DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPER 285

SURFACE WATER SUPPLY OF THE UNITED STATES

1910

PART V. HUDSON BAY AND UPPER MISSISSIPPI RIVER

PREPARED UNDER THE DIRECTION OF M. O. LEIGHTON

BY

ROBERT FOLLANSBEE, A. H. HORTON
AND G. C. STEVENS

WASHINGTON
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By Robert Follansbee, A. H. Horton, and G. C. Stevens.

INTRODUCTION.

AUTHORITY FOR INVESTIGATIONS.

This volume contains results of measurements of the flow of certain streams in the United States. The work was performed by the United States Geological Survey, either independently or in cooperation with private or State organizations. The organic law of the Geological Survey (Stat. L., vol. 20, p. 394) contains the following paragraph:

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

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

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

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

Annual appropriations for the fiscal year ending June 30—

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

SCOPE OF INVESTIGATIONS.

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

It is essential that records of stream flow shall be kept during a period of years long enough to determine within reasonable limits the entire range of flow from the absolute maximum to the absolute minimum. The length of such a period manifestly differs for different streams. Experience has shown that the records for some streams should cover 5 to 10 years, and those for other streams 20 years or even more, the limit being determined by the relative importance of the stream and the interdependence of the results with other long-time records on adjacent streams.

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

Records have been obtained at nearly 2,000 different points in the United States. The surface water supply of small areas in Seward Peninsula and the Yukon-Tanana region, Alaska, and in Hawaii has also been investigated. During 1910 regular gaging stations were maintained by the Survey and cooperating organizations at about 1,100 points in the United States, and many discharge measurements were made at other points. Data were also obtained in regard to precipitation, evaporation, storage reservoirs, river profiles, and water power in many sections of the country, and will be made available in the regular surface water-supply papers and in special papers from time to time.

PUBLICATIONS.

The data on stream flow collected by the United States Geological Survey have appeared in the annual reports, bulletins, and water-supply papers. Owing to natural processes of evolution and to changes in governmental requirements the character of the work and the territory covered by these different publications have varied greatly. For the purpose of uniformity in the presentation of reports a general plan has been agreed upon by the United States Reclamation Service, the United States Forest Service, the United States Weather Bureau, and the United States Geological Survey, according to which the area of the United States has been divided into twelve parts, whose boundaries coincide with certain natural drainage lines. The areas so described are indicated by the following list of papers on surface water supply for 1910. The dividing line between the north Atlantic and south Atlantic drainage areas lies between York and James rivers.

Papers on surface water supply of the United States, 1910.

Part.	No.	Title.
I	281	North Atlantic coast.
II	282	South Atlantic coast and eastern Gulf of Mexico.
III	283	Ohio River basin.
IV	284	St. Lawrence River basin.
V	285	Upper Mississippi River and Hudson Bay basins.
VI	286	Missouri River basin.
VII	287	Lower Mississippi River basin.
VIII	288	Western Gulf of Mexico.
IX	289	Colorado River basin.
X	290	Great basin.
XI	291	California, Pacific coast.
XII	292	North Pacific coast.

The following table gives the character of data regarding stream flow at regular stations to be found in the various publications of the United States Geological Survey, exclusive of special papers:

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

[A=Annual Report; B=Bulletin; WS=Water-Supply Paper.]

Report.	Character of data.	Year.
10th A, pt. 2	Descriptive information only	
11th A, pt. 2	Monthly discharge	1884 to Sept., 1890.
12th A, pt. 2	....do	1884 to June 30, 1891.
13th A, pt. 3	Mean discharge in second-feet	1884 to Dec. 31, 1892.
14th A, pt. 2	Monthly discharge (long-time records, 1871 to 1893)	1888 to Dec. 31, 1893.
B 131	Descriptions, measurements, gage heights, and ratings	1893 and 1894.
16th A, pt. 2	Descriptive information only	
B 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
WS 11	Gage heights (also gage heights for earlier years)	1896.
18th A, pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for earlier years).	1895 and 1896.
WS 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.

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

Report.	Character of data.	Year.
WS 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th A, pt. 4	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
WS 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1898.
WS 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th A, pt. 4	Monthly discharge (also for many earlier years)	1898.
WS 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.
21st A, pt. 4	Monthly discharge	1899.
WS 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.
22d A, pt. 4	Monthly discharge	1900.
WS 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
WS 75	Monthly discharge	1901.
WS 82 to 85	Complete data	1902.
WS 97 to 100	do	1903.
WS 124 to 135	do	1904.
WS 165 to 178	do	1905.
WS 201 to 214	Complete data, except descriptions	1906.
WS 241 to 252	Complete data	1907-8.
WS 261 to 272	do	1909.
WS 281 to 292	do	1910.

NOTE.—No data regarding stream flow are given in the fifteenth and seventeenth annual reports.

The records at most of the stations discussed in these reports extend over a series of years. An index of the reports containing records prior to 1904 has been published in Water-Supply Paper 119.

The first table which follows gives, by years and drainage basins, the numbers of the papers on surface water supply published from 1899 to 1910. Wherever the data for a drainage basin appear in two papers the number of one is placed in parentheses and the portion of the basin covered by that paper is indicated in the second table. For example, in 1904 the data for Missouri River were published in Water-Supply Papers 130 and 131, and the portion of the records contained in Water-Supply Paper 131, as indicated by the second table, is that relating to Platte and Kansas rivers.

Numbers of water-supply papers containing results of stream measurements, 1899–1910.

	1899 [1]	1900 [2]	1901	1902	1903
Atlantic coast and eastern Gulf of Mexico:					
New England rivers	35	47	65,75	82	97
Hudson River to Delaware River, inclusive	35	47,(48)	65,75	82	97
Susquehanna River to York River, inclusive	35	48	65,75	82	97
James River to Yadkin River, inclusive	(35),36	48	65,75	(82),83	(97),98
Santee River to Pearl River, inclusive	36	48	65,75	83	98
St. Lawrence River	36	49	65,75	(82),83	97
Hudson Bay	....	....	66,75	85	100
Mississippi River:					
Ohio River	36	48,(49)	65,75	83	98
Upper Mississippi River	36	49	65,75	83	98,(99)
Missouri River	(36),37	49,(50)	66,75	84	99
Lower Mississippi River	37	50	(65), 66,75	(83),84	(98),99
Western Gulf of Mexico	37	50	66,75	84	99
Pacific coast and Great Basin:					
Colorado River	(37),38	50	66,75	85	100
Great Basin	38,(39)	51	66,75	85	100
South Pacific coast to Klamath River, inclusive	(38),39	51	66,75	85	100
North Pacific coast	38	51	66,75	85	100

[1] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39.
[2] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52.

Numbers of water-supply papers containing results of stream measurements, 1899–1910—Continued.

	1904	1905	1906	1907–8	1909	1910
Atlantic coast and eastern Gulf of Mexico:						
New England rivers	124	165	201	241	261	281
Hudson River to Delaware River, inclusive	125	166	202	241	261	281
Susquehanna River to York River, inclusive	126	167	203	241	261	281
James River to Yadkin River, inclusive	126	167	203	242	262	282
Santee River to Pearl River, inclusive	127	168	204	242	262	282
St. Lawrence River	129	170	206	244	264	284
Hudson Bay	130	171	207	245	265	285
Mississippi River:						
Ohio River	128	169	205	243	263	283
Upper Mississippi River	128, (130)	171	207	245	265	285
Missouri River	130, (131)	172	208	246	266	286
Lower Mississippi River	(128), 131	(169), 173	(205), 209	247	267	287
Western Gulf of Mexico	132	174	210	248	268	288
Pacific coast and Great Basin:						
Colorado River	133, (134)	175, (177)	211, (213)	249, (251)	269, (271)	289
Great Basin	133, (134)	176, (177)	212, (213)	250, (251)	270, (271)	290
South Pacific coast to Klamath River, inclusive	134	177	213	251	271	291
North Pacific coast	135	(177), 178	214	252	272	292

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

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

The order of treatment of stations in any basin in these papers is downstream. The main stem of any river is determined by measuring or estimating the drainage area; that is, the headwater stream having the largest drainage area is considered the continuation of the main stream, and local changes in name and lake surface are disregarded. Records for all stations from the source to the mouth of the main stem of the river are presented first, and records for the tributaries in regular order from source to mouth follow, all records in each tributary basin being given before those of the next basin below.

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

DEFINITION OF TERMS.

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

"Second-foot" is an abbreviation for cubic foot per second and is the rate of discharge of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second. It is generally used as a fundamental unit from which others are computed by the use of the factors given in the following table of equivalents.

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

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

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

CONVENIENT EQUIVALENTS.

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

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

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

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

1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,272 gallons for one day.

1 second-foot equals 6.23 British imperial gallons per second.

1 second-foot for one year covers 1 square mile 1.131 feet or 13.572 inches deep.
1 second-foot for one year equals 31,536,000 cubic feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot for one day covers 1 square mile 0.03719 inch deep.
1 second-foot for one 28-day month covers 1 square mile 1.041 inches deep.
1 second-foot for one 29-day month covers 1 square mile 1.079 inches deep.
1 second-foot for one 30-day month covers 1 square mile 1.116 inches deep.
1 second-foot for one 31-day month covers 1 square mile 1.153 inches deep.
1 second-foot for one day equals 1.983 acre-feet.
1 second-foot for one 28-day month equals 55.54 acre-feet.
1 second-foot for one 29-day month equals 57.52 acre-feet.
1 second-foot for one 30-day month equals 59.50 acre-feet.
1 second-foot for one 31-day month equals 61.49 acre-feet.
100 California miner's inches equals 18.7 United States gallons per second.
100 California miner's inches equals 96.0 Colorado miner's inches.
100 California miner's inches for one day equals 4.96 acre-feet.
100 Colorado miner's inches equals 2.60 second-feet.
100 Colorado miner's inches equals 19.5 United States gallons per second.
100 Colorado miner's inches equals 104 California miner's inches.
100 Colorado miner's inches for one day equals 5.17 acre-feet.
100 United States gallons per minute equals 0.223 second-foot.
100 United States gallons per minute for one day equals 0.442 acre-foot.
1,000,000 United States gallons per day equals 1.55 second-feet.
1,000,000 United States gallons equals 3.07 acre-feet.
1,000,000 cubic feet equals 22.95 acre-feet.
1 acre-foot equals 325,850 gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 foot equals 0.3048 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 5,280 feet.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet.
1 acre equals 209 feet square, nearly.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot equals 7.48 gallons.
1 cubic foot of water weighs 62.5 pounds.
1 cubic meter per minute equals 0.5886 second-feet.
1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76.0 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
1⅓ horsepower equals about 1 kilowatt.

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

EXPLANATION OF DATA.

For each drainage basin there is given a brief general description covering such items as area, source, tributaries, topography, geology, forestation, rainfall, irrigation, storage, power, and other interesting or important facts.

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

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

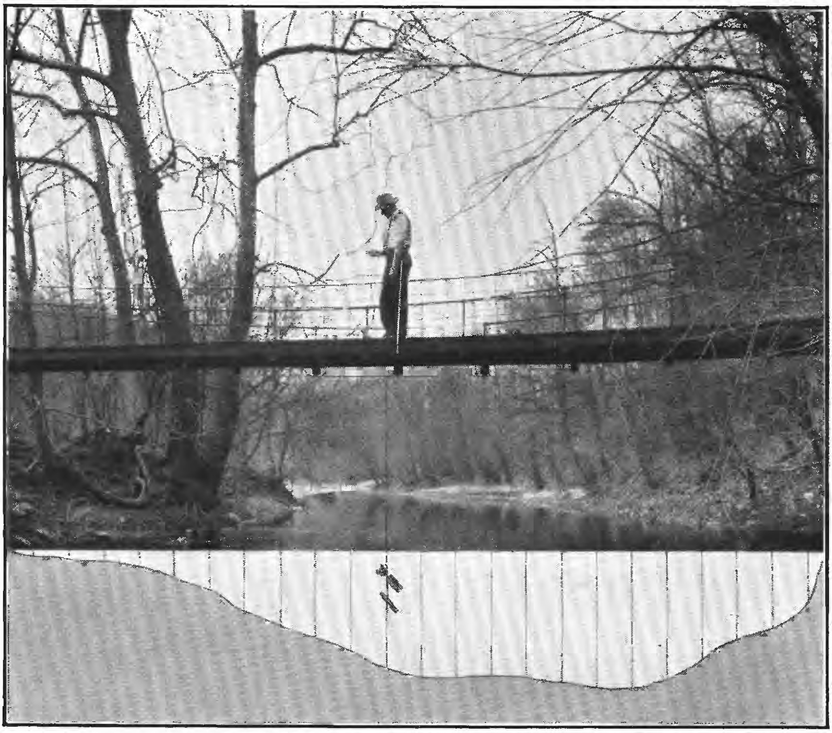
The discharge-measurement table gives the results of the discharge measurements made during the year, including the date, name of hydrographer, width and area of cross section, gage height, and discharge in second-feet.

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

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

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

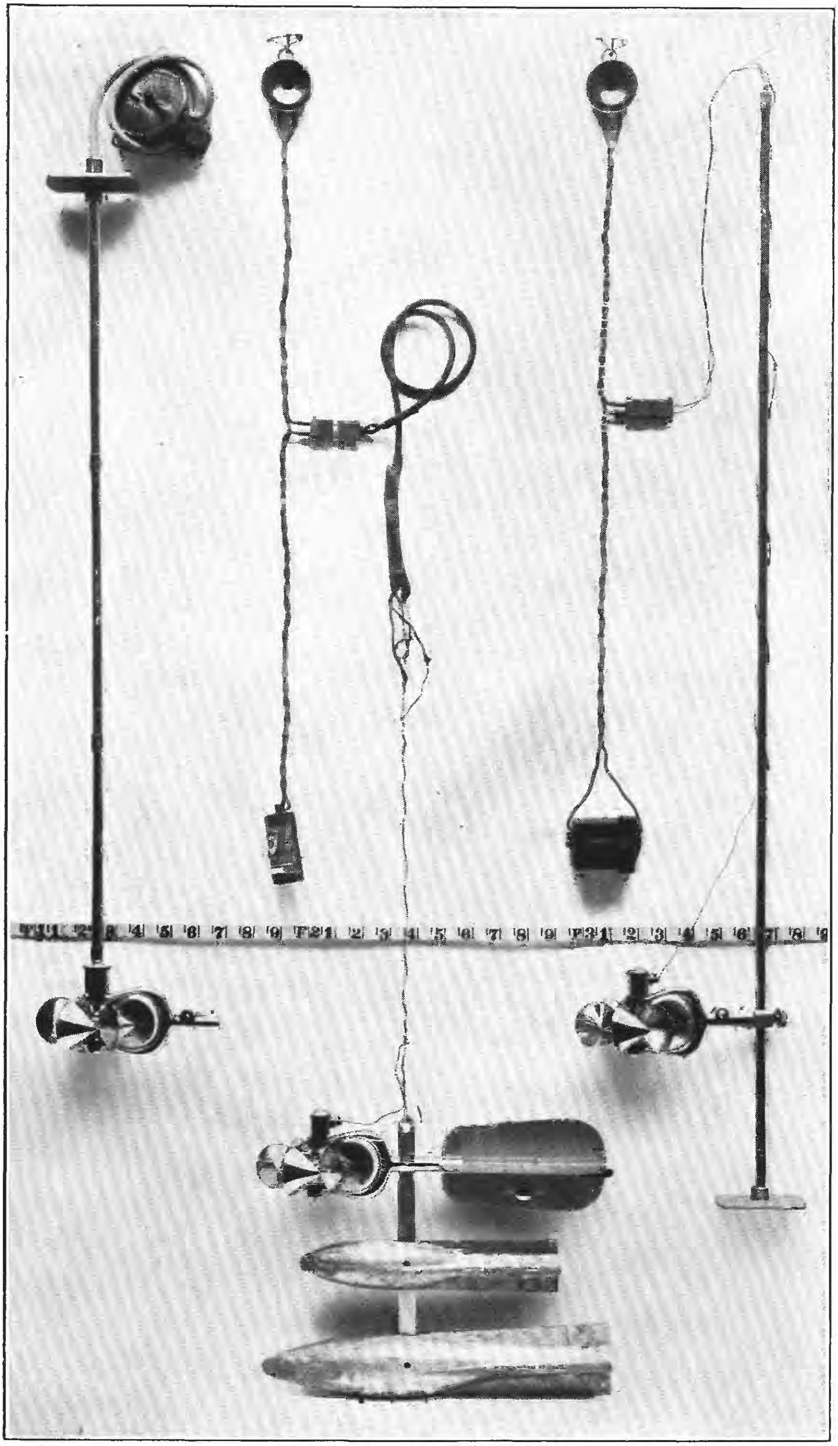
First plot the discharge measurements for the current and earlier years on cross-section paper, with gage heights in feet as ordinates and discharge in second-feet as abscissas. Then tabulate a number of gage heights taken from the daily gage-height table for the complete range of stage given and the corresponding discharges for the days selected from the daily discharge table and plot the values



A. FOR BRIDGE MEASUREMENT.

B. FOR WADING MEASUREMENT.

TYPICAL GAGING STATIONS.



SMALL PRICE CURRENT METERS.

on cross-section paper. The last points plotted will define the rating curve used and will lie among the plotted discharge measurements. After drawing the rating curve, a table can be developed by scaling off the discharge in second-feet for each tenth foot of gage height. These values should be so adjusted that the first differences shall always be increasing or constant, except for known backwater periods.

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

In the table of monthly discharge the column headed "Maximum" gives the mean flow, as determined from the rating table, for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge was consequently larger than given in the maximum column. Likewise, in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet for each second during the month. On this the computations for the remaining columns, which are defined on page 12, are based.

The field methods used in the collection of the data presented in this series of reports are described in the introductory sections of Water-Supply Papers 261 to 272, inclusive, "Surface water supply of the United States, 1909." Plate I shows typical gaging stations, indicating the method of suspending the current meter; Plate II shows the types of current meters [1] used in the work.

ACCURACY AND RELIABILITY OF FIELD DATA AND COMPARATIVE RESULTS.

The accuracy of stream-flow data depends primarily on the natural conditions at the gaging station and on the methods and care with which the data are collected. Errors of the first group depend on the degree of permanency of channel and of permanency of the relation between discharge and stage.

Errors of the second class are due, first, to errors in observation of stage; second, to errors in measurements of flow; and, third, to errors due to misinterpretation of stage and flow data.

Practically all discharge measurements made under fair conditions are well within 5 per cent of the true discharge at the time of observation. Inasmuch as the errors of meter measurements are largely

[1] See Hoyt, J. C., and others, Use and care of current meter as practiced by the U. S. Geol. Survey; Trans. Am. Soc. Civil Eng., vol. 66, 1910, p. 70.

compensating, the mean rating curve, when well defined, is much more accurate than the individual measurements. Numerous experiments made to test the accuracy of current-meter work show that it compares very favorably with the results from standard weirs and, owing to simplicity of methods, usually gives results that are much more reliable than those from stations at dams, where the coefficient may be uncertain and conditions of flow are complicated.

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

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

In order to give engineers and others information regarding the probable accuracy of the computed results, footnotes are added to the daily discharge tables, stating the probable accuracy of the rating tables used, and an accuracy column is inserted in the monthly discharge table. For the rating tables "well defined" indicates, in general, that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined" or "approximate," within 15 to 25 per cent. These notes are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

The accuracy column in the monthly discharge table does not apply to the maximum or minimum nor to any individual day, but to the monthly mean. It is based on the accuracy of the rating, the probable reliability of the observer, and knowledge of local conditions. In this column A indicates that the mean monthly flow is probably accurate within 5 per cent; B, within 10 per cent; C, within 15 per cent; D, within 25 per cent. Special conditions are covered by footnotes.

In general, the base data which are collected in the field each year by the Survey engineers are published, not only to comply with the law but also for the express purpose of giving to any engineer the opportunity of examining the computed results and of changing and adjusting them as may seem best to him. Although it is believed that the rating tables and computed monthly discharges are as good as the base data up to and including the current year will warrant, it should always be borne in mind that the additional data collected at each station from year to year nearly always throw new light on data already collected and published, and hence allow more or less improvement in the computed results of earlier years. It is therefore expected that the engineer who makes serious use of the figures presented in these papers will verify all ratings and make such adjustments for earlier years as may seem necessary. The work of compiling, studying, revising, and republishing data for different drainage basins for 5 or 10 year periods or more is carried on by the United States Geological Survey so far as the funds for such work are available.

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

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

COOPERATIVE DATA.

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

Many stations throughout the country are maintained for specific purposes by private parties who supply the records gratuitously to the United States Geological Survey for publication. When such records are furnished by responsible parties and appear to be reasonably accurate, they are verified, so far as possible, and estimated values of accuracy are given. Records clearly worthless or misleading are not published. As it is, however, impossible to completely verify all such records furnished—because of lack of funds or for other causes—they are published for what they are worth, as they are of value as a matter of record and afford at least approximate information regarding stream flow at the particular localities. The

Survey does not, however, assume any responsibility for inaccuracies found in such records, although most of them are believed to be reasonably good.

COOPERATION AND ACKNOWLEDGMENTS.

Assistance has been rendered or records furnished by the following, to whom special acknowledgment is due: United States Engineer Corps, for unpublished records of flow from the reservoirs on the upper Mississippi and miscellaneous low-water measurements; United States Reclamation Service, for maintenance of stations in the St. Mary basin; United States Weather Bureau, for records of gage heights at St. Paul, Mankato, and Chippewa Falls; Minnesota & Ontario Power Co., for cooperation in the maintenance of the station at International Falls; St. Anthony Falls Water Power Co., for records of Mississippi at Minneapolis; Kettle River Co., for cooperation in maintenance of the Sandstone station; Consumers Power Co., for cooperation in maintenance of the station at Rapidan Mills; Wisconsin Valley Improvement Co., for gage-height records at Rhinelander, Merrill, and Necedah; Chippewa Valley Railway, Light & Power Co., for gage records at Cedar Falls; Mr. Frank Dearborn, for gage records at Stone City.

The work in Minnesota during 1910 has been done with State cooperation under the terms of an act of the legislature of 1909, as embodied in joint resolution 19, which reads as follows:

> Whereas the water supplies, water powers, navigation of our rivers, drainage of our lands, and the sanitary condition of our streams and their watersheds generally form one great asset and present one great problem: Therefore be it resolved by the house of representatives, the senate concurring, That the State drainage commission be and is hereby directed to investigate progress in other States toward the solution of said problem in such States, to investigate and determine the nature of said problem in this State. * * *

The work has been carried on in conjunction with the State drainage commission, George A. Ralph, chief engineer.

The work in Illinois during 1910 has been done with the cooperation of the internal improvement commission, the organic law of which provides (Session Laws, Forty-fifth General Assembly, adjourned session, p. 33):

> The duties of the commission shall be to investigate * * * the reclamation of lands subject to overflow or inundation * * * and such other statistics and data as will enable the next general assembly to properly formulate and devise ways and means whereby legislative enactment may be had to carry out and put into effect the benefits to be derived by the * * * reclamation of lands subject to inundation in Illinois.

Mr. Isham Randolph was chairman of the internal improvement commission.

DIVISION OF WORK.

The field data for the Hudson Bay drainage basin were collected under the direction of Robert Follansbee and W. A. Lamb, district engineers, assisted by E. F. Chandler, G. A. Gray, M. E. McChristie, and J. O. Nomland.

The field data for the upper Mississippi drainage basin were collected under the direction of Robert Follansbee and A. H. Horton, district engineers, assisted by C. R. Adams, G. A. Gray, C. J. Emerson, H. J. Jackson, C. T. Bailey, and P. S. Monk.

The ratings, special estimates, and studies of the completed data were made by Robert Follansbee, A. H. Horton, W. A. Lamb, G. C. Stevens, and E. F. Chandler.

The computations and preparation of the completed data for publication were made under the direction of G. C. Stevens, by G. A. Gray, Raymond Richards, R. C. Rice, M. I. Walters, J. G. Mathers, G. H. Canfield, J. J. Phelan, and B. E. Jones. The report was edited by Mrs. B. D. Wood.

GAGING STATIONS MAINTAINED IN THE HUDSON BAY AND UPPER MISSISSIPPI RIVER DRAINAGE BASINS.

The following list comprises the gaging stations maintained in the Hudson Bay and upper Mississippi River basins by the United States Geological Survey and cooperative parties. Data for these stations have been published in the reports listed on pages 9 to 11. The stations are arranged by river basins, in downstream order, tributaries of main streams being indicated by indention. (See p. 11).

HUDSON BAY BASIN.

St. Mary River above Swiftcurrent Creek near Babb (formerly Main), Mont., 1902–1910.
St. Mary River below Swiftcurrent Creek at Babb (formerly Main), Mont., 1901–2, 1910.
St. Mary River near Cardston, Alberta, 1902–1910.
  Swiftcurrent Creek near Babb, Mont., 1902–1910.
  Kennedy Creek near Babb, Mont., 1903–1906.
Ottertail River (head of Red River), near Fergus Falls, Minn., 1904–1910.
Red River near Fergus Falls, Minn., 1909–10.
Red River at Fargo, N. Dak., 1901–1910.
Red River at Grand Forks, N. Dak., 1901–1910 (gage height record 1895–1901).
Red River at Emerson, Manitoba, 1902.
  Pelican River near Fergus Falls, Minn., 1909–10.
  Sheyenne River at Haggart, N. Dak., 1902–1907.
    Devils Lake near Devils Lake, N. Dak., 1901–1910.
  Wild Rice River at Twin Valley, Minn., 1909–10.
  Red Lake River at Thief River Falls, Minn., 1909–10.

Red River—Continued.
  Red Lake River at Crookston, Minn., 1901-1910.
    Thief River near Thief River Falls, Minn., 1909-10.
    Clearwater River at Red Lake Falls, Minn., 1909-10.
  Pembina River at Neche, N. Dak., 1903-1910.
  Mouse River near Foxholm, N. Dak., 1904-1906.
  Mouse River at Minot, N. Dak., 1903-1910.
    Des Lacs River at Foxholm, N. Dak., 1904-1906.
Rainy Lake near Rainier, Minn., 1910.
Rainy River at International Falls, Minn., 1909-10.
  Little Fork Rainy River at Little Fork, Minn., 1909-10.
  Big Fork River at Big Falls, Minn., 1909-10.
  Big Fork River near Laurel, Minn., 1909.
  Black River near Loman, Minn., 1909.

