	5.38	4.88	4.86	5.1
30	5.25	6.4	6.57	6.15	5.54	4.9	4.88	5.08
31	5.27	.....	6.7	.....	5.43	4.88	.....	5.1

Station rating table for North Platte River at Bridgeport, Nebr., from March 29 to July 11, 1905

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
5.10	1,400	5.60	4,400	6.10	8,750	6.60	13,700
5.20	1,900	5.70	5,250	6.20	9,700	6.70	14,700
5.30	2,400	5.80	6,100	6.30	10,700	6.80	15,700
5.40	3,000	5.90	6,950	6.40	11,700	6.90	16,700
5.50	3,700	6.00	7,800	6.50	12,700	7.00	17,700

The above table is based on four discharge measurements made during 1905 and is fairly well defined between gage heights 5.1 feet and 7 feet.

From July 12 to 21 the rating table was applied indirectly. After July 21 the following table was used:

Station rating table for North Platte River at Bridgeport, Nebr., from July 22 to October 31, 1905

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
4.80	200	5.10	930	5.30	1,720	5.50	2,920
4.90	350	5.20	1,270	5.40	2,300	5.60	3,600
5.00	600						

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during 1905 and the general form of the 1904 curve. It is not well defined.

Estimated monthly discharge of North Platte River at Bridgeport, Nebr., for 1905.

[Drainage area, 23,190 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
April	11,700	2,150	4,822	286,900	0.208	0.23
May	14,700	9,225	11,710	720,000	.505	.58
June	17,700	9,225	14,430	858,600	.622	.69
July	11,200	765	4,536	278,900	.196	.22
August	3,192	290	1,316	80,920	.057	.06
September	600	200	370	22,020	.016	.01
October	1,405	290	685	42,120	.030	.03
The period				2,289,000		

NORTH PLATTE RIVER AT NORTH PLATTE, NEBR.

This station was established October 5, 1894. It is located 3½ miles above the junction of North and South Platte rivers, at a highway bridge about one-half mile north of the city of North Platte, in sec. 28, T. 14 N., R. 30 W. It is the lowest station on the river.

The channel is nearly straight for about 500 feet both above and below the station. The banks are low, but are rarely, if ever, overflowed. The bed is composed of shifting sand. The river flows in two channels separated by a large island. The north channel is narrow and except in moderately high water is dry. At low stages the water is confined to a few channels along the right bank. The only obstructions in the channel are the pile bents and inclined ice guards of the bridge. The current is never sluggish, even at low stages. One small tributary, Birdwood Creek, maintains a small flow of water at the gaging station during months when the river itself would otherwise be entirely dry. During the winter months the river often freezes almost solid, since it is very shallow.

Discharge measurements are made from the highway bridge, which consists of 93 spans supported on pile bents 20 feet apart. The initial point for soundings is on the right bank.

The gage, which was read during 1905 by H. E. Dress, is a vertical staff spiked to the piling of the Union Pacific Railroad bridge 2 miles below the wagon bridge. The bench mark is the top of the east rail directly over the top of the gage rod; elevation, 12.00 feet. It is customary to refer the elevation of the water surface at the gaging section during measurements to the top of the upstream end of the cap of the second bent from the right-bank end of the highway bridge.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull.=Bulletin; WS=Water-Supply Paper):

Description: Ann 18, iv, pp 156–157; 19, iv, p 306; Bull 131, p 30; 140, pp 99–100; WS 15, p 86; 27, p 76; 37, pp 220–221; 49, p 277; 66, p 28; 84, p 62; 99, pp 157–158; 131, pp 44–45.

Discharge: Ann 13, iii, p 82; 18, iv, p 157; 20, iv, pp 301, 302; Bull 131, p 92; 140, p 100; WS 15, p 86; 27, p 86; 37, p 221; 49, p 277; 66, p 28; 84, p 62; 99, p 158; 131, p 45.

Discharge, monthly: Ann 18, iv, p 158; 19, iv, p 310; 20, iv, pp 263, 269; 21, iv, p 199; Bull 140, p 102; WS 84, p 64; 99, p 159; 131, p 47.

Discharge, yearly: Ann 20, iv, p 54.

Gage heights: Bull 140, p 102; WS 11, p 52; 15, p 86; 27, p 81; 37, p 221; 49, p 278; 66, p 29; 84, p 63; 99, pp 158, 161; 131, p 46.

Hydrographs: Ann 19, iv, p 310; 21, iv, p 199.

Rainfall and run-off relation: Ann 20, iv, p 266.

Rating tables: Ann 18, iv, pp 157–158; Bull 140, p 101; WS 27, p 88; 39, p 447; 84, p 63; 99, p 159; 131, p 46.

Discharge measurements of North Platte River at North Platte, Nebr., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 31	G. W. Bates	1,460	1,020	2.11	2.40	2,157
May 16	do	1,960	3,002	3.08	3.35	9,677
June 12	H. C. Gardner	1,950	5,213	3.37	3.95	17,570
June 20	do	1,970	4,875	3.28	3.75	16,010
July 13	do	3,740	2,336	2.51	2.75	5,878
July 22	do	1,760	1,500	2.34	2.40	3,513
August 5	do	1,120	1,294	1.98	2.20	2,564
September 20	F. S. Dobson	.....	426	1.65	1.80	703
October 24	Dobson and Bates	1,020	563	1.87	1.98	1,056
September 9	H. C. Gardner	.....	462	1.59	1.70	735

Daily gage height, in feet, of North Platte River at North Platte, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.58	3.18	3.65	3.4	2.52	1.6	1.48
2	.....	2.62	3.32	3.88	3.65	2.48	1.55	1.5
3	.....	2.65	3.45	3.88	3.68	2.45	1.5	1.55
4	.....	2.75	3.38	3.88	3.38	2.3	1.52	1.55
5	2.85	2.7	3.38	3.68	3.28	2.22	1.62	1.58
6	2.75	2.62	3.4	3.58	3.38	2.22	1.7	1.65
7	2.62	2.48	3.45	3.5	3.18	2.18	1.72	1.65
8	2.5	2.38	3.48	3.48	3.1	2.15	1.7	1.65
9	2.4	2.25	3.5	3.52	3.0	2.18	1.7	1.6
10	2.45	2.28	3.4	3.72	2.9	2.1	1.72	1.65
11	2.5	2.38	3.48	3.88	2.82	2.05	1.7	1.72
12	2.4	2.35	3.5	4.02	2.8	2.0	1.65	1.72
13	2.4	2.42	3.5	3.95	2.75	2.2	1.65	1.65
14	2.5	2.45	3.55	3.9	2.62	2.2	1.75	1.65
15	2.42	2.5	3.4	4.08	2.52	2.18	1.85	1.82
16	2.68	2.45	3.35	4.28	2.42	2.02	1.68	1.78
17	2.82	2.45	3.2	4.08	2.32	2.0	1.58	1.72
18	2.7	2.48	3.18	3.9	2.2	1.92	1.68	1.78
19	2.82	2.45	3.18	3.8	2.28	1.95	1.82	1.8
20	2.65	2.42	3.28	3.75	2.42	2.02	1.9	1.9
21	2.5	2.8	3.2	3.6	2.5	1.85	1.8	1.9
22	2.4	2.8	3.1	3.6	2.42	1.8	1.75	1.9
23	2.32	2.72	3.05	3.62	2.28	1.75	1.8	1.85
24	2.28	2.9	3.1	3.62	2.28	1.68	1.72	1.9
25	2.28	3.12	3.28	3.42	2.3	1.68	1.68	1.98
26	2.25	3.1	3.28	3.32	2.18	1.7	1.62	1.9
27	2.25	3.0	3.82	3.28	2.2	1.68	1.58	1.9
28	2.38	2.9	3.65	3.18	2.18	1.65	1.55	2.0
29	2.4	3.05	3.78	3.12	2.38	1.6	1.6	2.05
30	2.38	3.22	3.7	3.22	2.1	1.75	1.6	2.02
31	2.4	.....	3.65	.....	2.18	1.72	.....	2.0

Station rating table for North Platte River at North Platte, Nebr., from March 5 to June 15, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.30	1,630	2.80	4,620	3.30	9,080	3.80	15,440
2.40	2,150	2.90	5,370	3.40	10,200	3.90	16,900
2.50	2,700	3.00	6,190	3.50	11,400	4.00	18,400
2.60	3,290	3.10	7,080	3.60	12,680	4.10	19,930
2.70	3,930	3.20	8,040	3.70	14,030		

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during 1905, and is poorly defined. Owing to the shifting character of the stream bed, all estimates based on this and the following table are merely rough approximations.

Station rating table for North Platte River at North Platte, Nebr., from June 16 to September 10, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.50	360	2.30	3,050	3.00	7,910	3.70	15,430
1.60	530	2.40	3,600	3.10	8,810	3.80	16,690
1.70	740	2.50	4,200	3.20	9,770	3.90	17,970
1.80	1,000	2.60	4,850	3.30	10,790	4.00	19,270
1.90	1,310	2.70	5,540	3.40	11,870	4.10	20,590
2.00	1,670	2.80	6,280	3.50	13,010	4.20	21,930
2.10	2,080	2.90	7,070	3.60	14,200	4.30	23,280
2.20	2,540						

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during 1905. From September 11 to October 31 the discharge was obtained by the indirect method.

Estimated monthly discharge of North Platte River at North Platte, Nebr., for 1905.

[Drainage area, 28,520 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 5-31	4,995	1,390	2,727	146,000	0.096	0.096
April	8,248	1,390	3,743	222,700	.131	.146
May	15,730	6,635	10,270	631,500	.360	.415
June	23,010	9,002	14,700	874,700	.515	.575
July	15,180	2,080	5,983	367,900	.210	.242
August	4,330	530	1,862	114,500	.065	.075
September	1,000	260	585	34,810	021	.023
October	1,270	200	616	37,880	.022	.025
The period				2,430,000		

LARAMIE RIVER AT GLENDEVEY, COLO.

Laramie River rises on the east side of the Medicine Bow Range in Colorado, flows northwestward into Wyoming, and thence north and northeast until it joins the North Platte at Fort Laramie, Wyo. The drainage basin, which is narrow and very mountainous in its upper portion, broadens considerably in the middle and lower portions. The middle portion comprises the Laramie plains and surrounding foothills. The plains are about 30 miles wide and 80 miles long, extend north and south, and are bounded by the Laramie Hills on the east and the foothills of the Medicine Bow Range on the west. After passing around the Laramie Hills the river flows out on the Great Plains until it joins the North Platte. The soil throughout the entire area is sandy and along the river bottoms is fertile. Above the Laramie Plains the altitude is too great to permit the raising of crops other than hay and a few of the hardier cereals. Numerous small ditches divert the water of the stream to the hay lands along the first bottom and to a considerable extent to the higher lands on either side. Cattle raising is the chief industry. In the lower portion of the valley irrigation is practiced to some extent, and large crops are produced each year. There are extensive forests of pine and spruce on the headwaters of the stream, which lie in the Medicine Bow Forest Reserve.

The largest tributary from the west is the Little Laramie, which rises near the center of the Medicine Bow Range, flows eastward out on the Laramie Plains, and enters the main river

10 miles north of the city of Laramie. Its drainage area is similar in every respect to that of the upper and middle portions of the Laramie. The principal tributary of the Laramie on the right bank is Chugwater Creek, which rises in the Laramie Hills and joins the river about 18 miles above its mouth. The valley of Chugwater Creek is broad and fertile and the entire stream is used for irrigation during the summer season.

McIntyre Creek, the largest tributary of the Laramie in Colorado, is described on page 215, in connection with the gaging station at Gleneyre, Colo.

The Glendevey gaging station was established June 24, 1904. It is located at the highway bridge at Glendevey, Colo., on the State road between Walden and Fort Collins, in T. 9 N., R. 76 W.

The channel is straight for about 100 feet above and 300 feet below the station. Both banks are high and covered with a dense growth of willows and the stream does not overflow even at very high stages. The bed is composed of bowlders and coarse gravel and is free from vegetation and permanent. There is but one channel at all stages, broken by three piers. Gage heights have an ordinary range of about 2.5 feet. During the winter months the channel is obstructed by ice and gage readings are impracticable. The current is swift at high stages and medium at low stages. Discharge measurements are affected by the bowlders on the bed of the stream and by the piers of the bridge.

Discharge measurements are made from the downstream side of the three-span bridge to which the gage is attached. The initial point for soundings is a 30-penny nail driven into the guard log directly above the east face of the wooden pier at the left end of the bridge.

The gage, which was read twice each day during 1905 by E. S. Graves, consists of a vertical staff, graduated from 1 foot to 8 feet, attached to the northwest corner of the first pier from the right bank. The 1-foot mark rests on the bed of the stream. The gage is referred to bench marks as follows: (1) A cross cut in the top of a granite bowlder 18 inches in diameter, 10 feet northwest of the initial point for soundings; elevation, 7.32 feet above the zero of the gage. (2) A cross cut in the top of a granite bowlder 3 feet in diameter, 75 feet northwest of the initial point for soundings; elevation, 16.84 feet above the zero of the gage.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 66–67.

Discharge measurements of Laramie River at Glendevey, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 22	W. A. Lamb	52	76	4.00	2.72	304
June 22	do	50	92	4.61	3.05	424
July 20	do	45	52	2.42	2.30	126
August 5	do	35	41	1.80	2.10	74
August 20	do	34	33	1.36	1.99	45
September 20	do	25	26	.96	1.91	25

Daily gage height, in feet, of Laramie River at Glendevey, Colo., for 1905.

Day.	Apr.	May	June	July	Aug.	Sept.	Oct.
1	1.82	2.25	3.4	2.7	2.25	1.95	1.8
2	1.82	2.25	3.45	2.7	2.2	2.0	1.8
3	1.82	2.25	3.85	2.65	2.2	1.9	1.8
4	1.82	2.2	4.1	2.45	2.2	1.9	1.8
5	1.85	2.15	4.1	2.4	2.15	1.9	1.8
6	1.9	2.15	3.9	2.3	2.1	1.9	1.8
7	1.9	2.15	3.8	2.3	2.1	1.9	1.8
8	1.9	2.22	4.0	2.35	2.1	1.9	1.8
9	1.9	2.22	4.3	2.4	2.1	1.9	1.8
10	1.9	2.25	4.15	2.35	2.1	1.9	1.8
11	1.85	2.25	3.6	2.4	2.15	1.9	1.8
12	1.9	2.25	3.6	2.45	2.15	1.9	1.8
13	1.9	2.25	3.55	2.4	2.1	1.9	1.8
14	1.9	2.2	3.5	2.4	2.1	1.9	1.8
15	1.9	2.2	3.65	2.4	2.1	1.85	1.8
16	1.88	2.28	3.65	2.3	2.05	1.8	1.8
17	1.9	2.4	3.65	2.35	2.0	1.8	1.8
18	1.88	2.45	3.45	2.35	2.0	1.9	1.85
19	1.88	2.48	3.2	2.35	2.0	1.9	1.9
20	1.88	2.58	3.05	2.3	2.0	1.85	1.9
21	1.92	2.75	3.05	2.3	1.95	1.8	1.8
22	1.92	2.9	3.05	2.3	1.9	1.8	1.8
23	1.92	3.1	3.15	2.2	1.9	1.8	1.8
24	1.92	3.28	3.1	2.2	1.9	1.8	1.8
25	1.95	3.35	3.1	2.25	1.9	1.8	1.8
26	1.95	3.1	3.1	2.3	1.9	1.8	1.8
27	2.05	3.05	3.1	2.35	1.9	1.8	1.8
28	2.15	3.1	3.0	2.4	1.95	1.8	1.8
29	2.15	3.05	2.85	2.35	1.95	1.8	1.8
30	2.15	3.0	2.75	2.3	1.9	1.8	1.8
31	.....	3.25	.....	2.3	1.9	.....	1.8

Station rating table for Laramie River at Glendevey, Colo., from June 24, 1904, to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.80	7	2.50	205	3.20	495	3.90	830
1.90	25	2.60	245	3.30	540	4.00	880
2.00	50	2.70	285	3.40	585	4.10	930
2.10	75	2.80	325	3.50	630	4.20	985
2.20	105	2.90	365	3.60	680	4.30	1,040
2.30	135	3.00	405	3.70	730		
2.40	170	3.10	450	3.80	780		

The above table is applicable only for open-channel conditions. It is based on ten discharge measurements made during 1904-5, and is well defined between gage heights 2 feet and 3 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Laramie River at Glendevey, Colo., for 1904–5.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1904.				
June 24-30	405	265	299	4,151
July	405	90	165	10,140
August	90	50	63.4	3,898
September	50	25	31.7	1,886
October	50	7	26.6	1,636
The period				21,710
1905.				
April	90	11	31.3	1,862
May	562	90	263	16,170
June	1,040	305	627	37,310
July	285	105	162	9,961
August	120	25	60.7	3,732
September	50	7	18.5	1,101
October	25	7	8.5	523
The period				70,660

LARAMIE RIVER NEAR JELM, WYO.

This station was established June 22, 1904. It is located at a wagon bridge at H. T. Decker's ranch, one-half mile south of the Colorado-Wyoming State line, near Jelm, Wyo., in sec. 22, T. 12 N., R. 77 W., below all tributaries in Colorado.

The channel is straight for about 50 feet above and 300 feet below the station. Both banks are high and covered with willows and are not liable to overflow. The bed of the stream is composed of gravel and bowlders and is firm. There is but one channel at all stages, broken by the three piers of the bridge. The water is swift at high stages and medium at low stages. Discharge measurements are affected by large bowlders in the channel and also by the piers of the bridge. Gage heights have an ordinary range of about 4 feet. During the winter months the channel is obstructed by ice and gage readings are impracticable.

Discharge measurements are made from the downstream side of the four-span bridge to which the gage is attached. The initial point for soundings is a 30-penny nail driven into the left end of the downstream guard rail.

The gage, which was read during 1905 by Mr. Decker, consists of a staff fastened in a vertical position to the northwest corner of the center pier of the bridge. The bench mark is a 30-penny nail driven into the lower log at the southwest corner of Mr. Decker's house; elevation, 12.35 feet above the zero of the gage.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 67-68.

Discharge measurements of Laramie River near Jelm, Wyo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 21	W. A. Lamb	57	123	4.47	3.80	550
June 21	do	59	148	4.93	4.20	730
July 18	do	57	75	2.27	2.55	170
August 6	do	43	63	1.86	2.40	117
August 21	do	39	47	1.51	2.31	71
September 21 [a]	do	36	45	.93	1.98	42

[a] Made by wading.

Daily gage height, in feet, of Laramie River near Jelm, Wyo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.8	2.45	5.25	3.55	2.6	2.0	1.9
2	1.8	2.55	5.4	3.55	2.6	2.0	1.9
3	1.8	2.5	5.6	3.55	2.6	2.0	1.9
4	1.8	2.4	5.9	3.35	2.5	2.0	1.8
5	1.9	2.4	6.15	3.1	2.5	2.0	1.8
6	1.9	2.4	5.8	2.9	2.5	2.1	1.8
7	2.0	2.4	5.8	2.8	2.5	2.1	1.8
8	2.0	2.5	5.95	2.8	2.5	2.1	1.8
9	2.1	2.65	6.2	2.9	2.5	2.0	1.9
10	2.0	2.6	6.0	2.8	2.5	2.0	1.9
11	2.0	2.5	5.3	2.7	2.5	2.0	1.9
12	2.0	2.5	5.3	2.7	2.5	2.0	1.9
13	2.0	2.5	5.4	2.75	2.4	2.0	1.9
14	2.0	2.5	5.25	2.7	2.4	2.0	1.9
15	2.0	2.5	5.25	2.7	2.3	1.9	1.9
16	2.0	2.5	5.15	2.65	2.3	1.9	1.9
17	2.0	2.8	5.15	2.6	2.2	1.9	1.9
18	2.0	3.2	4.8	2.6	2.2	1.9	1.8
19	2.0	3.45	4.4	2.6	2.2	1.9	1.8
20	2.05	3.8	4.35	2.7	2.2	1.9	1.8
21	2.0	4.0	4.25	2.7	2.2	1.9	1.8
22	2.1	4.5	4.25	2.6	2.1	1.8	1.8
23	2.0	4.85	4.2	2.5	2.1	1.8	1.8
24	2.0	4.95	4.2	2.45	2.1	1.8	1.9
25	2.05	4.75	4.05	2.45	2.1	1.9	1.9
26	2.1	4.7	3.95	2.5	2.1	1.9	1.9
27	2.25	4.7	3.9	2.55	2.1	1.9	1.9
28	2.35	4.7	3.9	2.6	2.1	2.0	1.8
29	2.35	4.5	3.7	2.6	2.1	2.0	1.8
30	2.4	4.5	3.5	2.6	2.1	1.9	1.8
31	.....	4.85	.....	2.6	2.0	.....	1.8

Station rating table for Laramie River near Jelm, Wyo., from April 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-ft.*	*Feet.*	*Second-ft.*	*Feet.*	*Second-ft.*	*Feet.*	*Second-ft.*
1.80	22	2.80	210	3.80	555	4.80	1,045
1.90	33	2.90	240	3.90	600	4.90	1,100
2.00	45	3.00	270	4.00	645	5.00	1,155
2.10	58	3.10	300	4.10	690	5.20	1,270
2.20	73	3.20	330	4.20	735	5.40	1,390
2.30	91	3.30	365	4.30	785	5.60	1,515
2.40	112	3.40	400	4.40	835	5.80	1,645
2.50	135	3.50	435	4.50	885	6.00	1,780
2.60	185	3.60	475	4.60	935	6.20	1,920
2.70	160	3.70	515	4.70	990		

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1905 and two during 1904, and is not well defined.

Estimated monthly discharge of Laramie River near Jelm, Wyo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	112	22	50.1	2,981
May	1,128	112	458	28,160
June	1,920	435	1,160	69,020
July	455	124	212	13,040
August	160	45	97.8	6,014
September	58	22	39.6	2,356
October	33	22	27.7	1,703
The period				123,300

M'INTYRE CREEK AT GLENEYRE, COLO.

McIntyre Creek rises in the Medicine Bow Mountains, flows northeastward, and unites with Laramie River at Gleneyre, Colo., about 12 miles south of the Colorado-Wyoming State line. The entire basin is mountainous, and the greater portion of it is covered by heavy forests of pine and spruce and dense growths of quaking aspen and underbrush. No irrigation is carried on except near the mouth, where water is diverted to the bottom land along the stream. A project is being considered to divert water from the head of the stream by means of a canal, inverted siphon, and tunnel, to the headwaters of Cache la Poudre River.

The gaging station was established June 23, 1904. It is located at the wagon bridge on Joseph Smith's ranch at Gleneyre, Colo., in sec. 20, T. 11 N., R. 76 W.

The channel is straight for about 200 feet above and 30 feet below the station. The right bank is low, is partly covered by willows, and at high water overflows for a distance of 40 feet from the main channel. The left bank is high and covered with willows. The bed of the stream is covered with gravel and small bowlders, and is firm. There is but one channel at all stages. The velocity is swift at high water and medium at low water. The current at the upper side of the bridge is somewhat obstructed by bowlders in the bed of the stream. Gage heights have an ordinary range of 3 feet. During the winter months ice forms in the channel to such an extent as to make gage readings impracticable.

At all normal stages discharge measurements are made by wading at convenient points below the bridge. High-water measurements are made from the upstream side of the two-

span bridge to which the gage is attached. The initial point for soundings is a nail driven into the guard rail of the upstream side of the bridge directly above the gage rod.

The gage was read twice daily during 1905 by Elbert E. Smith, who lives about three-fourths of a mile south of the station. It consisted originally of a staff attached vertically to a post driven into the bed of the stream and fastened at the top to the end of the bridge. This gage was washed out June 11, 1905, and was replaced by a sloping gage, which was located 2 feet above the original one. The rod is set sloping in the bank and fastened to three posts set firmly in the ground. It reads from 0.5 foot to 5 feet. The datum of the new gage is the same as that of the old one. The bench mark is the top of an iron rod, three-fourths of an inch in diameter and 2½ feet long, with an L-shaped bend at the lower end, resting on a granite bowlder, 14 inches in diameter, which is set 2 feet under ground, 30 feet northeast of the gage; elevation, 5.31 feet above the zero of the gage.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 69–70.

Discharge measurements of McIntyre Creek at Gleneyre., Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 22	W. A. Lamb	32	52	3.71	3.20	193
June 22	do	33	59	2.59	2.85	153
July 19	do	24	20	1.65	1.90	33
August 6	do	21	14	1.50	1.75	21
August 20	do	12	15	.80	1.63	12
September 21	do	10	13	.60	1.55	7.8

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of McIntyre Creek at Gleneyre, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	1.52	1.75	4.15	2.75	1.82	1.58	17	1.58	1.88	3.75	1.82	1.62	.....
2	1.52	1.8	4.15	2.55	1.82	1.58	18	1.58	1.88	3.55	1.82	1.62	.....
3	1.52	1.8	4.35	2.5	1.78	1.58	19	1.58	1.88	3.35	1.8	1.62	.....
4	1.55	1.8	4.35	2.48	1.78	.....	20	1.58	1.85	3.25	2.0	1.62	.....
5	1.55	1.8	4.3	2.25	1.78	.....	21	1.58	3.1	3.2	1.92	1.62	.....
6	1.55	1.8	4.1	2.35	1.75	.....	22	1.58	3.1	2.75	1.92	1.62	.....
7	1.55	1.8	3.95	2.35	1.72	.....	23	1.58	3.2	2.92	1.92	1.62	.....
8	1.55	1.8	3.95	2.08	1.72	.....	24	1.58	3.2	2.88	1.9	1.62	.....
9	1.55	1.8	3.95	2.02	1.72	.....	25	1.58	3.2	2.88	1.92	1.62	.....
10	1.55	1.8	4.05	2.02	1.72	.....	26	1.58	3.2	2.82	1.92	1.62	.....
11	1.62	1.8	4.05	1.98	1.72	.....	27	1.58	3.2	2.8	1.92	1.62	.....
12	1.68	1.85	4.75	1.98	1.72	.....	28	1.65	3.5	2.75	1.88	1.64	.....
13	1.68	1.82	4.55	1.98	1.72	.....	29	1.65	3.62	2.75	1.88	1.62	.....
14	1.58	1.88	4.35	1.98	1.72	.....	30	1.65	3.95	2.75	1.88	1.58	.....
15	1.58	1.88	4.15	1.98	1.72	.....	31	.....	4.05	.....	1.88	1.58	.....
16	1.58	1.88	3.95	1.98	1.72	.....							

NOTE.—Gage heights estimated June 11–19.

Station rating table for McIntyre Creek at Gleneyre, Colo., from April 1 to September 3, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.50	5	2.40	92	3.30	212	4.20	340
1.60	11	2.50	105	3.40	226	4.30	355
1.70	18	2.60	118	3.50	240	4.40	370
1.80	26	2.70	131	3.60	254	4.50	385
1.90	35	2.80	144	3.70	268	4.60	400
2.00	45	2.90	157	3.80	282	4.70	415
2.10	56	3.00	170	3.90	296	4.80	430
2.20	68	3.10	184	4.00	310		
2.30	80	3.20	198	4.10	325		

The above table is applicable only for open-channel conditions. It is based on twelve discharge measurements made during 1904–5, and is well defined between gage heights 1.6 feet and 3.2 feet.

Estimated monthly discharge of McIntyre Creek at Gleneyre, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	14	6	10.1	601
May	318	22	98.2	6,038
June	422	138	263	15,650
July	138	26	52.5	3,228
August	28	10	17.0	1,045
The period				26,560

SOUTH PLATTE RIVER.

DESCRIPTION OF BASIN.

The headwaters of the South Platte have their sources in the mountainous region surrounding the large basin near the center of the State of Colorado known as South Park and in the long eastern slopes of the high mountains forming the Continental Divide. The general course of the stream is eastward to Lake George, thence through Platte Canyon northward to the junction with Cache la Poudre River near Greeley, and thence eastward until it joins the North Platte at the town of North Platte, Nebr.

The drainage basin, which is about 20,000 square miles in extent above Julesburg, Colo., is bisected in an irregular way by the channel of the South Platte. To the north and west lies the mountainous portion, which consists of a long, narrow strip lying in a north-south direction along the foothills from a point a short distance within Wyoming to Palmer Lake, Colo. This area produces at least 90 per cent of the total run-off of the basin. South and east of the river the basin lies entirely within the plains region.

The mountainous region consists of peaks and jagged masses of granite, with sedimentary rocks cut and gashed by stream channels along the foothills. The stream gradients are steep, and many of the streams consist of series of cascades and rapids. The soil cover as a whole is light, and except during spring freshets or heavy storms the streams are remarkably free from sediments in suspension. The forest cover of the mountains, consisting originally of coniferous trees, is rapidly disappearing, but through the occurrence of fires a foothold has been furnished for the deciduous aspen, which is gradually increasing its dominion. The South Platte, Plum Creek, and Medicine Bow forest reserves are in part comprised within this area.

The lower basin, somewhat broken and scarred along the foothills, gradually merges farther east into the undulating prairies so characteristic of the Great Plains east of the Rocky

Mountains. The soils of the plains are the product of the disintegration of shales and sandstones of the Laramie formation and range from adobe clays to sandy loams. The controlling vegetation is largely native grasses, the only timber being a few bunches of scraggly cottonwoods along the stream channels and small patches of pine, cedar, and piñon along the higher portions.

Precipitation varies from 25 inches along the Continental Divide, where the greater part of it is snowfall, to 14 to 17 inches among the foothills. Evaporation records are meager.

In the mountainous region the flow of the South Platte and its tributaries is perennial; but in the plains area the volume is greatly diminished, owing to the fact that the normal waters are completely diverted for irrigation, the acreage capacity of the canals far exceeding the capacity of the river. At North Platte, Nebr., just above the mouth of the river, the stream channel is dry for the greater part of the year or consists of several small channels carrying a few second-feet of water.

The tributaries of the South Platte comprise, first, the small streams that rise on the eastern slopes of the Rocky Mountains, and, second, the plains streams. The mountain streams furnish a perennial supply of water, the amount of which, however, varies with the snowfall, being light during the latter part of the summer and in the fall and winter, and large during the spring floods. This water is almost entirely diverted for irrigation and does not reach the South Platte except in times of heavy floods. The principal streams of this class are Bear, Clear, Boulder, and St. Vrain creeks and Big Thompson and Cache la Poudre rivers. The plains streams are all intermittent in their nature and furnish water only during storms or in the season of melting snow. The chief streams of this class are Cherry, Lone Tree, Kiowa, Boxelder, Bijou, Beaver, and Pawnee creeks.

The South Platte is subject to periodic floods, which occur in May and June, the magnitude varying from year to year with seasonal precipitation and temperature. At Julesburg, on the eastern margin of the basin in Colorado, the stream may vary from no flow up to 12,000 second-feet.

Information in regard to this basin is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Description: Ann 18, iv, p 159; 19, iv, p 311; 20, iv, pp 277–279; 21, iv, p 200; Bull 140, pp 102–103.
Drainage areas: Bull 140, p 103.
Irrigation surveys: Ann 13, iii, pp 82–91.
Rainfall and river stations, map: WS 75, p 131.
Rainfall data: WS 75, pp 131–135, 137. *See also* WS 74.
Water-storage possibilities: Ann 22, iv, pp 314–317.

SOUTH PLATTE RIVER AT SOUTH PLATTE, COLO.

This station was established March 28, 1902, at the wagon bridge crossing the South Platte about 150 feet below the junction of North and South forks at the town of South Platte, a station on the Colorado and Southern Railway about 9 miles above the mouth of the canyon. May 7, 1905, the old station was abandoned and a new station established at a point 150 feet below the county bridge. The station is very near the Colorado and Southern Railway station and is easily accessible from Denver.

This station is of special importance, its location being above the diverting gates of all irrigating ditches and also above the intake of the Denver Union Water Company, which derives the greater part of its supply from the South Platte, a few miles below. The location of the Cheesman storage reservoir on the South Fork 20 miles above this station and the contemplated installation of large power plants on the two forks at points above also add to the importance of the station as a base from which to secure data. Bridges across each fork above the main station allow of measurements being made on these streams, thereby checking all gagings on the main stream.

At the wagon bridge the channel is straight for 250 feet above and 400 feet below. The right bank is the side of the mountain. At ordinary stages the left bank is part of the old river bed, about 100 feet wide. At extremely high water the Colorado and Southern road-

bed forms the left bank. The stream is divided into two channels by the central pier of the bridge, the right channel being the deeper and carrying most of the water. The current is rough and rapid beneath the bridge, but becomes more even below. An old abutment foundation directly under the left end of the bridge interferes with the current at high stages.

At the station established May 7, 1905, the channel is straight for about 150 feet above and 75 feet below the cable section and is fairly uniform in width. The right bank is composed of granite bowlders and stands about 12 feet above low water. The left bank is the Colorado and Southern Railway embankment and is lined with a light growth of willows. Each bank has a slope of about 45°, and neither overflows. The bed of the stream is composed primarily of granite bowlders, the interstices being filled in with cobblestones and gravel. Upon this bed a loose deposit of disintegrated granite shifts constantly. During high water this deposit is entirely scoured out, but is immediately replaced with decreased flow. There is but one channel at all stages. The current is swift at high water and moderate at low. During extreme cold weather the channel is entirely covered with ice, but owing to the high gradient and the shifting bed accurate gage heights can not be obtained.

At the original station high-water measurements were made from the lower side of the two-span highway bridge to which the gage was attached, the initial point for soundings being the river face on the right abutment. At a gage height of 2.3 feet or less measurements were made by wading about 250 feet below the bridge.

Discharge measurements at the new station are made by means of a car, cable, and tagged and stay lines. The initial point for soundings is the zero on the tagged wire, about halfway between low water and the top of the right bank. At low water discharge measurements may be made by wading.

The original gage consisted of a vertical timber, reading from zero to 7 feet, fastened to the upper side of the center pier of the highway bridge. This gage was referred to a regulation metal bench-mark tablet in the cliff about 75 feet from the south end of the bridge; elevation, 18.43 feet above zero of gage.

The gage established May 7, 1905, was read twice daily, morning and evening, by Miss E. H. Jardine. It consists of an inclined staff, graduated from 1 foot to 9 feet, and is bolted to a bowlder on the right bank 100 feet above the cable. The bench mark is a standard United States Geological Survey tablet cemented into the top of a granite shelf near the south end of the cable and just above the gage rod; elevation, 17.63 feet above the zero of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey.

Description: 84, pp 89–90; 99, pp 203–204; 131, pp 70–71.
Discharge: 84, p 90; 99, pp 204, 207; 131, p 72.
Discharge, monthly: 84, p 92; 99, p 206; 131, p 73.
Gage heights: 84, p 91; 99, pp 204–205; 131, p 72.
Rating tables: 84, p 91; 99, pp 205–206; 131, p 73.

Discharge measurements of South Platte River at South Platte, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 6[a]	R. I. Meeker				1.42	203
May 12	M. C. Hinderlider	78	271	4.42	3.75	1,197
May 24	M. P. Beeson	83	342	4.92	4.35	1,683
May 30	Hinderlider and Hoyt	82	296	4.22	4.02	1,249
June 9	M. P. Beeson	83	360	5.39	4.90	1,940
June 20	do	78	220	3.77	3.20	830
June 27	do	77	176	2.90	2.50	510
July 17	do	75	119	2.25	1.90	258
July 24	do	75	123	2.13	1.90	262
July 30	do	75	139	2.48	2.20	345
September 5	R. I. Meeker	76	103	2.78	2.18	286
September 5	do	75	121	3.02	2.40	365
September 6	M. P. Beeson	75	132	2.82	2.38	373
September 7	R. I. Meeker	75	119	2.87	2.32	342
September 12	do	75	100	2.69	2.10	269
September 13	do	75	98	2.74	2.10	269
October 20	do	74	73	2.16	1.67	158

[a] This is the sum of the measurements on two forks. The gage height is doubtful. The old gage recorded 1.62 feet.

Daily gage height, in feet, of South Platte River at South Platte, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	4.35	4.3	2.4	2.3	2.2	1.7	1.7
2	.....	4.35	4.15	2.35	2.5	2.2	1.7	1.78
3	.....	4.1	4.35	2.35	2.38	2.2	1.7	1.78
4	.....	4.0	4.5	2.2	2.32	2.2	1.7	1.8
5	.....	3.95	4.75	2.1	2.25	2.3	1.7	1.8
6	1.65	3.75	4.55	2.1	2.3	2.4	1.7	1.78
7	1.98	3.65	4.75	2.1	2.3	2.32	1.7	1.9
8	2.18	3.5	5.05	2.15	2.2	2.3	1.7	1.8
9	2.35	3.45	4.95	2.2	2.2	2.3	1.6	1.8
10	2.55	3.7	4.9	2.2	2.1	2.25	1.6	1.75
11	2.35	3.7	4.85	2.1	2.1	2.2	1.7	1.7
12	2.3	3.7	4.5	2.1	2.3	2.12	1.7	1.75
13	2.35	3.8	4.6	2.1	2.38	2.1	1.7	1.75
14	2.32	3.75	4.5	2.1	2.35	2.1	1.7	1.82
15	2.45	3.65	4.2	2.1	2.25	2.02	1.72	1.8
16	2.32	3.7	3.95	2.05	2.15	2.0	1.75	1.8
17	2.35	3.8	3.8	1.92	2.08	2.0	1.82	1.8
18	2.5	3.85	3.6	1.8	1.95	2.0	1.8	1.8
19	2.65	3.9	3.38	1.8	1.9	2.0	1.8	1.6
20	2.45	4.1	3.2	1.9	1.9	2.0	1.7	1.6
21	2.3	4.1	3.05	2.0	1.8	2.0	1.7	1.75
22	2.45	4.05	2.95	2.0	1.8	1.9	1.78	1.65
23	2.55	4.2	2.9	2.0	1.8	1.9	1.8	1.65
24	2.62	4.35	2.85	2.3	1.95	1.8	1.75	1.6
25	2.55	4.4	2.7	2.15	2.0	1.7	1.7	1.6
26	2.85	4.4	2.6	2.0	2.0	1.7	1.7	1.6
27	3.15	4.45	2.55	2.1	2.1	1.7	1.7	1.6
28	3.65	4.3	2.4	2.15	2.1	1.7	1.7	1.6
29	3.9	4.0	2.4	2.2	2.1	1.7	1.8	.....
30	4.05	3.95	2.4	2.2	2.3	1.7	1.8	.....
31	.....	4.0	.....	2.2	2.2	.....	1.75	.....

Station rating table for South Platte River at South Platte, Colo., from April 6 to July 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.60	185	2.50	495	3.40	950	4.30	1,550
1.70	210	2.60	540	3.50	1,010	4.40	1,625
1.80	240	2.70	585	3.60	1,075	4.50	1,700
1.90	270	2.80	630	3.70	1,140	4.60	1,775
2.00	305	2.90	680	3.80	1,205	4.70	1,850
2.10	340	3.00	730	3.90	1,270	4.80	1,930
2.20	375	3.10	780	4.00	1,340	4.90	2,010
2.30	415	3.20	835	4.10	1,410	5.00	2,090
2.40	455	3.30	890	4.20	1,480	5.10	2,170

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during the first part of 1905, and is fairly well defined between gage heights 1.9 feet and 5 feet. Owing to shifting conditions between July 24 and September 5 the rating tables have been applied indirectly.

Station rating table for South Platte River at South Platte, Colo., from August 1 to November 28, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.60	142	1.90	210	2.20	300	2.50	420
1.70	162	2.00	237	2.30	335	2.60	465
1.80	185	2.10	267	2.40	375		

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during the latter part of 1905, and is well defined between gage heights 1.7 feet and 2.4 feet.

Estimated monthly discharge of South Platte River at South Platte, Colo., for 1905.

[Drainage area, 2,612 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
April 6–31	1,375	198	563	27,920	0.216	0.201
May	1,662	980	1,321	81,220	.506	.583
June	2,130	455	1,259	74,920	.482	.538
July	455	240	340	20,900	.130	.150
August	465	190	306	18,820	.117	.135
September	375	162	253	15,060	.097	.108
October	190	142	167	10,270	.064	.074
November 1–28	210	142	169	9,386	.065	.068
The period				258,500		

SOUTH FORK OF SOUTH PLATTE RIVER AT SOUTH PLATTE, COLO.

This station was established May 8, 1905, for the purpose of collecting data in regard to the run-off of the South Fork drainage basin and also to furnish information concerning power and irrigation possibilities on the stream. It is located about 500 feet above the junction of North and South forks of South Platte River, in T. 7 S., R. 20 W., and is about 700 feet above the wagon bridge at which the old station on the South Platte was located.

The channel is straight for about 300 feet above and 150 feet below the station. The right bank is of loam and gravel and slopes up to a narrow strip of bottom land which is covered with cottonwood trees. The left bank is more abrupt and about 7 feet high; it is composed of gravel, but has a scant growth of vegetation. Both banks overflow at extreme high water. The bed of the stream is primarily of cobblestones, which are covered by a shifting deposit of disintegrated granite along the right bank. This deposit is comparatively uniform and even throughout. There is but one channel at all stages. The current is swift at high water and moderate at low water. Gage heights range from 1 foot to 6 feet.

Discharge measurements are made by means of a cable, car, and stay and tagged lines. The initial point for soundings is the zero of the tagged wire, which is located above ordinary high-water line on the right bank. Measurements at low water may be made by wading at the cable station.

The gage, which was read twice daily during 1905 by Miss E. H. Jardine, consists of an inclined timber firmly bolted in place to a cottonwood tree on the left bank. It is graduated from zero to 8.6 feet. The bench mark is a spike driven horizontally 1 foot above the ground into the east side of a 6-inch cottonwood tree to which the cable is fastened on the left bank; elevation above the zero of the gage, 8.19 feet.

Discharge measurements of South Fork of South Platte River at South Platte, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec. ft.*
April 6	R. I. Meeker	42	52	23.3	1.60	121
May 12	M. C. Hinderlider	59	171	4.87	3.48	833
May 23	M. P. Beeson	62	175	46.7	3.50	818
May 24	do	63	183	4.60	3.65	843
May 30	Hoyt and Hinderlider	60	156	4.26	3.20	665
June 9	M. P. Beeson	63	214	4.11	4.30	879
June 20	do	59	111	3.48	2.50	387
June 27	do	56	80	2.36	1.90	189
July 17	do	56	58	1.60	1.50	93
July 24	do	56	65	1.51	1.50	98
July 30	do	55	63	2.44	1.80	154
September 6	do	58	72	2.90	2.20	209
Do	R. I. Meeker	58	73	3.12	2.20	228
September 7	M. P. Beeson	58	79	2.85	2.17	225
Do	R. I. Meeker	58	75	3.03	2.16	227
September 12	do	56	66	2.83	2.00	187
September 13	do	56	65	2.77	1.97	180
September 14	do	55	62	2.68	1.90	166
October 19	do	54	51	2.18	1.60	111

Daily gage height, in feet, of South Fork of South Platte River at South Platte, Colo., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	3.3	1.7	2.0	2.1	1.4	1.5
2	.....	3.3	1.65	2.2	2.2	1.4	1.6
3	.....	3.3	1.65	2.2	2.2	1.4	1.6
4	.....	3.65	1.55	2.18	2.2	1.4	1.6
5	.....	4.0	1.5	2.1	2.1	1.4	1.6
6	.....	4.0	1.5	2.1	2.3	1.4	1.6
7	.....	3.95	1.5	2.0	2.2	1.4	1.6
8	2.6	4.0	1.55	2.0	2.2	1.4	1.6
9	2.95	4.3	1.6	2.0	2.2	1.4	1.6
10	3.4	4.35	1.6	1.95	2.15	1.45	1.6
11	3.5	4.18	1.6	1.9	2.1	1.4	1.6
12	3.45	3.8	1.6	2.05	2.0	1.4	1.6
13	3.5	3.3	1.6	2.2	2.0	1.4	1.6
14	3.5	3.2	1.6	2.2	1.9	1.45	1.6
15	3.4	3.1	1.6	2.08	1.9	1.52	1.6
16	3.4	2.95	1.45	2.0	1.9	1.55	1.6
17	3.45	2.82	1.38	2.0	1.8	1.6	1.6
18	3.4	2.7	1.35	1.8	1.8	1.6	1.6
19	3.55	2.65	1.35	1.8	1.8	1.6	1.5
20	3.6	2.6	1.42	1.7	1.8	1.6	1.5
21	3.5	2.4	1.5	1.6	1.8	1.6	1.5
22	3.5	2.3	1.48	1.6	1.8	1.6	1.5
23	3.55	2.3	1.5	1.6	1.7	1.55	1.5
24	3.65	2.25	1.8	1.65	1.62	1.5	1.5
25	3.65	2.0	1.75	1.65	1.5	1.5	1.5
26	3.55	2.0	1.6	1.7	1.5	1.5	1.5
27	3.55	1.9	1.75	1.8	1.5	1.5	1.5
28	3.45	1.7	1.85	1.8	1.5	1.5	1.5
29	3.3	1.7	1.9	1.8	1.5	1.6	.....
30	3.2	1.7	1.9	2.0	1.5	1.6	.....
31	3.15	.....	1.9	2.05	.....	1.55	.....

Station rating table for South Fork of South Platte River at South Platte, Colo., from May 8 to November 28, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec. ft.*	*Feet.*	*Sec. ft.*	*Feet.*	*Sec. ft.*	*Feet.*	*Sec. ft.*
1.30	70	2.10	215	2.90	505	3.70	980
1.40	80	2.20	240	3.00	560	3.80	1,045
1.50	95	2.30	270	3.10	615	3.90	1,110
1.60	110	2.40	300	3.20	670	4.00	1,175
1.70	125	2.50	335	3.30	730	4.10	1,240
1.80	145	2.60	370	3.40	790	4.20	1,310
1.90	165	2.70	410	3.50	850	4.30	1,380
2.00	190	2.80	455	3.60	915	4.40	1,450

The above table is applicable only for open-channel conditions. It is based on fifteen discharge measurements made during 1905, and is fairly well defined between gage heights 1.5 feet and 3.5 feet. The table has been extended beyond these limits.

Estimated monthly discharge of South Fork of South Platte River at South Platte, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
May 8–31	948	370	798	37,990
June	1,415	125	638	37,960
July	165	75	112	6,887
August	240	110	176	10,820
September	270	95	171	10,180
October	110	80	93.4	5,743
November 1–28	110	95	104	5,776
The period				115,400

SOUTH PLATTE RIVER AT DENVER, COLO.

In the spring of 1895 a river station was established at the Twenty-third Street Viaduct in the city of Denver, but observations were discontinued June 18 of the same year, as the location was found to be unfavorable for accurate measurements and the water had fallen below the gage. In July, 1895, a station was established at the Fifteenth Street Bridge. The present station is located at a point immediately below the mouth of Cherry Creek, which enters between the Fourteenth and Fifteenth street bridges.

The station is important principally from the fact that it is used as a training station for the instruction of young hydrographers in the field use of current meters.

The channel is straight at low water for 100 feet above and 500 feet below the gage rod and at high water for several blocks each way from the Fifteenth Street Bridge. The average section of the bridge is 200 feet in width, confined by slag levees which overflow only in extreme floods. There is but one channel at all stages. The current is sluggish at low water and swift at high water. Gage heights range from 0.5 foot to 6 feet.

Discharge measurements are made at low water by wading at a point above or below the gage; high-water measurements are made from the 200-foot single-span steel bridge at Fifteenth street, the initial point for sounding being the edge of the right abutment of the bridge.