UPPER MISSISSIPPI RIVER BASIN.

Mississippi River above Sandy River, Minn., 1895-1910.
Mississippi River near Fort Ripley, Minn., 1909-10.
Mississippi River near Sauk Rapids, Minn., 1903-1906.
Mississippi River at Anoka, Minn., 1905-1910.
Mississippi River at St. Paul, Minn., 1873-1901.
  Sandy River below Sandy Lake Reservoir, Minn., 1910.
  Pine River below Pine River Reservoir, Minn., 1910.
  Prairie River near Grand Rapids, Minn., 1909.
  Crow Wing River at Nimrod, Minn., 1910.
  Crow Wing River at Motley, Minn., 1909.
  Crow Wing River at Pillager, Minn., 1903 and 1909-10.
  Long Prairie River near Motley, Minn., 1909-10.
  Sauk River near St. Cloud, Minn., 1909-10.
  Crow River, North Fork, near Rockford, Minn., 1909-10.
  Crow River at Rockford, Minn., 1909-10.
  Crow River near Dayton, Minn., 1906.
    Crow River, South Fork, near Rockford, Minn., 1909-10.
  Rum River at Onamia, Minn., 1909-10.
  Rum River at Cambridge, Minn., 1909-10.
  Rum River at St. Francis, Minn., 1903.
  Rum River near Anoka, Minn., 1905-1909.
  Minnesota River near Odessa, Minn., 1909-10.
  Minnesota River near Montevideo, Minn., 1909-10.
  Minnesota River near Mankato, Minn., 1903-1910.
    Whetstone River near Big Stone, S. Dak., 1910.
    Lac qui Parle River at Lac qui Parle, Minn., 1910.
    Chippewa River near Watson, Minn., 1909-10.
    Redwood River near Redwood Falls, Minn., 1909-10.
    Cottonwood River near New Ulm, Minn., 1909-10.
    Blue Earth River at Rapidan Mills, Minn., 1909-10.
  St. Croix River:
    Kettle River near Sandstone, Minn., 1909-10.
    Snake River at Mora, Minn., 1909-10.
  Cannon River at Welch, Minn., 1909-10.
  Chippewa River at Chippewa Falls, Wis., 1899-1910.
  Chippewa River near Eau Claire, Wis., 1902-1910.
    Flambeau River near Ladysmith, Wis., 1903-1906.
    Red Cedar River at Cedar Falls, Wis., 1907-1910.
    Red Cedar River at Menominee, Wis., 1907-8.

Mississippi River—Continued.
- Zumbro River at Zumbro Falls, Minn., 1909–10.
- Black River at Neillsville, Wis., 1905–1910.
- Black River at Melrose, Wis., 1902–3.
- Root River near Houston, Minn., 1909–10.
  - Root River, North Branch, near Lanesboro, Minn., 1910.
- Wisconsin River near Rhinelander, Wis., 1905–1910.
- Wisconsin River at Merrill, Wis., 1902–1910.
- Wisconsin River near Necedah, Wis., 1902–1910.
- Wisconsin River at Muscoda, Wis., 1902–3.
- Maquoketa River at Manchester, Iowa, 1903.
- Wapsipinicon River at Stone City, Iowa, 1903–1910.
- Rock River above mouth of Pecatonica River at Rockton, Ill., 1903.
- Rock River below mouth of Pecatonica River at Rockton, Ill., 1903–1910.
- Rock River near Nelson, Ill., 1906.
- Rock River at Sterling, Ill., 1905–6.
  - Catfish River at Madison, Wis., 1902–3.
  - Lake Mendota at Madison, Wis., 1902–3.
- Iowa River at Marshalltown, Iowa, 1903.
- Iowa River at Iowa City, Iowa, 1903–1906.
  - Cedar River near Austin, Minn., 1909–10.
  - Red Cedar River at Janesville, Iowa, 1905–6.
  - Cedar River at Cedar Rapids, Iowa, 1903–1910.
- Des Moines River at Jackson, Minn., 1910.
- Des Moines River at Fort Dodge, Iowa, 1905–6.
- Des Moines River at Des Moines, Iowa, 1902–3, 1905–6.
- Des Moines River at Keosauqua, Iowa, 1903–1906.
  - Raccoon River near Des Moines, Iowa, 1902–3.
- Illinois River near Minooka, Ill., 1903–4.
- Illinois River near Seneca, Ill., 1903.
- Illinois River near Ottawa, Ill., 1903–4.
- Illinois River near La Salle, Ill., 1903.
- Illinois River near Peoria, Ill., 1903–1906.
  - Kankakee River at Davis, Ind., 1905–6.
  - Kankakee River at Momence, Ill., 1905–6.
    - Yellow River at Knox, Ind., 1905–6.
  - Desplaines River above mouth of Jackson Creek near Channahon, Ill., 1903–1906.
  - Desplaines River above Kankakee River near Channahon, Ill, 1902–3.
  - Fox River at Sheridan, Ill., 1905–6.
  - Fox River at Ottawa, Ill., 1903.
  - Sangamon River at Monticello, Ill., 1908 and 1910.
  - Sangamon River at Decatur, Ill., 1905.
  - Sangamon River at Riverton, Ill., 1908–1910.
  - Sangamon River near Springfield, Ill., 1903.
  - Sangamon River near Oakford, Ill., 1909–10.
  - Sangamon River near Chandlerville, Ill., 1908.
    - Sangamon River, South Fork, near Taylorville, Ill., 1908–1910.
    - Salt Creek near Kenny, Ill., 1908–1910.
- Cahokia Creek at Poag, Ill., 1909–10.
- Kaskaskia River near Arcola, Ill., 1908–1910.
- Kaskaskia River at Shelbyville, Ill., 1908–1910.
- Kaskaskia River at Vandalia, Ill., 1908–1910.
- Kaskaskia River at Carlysle, Ill., 1908–1910.

Mississippi River—Continued.
  Kaskaskia River at New Athens, Ill., 1909–10.
    Shoal Creek near Breese, Ill., 1909–10.
    Silver Creek near Lebanon, Ill., 1908–1910.
  Big Muddy River near Cambon, Ill., 1908–1910.
  Beaucoup Creek near Pinckneyville, Ill., 1908–1910.

HUDSON BAY DRAINAGE AREA IN THE UNITED STATES.

PRINCIPAL STREAMS.

All the waters that reach Hudson Bay from the United States pass through Lake Winnipeg and thence into the bay through Nelson River. The principal tributaries of Lake Winnipeg, and thus, indirectly, of Nelson River, are Saskatchewan, Red, and Winnipeg rivers. The Saskatchewan drains the major portions of the Provinces of Alberta and Saskatchewan in the Dominion of Canada, and, through St. Mary River, a small area in northwestern Montana in the United States. Red River drains a large basin in the United States, covering portions of Minnesota and North and South Dakota. Winnipeg River is the outlet of Lake of the Woods, which receives Rainy River, an international stream rising in Rainy Lake.

ST. MARY RIVER.

GENERAL FEATURES OF AREA DRAINED.

St. Mary River heads in northern Montana, near the Canadian boundary line, on the eastern slope of the main range of the Rocky Mountains, in a region of perpetual snow and in the midst of innumerable glaciers. It starts from the great Blackfoot Glacier, probably the largest in the Rocky Mountains within the United States, and receives affluents from at least a dozen lesser glaciers. These small streams unite within a short distance from their sources and flow into a lake which is hemmed in by high mountains and is known as Upper St. Mary Lake. Below this lake and separated from it by a narrow strip of land is Lower St. Mary Lake. The aggregate length of these two lakes is about 22 miles. The river flows out of the lower lake, the elevation of which is 4,460 feet above sea level, and within 2 miles is joined by Swiftcurrent Creek, which is fed by waters of Grinnell Glacier and four small glaciers. From the confluence of these streams to the international boundary, a distance of 12 miles, the St. Mary flows in a northerly direction, receiving Kennedy Creek a few miles before crossing the boundary. Entering the Province of Alberta it empties into Belly River, its waters eventually finding their way through the Saskatchewan into Hudson Bay.[1]

[1] Information and data on stations maintained by the Dominion of Canada in this basin are contained in a Report of Progress of Stream Measurements for 1909, published by the Department of Interior, Dominion of Canada.

That portion of the drainage area below the region of glaciers is heavily forested, the timber consisting of spruce and fir on the higher slopes and a dense growth of willows and aspen on the lower portions.

The mean annual precipitation is about 60 inches, and occurs in greater part in the form of snow. The altitude of the drainage basin within the United States ranges from 4,000 feet to 10,000 feet.

The only diversion from the St. Mary in the United States is that which is being made by the United States Reclamation Service in connection with the Milk River project. It is proposed to reservoir Lower St. Mary Lake and divert 850 second-feet of water into the Milk River drainage basin. Both Upper and Lower St. Mary lakes can be made into storage reservoirs. Water power is not important in this basin, as the many small streams which form the river are frozen over during the winter months.

ST. MARY RIVER NEAR BABB, MONT.

This station, which was established April 9, 1902, for the purpose of procuring run-off data for use in connection with irrigation projects on the Blackfoot Indian Reservation and in the Milk River valley is located below Lower St. Mary Lake, above the mouth of Swiftcurrent Creek, the nearest tributary, and about 2 miles south of Babb. The run-off at this point is that from Upper and Lower St. Mary lakes. The drainage area is 177 square miles. No water is diverted above the station, but the United States Reclamation Service has appropriated 850 second-feet of water which will be diverted near the station. A reservoir will also be formed at Lower St. Mary Lake.

Discharge measurements are made from a cable or by wading. The cable was originally located about 4,500 feet below Lower St. Mary Lake and about 2,500 feet above the mouth of Swiftcurrent Creek. It was moved about 300 feet upstream to a better location on September 13, 1909. The chain gage, which is located about 1,000 feet above the original cable, has been maintained at a constant datum since the station was established.

Discharge measurements of St. Mary River near Babb, Mont., 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 19	W. A. Lamb	103	359	2.22	480
May 12	....do	108	536	3.80	1,580
June 9	M. E. McChristie	109	519	3.62	1,400
23	W. A. Lamb	104	479	3.50	1,250
Aug. 1	M. E. McChristie	103	373	2.28	567
Sept. 16	....do	89	287	1.42	204
Nov. 18	B. E. Jones	103	376	2.20	515
Dec. 30 [a]	....do	94	274	1.06	94

[a] Ice at gage. Height is referred to regular gage, and was obtained by use of a temporary gage with a known relation to the regular gage.

Daily gage height in feet of St. Mary River near Babb, Mont., for 1910.

[Chas. E. Hayes, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.70	3.50	3.85	3.25	2.25	1.50	1.80	2.20	1.60
2		1.70	3.40	3.90	3.20	2.20	1.50	2.00	2.20	1.60
3		1.70	3.30	3.95	3.20	2.20	1.50	2.00	2.20	1.50
4		1.60	3.15	3.90	3.20	2.10	1.50	2.00	2.10	1.60
5		1.50	3.00	3.75	3.15	2.10	1.50	2.20	2.10	1.60
6		1.50	3.00	3.60	3.10	2.05	1.50	2.50	2.00	1.60
7		1.50	3.00	3.55	3.00	2.05	1.50	2.30	2.00	1.50
8		1.60	3.15	3.70	2.95	2.00	1.50	2.60	2.00	1.50
9		1.60	3.40	3.60	2.90	2.00	1.50	2.70	2.00	1.50
10		1.80	3.65	3.60	2.85	2.00	1.45	2.70	2.00	1.50
11		1.70	3.80	3.60	2.80	2.00	1.45	2.80	2.00	
12		1.80	3.80	3.60	2.75	1.98	1.45	2.90	2.10	1.50
13	1.20	1.85	3.70	3.65	2.75	1.95	1.45	2.90	2.10	1.50
14	1.20	1.90	3.65	3.60	2.70	1.90	1.45	2.80	2.10	1.50
15	1.20	2.00	3.65	3.60	2.70	1.90	1.45	2.70	2.20	1.50
16	1.20	2.05	3.55	3.70	2.70	1.90	1.45	2.60	2.20	1.40
17	1.20	2.10	3.40	3.75	2.70	1.90	1.50	2.50	2.20	1.30
18	1.20	2.10	3.20	3.80	2.70	1.80	1.50	2.40	2.20	1.30
16	1.20	2.15	3.25	3.80	2.65	1.80	1.50	2.30	2.20	1.30
20	1.30	2.30	3.20	3.75	2.65	1.80	1.60	2.30	2.20	1.30
21	1.20	2.35	3.10	3.65	2.85	1.80	1.60	2.20	2.10	1.30
22	1.30	2.45	3.10	3.60	2.60	1.70	1.60	2.10	2.10	1.30
23	1.40	2.55	3.10	3.45	2.60	1.70	1.70	2.00	2.00	1.30
24	1.40	2.65	3.10	3.30	2.60	1.80	1.80	2.00	2.00	1.30
25	1.50	2.70	3.35	3.20	2.55	1.70	1.80	2.00	1.90	
26	1.50	2.85	3.55	3.20	2.40	1.70	1.80	2.10	1.90	
27	1.60	3.00	3.75	3.20	2.40	1.60	1.80	2.20	1.85	
28	1.60	3.25	3.80	3.20	2.40	1.60	1.80	2.10	1.85	
29	1.70	3.45	3.80	3.25	2.35	1.60	1.80	2.30	1.80	
30	1.80	3.50	3.85	3.25	2.30	1.50	1.80	2.20	1.70	
31	1.70		3.90		2.30	1.50		2.20		

NOTE.—Ice present Jan. 1 to Mar. 12 and Dec. 25 to 31.

Daily discharge in second-feet of St. Mary River near Babb, Mont., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		295	1,290	1,600	1,100	525	230	330	500	260
2		295	1,210	1,660	1,060	500	230	410	500	260
3		295	1,130	1,710	1,060	500	230	410	500	230
4		260	1,030	1,660	1,060	450	230	410	450	260
5		230	935	1,510	1,030	450	230	500	450	260
6		230	935	1,380	995	430	230	650	410	260
7		230	935	1,340	935	430	230	550	410	230
8		260	1,030	1,470	905	410	230	700	410	230
9		260	1,210	1,380	875	410	230	755	410	230
10		330	1,420	1,380	845	410	215	755	410	230
11		295	1,560	1,380	815	410	215	815	410	230
12		330	1,560	1,380	785	402	215	875	450	230
13	143	350	1,470	1,420	785	390	215	875	450	230
14	143	370	1,420	1,380	755	370	215	815	450	230
15	143	410	1,420	1,380	755	370	215	755	500	230
16	143	430	1,340	1,470	755	370	215	700	500	200
17	143	450	1,210	1,510	755	370	230	650	500	170
18	143	450	1,060	1,560	755	330	230	600	500	170
19	143	475	1,100	1,560	728	330	230	550	500	170
20	170	550	1,060	1,510	728	330	260	550	550	170
21	143	575	995	1,420	845	330	260	500	450	170
22	170	625	995	1,380	700	295	260	450	450	170
23	200	675	995	1,250	700	295	295	410	410	170
24	200	728	995	1,130	700	330	330	410	410	170
25	230	755	1,170	1,060	675	295	330	410	370	140
26	230	845	1,340	1,060	600	295	330	450	370	140
27	260	935	1,510	1,060	600	260	330	500	350	140
28	260	1,100	1,560	1,060	600	260	330	450	350	120
29	295	1,250	1,560	1,100	575	260	330	550	330	100
30	330	1,290	1,600	1,100	550	230	330	500	295	100
31	295		1,660		550	230		500		75

NOTE.—Daily discharge computed from a well-defined rating curve. Discharge estimated Dec. 25 to 31 because of presence of ice.

Monthly discharge of St. Mary River near Babb, Mont., for 1910.

[Drainage area, 177 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	....	....	90	0.508	0.59	5,530	D.
February	....	....	100	.565	.59	5,500	D.
March	330	....	169	.955	1.10	10,400	D.
April	1,290	230	519	2.93	3.27	30,900	A.
May	1,660	935	1,250	7.06	8.14	76,900	A.
June	1,710	1,060	1,380	7.80	8.70	82,100	A.
July	1,100	550	793	4.48	5.16	48,800	A.
August	525	230	363	2.05	2.36	22,300	A.
September	330	215	255	1.44	1.61	15,200	A.
October	875	330	573	3.24	3.74	35,200	A.
November	500	295	433	2.45	2.73	25,800	A.
December	260	....	193	1.09	1.26	11,900	B.
The year	1,710	....	511	2.88	39.25	371,000	

NOTE.—Mean discharges for January and February estimated by comparison with other St. Mary stations. Mean discharge for Mar. 1 to 12 estimated at 120 second-feet.

ST. MARY RIVER BELOW SWIFTCURRENT CREEK, AT BABB, MONT.

This station, which was established May 13, 1910, for the purpose of collecting run-off data for use in connection with the St. Mary irrigation project, is located at Babb below the mouth of Swiftcurrent Creek and about 3 miles below Lower St. Mary Lake. No water is diverted above the station, but the United States Reclamation Service has appropriated 850 second-feet of water, which will be diverted near the outlet of Lower St. Mary Lake.

Discharge measurements are made from a cable or by wading. In 1910 measurements were made from a footbridge at the station. The gage which was installed when the station was established was located on the left bank opposite the post office at Babb. It was an ordinary staff nailed to an old bridge pier. On July 19, 1911, a chain gage was installed on the right bank below the old gage, and at a different datum. A gaging station was maintained at this point from July, 1901, to November, 1902, but the gage was set at a different datum. The town was then called Main.

Discharge measurements of St. Mary River below Swiftcurrent Creek, at Babb, Mont., 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 13	W. A. Lamb	145	398	6.40	2,050
June 10	M. E. McChristie	149	400	6.20	1,930
25	W. A. Lamb	148	338	5.78	1,460
Aug. 1	M. E. McChristie	141	233	4.70	795
Sept. 15	.....do	106	169	3.82	312
Nov. 19	W. A. Lamb	125	196	4.55	681
Dec. 29	B. E. Jones	94	55	[a] 3.38	115

[a] Small amount of ice at gage.

Daily gage height in feet of St. Mary River below Swiftcurrent Creek, at Babb, Mont., for 1910.

[C. E. Hayes, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		6.60	5.90	4.72	3.85	4.50	4.70	4.00
2		6.65	5.85	4.62	3.80	4.90	4.70	4.00
3		6.60	5.85	4.60	3.80	5.20	4.60	4.00
4		6.40	5.80	4.55	3.80	5.20	4.50	4.00
5		6.30	5.75	4.60	3.80	5.20	4.40	3.90
6		6.20	5.70	4.45	3.80	5.20	4.30	3.90
7		6.20	5.60	4.25	3.80	5.30	4.40	3.90
8		6.40	5.55	4.40	3.90	5.65	4.30	3.90
9		6.30	5.50	4.45	3.90	5.80	4.30	3.90
10		6.20	5.45	4.40	3.90	5.75	4.30	3.80
11		6.20	5.40	4.40	3.90	5.70	4.40	3.80
12		6.30	5.10	4.38	3.80	5.70	4.95	3.80
13	6.40	6.40	5.20	4.35	3.80	5.60	4.95	3.80
14	6.35	6.35	5.30	4.35	3.80	5.50	4.90	3.80
15	6.30	6.35	5.20	4.30	3.80	5.30	4.80	3.80
16	6.20	6.40	5.20	4.30	3.85	5.25	4.70	3.70
17	6.05	6.40	5.25	4.20	4.00	4.95	4.60	3.70
18	5.90	6.45	5.30	4.20	4.00	4.90	4.50	3.70
19	6.05	6.35	5.30	4.20	4.20	4.80	4.50	3.70
20	6.00	6.30	5.25	4.10	4.50	4.70	4.50	3.70
21	5.95	6.25	5.20	4.10	4.50	4.60	4.50	3.70
22	5.80	6.15	5.25		4.50	4.50	4.40	3.70
23	5.90	6.00	5.20		4.40	4.40	4.40	3.70
24	5.95	5.85	5.05		4.30	4.30	4.30	3.70
25	6.40	5.95	5.00		4.35	4.50	4.30	3.60
26	6.55	5.90	5.05	4.10	4.25	5.10	4.20	3.60
27	6.60	5.90	4.95	4.00	4.20	5.10	4.20	3.60
28	6.55	5.95	4.85	3.95	4.20	5.00	4.20	3.50
29	6.60	5.95	4.80	3.85	4.20	4.90	4.10	3.40
30	6.60	5.90	4.75	3.90	4.20	4.80	4.10	3.40
31	6.65		4.70	3.90		4.80		3.30

NOTE.—Gage heights affected by ice Dec. 24 to 31.

Daily discharge, in second-feet, of St. Mary River below Swiftcurrent Creek, at Babb, Mont., for 1910.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2,200	1,560	782	322	655	770	395
2		2,240	1,520	722	300	895	770	395
3		2,200	1,520	710	300	1,100	710	395
4		1,960	1,460	682	300	1,100	655	395
5		1,920	1,430	710	300	1,100	606	345
6		1,850	1,390	628	300	1,100	545	345
7		1,850	1,320	520	300	1,170	600	345
8		2,000	1,300	600	345	1,440	545	345
9		1,910	1,260	628	345	1,560	545	345
10		1,820	1,220	600	345	1,520	545	300
11		1,820	1,200	600	345	1,480	600	300
12		1,900	1,000	589	300	1,480	928	300
13	2,050	2,000	1,070	572	300	1,400	928	300
14	2,000	1,940	1,030	572	300	1,320	895	300
15	1,940	1,940	1,060	545	300	1,170	830	300
16	1,860	1,960	1,060	545	322	1,140	770	255
17	1,740	1,960	1,100	495	395	928	710	255
18	1,620	2,020	1,130	495	395	895	655	255
19	1,730	1,940	1,130	495	495	830	655	255
20	1,680	1,900	1,100	445	655	770	655	255
21	1,640	1,850	1,070	445	655	710	655	255
22	1,520	1,760	1,100	445	655	655	600	255
23	1,600	1,640	1,070	445	600	600	600	255
24	1,640	1,520	980	445	545	545	545	255
25	2,030	1,620	950	445	572	655	545	210
26	2,160	1,560	985	445	520	1,030	495	210
27	2,200	1,560	928	395	495	1,030	495	210
28	2,160	1,600	862	370	495	960	495	170
29	2,200	1,600	830	322	495	895	445	130
30	2,200	1,560	800	345	495	830	445	130
31	2,240		770	345		830		95

NOTE.—Daily discharge computed from a fairly well-defined rating curve. From May 13 to July 26 the rating was applied indirectly. Discharge interpolated from Aug. 22 to 25.

Monthly discharge of St. Mary River below Swiftcurrent Creek, at Babb, Mont., for 1910.

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
May 13-31	2,240	1,520	1,910	6.41	4.53	72,000	B.
June	2,240	1,520	1,890	6.34	7.07	112,000	B.
July	1,560	770	1,140	3.83	4.42	70,100	B.
August	782	322	528	1.77	2.04	32,500	A.
September	655	300	416	1.40	1.56	24,800	A
October	1,560	545	1,030	3.46	3.99	63,300	A.
November	928	445	641	2.15	2.40	38,100	A.
December	395	95	276	.926	1.07	17,000	B.
The period						430,000	

ST. MARY RIVER NEAR CARDSTON, ALBERTA.

This station was established September 4, 1902, near Shaw's ranch, one-fourth mile north of the boundary line between the United States and Canada and 17 miles south of Cardston, Alberta, for the purpose of obtaining data for use in connection with irrigation projects in the Milk River valley.

The station is 6 miles below the mouth of Kennedy Creek, the last tributary entering from the United States. With the exception of the area drained by Boundary Creek, a small stream entering a short distance above the station, the drainage basin lies within the United States. The total area drained is 452 square miles.

The only diversion above the station is that which will be made at Babb by the United States Reclamation Service in connection with the Milk River project. About 850 second-feet of water will be diverted into the Milk River drainage basin.

The chain gage was originally located about 1,200 feet above the cable. This gage was destroyed during the high water of June, 1908, and a new chain gage was installed July 17, 1908, about one-fourth mile below the cable. There is no determined relation between the gages. An auxiliary staff gage, with the same datum as the chain gage, was established October 14, 1909, and was used during low water. Results at this station are affected by shifting channel and heavy ice during the winter months.

Discharge measurements are made from the cable or by wading.

Discharge measurements of St. Mary River near Cardston, Alberta, 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 20	W. A. Lamb	109	349	2.85	1,240
May 13	....do	110	483	4.15	2,450
June 10	M. E. McChristie	111	455	3.90	2,220
24	W. A. Lamb	108	388	3.32	1,640
July 31	M. E. McChristie	103	280	1.98	793
Sept. 14	....do	100	206	1.06	374
Nov. 19	B. E. Jones	104	267	1.93	700
20	W. A. Lamb	103	266	1.90	698
Dec. 29	B. E. Jones	94	162	(a)	134

a Gage height affected by ice.

Daily gage height, in feet, of St. Mary River near Cardston, Alberta, for 1910.