During 1905 the gage was read twice each day by Clarence Crisman. The original gage consisted of inclined timbers fastened to posts driven into the bank. In August, 1898, another inclined gage rod, reading the same as the one on the right bank, was placed on the left side. This gage rod was washed out by the high water of June, 1900, which also removed the sand bar in front of the rod on the right hand side, making it available at low-water stages, and since that time readings have been taken from the latter rod or from rods which replaced it and were located at the same point. May 15, 1901, a T rail was placed on the site of the right-bank rod, which had been stolen. This rail was embedded in an inclined position in the slag bank. All readings were taken from this rail from May 15, 1901, to June 9, 1903, when it was stolen. June 10, 1903, a vertical timber was placed at the same point and fastened to a cottonwood tree, the zero of the rod being set at the same elevation as the zero of the old gage. The gage is located on the right bank about 60 feet above the Sixteenth Street Viaduct; the rod is graduated from zero to 7 feet. The original bench mark is a cross on top of the east abutment of the Fifteenth Street Bridge, on the north corner, 107 feet southwest of the gage; it is marked "B. M.," and its elevation is 6.15 feet above the 9-foot mark on the original Fifteenth street gage rod, which has since been destroyed. The bench mark for the present gage is a cross cut in the capstone of the south end of the south abutment of the right masonry pier of the Sixteenth Street Viaduct; elevation, 11.90 feet above the zero of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull.=Bulletin; WS=Water-Supply Paper.

Description: Ann 18, iv, pp 162–163; Bull 140, pp 104–105; WS 15, p 88; 27, p 77; 37, p 225; 49, p 281; 66, p 30; 84, pp 86–87; 99, pp 199–200; 131, pp 74–75.

Discharge: Ann 13, iii, p 85; 18, iv, p 163; Bull 140, p 105; WS 15, p 88; 27, p 86; 37, p 225; 49, p 281; 66, p 30; 84, p 87; 99, p 201; 131, p 75.

Discharge, daily: WS 131, p 76.

Discharge, monthly: Ann 18, iv, p 165; 19, iv, p 314; 20, iv, pp 263, 279; 21, iv, p 202; 22, iv, p 319; Bull 140, p 106; WS 75, pp 127, 136; 84, p 88; 99, p 203; 131, p 77.

Discharge, yearly: Ann 20, iv, p 54.

Gage heights: Bull 140, p 105; WS 11, p 53; 15, p 88; 27, p 84; 37, p 226; 49, p 282; 66, p 30; 84, p 88; 99, pp 201–202.

Hydrographs: Ann 13, iii, p 85; 18, iv, p 166; 19, iv, p 314; 20, iv, p 280; 21, iv, p 202; 22, iv, p 319.

Rainfall and run-off relation: Ann 20, iv, p 266; WS 75, p 137.

Rating tables: Ann 18, iv, pp 164–165; 19, iv, p 313; Bull 140, p 105; WS 27, p 89; 39, p 448; 52, p 517; 66, p 171; 84, p 88; 99, p 202.

Discharge measurements of South Platte River at Denver, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
February 25	M. P. Beeson	60	91	2.91	1.75	265
March 4[a]	do	64	81	2.0	1.40	162
March 11	do	50	61	1.36	1.00	83
Do	do	50	61	1.34	1.00	82
March 25	do	55	90	2.39	1.41	215
April 4	do	89	155	3.09	2.11	479
April 8	do	92	155	3.67	2.30	569
April 8[a]	do				2.30	555
April 15	do	90	154	3.56	2.20	549
April 22	do	90	186	3.56	2.45	662
April 25	do	184	322	4.15	3.10	1,335
April 27	do	185	404	4.53	3.42	1,840
May 5	do	166	389	4.49	3.20	1,747
June 10	do	175	441	3.93	3.00	1,732
June 29	do	162	188	2.40	1.86	451
July 12	do	140	121	2.08	1.45	252
July 29[a]	do	105	132	2.28	1.50	301
September 16	do	129	105	1.71	1.25	180
November 4	W. A. Lamb	92	59	2.15	1.00	127
November 14[a]	do	62	58	1.69	.90	98
November 25[a]	do	68	49	1.88	.84	92
December 8	do	94	82	1.85	1.29	152

[a] Made at different section.

Daily gage height, in feet, of South Platte River at Denver, Colo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.9	0.88	1.55	1.75	3.5	3.0	1.8	1.85	1.18	0.8	0.95	0.75
2	.88	.78	1.48	2.05	3.48	3.0	1.8	1.82	1.25	.75	.95	.7
3	.9	.72	1.5	2.15	3.52	3.02	1.72	1.75	1.25	.75	.9	.7
4	.9	.7	1.4	1.95	3.5	3.2	1.65	1.7	1.35	.78	.9	.7
5	.9	1.0	1.35	1.95	3.4	3.4	1.58	1.6	1.42	.8	.9	.75
6	.9	1.0	1.35	2.05	3.25	3.25	1.42	1.6	1.55	.75	.9	.8
7	.9	.9	1.45	2.22	3.12	3.08	1.5	1.5	1.4	.8	.9	.8
8	.88	.9	1.4	2.35	3.12	3.02	1.7	1.45	1.3	.8	.95	1.1
9	.8	.82	1.15	2.52	3.18	3.02	1.68	1.35	1.35	.8	.98	1.25
10	.75	.78	1.0	2.7	3.5	3.05	1.6	1.38	1.35	.75	.9	1.0
11	.72	.72	1.0	2.85	3.42	3.0	1.5	1.58	1.32	.75	.9	.9
12	.65	.7	1.0	2.45	3.4	3.0	1.42	1.55	1.45	.78	.9	.88
13	.6	.7	.95	2.25	3.42	2.6	1.45	1.55	1.3	.88	.95	.85
14	.6	.75	.95	2.2	3.38	1.95	1.25	1.5	1.15	.92	1.0	.82
15	.6	.8	1.05	2.3	3.3	1.82	1.22	1.5	1.12	1.05	.92	.8
16	.7	.8	1.18	2.25	3.3	1.8	1.28	1.4	1.1	1.15	.9	.8
17	.98	.85	1.25	2.25	3.3	1.82	1.05	1.25	1.15	1.22	.9	.8
18	1.55	.9	1.35	2.25	3.35	1.82	.98	1.2	1.15	1.25	.9	.8
19	1.2	1.02	1.45	2.3	3.35	1.6	1.12	1.15	1.05	1.28	.9	.8
20	1.0	1.22	1.9	2.28	3.42	1.6	1.15	.98	1.02	1.2	.9	.8
21	1.0	1.45	1.75	2.32	3.5	1.5	1.28	1.02	1.0	1.1	.9	.8
22	1.0	1.75	1.7	2.35	3.5	1.5	1.4	1.0	1.08	.75	.85	.8
23	1.12	1.88	1.55	2.6	3.48	2.0	1.55	.95	1.0	.9	.82	.8
24	1.18	1.78	1.45	2.8	3.45	2.08	1.52	.92	.92	.9	.82	.82
25	1.12	1.68	1.15	3.08	3.4	2.02	1.42	1.0	1.0	.85	.8	.82
26	1.12	1.65	1.1	3.1	3.38	2.1	1.42	1.02	1.02	.82	.8	.78
27	1.18	1.5	1.25	3.4	3.45	2.05	1.48	1.05	1.05	.82	.8	.7
28	1.1	1.42	1.45	3.55	3.32	2.0	1.5	1.02	1.02	.9	.8	.7
29	.95	.....	1.5	3.5	3.22	1.8	1.5	1.02	1.02	.8	.8	.68
30	.95	.....	1.35	3.55	3.0	1.8	1.55	1.02	1.12	.9	.8	.7
31	.9	.....	1.35	.....	3.0	.....	1.75	1.08	.....	1.0	.....	.7

Daily discharge, in second-feet, of South Platte River at Denver, Colo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	87	77	196	330	2,014	1,392	410	440	167	92	115	72
2	84	64	175	455	1,982	1,392	410	426	184	84	115	65
3	87	57	169	505	2,046	1,420	378	398	184	84	106	64
4	87	55	159	410	1,014	1,685	350	378	214	88	106	63
5	87	95	149	410	1,854	1,998	322	338	235	92	106	68
6	87	95	149	455	1,745	1,760	260	338	282	84	106	69
7	87	79	169	542	1,434	1,505	290	298	229	92	106	69
8	84	79	159	620	1,434	1,420	370	278	199	92	115	115
9	73	69	110	736	1,520	1,420	362	242	214	92	121	145
10	73	64	85	890	2,014	1,462	330	252	214	84	106	98
11	62	56	82	1,045	1,934	1,434	283	322	199	84	101	81
12	54	54	82	685	1,902	1,434	252	310	238	88	101	78
13	50	54	78	560	1,934	950	263	310	193	88	110	74
14	50	59	78	530	1,870	485	199	290	157	112	119	70
15	50	65	96	590	1,745	422	190	290	151	137	105	68
16	59	65	119	560	1,745	414	208	252	147	157	101	68
17	98	72	139	560	1,745	422	151	205	157	171	101	68
18	226	78	165	560	1,822	422	137	190	157	178	101	68
19	139	96	202	590	1,822	334	165	175	137	187	101	68
20	101	96	366	578	1,934	334	171	141	131	167	101	68
21	98	175	314	602	2,110	302	220	143	127	147	101	68
22	98	270	302	620	2,110	302	260	139	143	84	93	68
23	112	322	249	800	2,078	520	318	129	127	108	88	68
24	131	282	220	990	2,030	566	306	123	137	108	88	70
25	119	246	149	1,324	1,950	530	266	139	127	100	85	70
26	119	235	135	1,350	1,918	578	266	143	105	95	82	65
27	131	190	165	1,790	2,030	548	290	149	92	95	82	56
28	115	169	220	2,030	1,822	520	298	143	88	108	81	56
29	90	.....	235	1,950	1,670	422	298	143	84	92	79	54
30	90	.....	220	2,030	1,350	422	318	143	92	92	78	56
31	82	.....	190	.....	1,350	.....	398	163	.....	127	.....	56

NOTE.—The daily discharge was obtained by the indirect method.

Estimated monthly discharge of South Platte River at Denver, Colo., for 1905.

[Drainage area, 3,840 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	226	50	93.9	5,774	0.024	0.028
February	322	84	118	6,553	.031	.032
March	366	78	172	10,580	.045	.052
April	2,030	330	837	49,800	.218	.243
May	2,110	1,350	1,836	112,900	.478	.551
June	1,998	302	894	53,200	.233	.260
July	410	137	282	17,340	.073	.084
August	440	123	240	14,760	.062	.071
September	282	84	164	9,759	.043	.048
October	187	84	110	6,764	.029	.033
November	121	78	100	5,950	.026	.029
December	145	54	71.8	4,415	.019	.022
The year	2,110	50	410	297,800	.107	1.45

SOUTH PLATTE RIVER NEAR KERSEY, COLO.

This station was established April 7, 1901. It is located at a bridge about 1½ miles north of the railroad station at Kersey, which is on the Union Pacific Railroad about 6 miles east of Greeley, in T. 5 N., R. 64 W., and was intended to take the place of the station previously maintained at Orchard, Colo. The station was discontinued in the fall of 1903, but was reestablished March 5, 1905, to satisfy the demand for hydrographic data pertaining to the storage of flood waters. The station is below all the important tributaries of the South Platte which derive their supply from the mountain region and is at about the point where water could be used to best advantage for storage in reservoirs along the South Platte in northeastern Colorado.

The channel is straight for 300 feet above and 400 feet below the station. The banks are composed of alluvial material, and vary from 5 to 8 feet in height. The right bank is high and is not liable to overflow except at extremely high water. The left bank is low and not well defined, as it extends into high timber and overflows at extreme flood stages. The stream bed is composed of shifting sand and gravel. The channel is entirely covered only at extreme high water. At ordinary stages there are two channels and at low water the stream runs very close to the right bank. Scattered trees and brush dot the portion of the bed to the left of the center of the channel. Pile bents with 20-foot centers interfere at low water by catching drift and also by causing eddy water. The current is fairly swift at high stages and moderate at low. Gage heights range from 2 to 8 feet on the gage.

Discharge measurements are ordinarily made from the downstream side of the bridge, but at low water measurements are occasionally made by wading. The initial point for soundings is the north face of the right abutment of the bridge on the downstream side. The bridge is of piling, and is about 15° askew.

The gage, which was read once each day by E. K. Plumb, consists of a vertical staff graduated from zero to 8 feet, spiked to the downstream side of the third pile of the bridge from the south end. There is no bench mark, but a spike has been driven at each foot mark into the pile, to which the gage is attached.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 66, p 37; 84, p 77; 99, pp 183–184.
Discharge: 66, p 38; 84, p 77; 99 p 184, 207.
Discharge, monthly: 75, pp 130, 136; 84, p 79; 99, p 186.
Gage heights: 66, p 38; 84, p 78; 99, pp 184–185.
Hydrograph: 75, p 132.
Rating tables: 66, p 171; 84, p 78; 99, p 185.

Discharge measurements of South Platte River near Kersey, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 6	M. C. Hinderlider	490	1,580	3.82	6.22	6,032
June 1	Brick and Beeson	529	1.947	3.73	6.80	7,274
July 11	M. P. Beeson	141	172	1.09	2.40	188
October 3	M. C. Hinderlider	131	142	1.18	2.50	168
October 12 [a]	do	125	130	2.02	2.72	262

[a] Made at different section.

Daily gage height, in feet, of South Platte River near Kersey, Colo., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.4	2.5	6.3	6.8	2.6	2.75	2.3	2.5	3.2	2.9
2	2.4	3.0	6.1	6.9	2.55	2.75	2.3	2.5	3.3	2.9
3	2.4	3.6	6.22	6.9	2.5	2.5	2.3	2.5	3.3	2.9
4	2.5	3.4	6.5	6.8	2.45	2.5	2.3	2.5	3.3	2.85
5	2.5	3.4	6.35	6.8	2.4	2.5	2.3	2.5	3.3	2.85
6	2.5	3.4	6.3	6.9	2.4	2.4	2.35	2.5	3.3	2.85
7	2.5	3.4	6.25	7.0	2.4	2.4	2.35	2.5	3.3	2.8
8	2.5	3.2	6.2	7.5	2.4	2.4	2.4	2.5	3.0	2.8
9	2.45	3.3	6.1	7.4	2.35	2.4	2.4	2.5	2.95	2.75
10	2.4	3.3	6.0	7.2	2.35	2.4	2.4	2.6	2.95	2.75
11	2.4	3.7	6.0	7.2	2.35	2.4	2.4	2.65	2.9	2.75
12	2.4	3.9	6.1	6.0	2.35	2.5	2.4	2.7	2.9	2.75
13	2.4	4.0	6.0	5.8	2.3	2.5	2.4	2.8	2.9	2.75
14	2.4	4.0	5.95	5.5	2.3	2.45	2.4	2.9	2.9	2.8
15	2.4	3.9	5.9	5.0	2.3	2.45	2.4	2.9	2.85	2.8
16	2.45	3.9	5.85	5.0	2.3	2.45	2.4	2.9	2.85	2.8
17	2.5	3.8	5.8	5.0	2.35	2.45	2.4	2.9	2.8	2.75
18	2.6	3.8	5.7	4.5	2.35	2.4	2.4	2.9	2.8	2.75
19	2.55	3.9	5.8	4.0	2.35	2.4	2.4	2.9	2.8	2.75
20	2.5	3.9	6.0	3.5	2.35	2.4	2.4	2.9	2.8	2.75
21	2.55	3.9	6.0	3.2	2.35	2.4	2.4	2.95	2.8	2.75
22	2.6	4.0	6.0	3.1	2.35	2.35	2.4	2.95	2.8	2.75
23	3.0	3.8	7.75	3.0	2.35	2.35	2.4	2.95	2.85	2.75
24	3.0	4.25	7.0	3.0	2.35	2.35	2.4	2.95	2.85	2.75
25	2.9	6.0	6.8	2.9	2.3	2.3	2.4	2.95	2.9	2.75
26	2.8	5.95	6.6	2.9	2.3	2.3	2.45	2.95	2.9	2.75
27	2.75	6.1	6.6	2.8	2.3	2.3	2.45	3.0	2.9	2.75
28	2.65	6.25	6.8	2.7	2.3	2.3	2.5	3.0	2.9	2.75
29	2.5	6.5	6.9	2.7	2.3	2.3	2.5	3.0	2.9	2.75
30	2.5	6.4	7.2	2.6	2.3	2.3	2.5	3.1	2.9	2.75
31	2.5	.....	7.25	.....	2.3	2.3	.....	3.1	.....	2.7

NOTE.—Gage heights estimated March 1-4.

Station rating table for South Platte River near Kersey, Colo., from March 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.30	140	3.50	1,200	4.70	3,160	5.90	5,410
2.40	160	3.60	1,340	4.80	3,340	6.00	5,610
2.50	190	3.70	1,490	4.90	3,520	6.20	6,010
2.60	230	3.80	1,640	5.00	3,700	6.40	6,420
2.70	280	3.90	1,790	5.10	3,890	6.60	6,840
2.80	350	4.00	1,950	5.20	4,080	6.80	7,260
2.90	440	4.10	2,120	5.30	4,270	7.00	7,680
3.00	550	4.20	2,290	5.40	4,460	7.20	8,110
3.10	670	4.30	2,460	5.50	4,650	7.40	8,550
3.20	800	4.40	2,630	5.60	4,840	7.60	8,990
3.30	930	4.50	2,800	5.70	5,030	7.80	9,450
3.40	1,060	4.60	2,980	5.80	5,220		

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during 1905 and two during 1903, and is fairly well defined between gage heights 2.5 feet and 7 feet.

Estimated monthly discharge of South Platte River near Kersey, Colo., for 1905.

[Drainage area, 9,470 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March	550	160	227	13,960	0.024	0.028
April	6,630	190	2,348	139,700	.248	.277
May	9,335	5,030	6,301	387,400	.665	.767
June	8,770	230	4,084	243,000	.431	.481
July	230	140	154	9,469	.016	.018
August	315	140	170	10,450	.018	.021
September	190	140	160	9,521	.017	.019
October	670	190	383	23,550	.040	.046
November	930	350	533	31,720	.056	.062
December	440	280	339	20,840	.036	.042
The period				889,600		

SOUTH PLATTE RIVER NEAR JULESBURG, COLO.

This station was established April 2, 1902. It is located at the wagon bridge crossing the South Platte about 1 mile southeast of Julesburg, Colo., a station at the junction of the main line and the Denver branch of the Union Pacific Railroad.

As this is the last station on the South Platte in Colorado, and as it is also below all irrigation ditches taking water from the South Platte in Colorado with the exception of one, it is of considerable importance for obtaining data relative to the flow of return waters as well as to the natural flow of the main channel.

The channel is straight for 600 feet above and 400 feet below the bridge. The banks are composed of alluvial material and are likely to overflow. The bed, which is about half a mile wide, is composed of shifting sands and at ordinary stages the section is broken by islands covered with undergrowth and vegetation. As a result the stream flow is usually divided into a number of small threads, some of which are too small to measure and at low water are generally estimated. The bed of the stream is dry the larger part of the year. The current is swift during high water but moderate at low. Records are usually discontinued during the winter months.

High-water measurements are made from the bridge, which is one-half mile long and is supported on piles at intervals of 20 feet. The initial point for soundings is the north abutment on the left bank. At low water the flow is divided into a number of small channels which are measured by wading.

The gage, which was read during 1905 by Volney Parker, consists of a vertical staff spiked to a pile of the bridge about 1,600 feet from the north end on the downstream side. The bench mark is a spike driven into the south face of the cap timber on the piling to which the gage is spiked; it is directly over the gage, and is inclosed in a circle of white paint and marked "B. M.;" the elevation of the center of the spike above the zero of the gage is 8.00 feet. The gage is read once daily except during high water, when several observations may be made each day.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Description: WS 49, p 283; 84, pp 73-74; 99, p 179; 131, pp 77-78.
Discharge: Ann 20, iv, p 302; Bull 140, p 114; WS 49, p 283; 84, p 74; 99, p 180; 131, pp 78, 87.
Discharge, monthly: WS 84, p 75; 99, p 181; 131, p 80.
Gage heights: WS 84, p 74; 99, p 180; 131, p 79.
Rating tables: WS 84, p 75; 99, p 181; 131, p 79.

Discharge measurements of South Platte River, near Julesburg, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 6	T. W. Jenkins	1,523	2,253	2.50	3.75	5,643
May 10	M. C. Hinderlider	1,378	1,968	2.65	3.50	5,216
May 20	T. W. Jenkins	1,134	1,543	2.68	3.27	4,130
May 25	do	1,371	1,830	2.59	3.48	4,748
May 27	do	1,703	2,744	2.69	3.99	7,405
October 4[a]	M. C. Hinderlider	66	27	1.37	1.05	37

[a] Made by wading.

Daily gage height, in feet, of South Platte River near Julesburg, Colo., for 1905.

Day.	Jan.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.55	2.0	1.95	3.65	4.35	0.75	1.63	1.2	1.65	1.5	1.65
2	2.6	2.0	2.5	3.75	4.35	1.5	1.85	1.15	1.05	1.65	1.65
3	2.6	2.0	1.95	3.85	4.0	1.4	2.05	1.15	1.05	1.85	1.65
4	2.6	2.0	1.9	3.85	3.85	1.2	3.0	1.1	1.05	1.9	1.65
5	2.6	2.0	1.95	3.8	3.8	.7	2.8	1.15	1.05	2.0	1.9
6	2.7	2.15	1.95	3.75	3.85	.6	2.9	1.2	1.05	2.0	1.9
7	2.8	2.05	2.5	3.7	3.9	.55	2.75	1.2	1.05	2.0	1.9
8	2.8	2.1	2.5	3.75	4.0	.5	2.3	1.35	1.05	2.25	1.95
9	2.75	2.15	2.5	3.75	4.5	.5	2.2	1.15	1.05	2.0	2.0
10	2.7	2.0	2.1	3.6	4.0	.45	2.15	1.15	1.05	1.9	2.1
11	.....	2.0	2.15	3.45	4.95	.4	2.5	1.1	1.05	1.9	2.1
12	.....	2.5	2.25	3.35	4.95	.4	2.45	1.1	1.15	1.9	2.1
13	2.65	1.95	2.25	3.45	4.0	2.0	2.35	1.1	1.25	2.0	2.1
14	2.65	2.0	2.25	3.5	3.95	1.9	2.3	1.1	1.2	2.0	2.15
15	2.65	2.5	2.5	3.5	3.55	1.8	2.0	1.1	1.25	1.9	2.2
16	2.65	2.1	2.4	3.45	3.5	1.75	2.1	1.15	1.35	1.8	2.2
17	2.7	2.5	2.5	3.35	3.3	1.9	2.15	1.2	1.25	1.75	2.1
18	2.8	2.5	2.55	3.35	3.1	1.8	2.2	1.15	1.3	1.65	2.15
19	2.95	2.2	2.4	3.4	3.0	1.85	2.25	1.15	1.35	1.7	2.2
20	3.15	2.1	2.75	3.3	3.0	1.75	1.75	1.1	1.32	1.6	2.15
21	3.25	2.0	2.7	3.45	2.85	1.7	1.65	1.1	1.35	1.65	2.25
22	.....	1.9	2.65	3.45	2.4	2.0	1.6	1.1	1.4	1.6	2.2
23	.....	1.95	2.7	3.45	1.0	1.95	1.45	1.1	1.4	1.75	2.2
24	.....	1.95	3.5	3.5	.85	1.9	1.3	1.05	1.35	1.65	2.15
25	.....	1.9	3.2	3.5	.95	1.85	1.2	1.05	1.5	1.65	2.0
26	.....	1.9	3.1	4.0	1.0	1.7	1.15	1.05	1.5	1.65	2.1
27	.....	1.9	3.5	4.0	.95	1.65	1.1	1.05	1.45	1.65	2.1
28	.....	1.9	3.4	4.2	.95	1.6	1.1	1.05	1.5	1.65	2.2
29	.....	1.9	3.6	4.3	.95	1.65	1.1	1.0	1.5	1.65	2.2
30	.....	1.8	3.6	4.3	.9	1.75	1.12	1.15	1.5	1.65	2.2
31	.....	1.95	.....	4.35	.....	1.7	1.12	.....	1.5	.....	2.25

NOTE.—Gage heights estimated March 1–4.

Station rating table for South Platte River near Julesburg, Colo., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.40	9	1.60	175	2.80	2,140	4.00	7,450
0.50	10	1.70	230	2.90	2,490	4.10	7,950
0.60	12	1.80	295	3.00	2,870	4.20	8,460
0.70	15	1.90	375	3.10	3,270	4.30	8,970
0.80	19	2.00	470	3.20	3,690	4.40	9,490
0.90	24	2.10	590	3.30	4,130	4.50	10,010
1.00	30	2.20	730	3.40	4,580	4.60	10,530
1.10	37	2.30	890	3.50	5,040	4.70	11,060
1.20	50	2.40	1,080	3.60	5,510	4.80	11,590
1.30	70	2.50	1,300	3.70	5,980	4.90	12,120
1.40	98	2.60	1,550	3.80	6,460	5.00	12,650
1.50	131	2.70	1,830	3.90	6,950		

The above table is applicable only for open-channel conditions. It is based on ten discharge measurements made during 1904–5, and is fairly well defined between gage heights 1 foot and 4 feet.

Estimated monthly discharge of South Platte River near Julesburg, Colo., for 1905.

[Drainage area, 20,600 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January (19 days)	3,910	1,425	2,018	76,050	0.098	0.069
March	1,300	295	581	35,720	.028	.032
April	5,510	375	1,903	113,200	.092	.103
May	9,230	4,130	5,913	363,600	.287	.331
June	12,380	24	4,804	285,800	.233	.260
July	470	9	199	12,240	.0097	.011
August	2,870	37	695	42,730	.034	.039
September	84	34	41.8	2,487	.0020	.0022
October	131	34	68.8	4,230	.0033	.0038
November	810	131	310	18,450	.015	.017
December	810	202	565	34,740	.027	.031
The period				989,200		

CLEAR CREEK AT FORKSCREEK, COLO.

Clear Creek rises on the eastern slope of the Rocky Mountains, flows eastward, and unites with the South Platte about 6 miles north of Denver. Its drainage basin comprises a narrow strip of exceedingly mountainous country, consisting entirely of granitic rocks, in many places barren of soil, covered with scattered patches of coniferous trees, such as pine, spruce, and fir, remnants of the once extensive forests of the area. The basin includes also a small portion of Great Plains territory. Two of Colorado's oldest mining districts lie wholly within this basin, and in these districts the water of the upper tributaries of Clear Creek is used to such an extent that the name has long since become a misnomer. From Forkscreek to Golden, a distance of 13 miles, the creek flows in a canyon and has a total fall of 1,225 feet, an average of 94 feet per mile. Before the stream leaves the canyon a large volume of water is diverted by the canals that wind sinuously along the steep, rocky canyon sides.

and the entire normal flow of the creek between Golden and Denver is used for the irrigation of lands in Clear Creek Valley.

The gaging station was established May 29, 1899. It is located at the United States Geological Survey bridge, just below the Colorado and Southern Railway bridge at the railroad station, in T. 33 S., R. 72 W.

The station is important because of its location above all diversions and also because of contemplated power development.

The channel is narrow and straight for 30 feet above and 150 feet below the station. The right bank is the side of the mountain; the left is the retaining wall of the Colorado and Southern Railway embankment; both banks are high and can not overflow. The bed of the stream is composed of cobblestones and bowlders, over which a shallow deposit of silt forms during low-water stages, which is scoured out at high water. There is but one channel at all stages. The current is swift at low water and very rapid at high water. The surface of the water is rough and high-water measurements are difficult to obtain. During the winter ice blocks the channel and interferes with gage readings.

Discharge measurements are made from a substantial single-span footbridge, to which the gage is attached. The initial point for soundings is a brass-headed nail in the hand rail at the end of the bridge, and is marked zero with white paint.

The chain gage, which was read twice each day during 1905 by C. W. Hoisington, was originally fastened to the retaining wall on the left bank 30 feet below the footbridge. July 19, 1905, the gage was removed to the footbridge on account of the settling of the crib work to which it was attached. The length of the chain is 19.37 feet. The bench mark is a standard aluminum cap set in the bowlder, to which the downstream stay line of the bridge is anchored on the right bank;, elevation above the zero of the gage, 9.50 feet.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; WS=Water-Supply Paper):

Description: WS 37, pp 228–229; 49, pp 285–286; 66, p 31; 84, p 84; 99, pp 197–198; 131, p 80.
Discharge: WS 37, p 229; 49, p 286; 66, p 31; 84, p 84; 99, p 198; 131, p 81.
Discharge, monthly: Ann 21, iv, p 205; 22, iv, p 322; WS 75, p 128; 84, p 86; 99, p 199; 131, p 82.
Gage heights: WS 37, p 229; 49, p 286; 66, p 32; 84, p 85; 99, p 198; 131, p 81.
Hydrographs: Ann 21, iv, p 205; 22, iv, p 322.
Rating tables: WS 39, p 448; 52, p 517; 66, p 171; 84, p 85; 99, p 199; 131, p 82.

Discharge measurements of Clear Creek at Forkscreek, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 14	T. E. Brick	29	32	4.12	2.23	132
June 2	M. P. Beeson	36	121	8.61	3.85	1,042
June 16	do	36	138	9.00	4.10	1,242
July 19	do	36	83	3.19	2.94	265
July 19	J. C. Stevens	36	85	4.22	2.94	359
July 27	M. P. Beeson	36	83	3.37	2.79	280
October 19	R. I. Meeker	28	28	2.57	1.74	72
October 19	do	28	26	2.23	1.62	58

Daily gage height, in feet, of Clear Creek at Forkscreek, Colo., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.83	2.7	3.96	3.45	2.68	2.23	2.03
2	1.83	2.78	3.99	3.4	2.62	2.23	1.98
3	1.83	2.8	4.14	3.4	2.62	2.23	1.98
4	1.73	2.8	4.39	3.35	2.58	2.2	1.93
5	1.68	2.6	4.59	3.38	2.58	2.16	1.9
6	1.83	2.66	4.49	3.32	2.58	2.16	1.88
7	2.03	2.66	4.49	3.32	2.6	2.13	1.86
8	2.08	2.7	4.56	3.3	2.62	2.13	1.88
9	2.05	2.86	4.59	3.28	2.58	2.13	1.83
10	2.13	2.8	4.52	3.22	2.5	2.1	1.83
11	2.03	2.86	4.36	3.12	2.84	2.08	1.82
12	2.18	2.86	4.39	3.12	2.7	2.08	1.82
13	2.18	2.83	4.32	3.18	2.5	2.08	1.82
14	2.18	2.8	4.24	3.3	2.5	2.06	1.77
15	2.16	2.72	4.22	3.35	2.48	2.03	1.77
16	2.16	2.76	4.22	3.32	2.48	2.03	1.77
17	2.16	2.89	4.15	3.32	2.52	2.03	1.85
18	2.2	3.09	4.08	3.35	2.4	2.03	1.85
19	2.2	3.16	4.05	3.2	2.3	2.03	1.77
20	2.13	3.26	3.95	2.95	2.3	2.0	1.72
21	2.1	3.44	3.95	2.92	2.25	1.98	1.72
22	2.16	3.59	3.88	2.88	2.25	1.98	1.75
23	2.16	3.64	3.82	2.82	2.22	1.98	1.72
24	2.13	3.69	3.78	2.82	2.25	1.98	1.62
25	2.16	3.56	3.78	2.82	2.22	1.98	1.57
26	2.26	3.59	3.65	2.78	2.25	1.98	1.67
27	2.5	3.64	3.55	2.78	2.25	1.98	1.67
28	2.6	3.76	3.52	2.82	2.24	1.98	1.67
29	2.6	3.79	3.5	2.72	2.24	1.98	1.67
30	2.6	3.76	3.45	2.7	2.22	1.98	1.57
31	.....	3.89	.....	2.7	2.21	.....	1.52

Station rating table for Clear Creek at Forkscreek, Colo., from April 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.50	47	2.30	160	3.10	390	3.90	1,010
1.60	55	2.40	180	3.20	440	4.00	1,130
1.70	65	2.50	200	3.30	500	4.10	1,260
1.80	75	2.60	230	3.40	560	4.20	1,400
1.90	90	2.70	260	3.50	630	4.30	1,540
2.00	105	2.80	290	3.60	710	4.40	1,690
2.10	120	2.90	320	3.70	800	4.50	1,850
2.20	140	3.00	350	3.80	900	4.60	2,010

The above table is applicable only for open-channel conditions. It is based on seven discharge measurements made during 1905 and four older measurements. It is fairly well defined between gage heights 1.6 feet and 4 feet.

Estimated monthly discharge of Clear Creek at Forkscreek, Colo., for 1905.

[Drainage area, 345 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
April	230	63	131	7,795	0.380	0.424
May	999	230	472	29,020	1.37	1.58
June	1,994	595	1,291	76,820	3.74	4.17
July	595	260	420	25,820	1.22	1.41
August	302	142	193	11,870	.556	.641
September	146	102	116	6,902	.336	.375
October	110	49	75.3	4,630	.218	.251
The period				162,900		

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements made in South Platte River drainage basin for 1905.

Date.	Stream.	Locality.	Area of section.	Mean velocity.	Discharge.
			Sq. ft.	*Ft. per sec.*	*Sec.-ft.*
March 31	South Platte	North Platte, Nebr.	236	1.62	382
June 14	do	do	2,781	2.74	7,614
July 13	do	do	89	1.92	170
April 8	Cherry Creek	Denver, Colo			46

PLATTE RIVER.

DESCRIPTION OF BASIN.

From the point of junction of North and South Platte rivers the main stream winds eastward across Nebraska, uniting with the Missouri at Plattsmouth, about 10 miles south of Omaha. Its course lies for the most part through a broad, level bottom, rather sandy in places, but for the most part fertile, bordered by bluffs varying in height from 50 to 300 or 400 feet. From its source to a point near Ashland, Saunders County, it is a broad, shallow stream, flowing in many places as a network of interlacing channels among numerous islands and sand bars, but farther east it is confined between heavily wooded limestone bluffs.

The drainage basin lies wholly to the north of a line bordering closely the south bank of the stream and consists generally of rolling prairie land in the middle portion, which to the east and west gives way to extensive areas of sand hills. Along the main stream and its tributaries is a deep flood plain, composed of loam, sand, and gravel in the valleys and of talus on the slopes. Outside of this flood plain the soil is mostly loess, consisting of yellow clays and fine sandy loam. There is little timber except in the immediate vicinity of the small tributaries.

The average annual precipitation is about 23 inches, of which 69 per cent falls during the five months of the growing season, from April to August; about half of the remainder is snowfall. The stream is subject to periodic floods, caused by the melting of snows in the headwater regions of North and South Platte rivers; these floods reach a maximum in June and July and often do considerable damage to property on the lower portions of the stream. In the western part of the drainage area the waters of the river are extensively used for irrigation.

The principal tributaries of the Platte are the Elkhorn and the Loup, both draining long, narrow valleys north of the river.

Information in regard to the basin is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; W. S. Water-Supply Paper):

Description: Ann 12, ii, pp 238–239; 22, iv, p 306; Bull 131, p 28; WS 75, pp 124–125; 84, pp 50–51; 99, pp 137–138; 131, p 201.
Irrigation surveys: Ann 13, iii, pp 73–91.
Rainfall and river stations, map: Ann 20, iv, p 256.
Rainfall and run-off relation: Ann 20, iv, pp 265–266.
Rainfall data: Ann 13, iii, pp 76–77; 20, iv, pp 256–266.

PLATTE RIVER NEAR LEXINGTON, NEBR.

This station was established April 2, 1902. It is located at a highway bridge 3 miles south of Lexington, Nebr., in sec. 20, T. 9 N., R. 21 W.

The channel is straight both above and below the station. The banks are low and not liable to overflow, and the bed is composed of shifting sand. There are no obstructions in the channel other than the bridge piling, and the current is never sluggish, even at low water, when the stream some times flows in as many as forty channels of varying widths and depths. Gage heights have a range of about 3 feet. Records of winter flow are not obtained, as the river, on account of its shallowness, often freezes solid.

Discharge measurements are made from the upstream side of the highway bridge, which consists of 187 spans of 20 feet each, supported on piles. The initial point for soundings is the zero mark on the hand rail at the north (left) bank of the stream. A second, smaller channel, about one-fourth mile to the south, is measured from a similar pile bridge having a total span of 60 feet.

On account of the extreme width of the section (3,720 feet) and the shallowness of the stream, and also to partly eliminate the effect of wind, two gages are maintained at this station, the observer being E. J. Duryee, a mail carrier, who reads both gages as he crosses the bridge, no observations being taken on Sundays or holidays. The gages are of the standard chain type. One of them is located at the north end of the bridge, downstream side, and the other at the south end, upstream side, with their zeros at the same elevation. The wind sometimes creates a difference of over a foot between the two gages, but this difficulty is largely eliminated by using the means of the readings in computations of discharge. The zeros of the gages are referred to three bench marks: (1) The top of the east end of the first cap at the north end of the bridge; elevation, 7.66 feet. (2) The top of the upstream end of the cap of the third bent from the north end of the bridge, marked with a cross; elevation, 9.22 feet. (3) The top of the upstream end of the cap of the third bent from the south end of the bridge, marked with a cross; elevation, 9.03 feet. Bench mark No. 1 is 2,392 feet above sea level.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, pp 59-60; 99, p 155; 131, pp 47–48.
Discharge: 84, p 60; 99, p 155; 131, p 48.
Discharge, monthly: 84, p 61; 99, p 157; 131, p 50.
Gage heights: 84, pp 60–61; 99, p 156; 131, p 49.
Rating tables: 84, p 61; 99, p 156; 131, p 49.

Discharge measurements of Platte River near Lexington, Nebr., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 11	G. W. Bates	3,720	1,421	1.73	3.50	2,473
May 16	do	3,790	5,046	2.77	4.25	13,820
June 12	H. C. Gardner	3,720	8,223	3.14	4.93	25,830
July 10	do	3,800	4,705	2.34	3.93	11,010
July 18	do	2,900	1,681	1.71	3.38	2,882
August 2	do	3,140	1,765	1.63	3.48	2,877
August 23	H. O. Smith					0
September 6	H. C. Gardner	1,480	637	1.55	3.25	990
September 20	F. S. Dobson	1,540	502	1.61	3.10	760

Daily gage height, in feet, of Platte River near Lexington, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1		3.45	4.2	4.9	4.05	3.6	3.15	3.15
2		3.52	4.2	4.9	4.25	3.48	3.2	3.18
3		3.58	4.28	4.9	4.48	3.6	3.2	3.15
4		3.62	4.3	4.85	4.33	3.55	3.2	3.15
5		3.62	4.32	4.8	4.18	3.48	3.35	3.15
6		3.62	4.32	4.65	4.05	3.45	3.25	3.15
7		3.6	4.36	4.55	4.2	3.42	3.22	3.15
8		3.55	4.4	4.5	4.08	3.42	3.2	3.16
9		3.48	4.35	4.5	4.0	3.45	3.2	3.18
10		3.4	4.35	4.75	3.92	3.5	3.16	3.12
11		3.45	4.42	4.82	3.92	3.35	3.12	3.1
12		3.42	4.52	4.9	3.85	3.3	3.12	3.18
13		3.52	4.52	4.8	3.82	3.3	3.15	3.15
14		3.5	4.44	4.72	3.75	3.32	3.12	3.25
15		3.5	4.35	5.0	3.65	3.38	3.12	3.26
16		3.5	4.25	5.15	3.6	3.42	3.28	3.28
17		3.52	4.28	5.05	3.55	3.45	3.33	3.3
18		3.55	4.25	4.95	3.42	3.3	3.38	3.3
19		3.52	4.22	4.82	3.40	3.28	3.32	3.32
20		3.52	4.3	4.78	3.42	3.28	3.28	3.28
21		3.72	4.3	4.68	3.4	3.28	3.28	3.28
22		3.82	4.3	4.58	3.62	3.42	3.3	3.3
23		3.85	4.2	4.75	3.56	3.4	3.3	3.3
24	3.55	3.88	4.15	4.7	3.5	3.28	3.25	3.3
25	3.42	4.05	4.12	4.55	3.42	3.25	3.2	3.3
26	3.45	4.12	4.25	4.42	3.42	3.25	3.2	3.32
27	3.45	4.15	4.3	4.32	3.4	3.22	3.18	3.3
28	3.38	4.15		4.2	3.32	3.18	3.15	3.32
29	3.42	4.12	4.75	4.12	3.38	3.2	3.1	3.35
30	3.50	4.16	4.72	4.1	3.42	3.18	3.12	3.38
31	3.50		4.78		3.45	3.18		3.4

NOTE.—Sunday and holiday gage heights interpolated. These gage heights are the mean of the two gages.

PLATTE RIVER NEAR COLUMBUS, NEBR.

This station was established June 4, 1895. It is located at the Meridian Bridge, about 3 miles south of Columbus, Nebr., in sec. 31, T. 17, R. 1 E. The bridge lies on the sixth principal meridian.

The river at this point flows in three channels, known as the main, middle, and south channels, having widths of 1,940 feet, 320 feet, and 75 feet, respectively, and each channel is spanned by a pile bridge. The main channel is crossed by the Meridian Bridge, which consists of sixty-five 30-foot spans; the middle-channel bridge consists of sixteen 20-foot spans, and is located $1\frac{1}{8}$ miles south of the Meridian Bridge; the south channel is spanned by a pile bridge about 80 feet long, located one-eighth mile south of the middle-channel bridge.

Above the bridges the channels are straight for 5,000 feet in the main channel, 200 feet in the middle channel, and 100 feet in the south channel; below the bridges the channel is straight for 3,000 feet in the main channel, 300 feet in the middle channel, and 500 feet in the south channel. The sections are broad and shallow, with rapid velocity, and shifting, sandy beds. The banks are low but are not subject to overflow. At low stages the river flows in many shallow channels, so that the measurement of discharge is mainly a matter of estimation. A small tributary furnishes a supply of water in the south channel, even when the other channels are entirely dry. The only obstructions are the piling bents. Discharge measurements are made from the upstream side of all three bridges, whose hand rails are marked at intervals of 10 or 20 feet. The initial point for soundings is the zero mark on the upstream hand rail at the north end of the main-channel bridge and at the south ends of the middle and south channel bridges.

A standard chain gage, which is read by W. D. Benson, is fastened to the downstream hand rail of the Meridian Bridge approach. The length of the chain is 16.21 feet. The gage is referred to two bench marks, as follows: (1) A standard United States Geological Survey bench mark, located 60 feet north of the north end of the bridge truss and 10 feet west of a cottonwood tree 6 feet in diameter; elevation, 7.06 feet above the zero of the gage. (2) A bunch of three spikes driven in the top of the second piling from the downstream end of the second bent from the north end of the bridge, counting approach bent "one;" elevation, 9.62 feet above the gage datum. In past years deposits of sand about the gage have caused considerable trouble, and the records have been frequently interrupted.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Description: Ann 18, iv, p 188; Bull 140. pp 121–122; WS 15, p 98; 27, p 78; 37, p 242; 50, p 307; 66, p 39; 84, p 57; 99, pp 152–153; 131, pp 50–51.

Discharge: Ann 18, iv, p 189; 20, iv, p 302; Bull 131, p 92; 140, p 122; WS 15, p 98; 27, p 87; 37, p 242; 50, p 308; 66, p 39; 84, p 58; 99, p 153; 131, p 51.

Discharge, daily: Ann 18, iv, p 190.

Discharge, flood: Ann 18, iv, pp 184–186.

Discharge, monthly: Ann 19, iv, p 334; 20, iv, pp 264, 295; 22, iv, p 329; WS 75, p 138; 84, p 59; 99, p 154; 131, p 53.

Discharge, yearly: Ann 20, iv, p 55.

Gage heights: Bull 140, p 122; WS 15, p 98; 27, p 85; 37, p 243; 50, p 308; 66, p 39; 84, p 58; 99, pp 153–154; 131, p 52.

Hydrographs: Ann 18, iv, p 190; 19, iv, p 334; 20, iv, p 296; WS 75, p 138.

Rainfall and run-off relation: Ann 20, iv, p 266.

Rating tables: Ann 18, iv, p 189; 19, iv, p 333; Bull 120, p 122; WS 39, p 449; 84, p 59; 99, p 154; 131, p 52.

Discharge measurements of Platte River near Columbus, Nebr., in 1905.

Date	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 16	Dobson, Bates, and Gardner	2,310	1,473	2.70	3.08	3,978
April 27	H. C. Gardner	2,330	4,153	3.28	4.45	13,630
May 16	do	2,300	7,384	4.52	5.60	33,410
June 21	do	2,280	7,256	3.79	5.10	27,570
July 8	do	2,285	5,899	3.36	4.45	19,760
July 14	do	2,295	3,336	2.55	3.50	8,514
August 12	do	1,660	1,060	2.31	2.25	2,341
September 27	F. S. Dobson	1,486	880	1.98	2.10	1,739
October 13	do	.....	586	1.52	1.80	891

Daily gage height, in feet, of Platte River near Columbus, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.6	4.8	5.35	4.6	2.75	1.5	1.7
2	.....	2.4	4.6	5.55	4.65	3.2	.75	1.55
3	.....	2.6	4.4	5.5	4.85	3.2	.7	1.5
4	.....	2.7	4.15	5.35	5.3	3.4	.75	1.5
5	.....	2.6	4.75	5.3	4.95	3.2	1.6	1.3
6	.....	3.0	5.6	5.2	5.5	3.25	1.8	1.3
7	.....	3.2	4.5	5.2	4.7	3.15	2.35	1.25
8	.....	3.1	4.4	5.2	4.55	3.0	2.85	1.2
9	.....	3.1	4.5	4.95	4.2	2.8	2.65	1.35
10	.....	2.9	4.3	5.25	4.15	2.5	2.4	1.2
11	.....	2.9	4.6	5.1	4.0	2.35	2.2	1.15
12	.....	2.8	4.55	5.3	3.75	2.25	1.9	1.15
13	.....	2.6	5.3	5.3	3.55	2.25	1.85	1.2
14	.....	2.7	5.75	5.25	3.35	2.2	2.6	1.35
15	.....	2.6	6.2	5.3	3.15	2.2	2.55	1.4
16	.....	2.6	5.45	5.3	3.0	2.25	2.2	1.3
17	3.1	2.8	5.6	5.8	2.85	2.5	2.25	1.35
18	3.6	2.8	5.15	5.35	2.7	2.55	3.5	1.3
19	3.2	2.8	4.6	5.45	2.5	2.6	3.45	1.35
20	3.8	3.4	4.55	5.15	2.3	2.35	3.35	1.4
21	3.7	3.8	4.35	5.15	2.3	2.35	3.25	1.5
22	3.6	4.0	4.35	4.95	2.2	2.25	3.15	1.6
23	3.7	4.2	4.25	6.35	2.25	2.3	3.0	1.65
24	3.5	4.4	4.2	5.4	2.1	1.95	2.95	1.85
25	3.3	4.6	4.1	5.25	2.1	1.9	2.45	2.0
26	3.1	4.8	4.25	5.25	2.85	2.1	2.2	1.9
27	3.0	5.0	4.15	5.3	3.15	2.2	2.05	1.9
28	2.8	5.3	4.45	5.0	2.85	1.75	1.9	2.0
29	2.7	5.15	5.1	4.95	2.7	1.55	1.75	2.5
30	2.6	5.1	5.25	4.85	2.65	1.35	1.7	2.5
31	2.6	.....	5.5	.....	2.6	1.15	.....	2.5

NOTE.—Gage heights estimated April 22–27.