[Mrs. H. F. Cook, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.85	3.6	4.7	3.3	2.0	1.1	2.3	1.9	1.5
2		1.8	3.3	4.7	3.25	1.95	1.05	2.5	1.9	1.4
3		1.75	3.2	4.6	3.2	1.95	1.1	2.5	1.9	1.4
4		1.75	3.2	4.55	3.15	1.85	1.05	2.6	1.9	1.3
5		1.55	3.15	4.25	3.05	1.85	1.05	2.5	1.85	1.1
6		1.7		4.0	3.0	1.8	1.05	2.6	1.9	1.1
7		1.7	3.4	4.0	2.85	1.75	1.1	2.6	1.9	1.1
8		1.8	4.2	4.3	2.85	1.8	1.05	2.8	1.9	1.1
9		1.9	4.6	4.2	2.8	1.8	1.1	2.9	1.7	1.1
10		2.1	4.5	3.9	2.7	1.75	1.05	2.9	1.8	1.1
11		2.15	4.4	4.0	2.6	1.75	1.05	3.1		1.2
12		2.3	4.2	4.1	2.55	1.7		3.1		1.2
13		2.55	4.2	4.1	2.6	1.7			2.5	1.15
14	3.0	2.3	4.15	4.1	2.6	1.7	1.1		2.5	
15	2.9	2.5	4.15	4.1	2.55	1.65	1.05	2.6	2.3	
16	2.6	2.4	3.9	4.1	2.6	1.6	1.25	2.5	2.3	1.1
17	2 0	2 45	3 6	4.15	2.55	1.55	1.55	2.5	2.2	1.0
18	1.9	2.5	3.55	4.2	2.6	1.6	1.6	2.4	2.0	1.0
19	1.9	2.7	3.8	4.15	2.6	1.5	1.6	2.3	1.9	1.0
20	1.8	3.0	3.6	4.0	2.55	1.45	1.45	2.1	1.8	1.0
21	1.7	3.1	3.5	3.9	2.55	1.4	1.65	2.1	2.0	1.1
22	1.9	3.1	3.45	3.8	2.45	1.35	1.9	2.0	2.0	1.1
23		3.05		3.55	2.5	1.3		1.9	2.0	1.1
24	2.0	3.05	4.5	3.3	2.45	1.2			2.1	
25	1.9	3.2	4.55	3.35	2.45	1.05	2.0	2.0	2.0	
26	1.9	3.7	4.6	3.35	2.4	1.05	2.05	2.3	2.0	
27	2.0	4.7	4.7	3.4	2.25	1.0	2.1	2.3	1.9	
28	1.9	4.35	4.7	3.4	2.2	1.05	2.1	2.3	1.9	
29	1.9	4.3	4.7	3.35	2.05	1.1	2.2	2.25	1.9	
30	1.9	4.0	4.7	3.25	2.05	1.05	2.15		1.7	
31	1.9		4.7		2.0	1.1		1.9		

NOTE.—Relation of gage height to discharge probably affected by ice about Jan. 1 to Mar. 13 and Dec. 10 to 31.

Daily discharge, in second-feet, of St. Mary River near Cardston, Alberta, for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		667	1,970	2,960	1,640	803	394	969	696	505
2		643	1,720	2,960	1,600	777	374	1,090	696	461
3		620	1,640	2,860	1,560	777	394	1,090	691	461
4		620	1,640	2,810	1,530	726	374	1,150	691	418
5		528	1,610	2,540	1,450	726	374	1,090	667	338
6		596	1,700	2,310	1,420	701	374	1,150	687	338
7		596	1,800	2,310	1,310	677	394	1,150	687	338
8		643	2,490	2,580	1,310	701	374	1,270	682	338
9		691	2,860	2,490	1,280	701	394	1,340	588	338
10		790	2,770	2,220	1,210	677	374	1,330	634	

Daily discharge, in second-feet, of St. Mary River near Cardston, Alberta, for 1910—Con.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	....	816	2,670	2,310	1,150	677	374	1,470	760	....
12	....	896	2,490	2,390	1,120	653	380	1,470	885	....
13	....	1,040	2,490	2,380	1,150	653	387	1,350	1,010	....
14	1,340	896	2,440	2,370	1,150	653	394	1,240	1,010	....
15	1,270	1,010	2,440	2,360	1,120	630	374	1,120	896	....
16	1,070	952	2,220	2,350	1,150	606	454	1,060	896	....
17	740	982	1,760	2,390	1,120	584	584	1,060	842	....
18	691	1,010	1,920	2,430	1,150	606	606	1,000	740	....
19	691	1,140	2,130	2,370	1,150	561	606	940	691	....
20	643	1,340	1,760	2,230	1,120	539	539	825	643	....
21	596	1,420	1,880	2,130	1,120	517	630	825	740	....
22	691	1,420	1,840	2,040	1,060	496	751	767	740	....
23	716	1,380	2,300	1,820	1,090	475	768	716	740	....
24	740	1,380	2,770	1,640	1,060	434	785	738	790	....
25	691	1,490	2,810	1,670	1,060	374	803	761	740	....
26	691	1,900	2,860	1,670	1,030	374	830	922	740	....
27	740	2,820	2,960	1,710	940	355	857	918	691	....
28	691	2,530	2,960	1,710	912	374	857	918	691	....
29	691	2,520	2,960	1,670	830	394	912	894	691	....
30	691	2,290	2,960	1,600	830	374	884	798	596	....
31	691	....	2,960	....	803	394	....	701	....	....

NOTE.—Daily discharge computed by shifting channel method, giving each discharge measurement made during the year full weight. Standard curve used is well defined between gage heights 1.0 foot and 5.5 feet.

Daily discharge Mar. 1 to 13, and Dec. 10 to 31 estimated, because of ice, on basis of climatological records and discharge at other stations in St. Mary River drainage basin.

Mean discharge Mar. 1 to 13 estimated 180 second-feet.

Mean discharge Dec. 10 to 31 estimated about 254 second-feet, varying from 120 to 320 second-feet.

Daily discharge interpolated for other days when gage was not read.

Monthly discharge of St. Mary River near Cardston, Alberta, for 1910.

[Drainage area, 452 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	....	....	150	0.332	0.38	9,220	D.
February	....	....	160	.354	.37	8,890	D.
March	....	....	530	1.17	1.35	32,600	C.
April	2,820	528	1,190	2.63	2.93	70,800	A.
May	2,960	1,610	2,320	5.13	5.91	143,000	A.
June	2,960	1,600	2,240	4.96	5.53	133,000	A.
July	1,640	803	1,170	2.59	2.99	71,900	A.
August	803	355	580	1.28	1.48	35,700	A.
September	912	374	553	1.22	1.36	32,900	A.
October	1,470	701	1,040	2.30	2.65	64,000	A.
November	1,010	588	742	1.64	1.83	44,200	A.
December	505	....	293	.648	.75	18,000	C.
The year	....	....	917	2.03	27.52	664,000	

NOTE.—Monthly discharge, January and February, estimated by means of comparisons with discharge at other stations in St. Mary River drainage basin.

See footnotes to table of daily discharge for other periods estimated.

SWIFTCURRENT CREEK NEAR BABB, MONT.

This station, which is located about 1 mile from the mouth of the stream, at a point where it leaves the foothills, and about 2 miles south of Babb, was established April 8, 1902, to obtain data for use in connection with irrigation projects on the Blackfoot Indian Reservation and in the Milk River valley.

No water is diverted or stored above this station. The construction of storage reservoirs is, however, feasible, and because of the great fall of the stream considerable power could be developed. Although the current is swift the flow during the winter months is to some extent affected by ice.

Discharge measurements are made from a cable or by wading. The cable has been located at different positions since the station was first established. Low-water measurements are made by wading near the gage.

The first gage was destroyed by high water in June, 1902, and the station was reestablished July 30, 1902, at a point 1,800 feet above the first gage. It was again moved September 27, 1902, to a point about 900 feet farther upstream and set at a different datum. At this location it remained until it was destroyed by the flood of June 5, 1908. July 26, 1908, the gage was reestablished, with a new datum, about 100 feet above its former location and 400 feet above the present cable.

This station was discontinued May 13, 1910, when a new station was established on St. Mary River below Swiftcurrent Creek. The difference between the records at this station and that of the St. Mary near Babb will indicate the flow of Swiftcurrent Creek.

The following discharge measurement was made by W. A. Lamb:

April 21: Width, 85 feet; area of section, 140 square feet; gage height, 3.75 feet; discharge, 682 second-feet.

Daily gage height, in feet, and discharge, in second-feet, of Swiftcurrent Creek near Babb, Mont., for 1910.

[Chas. E. Hayes, observer.]

Day.	Mar.		Apr.		May.		Day.	Mar.		Apr.		May.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.		Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1			2.8	165	3.5	520	16	2.6	110	3.25	370		
2			2.7	130	3.4	460	17	2.6	110	3.25	370		
3			2.7	130	3.25	370	18	2.7	130	3.25	370		
4			2.7	130	3.2	340	19	2.7	130	3.4	460		
5			2.7	130	3.25	370	20	2.8	165	3.7	670		
6			2.8	165	3.4	460	21	3.0	240	3.8	750		
7			2.8	165	3.7	670	22	3.1	290	3.65	630		
8			2.8	165	4.1	1,030	23	3.2	340	3.5	520		
9			2.8	165	4.2	1,140	24	3.1	290	3.5	520		
10			3.1	290	4.1	1,030	25	3.1	290	3.7	670		
11			3.2	340	3.9	840	26	3.0	240	3.95	890		
12			3.3	400	3.75	710	27	2.9	205	4.1	1,030		
13	2.5	90	3.4	460	3.65	630	28	2.9	205	4.1	1,030		
14	2.5	90	3.4	460			29	2.8	165	3.95	890		
15	2.5	90	3.35	430			30	2.8	165	3.7	670		
							31	2.8	165				

NOTE.—Discharge computed from a rating curve fairly well defined.

Monthly discharge of Swiftcurrent Creek near Babb, Mont., for 1910.

[Drainage area, 101 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January			40	0.396	0.46	2,460	D.
February			45	.446	.46	2,500	D.
March			135	1.34	1.54	8,300	C.
April	1,030	130	452	4.47	4.99	26,900	B.
May 1-13	1,140	340	659	6.52	3.15	16,900	B.

NOTE.—Mean discharge for January and February estimated. Mean discharge for Mar. 1-12 estimated at 55 second-feet.

RED RIVER.

GENERAL FEATURES OF AREA DRAINED.

Red River rises in Minnesota, its most remote source being a small lake near the southwest corner of Clearwater County, about 13 miles west of Lake Itasca, at an elevation of about 1,550 feet above sea level. From this lake it flows southward 60 miles (measured in a direct line) through a succession of small lakes to Ottertail Lake (elevation about 1,320 feet), thence westward 42 miles to Breckenridge, Minn., and Wahpeton, N. Dak. (elevation 943 feet); from this point it runs northward 285 miles (measured in a direct line) to the southern end of Lake Winnipeg, passing the Canadian boundary at Pembina at a distance of 190 miles and the city of Winnipeg at about 250 miles. On account of the meandering of the river the length of its channel is nearly double the length of the direct line.

Lake Winnipeg is about 250 miles long, and from its north end Nelson River flows northeastward 400 miles to Hudson Bay.

The upper part of Red River is called Ottertail River, that name being variously applied down as far as Ottertail Lake, Fergus Falls, or exceptionally to Breckenridge and Wahpeton as a lower limit; the portion flowing northward from Wahpeton to Lake Winnipeg is universally called Red River.

The upper course of Red River lies in that region of many lakes known as the park region of Minnesota. In Ottertail County there are more than 1,000 lakes, the largest being Ottertail Lake itself, which is 8 miles long and 2½ miles in average width. Many of these lakes have no visible outlet except during high water. In this portion of the drainage basin the country is a rolling prairie.

Although the main branch of Red River is Ottertail River, the term Red River valley is applied to the valley of the Bois des Sioux rather than to that of the Ottertail and extends from Lake Traverse northward to Lake Winnipeg. This valley is a plain from 30 to 50 miles wide and 315 miles long. As the elevation of Lake Traverse is 970 feet and that of Lake Winnipeg 710 feet, the fall of the valley in the entire distance is 260 feet or considerably less than 1 foot per mile. Lake Traverse is 15 miles long and from 1 to 1½ miles wide and is shallow, being for the most part less than 10 feet in depth; it is bordered on either side by bluffs rising from 100 to 150 feet above the lake level. Those bluffs continue on each side of Browns Valley to Big Stone Lake, where they have the same height. During the glacial epoch Red River valley was occupied by an immense lake, now called Lake Agassiz, which had its outlet through Browns Valley into Big Stone Lake and through the present Minnesota Valley. At the present time there is water connection between the two lakes during periods of very high water, as the watershed between the two is a marsh that is only 3 feet above Lake Traverse and 11 feet above Big Stone Lake.

In addition to the gentle northward slope of the valley, there is a gentle slope toward the center from each side. In this axial depression Red River has cut a channel 20 to 60 feet deep. Between the drainage lines of the tributaries, which cross the valley at right angles to the river, there are areas from 5 to 15 miles wide that have no watercourses.

The entire area is covered with a sheet of blue till, consisting of a mixture of sand, clay, and gravel. The portion of the basin formerly occupied by Lake Agassiz is covered with a deposit of lacustrine clay. The basin is underlain by Cretaceous rocks. In one of these rocks, the Dakota sandstone, is found the source of the artesian water in North and South Dakota. In the lower portion of the valley, especially in Kittson County, salt water is found not only in the gravel beds of the glacial drift, but also in the underlying rock; much of the surface water is also permeated by salt.

At the margins of the Red River drainage basin elevations range between 1,200 and 1,600 feet, but the boundaries are not precisely defined. Along much of the eastern side the country is so level that many swamps and marshes drain with equal facility to either side; along the western side there are wide belts whose drainage systems were destroyed by the accumulation of drift and moraines left by the ice of the glacial epoch, and in these belts the surface water collects in innumerable hollows, kettle holes, and sloughs, and stands till it evaporates. If the rainfall were greater these many sink holes and lakelets would overflow and natural erosion would perfect the drainage system.

The following drainage areas have been measured in the basin:

Drainage areas in Red River basin.

River.	Drainage area above—	Square miles.
Ottertail	Pine Lake outlet	690
Do	Ottertail Lake outlet	1,160
Do	Sec. 19, T. 134 N., R. 42 W	1,310
Do	Fergus Falls	1,360
Red	Sec. 6, T. 132 N., R. 43 W	1,800
Do	Fargo	6,020
Do	Grand Forks	25,000
Do	International boundary	34,300
Pelican	Mouth	450
Bois des Sioux	Lake Traverse outlet	1,110
Do	Mouth	1,740
Buffalo	South Fork	573
Do	Mouth	1,400
Sand Hill	...do	535
Snake	...do	1,040
Middle River	...do	397
Tamarack	...do	578

East of a north-south line drawn about 50 miles east of the main Red River the whole country is heavily timbered; west of such a line it is open prairie, treeless except along the streams.

The mean annual rainfall of the Red River drainage area increases uniformly from west to east, being 15 to 18 inches at the western boundary, 19 to 24 inches at stations in the middle of the valley, and 24 to 26 inches at the eastern boundary. Owing to the larger rainfall on the eastern side of the area the run-off per square mile from the tributaries on this side is from two to ten times as great as that on the west side. About 75 per cent of the total rainfall occurs in the six months from April 1 to September 30.

Drainage work is being carried on rapidly in this basin, especially in that portion lying in Minnesota. As a result, the following areas have been benefited by ditching:

Areas improved by drainage.

	Acres.		Acres.
Kittson County	222,000	Traverse County	89,000
Roseau County	160,000	Grant County	54,000
Norman County	164,000	Polk County	972,000
Clay County	262,000	Clearwater County	23,000
Wilkin County	196,000		
Ottertail County	27,000		2,170,000
Becker County	3,000		

The best reservoir site in the portion of the drainage basin drained by the principal river itself is Ottertail Lake, which has an area of about 22 square miles and receives the run-off from an area of 1,160 square miles.

During 1911 a topographic survey of this lake was made by the United States Geological Survey, which shows the possibilities of the lake as a reservoir.

A survey of Ottertail River from the dam at Phelps to a point several miles below the Dayton Hollow dams was made to determine the amount of power available on the river. From the data collected on this survey, sheets have been prepared showing a profile of the water surface, a plan of the river, and the topography adjacent to the river. The results of this survey have been published on separate sheets and may be had upon application to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn. From this survey the following table of elevations and distances has been compiled:

Elevations and distances along Ottertail River.

Place.	Distance below Phelps Dam.	Elevation.
	Miles.	*Feet.*
Highway bridge, S. 26, T. 132 N., R. 44 W	51	1,035
Ottertail Power Co. tailwater	45	1,073
Ottertail Power Co. headwater	45	1,108
Pelican River	39	1,118
Township line 132–133 N	38	1,125
Red River Milling Co. tailwater	35	1,157
Red River Milling Co. headwater	35	1,167
Fergus Flour Mill tailwater	35	1,168
Fergus Flour Mill headwater	35	1,182
City Water Co. tailwater	34	1,185
City Water Co. headwater	34	1,198
Electric-power plant tailwater	32	1,203
Electric-power plant headwater	32	1,215
Northern Pacific Ry	28	1,232
United States Geological Survey gaging station	21	1,251
Range line 42–43 W	15	1,268
Outlet chain of ponds	13	1,287
Oliver Dam tailwater	9	1,298
Oliver Dam headwater	9	1,302
West Lost Lake outlet	6	1,303
Phelps Dam tailwater	0	1,309
Phelps Dam headwater	0	1,318

The following table of approximate elevations and distances has been compiled chiefly from the reports of the Minnesota Geological Survey:

Elevations and distances along Pelican River.

Place.	Miles above mouth.	Elevation.
		Feet.
Ottertail River	0	1,118
Carlisle (Great Northern Ry.)	4	1,149
Elizabeth tailwater	11	1,215
Elizabeth headwater	11	1,228
Erhard	18	1,268
Pelican Rapids (Great Northern Ry.)	23	1,280
Pelican Rapids tailwater	25	1,289
Pelican Rapids headwater	25	1,301
Lake Lizzie outlet	30	1,315
Pelican Lake outlet	31	1,320
Lake Melissa outlet	40	1,330
Detroit Lake outlet	46	1,335
Lake Elsa outlet	51	1,345

Water power is developed at the following points:

Developed water powers in Red River basin.

Place.	Stream.	Fall utilized.	Average horse-power.
		Feet.	
Maine Mills	Ottertail River	8	50
Fergus Falls	.....do	65	860
Dayton Hollow	.....do	36	250
Lakeview	Pelican River	....	50
Kingsbury	.....do	11	30
Pelican Rapids	.....do	12	100
Elizabeth	.....do	13	100
Richwood	Buffalo River	11	40
Fertile	Sand Hill River	15	50

Red River is navigable from Grand Forks down to Winnipeg. Theoretically it is navigable from Grand Forks up to Breckenridge except during low water, but in recent years there has been no traffic except in the lower 25 miles of this stretch, and many fixed bridges have been cheaply built, practically closing it to navigation.

Records of discharge have been maintained in the upper portion of the basin since 1899. These records show that the driest year was 1910 and the wettest 1906. The ratio of flow during these two years was 1 to 3.09.

The records of the gaging stations in this area provide data of value in determining the seasonal or total flow of the whole river or any of its tributaries, information necessary in studies of navigation and the prevention of flood damage, water-power development, and drainage.

Water storage on Red River and its tributaries has been made the subject of an investigation by the United States Engineer Corps, the results being published in House Document 127, Fifty-second Congress, first session, and House Document 539, Fifty-eighth Congress, second session.

The quality of the water in Red River has been examined by the United States Geological Survey in connection with a general study of the quality of surface waters in Minnesota. The results of the investigation have been published by the Survey as Water-Supply Paper 193.

OTTERTAIL RIVER NEAR FERGUS FALLS, MINN.

This station, which was established May 9, 1904, is located at Threemile Bridge, about 3¼ miles northeast of Fergus Falls, Minn., on the line between secs. 18 and 19, T. 133 N., R. 42 W.; because of the loop in the river, however, this point is 8 miles up the valley from Fergus Falls. The gage is attached to the bridge and discharge measurements are made at the same section.

The records furnish information of especial value in connection with the future development of water power, for which this stream is particularly available.

The nearest tributary is the outlet of Wall Lake, which enters Ottertail River several miles below the station. Twenty miles above the station is Ottertail Lake, about 22 square miles in area, through which the river flows and by which its flow is so well regulated that the recorded range of stage has not exceeded 2 feet. On the upper part of the river there are a number of logging dams used to drive logs to the sawmill at Frazee, but there are none between the lowest logging dam at Frazee and the dam at Maine, several miles below Ottertail Lake, in about sec. 35, T. 134, R. 41. During the low-water season, the closing of the turbine gates at Maine may affect the flow immediately below the dam, but the small lakes through which the river flows before reaching the gaging station serve to equalize the flow at the latter point. Below this station there are a number of power plants, but owing to the fall of the river the operation of the plants produces no effect at the gage.

There have been no changes in either gage datum or discharge curve since the station was established. The records are affected to some extent by the use of incorrect chain length and staff gages when the chain gage was out of commission. From December to March the river is frozen over and occasional discharge measurements are made through the ice to determine the winter flow.

The records at this station and those at the outlet of Ottertail Lake furnish 12 years' record of flow of the river below Ottertail Lake.

The United States Engineer Office maintained a gaging station on Ottertail River at the outlet of Ottertail Lake from May 1, 1899, to May 14, 1904. As there is no important tributary between, these records are almost directly comparable with those of the Geological Survey given herewith, the difference in drainage area being about 12 per cent.

The daily discharge and monthly estimates for all years prior to 1910, inclusive, have been republished in "Report of water resources investigation of Minnesota during 1909–10," by the State drainage commission, St. Paul, Minn.

Discharge measurements of Ottertail River near Fergus Falls, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 21	E. F. Chandler	90	90.0	[a]4.08	219
July 16	Robert Follansbee	90	104	2.60	167
Aug. 23[b]	.....do	54	38.7	2.14	48.1
Dec. 23	C. R. Adams	85	49.1	[c]3.17	85.2

[a] Gage height to water surface; thickness of ice approximately 1.7 feet.
[b] Wading measurement.
[c] Gage height to water surface; thickness of ice 1.2 feet.

Daily gage height, in feet, of Ottertail River near Fergus Falls, Minn., for 1910.

[H. G. Evensen, jr., observer.]

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.4	......	3.2	3.3	3.1	2.8	2.35	2.1	2.0	2.3	......
2	......	......	3.2	3.3	3.1	2.8	2.3	2.15	2.0	2.3	2.25
3	......	......	3.2	3.3	3.05	2.8	2.3	2.1	2.0	2.3	2.25
4	......	......	3.2	3.3	3.05	2.75	2.3	2.05	1.95	2.35	2.25
5	......	......	3.2	3.3	3.05	2.75	2.3	2.05	1.95	2.4	3.0
6	......	......	3.25	3.3	3.05	2.7	2.3	2.05	1.95	2.4	3.05
7	......	......	3.25	3.3	3.05	2.7	2.3	2.05	1.95	2.3	3.05
8	......	......	3.25	3.3	3.0	2.65	2.3	2.0	2.0	2.3	3.05
9	......	......	3.25	3.3	3.0	2.65	2.3	1.95	2.05	2.3	3.0
10	4.2	......	3.25	3.3	3.0	2.65	2.3	1.95	2.05	2.3	3.0
11	......	......	3.25	3.3	3.0	2.65	2.25	1.95	2.05	2.3	......
12	......	......	3.25	3.25	3.0	2.6	2.25	1.95	2.05	2.3	......
13	......	......	3.25	3.25	3.0	2.6	2.25	1.9	2.0	2.3	......
14	......	3.25	3.25	3.25	3.0	2.6	2.25	2.0	2.05	2.3	3.0
15	......	3.2	3.3	3.25	3.0	2.6	2.2	2.0	2.05	2.3	......
16	......	3.1	3.3	3.2	2.95	2.6	2.2	2.0	2.0	2.25	......
17	......	3.1	3.3	3.2	2.95	2.6	2.2	2.0	2.0	2.25	......
18	4.5	3.05	3.3	3.2	2.9	2.6	2.2	2.0	2.0	2.25	......
19	......	3.05	3.3	3.2	2.9	2.55	2.2	2.0	2.1	2.25	......
20	......	3.05	3.3	3.2	2.9	2.55	2.25	2.0	2.1	2.25	......
21	4.0	3.05	3.3	3.2	2.9	2.5	2.25	2.0	2.15	2.25	......
22	......	3.05	3.3	3.2	2.85	2.5	2.15	2.1	2.15	2.25	3.1
23	......	3.0	3.3	3.2	2.85	2.5	2.15	2.1	2.25	2.25	......
24	......	3.0	3.3	3.2	2.85	2.45	2.05	2.0	2.3	2.25	......
25	......	3.0	3.3	3.2	2.85	2.45	2.05	2.15	2.3	2.2	......
26	......	3.0	3.3	3.15	2.85	2.4	2.05	2.2	2.35	2.2	......
27	......	3.0	3.3	3.15	2.8	2.4	2.05	2.0	2.35	2.2	......
28	......	3.05	3.3	3.15	2.8	2.35	2.05	2.0	2.3	2.2	......
29	......	3.05	3.3	3.15	2.8	2.35	2.05	2.0	2.3	2.2	3.2
30	......	3.15	3.3	3.15	2.8	2.35	2.05	2.0	2.3	2.2	......
31	......	3.15	3.3	3.1	......	2.35	2.05	......	2.3	......	......

NOTE.—Ice from Jan. 1 to Mar. 14 and from Dec. 5 to 31.

Daily discharge, in second-feet, of Ottertail River near Fergus Falls, Minn., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	402	449	357	236	98	43	28	85	68
2	......	......	......	402	449	357	236	85	52	28	85	74
3	......	......	......	402	449	336	236	85	43	28	85	74
4	......	......	......	402	449	336	218	85	36	22	98	74
5	......	......	......	402	449	336	218	85	36	22	111	......
6	......	......	......	426	449	336	201	85	36	22	111	......
7	......	......	......	426	449	336	201	85	36	22	85	......
8	......	......	......	426	449	315	184	85	28	28	85	......
9	......	......	......	426	449	315	184	85	22	36	85	......
10	......	......	......	426	449	315	184	85	22	36	85	......
11	......	......	......	426	449	315	184	74	22	36	85	......
12	......	......	......	426	426	315	168	74	22	36	85	......
13	......	......	......	426	426	315	168	74	16	28	85	......
14	......	......	426	426	426	315	168	74	28	36	85	......
15	......	......	402	449	426	315	168	62	28	36	85	......
16	......	......	357	449	402	294	168	62	28	28	74	......
17	......	......	357	449	402	294	168	62	28	28	74	......
18	......	......	336	449	402	274	168	62	28	28	74	......
19	......	......	336	449	402	274	153	62	28	43	74	......
20	......	......	336	449	402	274	153	74	28	43	74	......
21	......	*a*219	336	449	402	274	138	74	28	52	74	......
22	......	......	336	449	402	255	138	52	43	52	74	......
23	......	......	315	449	402	255	138	52	43	74	74	*a* 85
24	......	......	315	449	402	255	124	36	28	85	74	......
25	......	......	315	449	402	255	124	36	52	85	62	......
26	......	......	315	449	380	255	111	36	62	98	62	......
27	......	......	315	449	380	236	111	36	28	98	62	......
28	......	......	336	449	380	236	98	36	28	85	62	......
29	......	......	336	449	380	236	98	36	28	85	62	......
30	......	......	380	449	380	236	98	36	28	85	62	......
31	......	......	380	......	357	......	98	36	......	85	......	......

a Discharge measurement.

NOTE.—Discharge at this station computed from an excellent rating curve.

Monthly discharge of Ottertail River near Fergus Falls, Minn., for 1910.

[Drainage area 1,310 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January			325	0.248	0.27	C.
February			240	.168	.17	C.
March	426		285	.218	.25	B.
April	449	402	434	.331	.37	A.
May	449	357	417	.318	.37	A.
June	357	236	294	.224	.25	A.
July	236	98	163	.124	.14	A.
August	98	36	64.8	.049	.06	A.
September	52	16	32.6	.025	.03	A.
October	98	22	48.3	.037	.04	A.
November	111	62	79	.060	.07	A.
December			80	.061	.07	C.
The year	449	16	205	.156	2.09	

NOTE.—Mean discharge for January and February estimated. Mean discharge, Mar. 1 to 14, estimated, 200 second-feet; Dec. 5 to 31, 81second-feet.

RED RIVER NEAR FERGUS FALLS, MINN.

This station, which is located at Dewey Bridge, 3½ miles west of Fergus Falls and about 1 mile below the mouth of Pelican River, was established June 19, 1909, to obtain data for use in connection with water power development on Red River.

Except Pelican River no tributary enters within several miles of the station. The drainage area above this point is 1,800 square miles.

The nearest dam above the station is at Fergus Falls. Although the intermittent operation of the mills at this point may cause a daily fluctuation, its effect is very slight at the station, as there is no consistent difference between the recorded morning and evening gage heights. Three or four miles below the vertical staff gage at the bridge section is the Dayton Hollow dam, which is the control for the gaging section, as is shown by the drop in the gage heights when the water level above the dam is lowered for repairs to that structure. (See Pl. III, *A*.) When the station was established, it was believed that this control was reasonably permanent, but the data were so unsatisfactory that the station was discontinued March 31, 1910.

Discharge measurements are made from the bridge.

Owing to the short time that the station was operated, it was not completely rated; hence no estimate of daily flow can be given.

A. DAYTON HOLLOW DAM ON OTTERTAIL RIVER BELOW FERGUS FALLS, MINN

A typical modern power development.

B. MEASUREMENT OF RAINY RIVER AT INTERNATIONAL FALLS, MINN.

Daily gage height, in feet, of Red River near Fergus Falls, Minn., for 1910.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1			7.29	11				21			5.48
2				12	6.99			22		7.21	5.51
3		7.12		13				23			5.47
4				14				24			5.42
5				15		6.99		25			5.44
6				16			7.40	26	7.12		5.48
7				17			7.48	27			5.51
8				18			6.17	28			5.42
9		7.22	7.35	19	6.91		5.90	29			5.45
10				20			5.65	30			5.51
								31			5.46

NOTE.—Ice from Jan. 1 to Mar. 15. The average thickness of ice during this period was 1.6 feet.

RED RIVER AT FARGO, N. DAK.

This station, which is located at the highway bridge connecting Front Street, Fargo, N. Dak., with Moorhead, Minn., was established May 23, 1901. Discharge measurements are made half a mile farther upstream, at the footbridge at the Fargo waterworks pumping station, except at very high stage, when the Front Street Bridge or the Northern Pacific Railway bridge is used.

The drainage area above this station is about 6,020 square miles, 3,770 being in Minnesota, 500 in South Dakota, and 1,750 in North Dakota. The nearest tributary is Sheyenne River, which enters Red River 10 miles below.

The vertical staff gage is attached to the breakwater for the center pier of the Front Street Bridge and is read from the bridge or the banks by the aid of a field glass.

The gage datum has not been changed since the establishment of the station. The channel is in clay and silt, and slight changes in depth occur from time to time. The fall is so slight that any accidental obstruction in the channel is likely to cause an appreciable effect for a long distance upstream and to affect the rating. Hence, unless frequent discharge measurements are made, slight errors will enter, but there have been no very great changes in the rating curves for nine years, and the records are fairly good except when affected by ice, by which the stream is smoothly closed for about four months of the year. At the spring break-up, on account of the comparatively sluggish current and the fact that the river flows northward into a colder district, a pronounced backwater effect is usually caused by ice jams and partial ice jams, and the river is raised disproportionately high for several days or weeks. At that season, therefore, the records can only be approximate unless daily discharge measurements are made.

The estimates of daily and monthly discharge for all years prior to 1910, inclusive, have been published in "Report of water resources investigation in Minnesota during 1909–10" by the State drainage commission, St. Paul, Minn.

Discharge measurements of Red River at Fargo, N. Dak., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec. ft.*
July 27	E. F. Chandler	93	142	6.74	150
Aug. 16	do	95	163	5.98	56

Daily gage height, in feet, of Red River at Fargo, N. Dak., for 1910.

[H R. Grasse, observer.]

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		9.4	11.6	11.0	8.8	7.7	6.6	5.9	6.0	5.7	5.4
2		9.4	11.6	10.9	8.7	7.6	6.6	5.9	6.0	5.9	5.3
3		9.4	11.4	10.9	8.6	7.5	6.6	5.9	5.9	6.0	5.7
4		9.4	11.4	10.8	8.6	7.5	6.6	5.8	5.9	6.0	5.8
5		9.5	11.4	10.7	8.5	7.5	6.3	5.8	5.9	5.8	6.0
6		10.5	11.4	10.7	8.6	7.5	6.4	5.9	5.9	5.8	6.2
7		11.5	11.3	10.6	8.6	7.4	6.5	5.9	5.9	5.9	
8		11.8	11.1	10.6	8.6	7.4	6.5	5.8	5.9	6.0	
9		11.8	11.0	10.5	8.5	7.3	6.5	5.8	5.9	6.0	
10		11.9	11.0	10.5	8.5	7.1	6.4	5.8	5.9	6.2	
11		12.8	10.9	10.4	8.5	7.0	6.4	5.8	5.9	6.2	
12		13.6	11.7	10.4	8.4	7.0	6.3	5.8	5.9	6.2	
13		15.3	11.6	10.4	8.4	7.0	6.4	5.8	5.9	6.2	
14		17.8	11.5	10.4	8.4	7.0	6.4	5.8	5.95	6.1	
15		19.5	11.5	10.0	8.3	7.0	6.4	5.9	5.95	6.2	
16		21.2	11.5	9.8	8.2	7.2	6.0	5.9	6.0	6.2	
17		22.3	11.0	9.7	8.3	7.2	6.0	5.9	6.0	6.3	
18		23.0	10.5	9.7	8.4	7.1	6.0	5.8	6.0	6.4	
19		23.1	10.5	9.7	8.1	7.1	6.1	5.8	6.0	6.3	
20		22.9	10.5	9.6	8.0	7.0	5.9	5.8	6.3	6.1	
21		21.7	10.6	9.5	7.9	6.9	6.0	5.8	6.2	6.1	
22		20.2	10.9	9.5	7.9	6.8	6.1	5.9	6.4	6.1	
23		18.3	12.7	9.5	7.9	6.9	5.8	5.8	6.1	6.3	
24		16.0	13.0	9.4	7.8	6.9	6.0	5.8	6.2	6.4	
25		14.3	12.9	9.3	7.8	6.8	6.1	5.8	6.2	6.5	
26		13.3	12.5	9.3	7.8	6.7	6.1	5.9	6.0	6.3	
27	9.4	12.8	12.0	9.2	7.8	6.7	5.8	6.0	6.2	6.4	
28	9.4	12.5	11.8	9.0	7.8	6.7	6.1	6.0	5.8	6.5	
29		12.3	11.5	9.0	7.8	6.6	6.2	6.0	5.6	6.5	
30		12.0	11.1	9.0	7.8	6.6	6.1	6.0	5.6	6.5	
31		11.8		8.9		6.6	5.9		5.7		

NOTE.—Ice present from Jan. 1 to Mar. 22 and from Nov. 9 to Dec. 31.

Daily discharge, in second-feet, of Red River at Fargo, N. Dak., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	270	1,470	1,280	635	356	131	51	60	36
2	270	1,470	1,250	608	332	131	51	60	51
3	270	1,400	1,250	582	309	131	51	51	60
4	270	1,400	1,220	582	309	131	43	51	60
5	290	1,400	1,190	556	309	90	43	51	43
6	520	1,400	1,190	582	309	102	51	51	43
7	790	1,370	1,160	582	286	116	51	51	51
8	850	1,310	1,160	582	286	116	43	51	60
9	820	1,280	1,120	556	264	116	43	51	
10	820	1,280	1,120	556	221	102	43	51	
11	1,070	1,250	1,090	556	201	102	43	51	
12	1,300	1,500	1,090	530	201	90	43	51	
13	1,850	1,470	1,090	530	201	102	43	51	
14	2,700	1,440	1,090	530	201	102	43	55	
15	3,300	1,440	969	504	201	102	51	55	

Daily discharge, in second-feet, of Red River at Fargo, N. Dak., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
16	3,800	1,440	911	478	242	60	51	60	
17	4,000	1,280	882	504	242	60	51	60	
18	4,300	1,120	882	530	221	60	43	60	
19	4,500	1,120	882	453	221	69	43	60	
20	4,700	1,120	853	428	201	51	43	90	
21	4,600	1,160	824	404	182	60	43	79	
22	4,400	1,250	824	404	164	69	51	102	
23	4,100	1,850	824	404	182	43	43	69	
24	3,100	1,960	797	380	182	60	43	79	
25	2,440	1,920	770	380	164	69	43	79	
26	2,070	1,780	770	380	147	69	51	60	
27	1,890	1,600	743	380	147	43	60	79	
28	1,780	1,530	689	380	147	69	60	43	
29	1,710	1,440	689	380	131	79	60	30	
30	1,600	1,310	689	380	131	69	60	30	
31	1,532		662		131	51		36	

NOTE.—Daily discharge computed from well-defined rating curve except from Mar. 1 to 22, when the discharge was estimated.

Monthly discharge of Red River at Fargo, N. Dak., for 1910.

[Drainage area, 6,020 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
March			2,130	0.354	0.41	131,000	C.
April	1,960	1,120	1,430	.238	.27	85,100	A.
May	1,280	662	967	.161	.19	59,500	A.
June	635	380	491	.081	.09	29,200	B.
July	356	131	220	.037	.04	13,500	B.
August	131	43	85.3	.014	.02	5,240	B.
September	60	43	47.9	.0080	.009	2,850	B.
October	102	30	58.3	.0097	.01	3,580	B.
November			[a] 45.0	.0075	.008	2,680	C.
The period						332,650	

[a] Mean discharge, Nov. 9 to 30, estimated 43 second-feet.

RED RIVER AT GRAND FORKS, N. DAK.

This station, which is located at the Northern Pacific Railway bridge between Grand Forks, N. Dak., and East Grand Forks, Minn., was established May 26, 1901. Gage-height records had, however, been kept by the United States Army engineers for many years at this point, their staff gage being located on the breakwater to which the original United States Geological Survey gage was attached, but at a datum 5.00 feet higher. A chain gage later installed on the downstream side of the bridge at the same datum has remained unchanged since the establishment of the station.

Discharge measurements are usually made from the Great Northern Railway bridge about 1,000 feet above the chain gage. The chain gage is one-half mile below the mouth of Red Lake River. The drainage area at this station includes about 13,400 square miles in Minnesota, 500 in South Dakota, and 11,100 in North Dakota, a total of 25,000 square miles. Red Lake River, which drains 5,680 square miles of the total area, is much more steady in its flow than Red River, so that at low stages (in winter, and often in late summer and fall) Red Lake River brings from one-half to three-fifths of all the water passing this station.

The channel is cut in clay and silt and is subject to small gradual changes, but unusually precise gage records have been kept; the range of the river in height is so great—47 feet between the extremes of low and high water—that a change of 0.1 foot in gage height causes only a small percentage change in flow, and as frequent discharge measurements have been made the records are satisfactory, being as a rule excellent through the open season.

The river flows under smooth ice from about November 15 to April 10; the flow during the winter fluctuates little, and since 1895 enough discharge measurements have been made each winter to give fairly satisfactory summaries for the winter.

When the ice breaks up in the spring, because the river has only a gentle current and because it flows north into cooler regions where the river is not yet open, the gage reading is usually excessively and disproportionately high for a few days or weeks, so that the figures for quantity of flow must depend largely on estimation; actual measurements when the river appeared entirely open and clear of ice at this point have sometimes shown the gage reading to be 5 feet greater than would have been needed for the same discharge later in the season, after the whole length of the river was entirely open.

The daily and monthly discharge estimates for all years prior to 1910, inclusive, have been published in "Report of water resources investigation of Minnesota during 1909–10," by the State drainage commission, St. Paul, Minn.

Discharge measurements of Red River at Grand Forks, N. Dak., 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 14	J. O. Nomland	215	1,300	[a] 8.77	1,530
Feb. 28	.....do	208	897	[b] 7.67	983
Mar. 23	E. F. Chandler	543	7,580	30.17	18,300
July 25	.....do	128	621	5.12	830
Aug. 20	.....do	115	384	3.39	366
Oct. 14	.....do	70	319	3.36	395
Dec. 13	Chandler and Ebner	73	253	[c] 3.74	312

[a] Gage height to water surface; thickness of ice, 1.10 feet.
[b] Gage height to water surface; thickness of ice, 1.80 feet.
[c] Gage height to water surface; thickness of ice, 0.95 foot.

Daily gage height, in feet, of Red River at Grand Forks, N. Lak., for 1910.

[H. L. Hayes, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.50			18.20	17.80	8.95	5.98	4.65	3.60	3.50	3.38	3.62
2				18.48	16.95	8.69	5.88	4.68	3.35	3.45	3.68	3.68
3				18.30	16.20	8.70	5.72	4.48	3.25	3.50	3.52	3.70
4				18.25	15.45	8.78	5.62	4.40	3.40	3.45	3.60	
5		8.90	8.90	17.95	14.80	8.80	5.65	4.42	3.60	3.60	3.00	
6				17.62	14.45	8 89	5.60	4.30	3.98	3.50	3.18	
7				17.35	13.90	8.81	5.50	4.22	4.20	3.35	2.70	
8	9.10			16.95	13.50	8.78	5.40	4.30	3.75	3.25	3.22	
9				16.55	12.92	8.75	5.42	4.16	3.70	3.12	3.30	
10				16.18	12.55	8.60	5.42	3.75	3.70	3.62	3.40	3.10
11				15.70	12.00	8.45	5.40	4.38	3.65	3.62	3.52	
12		8 92		15.32	11.90	8.20	5.38	3.97	3.66	3.65	3.10	
13			13.50	14.70	11.65	8.25	5.20	3.92	3.55	3.50	3.42	3.70
14				13.98	11.39	8.18	5.05	4.00	3.62	3.35	3.40	
15	8.70			13.75	10.90	8.00	5.00	3.90	3.65	3.35	3.20	
16				13.65	10.90	7.98	5.07	3.82	3.65	3.45	3.38	
17				13.50	10.95	7.68	4.90	3.82	3.70	3.30	3.38	3.90
18				13.22	10.85	7.52	4.88	3.82	3.95	3.65	3.30	
19		8.60	28.50	13.15	10.80	7.35	4.92	3.62	3.45	3.25	3.38	
20			29.60	13.75	10.68	7.22	4.82	3.35	3.35	3.40	3.45	
21			30.55	15.25	10.50	7.10	4.80	3.50	3.25	3.25	3.45	
22	8.88		30.70	17.05	10.40	6.95	4.78	3.50	3.35	3.58	3.42	
23			30.25	19.30	10.49	6.68	4.72	3.50	3.25	3.72	3.38	
24			29.40	20.25	10.42	6.50	5.05	3.50	3.92	3.75	3.40	4.10
25			29.25	20.40	10.08	6.45	5.15	3.45	3.19	3.65	3.75	
26		8.10	26.45	20.52	9.92	6.38	5.16	3.45	3.75	3.80	3.80	
27			24.75	20.58	9.70	6.20	5.08	3.40	3.48	3.90	3.70	
28			22.60	20.15	9.52	6.19	4.98	3.30	3.35	3.68	3.68	
29	8.85		20.20	19.35	9.42	6.10	4.96	3.30	3.48	3.65	3.60	
30			18.80	18.65	9.29	6.05	4.88	3.30	3.40	3.55	3.58	
31			18.28		9.32		4.80	3.45		3.50		4.20

NOTE.—Ice present from Jan. 1 to Mar. 25 and from Nov. 5 to Dec. 31.

Daily discharge, in second-feet, of Red River at Grand Forks, N. Dak., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		8,760	8,440	2,560	1,140	682	429	410	387
2		8,990	7,760	2.420	1,100	691	382	400	445
3		8,850	7,180	2,430	1,040	635	364	410	414
4		8,800	6,610	2,470	1,000	613	391	400	429
5		8,560	6,160	2,480	1,010	618	429	429	325
6		8,290	5,920	2,530	995	587	510	410	353
7		8,080	5,530	2,540	960	567	562	382	280
8		7,760	5,250	2,470	925	587	460	364	359
9		7,450	4,870	2,460	932	552	449	343	373
10		7,170	4,620	2,380	932	460	449	433	391
11		6,810	4,290	2,300	925	608	439	433	414
12		6,530	4,230	2,180	918	508	441	439	340
13		6,090	4,080	2,200	856	497	420	410	395
14		5,590	3,920	2,170	806	515	433	382	391
15		5,420	3,640	2,080	790	492	439	382	356
16	6,500	5,360	3,640	2,070	813	474	439	400	387
17	9,000	5,250	3,660	1,920	758	474	449	373	387
18	12,500	5,060	3,610	1,840	752	474	504	439	373
19	16,100	5,020	3,580	1,760	764	433	400	364	387
20	17,200	5,420	3,510	1,690	733	382	382	391	400
21	18,200	6,480	3,420	1,630	727	410	364	364	400
22	18,500	7,840	3,360	1,560	721	410,	382	425	395
23	18,400	9,690	3,410	1,440	703	410	364	453	387
24	18,100	10,500	3,370	1,360	806	410	497	460	391
25	18,400	10,700	3,180	1,340	840	400	354	439	460
26	16,000	10,800	3,100	1,310	843	400	460	470	470
27	14,500	10,800	2,980	1,230	817	391	406	492	449
28	12,600	10,400	2,880	1,230	784	373	382	445	445
29	10,500	9,730	2,820	1,190	777	373	406	439	429
30	9,260	9,140	2,750	1,170	752	373	391	420	425
31	8,730		2,770		727	400		410	

NOTE.—Daily discharge computed from a well-defined rating curve, except from Mar. 16 to 27, which was estimated from the gage heights and a measurement.

Monthly discharge of Red River at Grand Forks, N. Dak., for 1910.

[Drainage area, 25,000 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January			1,520	0.061	0.07	93,500	C.
February			1,300	.052	.05	72,200	C.
March	18,500		8,420	.336	.39	518,000	C.
April	10,800	5,020	7,840	.314	.35	467,000	A.
May	8,440	2,750	4,340	.174	.20	267,000	A.
June	2,560	1,170	1,950	.078	.09	116,000	A.
July	1,140	703	860	.034	.04	52,900	A.
August	691	373	490	.020	.02	30,100	A.
September	562	354	426	.017	.02	25,300	A.
October	492	343	413	.017	.02	25,400	A.
November	470	280	395	.016	.02	23,500	B.
December			310	.012	.01	19,100	B.
The year				.094	1.28	1,710,000	

NOTE.—Mean discharge for January, February, and December estimated from discharge measurements, gage heights, and notes regarding ice. Mean discharge, Mar. 1 to 15, estimated, 2,430 second-feet.

PELICAN RIVER NEAR FERGUS FALLS, MINN.

Pelican River rises in Rice Lake near Richwood, Becker County, and flows southward through a chain of lakes, the chief of which are Floyd, Little Floyd, Elsa (elevation, 1,345 feet), Detroit (1,335 feet), Sallie, Melissa (1,330 feet), Pelican (1,320 feet), Lizzie (1,315 feet), and Lida lakes.

The gaging station, which was established June 19, 1909, in connection with the general investigation of the water resources of Minnesota, is located 6 miles northwest of Fergus Falls, in sec. 18 of that township, at a private bridge, from which discharge measurements are made.

Pelican River enters Red River about 5 miles below the gaging station, and as the range of stage in Red River is small, there is no danger of backwater. The nearest dam is at Elizabeth, 6 or 8 miles above the station, and the intermittent operation of the mill at that point causes a slight daily fluctuation in the gage heights. The staff gage at the bridge is read twice each day and the mean of these readings is taken as the mean for the day. It is located at the measuring section.

From the middle of November to the 1st of April, when the river is ice-bound, gage readings are taken through a hole in the ice.

With the exception of the daily fluctuation, due to the mill at Elizabeth, conditions of flow are excellent, and therefore the records should be considered good.

Discharge measurements of Pelican River near Fergus Falls, Minn., 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 12	E. F. Chandler	29	53.0	6.26	126
Aug. 4	.....do	29	48.1	5.99	74.6
Sept. 3	.....do	29	66.1	6.54	193
Oct. 4	.....do	29	68.5	6.56	195
Dec. 12	.....do	29	63.0	[a] 7.40	128
1910.					
Feb. 20	E. F. Chandler	28	46.7	[b] 8.55	73.4
July 16	Robert Follansbee	26	37.2	5.78	35.8
Aug. 23 [c]	.....do	15	7.2	5.44	5.5
Dec. 23	C. R. Adams			[d] 5.8	[e] 1.0

[a] Gage height to water surface; thickness of ice, 1.90 feet.
[b] Gage height to water surface; thickness of ice, 2.50 feet.
[c] Wading section.
[d] Gage height to water surface; thickness of ice about 2 feet.
[e] Discharge estimated.

Daily gage height, in feet, of Pelican River near Fergus Falls, Minn., for 1910.

[Henry W. Luther, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1				6.42	6.51	6.11	5.82	5.50	5.36	5.39	5.52	
2			8.70	6.46	6.49	6.11	5.81	5.56	5.45	5.40	5.68	5.88
3		8.35		6.49	6.50	6.14	5.70	5.50	5.39	5.58	5.70	
4				6.51	6.49	6.11	5.48	5.51	5.36	5.56	5.78	
5			9.45	6.59	6.46	6.14	5.46	5.49	5.36	5.61	5.82	
6	7.85			6.50	6.45	6.19	5.80	5.46	5.35	5.60	5.55	
7				6.49	6.41	6.14	5.50	5.44	5.35	5.59	5.45	
8				6.44	6.44	6.14	5.46	5.42	5.36	5.51	5.44	
9			9.50	6.49	6.41	6.18	5.54	5.41	5.35	5.46	5.45	6.00
10		8.55		6.51	6.42	6.11	5.52	5.42	5.36	5.54	5.46	
11				6.39	6.41	6.09	5.80	5.41	5.34	5.61	5.45	
12				6.49	6.39	6.06	5.54	5.42	5.35	5.60	5.46	
13	7.85			6.46	6.40	6.04	5.60	5.45	5.41	5.55	5.48	6.15
14				6.50	6.34	6.00	5.48	5.44	5.55	5.45	5.50	
15				6.46	6.45	6.04	5.58	5.46	5.41	5.41	5.46	
16			8.50	6.60	6.42	5.75	5.48	5.48	5.54	5.31	5.51	6.50
17				6.64	6.38	6.00	5.41	5.45	5.52	5.32	5.50	
18				6.61	6.42	5.96	5.88	5.48	5.46	5.38	5.49	
19				6.61	6.40	5.78	5.45	5.46	5.40	5.39	5.54	
20		8.55	6.54	6.61	6.34	5.76	5.46	5.45	5.34	5.32		5.80
21	8.00		6.50	6.70	6.31	5.90	5.49	5.44	5.36	5.29		
22		9.00	6.51	6.69	6.32	5.92	5.51	5.41	5.44	5.31	5.52	
23		8.65	6.54	6.70	6.28	5.86	5.52	5.70	5.40	5.35		5.80
24			6.51	6.64	6.32	5.88	5.45	5.45	5.44	5.34		
25			6.49	6.51	6.31	5.90	5.49	5.40	5.41	5.35	5.50	
26	8.35		6.49	6.49	6.31	5.89	5.51	5.68	5.40	5.35		
27			6.46	6.48	6.24	5.82	5.52	5.40	5.40	5.36		
28			6.45	6.55	6.21	5.81	5.52	5.40	5.40	5.34		
29			6.46	6.44	6.20	5.74	5.80	5.39	5.36	5.34		
30			6.48	6.49	6.16	5.71	5.55	5.41	5.39	5.36	5.60	5.70
31			6.49		6.14		5.49	5.41		5.41		

NOTE.—Ice present from Jan. 1 to Mar. 19 and from Nov. 20 to Dec. 31.

Daily discharge, in second-feet, of Pelican River near Fergus Falls, Minn., for 1909–10.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.							1909.						
1	......	111	89	170	190	144	16	......	75	166	200	166	150
2	......	107	103	178	195	154	17	......	82	154	205	185	150
3	......	107	84	190	185	154	18	......	77	151	180	158	140
4	......	93	73	180	180	151	19	170	77	144	192	142	140
5	......	93	75	182	185	151	20	170	36	144	185	156	140
6	......	56	84	190	180	144	21	144	175	135	200	168	140
7	......	77	138	190	185	151	22	147	154	138	200	158	130
8	......	82	147	180	182	151	23	142	144	168	190	168	130
9	......	66	144	182	200	151	24	129	133	190	195	180	130
10	......	75	135	180	226	156	25	208	113	182	192	168	130
11	......	93	154	190	168	151	26	138	101	195	200	168	130
12	......	111	182	182	180	147	27	71	91	182	200	166	120
13	......	120	218	180	168	151	28	73	93	180	205	147	120
14	......	91	218	170	170	150	29	109	91	180	200	142	120
15	......	80	185	185	168	150	30	113	84	178	192	158	120
							31	......	89	170	......	168	......