Station rating table for Platte River near Columbus, Nebr., from March 17 to May 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.40	1,750	3.40	5,530	4.40	13,170	5.40	29,400
2.50	2,000	3.50	6,100	4.50	14,260	5.50	31,450
2.60	2,280	3.60	6,720	4.60	15,500	5.60	33,550
2.70	2,580	3.70	7,380	4.70	16,900	5.70	35,700
2.80	2,910	3.80	8,080	4.80	18,450	5.80	37,900
2.90	3,270	3.90	8,820	4.90	20,100	5.90	40,150
3.00	3,650	4.00	9,600	5.00	21,800	6.00	42,450
3.10	4,060	4.10	10,420	5.10	23,600	6.10	44,800
3.20	4,510	4.20	11,280	5.20	25,450	6.20	47,200
3.30	5,000	4.30	12,190	5.30	27,400		

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during 1905. Owing to the shifting character of the stream bed, estimates based on the above table and on that following can only be considered rough approximations.

Station rating table for Platte River near Columbus, Nebr., from June 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.40	80	2.40	2,780	3.40	8,040	4.80	23,300
1.50	260	2.50	3,180	3.50	8,780	5.00	26,350
1.60	460	2.60	3,600	3.60	9,570	5.20	29,600
1.70	670	2.70	4,040	3.70	10,420	5.40	32,950
1.80	900	2.80	4,500	3.80	11,330	5.60	36,500
1.90	1,150	2.90	4,990	3.90	12,280	5.80	40 150
2.00	1,430	3.00	5,520	4.00	13,280	6.00	44,000
2.10	1,730	3.10	6,090	4.20	15,450	6.20	48,000
2.20	2,050	3.20	6,700	4.40	17,830	6.40	52,150
2.30	2,400	3.30	7,350	4.60	20,450		

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1905, and is fairly well defined between gage heights 1.8 feet and 5 feet. See note to preceding table.

Estimated monthly discharge of Platte River near Columbus, Nebr., for 1905.

[Drainage area, 56,870 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 17-31	8,080	2,280	4,914	146,200	0.086	0.048
April	27,400	1,758	7,800	464,100	.137	.153
May	47,200	10,420	19,360	1,190,000	.340	.392
June	51,100	24,050	31,180	1,855,000	.548	.611
July	34,700	1,730	10,770	662,200	.189	.218
August	8,040	0	3,217	197,800	.057	.066
September	8,780	0	2,978	177,200	.052	.058
October	3,180	0	604	37,140	.011	.013
The period				4,730,000		

LOUP RIVER AT COLUMBUS, NEBR.

The Loup and its branches, which form the most important tributaries of the Platte, drain an area 13,540 square miles in extent, lying in the heart of Nebraska. The Loup proper is formed by the junction of North and Middle Loup rivers, which unite near the city of St. Paul, the Middle Loup in turn receiving the South Loup in the southwestern part of Howard County. The principal tributaries are Beaver, Cedar, Calamus, and Dismal creeks.

The country drained is generally rolling, with an occasional high plain or table-land. The headwaters of the North and Middle Loup lie in a region of sand hills, among which are found numerous lakes varying in size from small ponds up to those with an area of several square miles. The immediate valleys of the streams are composed of alluvial deposits of sand, gravel, and loam, with areas of yellow clay and fine sandy loam beyond. The region abounds in springs, caused by the percolation of the precipitation through the sandy soil to the impervious clays below, and this fact no doubt accounts for the remarkable constancy of flow of the streams. The soil is generally fertile, and large quantities of hay, grain, etc., are grown. The streams are subject to a succession of floods during the spring and early summer, the result of melting snows and heavy rainfall in the spring months. As a large part of the area is grass grown, evaporation is considerable, averaging 5 feet.

A comparatively small amount of water is diverted for irrigation, the ditches generally being small and covering limited areas. A number of power plants are in operation, and others of considerable extent have been proposed, particularly one near Columbus, by which it is believed that about 20,000 continuous horse-power may be developed.

The gaging station was established October 13, 1894. It is located about 75 yards above the Union Pacific Railroad bridge and 6 miles above the mouth of the river, in sec. 23, T.17 N., R. 1 W.

At the measuring section the river is straight for about 1.000 feet above and a considerable distance below. The left bank is high; the right is low and overflows at high water. The bed is composed entirely of shifting sand. There is but one channel at all stages, and the current is rapid. The channel is unobstructed. At the lower gaging station the river flows chiefly in a deep channel near the right bank, obstructed by the piling of an old bridge a short distance below the existing highway bridge. Gage heights range from 3 to 12 feet, excessive floods being very rare and usually caused by ice gorges.

Discharge measurements are made by means of a cable and car. The initial point for soundings is the zero-mark on the cable. In the spring of 1905 the cable at this station, which consisted of a five-eighths inch steel wire, was broken by the ice. Later in the season it was replaced by a new three-fourths inch steel cable. During the time that the cable was out measurements were made from the highway bridge or from the Union Pacific Railroad bridge near the station.

Two gages are maintained at this station—one a vertical staff spiked to piling at the cable, the other a standard chain gage at the highway bridge 1½ miles below. The gage heights here reported are those of the gage at the highway bridge, the observer being W. D. Benson. The length of the chain is 24.50 feet. These gages are referred to two bench marks as follows: (1) A standard United States Geological Survey bench mark, located 72 feet east of the upper gage; elevation 21.83 feet above the zero of the lower gage and 13.27 feet above the zero of the upper gage. (2) A cross cut on the west end of the cap of the first bent at the north end of the highway-bridge approach; elevation 10.91 feet above the zero of the lower gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Papers):

Description: Ann 18, iv, p 182; Bull 131, p 32; 140, p 118; WS 15, p 97; 27, p 78; 37 pp 240–241; 50, pp 306–307; 66, p. 38; 84, p 55; 99, p 145; 131, pp 82–83.

Discharge: Ann 18, iv, p 182; Bull 131, p 91; 140, p 118; WS 15, p 97; 27, p 87; 35, p 16; 37, p 241; 50, p 307; 66, p 38; 84, p 56; 99, p 146; 131, p 84.

Discharge, daily: Ann 18, iv, pp 183–184; 131, p 85.
Discharge, flood: Ann 18, iv, pp 184–186.
Discharge, monthly: Ann 18, iv, p 187; 19, iv, p 332; 20, iv, pp 263, 294; 22, iv, p 328; Bull 140, p 120; WS 75; p 137; 84, p 57; 99, p 147; 131, p 86.
Discharge, yearly: Ann 20, iv, p 55.
Gage heights: Bull 140, p 119; WS 15, p 97; 27, p 85; 37, p 241; 50, p 307; 66, p 39; 84, p 56; 99, p 146; 131 p 84.
Hydrographs: Ann 18, iv, p 184; 19, iv, p 333; 20, iv, p 295; 22, iv, p 328.
Rainfall and run-off relation: Ann 20, iv, p 266.
Rating tables: Ann 18, iv, p 183; 19, iv, pp 331–332; Bull 140, p 119; WS 39, p 449; 84, p 57; 99, p 147.

Discharge measurements of Loup River at Columbus, Nebr., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 17	H. C. Gardner	820	1,046	4.45	4.40	4,659
May 4	do	295	870	5.72	4.55	4,982
May 16	do	740	2,162	5.96	5.90	12,890
June 21	do	660	1,695	3.13	4.65	5,316
July 8	do	800	2,040	4.54	5.30	9,263
July 14	do	540	1,144	3.60	4.80	4,126
August 12	do	800	1,945	2.62	4.20	5,089
September 27	F. S. Dobson	180	774	4.07	[a]4.03	3,153
October 13	do	330	965	4.26	4.18	4,113

[a] New rod; old rod read 4.30 feet.

Daily gage height, in feet, of Loup River at Columbus, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	4.3	4.6	5.2	6.85	4.8	4.4	4.25	4.2	.....
2	.....	4.4	4.55	5.0	6.25	6.8	4.35	4.4	4.15	.....
3	.....	4.5	4.7	5.5	6.7	5.9	4.3	4.35	4.1	.....
4	.....	4.9	4.6	5.0	6.55	5.0	4.3	4.3	4.1	.....
5	.....	4.6	4.75	4.7	5.85	4.75	4.5	4.2	4.25	.....
6	.....	4.4	4.85	4.65	5.7	4.4	4.6	4.2	4.5	.....
7	.....	4.2	4.8	4.35	5.8	4.45	4.85	4.2	4.35	.....
8	.....	4.1	4.7	4.25	5.4	4.5	4.85	4.2	4.3	4.5
9	.....	4.2	4.75	4.45	5.22	4.4	4.55	4.3	4.3	5.7
10	.....	4.3	5.6	4.35	5.0	4.35	4.5	4.3	4.35	5.7
11	.....	4.3	5.0	4.6	4.95	4.35	4.45	4.3	4.35	5.75
12	.....	4.2	4.9	4.6	4.9	4.3	4.4	4.3	4.4	5.7
13	.....	4.2	5.8	4.55	4.75	4.3	4.45	4.35	4.4	5.8
14	.....	4.3	6.35	4.45	4.5	4.25	4.95	4.4	4.45	6.5
15	.....	4.4	6.9	4.5	5.0	4.3	5.5	4.4	4.35	6.0
16	.....	4.3	5.8	4.6	4.95	4.55	5.1	4.6	4.35	5.95
17	4.4	4.3	5.4	4.7	4.85	4.45	4.95	4.5	4.35	5.85
18	4.6	4.3	5.0	4.6	4.8	4.6	5.25	4.45	4.45	.....
19	4.7	4.2	4.95	4.6	4.8	5.5	6.25	4.55	4.4	.....
20	4.9	5.6	4.9	4.7	4.8	4.5	5.3	4.45	4.4	.....
21	4.7	5.2	4.9	4.85	4.85	4.5	4.85	4.3	4.35	.....
22	4.7	5.15	4.8	5.0	4.85	4.85	4.65	4.4	4.3	.....
23	4.6	5.1	4.75	6.4	4.95	4.55	4.4	4.35	4.65	.....
24	4.4	5.05	4.65	6.5	5.15	4.6	4.3	4.2	4.55	.....
25	4.5	5.0	4.6	5.65	4.95	4.7	4.45	4.2	4.65	.....
26	4.5	4.95	4.9	5.2	7.95	4.55	4.1	4.2	4.5	.....
27	4.6	4.95	4.95	4.95	6.4	4.55	4.3	4.2	4.6	.....
28	4.4	4.95	5.1	6.9	5.4	4.4	4.25	4.25	4.5	.....
29	4.3	4.9	6.95	7.0	5.2	4.4	4.25	4.35	3.95	.....
30	4.2	4.7	6.1	6.05	4.95	4.4	4.25	4.25	5.45	.....
31	4.3	.....	5.75	.....	4.5	4.4	.....	4.25	.....	.....

NOTE.—Gage height estimated April 22–27, inclusive. River frozen November 30 to December 7, inclusive.

Daily discharge, in second-feet, of Loup River at Columbus, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	3,950	5,400	8,700	19,020	6,700	5,000	3,180	3,670
2	.....	4,400	5,150	7,500	15,120	19,190	4,700	3,910	3,450
3	.....	4,900	5,900	10,500	18,050	13,600	4,420	3,750	3,210
4	.....	6,950	5,400	7,500	17,080	8,270	4,380	3,580	3,210
5	.....	5,400	6,150	5,900	12,600	7,000	5,300	3,200	3,900
6	.....	4,400	6,675	5,650	11,700	5,300	5,770	3,250	5,100
7	.....	3,500	6,400	4,175	12,300	5,700	7,000	3,300	4,380
8	.....	3,050	5,900	3,725	9,900	6,110	6,960	3,350	4,110
9	.....	3,500	6,150	4,650	8,370	5,720	5,300	3,880	4,110
10	.....	3,950	11,100	4,175	6,750	5,600	5,010	3,940	4,380
11	.....	3,950	7,500	5,400	6,050	5,750	4,700	4,000	4,380
12	.....	3,500	6,950	5,400	5,400	5,600	4,410	4,070	4,600
13	.....	3,500	12,300	5,150	4,270	5,550	4,600	4,350	4,600
14	.....	3,950	15,780	4,650	2,900	5,250	7,110	4,600	4,850
15	.....	4,400	19,350	4,900	5,220	5,450	10,250	4,600	4,380
16	.....	3,950	12,300	5,400	5,100	6,700	8,400	5,600	4,380
17	4,400	3,950	9,900	5,900	4,730	6,110	6,950	5,100	4,380
18	5,400	3,950	7,500	5,400	4,650	6,850	8,580	4,850	4,850
19	5,900	3,500	7,225	5,400	4,800	12,100	14,600	5,330	4,600
20	6,950	11,100	6,950	5,900	4,920	6,200	8,710	4,850	4,600
21	5,900	8,700	6,950	6,675	5,310	6,150	6,130	4,110	4,380
22	5,900	8,400	6,400	7,500	5,460	8,000	5,050	4,600	4,110
23	5,400	8,100	6,150	16,100	6,130	6,300	3,810	4,380	5,850
24	4,400	7,800	5,650	16,750	7,400	6,500	3,310	3,670	5,350
25	4,900	7,500	5,400	11,400	6,430	7,000	3,950	3,670	5,850
26	4,900	7,225	6,950	8,700	25,800	6,110	2,400	3,670	5,100
27	5,400	7,225	7,225	7,225	15,450	6,050	3,150	3,670	5,600
28	4,400	7,225	8,100	19,350	9,450	5,230	3,000	3,900	5,100
29	3,950	6,950	19,680	20,000	8,430	5,170	3,050	4,380	2,600
30	3,500	5,900	14,150	13,820	7,320	5,100	3,120	3,900	2,600
31	3,950	.....	12,000	.....	4,970	5,050	.....	3,900	.....

NOTE.—The daily discharge was obtained from a rating table March 17 to July 10; and by the indirect method for the remainder of the year.

Estimated monthly discharge of Loup River at Columbus, Nebr., for 1905.

[Drainage area, 13,540 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 17-31	6,950	3,500	5,017	149,300	0.371	0.207
April	11,100	3,050	5,492	326,800	.406	.453
May	19,680	5,150	8,665	532,800	.640	.738
June	20,000	3,725	8,117	483,000	.599	.668
July	25,800	2,900	9,067	557,500	.670	.772
August	19,190	5,050	6,949	427,300	.513	.591
September	14,600	2,400	5,637	335,400	.416	.464
October	5,600	3,180	4,082	251,000	.301	.347
November	5,850	2,600	4,389	261,200	.324	.362
The period	.....	.....	.....	3,324,000	.....	.....

NOTE.—No estimate for ice period.

KANSAS RIVER DRAINAGE BASIN.

GENERAL FEATURES.

The drainage basin of Kansas river lies between the basins of the Platte and the Arkansas, entirely within the region of the Great Plains and extends through the arid, semiarid, and humid regions. It extends from Eastern Colorado to Missouri river, a distance of 485 miles.

The country presents throughout the same general appearance so far as contour of surface is concerned. It is a rolling prairie, through which the streams meander in winding courses in broad, fertile bottoms flanked on either side by bluffs. In the eastern part of Kansas the rivers are fringed with groves of timber; but to the west this becomes more and more scant, practically disappearing at the ninety-ninth meridian.

The principal tributaries are Smoky Hill and Republican rivers, whose union forms the main stream, and Blue River.

REPUBLICAN RIVER.

DESCRIPTION OF BASIN.

Republican River rises in the arid plains of Eastern Colorado, flows northeastward into southwestern Nebraska, then eastward through the southern tier of counties to Superior, where it turns to the southeast, enters Kansas, and about 2 miles northeast of Junction unites with Smoky Hill River to form Kansas River. The length of the basin east and west is approximately 360 miles, its greatest width is 120 miles, and the total area drained is 25,840 square miles. The river is wide and rather shallow, with a rapid descent, and the bed is largely shifting quicksand of the most unstable character.

In the upper portion of its course the Republican receives many tributaries, chiefly from the south. Nearly all of these flow through a region where the rainfall is less than 22 inches; but as this part of the basin is covered with buffalo grass, which sheds rain like a roof, the per cent of rainfall reaching the streams is great. Near the mouth the drainage area is very narrow, and the tributaries are small and unimportant; but here the rainfall is 28 to 38 inches. Many small springs occur along the main stream and its branches and the ground water lies generally at medium depth. There are no lakes or marshes of any considerable extent in the area.

The soil of the middle part of the basin is a porous, sandy loam and about 55 per cent of the land is under cultivation; along the lower course the soil is black loam and clay and about 75 per cent of the land is cultivated. The rainfall in the lower basin is considered sufficient for all growing crops and there are no irrigation works.

The Republican is subject to sudden rises and falls and occasionally overflows its banks. The most notable flood since 1895, when the gaging station at Junction was established, occurred in May and June, 1903. This covered all the low bottom lands and washed away fences, houses, crops, railway tracks, bridges, stock, and everything movable.

Information in regard to the basin is contained in the following Annual Reports of the United States Geological Survey: Eighteenth, Part IV, page 194; Twenty-first, Part IV, page 219.

REPUBLICAN RIVER NEAR BOSTWICK, NEBR.

This station was established June 6, 1904. It is located at a highway bridge 1 mile south of Bostwick, Nebr., in sec. 23, T. 1 N., R. 8 W., and replaces a station established at Superior, Nebr., in 1895.

The channel is straight both above and below the station. The left bank is high, but the right bank is low and subject to overflow at high stages. The bed of the stream is composed of shifting sands. The channel is somewhat obstructed by ice breakers and piers, but not seriously so. The current is never sluggish, even at low stages. Gage heights have a range of about 10 feet

Discharge measurements are made from the bridge, which has three 150-foot spans resting on tubular concrete piers. The initial point for soundings is the zero mark on the hand rail in line with the south face of the north downstream pier.

The gage was read during 1905 by M. A. McPherson, who lives one-fourth mile distant. It is of the standard chain type and the length of the chain is 20.52 feet. The gage is referred to bench marks as follows: (1) The top of the cast-iron bearing shoe at the north end of the downstream truss of the north span; the shoe rests on rollers on the top of the pier and has three openings, the east opening being the bench mark; elevation, 15.75 feet. (2) The northwest cardinal point of the rim or edge of the cover plate of the pier at the south end of truss described above; elevation, 15.89 feet. Elevations are above the zero of the gage.

A description of this station with gage height and discharge data is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 102–104.

Discharge measurements of Republican River near Bostwick, Nebr., in 1905.

Date.	Hydrographer	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 22	H. C. Gardner	430	639	1.85	2.45	1,181
April 29	do	930	830	2.40	3.00	2,009
June 7	do	420	585	1.78	2.55	1,045
July 6	do	440	3,188	4.66	8.30	14,870
July 26	do	430	1,806	3.27	5.45	5,915
August 10	do	410	1,141	2.70	3.55	3,082
September 30	F. S. Dobson	120	359	1.80	1.32	648

Daily gage height, in feet, of Republican River near Bostwick, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.15	2.75	3.3	6.25	6.35	1.2	1.25
2	.....	2.15	2.55	3.3	8.7	6.45	1.2	1.15
3	.....	2.2	2.5	4.1	9.3	6.9	1.9	1.15
4	.....	2.15	2.45	3.7	10.4	7.3	1.9	1.15
5	.....	2.15	2.45	2.9	9.5	5.65	1.9	1.1
6	.....	2.15	2.35	2.65	7.65	5.3	1.9	1.1
7	.....	2.5	2.35	2.55	5.5	5.5	1.5	1.1
8	.....	2.4	2.35	2.35	4.75	4.65	1.3	1.1
9	.....	2.35	2.4	2.25	4.5	4.05	1.3	1.05
10	.....	2.25	2.45	2.35	4.6	3.8	1.9	1.0
11	.....	2.2	6.1	2.4	4.1	3.5	1.3	1.0
12	.....	2.2	2.7	2.5	3.6	3.05	1.3	1.0
13	.....	2.1	3.0	4.0	3.35	2.8	1.1	.95
14	.....	2.1	3.05	3.0	3.05	2.5	1.1	.95
15	.....	2.1	3.15	2.7	2.9	2.35	1.1	.95
16	.....	2.05	5.4	4.15	2.85	2.5	1.2	1.0
17	.....	2.1	4.1	4.55	2.8	2.65	1.1	.95
18	.....	2.05	3.15	5.5	2.7	2.85	1.3	1.0
19	.....	2.05	2.95	3.85	2.65	2.55	1.2	1.0
20	.....	2.0	2.7	3.5	4.1	2.15	1.4	1.05
21	.....	2.25	2.5	3.0	2.5	2.0	1.45	1.05
22	2.45	2.05	2.45	2.85	2.4	1.85	1.4	1.05
23	2.5	2.2	2.35	5.2	2.35	1.75	1.35	1.1
24	2.45	2.45	2.45	5.75	2.25	1.7	1.45	1.1
25	2.4	2.6	2.35	6.05	2.15	1.65	1.6	1.1
26	2.4	2.95	2.25	5.85	5.7	1.65	1.55	1.1
27	2.4	2.8	2.45	5.5	3.65	1.6	1.55	1.1
28	2.3	3.1	2.25	4.15	3.5	1.5	1.5	1.1
29	2.3	3.0	5.4	3.85	5.4	1.3	1.4	1.1
30	2.25	2.9	3.9	4,15	4.65	1.3	1.35	1.1
31	2.2	.....	3.7	.....	4.9	1.3	.....	1.1

Station rating table for Republican River near Bostwick, Nebr., from June 6, 1904, to July 1, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	110	2.10	845	3.20	1,995	4.60	4,090
1.10	160	2.20	930	3.30	2,120	4.80	4,450
1.20	215	2.30	1,020	3.40	2,250	5.00	4,820
1.30	275	2.40	1,115	3.50	2,385	5.20	5,210
1.40	335	2.50	1,210	3.60	2,555	5.40	5,610
1.50	400	2.60	1,310	3.70	2,670	5.60	6,030
1.60	465	2.70	1,415	3.80	2,815	5.80	6,460
1.70	535	2.80	1,525	3.90	2,965	6.00	6,900
1.80	605	2.90	1,635	4.00	3,115	6.20	7,360
1.90	680	3.00	1,750	4.20	3,420		
2.00	760	3.10	1,870	4.40	3,750		

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1904 and three made in 1905, and is well defined between gage-heights 1.5 feet and 3.5 feet. Estimates based on the above and following tables are liable to considerable error, owing to the shifting character of the stream bed.

Station rating table for Republican River near Bostwick, Nebr, from July 2 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	440	2.60	1,750	4.20	3,850	6.60	8,860
1.10	500	2.70	1,860	4.30	4,010	6.80	9,460
1.20	560	2.80	1,970	4.40	4,170	7.00	10,080
1.30	630	2.90	2,080	4.50	4,340	7.20	10,720
1.40	700	3.00	2,200	4.60	4,510	7.40	11,400
1.50	770	3.10	2,320	4.70	4,680	7.60	12,120
1.60	850	3.20	2,440	4.80	4,860	7.80	12,880
1.70	930	3.30	2,570	4.90	5,040	8.00	13,640
1.80	1,010	3.40	2,700	5.00	5,220	8.20	14,400
1.90	1,090	3.50	2,830	5.20	5,600	8.40	15,200
2.00	1,180	3.60	2,970	5.40	6,000	8.60	16,000
2.10	1,270	3.70	3,110	5.60	6,410	8.80	16,850
2.20	1,360	3.80	3,250	5.80	6,840	9.00	17,750
2.30	1,450	3.90	3,390	6.00	7,300	9.20	18,650
2.40	1,550	4.00	3,540	6.20	7,780	9.40	19,550
2.50	1,650	4.10	3,690	6.40	8,300		

The above table is applicable only for open-channel conditions. It is based on four discharge measurements made during 1905, and is poorly defined. See note to preceding table.

Estimated monthly discharge of Republican River near Bostwick, Nebr., for 1905.