NOTE.—Discharge computed from a well-defined rating curve, except from Nov. 14 to 30, for which period the discharge is estimated.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910.											
1	....	....	161	182	93	45	11	3.4	4.6	13	....
2	....	....	170	178	93	43	16	8.0	5	28	....
3	....	....	178	180	99	30	11	4.6	18	30	....
4	....	....	182	178	93	9.8	12	3.4	16	40	....
5	....	....	202	170	99	8.6	10	3.4	21	45	....
6	....	....	180	168	109	42	8.6	3.0	20	16	....
7	....	....	178	158	99	11	7.4	3.0	19	8.0	....
8	....	....	166	166	99	8.6	6.2	3.4	12	7.4	....
9	....	....	178	158	107	15	5.6	3.0	8.6	8.0	....
10	....	....	182	161	93	13	6.2	3.4	15	8.6	....
11	....	....	154	158	89	42	5.6	2.6	21	8.0	....
12	....	....	178	154	84	15	6.2	3.0	20	8.6	....
13	....	....	170	156	80	20	8.0	5.6	15	9.8	....
14	....	....	180	142	73	9.8	7.4	16	8	11	....
15	....	....	170	168	80	18	8.6	5.6	5.6	8.0	....
16	....	....	205	161	36	9.8	9.8	15	1.4	12	....
17	....	....	215	151	73	5.6	8.0	13	1.8	11	....
18	....	....	208	161	66	53	9.8	8.6	4.2	10	....
19	....	....	208	156	40	8.0	8.6	5	4.6	15	....
20	*a* 73	190	208	142	37	8.6	8.0	2.6	1.8	10	....
21	....	180	231	135	56	10	7.4	3.4	.9	10	....
22	....	182	228	138	59	12	5.6	7.4	1.4	8.0	....
23	....	190	231	129	50	13	30	5	3	8.0	*a* 1.0
24	....	182	215	138	53	8.0	8.0	7.4	2.6	8.0	....
25	....	178	182	135	56	10	5.0	5.6	3	8.0	....
26	....	178	178	135	55	12	28	5	3	7.0	....
27	....	170	175	120	45	13	5.0	5	3.4	7.0	....
28	....	168	192	113	43	13	5.0	5	2.6	6.0	....
29	....	170	166	111	35	42	4.6	3.4	2.6	6.0	....
30	....	175	178	103	31	16	5.6	4.6	3.4	5.0	....
31	....	178	....	99	....	10	5.6	....	5.6	....	....

a Discharge measurement.

NOTE.—Discharge computed from a well-defined rating curve, except from Nov. 20 to 30, for which period it is estimated.

Monthly discharge of Pelican River near Fergus Falls, Minn., for 1909–10.

(Drainage area, 433 square miles.)

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
June 19–30	208	71	134	0.309	0.14	A.
July	175	36	96	.222	.26	A.
August	218	73	151	.349	.40	A.
September	205	170	189	.436	.49	A.
October	226	142	173	.400	.46	A.
November	156	120	142	.328	.37	B.
December			125	.289	.33	C.
1910.						
January			125	.289	.33	C.
February			80	.185	.19	C.
March			180	.416	.48	C.
April	231	154	188	.434	.48	A.
May	182	99	149	.344	.40	A.
June	109	31	70.8	.164	.18	A.
July	53	5.6	18.5	.043	.05	A.
August	30	4.6	9.15	.021	.02	B.
September	16	2.6	5.58	.013	.01	B.
October	21	.8	8.06	.016	.02	B.
November	45		12.7	.029	.03	D.
December			3.00	.0069	.01	D.
The year	231		70.6	.163	2.20	

NOTE.—Mean discharge for December, 1909, and for January, February, and December, 1910, estimated. Mean discharge, Mar. 1 to 19, estimated at 181 second-feet.

WILD RICE RIVER.

GENERAL FEATURES OF AREA DRAINED.

Wild Rice River, next to Red Lake River the most important tributary of Red River, rises in Upper Rice Lake (at an elevation of 1,500 feet above sea level) in T. 145 N., R. 37 W., in the southern part of Clearwater County. It flows southwestward into Lower Rice Lake, which has an area of about 4 square miles, and thence in a general westerly course to its junction with Red River (at an elevation of about 870 feet), near Hendrum post office in Norman County. Its chief tributaries are Simon Lake outlet, Twin Lake outlet, White Earth and Marsh rivers, and the South Branch. During periods of high water Wild Rice River overflows to Marsh River, which is a slough near Ada and has no connection with the Wild Rice at any other time.

The following drainage areas have been measured in the basin:

Drainage areas on Wild Rice River.

	Square miles.
Above Lower Rice Lake outlet	128
Above Faith	567
Above sec. 20, T. 144 N., R. 43 W	752
Above Twin Valley	805
Above sec. 18, T. 144 N., R. 44 W	908
Above mouth	1,440

For the first 2 miles below Lower Rice Lake the river is an arm of the lake controlled by a logging dam which stores water on the lake to a depth of 8 feet or more. Below the dam the slope becomes steeper, and between the mouth of White Earth River and a point 10 miles below Heiberg the average is 4.8 feet per mile. From this point the slope gradually decreases until it nearly disappears below range line 46-47. Notwithstanding this comparatively steep slope the river is in places extremely tortuous. Between Mahnomen and Faith, for example, 7 miles, the distance along the river is 20 miles.

Above Beaulieu the area is rolling and there is no well-defined bluff line, but below that point the ground becomes more level and well-defined bluffs appear. From White Earth River to Heiberg the Wild Rice flows through a valley having an average width of one-fourth mile and lying 20 to 30 feet below the general surface level. Below Heiberg the valley is much narrower. In the upper portion of the basin the surface is somewhat undulating, but along the lower course it is in general flat. Elevations in the basin range from 870 to 1,550 feet above sea level.

With scarcely an exception the valley lands, although not subject to overflow except during unusual floods, are not under cultivation but are heavily timbered. In the prairie section west of Beaulieu much of the land is under cultivation. East of Beaulieu the area is largely covered with brush interspersed with tracts of prairie which constitute possibly a third of this part of the basin. The brush and prairie prevail to a point within a few miles of Lower Rice Lake, and the rest of the basin is heavily covered with pine.

The geology of the basin is very similar to that of the Red Lake basin, the surface formation consisting of chiefly blue till overlain in its lower portion by lacustrine clays and underlain by Cretaceous rocks. The area contains about 50 lakes, all located in its upper third, the lake surface making 5 to 10 per cent of that part of the basin. Many of these lakes are small and have no visible outlet.

The mean annual rainfall ranges from 25 inches in the upper area to 21 inches at the mouth of the river. Of this amount about 2 inches fall as snow, which remains during the winter. From November to April the river flows under ice 2 feet thick. As there are no winter thaws, the winter flow is derived from the lakes and from ground water and is very uniform, decreasing gradually till midwinter, when it is usually a minimum.

No good reservoir sites exist in the basin, as the lakes are too far up on the headwaters to have sufficient tributary run-off to make them of value except as log-driving reservoirs. Although the river itself flows between banks 20 to 30 feet high for a considerable part of its course, the fall of the river is so great that the storage capacity is limited. In order to determine this fact, as well as to determine the availability of Wild Rice River for power development, a survey was made in 1911 by the United States Geological Survey from the mouth of White Earth River near Mahnomen to a point 11 miles below the Heiberg dam. At this point the survey was tied to a drainage survey by the State drainage engineer, extending to a point below Ada. From the data collected on these surveys sheets have been prepared showing the profile of the water surface, a plan of the river, and the contours along the river bank. These sheets have been published separately and may be had on application to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn. From these surveys the following table of elevations and distances has been compiled:

Elevations and distances on Wild Rice River.

River.	Distance below mouth of White Earth River.	Elevation above sea level.
	Miles.	*Feet.*
White Earth River	0	1,187
Mahnomen, headwater	2	1,184
Mahnomen, tailwater	2	1,180
Section line 11–10	4	1,173
Highway bridge section line 10–9	6	1,164
Section line 16–17	9	1,156
Section line 17–18	14	1,139
Range line 42–43 W	17	1,128
Section line 13–14	20	1,110
Faith	21	1,102
Creek in sec. 22	23	1,090
Section line 21–22	24	1,076
Creek in sec. 21	25	1,072
	28	1,057
Range line 43-44 W	32	1,033
Section line 26–27	36	1,012
Twin Valley	38	1,005
Section line 21–22	40	1,001
Heiberg, headwater	42	991
Heiberg, foot of dam	42	987
Heiberg, tailwater	43	977
Section line 17–18	45	963
Section line 23–24	50	944
Highway bridge, sec. 15	53	933
Section 16–17	56	920
Highway bridge, range line 45–46	60	910
Highway bridge, near secs. 27–28	66	891
Highway bridge	71	874
Section line 25–36	75	871
South Branch Wild Rice River	83	861
Section line 25–36	88	857
Johnson's dam, crest	92	857
Johnson's dam, foot	92	852
Highway bridge, section line 14–15	97	845
Highway bridge section line 8–9	101	841
Township line 143–144	105	839

At present water power is used at Heiberg, where a fall of 15 feet develops 100 horsepower, and at a point near Perley, where about 65 horsepower is developed.

The Wild Rice is used extensively for log driving, and dams have been built at the outlet of Lower Rice Lake and at Twin Lakes.

These dams hold back the flow during the fall and winter months in order to obtain a sufficient supply to drive the logs to Ada during the spring months. Thus the fall and winter discharge of the river is less than the natural run-off, and the spring discharge is increased by the amount of the stored water. Water can be stored on Lower Rice Lake to a depth of 8 feet by the present dam.

WILD RICE RIVER AT TWIN VALLEY, MINN.

This station, which is located at the steel highway bridge at Twin Valley, Minn., was established June 30, 1909, to obtain data for use in determining available water power and in studying means of flood prevention, which are much needed in this valley.

The nearest tributary is at Heiberg, 2 miles below.

A staff gage is located at the bridge from which discharge measurements are made.

There is a dam across the river at Heiberg, but the highest backwater effect is at a point a mile below Twin Valley. At the outlet of Wild Rice Lake is a logging dam used to store the flow through the winter and early spring months for the purpose of driving the logs to Ada. During the winter period, therefore, the flow at Twin Valley is less than normal, and in the spring the flood flow is augmented by the stored water. There is also a dam at Twin Lake outlet which is used in the same way. An exceptionally severe flood in July, 1909, overflowed the lower part of the valley and wrecked the power dam at Faith by cutting around the end of it and greatly increasing the width of the channel. The maximum stage of this flood was 20 feet at Twin Valley and the corresponding discharge 9,200 second-feet.

The river overflows at a stage of 12 feet and covers a width of several hundred feet.

Sufficient measurements have been made to enable computation of the daily flow. The estimate for the flood discharge above 14 feet is based on Kutter's formula in connection with the known area of the cross section, and may be somewhat in error, but it is believed this error will not exceed 10 per cent. The remaining estimates are based on a well-defined rating curve and should be reliable.

Discharge measurements of Wild Rice River at Twin Valley, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 16	E. F. Chandler	63	169	6.22	345
17	....do	63	188	6.55	416
July 14	....do	54	69.9	4.81	61.1
14[a]	....do	65	60.1	4.81	55.9
Dec. 18	Gorie Monley	55	36.0	[b]5.00	20.8

[a] Wading measurement.
[b] Gage height to water surface; thickness of ice approximately 0.80 feet.

Daily gage height, in feet, of Wild Rice River at Twin Valley, Minn., for 1910.

[Axel Johnson, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		5.70	8.48	5.90	5.00	4.60	4.40	4.60	4.55	
2		5.60	8.65	5.90	5.00	4.60	4.40	4.50	4.55	
3		5.50	8.38	5.85	4.90	4.60	4.45	4.50	4.55	
4		5.50	7.90	5.90	4.80	4.60	4.45	4.50	4.55	
5		5.45	7.50	5.90	4.80	4.55	4.45	4.50	4.55	
6		5.55	7.42	5.80	4.80	4.55	4.45	4.50	4.55	
7		5.45	7.50	6.00	4.80	4.55	4.45	4.50		
8		5.40	7.40	6.70	4.80	4.55	4.45	4.50		
9		5.30	7.45	6.90	4.80	4.55	4.45	4.50		
10		5.20	7.25	6.50	4.80	4.50	4.45	4.50		
11		5.10	7.05	6.45	4.80	4.50	4.50	4.45		
12		5.00	6.95	6.75	4.80	4.45	4.50	4.45		4.4
13		4.90	6.80	6.55	4.80	4.40	4.50	4.45		
14		4.90	6.68	6.65	4.80	4.40	4.50	4.45		
15		4.95	6.60	6.45	4.80	4.40	4.50	4.45		
16		5.22	6.95	6.55	4.80	4.40	4.45	4.45		
17		6.60	7.20	6.00	4.70	4.40	4.45	4.45		
18		6.80	6.57	5.50	4.70	4.35	4.45	4.50		5.0
19		7.20	6.40	5.50	4.65	4.35	4.45	4.50		
20		7.65	6.55	5.60	4.60	4.40	4.45	4.55		
21		7.78	6.55	5.45	4.60	4.40	4.45	4.55		
22		7.82	6.50	5.40	4.60	4.40	4.45	4.55		
23		7.85	6.45	5.40	4.75	4.40	4.45	4.55		
24		8.80	6.50	5.30	4.80	4.40	4.45	4.55		
25		9.20	6.35	5.30	4.85	4.40	4.45	4.55		
26	5.60	9.50	6.30	5.20	4.80	4.40	4.45	4.55		
27	5.50	9.10	6.30	5.20	4.70	4.40	4.55	4.55		
28	5.50	8.90	6.20	5.20	4.70	4.40	4.55	4.55	5.7	5.4
29	5.55	8.70	6.15	5.05	4.60	4.40	4.60	4.55		
30	5.60	8.65	6.10	5.00	4.60	4.40	4.60	4.55		
31	5.75		5.80		4.60	4.40		4.55		

NOTE.—Ice present from Jan. 1 to Mar. 25, and from Nov. 7 to Dec. 31.

Daily discharge, in second-feet, of Wild Rice River at Twin Valley, Minn., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		228	1,110	272	92	32	17	32	28	
2		208	1,180	272	92	32	17	23	28	
3		188	1,070	261	75	32	20	23	28	
4		188	875	272	59	32	20	23	28	
5		178	722	272	59	28	20	23	28	
6		198	695	250	59	28	20	23	28	
7		178	722	295	59	28	20	23		
8		168	688	473	59	28	20	23		
9		148	705	530	59	28	20	23		
10		129	638	419	59	23	20	23		
11		110	575	406	59	23	23	20		
12		92	545	487	59	20	23	20		
13		75	501	432	59	17	23	20		
14		75	467	459	59	17	23	20		
15		84	445	406	59	17	23	20		
16		133	545	432	59	17	20	20		
17		445	622	295	44	17	20	20		
18		501	437	188	44	14	20	23		[a]21
19		622	445	188	38	14	20	23		
20		777	432	208	32	17	20	28		
21		827	432	178	32	17	20	28		
22		843	419	168	32	17	20	28		
23		855	406	168	52	17	20	28		
24		1,250	419	148	59	17	20	28		
25		1,430	380	148	67	17	20	28		
26	208	1,560	367	129	59	17	20	28		
27	188	1,380	367	129	44	17	28	28		
28	188	1,300	343	129	44	17	28	28		
29	198	1,210	331	101	32	17	32	28		
30	208	1,180	319	92	32	17	32	28		
31	239		250		32	17		28		

[a] Discharge measurement.

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

Monthly discharge of Wild Rice River at Twin Valley, Minn,, for 1910.

[Drainage area, 805 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy
	Maximum.	Minimum.	Mean.	Per square mile.		
April	1,560	75	552	0.686	0.77	A.
May	1,180	250	563	.699	.81	A.
June	530	92	274	.340	.38	A.
July	92	32	53.8	.067	.08	A.
August	32	14	21.0	.026	.03	B.
September	32	17	21.6	.027	.03	C.
October	32	20	24.5	.030	.03	C.
November			25.0	.031	.03	D.
December			[a] 20.0	.025	.03	D.

[a] Estimated.

NOTE.—Mean discharge, Nov. 7 to 30, estimated at 24.7 second-feet.

DEVILS LAKE NEAR DEVILS LAKE, N. DAK.[1]

Devils Lake, in the north-central part of North Dakota, affords an interesting example of the ratios between rainfall, evaporation, and run-off. This lake has no outlet, its size depending entirely upon the relations between the evaporation from its surface, the rainfall upon it, and inflow from the surrounding country. The total area draining to Devils Lake is theoretically somewhat more than 3,500 square miles. Surveys made about 25 years ago, when the region was first settled, showed the lake to have a length of 35 miles, a width ranging from 1 mile to 15 miles, and an area of approximately 120 square miles; because of its many bays and slender arms, the shore line measured more than 200 miles. The present area of the lake is not precisely known but is estimated as not more than 60 square miles.

Since June 8, 1901, the United States Geological Survey has maintained on Devils Lake a staff gage, which is attached to the piles of the pier at the Chautauqua grounds steamer landing, 6 miles southwest of the city of Devils Lake. This gage is read occasionally by Capt. E. E. Heerman. A standard United States Geological Survey bench-mark post is set in the bank directly behind the gage and about 8 rods distant. The gage zero is 1,416.2 feet above sea level, and the bench mark is 22.90 feet above the gage zero.[2]

[1] For description of Devils Lake and all data available from 1867–1908 see Water-Supply Paper U. S. Geol. Survey No. 245, pp. 51–54.

[2] In the description of the station published in Water-Supply Paper U. S. Geol. Survey No. 66, p. 14, and No. 85, p. 238, the statement of the elevation of the bench mark above mean sea level was in error.

That the lake level is still being lowered is shown by the following gage heights, those at the close of the season being the lowest ever recorded:

Gage heights of Devils Lake, N. Dak., in 1910.

	Feet.		Feet.
June 25	9.67	Aug. 4	8.85
July 2	9.57	Aug. 13	8.75
July 12	9.21	Aug. 22	8.66
July 20	9.02	Sept. 1	8.60
July 27	9.01	Sept. 13	8.80
Aug. 1	8.90		

RED LAKE RIVER.

GENERAL FEATURES OF AREA DRAINED.

Red Lake River, the principal tributary of Red River, drains a large area in Beltrami and Polk counties. It is the outlet of Red Lake, which is the largest lake wholly in Minnesota, its area being 441 square miles. From Red Lake the river flows in a general westerly though very tortuous course until it reaches Red Lake Falls, where it receives the water from Thief River, and turning sharply to the south pursues a southerly and then a westerly course to Red River, joining that stream at Grand Forks. Above the junction it carries a larger volume than Red River.

From the outlet of Red Lake to Thief River Falls the river has very little fall and is bordered by low banks. For a distance of 30 miles below Red Lake the river is bordered by swampy banks, whose elevation is nearly the same as the river. Below Thief River Falls the stream flows through a narrow valley that increases in depth from 20 feet at the upper end to 60 feet at Red Lake Falls. In this portion there are stretches of river that have a heavy fall. From Red Lake Falls to Crookston the valley becomes deeper and has an average width of three-quarters of a mile, except for the first few miles below Red Lake Falls, where the width is one-quarter mile. The fall below Red Lake Falls becomes less. No tributaries enter the river between Red Lake and Thief River, a distance of 71 miles; below Thief River the only important tributaries are Clearwater and Black rivers. The following drainage areas have been measured in the basin:

Drainage areas in Red Lake River basin.

	Square miles.
Red Lake River above Red Lake outlet	1,950
Red Lake River above Thief River	2,420
Red Lake River above Huot (including Black River)	5,070
Red Lake River above Crookston	5,320
Red Lake River above mouth	5,760
Thief River above mouth	1,020
Clearwater River above Lost River	521
Clearwater River above mouth	1,310

The entire basin is very flat and is covered with a sheet of blue till of glacial origin. Overlying the till and separated from it is a layer of clay loam. In the lower part of the basin in the valley of the Red River are lacustrine deposits of clay. The drift is underlain by Cretaceous rocks which form the source of supply of the water in the artesian basin in North and South Dakota.

The lakes in the area are chiefly in the section above Red Lake and in the upper part of the region drained by Clearwater River. In the former section lake surface comprises about 500 square miles, or 25 per cent of the area of 1,950 square miles. Of the 1,310 square miles drained by the Clearwater, not more than 1 per cent is lake surface.

The basin is forested except in the part, chiefly below Crookston, which lies in the Red River valley. North of Red Lake there are extensive areas of muskeg containing chiefly a dense growth of short and stubby spruce. Beside the muskeg there are considerable areas of virgin pine north of the lake. West and south of the lake the basin is within the heavy timber belt where white and Norway pine, spruce, cedar, balsam, and tamarack are found. Although this region has been logged over the growth is dense.

In the middle third of the basin, in Marshall, Pennington, and Red Lake counties, the dense forest is interspersed with open prairie which comprises one-third of this part of the area. Above Red Lake Falls very little of the land is under cultivation, but below that point the cultivated area is larger.

The annual rainfall ranges from 25 inches on Red Lake to 21 inches at the mouth. Of this amount $3\frac{1}{2}$ inches are precipitated as snow, which remains during the winter. From November to April the lakes and rivers are frozen over with ice 2 feet or more in thickness. As there are no winter thaws the winter flow is derived from the lakes and from ground water and is very uniform, decreasing gradually till midwinter when it is at the minimum.

A survey to determine the availability of Red Lake River for power development was made during 1910 from Red Lake to Crookston, and in 1911 a special survey was made of Red Lake, which is by far the best reservoir site in the basin. From the data thus collected sheets have been prepared showing the profile of the water surface, a plan of the river and the contours along the river bank, the shore line of the lake, and the location of the 5-foot contour above and below the lake surface. These maps may be obtained by applying to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn.

From the river survey the following table of elevations and distances has been compiled:

Elevations and distances along Red Lake River.

Place.	Distance above Crookston.	Elevation above sea level.
	Miles.	*Feet.*
Crookston, tailwater	0	842
Crookston, headwater	0	852
Section line 32-33	6	853
Highway bridge	11	861
Do	14	865
Section line 7-8	18	873
Polk-Red Lake County line	23	883
Huot Bridge	26	887
Section line 26-27	28	893
Section line 25-26	30	904
Range line 44-45 W	32	917
Northern Pacific Railway	37	937
Lower dam, tailwater	38	943
Lower dam, headwater	38	955
Red Lake Falls, highway bridge	39	955
Upper dam, tailwater	42	963
Upper dam, headwater	42	973
Range line 43-44 W	45	981
	47	1,007
	49	1,027
Section line 17-20	56	1,062
St. Hilaire, tailwater	61	1,075
St. Hilaire, headwater	61	1,080
Section line 17-20	67	1,085
Thief River Falls, tailwater	72	1,102
Thief River Falls, headwater	72	1,116
Range line 42-43 W	77	1,118
Section line 10-15	85	1,130
Range line 41-42 W	90	1,136
Section line 22-23	99	1,145
Township line 152-153 N	110	1,154
Western boundary Red Lake Indian Reservation	124	1,165
Red Lake	143	1,175

The following table of approximate distances and elevations has been compiled chiefly from the reports of the Minnesota Geological Survey:

Elevations and distances along Clearwater River.

Place.	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
Red Lake River	0	955
Sec. 26, T. 151 N., R. 44 W	3	1,000
Sec. 6, T. 150 N., R. 42 W., The Forks	16	1,050
Sec. 32, T. 152 N., R. 41 W	28	1,100
Sec. 2, T. 151 N., R. 39 W	49	1,150
Sec. 27, T. 150 N., R. 37 W	69	1,200
Sec. 6, T. 149 N., R. 36 W	73	1,250
Sec. 11, T. 149 N., R. 36 W	80	1,300
Sec. 29, T. 149 N., R. 35 W	86	1,350
Bagley	112	1,400
Ebro	120	1,440

Water power is developed at the following points:

Developed water power on Red Lake and Clearwater Rivers.

Place.	Stream.	Fall utilized.	Average horsepower.
		Feet.	
Thief River Falls	Red Lake River	12	225
Red Lake Falls	.....do	12	125
Do	.....do	14	125
Crookston	.....do	10	850
Terrebonne	Clearwater River	10	80

The upper part of the basin contains large areas of swamp land. In the part drained by Thief River drainage work is being actively carried on. Three systems, draining 470,000 acres lying west of Thief River, have their outlets in that stream in Tps. 155 and 156. One of the outlets passes through Mud Lake, which has been drained. The channel of Thief River has been enlarged and straightened for a distance of 21 miles, beginning a few miles above the gaging station and extending upstream. The average width is 50 feet and the depth 12 feet.

Red Lake River is used extensively for log driving, the logs being brought from Red Lake to Crookston. These logs frequently jam on the rapids and cause backwater. There are no logging dams to control the flow.

Until 1910 the upper river was navigable and small steamers ran from Red Lake to Thief River Falls. The low water of 1910 and 1911 made navigation impossible, both on account of shallow water and frequency of log jams.

An examination of Red Lake and Red Lake River was made by the United States Engineer Corps and the results published in House Document No. 127, Fifty-second Congress, first session, and House Document No. 539, Fifty-eighth Congress, second session.

An investigation of the swamp lands tributary to Mud River in the Thief River basin was made by the United States Geological Survey and the results (including a plan for drainage) published in House Document 607, Fifty-ninth Congress, second session. This report contains a topographic map with 10-foot contours.

An examination of the ceded Chippewa lands in Red Lake and Rainy River basins was made by the United States Geological Survey, and the results, including a plan for drainage, were published in House Document 27, Sixty-first Congress, first session. The report contains a list of bench-mark elevations and a topographic map on a scale of 1:125,000.

Records of flow have been maintained in the basin since 1901. During that period the driest year was 1910 and the wettest 1906.

The ratio of flow of these two years was 1 to 1.80. This uniformity is accounted for by the regulating effect of Red Lake and the fact that much of the area was flat and swampy.