[Drainage area, 23,270 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 23-31	1,210	930	1,082	21,460	0.046	0.017
April	1,870	760	1,060	63,070	.046	.051
May	7,130	975	1,927	118,500	.083	.096
June	7,015	975	2,949	175,500	.127	.142
July	24,500	1,315	5,734	352,600	.246	.284
August	11,060	630	3,082	189,500	.132	.152
September	1,090	500	725	43,140	.031	.035
October	595	410	479	29,450	.021	.024
The period				993,200		

REPUBLICAN RIVER AT BENKELMAN, NEBR.

This station was established November 1, 1894, discontinued September 7, 1895, and reestablished May 20, 1903, at a point some distance below the original location. It is located about one-half mile east of Benkelman, Nebr., on the line between secs. 17 and 20, T. 1 N., R. 37 W.

The river is nearly straight both above and below the station. The banks are low, but seldom overflow. The bed is composed of shifting sand. The channel is slightly obstructed by the piling of the bridge, on which considerable débris lodges at times of high water. The current is never sluggish, even at low stages. Gage heights have a range of about 4 feet. It is impossible to obtain records of winter flow.

Discharge measurements are made from the upstream side of the highway bridge. The initial point for soundings is the zero mark on the upstream hand rail at the east end of the bridge.

The gage, which was read during 1905 by Leon L. Hines, is a vertical staff 6 feet long spiked to the downstream side of the second bent from the west end of the bridge. The gage is referred to five bench marks, as follows: (1) The top of the south end of the concrete foundation for the west upright bent of the elevated track in the Burlington and Missouri River Railroad yards; elevation, 16.14 feet. Nos. 2, 3, 4, and 5 are, respectively, the tops of the south ends of the first, second, third, and fourth bents from the west end of the bridge; elevations, respectively, 6.88, 6.74, 6.34, and 6.19 feet above the zero of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Description: Bull 131, p 33; 140, pp 125–127; WS 99, pp 220–221; 131, p 95.
Discharge: Ann 18, iv, p 206; 20, iv, p 302; Bull 131, pp 33, 92; 140, p 126; WS 50, p 311; 84, p 113; 99, p 221; 131, p 95.
Discharge, mean daily: WS 131, p 97.
Discharge, monthly: WS 99, p 222; 131, p 98.
Gage heights: Bull 140, p 129; WS 99, p 221; 131, p 96.
Rating table: Bull 140, p 128; WS 99, p 222.

Discharge measurements of Republican River at Benkelman, Nebr., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 21	H. C. Gardner	160	61	1.16	1.20	171
May 2	do	230	69	2.26	1.35	156
June 6	do	45	34	1.79	1.25	61
July 5	do	65	24	1.50	1.10	36
July 31	G. W. Bates	.....	70	2.29	1.40	160
August 28	H. C. Gardner	20	6.7	1.60	.80	10
September 28	F. S. Dobson	130	35	1.40	1.10	49

Daily gage height, in feet, of Republican River at Benkelman, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	1.45	1.3	1.4	1.3	1.2	0.8	1.2
2	.....	1.5	1.25	1.35	1.4	1.1	.....	1.2
3	.....	1.35	1.3	1.25	1.25	1.2	.8	1.2
4	.....	1.2	1.3	1.2	1.15	1.15	.....	1.2
5	.....	1.3	1.3	1.25	1.1	1.05	.....	1.2
6	.....	1.25	1.3	1.2	1.1	1.2	1.05	1.2
7	.....	1.25	1.3	1.15	1.1	1.1	1.1	1.2
8	.....	1.3	1.4	1.1	1.18	1.05	1.05	1.15
9	.....	1.3	1.4	1.15	1.25	1.05	1.3	1.1
10	.....	1.35	1.4	1.3	1.25	1.05	1.3	1.2
11	.....	1.3	1.3	1.4	1.25	1.15	1.2	1.2
12	.....	1.3	1.3	1.35	1.1	1.25	1.1	1.2
13	.....	1.3	1.3	1.35	1.1	1.15	1.2	1.2
14	.....	1.3	1.25	1.2	1.05	1.05	1.2	1.2
15	.....	1.3	1.25	1.2	1.0	1.05	1.1	1.3
16	.....	1.3	1.25	1.25	1.0	1.05	1.2	1.2
17	.....	1.25	1.25	1.45	1.1	1.0	1.1	1.2
18	.....	1.25	1.3	1.35	1.05	1.0	1.2	1.2
19	1.4	1.25	1.4	1.25	1.0	.95	1.3	1.2
20	1.35	1.3	1.3	1.2	1.1	.95	1.3	1.2
21	1.2	1.35	1.35	1.2	1.15	.95	1.2	1.25
22	1.0	1.3	1.3	1.4	1.2	.95	1.2	1.3
23	1.1	1.52	1.3	1.2	1.15	.8	1.2	1.25
24	1.1	1.75	1.45	1.2	1.15	.8	1.1	1.25
25	1.05	1.5	1.45	1.15	1.1	.8	1.2	1.25
26	1.15	1.4	1.4	1.2	1.1	.85	1.2	1.25
27	1.2	1.3	1.4	1.2	1.1	.95	1.2	1.3
28	1.2	1.35	1.4	1.15	1.35	.8	1.2	1.35
29	1.1	1.4	1.6	1.15	1.35	.8	1.1	1.45
30	1.0	1.35	1.5	1.15	1.8	.78	1.1	1.55
31	1.25	.....	1.4	.....	1.3	.75	.....	1.6

SOUTH FORK OF REPUBLICAN RIVER AT BENKELMAN, NEBR.

This station was established November 1, 1894, discontinued September 5, 1895, and reestablished May 20, 1903. It is located at the highway bridge about three-fourths of a mile east of Benkelman, on the line between secs. 17 and 20, T. 1 N., R. 37 W., and is about one-fourth mile above the mouth of the South Fork.

The channel is straight both above and below the station. The banks are low, but seldom overflow. The bed is composed of shifting sand. The piling of the bridge obstructs the

channel to a limited extent. The current is never sluggish, even at low stages. Gage heights have a range of about 4 feet.

Discharge measurements are made from the upstream side of the highway bridge. The initial point for soundings is the zero mark on the upstream hand rail at the east end of the bridge.

The gage, which was read during 1905 by Leon L. Hines, is a vertical staff 5.5 feet long spiked to the upstream side of the first bent in the channel from the east bank of the stream. It is referred to five bench marks, as follows: (1) The top of the south end of the concrete foundation for the first upright bent of the elevated track in the Burlington and Missouri River Railroad yards; elevation, 18.29 feet. Nos. 2, 3, 4, and 5 are, respectively, the tops of the south ends of the first, second, third, and fourth bents from the west end of the bridge; elevations, respectively, 6.62, 6.48, 6.38, and 6.20 feet above the zero of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Description: Bull 131, p 33; 140, p 130; WS 99, pp 222–223; 131, pp 98–99.
Discharge: Ann 18, iv, p 206; Bull 140, p 130; WS 50, p 311; 84, p 113; 99, p 223; 131, p 99.
Discharge, mean daily: WS 131, p 101.
Discharge, monthly: WS 99, p 224; 131, p 102.
Gage heights: Bull 140, pp 130–131; WS 99, pp 223–224; 131, p 100.
Rating table: WS 99, p 224.

Discharge measurements of South Fork of Republican River at Benkelman, Nebr., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 21	H. C. Gardner	108	77	1.82	1.77	140
May 2	do	210	73	1.52	1.65	111
June 6	do	60	25	1.36	1.30	34
July 5	do	100	29	1.91	1.40	51
July 31	G. W. Bates	85	44	1.63	1.45	72
August 28	H. C. Gardner					0
September 28	F. S. Dobson	75	16	1.28	1.20	21

Daily gage height, in feet, of South Fork of Republican River at Benkelman, Nebr., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	1.85	1.7	1.65	1.6	1.6	.....	.....
2	.....	1.9	1.65	1.55	1.55	1.5	.....	.....
3	.....	2.05	1.65	1.5	1.6	1.5	.....	.....
4	.....	1.95	1.7	1.45	1.5	1.5	.....	.....
5	.....	1.9	1.7	1.35	1.4	1.4	1.35	.....
6	.....	1.8	1.6	1.35	1.4	1.35	.....	.....
7	.....	1.75	1.6	1.3	1.4	1.3	.....	.....
8	.....	1.75	1.6	1.25	1.35	1.25	.....	.....
9	.....	1.75	1.65	1.35	1.35	1.25	.....	.....
10	.....	1.75	1.7	1.85	1.25	1.2	1.45	.....
11	.....	1.75	1.7	1.6	1.2	1.25	.....	.....
12	.....	1.55	1.7	1.55	1.2	1.25	.....	.....
13	.....	1.5	1.5	1.35	1.15	1.3	.....	.....
14	.....	1.4	1.55	1.35	1.1	(a)	.....	.....
15	.....	1.4	1.55	1.3	1.0	.....	.....	.....
16	.....	1.4	1.55	13.5	1.1	.....	.....	.....
17	2.1	1.5	1.5	2.2	1.0	.....	.....	.....
18	1.95	1.45	1.45	1.7	1.1	1.55	.....	.....
19	2.1	1.45	1.6	1.6	1.0	.....	1.5	.....
20	1.95	1.55	1.7	1.55	1.0	.....	1.5	.....
21	1.85	1.6	1.4	1.2	1.1	.....	.....	.....
22	1.8	1.5	1.75	1.55	1.15	.....	.....	.....
23	1.8	1.8	1.45	1.45	1.1	.....	.....	.....
24	1.8	2.1	1.45	1.45	1.1	.....	.....	.....
25	1.75	2.25	1.45	1.35	1.1	.....	.....	1.35
26	1.7	2.05	1.65	1.35	1.1	.....	.....	1.35
27	1.6	2.05	1.65	1.35	1.05	.....	.....	1.4
28	1.7	2.0	1.6	1.25	1.1	.....	.....	1.45
29	1.7	1.8	1.75	1.25	1.2	.....	.....	1.5
30	1.7	1.75	1.65	1.25	1.8	.....	.....	1.55
31	1.78	.....	1.75	.....	1.7	.....	.....	1.6

(a) Channel obstructed by sand August 14 to October 31.

Station rating table for South Fork of Republican River at Benkelman, Nebr., from March 17 to August 13, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	5	1.40	52	1.70	123	2.00	215
1.10	10	1.50	73	1.80	152	2.10	249
1.20	21	1.60	96	1.90	183	2.20	283
1.30	35						

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1905. Estimates based on this table are liable to considerable error owing to the shifting character of the stream beds.

Estimated monthly discharge of South Fork of Republican River at Benkelman, Nebr., for 1905.

[Drainage area, 5,910 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 17–31	249	96	159	4,730	0.027	0.015
April	300	52	141	8,390	.024	.027
May	137	52	100	6,149	.017	.020
June	283	21	68.6	4,082	.012	.013
July	152	5	35.4	2,177	.006	.0069
August 1–13	96	21	47.7	1,230	.0081	.0039
The period				26,760		

REPUBLICAN RIVER AT JUNCTION, KANS.

This station was established April 26, 1895. It is located at the wagon bridge at the north end of Washington street, Junction, about 2 miles above the mouth of the river.

The channel is straight for about 300 feet both above and below the station and is broken by three piers. The right bank is high, but the left is low and may overflow at high water. The bed of the stream is sandy and liable to change. The flow is moderately rapid. The flood of 1903 cut a new channel, about 220 feet wide, north of the wagon bridge, and for a time this carried most of the water. This channel was at first bridged by a pile bridge, but later it was filled, so that now all the water flows in the old channel. The slope of the river at the gage October 3, 1905, was 0.0024544 foot per foot for a distance of 658 feet.

Discharge measurements are made from the downstream side of the bridge, to which the gage is attached. The initial point for soundings is at the south end of the bridge.

The gage, which was read during 1905 by J. H. Rathert, is in two sections. The first section is an inclined timber, graduated from zero to 11 feet, spiked to a pile and to a large cottonwood tree; the second section is graduated from 11 to 25 feet, and spiked in an upright position to a large cottonwood tree. The gage is referred to bench marks as follows: (1) A spike driven into the west side of an 18-inch cottonwood tree standing 10 feet west of the bridge on the right bank of the river; the spike is about 2 feet above the ground and has an elevation of 12.36 feet above the zero of the gage. (2) The top of a stone, marked with a cross and the letters "B. M.," at the base of the abutment south of No. 3; elevation, 14.28 feet above the zero of the gage.

This station was discontinued October 31, 1905.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Description: Ann 18, iv, p 203; Bull 140, pp 136-137; WS 16, p 109; 27, p 90; 37, p 248; 50, p 313; 66, p 43; 84, p 100; 99, p 214; 131, p 105.

Discharge: Ann 18, iv, p 204; Bull 140, p 137; WS 16, p 109; 27, p 95; 37, p 248; 50, p 313; 66, p 43; 84, p 100; 99, p 214; 131, p 105.

Discharge, monthly: Ann 18, iv, p 205; 19, iv, p 340; 20, iv, pp 312, 318; 21, iv, p 221; 22, iv, p 333; Bull 140, p 138; WS 75, p 141; 84, p 102; 99, p 216; 131, p 108.

Discharge, yearly: Ann 20, iv, p 55.

Gage heights: Bull 140, p 137; WS 11, p 57; 16, p 109; 27, p 92; 37, p 249; 50, p 314; 66, p 43; 84, p 101; 99, p 215; 131, p 106.

Hydrographs: Ann 18, iv, p 204; 19, iv, p 340; 20, iv, p 318; 21, iv, p 221; 22, iv, p 333; WS 75, p 141.

Rainfall and run-off relation: Ann 20, iv, p 313.

Rating tables: Ann 18, iv, p 205; 19, iv, p 339; WS 27, p 96; 39, p 449; 52, p 517; 66, p 171; 84, p 101; 99 p 215; 131, p 107.

Discharge measurements of Republican River at Junction, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 28	W. G. Russell	163	410	3.33	4.20	1,368
April 11	do	163	389	2.97	4.10	1,156
May 23	do	186	557	3.98	4.70	2,219
June 26	do	248	1,964	4.57	8.70	8,973
June 27	do	246	1,887	4.46	8.45	8,421
July 22	do	313	1,051	3.46	5.70	3,641
August 15	do	248	858	3.43	5.30	2,941
October 4	do	248	446	2.17	3.65	969

Daily gage height, in feet, of Republican River at Junction, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	3.9	4.1	7.42	4.0	4.65	7.98	7.4	8.28	4.0	3.8
2	3.9	4.1	6.1	4.0	4.95	6.75	9.3	7.55	3.98	3 8
3	3.9	4.1	5.95	4.0	4.88	5.5	10.65	7.45	3.9	3.8
4	4.05	4.1	5.65	4.0	4.68	5.7	11.0	7.85	3.9	3.7
5	4.1	3.9	5.48	3.95	4.58	6.5	11.1	7.88	3.92	3.6
6	4.1	3.8	5.48	3.95	4.4	6.12	11.2	8.55	4·1	3.6
7	4.1	3.7	5 12	3.95	4.4	5.9	12.55	8.58	4.1	3.58
8	4.02	3.5	4.78	3.92	4.4	5.18	15.3	7.45	4.28	3.52
9	3.88	3.2	4.68	3.9	6.3	4.85	12.25	6.95	4.35	3.5
10	3.85	3.2	4.5	3.9	5.45	4.65	7.65	6.4	4.35	3.5
11	3.85	3.2	4.42	4.02	4.42	4.6	7.2	5.9	4.15	3.5
12	3.85	3.2	4.3	4.15	4.4	4.6	6.5	5.65	4.05	3.5
13	3.85	3.15	4.3	4.08	5.35	4.35	6.3	5.5	4.0	3.5
14	3.85	3.15	4.22	4.08	7.15	4.08	6.0	5.4	4.15	3.45
15	3.85	3.15	4.15	3.9	5.45	4.15	5.6	5.28	4.02	3.4
16	3.85	3.15	4.25	3.85	4.8	4.9	5.4	5.5	4.0	3.4
17	3.85	3.15	4.28	3.8	4.9	5.6	4.8	5.2	3.9	3.4
18	3.85	3.15	4.3	3.8	5.45	5.05	5.02	5.05	3.9	3.35
19	3.85	3.15	4.3	3.75	7.35	5.1	4.7	4.9	3.82	3.4
20	3.92	3.15	4.3	3.7	6.1	6.85	4.65	4.88	3.8	3.4
21	3.98	4.75	4.32	3.7	5.35	7.55	4.6	5.05	3.75	3.4
22	4.08	5.9	4.38	3.78	5.02	6.35	5.3	5.0	3.72	3.4
23	4.1	6.2	4.4	3.8	4.72	5.95	6.35	4.6	3.68	3.4
24	4.1	5.85	4.25	3.9	4.55	8.55	5.68	4.5	3.75	3.4
25	4.1	5.45	4.38	4.62	9.0	8.1	4.8	4.4	3.8	3.4
26	4.1	5.22	4.35	4.45	7.7	8.7	5.15	4.4	3.65	3.4
27	4.1	7.05	4.32	4.5	6.1	8.35	5	4.4	3.65	3.4
28	4.1	7.2	4.28	5.25	5.52	8.3	9.0	4.3	3.65	3.4
29	4.1	.....	4.2	5.22	5.35	11.15	8.65	4.28	3.8	3.4
30	4.1	.....	4.0	4.95	6.4	9.3	8.48	4.15	3.85	3.45
31	4.1	.....	4.0	.....	9 0	.....	7.7	4.08	.....	3.5

Station rating table for Republican River at Junction, Kans., from January 1 to May 13, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
3.10	250	4.20	1,320	5.30	2,950	6.40	4,730
3.20	310	4.30	1,460	5.40	3,100	6.50	4,905
3.30	380	4.40	1,600	5.50	3,250	6.60	5,085
3.40	460	4.50	1,750	5.60	3,400	6.70	5,265
3.50	550	4.60	1,900	5.70	3,560	6.80	5,450
3.60	650	4.70	2,050	5.80	3,720	6.90	5,640
3.70	750	4.80	2,200	5.90	3,880	7.00	5,830
3.80	850	4.90	2,350	6.00	4,050	7.20	6,230
3.90	960	5.00	2,500	6.10	4,220	7.40	6,650
4.00	1,080	5.10	2,650	6.20	4,390		
4.10	1,200	5.20	2,800	6.30	4,560		

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during the first part of 1905, and is fairly well defined.

Station rating table for Republican River at Junction, Kans., from May 14 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
3.20	600	4.70	2,210	6.40	4,730	9.40	11,660
3.30	680	4.80	2,340	6.60	5,085	9.60	12,230
3.40	760	4.90	2,470	6.80	5,450	9.80	12,830
3.50	850	5.00	2,600	7.00	5,830	10.00	13,450
3.60	950	5.10	2,735	7.20	6,230	10.50	15,020
3.70	1,050	5.20	2,870	7.40	6,650	11.00	16,700
3.80	1,150	5.30	3,010	7.60	7,080	11.50	18,450
3.90	1,250	5.40	3,150	7.80	7,525	12.00	20,200
4.00	1,360	5.50	3,295	8.00	7,995	12.50	22,200
4.10	1,470	5.60	3,440	8.20	8,480	13.00	24,200
4.20	1,580	5.70	3,590	8.40	8,980	14.00	28,700
4.30	1,700	5.80	3,745	8.60	9,490	15.00	33.700
4.40	1,820	5.90	3,900	8.80	10,010		
4.50	1,950	6.00	4,060	9.00	10,550		
4.60	2,080	6.20	4,390	9.20	11,100		

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1905 and five during 1904, and is fairly well defined. The table has been extended beyond these limits.

Estimated monthly discharge of Republican River at Junction, Kans., for 1905.

[Drainage area, 25,840 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	1,200	905	1,056	64,930	0.041	0.047
February	6,230	280	1,562	86,750	.060	.062
March	6,692	1,080	2,043	125,600	.079	.091
April	2,875	750	1,233	73,370	.048	.054
May	10,550	1,600	3,589	220,700	.139	.160
June	17,220	1,448	5,184	308,500	.201	.224
July	35,350	2,080	8,559	526,300	.331	.382
August	9,439	1,448	4,048	248,900	.157	.181
September	1,760	1,000	1,293	76,940	.050	.056
October	1,150	720	847	52,080	.033	.038
The period				1,784,000		

NOTE.—Ice conditions uncertain; discharge applied as for open channel.

MISCELLANEOUS MEASUREMENT.

July 18, 1905, a measurement of the North Fork of Republican River at Benkelman, Nebr., gave the following results: Area of section, 70 square feet; mean velocity, 2.29 feet per second; discharge, 160 second-feet.

SMOKY HILL RIVER.

DESCRIPTION OF BASIN.

Smoky Hill River rises near the boundary between Kansas and Colorado, pursues a winding, but on the whole easterly, course through Kansas, and near Junction unites with Republican River to form Kansas River. Its length is 335 miles and the extreme width of its basin is about 100 miles. The river runs close to the northern border of the Arkansas basin, and its chief tributaries are from the north. Solomon and Saline rivers are the most important, the former draining the northern part of Kansas and the latter the territory between the Solomon and the Smoky Hill.

The headwater region is a rolling, upland prairie, sparsely timbered along the streams with cottonwood, box elder, hackberry, elm, and willow trees. To the east the stream is bordered by bluffs rising from 100 to 250 feet above the bottoms. The middle portion of the basin is an undulating prairie, well adapted to stock raising and farming. The eastern section is a rich agricultural country, the soil being a black, sandy loam, which produces large and varied crops. There are no lakes or marshes in the area.

The precipitation varies from about 12 inches, in the extreme western part of the basin, to 30 inches in the eastern part. Nearly all of this is rain which falls during the growing season. The snowfall is generally light, is very dry, and never causes any high water. There is an abundant supply of underground water in the western part of the area, but as a rule it is deep. In other sections the supply is good. Numerous springs occur along the banks of the river and its tributaries. There are several good dam sites in the basin, but the flood water carries so much sand and silt that any reservoir would soon fill up.

Floods seldom occur in the upper and middle sections of the river, but in the lower part they are more frequent. The most notable flood in the upper river was that in July, 1895, but this did little damage farther down. The great floods in the lower river occurred in 1903 and 1904. The 1903 flood did much damage.

Information in regard to the basin is contained in United States Geological Survey publications as follows: Eighteenth Annual Report, Part IV, page 207; Twenty-first Annual Report, Part IV, page 223; Bulletin No. 140, page 138.

SMOKY HILL RIVER AT ELLSWORTH, KANS.

This station was established April 16, 1895. It is located at the highway bridge on Douglass avenue, Ellsworth, Kans.

The channel is straight above and below the station at high water, but at other times is slightly curved. Both banks are low, wooded, and subject to overflow. The bed of the stream is composed of sand and is free from vegetation and shifting. The current is medium at low and swift at high stages. The slope of the stream above the gage is 1.44 feet in 2,536 feet, or 0.000568 foot per foot.

Discharge measurements are made from the downstream side of the bridge, which is 293 feet long between abutments and consists of three spans. The initial point for soundings is at the noth end of the bridge, downstream side.

The gage, which was read during 1905 by Thomas Coyne, is in two sections. The first section is an inclined timber, graduated from zero to 4 feet, securely fastened to the iron pier of the bridge and to posts driven into the bed of the river. The second section is graduated from 3.7 to 21 feet, and spiked to the same pier. The gage is referred to bench marks as follows: (1) A nail driven into the base of a box elder tree near the southeast corner of the bridge, 90 feet from the gage; elevation above the zero of the gage, 13.07 feet. (2) The top of a nail driven into the root on the north side of an elm tree 2 feet in diameter about 45 feet west of bench mark No. 1; elevation about 11.34 feet above the zero of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey. (Ann.=Annual Report; Bull.=Bulletin. WS.=Water-Supply Paper):

Description: Ann 18, iv, pp 212-213; Bull 140, p 142; WS 16, p 114; 27, p 90; 37, p 251; 50, p 316; 66, p 45; 84, p 110; 99, p 230; 131, pp 108–109.