RED LAKE RIVER AT THIEF RIVER FALLS, MINN.

This station, which is located one-third mile below the dam at Thief River Falls, was established July 2, 1909, to obtain data for use in connection with the development of water power and the practicability of storage on upper Red Lake River as an aid to navigation and flood prevention.

The nearest tributary, Thief River, enters a mile or more above the station. The drainage area above this point is 3,430 square miles.

The dam which supplies head to the Hansen & Barzen mill and the city-lighting plant is a short distance above the station. The varying loads on the turbines cause a fluctuation in the river below the dam. This fluctuation is reduced by the operation of the lighting plant at night and of the mill, chiefly during the daytime. The gage is read morning and evening and the mean of the two readings is taken as the mean for the day. Logs are floated down Red Lake River and by jamming may cause backwater for a few days or may hold back the normal flow above the gage. The log jams interfered with the records in 1910 to such an extent that no estimates of flow are presented after July 31.

Discharge measurements are made by means of a car and cable located at the gage section.

From the later part of November to the 1st of April the river is frozen over and the gage heights are taken through the ice.

Conditions at this station are not satisfactory, but are typical of the entire upper river, and therefore the records can not be considered better than fair.

Discharge measurements of Red Lake River at Thief River Falls, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Aug. 19	Chandler and Nomland	142	426	5.83	972
20	.....do	140	414	5.74	886
Sept. 15	E. F. Chandler	139	442	5.96	906
27	J. O. Nomland	144	524	6.55	1,020
1910.					
Feb. 5	J. O. Nomland	127	402	[a] 6.78	690
Mar. 23	.....do	142	784	8.37	2,830
25	.....do	144	818	8.51	3,010
Apr. 9	.....do	140	682	7.80	2,470
25	.....do	142	674	7.68	2,320
May 6	.....do	141	568	7.02	1,630
July 13	E. F. Chandler	137	329	5.20	543
Dec. 20	Gorie Monley		262	[b] 4.62	136

[a] Gage height to water surface; thickness of ice, 1.05 feet.
[b] Gage height to water surface; thickness of ice, 0.70 foot.

Daily gage height, in feet, of Red Lake River at Thief River Falls, Minn., for 1910.

[Chas. P. Quist, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1			6.45	8.20	7.32	6.50	5.08
2		6.80		8.15	7.08	6.60	5.10
3				8.08	7.18	6.85	4.95
4				8.15	7.05	6.54	4.95
5		6.80	6.60	8.14	6.95	6.04	5.05
6				8.10	6.95	6.02	5.12
7				7.98	6.80	6.15	5.05
8		6.70	6.70	7.88	6.54	6.05	4.95
9				7.80	6.68	5.95	4.80
10				7.75	6.62	5.86	4.82
11				7.55	6.60	5.78	4.78
12				7.25	6.55	5.78	4.78
13				6.92	6.50	5.85	4.84
14				7.05	6.65	5.65	4.84
15	6.60		7.60	6.92	6.90	5.70	4.80
16				7.20	7.10	5.68	4.64
17				7.38	7.25	5.65	4.75
18				7.55	6.45	5.50	4.75
19	6.70	6.45	7.65	7.96	6.39	5.50	4.75
20				8.35	6.42	5.36	4.92
21				8.25	6.39	5.30	4.95
22	6.70		7.50	8.05	6.20	5.30	4.80
23				7.74	6.29	5.35	4.75
24	6.60	6.45	8.70	7.66	6.16	5.60	4.81
25			8.60	7.68	6.18	5.36	4.82
26		6.40		7.52	6.14	5.35	4.80
27				7.42	6.16	5.38	5.05
28				7.41	6.35	5.25	4.92
29	6.70			7.45	6.10	5.05	4.92
30				7.45	6.12	5.25	4.92
31					6.25		5.05

NOTE.—The river was frozen across from Jan. 1 to about the middle of March. The river was clear of ice on Mar. 23. Gage heights for May 16 and 17, and June 1 to 4 were affected by log jams. After July 31 the readings are not an index of the flow, because of backwater from a large log jam down stream.

Daily discharge, in second-feet, of Red Lake River at Thief River Falls, Minn., for 1909–10.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	850	735	972	740	1,050	16	1,980	990	872	889	a 90
2	872	757	960	725	1,040	17	1,820	906	872	930	635
3	710	779	960	695	1,030	18	1,660	872	930	936	790
4	685	779	930	762	1,050	19	2,970	801	900	966	735
5	834	801	872	779	1,090	20	3,500	746	912	954	762
6	1,090	762	845	746	1,130	21	2,920	735	1,050	1,080	750
7	1,000	779	817	762	1,110	22	1,780	762	1,140	1,140	750
8	1,090	900	735	735	1,180	23	1,210	735	1,210	1,170	750
9	1,160	936	665	735	1,130	24	1,090	1,020	1,320	1,110	725
10	1,080	948	710	640	1,080	25	1,010	1,280	1,320	1,170	725
11	1,070	1,110	675	834	1,160	26	990	1,350	1,280	1,180	725
12	1,700	1,120	710	1,020	1,130	27	1,070	1,240	1,280	1,070	725
13	1,800	1,110	817	984	1,020	28	900	1,140	1,280	1,020	725
14	1,900	1,050	845	924	a 245	29	845	1,070	1,270	1,030	700
15	1,940	936	845	900	a 100	30	695	1,140	1,010	1,040	700
						31	710	1,090		1,050	

a Water held back by ice and log jams and discharge estimated.

Daily discharge, in second-feet, of Red Lake River at Thief River Falls, Minn., for 1909-10—Continued.

Day.	Feb.	Apr.	May.	June.	July.	Day.	Feb.	Apr.	May.	June.	July.
1910.						1910.					
1		2,720	1,920	a 1,080	486	16		1,820	a 1,470	779	309
2		2,670	1,720	a 1,060	495	17		1,970	a 1,360	762	350
3		2,610	1,800	a 1,040	430	18		2,120	1,240	685	350
4		2,670	1,700	a 1,010	430	19		2,490	1,200	685	350
5	b 690	2,660	1,620	984	472	20		2,870	1,220	615	418
6		2,620	1,620	972	504	21		2,270	1,200	585	430
7		2,510	1,500	1,050	472	22		2,570	1,080	585	370
8		2,420	1,310	990	430	23		2,290	1,140	610	350
9		2,340	1,410	930	370	24		2,210	1,060	735	374
10		2,290	1,360	878	378	25		2,320	1,070	615	378
11		2,120	1,350	834	362	26		2,090	1,040	610	370
12		1,860	1,320	834	362	27		2,000	1,060	625	472
13		1,590	1,280	872	386	28		1,990	1,180	562	418
14		1,700	1,390	762	386	29		2,030	1,020	472	418
15		1,590	1,580	790	370	30		2,030	1,030	562	418
						31			1,110		472

a Water held back by ice and log jams and discharge estimated. b Discharge measurement.

NOTE.—Discharges based on a rating curve that is not well defined.

Monthly discharge of Red Lake River at Thief River Falls, Minn., for 1909-10.

[Drainage area, 3,430 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
July	3,500	685	1,380	0.402	0.46	C.
August	1,350	735	948	.276	.32	C.
September	1,320	665	967	.282	.31	C.
October	1,180	640	926	.270	.31	C.
November	1,180		828	.241	.27	C.
December			a 700	.204	.24	C.
1910.						
January			a 530	.155	.18	C.
February			a 530	.155	.16	C.
March			a 2,200	.641	.74	D.
April	2,870	1,590	2,260	.659	.74	C.
May	1,920	1,020	1,330	.388	.45	C.
June	1,080	472	786	.229	.26	C.
July	504	309	406	.118	.14	C.

a Estimated.

RED LAKE RIVER AT CROOKSTON, MINN.

This station, which is located a short distance below the dam in Crookston, at the new highway bridge, was established May 19, 1901, to obtain data necessary in developing water power on Red Lake River, and also in planning relief for the serious floods in the lower Red River valley.

No tributaries enter within several miles of Crookston. Less than a quarter of a mile above this station are the dam and power house of the Crookston Waterworks, Power & Light Co. As the power plant operated almost continuously, though with varying load, the gage heights below the dam fluctuate less than they would if the plant were shut down during a portion of the time with the water below the crest of the dam. The gage is read twice a day or oftener to determine the daily mean stage.

Until July 1, 1909, the chain gage and auxiliary staff gages were located at the old "Sampson's Addition" bridge, but on that date a new chain gage was installed on the new steel bridge, 20 rods below, and set to read the same as the original gage, whose datum has remained constant since the station was established. Discharge measurements are now made from this bridge.

The river channel at the old gaging section was wholly or partly open during the winter, owing to the presence of the dam, but at the the present section the river freezes entirely across from December to March, and discharge measurements are made through the ice to determine the approximate winter flow.

The daily fluctuation of the water surface may possibly cause a slight error in the daily mean gage height, but otherwise the records of this station should be considered good.

The daily discharge and monthly estimates for all years prior to 1910, inclusive, have been published in "Report of water-resources investigation of Minnesota during 1909–10," by the State drainage commission, St. Paul, Minn.

Discharge measurements of Red Lake River at Crookston, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 8	J. O. Nomland	149	394	[a] 6.57	767
Mar. 1	....do	147	342	[b] 6.30	646
Apr. 6	....do	184	1,580	10.04	5,070
July 13	E. F. Chandler	153	356	3.76	461
Nov. 7	....do	150	258	3.18	275
7 [c]	....do	146	148	2.49	56.2
7 [c]	....do	145	146	2.42	67.4
Dec. 21	Gorie Monley	141	477	[d] 3.76	185

[a] Gage height to water surface; thickness of ice, 2.10 feet. Stage rose .48 foot during measurement.
[b] Gage height to water surface; thickness of ice, 2.60 feet.
[c] Low water due to closure of turbines in the power house above gage.
[d] Gage height to water surface; thickness of ice, 1.10 feet.

Daily gage height, in feet, of Red Lake River at Crookston, Minn., for 1910.

[J. E. Carroll, observer.]

Day.	Jan.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		6.30	10.90	8.28	5.25	4.25	4.65	2.93	3.63	2.90	3.35
2			10.80	8.03	5.25	4.15	3.68	3.16	3.00	3.00	3.30
3			10 60	7.88	5.27	3.95	3.53	3.27	3.35	2.40	3.33
4			10.40	7.55	5.28	3.85	3.52	2.90	3.40	2.75	3.25
5			10.30	7.55	4.80	4.12	3.50	3.90	3.35	2.70	3.23
6			10.00	7.50	5.30	4.08	3.50	3.85	3.30	2.50	3.05
7			10.00	7.30	5.40	4.05		4.00	3.40	2.80	3.50
8	6.60		9.50	6.85	5.65	4.17	3.20	3.80	3.40	2.80	3.30
9			9.30	6.70	5.40	4.10	3.75	3.40	3.40	3.15	3.75
10			9.10	6.50	5.40	3.75	3.45	3.30	3.63	3.05	3.75

Daily gage height, in feet, of Red Lake River at Crookston, Minn., for 1910—Continued.

Day.	Jan.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11			8.90	6.62	5.20	3.95	3.58	3.20	3.38	3.10	3.45
12			8.50	6.30	6.00	3.80	3.48	3.40	3.23	3.10	3.45
13		8.90	8.00	6.25	5.25	3.62	3.45	3.30	3.17	3.15	3.70
14		10.20	7.80	6.20	5.27	3.85	3.35	3.35	3.30	3.00	3.85
15		10.85	7.80	6.10	4.93	4.05	3.42	3.35	2.90	2.90	3.80
16		11.10	7.80	6.17	5.00	4.05	3.42	3.30	2.90	3.10	3.70
17		11.40	8.10	6.15	4.95	3.88	3.25	3.30	2.90	3.30	3.60
18	6.80	12.15	8.15	6.15	4.80	3.90	2.80	3.20	2.90	3.20	3.60
19		13.25	8.60	6.00	4.70	3.70	3.30	3.25	3.13	3.10	3.60
20		13.80	9.95	6.00	4.80	3.70	3.25	3.30	3.30	2.90	3.45
21		11.60	10.90	6.05	4.62	3.55	3.40	3.30	3.40	3.00	3.55
22		10.25	11.10	6.05	4.50	3.67	3.25	2.97	3.40	3.10	3.25
23		10.60	10.55	6.02	4.32	4.20	3.31	3.40	3.40	3.05	3.45
24		10.75	9.60	5.95	4.48	4.25	3.32	3.62	3.37	3.15	3.40
25		10.85	9.40	6.01	4.60	4.10	3.30	3.45	3.30	3.00	3.65
26	6.60	11.00	9.15	5.80	4.00	4.10	3.42	3.35	2.95	3.05	3.65
27		10.80	9.00	5.80	4.65	4.07	3.20	3.17	3.37	3.00	3.55
28		9.75	8.70	5.70	4.45	4.03	3.40	3.40	2.95	2.98	3.40
29		9.50	8.60	5.75	4.50	4.00	3.20	3.40	3.08	2.90	3.40
30		10.25	8.50	5.70	4.35	4.00	3.40	3.37	3.10	2.95	3.40
31		10.60		5.38		3.75	3.18		3.07		3.50

NOTE.—Ice present from Jan. 1 to Mar. 12 and from Dec. 3 to 31.

Daily discharge, in second-feet, of Red Lake River at Crookston, Minn., for 1910.

Day.	Jan.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		a 646	5,380	3,280	1,230	680	898	204	416	196	325
2		650	5,300	3,080	1,230	630	433	269	224	224	310
3		650	5,130	2,970	1,240	538	382	301	325	72	319
4		650	4,970	2,720	1,250	495	379	196	340	157	
5		700	4,890	2,720	980	615	372	515	325	144	
6		700	4,640	2,680	1,260	596	372	495	310	96	
7		700	4,640	2,540	1,320	582	326	560	340	170	
8	a 767	700	4,240	2,220	1,460	640	280	475	340	170	
9		800	4,080	2,110	1,320	605	458	340	340	266	
10		900	3,920	1,980	1,320	458	356	310	416	238	
11		1,000	3,760	2,060	1,200	538	398	280	334	252	
12		1,500	3,450	1,850	1,670	475	366	340	289	252	
13		3,760	3,060	1,820	1,230	412	356	310	272	266	
14		4,800	2,910	1,790	1,240	495	325	325	310	224	
15		5,340	2,910	1,730	1,050	582	346	325	196	196	
16		5,540	2,910	1,770	1,090	582	346	310	196	252	
17		5,800	3,140	1,760	1,060	507	295	310	196	310	
18		6,430	3,180	1,760	980	515	170	280	196	280	
19		7,360	3,530	1,670	925	440	310	295	260	252	
20		7,830	4,600	1,670	980	440	295	310	310	196	
21		5,960	5,380	1,700	881	388	340	310	340	224	a 185
22		4,840	5,540	1,700	815	430	295	216	340	252	
23		5,130	5,090	1,680	716	655	313	340	340	238	
24		5,260	4,320	1,640	804	680	316	412	331	266	
25		5,340	4,160	1,680	870	605	310	356	310	224	
26		5,460	3,960	1,550	560	605	346	325	210	238	
27		5,300	3,840	1,550	898	592	280	272	331	224	
28		4,440	3,610	1,490	788	574	340	340	210	218	
29		4,240	3,530	1,520	815	560	280	340	246	196	
30		4,840	3,450	1,490	732	560	340	331	252	210	
31		5,130		1,300		458	274		244		

a Discharge measurement.

NOTE.—Discharge determined from well defined rating curves, except for Mar. 2 to 12, which were estimated.

Monthly discharge of Red Lake River at Crookston, Minn., for 1910.

[Drainage area, 5,320 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January			754	0.142	0.16	C.
February			700	.132	.14	C.
March	7,830	646	3,630	.682	.79	B.
April	5,540	2,910	4,120	.774	.86	A.
May	3,280	1,300	1,980	.372	.43	A.
June	1,670	560	1,060	.199	.22	A.
July	680	388	546	.103	.12	A.
August	898	170	352	.066	.08	A.
September	560	196	333	.063	.07	A.
October	416	196	293	.055	.06	A.
November	310	72	217	.041	.05	A.
December	325		219	.041	.05	D.
The year	7,830		1,180	.222	3.03	

NOTE.—Mean discharge for January and February estimated. Mean discharge, for Dec. 3 to 31, estimated at 209 second-feet.

THIEF RIVER NEAR THIEF RIVER FALLS, MINN.

This station, which is located at the Drybrooke ford, 6 miles north of Thief River Falls, in sec. 3, T. 154 N., R. 43 W., was established July 1, 1909, in connection with the general plan of investigating the water resources of Minnesota and also to determine the practicability of draining swamp lands in the basin.

Thief River, which is the outlet of Thief Lake in the northeastern part of Marshall County, has its ultimate source in Moose River, which rises in the western part of Beltrami County. The entire area drained by Thief River is 1,030 square miles.

The nearest tributary is the outlet of Mud Lake, which enters Thief River in the northeastern part of T. 156 N., R. 42 W.

The nearest dam is at Thief River Falls at the mouth of Thief River. This dam backs up the water in Thief River for several miles, but produces no effect at the gage, owing to rapids below the station.

During 1910 drainage has been carried on extensively in Thief River basin, and the effect will be to modify the regimen of the river. The extremely low flow of 1910 was caused partly by the fact that temporary dams were built on the upper river to hold back the flow for the floating dredges.

Discharge measurements are made by means of a boat and cable a short distance below the staff gage, or by wading at the ford at very low stages.

From the middle of November to the first of April the river is entirely frozen over and readings are taken through the ice.

Discharge measurements of Thief River near Thief River Falls, Minn., in 1909-10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 1[a]	E. F. Chandler	136	212	6.21	327
Aug. 2[a]	.....do	111	248	6.36	381
16	Chandler and Nomland	82	233	6.36	371
19	.....do	81	220	6.14	288
Sept. 15	E. F. Chandler	81	227	6.25	324
Oct. 1	J. O. Nomland	80	210	6.12	298
1910.					
Feb. 7	J. O. Nomland	75	73.5	[b]6.24	62.3
Mar. 22	.....do	82	251	6.49	442
Apr. 9	.....do	90	464	8.82	1,270
25	.....do	89	387	8.05	998
May 6	.....do	84	298	7.08	645
July 12	E. F. Chandler	74	117	4.86	53.4
Oct. 6	.....do	....	....	3.35	[c]0.2

[a] Wading measurement.
[b] Gage height of water surface; thickness of ice, 1.70 feet.
[c] Discharge estimated.

Daily gage height, in feet, of Thief River near Thief River Falls, Minn., for 1910.

[H. J. Maland, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1				8.92	7.56	5.88	5.08	5.28	4.36
2				9.06	7.48	5.84	5.04	5.25	4.32
3	6.50	6.30		9.20	7.30	5.85	5.00	5.10	4.38
4				9.20	7.22	5.88	5.00	5.10	4.40
5			5.30	9.20	7.16	5.88	5.30	4.98	4.48
6				9.20	7.08	5.86	5.30	4.82	4.48
7		6.24		9.12	7.01	5.84	5.04	4.80	4.48
8				8.98	6.91	5.82	5.00	4.78	4.44
9				8.78	6.82	5.76	4.95	4.69	4.40
10	6.50			8.68	6.72	5.72	4.78	4.60	4.28
11				8.48	6.62	5.71	4.87	4.60	4.05
12		6.10	6.45	8.35	6.56	5.66	4.87	4.60	3.85
13				8.24	6.51	5.64	4.92	4.60	3.72
14				8.14	6.49	5.60	4.92	4.60	3.68
15				8.12	6.46	5.56	4.91	4.60	3.65
16				8.21	6.46	5.51	4.90	4.65	3.59
17			6.72	8.14	6.32	5.50	4.90	4.65	3.65
18				8.16	6.30	5.46	4.89	4.65	3.62
19	6.48			8.48	6.36	5.42	4.84	4.61	3.60
20		5.80		8.69	6.32	5.39	5.58	4.55	3.55
21			7.98	8.60	6.22	5.36	5.74	4.48	3.55
22			6.54	8.45	6.19	5.34	5.72	4.48	3.55
23			6.90	8.06	6.14	5.44	5.72	4.45	3.55
24			7.00	8.12	6.11	5.42	5.68	4.51	3.50
25			7.10	8.06	6.10	5.30	5.65	4.65	3.50
26	6.40		7.14	7.98	6.09	5.22	5.62	4.68	3.50
27		5.42	7.29	7.88	6.01	5.25	5.60	4.60	3.50
28			7.55	7.72	6.00	5.21	5.56	4.41	3.50
29			8.05	7.65	5.94	5.04	5.51	4.40	3.50
30			8.60	7.62	5.90	5.08	5.48	4.40	3.50
31			8.76		5.90		5.45	4.40	

NOTE.—Ice present from Jan. 1 to Mar. 15.
River below 3.4 feet the entire month of October. Practically no flow during October, November, and December; water held back for dredging.

Daily discharge, in second-feet, of Thief River near Thief River Falls, Minn., for 1909–10.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.										
1						327	347	288	288	361
2						249	334	288	288	361
3						219	423	276	314	357
4						187	392	294	320	354
5						146	406	282	340	354
6						122	361	282	354	354
7						112	337	262	371	347
8						103	569	259	381	337
9						97	525	259	381	337
10						97	514	259	381	337
11						97	532	259	374	327
12						221	525	259	357	320
13						228	473	294	354	294
14						209	459	327	354	
15						221	427	337	361	
16						191	385	320	361	
17						166	354	301	368	
18						150	327	288	361	
19						1,970	304	320	361	
20						1,700	282	320	368	
21						1,440	259	368	406	
22						1,040	307	361	395	
23						810	288	351	395	
24						736	441	327	395	
25						550	495	317	395	
26						488	466	307	388	
27						430	430	304	374	
28						388	388	304	361	
29						361	347	291	368	
30						347	288	288	368	
31						361	282		361	
1910.										
1			1,330	814	228	82	109	20		
2			1,380	784	219	77	104	18		
3			1,440	717	221	72	84	21		
4			1,440	687	228	72	84	22		
5			1,440	665	228	112	70	27		
6			1,440	636	223	112	54	27		
7	*a* 62		1,410	610	219	77	52	27		
8			1,350	573	214	72	50	24		
9			1,280	539	200	67	43	22		
10			1,240	502	191	50	36	16		
11			1,160	466	189	59	36	7.5		
12			1,110	445	179	59	36	3.0		
13			1,170	427	174	64	36	1.2		
14			1,030	420	166	64	36	.9		
15			1,030	409	158	63	36	.8		
16			1,060	409	148	62	40	.5		
17			1,030	361	146	62	40	.8		
18			1,040	354	139	61	40	.6		
19			1,160	374	132	56	37	.5		
20			1,240	361	126	162	31	.4		
21		973	1,210	327	122	196	27	.4		
22		437	1,150	317	118	191	27	.4		
23		569	1,000	301	135	191	25	.4		
24		606	1,030	291	132	183	29	.3		
25		643	1,000	288	112	176	40	.3		
26		658	973	285	100	170	42	.3		
27		713	935	262	104	166	36	.3		
28		810	875	259	98	158	23	.3		
29		1,000	848	243	77	148	22	.3		
30		1,210	837	233	82	142	22	.3		
31		1,270		233		137	22			

a Discharge measurement.

NOTE.—Discharge based on a well-defined rating curve. Practically no flow during October, November, and December, 1910.

Monthly discharge of Thief River near Thief River Falls, Minn., for 1909–10.

[Drainage area, 1,010 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
uly	1,970	97	444	0.440	0.51	A.
August	569	282	396	.392	.45	A.
September	368	259	300	.297	.33	A.
October	406	288	363	.359	.41	A.
November	361		290	.287	.32	C.
December			200	.198	.23	D.
1910.						
January			100	.099	.11	C.
February			45	.045	.05	C.
March	1,270		330	.327	.38	B.
April	1,440	837	1,150	1.14	1.27	A.
May	814	233	438	.434	.50	A.
June	228	77	160	.158	.18	A.
July	196	50	108	.107	.12	A.
August	109	22	44.2	.044	.05	A.
September	27	.3	8.12	.0080	.009	A.
October	0	.0	0.00	.000	.00	
November	0	.0	0.00	.000	.00	
December	0	.0	0.00	.000	.00	
The year	1,440	.0	199	.197	2.67	

NOTE.—Mean discharge estimated for December, 1909, January and February, 1910. Mean for Nov. 14 to 30 estimated at 251 second-feet. Mean for March 1 to 20 estimated at 67 second-feet.

CLEARWATER RIVER AT RED LAKE FALLS, MINN.

Clearwater River rises in the western part of Clearwater County, near Ebro (elevation 1,440 feet), and flows northwest and southwest, emptying into Red Lake River (elevation 955 feet) at Red Lake Falls.

The gaging station, which is located 30 rods southeast of the Great Northern Railway station at Red Lake Falls and 1½ miles above the mouth of the Clearwatei, was established June 18, 1909, to determine the amount of available power on this stream.

The nearest tributary is 2 miles above Red Lake Falls. The station is at least half a mile above the influence of the Healy dam, which is located a short distance below the mouth of Clearwater River.

The gage is an inclined staff on the right bank. Discharge measurements are made at high stage from a car and cable located at a tag-wire section a short distance below the gage; during medium and low stages wading measurements are made at the tag-wire section.

From the middle of November to the first of April, when the river is fiozen over, gage readings are taken through a hole in the ice.

Conditions at this station are excellent, and the records may be considered reliable.

Discharge measurements of Clearwater River at Red Lake Falls, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 4	J. O. Nomland	151	91.4	[a] 7.52	117
Mar. 23	....do	182	600	9.40	2,190
July 11[b]	E. F. Chandler	78	43.7	5.66	32.4
Dec. 19	Gorie Monley	....	101	[c] 6.62	50.8

[a] Gage height and water surface; thickness of ice, 1.30 feet.
[b] Wading measurement.
[c] Gage height to water surface; thickness of ice, 1.30 feet.

Daily gage height, in feet, of Clearwater River at Red Lake Falls, Minn., for 1910.

[James Benoit, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	7.35	9.29	8.16	6.60	5.61	5.74	5.70	5.70	......	......
2	7.80	......	......	9.24	8.10	6.82	5.64	5.68	5.70	5.70	5.92	......
3	7.82	......	......	9.16	8.02	6.89	5.62	5.70	5.70	5.70	......	......
4	7.85	7.52	......	9.09	7.92	6.92	5.64	5.68	5.75	5.70	......	......
5	......	......	......	9.02	7.80	6.96	5.64	5.68	5.79	5.70	......	6.25
6	......	......	......	8.91	7.62	6.96	5.69	5.69	5.90	5.70	......	......
7	......	......	......	8.82	7.39	6.96	5.68	5.70	5.85	5.82	5.90	......
8	......	......	......	8.66	7.29	6.80	5.65	5.70	5.82	5.78	......	......
9	......	......	7.40	8.52	7.19	6.51	5.62	5.69	5.84	5.78	......	6.65
10	......	......	......	8.51	7.06	6.54	5.65	5.64	5.79	5.78	5.90	......
11	7.62	......	......	8.44	6.99	6.56	5.59	5.68	5.72	5.78	......	......
12	......	......	......	8.34	6.88	6.49	5.54	5.68	5.75	5.79	......	......
13	......	......	......	8.28	6.78	6.50	5.59	5.61	5.72	5.80	......	......
14	......	......	......	8.12	6.67	6.35	5.60	5.60	5.72	5.85	5.92	......
15	......	......	......	8.10	6.65	6.21	5.68	5.65	5.76	5.88	......	......
16	......	7.48	......	8.09	6.68	6.14	5.60	5.68	5.85	5.88	......	......
17	......	......	......	8.06	6.62	5.91	5.60	5.68	5.84	5.86	5.95	......
18	......	......	......	8.18	6.65	6.00	5.62	5.61	5.82	5.84	......	......
19	7.32	......	......	8.59	6.62	6.00	5.65	5.61	5.81	5.91	......	6.62
20	......	......	......	9.19	6.61	6.00	5.65	5.65	5.82	5.89	......	6.62
21	......	......	......	9.19	6.59	5.85	5.70	5.68	5.79	5.90	5.98	......
22	......	......	9.50	9.08	6.56	5.65	5.68	5.70	5.75	5.91	......	......
23	......	......	9.40	8.90	6.56	5.56	5.65	5.70	5.74	5.86	......	......
24	......	7.50	9.21	8.81	6.52	5.36	5.68	5.74	5.72	5.90	5.95	......
25	......	......	9.16	8.78	6.52	5.68	5.74	5.74	5.70	5.90	......	......
26	7.30	......	9.11	8.69	6.55	5.72	5.79	5.78	5.62	5.79	......	......
27	......	......	9.02	8.56	6.54	5.68	5.81	5.78	5.62	5.80	6.22	......
28	......	......	8.99	8.46	6.52	5.65	5.80	5.78	5.65	5.85	......	6.68
29	......	......	8.96	8.38	6.54	5.64	5.81	5.72	5.68	5.80	......	......
30	......	......	8.98	8.19	6.49	5.62	5.74	5.72	5.68	......	7.75	......
31	......	......	9.13	......	6.50	......	5.74	5.71	......	......	......	......

NOTE.—Ice present from Jan. 1 to Mar. 21 and from Nov. 1 to Dec. 31.

Daily discharge, in second-feet, of Clearwater River at Red Lake Falls, Minn., for 1910.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Dec.
1	....	100	1,790	949	166	32	40	37	37	....
2	....	100	1,750	910	224	34	36	37	37	....
3	....	100	1,680	858	247	33	37	37	37	....
4	[a] 117	100	1,630	793	257	34	36	40	37	....
5	....	100	1,570	715	272	34	36	43	37	....
6	....	100	1,480	607	272	36	36	53	37	....
7	....	100	1,420	470	272	36	37	48	46	....
8	....	100	1,300	415	218	34	37	46	43	....
9	....	100	1,190	366	146	33	36	48	43	....
10	....	125	1,190	310	153	34	34	43	43	....

[a] Discharge measurement.

Daily discharge in second-feet, of Clearwater River at Red Lake Falls, Minn., for 1910—Continued.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Dec.
11	....	125	1,140	282	157	32	36	38	43	....
12	....	125	1,070	244	142	30	36	40	43	....
13	....	150	1,030	212	144	32	32	38	44	....
14	....	150	923	183	112	32	32	38	48	....
15	....	200	910	178	89	36	34	41	51	....
16	....	200	904	185	79	32	36	48	51	....
17	....	200	884	171	54	32	36	48	49	....
18	....	200	962	178	63	33	32	46	48	....
19	....	250	1,240	171	63	34	32	45	54	[a] 51
20	....	300	1,710	168	63	34	34	46	52	....
21	....	400	1,710	164	48	37	36	43	53	....
22	....	1,960	1,620	157	34	36	37	40	54	....
23	....	1,880	1,480	157	31	34	37	40	49	....
24	....	1,720	1,410	148	27	36	40	38	53	....
25	....	1,680	1,380	148	36	40	40	37	53	....
26	....	1,640	1,320	155	38	43	43	33	43	....
27	....	1,570	1,220	153	36	45	43	33	44	....
28	....	1,550	1,150	148	34	44	43	34	48	....
29	....	1,520	1,100	153	34	45	38	36	44	....
30	....	1,540	968	142	33	40	38	36	44	....
31	....	1,660	....	144	....	40	38	....	44	....

[a] Discharge measurement.

NOTE.—Discharge computed from a well-defined rating curve, except Mar. 1 to 21, when discharge is estimated.

Monthly discharge of Clearwater River at Red Lake Falls, Minn., for 1910.

[Drainage area, 1,310 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January			[a] 220	0.168	0.19	C.
February			[a] 115	.088	.09	C.
March	1,960	100	666	.508	.59	C.
April	1,790	884	1,300	.992	1.11	A.
May	949	142	324	.247	.28	A.
June	272	27	118	.091	.10	B.
July	45	30	35.7	.027	.03	C.
August	43	32	36.7	.028	.03	C.
September	53	33	41.0	.031	.03	C.
October	54	37	45.5	.035	.04	C.
November			[a] 48.0	.037	.04	D.
December			[a] 50.0	.038	.04	D.
The year			250	.191	2.57	

[a] Estimated.

PEMBINA RIVER.

PEMBINA RIVER AT NECHE, N. DAK.

Pembina River rises in Manitoba, flowing from the northern part of Turtle Mountain in a rather crooked easterly course through southern Manitoba and the edge of North Dakota about 130 miles, measured in a direct line, to its mouth at Pembina and St. Vincent. From its junction with the outlet of Pelican Lake to Walhalla, at the foot of First Pembina Mountain, its valley ranges from 175 to 450 feet in depth. Rock Lake and Swan Lake, on this part of the river, are several miles long and from half a mile to a mile wide. At the crossing of the Red River valley the Pembina flows in a channel 20 to 40 feet deep. Its descent from the north base of Turtle Mountain to Walhalla is about 700 feet; and thence to its mouth 186, its junction with Red River being 748 feet above sea level. Long, or White Mud River, Clearwater, or Cypress River, and Tongue River are its chief tributaries, all from the south side.[1]

The gaging station, which was established April 29, 1903, is located at the Great Northern Railway bridge two-thirds of a mile north of Neche, N. Dak.

The records of this stream are necessary to determine the value of the many water-power sites on the Pembina, and are valuable in connection with problems of navigation and flood damages on Red River and in drainage investigations.

The total drainage area above this station is about 2,940 square miles, of which 2,020 are in Manitoba.

The datum of the staff gage, which is spiked to a bridge abutment, has remained unchanged.

A loose-rock dam, about 3 feet high, at the railway water-tank intake pipe, one-third mile below the gage, raises the water at the gage from 1 to 2 feet at low stage. As the dam is changed somewhat by the ice each spring, the lower part of the rating curve requires revision each year. Hence unless several low-stage discharge measurements are made each season the summaries for the low-water season are merely approximate or fair.

Discharge measurements of Pembina River at Neche, N. Dak., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 28	Chandler & Monley	30	15.6	2.36	8.6
28	.....do	16	12.5	2.36	8.6

NOTE.—Wading measurements.

Daily gage height, in feet, of Pembina River at Neche, N. Dak., for 1910.

[Roy Young to May 31, Willie Young to November, observers.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		3.8	3.8	3.3	3.4	2.4		3.8	3.8
2		3.85	3.75	3.3	3.4	2.4		3.7	3.8
3		3.8	3.7	3.35	3.2	2.4		3.7	3.7
4		3.7	3.65	3.3	3.2	2.4		3.7	
5		3.7	3.6	3.4	3.2	2.2		3.7	
6		3.8	3.6	3.35	3.0	2.2		3.7	
7		3.8	3.6	3.3	3.0	2.2		3.7	
8		3.75	3.5	3.2	3.0	2.2		3.8	
9		3.8	3.5	3.2	3.0	2.2		3.8	
10		3.7	3.55	3.2	3.0	2.1	2.5	4.0	

[1] Description abstracted from Report of exploration of the glacial Lake Agassiz in Manitoba, by Warren Upham: Geol. and Nat. Hist. Survey Canada, new ser., vol. 4, 1888-89, p. 23 E.

Daily gage height, in feet, of Pembina River at Neche, N. Dak., for 1910—Continued.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
11	....	3.7	3.5	3.2	3.0	2.1	2.7	4.0	....
12	....	3.75	3.5	3.2	3.0	2.3	2.7	4.0	....
13	....	3.8	3.55	3.2	2.8	2.3	3.2	4.0	....
14	....	3.8	3.6	3.1	2.8	2.3	3.4	4.0	....
15	6.5	3.8	3.5	3.1	2.8	2.3	3.5	4.0	....
16	6.5	3.75	3.5	3.1	2.8	2.3	3.7	4.0	....
17	6.0	3.75	3.55	3.1	2.8	2.4	3.7	3.9	....
18	5.7	3.7	3.5	3.1	2.8	2.4	3.7	3.9	....
19	5.6	4.0	3.5	3.1	2.5	2.4	3.7	3.8	....
20	5.3	4.3	3.5	3.1	2.5	2.4	3.7	3.7	....
21	5.3	4.1	3.6	3.0	2.5	2.4	3.7	3.9	....
22	4.8	4.0	3.6	3.0	2.5	2.4	3.7	3.9	....
23	5.4	4.0	3.55	3.0	2.5	2.4	3.8	3.9	....
24	4.15	3.8	3.5	2.8	2.5	2.4	3.8	3.9	....
25	3.8	3.7	3.5	2.8	2.5	....	3.9	4.0	....
26	3.8	3.7	3.4	2.8	2.4	....	3.9	4.0	....
27	3.7	3.8	3.35	2.5	2.4	....	3.9	3.8	....
28	3.6	3.7	3.3	2.5	2.4	....	3.9	3.8	....
29	3.5	3.7	3.3	2.3	2.4	....	3.9	3.8	....
30	3.8	3.7	3.4	....	2.4	....	3.9	3.8	....
31	3.9	....	3.4	....	2.4	....	....	3.8	....

NOTE.—Ice present from Jan. 1 to Mar. 14 and from Nov. 4 to Dec. 31. From Aug. 25 to Sept. 9 the gage height was less than 2.2 feet. The rock dam was raised approximately 1.6 feet from Sept. 10 to Sept. 16. This had no effect on the discharge.

Daily discharge, in second-feet, of Pembina River at Neche, N. Dak., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	....	164	164	86	100	10	3	5
2	....	172	156	86	100	10	3	3
3	....	164	147	93	73	10	3	3
4	....	147	139	86	73	10	3	3
5	....	147	131	100	73	5	3	3
6	....	164	131	93	49	5	3	3
7	....	164	131	86	49	5	3	3
8	....	156	115	73	49	5	3	5
9	....	164	115	73	49	5	3	5
10	....	147	123	73	49	4	3	10
11	....	147	115	73	49	4	3	10
12	....	156	115	73	49	7	3	10
13	....	164	123	73	27	7	3	10
14	....	164	131	61	27	7	3	10
15	685	164	115	61	27	7	3	10
16	685	156	115	61	27	7	3	10
17	580	156	123	61	27	10	3	7
18	518	147	115	61	27	10	3	7
19	498	198	115	61	14	10	3	5
20	438	250	115	61	14	10	3	3
21	438	215	131	49	14	10	3	7
22	341	198	131	49	14	10	3	7
23	458	198	123	49	14	10	5	7
24	224	164	115	27	14	10	5	7
25	164	147	115	27	14	4	7	10
26	164	147	100	27	10	4	7	10
27	147	164	93	14	10	4	7	5
28	131	147	86	14	10	4	7	5
29	115	147	86	7	10	3	7	5
30	164	147	100	54	10	3	7	5
31	181	....	100	....	10	3	....	5

NOTE.—Discharge computed on a well-defined rating curve, except from Sept. 10 to Oct. 31, when it was estimated because of a change in the control.

Monthly discharge of Pembina River at Neche, N. Dak., for 1910.

[Drainage area, 2,940 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
March 15-31	685	115	349	0.118	0.08	11,800	B.
April	250	147	166	.056	.06	9,880	B.
May	164	86	120	.041	.05	7,380	C.
June	100	7	60.4	.020	.02	3,590	C.
July	100	10	34.9	.012	.01	2,150	C.
August	10	3	6.87	.0023	.003	422	D.
September	7	3	3.93	.0013	.001	234	D.
October	10	3	6.39	.0022	.003	393	D.
The period						25,200	

MOUSE RIVER.

GENERAL FEATURES OF AREA DRAINED.

Mouse (or Souris) River rises in the southeastern part of the Province of Saskatchewan, Canada, and flows southeastward 230 miles to the northern boundary of North Dakota; thence it continues in a southeasterly direction for 80 miles to the southwestern part of McHenry County, where it makes a loop by swinging to the northeast, north, and northwest, and in 90 miles reaches the Canadian boundary again; thence it flows north and east 120 miles through the Province of Manitoba to Assiniboine River, which discharges into Red River 120 miles farther east, at Winnipeg.

The drainage area above the point where the river enters the United States is about 7,200 square miles, nine-tenths of this area being in Saskatchewan and the remainder comprising a narrow strip along the northern edge of North Dakota. Above the point where the river leaves the United States the total drainage area is about 12,000 square miles.

The Mouse has only three important tributaries in North Dakota—Des Lacs River, draining about 700 square miles, and Cut Bank and Willow creeks, draining each about 1,100 square miles. All three streams flow from a rolling prairie whose surface was left uneven by the ice of the glacial epoch and whose drainage is imperfectly developed. Hence in ordinary years the run-off from only a small portion of the drainage area—perhaps one-fourth—reaches the streams, but the water stands in scattered pools and lakelets that dry away through the season. In unusually wet or stormy years these pools and sloughs overflow, causing abnormal increases in the flow of the river.

The whole area is deeply covered with glacial drift, except a portion of the "Mouse River loop," which is covered with silt and is more level, having been in the glacial epoch the bottom of Lake Souris, an arm of Lake Agassiz, which filled the Red River valley at that time.

The elevation of this drainage basin is 1,450 feet above sea level at the lowest point in North Dakota and about 2,000 feet at its western margin in North Dakota.

In the upper part of its course the river occupies a valley a hundred feet deep and a mile wide; after turning north around the loop, it runs through a prairie scarcely above the water level. The whole stretch in North Dakota is very sluggish on account of its small fall, and in the last 40 miles before the river reenters Canada its total fall is only 8 feet.

The area is without forests or trees except small scattered clumps or groves on the steep hillsides and fringes along the streams. The mean annual rainfall is from 13 to 17 inches, half of which falls in the three months of May, June, and July.

During the winter the streams are closed for at least four months, and the flow beneath the ice is very small. Thaws sufficient to cause any considerable rise or flood in winter are unknown.

The stations in the Mouse River basin were established to determine the practicability of irrigation, and the records have shown that (except in years so wet that the irrigation would be of little value) the flow of the streams is too small to justify as expensive construction as would be necessary for extensive irrigation works in a country of such small slope. The station records are now found to be essential for investigating the methods of reclamation by drainage in the Mouse River loop, and for flood prevention.

The tributaries afford some storage sites, as, for example, at Des Lacs Lakes on Des Lacs River, but losses by evaporation would be so great that this storage would probably be useless except for flood prevention.

MOUSE RIVER AT MINOT, N. DAK.

This station, which is located north of the Great Northern Railway roundhouse, at Minot, N. Dak., was established May 5, 1903.

Des Lacs River enters 7 miles above the station.

The original staff gage was located at a footbridge near the roundhouse. This bridge was removed June 28, 1909, but the gage was left undisturbed. On December 28, 1909, a new staff gage was installed at the Anne Street Bridge about 40 rods downstream. Both gages read practically the same because of the flat slope of the river. The character of the channel remains nearly constant. Gage heights at low stages are controlled by a 3-foot rock-filled dam with plank core wall at the "Soo" Railway water tank, a mile below the former location of the gage. At extreme low water this dam raises the water at the gage about 2 feet. During the summer of

1904 the dam was rebuilt and has since remained practically unchanged. It has an approximately level crest. Weir formulas have been found to apply satisfactorily except at extreme low stages, when the slight leakage has to be considered. A good rating curve for nearly all stages has been developed.

Discharge measurements of Mouse River at Minot, N. Dak., 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 21[a]	E. F. Chandler	48	28.8	3.89	19.6
Oct. 21[b]	do			3.01	0.6

[a] Wading section. [b] Float measurement.

Daily gage height, in feet, of Mouse River at Minot, N. Dak., for 1910.

[Ephraim Cox, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		4.85	4.55	4.2	4.0	3.75		3.05	3.0
2		4.85	4.55	4.2	4.0	3.75		3.05	3.0
3		4.85	4.55	4.2	3.95	3.75		3.05	3.0
4		4.85	4.5	4.2	3.95	3.75		3.05	3.0
5		4.8	4.5	4.1	3.95	3.75		3.05	3.0
6	4.15	4.8	4.5	4.1	3.95	3.7		3.0	3.0
7	4.25	4.75	4.5	4.05	4.0	3.7		3.0	3.0
8	4.35	4.75	4.5	4.05	4.0	3.7		3.0	3.0
9	4.4	4.7	4.5	4.1	4.0	3.65		3.0	3.0
10	4.45	4.7	4.45	4.1	4.0	3.65		3.0	3.0
11	4.5	4.7	4.45	4.1	3.95	3.65		3.0	3.0
12	4.6	4.7	4.45	4.1	3.95	3.65		3.0	3.0
13	4.7	4.65	4.45	4.1	3.90	3.2		3.0	3.0
14	4.75	4.65	4.4	4.1	3.90	3.2		3.0	3.05
15	4.7	4.65	4.4	4.1	3.85	3.15	3.0	3.0	3.05
16	4.65	4.65	4.35	4.1	3.8	3.1	3.0	3.0	3.05
17	4.65	4.6	4.35	4.1	3.8	3.0	3.05	3.0	3.05
18	4.6	4.6	4.35	4.1	3.8		3.05	3.0	3.05
19	4.55	4.6	4.35	4.1	3.8		3.05	3.0	3.05
20	4.55	4.6	4.35	4.0	3.85		3.05	3.0	3.05
21	4.6	4.55	4.35	4.0	3.85		3.05	3.0	3.05
22	4.6	4.55	4.35	4.0	3.85		3.0	3.0	3.1
23	4.55	4.6	4.35	3.95	3.85		3.0	3.0	3.1
24	4.55	4.7	4.35	3.95	3.85		3.0	3.0	3.15
25	4.6	4.8	4.35	3.95	3.8		3.0	3.0	3.15
26	4.65	4.75	4.35	3.95	3.8		3.0	3.0	3.20
27	4.65	4.6	4.3	4.0	3.8		3.0	3.0	3.25
28	4.7	4.6	4.3	4.0	3.8		3.05	3.0	
29	4.75	4.6	4.3	4.0	3.8		3.05	3.0	
30	4.8	4.55	4.25	4.0	3.8		3.05	3.0	
31	4.8		4.25		3.8			3.0	

NOTE.—Ice present from Jan. 1 to Mar. 6 and from Nov. 28 to Dec. 31. Gage heights below 3 feet from Aug. 18 to Sept. 14.

Daily discharge, in second-feet, of Mouse River at Minot, N. Dak., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	6	207	141	70	38	7	0.2	0.6	0.5
2	8	207	141	70	38	7	.2	.6	.5
3	10	207	141	70	35	7	.2	.6	.5
4	20	207	130	70	35	7	.2	.6	.5
5	30	196	130	52	35	7	.2	.6	.5
6	61	196	130	52	35	4.5	.2	.5	.5
7	79	185	130	43	38	4.5	.2	.5	.5
8	99	185	130	43	38	4.5	.2	.5	.5
9	109	174	130	52	38	2.5	.2	.5	.5
10	119	174	119	52	38	2.5	.2	.5	.5

Daily discharge, in second-feet, of Mouse River at Minot, N. Dak., for 1910—Continued.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
11	130	174	119	52	35	2.5	0.3	0.5	0.5
12	152	174	119	52	35	2.5	.3	.5	.5
13	174	163	119	52	21	.7	.3	.5	.5
14	185	163	109	52	21	.7	.3	.5	.6
15	174	163	109	52	15	.6	.5	.5	.6
16	163	163	99	52	10	.6	.5	.5	.6
17	163	152	99	52	10	.5	.6	.5	.6
18	152	152	99	52	10	.4	.6	.5	.6
19	141	152	99	52	10	.4	.6	.5	.6
20	141	152	99	35	15	.4	.6	.5	.6
21	152	141	99	35	15	.3	.6	.5	.6
22	152	141	99	35	15	.3	.5	.5	.6
23	141	152	99	28	15	.3	.5	.5	.6
24	141	174	99	28	15	.3	.5	.5	.6
25	152	196	99	28	10	.3	.5	.5	.6
26	163	185	99	28	10	.3	.5	.5	.7
27	163	152	89	35	10	.3	.5	.5	.7
28	174	152	89	35	10	.3	.6	.5	.7
29	185	152	89	35	10	.3	.6	.5	.7
30	196	141	79	35	10	.3	.6	.5	.7
31	196		79		10	.3		.5	

NOTE.—Discharge computed from a rating curve well defined between 36 and 2,600 second-feet. Below 36 second-feet the curve is only fairly well defined. From Mar. 1 to 5, Aug. 18 to Sept. 14, and Nov. 28 to 30 the discharge is estimated.

Monthly discharge of Mouse River at Minot, N. Dak., for 1910.

[Drainage area, 8,400 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January			*a* 0.5	0.000060	0.00007	31	D.
February			*a* .5	.000060	.00006	28	D.
March	196		127	.015	.02	7,810	A.
April	207	141	171	.020	.02	10,200	A.
May	141	79	110	.013	.01	6,960	A.
June	70	28	46.6	.0055	.01	2,770	A.
July	38	10	21.9	.0026	.003	1,350	B.
August	7	.3	2.13	.00025	.0003	131	C.
September	.6	.2	.40	.000048	.00005	24	C.
October	.6	.5	.52	.000061	.00007	32	C.
November	.7	.5	.57	.000068	.00008	34	C.
December			*a* .5	.000060	.00007	31	D.
The year	207		40.1	.0047	.06	30,400	

a Estimated.

EVAPORATION AT UNIVERSITY, N. DAK.[1]

The evaporation gage at University, N. Dak., was established April 17, 1905. It is located on a pool in a ravine called English Coulee, which runs through the campus of the University of North Dakota, which is immediately west of Grand Forks, N. Dak., and 2 miles west of the Minnesota boundary.

[1] For complete description of this station and records of evaporation, rainfall, and temperature for 1905, 1908, see Water-Supply Paper U. S. Geol. Survey No. 245, p. 64-67.

The coulee drains about 60 square miles of very level prairie. Except for brief freshets the flow in the coulee is small, varying from 1 second-foot or less to 20 second-feet. In very dry weather the water lies in pools with scarcely any perceptible flow.

A heavy galvanized-iron tank, 3 feet square and 18 inches deep, is placed in the center of an anchored raft, so that the water in the tank is at the same level as the water surface outside. The tank is filled nearly to the top, to a height precisely marked by the pointed tip of a vertical rod in the center of the tank. Once each day, after the change produced by evaporation or rainfall, the water level is restored to the original height, the precise amount of water transferred being measured with a cup of such size that one cupful of water is equivalent to 0.01 inch depth in the tank.

A standard rain gage is located on the open prairie about 10 rods distant. On days of rainfall the difference (which is usually small) between the quantity measured by the rain gage and the surplus in the tank is considered the total evaporation for the day. Observations were made usually about 6 p. m. The water temperature is the mean temperature of the water at that hour; the air temperature is the mean of the maximum and minimum thermometer readings for each day. On account of the unusually dry weather in 1910, the evaporation was greater than in any previous year since this gage was established.

Results of observations of evaporation, rainfall, and temperature for 1910 are presented in the following table:

Evaporation, rainfall, and temperature at University, N. Dak., for 1910.

[Observer, W. R. Holgate.]

Date.	Evaporation.	Rainfall.	Temperature of— Water.	Temperature of— Air.
	Inches.	*Inches.*	°*F.*	°*F.*
Apr. 3–10	0.95	0.11	47	50
Apr. 11–20	.74	.78	40	42
Apr. 21–30	1.12	.24	40	47
May 1–10	1.50	.00	51	48
May 11–20	1.59	.67	52	49
May 21–31	1.99	.04	54	53
June 1–10	1.63	.63	60	53
June 11–20	2.63	.05	73	74
June 21–30	2.69	.00	77	77
July 1–10	2.58	.09	70	73
July 11–20	2.06	.54	72	74
July 21–31	2.37	.13	67	70
Aug. 1–10	1.50	.40	70	66
Aug. 11–20	1.80	.09	71	65
Aug. 21–31	1.46	.41	61	61
Sept. 1–10	1.04	2.69	60	57
Sept. 11–20	.90	.00	60	55
Sept. 21–30	1.09	.35	55	54
Oct. 1–10	1.29	.00	55	56
Oct. 11–20	1.25	.56	50	50
Oct. 21–31	.78	.05	40	39
Total for period	32.96	7.83		

RAINY RIVER.

GENERAL FEATURES OF AREA DRAINED.