Discharge: Ann 18, iv, p 213; Bull 140, p 143; WS 16, p 114; 27, p 95; 37, p 251; 50, p 316, 66, p 45; 84 p 110; 99, p 231; 131, p 109.

Discharge, monthly: Ann 18, iv, p 214; 19, iv, p 347; 20, iv, p 315; 21, iv, p 225; 22, iv, p 336; Bull 140, p 143; WS 75, p 143; 84, p 112; 99, p 232; 131, p 111.

Discharge, yearly: Ann 20, iv, p 56.

Gage heights: Bull 140, p 143; WS 11, p 58; 16, p 114; 27, p 93; 37, p 252; 50, p 317; 66, p 45; 84, p 111; 99, p 231; 131, p 109.

Hydrographs: Ann 18, iv, p 215; 19, iv, p 347; 20, iv, p 315; 21, iv, p 226; 22, iv, p 336.

Rating tables: Ann 18, iv, p 214; 19, iv, p 346; WS 27, p 96; 39, p 449; 52, p 517; 66, p 172; 84, p 111; 99, p 232; 131, p 110.

Discharge measurements of Smoky Hill River at Ellsworth, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
July 21	W. G. Russell	57	80	2.04	1.55	163
August 14	do	150	206	1.73	2.25	356

Daily gage height, in feet, of Smoky Hill River at Ellsworth, Kans., for 1905.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	1.8	0.9	1.4	4.0	9.15	2.8	0.9	0.9
2	.....	1.6	.9	1.3	3.2	6.4	3.6	.9	.9
3	.....	1.5	.95	1.3	2.8	6.0	3.2	.9	.85
4	.....	1.5	.9	1.2	3.0	5.0	2.6	.9	.85
5	.....	1.4	.9	1.15	2.6	5.8	2.25	.95	.85
6	.....	1.4	.9	1.1	2.3	4.3	2.2	1.3	.85
7	.....	1.3	.85	1.05	2.1	4.6	2.1	1.1	.85
8	.....	1.25	.85	1.0	2.0	3.4	1.9	1.0	.85
9	.....	1.2	.85	8.5	1.8	3.0	1.8	1.0	.85
10	.....	1.2	.85	2.7	1.7	2.7	1.7	1.0	.85
11	.....	1.2	.85	1.8	1.65	2.6	1.6	1.0	.8
12	.....	1.15	.8	1.6	1.6	2.4	1.5	.95	.8
13	.....	1.15	.8	1.5	1.55	2.3	6.0	.95	.8
14	.....	1.1	.8	1 35	1.5	3.2	4.3	.95	.8
15	.....	1.1	.85	1.3	1.4	2.4	3.6	1.0	.75
16	.....	1.05	.85	1.3	2.2	2.1	3.4	1.0	.75
17	.....	1.05	.8	1.25	1.7	1.9	2.6	1.0	.75
18	.....	1.15	.8	1.2	1.7	1.7	2.0	1.0	.75
19	1.7	1.15	.85	1.25	1.65	1.6	1.7	.95	.75
20	1.7	1.1	.9	1.2	1.8	1.5	1.6	.95	.75
21	3.3	1.1	.9	1.2	1.6	1.55	1.55	.95	.75
22	3.4	1.1	.9	1.2	1.5	1.65	1.5	.9	.7
23	2.1	1.05	.85	1.2	1.4	1.9	1.5	.9	.7
24	1.9	1.05	.9	1.4	1.9	1.85	1.4	.95	.7
25	1.7	1.05	.95	2.5	1.7	1.6	1.35	.95	.9
26	1.8	1.0	.95	1.8	1.5	1.6	1.2	.95	.9
27	1.85	1.0	.95	1.6	1.45	1.5	1.1	.95	.85
28	1.8	.95	1.0	5.5	1.4	1.4	1.1	.95	.85
29	.....	.95	1.5	4.4	1.8	1.6	1.05	.9	.85
30	.....	.95	1.45	3.6	8.4	1.7	1.05	.9	.85
31	.....	.9	.....	3.1	.....	1.7	1.0	.....	.85

NOTE.—River frozen January 1 to February 18.

BEAVER RIVER (LADDER CREEK) NEAR SCOTT CITY, KANS.

Beaver River rises in eastern Colorado and flows southeastward, eastward, and then northward to its junction with Smoky Hill River. Its basin, which lies entirely within the Great Plains and chiefly in the arid belt, has a length, east and west, of about 90 miles and an extreme width of not over 25 miles, the total area, measured at the mouth, being 1,464 square miles. The stream has no mountain tributaries but depends for its supply on the precipitation, which ranges from an annual average of about 12 inches at the source to 18 inches near the mouth. There is very little timber in the basin and that is of poor quality. Throughout its middle and lower course the stream flows in a narrow valley between hills 150 to 200 feet high, affording sites for dams and reservoirs; but the dams would be long and expensive and the supply of water from the basin would be insufficient. The tributaries are few and small and furnish little water except in the wet season. Along the lower course of the creek there are very fine springs which furnish water for a small amount of irrigation.

The gaging station was established May 18, 1904. It is located about 18 miles north of Scott City, Kans., at the Hatheway ranch, about 250 yards southwest of H. H. Hatheway's residence.

At low water the channel is very crooked, but after the water covers the bottom the channel is straight for about 100 feet above and below the station. The right bank is high and

wooded and does not overflow; the left bank is low and wooded and overflows at high water. The bed of the stream is composed of mud and is covered with vegetation and permanent. There is but one channel at all stages. A heavy growth of willows and other small brush along the channel prevents very accurate measurements.

Discharge measurements are made at low water by wading; at high water the flow must be computed from the cross section and slope, both of which were taken at the time the gage was established. The initial point for soundings is at the right bank.

The gage, which was read daily by James H. Drain, is a staff, spiked in a perpendicular position to a willow tree on the left bank. The bench mark is the top of a nail driven into the root of a willow tree about 8 inches in diameter, located on the right bank of the creek about 20 feet northeast of the gage; it is near the surface of the ground and has an elevation of 3.04 feet above the zero of the gage.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 131 of the United States Geological Survey, pages 112–113.

A discharge measurement of this creek, made May 18, 1905, by W. G. Russell, gave the following results: Width, 6 feet; area of section, 5.4 square feet; mean velocity, 1.69 feet per second; gage height, 1.30 feet; discharge, 9.1 second-feet.

Daily gage height, in feet, of Beaver River (Ladder Creek) near Scott City, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.7	1.7	1.8	1.75	3.0	3.0	4.8	8.0	1.5	1.5	1.5
2	1.7	1.7	1.8	1.6	2.9	2.0	6.0	3.0	1.5	1.5	1.5
3	1.7	1.8	1.9	1.6	2.9	1.5	5.5	2.5	1.5	1.5	2.0
4	1.7	1.8	2.0	1.7	2.8	1.0	4.5	2.5	1.5	1.5	2.0
5	1.7	2.0	1.6	1.7	2.75	1.0	4.0	2.0	2.0	1.5	2.0
6	1.7	2.0	1.6	1.7	2.65	1.0	3.0	1.5	2.5	1.5	1.5
7	1.7	2.0	1.6	1.7	2.0	1.0	2.0	1.5	6.0	1.5	1.5
8	1.8	2.0	1.6	1.7	2.0	1.0	2.0	1.5	5.5	1.5	1.5
9	1.8	2.0	1.7	1.8	2.0	1.0	1.5	1.5	2.5	1.5	1.5
10	1.8	2.0	1.7	1.8	1.95	1.0	1.5	1.5	2.5	1.5	1.5
11	1.8	2.0	1.7	1.9	1.8	4.0	1.5	1.5	2.5	1.5	2.0
12	1.8	2.0	2.0	1.9	1.75	3.0	1.5	2.0	2.5	1.5	2.0
13	1.9	2.0	2.0	1.9	1.6	2.5	1.5	1.5	2.5	1.5	1.5
14	2.0	2.0	2.0	1.9	1.3	2.0	1.5	1.5	2.5	1.5	1.5
15	2.0	2.0	2.0	1.9	1.3	1.5	1.5	1.5	2.0	1.5	1.5
16	1.1	2.1	2.0	1.95	1.3	1.5	1.5	1.5	2.0	1.5	1.5
17	1.1	2.1	2.0	1.95	1.3	1.5	1.5	1.5	2.5	1.5	1.5
18	1.1	2.1	2.0	1.95	1.3	1.5	1.5	1.5	2.5	1.5	1.5
19	1.9	2.2	1.9	1.95	1.3	1.5	1.5	1.5	2.5	1.5	1.5
20	1.9	2.2	1.9	2.0	1.3	4.0	1.5	1.5	2.5	1.5	1.5
21	1.8	2.2	1.9	2.0	1.3	3.0	1.5	1.5	1.5	1.5	1.5
22	1.8	2.2	1.85	2.0	1.3	1.5	1.5	1.5	1.5	1.5	1.5
23	1.8	2.2	1.8	2.0	1.3	1.5	1.5	1.5	1.5	1.5	1.5
24	1.7	2.2	1.8	2.0	6.0	1.5	3.5	1.5	1.5	1.5	1.5
25	1.7	2.2	1.8	2.3	4.0	1.5	2.0	1.5	1.5	1.5	1.5
26	1.7	1.6	1.8	2.3	3.0	1.5	2.0	1.5	1.5	1.5	1.5
27	1.7	1.6	1.8	2.5	2.5	1.5	1.5	1.5	2.0	1.5	1.5
28	1.7	1.6	1.8	2.6	6.5	1.5	3.5	1.5	2.0	1.5	1.5
29	1.7	.....	1.75	2.9	6.5	1.5	2.5	1.5	2.0	1.5	1.5
30	1.7	.....	1.75	3.6	5.0	5.0	4.5	1.5	2.0	1.5	1.5
31	1.7	.....	1.75	.....	4.3	.....	3.0	1.5	.....	1.5	.....

KANSAS RIVER.

DESCRIPTION OF BASIN.

Kansas River as such is a comparatively short stream, being formed by the union of Smoky Hill and Republican rivers in Geary County, Kans., whence it flows eastward, entering the Missouri at Kansas City, Mo.

The immediate basin, which comprises the richest portion of the State of Kansas, consists of bottoms and rolling uplands, well timbered with oak, cottonwood, ash, elm, hickory, etc. The section is under a high state of cultivation and produces a great variety of crops.

The river flows through a rich alluvial bottom land. The banks are sandy and easily cave in. In places the bed contains rock and bowlders, but in general it is composed of sand and at many points of quicksand. The channel as a rule hugs one bank or the other and is somewhat shifting. Islands are formed here and there by the deposit of sediment during high water, drift lodges upon them, and a thick growth of brush, mainly cottonwood, soon springs up. At Topeka the river is 900 feet wide between banks. At ordinary low water the channel occupies 150 to 200 feet of this width and has a depth of 8 to 9 feet; at mean high water the average depth of the water is probably 10 feet for the entire distance between banks.

The most important feeder of the Kansas below the junction of Smoky Hill and Republican rivers is the Blue, which rises in southeastern Nebraska, flows to the southeast and south into Kansas, and joins Kansas River at Manhattan. The principal tributary of the Blue is the Little Blue, which rises in southern Nebraska, flows southeastward, and unites with the main stream near Blue Rapids. The Blue runs through a bottom land 1½ miles wide, bordered by bluffs 300 feet high. The banks are of loam and range in height from 10 to 30 feet. The bed is sandy and gravelly, with many limestone ledges. In its lower course the river is about 250 feet wide, and at medium low water has a depth of perhaps 4 feet and a moderate current. The soil of the basin is chiefly a sandy loam with some clay and is generally porous; the region is in a high state of cultivation.

Both the Kansas and the Blue have periods of high water nearly every year, but disastrous floods are rare. The most notable flood on record is that which occurred in May and June, 1903, when the water covered all the low bottom lands, destroying many lives and millions of dollars worth of property.

There are no irrigation projects in the basin, as it is claimed that the rainfall is ample and timely. Good natural dam sites are lacking.

Information in regard to the basin is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper):

Altitudes in: Bull 140, p 124.
Description: Ann 18, iv, p 194; 18, iv, p 215; 19, iv, pp, 337–338; 20 iv, pp 304–305; 21, iv, p 228; 22, iv, p 331; Bull 131, pp 32–33; 140, pp 123–125; WS 75, p 140; 84, p 95; 99, p 208; 131, pp 87–88.
Drainage areas: Bull 140, p 124.
Rainfall and river stations, map: Ann 20, iv, p 305.
Rainfall and run-off relation: Ann 20, iv, p 313.
Rainfall data: Ann 20, iv, pp 305–313.
See also WS 74.

KANSAS RIVER AT LECOMPTON, KANS.

This station was established April 16, 1899. It is located at the new wagon bridge at Lecompton, Kans.

The channel is somewhat curved at the bridge and has a width of 800 feet, broken by four metal piers. The bridge is slightly oblique to the direction of the current. The left bank is low and subject to overflow during high water. The bed of the stream is composed of sand, with some rock, and changes slightly.

Discharge measurements are made from the bridge to which the gage is attached. The initial point for soundings is at the first set of piers at the south end of the bridge.

The gage was read during 1905 by A. D. McAdow. The original gage having been broken, a new gage was established June 24, 1900. Later a pine board 10 feet long was spiked on top of the old gage, at the same elevation. November 5, 1904, a new gage was put in. This gage is in three sections. The first section is a pine board, graduated from zero to 3 feet, spiked to a pile 23 feet north of the initial point; the second section is painted on the downstream pier of the second set and graduated from 3 to 10 feet; the third section is painted on the upstream pier of the first set and is graduated from 10 to 29.5 feet. October 26, 1900, a bench mark was established on top of the bottom flange of the iron strut connecting the two iron cylinders at the south end of the highway bridge over the river; the bench mark is at the west end of the strut, next to the cylinder; its elevation is 12.19 feet above the zero of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; WS=Water-Supply Paper):

Description: Ann 18, iv, pp 218–219; WS 37, p 253; 50, p 318; 66, p 46; 84, p 95; 99, p 208; 131, pp 91–92.
Discharge: WS 27, p 95; 37, p 253; 50, p 318; 66, p 46; 84, p 96; 99, p 209; 131, p 92.
Discharge, monthly: Ann 21, iv, p 228; 22, iv, p 338; WS 75, p 144; 84, p 97; 99, p 211; 131, p 94.
Gage heights: WS 11, p 59; 37, p 254; 50, p 319; 66, p 47; 84, p 96; 99, p 209; 131, p 92.
Hydrographs: Ann 21, iv, p 229; 22, iv, p 338; WS 75, p 144.
Rating tables: WS 39, p 449; 52, p 518; 66, p 172; 84, p 97; 99, p 210; 131, pp 93–94.

Discharge measurements of Kansas River at Lecompton, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 14	W. G. Russell	744	2,104	2.55	3.20	5,366
May 27	do	778	6,164	3.39	7.80	20,920
May 28	do	771	5,546	3.39	7.00	18,800
June 5	Murphy and Russell	767	5,065	3.02	6.55	15,310
June 28	W. G. Russell	777	5,347	3.74	7.55	20,000
July 9	J. C. Stevens	801	9,866	5.00	12.35	49,310
August 4	W. G. Russell	764	4,573	3.34	6.60	15,250
September 22[a]	do	774	4,999	1.91	7.40	9,535
October 9	do	644	1,497	2.22	3.30	3,330

[a] Affected by backwater of Delaware River.

Daily gage height, in feet, of Kansas River at Lecompton, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.9	4.1	7.7	4.6	4.2	9.0	9.9	7.3	4.1	5.6	2.6	4.6
2	1.9	4.1	7.7	4.6	4.1	9.9	9.0	7.0	4.0	5.6	2.6	4.55
3	1.9	4.1	7.7	4.6	4.1	9.2	12.3	7.0	3.95	5.6	2.6	4.5
4	1.9	4.1	7.5	4.55	4.0	7.15	11.25	6.6	3.9	5.5	2.6	4.4
5	1.9	4.1	7.4	4.45	4.0	6.5	10.65	7.0	3.9	5.5	2.75	4.3
6	1.9	4.0	7.1	4.4	3.9	6.1	10.7	7.0	3.9	5.5	4.5	4.25
7	1.9	4.0	7.0	4.35	3.9	5.9	10.55	6.8	3.85	5.45	5.4	4.2
8	2.15	4.0	6.85	4.3	3.8	5.5	10.85	6.7	3.8	3.4	5.05	4.2
9	2.35	4.0	6.7	4.1	3.8	5.2	12.1	6.7	3.8	3.4	5.0	4.2
10	2.7	4.0	6.35	3.85	3.7	5.05	12.0	6.7	3.8	3.4	4.15	4.1
11	3.1	4.0	6.25	3.65	5.6	4.7	9.9	6.6	3.7	3.3	3.65	4.0
12	3.6	3.9	6.2	3.45	5.6	4.45	8.95	6.6	3.7	3.3	3.5	3.9
13	3.85	3.9	6.2	3.3	5.6	4.35	8.4	6.6	3.65	3.25	3.5	3.85
14	4.0	3.9	6.2	3.2	5.45	4.05	6.65	6.5	3.9	3.2	3.4	3.8
15	4.05	3.9	6.1	3.2	7.85	4.0	6.3	6.5	10.05	3.15	3.35	3.7
16	4.15	3.8	6.1	3.1	8.45	4.0	5.75	6.4	11.75	3.1	3.3	3.6
17	4.3	3.8	6.1	3.1	7.0	3.95	5.7	6.4	11.8	3.1	3.2	3.5
18	4.3	3.8	6.1	3.0	5.8	3.95	5.0	6.4	12.95	3.1	3.2	3.5
19	4.3	3.8	6.0	2.95	5.6	5.0	4.8	7.0	12.45	3.0	3.2	3.5
20	4.3	3.8	6.0	2.9	5.8	5.0	4.8	7.75	10.25	3.0	3.1	3.4
21	4.3	3.95	5.9	2.9	6.3	4.9	4.7	7.65	8.85	2.95	3.1	3.4
22	4.3	4.3	5.9	2.8	5.9	4.95	4.65	7.25	6.8	2.9	3.05	3.4
23	4.2	4.8	5.85	2.8	5.5	5.75	4.6	6.8	5.95	2.9	3.4	3.4
24	4.2	5.55	5.8	2.8	5.1	6.0	4.6	6.2	5.85	2.85	4.05	3.3
25	4.2	6.8	5.75	2.8	11.5	6.0	4.6	5.35	5.8	2.8	5.4	3.3
26	4.2	7.15	5.7	3.7	10.9	6.6	4.5	4.45	5.75	2.8	5.0	3.3
27	4.2	7.9	5.6	3.7	7.4	7.9	4.5	4.3	5.7	2.7	4.8	3.25
28	4.2	7.7	5.5	4.7	7.15	7.55	4.5	4.25	5.65	2.7	4.75	3.2
29	4.2	.....	5.0	4.5	6.7	8.0	5.1	4.2	5.6	2.7	4.7	3.2
30	4.2	.....	4.7	4.2	6.25	9.0	7.0	4.15	5.6	2.7	4.65	3.2
31	4.15	.....	4.6	.....	7.0	.....	6.85	4.1	.....	2.7	.....	3.2

Station rating table for Kansas River at Lecompton, Kans., from January 1 to September 21, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.90	2,525	3.40	5,600	4.90	9,600	7.80	21,100
2.00	2,700	3.50	5,850	5.00	9,900	8.00	22,100
2.10	2,875	3.60	6,100	5.20	10,500	8.20	23,100
2.20	3,050	3.70	6,350	5.40	11,100	8.40	24,200
2.30	3,250	3.80	6,600	5.60	11,750	8.60	25,300
2.40	3,450	3.90	6,850	5.80	12,450	8.80	26,400
2.50	3,650	4.00	7,100	6.00	13,200	9.00	27,500
2.60	3,850	4.10	7,375	6.20	13,950	9.50	30,300
2.70	4,050	4.20	7,650	6.40	14,750	10.00	33,300
2.80	4,250	4.30	7,925	6.60	15,550	10.50	36,550
2.90	4,475	4.40	8,200	6.80	16,400	11.00	39,800
3.00	4,700	4.50	8,475	7.00	17,300	11.50	43,200
3.10	4,925	4.60	8,750	7.20	18,200	12.00	46,900
3.20	5,150	4.70	9,025	7.40	19,100		
3.30	5,375	4.80	9,300	7.60	20,100		

The above table is applicable only for open-channel conditions. It is based on seven discharge measurements made during 1905, and is well defined between gage heights 6 feet and 8 feet.

Station rating table for Kansas River at Lecompton, Kans., from September 22 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.60	2,000	3.60	4,500	4.60	7,850	5.60	11,500
2.70	2,200	3.70	4,825	4.70	8,200	5.70	11,875
2.80	2,400	3.80	5,150	4.80	8,550	5.80	12,250
2.90	2,625	3.90	5,475	4.90	8,900	5.90	12,650
3.00	2,850	4.00	5,800	5.00	9,250	6.00	13,050
3.10	3,100	4.10	6,125	5.10	9,625	6.20	13,850
3.20	3,350	4.20	6,450	5.20	10,000	6.40	14,675
3.30	3,625	4.30	6,800	5.30	10,375	6.60	15,525
3.40	3,900	4.40	7,150	5.40	10,750	6.80	16,400
3.50	4,200	4.50	7,500	5.50	11,125	7.00	17,300

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during 1905, and is not well defined.

Estimated monthly discharge of Kansas River at Lecompton, Kans., for 1905.

[Drainage area, 58,550 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	7,925	2,525	5,932	364,700	0.101	0.116
February	21,600	6,600	9,008	500,300	.154	.160
March	20,600	8,750	14,370	883,600	.245	.282
April	9,025	4,250	6,402	380,900	.109	.122
May	43,200	6,350	13,930	856,500	.238	.274
June	32,700	6,975	14,180	843,800	.242	.270
July	49,150	8,475	21,850	1,344,000	.373	.430
August	20,850	7,375	14,640	900,200	.250	.288
September	54,300	6,225	16,570	986,000	.283	.316
October	11,500	2,200	4,811	295,800	.082	.095
November	10,750	2,000	5,337	317,600	.091	.102
December	7,850	3,350	5,035	309,600	.086	.099
The year	54,300	2,000	11,010	7,983,000	.188	2.55

NOTE.—Ice conditions uncertain; discharge applied as for open channel.

BLUE RIVER NEAR MANHATTAN, KANS.

This station was established April 12, 1895. It is located at the county bridge 4 miles north of Manhattan, Kans.

The channel is straight for 200 feet above and below the station and has a width of 225 feet at ordinary stages. Both banks are subject to overflow during very high floods, the left bank being the lower of the two. The bed of the stream is composed of sand, clay, and silt and is free from vegetation and slightly shifting. There is but one channel at low stages; but during very high floods there are five channels or more. The current is sluggish at low and swift at high stages.

Discharge measurements are made from the bridge, which ordinarily spans the entire channel. The initial point for soundings is at the south end of the bridge.

The gage, which was read once each day during 1905 by J. M. Deckert, is in three sections. The first section, used for low-water readings, is a chain gage on the hand railing on the east

side and south end of the bridge, reading from zero to 14 feet from a scale spiked to the hand rail. The second section is an oak rod, reading from 11.3 to 17 feet, spiked to the north face of the south pier. The third section is a similar rod, graduated from 17 to 30 feet, bolted to the south side of the south pier. The gage is referred to bench marks, as follows: (1) A cross cut in the capstone of the south bridge pier immediately above the upper gage; elevation, 32.14 feet above gage datum. (2) A cross near the top of the second stone from the ground in the northwest corner of the south abutment; elevation, 27.32 feet above the zero of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Report; Bull=Bulletin; WS=Water-Supply Paper).

Description: Ann 18, iv, pp 215–216; Bull 140, p 144; WS 16, p 115; 27, p 90; 37, p 252; 50, p 317; 66, p 46; 84, pp 97–98; 99, p 211; 131, p 111.

Discharge: Ann 18, iv, p 216; Bull 140, p 144; WS 16, p 115; 27, p 95; 37, p 252; 50, p 317; 66, p 46; 84, p 98; 99, p 212; 131, p 114.

Discharge, monthly: Ann 18, iv, p 218; 19, iv, p 348; 20, iv, pp 312, 319; 21, iv, p 227; 22, iv, p 337; WS 75, p 143; 84, p 99; 99, p 213; 131, p 117.

Discharge, yearly: Ann 20, iv, p 56.

Gage heights: Bull 140, p 145; WS 11, p 59; 16, p 115; 27, p 94; 37, p 253; 50, p 318; 66, p 46; 84, p 98; 99, p 212; 131, p 115.

Hydrographs: Ann 18, iv, p 219; 19, iv, p 349; 20, iv, p 319; 21, iv, p 227; 22, iv, p 337.

Rainfall and run-off relation: Ann 20, iv, p 313.

Rating tables: Ann 18, iv, p 217; 19, iv, p 348; WS 27, p 96; 39, p 449; 52, p 518; 66, p 172; 84, p 99; 99, p 213; 131, p 116.

Discharge measurements of Blue River near Manhattan, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 24	W. G. Russell	215	1,135	2.35	7.60	2,670
July 10	J. C. Stevens	223	1,470	2.67	9.33	3,826
August 16	W. G. Russell	208	556	1.86	5.80	1,032
October 5	do	212	601	2.06	6.10	1,234

Daily gage height, in feet, of Blue River near Manhattan, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	5.8	5.9	14.4	6.0	7.5	18.85	9.1	7.2	5.9	6.7
2	5.9	5.8	13.5	6.0	7.1	17.6	11.1	7.0	5.8	6.4
3	5.9	5.8	13.3	5.95	6.9	12.8	12.5	7.3	5.6	6.4
4	6.0	5.8	12.9	6.0	6.7	10.7	13.0	8.4	5.55	6.3
5	5.9	5.9	12.4	6.0	6.5	9.75	13.1	7.9	5.5	6.1
6	5.8	6.0	11.7	5.95	6.4	10.3	12.1	7.2	5.6	6.0
7	5.8	6.1	9.7	5.9	6.2	10.1	11.0	6.8	5.6	6.0
8	5.7	6.0	8.7	5.9	6.1	8.2	10.8	9.0	5.65	5.9
9	5.7	6.0	8.2	6.0	6.1	7.7	11.4	7.3	5.6	5.8
10	5.7	6.0	7.8	5.8	9.2	7.4	9.8	7.1	5.6	5.8
11	5.8	6.1	7.5	5.9	7.75	7.15	8.85	7.4	5.6	5.75
12	5.7	6.1	7.2	5.9	6.5	6.9	7.9	6.8	5.7	5.7
13	5.9	6.0	7.1	5.85	6.8	6.8	7.45	6.3	5.8	5.65
14	5.6	5.0	6.9	5.8	13.2	6.75	7.1	6.15	6.45	5.6
15	5.7	5.0	6.8	5.7	14.5	6.6	6.9	6.0	5.8	5.6
16	5.8	5.1	6.7	5.7	12.8	6.6	6.7	5.8	16.2	5.65
17	5.8	5.1	6.75	5.65	10.8	7.0	6.6	5.75	21.1	5.7
18	5.9	5.1	6.8	5.7	10.65	8.7	6.45	5.6	13.5	5.7
19	5.9	5.2	7.1	5.65	12.3	7.9	6.3	15.2	13.5	5.75
20	5.9	5.2	7.0	5.6	11.6	8.1	6.2	13.1	14.1	5.8
21	5.8	5.3	6.85	5.6	9.8	7.7	7.0	8.65	10.5	5.75
22	5.8	7.1	6.7	5.8	8.9	7.45	7.6	8.2	9.7	6.4
23	5.8	9.0	6.7	6.5	8.2	8.2	7.1	8.55	9.5	6.0
24	5.8	9.8	6.65	6.1	7.6	8.1	6.9	8.5	9.45	5.85
25	5.7	10.0	6.6	6.2	11.3	7.85	6.7	7.5	9.1	5.8
26	5.7	12.8	6.5	8.7	8.9	8.0	6.75	7.7	8.65	5.7
27	5.8	14.9	6.4	9.6	7.2	7.8	6.8	6.9	8.2	5.6
28	5.7	14.0	6.3	8.25	7.7	7.9	7.3	6.7	7.7	5.6
29	5.7	.....	6.2	8.0	9.2	9.6	7.5	6.45	7.3	5.5
30	5.9	.....	6.1	7.8	12.5	10.8	7.9	6.2	6.9	5.45
31	6.0	.....	6.1	.....	17.8	.....	8.0	6.1	.....	5.5

Station rating table for Blue River near Manhattan, Kans., from January 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
5.00	650	6.50	1,510	8.00	2,680	11.00	5,810
5.10	700	6.60	1,580	8.20	2,850	11.50	6,470
5.20	750	6.70	1,650	8.40	3,020	12.00	7,190
5.30	800	6.80	1,720	8.60	3,190	12.50	7,940
5.40	850	6.90	1,790	8.80	3,370	13.00	8,690
5.50	900	7.00	1,860	9.00	3,550	13.50	9,440
5.60	960	7.10	1,930	9.20	3,740	14.00	10,200
5.70	1,020	7.20	2,010	9.40	3,940	14.50	10,990
5.80	1,080	7.30	2,090	9.60	4,150	15.00	11,800
5.90	1,140	7.40	2,170	9.80	4,370	15.50	12,640
6.00	1,200	7.50	2,255	10.00	4,600	16.00	13,490
6.10	1,260	7.60	2,340	10.20	4,830	16.50	14,340
6.20	1,320	7.70	2,425	10.40	5,070	17.00	15,190
6.30	1,380	7.80	2,510	10.60	5,310	17.50	16,040
6.40	1,440	7.90	2,595	10.80	5,560	18.00	16,900

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1903 and 1905, and is fairly well defined.

Estimated monthly discharge of Blue River near Manhattan, Kans., for 1905.

[Drainage area, 9,490 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	1,200	1,020	1,082	66,530	0.114	0.131
February	11,640	650	2,346	130,300	.247	.257
March	10,830	1,260	3,237	199,000	.341	.393
April	4,150	960	1,460	86,880	.154	.172
May	16,550	1,260	4,282	263,300	.451	.520
June	18,440	1,580	4,034	240,000	.425	.474
July	8,840	1,320	3,433	211,100	.362	.417
August	12,130	960	2,555	157,100	.269	.310
September	22,770	900	3,827	227,700	.403	.450
October	1,650	875	1,113	68,440	.117	.135
The period				1,650,000		

OSAGE RIVER DRAINAGE BASIN.

OSAGE RIVER AT OTTAWA, KANS.

Osage (Marais des Cygnes) River rises in the prairies of eastern Kansas, about 30 miles southwest of Topeka, and flows southeastward to its junction with the Missouri, near Jefferson City, Mo. The entire length of the stream, measured along the general trend of the valley, the minor bends being neglected, is about 280 miles, but its actual length is probably at least 500 miles, and the total area of the basin is about 15,300 square miles.

The eastern portion of the basin has a diversified surface, varying from the level alluvial bottoms of the streams to broken hilly uplands. It is covered with a thick growth of timber, including oak, elm, walnut, ash, maple, and many other varieties of trees. To the west the surface of the country becomes more gently undulating, the timber gradually disappears from the uplands, and the region finally merges with the great prairies which extend unbroken to the Rocky Mountains. The river winds through an alluvial bottom land, approaching first one bluff and then the other. The bed is generally gravel, especially on the shoals. The banks are gravelly and stable and range from 18 to 35 feet in height above low water. The stream has no mountain tributaries, but depends for its water supply entirely on the precipitation within its basin. This ranges from 35 to 40 inches each year. The basin contains no lakes or marshes of any extent.

The region is rich in mineral resources, and the gently rolling prairies of the western half and the valleys and river bottoms of the eastern half are well adapted to agriculture. About 62 per cent of the area is under cultivation and 10 per cent is timbered. Large quantities of coal are mined at Osage, Burlingame, Scranton, and Carbondale.

High water is frequent in the stream, but there is little danger of floods unless the rainfall is very heavy, sudden, or of long duration. The danger line is about 25 feet on the gage. The worst flood since the establishment of the gaging station at Ottawa was in 1904, when the water rose to 34.4 feet and flooded all the lower bottom lands, doing much damage to farms, towns, and cities along the course and stopping all railroad traffic for some time.

The gaging station was established August 26, 1902. It is located at the highway bridge on Main street near the center of the town of Ottawa, Kans.

The channel is slightly curved at the station, and both banks are high, but overflow at extreme flood stages. The bed of the stream is composed of rock, with small bowlders.

Discharge measurements are made from the highway bridge, which has a span of 135 feet between abutments and is somewhat oblique to the trend of the stream. The initial point

for soundings is the south end of the bridge, downstream side. At low stages the discharge can be measured by wading a short distance below the bridge.

The gage was read once each day during 1905 by W. H. Blacksten. The first gage was of the old wire type, with its scale spiked to the bridge floor. This gage was destroyed by the flood of May 30, 1904. A temporary gage was installed June 3, 1904. A new gage was put in September 9, 1904, as the water had left the temporary gage. This is a standard chain gage, placed on the outside of the hand rail on the downstream side of the bridge. The length of the chain is 30.9 feet. The gage rod is bolted to the hand rail and graduated from zero to 32 feet. The bench mark is the top of the hydrant cap on the north side of the river about 50 feet from the northeast corner of the bridge; elevation 31.34 feet above gage datum.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 41; 130, p 187.
Discharge: 99, p 42; 130, p 188.
Gage heights: 99, p 42; 130, p 188.

Discharge measurements of Osage River at Ottawa, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 28	W. G. Russell	130	192	3.16	2.40	607
May 11	do	129	128	1.73	1.90	221
May 30	do	133	486	4.19	4.60	2,039
June 17	do	75	58	.67	1.40	39
August 17	do	77	64	.97	1.50	62
September 20	do	138	3,401	4.68	26.15	15,920
September 21	do	138	3,159	4.34	24.45	13,710
September 21	do	138	2,675	3.76	20.80	10,060
September 22	do	133	951	2.80	7.07	2,659
October 10	do	87	83	1.48	1.30	123

Daily gage height, in feet, of Osage River near Ottawa, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.4	1.3	2.5	2.9	1.9	2.5	1.9	2.6	1.35	1.6
2	1.4	1.3	2.0	2.6	1.8	2.2	6.55	2.2	1.3	1.5
3	1.4	1.3	2.0	2.4	1.7	2.1	24.8	2.0	1.3	1.5
4	1.4	1.3	1.9	2.3	1.7	2.0	25.45	2.1	1.8	1.5
5	1.3	1.3	1.8	2.2	1.7	2.0	23.2	3.1	1.6	1.5
6	1.3	1.3	1.6	2.15	1.7	1.9	9.25	2.3	1.7	1.45
7	1.3	1.3	1.6	2.1	1.7	1.8	3.2	2.0	1.7	1.4
8	1.3	1.3	1.6	2.1	1.7	1.8	2.7	1.8	1.7	1.3
9	1.3	1.3	1.5	1.9	2.1	1.6	2.6	1.7	2.3	1.3
10	1.3	1.3	1.6	1.9	2.2	1.6	2.7	1.6	12.35	1.3
11	1.3	1.3	1.5	1.8	2.0	1.5	2.5	1.6	8.6	1.3
12	1.3	1.3	1.4	1.7	1.8	1.5	2.2	1.5	3.1	1.3
13	1.3	1.3	1.5	1.7	2.2	1.5	2.15	1.5	2.2	1.3
14	1.3	1.3	1.5	1.7	2.1	1.45	2.0	1.5	2.1	1.2
15	1.3	1.3	1.5	1.7	2.1	1.4	1.9	1.6	15.35	1.2
16	1.3	1.3	1.5	1.6	2.0	1.4	1.9	1.5	23.45	1.2
17	1.3	1.3	1.45	1.6	1.9	1.4	1.8	1.4	17.85	1.2
18	1.3	1.3	2.9	1.6	1.8	1.35	1.7	3.55	21.95	1.15
19	1.3	1.3	3.3	1.6	1.7	1.6	1.7	10.8	26.28	1.4
20	1.3	1.3	3.1	1.55	1.6	1.8	1.7	3.4	26.18	1.3
21	1.3	1.3	2.5	1.6	1.6	1.7	1.6	2.9	22.15	1.2
22	1.3	2.15	1.65	1.55	1.5	1.6	1.6	2.0	5.35	1.2
23	1.4	4.2	2.2	1.6	1.5	1.6	1.6	1.8	2.7	1.2
24	1.3	5.9	2.9	1.5	1.5	1.5	1.5	1.7	2.6	1.2
25	1.2	6.0	3.05	1.6	3.55	1.5	1.5	1.7	2.2	1.2
26	1.4	4.9	2.4	2.3	16.08	1.4	1.5	1.5	2.0	1.3
27	1.3	3.3	2.15	2.6	14.45	1.5	7.5	1.5	1.9	1.2
28	1.3	2.8	11.27	2.4	3.48	1.5	9.7	1.4	1.7	1.3
29	1.2	.....	17.0	2.1	4.35	2.2	3.75	1.4	1.7	1.3
30	1.2	.....	12.4	2.0	4.4	2.0	2.5	1.4	1.6	1.3
31	1.3	.....	4.2	.....	3.2	.....	2.6	1.4	.....	1.3

GASCONADE RIVER DRAINAGE BASIN.

GASCONADE RIVER AT ARLINGTON, MO.

Gasconade River is formed by Piney, Lock, and Osage forks, which rise in southern Missouri and unite in Laclede and Pulaski counties. From the junction of the forks to the point where the Gasconade enters the Missouri the distance by general course is about 60 miles, but accurately measured along the stream it is probably over 100 miles. The basin comprises a total area of 3,667 square miles. The headwater region is an elevated table-land belonging to the Ozark Range of hills. The surface is irregular and along the streams becomes very rough and broken. The streams, which are bordered by alluvial bottom lands varying in width from a few hundred feet to a half mile, are supplied by a great number of springs, many of which are of large size.

The valley averages half a mile in width and is bordered by bluffs 100 to 200 feet high. The bed is usually gravel on the shoals, with considerable sand and mud in the pools. The banks are about 20 feet high on the lower river and show a deposit of alluvial soil, with sand and gravel underneath. The rock occurring along the stream is mainly limestone and sand stone.

The gaging station was established April 11, 1903. It was at first located about 2 miles below Arlington, on the right bank of the river; but owing to the impossibility of maintaining a cable across the river during high water the station was moved July 27, 1904, to the

St. Louis and San Francisco railroad bridge, 1¼ miles upstream from the cable and one-fourth mile west of Arlington, Mo.

The channel is straight for about 1,000 feet above and below the bridge. Both banks are fairly high, partly wooded, and not liable to overflow except during very high stages. The bed of the stream is composed of clean gravel and rock and is practically permanent. There is a swift, direct current. At all stages the water passes between the abutments of the bridge.

Discharge measurements are made from the three-span railroad bridge, which has a total length of 431 feet between abutments. The meter is operated from the upstream lower chord of the trusses. The initial point for soundings is at the top of the inner face of the right abutment.

The gage was read during 1905 by C. W. Harrison. The gage at the old location was a vertical rod fastened to a leaning willow tree. The new gage is of the standard chain type. The length of the chain is 33.50 feet. The pulley center is 0.53 foot to the left of the zero of the gage, which is 117.01 feet from the initial point for soundings. The bench mark is located on the top surface of a cap on the upstream lower chord just to the right of the fifth panel point from the right abutment and is designated by a dent in the upper surface of the cap; elevation above gage datum 28.85 feet. The elevation of the pulley center above the zero of the gage is 32.75 feet.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 36; 130, pp 188-189.
Discharge: 99, p 36; 130, p 190.
Discharge, monthly: 99, p 38; 130, p 191.
Gage heights: 99, p 37; 130, p 190.
Rating table: 99, p 37; 130, p 191.

Discharge measurements of Gasconade River at Arlington, Mo., 1904–5.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1904.		*Feet.*	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 11	F. W. Hanna	410	2,415	3.32	6.85	8,025
April 27	do	410	4,029	4.20	10.75	16,910
June 14	Hanna and Murphy	410	1,138	1.78	4.07	2,032
1905.						
April 7	M. S. Brennan	318	1,104	1.52	3.80	1,677
May 14	S. K. Clapp	413	1,944	2.93	5.75	5,700
June 21	F. W. Hanna	276	838	1.01	2.85	844
July 25	M. S. Brennan	410	2,049	2.58	6.16	5,283
September 7	do	323	1,071	1.38	3.81	1,479
October 11	do	312	982	1.36	3.55	1,334
December 9	do	301	948	1.32	3.41	1,255

NOTE.—Gage heights all refer to gage established July 26, 1904, at St. Louis and San Francisco railroad bridge.

Daily gage height, in feet, of Gasconade River at Arlington, Mo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.85	2.65	6.8	3.95	4.1	4.0	3.7	10.3	4.3	4.3	5.8	3.5
2	2.8	2.7	6.4	3.9	4.0	3.85	3.45	9.5	4.1	4.15	5.2	3.45
3	2.85	2.85	5.9	3.85	4.5	4.0	3.4	8.4	3.8	4.0	4.85	3.3
4	2.8	2.8	5.1	3.8	3.8	3.95	4.0	7.8	3.8	3.9	4.6	3.6
5	2.8	2.85	4.9	3.75	3.75	3.8	4.15	7.7	3.6	3.75	5.5	3.65
6	2.85	2.85	4.7	3.7	3.3	3.4	4.0	6.7	3.65	3.5	6.0	3.5
7	2.8	2.9	5.0	3.65	3.5	3.0	3.85	6.5	4.4	3.45	6.8	3.45
8	2.75	2.85	10.5	3.6	5.1	2.85	3.7	6.4	4.5	3.4	6.9	3.3
9	2.9	2.9	13.5	3.2	6.5	2.5	3.25	4.9	4.6	3.3	6.8	3.25
10	2.85	2.9	11.5	3.15	6.3	2.5	3.45	4.5	4.6	3.6	6.4	3.2
11	2.9	2.9	7.5	3.6	6.2	2.6	3.9	4.3	6.3	3.5	5.0	3.15
12	2.9	2.85	6.5	3.55	5.8	2.55	6.0	3.95	5.8	3.45	4.85	2.9
13	3.0	2.8	5.0	3.7	5.9	2.4	5.7	3.7	5.1	3.2	4.5	2.9
14	2.95	2.85	4.5	3.65	5.8	2.25	5.5	4.5	4.8	3.3	4.3	2.85
15	2.8	2.8	4.3	3.7	7.0	2.2	5.3	4.4	4.0	3.3	4.15	2.8
16	2.95	2.8	4.25	3.75	9.0	3.1	5.25	4.6	3.95	3.15	4.2	2.75
17	2.95	2.85	4.2	3.7	8.0	3.5	4.9	5.4	13.8	3.5	4.0	3.35
18	3.0	2.8	4.3	3.4	5.5	3.15	3.8	5.4	12.5	5.4	3.85	3.3
19	3.1	2.85	4.5	3.35	5.0	3.0	3.6	7.4	16.5	9.3	4.2	3.25
20	3.2	2.8	4.3	3.3	4.5	3.5	3.4	7.0	13.6	7.6	4.3	3.2
21	3.1	2.85	4.1	3.3	4.4	3.3	8.5	7.5	14.0	5.0	4.15	3.1
22	3.05	2.95	3.9	3.25	4.5	3.2	15.7	7.2	10.4	4.85	4.0	3.2
23	3.05	3.0	3.75	3.2	6.1	2.95	20.3	7.5	7.4	4.5	4.05	3.4
24	2.9	3.35	4.0	3.1	5.1	2.9	8.5	7.8	6.3	4.45	3.85	3.45
25	2.8	4.4	3.9	3.4	5.5	2.7	6.3	7.6	5.8	8.5	3.8	3.5
26	2.8	5.9	3.85	4.5	5.1	2.8	5.8	7.3	5.8	9.4	3.6	3.5
27	2.75	6.4	3.7	4.7	4.9	2.75	5.4	6.8	5.0	8.8	3.6	3.4
28	2.8	7.4	3.55	4.8	4.5	2.7	10.9	5.1	4.8	8.5	3.65	3.6
29	2.75	.....	3.75	4.8	4.3	3.2	16.3	5.0	4.7	5.9	3.6	3.75
30	2.7	.....	3.8	4.2	4.0	3.4	19.1	5.1	3.95	5.6	3.45	3.6
31	2.7	.....	3.9	.....	3.8	.....	18.4	4.8	.....	5.7	.....	3.8

NOTE.—Ice conditions not sufficient to modify flow.

Station rating table for Gasconade River at Arlington, Mo., from July 26, 1904, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-feet.*	*Feet.*	*Sec.-feet.*
2.20	300	3.70	1,520	5.40	4,710	9.00	12,700
2.30	350	3.80	1,660	5.60	5,130	9.50	13,850
2.40	400	3.90	1,820	5.80	5,560	10.00	15,050
2.50	450	4.00	1,990	6.00	6,000	10.50	16,250
2.60	510	4.10	2,160	6.20	6,440	11.00	17,500
2.70	570	4.20	2,340	6.40	6,880	11.50	18,800
2.80	630	4.30	2,520	6.60	7,320	12.00	20,100
2.90	700	4.40	2,710	6.80	7,760	12.50	21,440
3.00	780	4.50	2,900	7.00	8,200	13.00	22,800
3.10	870	4.60	3,100	7.20	8,640	13.50	24,200
3.20	965	4.70	3,300	7.40	9,080	14.00	25,600
3.30	1,060	4.80	3,500	7.60	9,520	15.00	28,400
3.40	1,160	4.90	3,700	7.80	9,960	16.00	31,400
3.50	1,270	5.00	3,900	8.00	10,400	17.00	34,400
3.60	1,390	5.20	4,300	8.50	11,550	18.00	37,600

The above table is applicable only for open-channel conditions. It is based on twelve discharge measurements made during 1904–5, and is well defined between gage heights 2.8 feet and 10.75 feet. The table has been extended beyond these limits; above gage height 17 feet the rating curve is a tangent, the difference being 320 per tenth.

Estimated monthly discharge of Gasconade River at Arlington, Mo., for 1904 and 1905.

[Drainage area, 2,725 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1904.						
July	9,108	965	2,580	158,600	0.947	1.09
August	3,900	630	1,256	77,230	.461	.532
September	1,330	740	903	53,730	.331	.369
October	1,110	570	743	45,680	.273	.315
November	700	510	571	33,980	.210	.234
December	740	510	647	39,780	.237	.273
The period				409,000		
1905.						
January	965	570	696	42,800	0.255	0.294
February	9,080	540	1,456	80,860	.534	.556
March	24,200	1,330	4,908	301,800	1.80	2.08
April	3,500	870	1,641	97,650	.602	.672
May	12,700	1,060	4,341	266,900	1.59	1.83
June	1,990	300	899	53,490	.330	.368
July	44,960	1,012	9,534	586,200	3.50	4.04
August	15,770	1,520	6,744	414,700	2.47	2.85
September	32,900	1,390	7,710	458,800	2.83	3.16
October	13,620	918	4,195	257,900	1.54	1.78
November	7,980	1,215	3,350	199,300	1.23	1.37
December	1,660	600	1,104	67,880	.405	.467
The year	44,960	300	3,882	2,828,000	1.42	19.46

NOTE.—The estimate for July 26 to August 11, as published in the 1904 report, has been revised.

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1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35, 36, 37, 38, and 39; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47, 48, 49, 50, 51, and 52; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.

1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers, Nos. 124, 125, 126, 127, 128, and 129.
West of Mississippi River, Water-Supply Papers Nos. 130, 131, 132, 133, 134, and 135.
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AUGUST, 1906.

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