Rainy River connects Rainy Lake with Lake of the Woods, but above Rainy Lake is a succession of lakes connected by rapids, at the head of which, in T. 65 N., R. 2 W. on the international boundary, is North Lake. From North Lake a stream flows westward, passing through Gunflint, Pine, Granite, Saganaga, Otter Track, Knife, Sucker, Basswood, Crooked, and Iron lakes, Lac La Croix, and Namekan River into Rainy Lake. With the exception of Namekan River, whose course lies in Ontario, these waters form a portion of the boundary between Minnesota and Canada, but no general term other than "boundary waters" has been applied to the chain above Rainy Lake.

The principal American tributaries of the boundary waters are Cross River, which flows through Kaskadinna, Sucker, and Ham lakes into Gunflint Lake; a line of drainage passing through Charley, Bashitanaqueb, Greenwood, East and West, Little Saganaga, Gabimichigami, Ogishke-Muncie, Frog Rock, West Sea Gull, and Sea Gull lakes and emptying into Saganaga Lake; Kawishiwi River, which rises in Syenite Lake and flows through Polly, Boulder, Alice, Wilder, Crab, Copeland, Birch, White-Iron, Garden, Fall, and Newton lakes into Basswood Lake; Loon River, which enters Loon Lake and flows through Little Vermilion and Sand Point lakes into Namekan Lake; Vermilion River, which flows through Crane and Sand Point lakes into Namekan Lake; Ash River, which flows through Kabetogama Lake into Namekan Lake; Rat Root River, which flows into Rainy Lake; and Little Fork, Big Fork, Black, Rapid, and Winterroad rivers, which discharge into Rainy River.

The chief Canadian tributaries are a line of drainage through Weikwabinonaw, Koss, and Northern Light lakes into Saganaga Lake; Maligne River, which drains a region thickly dotted with lakes (the largest being Pickerel and Sturgeon lakes) and discharges into Lac La Croix; Pipestone, Manitou, Turtle, and Otukamamoan Lake outlets, which enter Rainy Lake; and La Valle and Pine rivers, which enter Rainy River.

The following drainage areas have been measured in the basin:

Drainage areas in Rainy River basin.

River.	Above—	Drainage area.
		Sq. miles.
Rainy	International Falls	a 14,600
Do	Lake of the Woods Inlet	a 20,800
Cross	Mouth	61
Kawishiwi	Forks	242
Do	Mouth	1,410
Stony	do	254
Burntside	do	146
Ash	do	146
Rat Root	do	283
Black	West Fork	288
Do	Mouth	408
Warroad	do	256

a Revised since 1909 report.

Above Rainy Lake the drainage area is rough and hilly and thickly dotted with lakes which lie in rock-bound basins and have outlet over rocky rims that have been little eroded. The southern boundary of this part of the drainage area is a broad undulating plateau which rises 1,800 to 1,900 feet above sea level. This is the region of light glacial drift or bare rocks, the latter comprising granites, gneisses, mica schists, gabbros, and greenstones. The valleys of the Vermilion and other rivers show a thin layer of fine clay, probably deposited by a glacier-dammed lake.

West of Rainy Lake the basin is deeply covered with glacial drift, lakes are rare, and the country is, for the most part, flat with a few hills rising 50 to 75 feet above the plain. During the glacial period this part of the basin was covered by a lake, now called Lake Agassiz, and in consequence the surface is very smooth. The northward slope of the area south of Rainy River is insufficient to afford good drainage and extensive tracts are swampy. In general dry land is only found along the banks of the streams which flow in very tortuous channels cut 5 to 40 feet below the general surface level. Settlers are few except along the streams, as the infrequent roads are almost impassable during the open season.

Between the southern end of Bow String Lake and Lake Winnibigoshish is a continuous river valley that during high stages affords water connection between Mississippi River and Hudson Bay. In the eastern portion of the area there is probably a connection between North Lake in the Hudson Bay drainage area and South Lake in the Lake Superior drainage area. Altitudes in the Rainy River basin range from 1,025 to 2,000 feet above sea level.

The portion of the drainage area in Minnesota and probably also that in Ontario lies within the forested region and contains very little cleared land. East of Rat Root River are tracts of dense timber interspersed with patches of thin timber. The western part of the basin is covered with dense, heavy forests, in which white and Norway pine, spruce, cedar, balsam, and tamarack are the principal growths. In the extreme western end of the basin, south of Lake of the Woods, are extensive areas of muskeg which are covered with short, scrubby, fairly dense growths of black spruce.

Many of the tributary streams are used for driving logs which are carried either to International Falls or to Baudette and Spooner.

As no rainfall records have been kept within the Rainy River area for any considerable time, the rainfall is not known accurately, but stations outside the basin indicate a probable mean annual precipitation of 30 inches or more in the extreme eastern portion with a decrease to some 24 inches at Lake of the Woods. The annual snowfall equals about 5½ inches of the precipitation. From November to March (except at falls) the streams are frozen over and the ground is covered with several feet of snow. The melting of this snow causes very high water on rivers uncontrolled by lakes or other natural storage; on streams fed by many lakes the rise is much less.

The best reservoir sites are the lakes forming the boundary waters, of which the largest (excepting Lake of the Woods) is Rainy Lake. This lake embraces about 344 square miles and is thickly dotted with islands. The power dam at International Falls is said to store water on Rainy Lake to a depth of 4 feet. Beside the reservoir sites afforded by the boundary waters other sites can be found on the tributary streams, notably on Vermilion Lake and River and Kawishiwi River in Minnesota, and the larger of the numberless lakes in Canada.

The following table of elevations and distances along the boundary waters is presented to give an idea of the available power. Above Basswood Lake the elevations are only approximate, being largely aneroid readings taken from the final report of the Minnesota Geological Survey. Below that point the elevations are based on a survey made by E. B. Banks, city engineer of Superior, Wis., and furnished the United States Geological Survey through his courtesy.

Elevations and distances along boundary waters.

Point.	Distance below North Lake outlet.	Elevation above sea level.
	Miles.	*Feet.*
North Lake	0	1,550
Gun Flint Lake	0.5- 8	1,547
Pine Lake	10 - 12.5	1,465
Granite Lake	15.5- 21.5	1,448
Saganaga Lake	22.5- 32.5	1,434
Ottertrack Lake	34 - 39	1,385
Knife Lake	39.5- 49	1,381
Carp Lake	51 - 52	1,335
Sucker Lake	53 - 57	1,330
Basswood Lake	57.5- 84	1,299
Crooked Lake	88 -104	1,246
Iron Lake	105 -108	1,217
Lac La Croix	109 -125	1,183
Namekan Lake	143 -161	1,115
Rainy Lake	161.5-201	1,106
Top of dam, International Falls	203	1,106
Foot of dam, International Falls	203	1,077
Head Manitou Rapids	236	1,069
Foot of Manitou Rapids	236.5	1,068
Head Long Sault	243.5	1,065
Foot Long Sault	245.5	1,060
Lake of the Woods	254	1,054

In order to determine the availability of the South Branch of the Kawishiwi for water-power development and storage, a survey was made during 1911 from Birch Lake to Fall Lake. From the data collected on this survey sheets have been prepared showing a profile of the water surface, a plan of the river and the lakes through which it flows, and the contours on the river and lake banks. These sheets have been prepared separately and may be obtained by applying to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn.

The following tables of approximate elevations and distances have been compiled chiefly from the State drainage engineer's "Report on the topographical survey of Minnesota" and from the reports of the Minnesota Geological Survey:

Elevations and distances along streams in Rainy River basin.

Place.	Distance above mouth.	Elevation.
Cross River.	*Miles.*	*Feet.*
Gunflint Lake	0	1,547
Sec. 26, T. 65 N., R. 4 W	2	1,600
Ham Lake outlet	4	1,706
Sucker Lake outlet	7	1,740
Kaskadinna Lake outlet	10	1,767
Kawishiwi River.		
Basswood Lake	0	1,299
Newton Lake outlet	8	1,307
Fall Lake outlet	11	1,313
Fall Lake inlet	14.5	1,313
Garden Lake outlet	15	1,384
Farm Lake outlet	18	1,386
Friday Lake outlet	19	1,388
Junction of branches	27	1,451
Crab Lake outlet	31	1,487

Elevations and distances along streams in Rainy River basin—Continued.

Place.	Distance above mouth.	Elevation.
Kawishiwi River—Continued.	*Miles.*	*Feet.*
Sec. 31, T. 63 N., R. 8 W	39	1,503
Wilder Lake outlet	44	1,540
Lake Alice outlet	50	1,544
Range line 6–7	56	1,560
Sec. 8, T. 63 N., R. 6 W	61	1,580
Boulder Lake outlet	62	1,587
Polly Lake outlet	64	1,617
Township line 62–63	67	1,714
Syenite Lake outlet	69	1,777
Rat Root River.		
Rat Root Lake	0	1,117
Sec. 3, T. 69 N., R. 23 W	8	1,120
Sec. 10, T. 69 N., R. 24 W	16	1,125
Range line 23–24	27	1,128
Sec. 18, T. 68 N., R. 22 W	38	1,144
Black River.		
Rainy River	0	1,078
Road Crossing	9	1,086
Settler	12	1,095
Secs. 34–35	14	1,106
Sec. 27, T. 158 N., R. 27 W	23	1,122
Brook	26	1,126
Sec. 16, T. 157 N., R. 27 W	32	1,155
Sec. 28, T. 157 N., R. 27 W	34	1,163
Rapid River.		
Rainy River	0	1,061
Sec. 19, T. 160 N., R. 29 W	4	1,073
Sec. 31, T. 160 N., R. 29 W	6	1,074
Sec. 1, T. 158 N., R. 31 W	28	1,098
Sec. 1, T. 158 N., R. 32 W	36	1,140
Warroad River.		
Lake of the Woods	0	1,057
Sec. 12, T. 162 N., R. 37 W	8	1,080
Sec. 23, T. 162 N., R. 37 W	10	1,090
Sec. 26, T. 162 N., R. 37 W	11	1,100
Sec. 26, T. 162 N., R. 37 W	13	1,110
Sec. 12, T. 161 N., R. 37 W	16	1,120
Sec. 13, T. 161 N., R. 37 W	17	1,130
Sec. 20, T. 161 N., R. 36 W	19	1,152
Sec. 6, T. 160 N., R. 36 W	23	1,200

Most of the streams in the basin have a good fall and many of them afford excellent power sites. By far the best site, and the only one utilized at the present time, is that at International Falls, where 12,000 horsepower is being developed on the American side and 8,000 on the Canadian. This power is used largely in operating the paper mill located at the American power site.

Although the basin includes a vast amount of swamp land, the country is so undeveloped that little drainage work has been undertaken. About 40,000 acres have been drained in Koochiching County.

Rainy River is navigable for small steamers between International Falls and Lake of the Woods. The Canadian Government is investigating the river with a view to improving navigation by building locks on the Long Sault and Manitou Rapids.

An examination of the ceded Chippewa lands in Rainy River basin was made by the United States Geological Survey, and the results (including a plan for drainage) were published in House Document 27, Sixty-first Congress, first session. The report contains a list of bench-mark stations and a topographic map (with 10-foot contours) on a scale of 1:125,000.

The quality of the water in Rainy River is described in a report entitled "The quality of surface waters in Minnesota," published by the United States Geological Survey as Water-Supply Paper 193.

RAINY RIVER AT INTERNATIONAL FALLS, MINN.

This station, which was established by the Minnesota & Ontario Power Co. March 1, 1907, is located at the American power house just below the dam at International Falls. As the dam controls the stage of water in Rainy Lake, this latter acts as a reservoir, and accordingly any change of water surface in the lake indicates that the natural run-off of Rainy River at International Falls is being increased or partially withheld. Therefore it is necessary to know the changes of lake level in order to determine the natural run-off from the Rainy River basin. These data are of value in connection with studies of water power and navigation.

The gage heights have been furnished through the courtesy of the power company. In 1909 the Geological Survey began to rate the section by means of discharge measurements made from a boat and cable several hundred yards below the gage. (See Pl. III, *B*.) When that rating is completed it will be possible to estimate the daily discharge since 1907, as conditions of flow are practically permanent. During the latter part of 1909 a portion of the natural run-off was held back to fill the reservoir.

Discharge measurements of Rainy River at International Falls, Minn., 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 6	G. A. Gray	564	8,300	466.72	11,400
June 23	C. R. Adams	523	7,410	[a] 465.74	10,600

[a] Gage height rose 0.53 foot during measurement.

Daily gage height, in feet, of Rainy River at International Falls, Minn., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1...	467.95	467.00	467.36	467.16	466.76	464.86	465.46	a461.66	462.66	462.36	463.55	463.86
2...	....	467.00	467.26	467.16	466.86	465.86	465.56	463.16	462.46	....	461.24	463.86
3...	468.08	467.10	467.06	467.16	466.86	464.86	465.56	463.16	462.46	462.26	463.46	464.01
4...	....	467.10	466.86	466.86	466.76	464.86	465.50	463.36	462.46	462.26	463.66	....
5...	468.06	467.35	466.86	466.76	466.76	464.86	464.46	463.21	462.46	462.26	463.66	a462.66
6...	468.05	....	466.76	466.66	466.76	465.16	465.06	463.21	462.46	462.26	....	463.36
7...	468.11	467.15	466.66	466.66	466.76	466.26	464.86	a461.76	462.46	463.04	a461.21	463.36
8...	468.14	467.15	466.61	466.50	466.76	465.86	463.96	462.66	462.46	462.76	463.51	463.96
9...	....	467.10	466.56	466.46	466.76	466.86	463.81	463.26	462.46	462.76	463.51	464.06
10...	468.05	467.45	466.56	....	466.96	466.66	463.36	462.76	462.46	a460.42	463.53	464.16
11...	468.03	467.30	....	466.05	467.06	466.86	463.86	462.26	462.46	462.96	463.51	....
12...	468.04	467.30	....	466.06	467.26	466.86	463.56	462.56	462.46	462.96	463.61	462.66
13...	467.92	....	....	465.96	467.26	466.36	463.76	462.66	462.56	463.11	....	463.16
14...	467.90	467.30	....	465.96	465.46	466.86	463.66	a461.96	462.36	463.26	462.76	463.06
15...	467.85	467.36	465.91	465.96	465.46	466.56	463.56	461.96	462.36	463.36	463.51	463.76
16...	....	467.66	....	465.96	465.56	466.61	463.36	461.96	462.36	a460.22	463.61	463.56
17...	467.55	....	....	466.06	465.56	466.56	463.36	462.46	462.36	461.26	463.76	463.56
18...	467.65	....	....	466.26	465.96	464.81	a461.36	462.46	462.46	462.61	463.86	....
19...	467.65	....	....	466.76	466.26	464.81	463.21	462.56	462.46	463.11	464.21	a461.46
20...	467.65	....	....	467.56	464.41	464.86	463.16	462.56	462.46	463.16	....	463.16
21...	467.66	467.56	465.66	467.96	465.01	464.86	463.06	462.56	462.46	463.11	463.76	463.46
22...	467.54	467.56	465.50	467.96	464.46	465.46	462.76	462.56	462.46	463.21	464.86	463.56
23...	....	467.56	465.36	467.96	466.36	465.26	462.36	461.46	462.46	....	464.46	463.10
24...	467.40	467.56	466.16	467.96	466.36	465.96	462.36	462.56	462.46	461.35	464.16	463.00
25...	467.40	467.56	465.76	467.50	465.86	465.86	462.30	462.66	462.46	463.54	464.26	....
26...	467.25	467.56	466.36	467.15	464.86	465.86	462.16	462.66	462.56	463.54	464.06	....
27...	....	....	466.50	467.15	465.56	465.36	462.00	462.75	462.36	463.51	....	a461.40
28...	467.20	467.26	466.36	466.76	465.50	465.36	462.00	463.66	462.46	463.45	a461.76	462.86
29...	467.10	....	466.76	466.76	465.50	465.36	462.86	a461.46	462.46	463.46	463.36	462.56
30...	467.15	....	466.76	466.56	465.25	465.06	463.06	462.86	462.36	....	463.86	462.66
31...	467.15	....	467.06	....	465.25	....	463.16	462.76	....	462.74	....	462.76

a Low water caused by closing of dam on Sunday.

NOTE.—Gage heights were affected by presence of ice during the winter months.

RAINY LAKE NEAR RANIER, MINN.

This station is located above the Minnesota & Ontario Power Co.'s dam at International Falls, 2 miles below Ranier. Although there is a slope of several tenths of a foot between the water surface at the dam and that of the lake, the surface of the latter is controlled by the dam. Thus any change of stage in the lake indicates that the natural run-off is not passing the dam. Rainy Lake has an approximate area of 344 square miles but its effective reservoir capacity is somewhat uncertain, owing to the many small islands in the lake. The existing maps are too small to indicate accurately the areas of these islands.

The gage heights given herewith are furnished through the courtesy of the power company. By adding 460.82 feet the gage heights are referred to the same datum as the gage heights of Rainy River.

Daily gage height, in feet, of Rainy Lake River near Ranier, Minn., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.45	6.90	5.55	4.90	6.15	6.05	4.85	4.55	3.75	2.95	1.30	0.30
2	......	6.90	5.55	4.90	6.15	5.90	4.65	4.50	3.80	......	2.20	.20
3	7.48	6.85	5.55	5.00	6.15	6.05	4.65	4.25	3.80	2.80	1.15	.10
4	......	6.85	5.55	5.05	6.15	6.20	4.65	4.35	3.80	2.75	1.07	......
5	7.47	6.80	5.55	5.15	6.15	6.20	4.65	4.35	3.80	2.45	.95	.00
6	7.47	......	5.55	5.25	6.15	6.15	4.55	4.35	3.80	2.51	......	.30
7	7.42	6.65	5.45	5.25	6.15	5.75	4.75	4.35	3.75	2.49	.90	+.10
8	7.40	6.65	5.35	5.35	6.15	5.95	4.80	4.15	3.75	2.35	.80	−.14
9	......	6.55	5.25	5.35	6.10	5.55	4.85	4.25	3.75	2.35	.80	−.15
10	7.38	6.50	5.25	5.35	5.95	5.35	4.95	4.35	3.75	2.35	.70	−.27
11	7.37	6.45	5.00	5.45	5.85	5.35	4.85	4.35	3.75	2.35	.66	.00
12	7.35	6.45	5.00	5.45	5.65	5.35	4.90	4.35	3.75	2.50	.6	.00
13	7.35	......	5.00	5.45	6.30	5.30	4.85	4.35	3.65	2.35	......	+.20
14	7.30	6.35	4.97	5.45	6.30	5.20	4.75	4.35	3.45	2.35	.6	+.22
15	7.25	6.30	4.93	5.55	6.30	5.25	4.75	4.35	3.35	1.85	.5	−.15
16	......	6.25	4.75	5.55	6.25	5.25	4.90	4.25	3.30	2.75	.35	−.10
17	7.28	......	4.75	5.75	6.25	5.25	4.90	4.25	3.25	2.55	.30	−.10
18	7.25	......	4.70	5.75	6.10	5.65	4.75	4.20	3.15	2.10	.20	......
19	7.25	......	4.65	5.90	6.15	5.65	4.60	4.10	3.15	2.40	.30	+.08
20	7.24	......	4.65	6.05	6.45	5.55	4.55	4.10	3.15	2.11	......	−.25
21	7.25	5.95	4.65	6.05	6.35	5.50	4.55	4.10	3.15	2.07	.5	−.25
22	7.15	5.90	4.75	5.95	6.35	5.25	4.65	4.05	3.15	2.00	.05	−.20
23	......	5.85	4.75	5.95	6.25	5.30	4.70	4.05	3.20	......	.60	.00
24	7.10	5.85	4.65	5.95	6.10	5.15	4.70	4.05	3.15	2.32	.50	.00
25	7.10	5.85	4.65	6.10	6.35	5.05	4.75	4.00	3.25	1.74	.4	......
26	7.05	5.75	4.70	6.15	6.35	5.05	4.55	3.85	3.05	1.71	.4	+.10
27	......	......	4.70	6.25	6.10	5.05	4.75	3.90	3.05	1.61	......	−.15
28	7.00	5.65	4.65	6.10	5.85	5.00	4.65	3.90	3.00	1.60	.60	−.35
29	6.95	......	4.75	6.15	5.95	5.00	4.45	3.90	3.05	1.55	.60	−.35
30	6.90	......	4.85	6.25	6.00	4.90	4.50	3.65	2.95	......	.20	−.35
31	6.90	......	4.90	......	6.25	......	4.50	3.75	......	1.57	......	−.35

LITTLE FORK RIVER.

GENERAL FEATURES OF AREA DRAINED.

Little Fork River, the largest tributary of Rainy River from the Minnesota side, rises in the central part of St. Louis County, a few miles south of Vermilion Lake, at an elevation of about 1,440 feet above sea level, and flows westward and then northwestward to its junction with Rainy River about 12 miles below International Falls. Fifteen miles below its source it receives Rice River from the southeast, and about 15 miles farther downstream it is joined by Sturgeon River, its principal tributary. Other tributaries are Valley, Cross, and Net Lake rivers and Beaver and Willow creeks. The total length of the river is about 160 miles and its drainage area is 1,900 square miles.

The river meanders through a narrow valley between wooded banks and throughout its length there are very few clearings. The region is flat and is deeply covered with blue till—a mixture of clay, sand, and gravel—which is underlain by crystalline rocks. Rock outcrops in a few places along the river. Altitudes in the basin range from 1,100 to 1,450 feet. The greater part of the area is too wet for cultivation without being drained and little drainage work has been done up to the present time.

A. LOG JAM ON LITTLE FORK RIVER, MINN.

Jam extended 4 miles upstream.

B. DAM ON ST. LOUIS RIVER 6 MILES BELOW SKIBO, MINN.

Typical logging dam on a northern Minnesota river.

The area supports a dense growth of heavy timber. Little of the land has been cleared. Little Fork River is used extensively for log driving, and although there are no logging dams on the main river the flow of the upper river is to a certain extent controlled by dams on one or two tributaries. (See Pl. IV, *B*.)

The mean annual rainfall ranges from about 30 inches in the upper end of the basin to about 25 inches near the mouth of the river. Of this amount 5½ inches falls as snow. From November to March the rivers are frozen except at heavy rapids and the ground is covered with several feet of snow, the spring melting of which causes a river rise of 15 feet or more. Winter thaws are unknown and groundwater is the principal source of supply for the streams. The flow is, therefore, very uniform during the winter, decreasing gradually till midwinter, when it is a minimum. The flatness of the topography and absence of lakes except on the extreme headwaters preclude the possibility of any large amount of storage except such as could be formed within the main channel of Little Fork River.

In order to determine the availability of Little Fork River for power development, a survey was made in 1911 from the big falls located in sec. 9, T. 62 N., R. 20 W., to the mouth of the river. From the data collected on this survey sheets have been prepared showing a profile of the water surface, a plan of the river, and the contours along the river bank. These sheets have been published separately, and may be had on application to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn. No water power is developed in the basin at the present time.

LITTLE FORK RIVER AT LITTLE FORK, MINN

This station, which is located at the lower of the two highway bridges at Little Fork, Minn., in sec. 9, T. 68 N., R. 25 W., was established June 23, 1909, in connection with the general investigation of the water resources of Minnesota.

Beaver Brook, the nearest tributary, enters the river 1½ mile below the station.

Little Fork is used extensively for log driving during the spring and summer months and log jams frequently occur which cause backwater for some time. (See Pl. IV, *A*.) The river is frozen over at the station and observations are discontinued from November to April.

The datum of the staff gage has remained unchanged since the station was established.

Discharge measurements are made from the bridge at ordinary stages and by wading at extreme low stages.

Conditions at the station are favorable and the records of flow should be reliable.

Discharge measurements of Little Fork River at Little Fork, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 4	G. A. Gray	122	201	5.52	237
24	Robert Follansbee	122	184	5.41	190
Aug. 26	G. A. Gray	133	452	7.66	910
Sept. 30	do	132	445	7.50	824
1910.					
June. 21	C. R. Adams	136	214	5.30	180
July 22	Robert Follansbee	54	82.6	4.82	87.3

Daily gage height, in feet, of Little Fork River at Little Fork, Minn., for 1910.

[Theo. La Chapell, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	14.00	8.88	6.75	5.42	5.72	4.83	5.00	5.30
2	13.70	8.65	6.58	5.35	5.48	4.84	5.30	5.21
3	13.21	8.42	6.40	5.15	5.32	4.86	5.40	5.28
4	12.69	8.16	6.40	4.92	5.28	4.75	5.45	5.30
5	12.64	7.95	6.45	5.02	5.28	4.40	5.40	5.40
6	12.66	7.70	6.40	4.95	5.20	4.70	5.40	5.50
7	12.45	7.49	6.45	4.80	5.05	4.75	5.30	5.50
8	12.00	7.35	6.60	4.78	5.00	4.84	5.30	5.50
9	11.50	7.25	6.55	4.72	5.00	4.80	5.25	5.50
10	11.00	7.01	6.35	4.75	4.95	4.85	5.18	5.50
11	10.58	6.79	6.24	4.96	4.85	4.85	5.10	5.50
12	10.05	6.80	6.05	5.00	4.95	4.86	5.10	5.50
13	9.68	6.69	6.00	5.00	4.95	4.90	5.18	5.50
14	9.35	6.58	5.95	4.88	4.90	4.88	5.15	5.50
15	9.10	6.50	5.75	5.02	4.98	4.80	5.10	5.50
16	9.60	6.40	5.62	5.02	4.95	4.71	5.05	....
17	10.80	6.35	5.58	5.15	4.92	4.70	5.00	....
18	14.95	6.40	5.54	5.20	4.95	4.80	5.00	....
19	15.60	6.39	5.46	4.90	4.98	4.78	5.38	....
20	15.25	6.38	5.38	4.90	4.98	4.76	5.20	....
21	15.00	6.62	5.28	4.88	4.96	4.90	5.22	....
22	14.32	6.78	5.21	5.10	4.95	4.96	5.20	....
23	12.95	7.00	5.16	5.15	4.93	4.89	5.19	....
24	11.92	7.10	5.10	5.02	4.95	4.80	5.20	....
25	11.20	7.15	5.04	5.02	4.95	4.80	5.30	....
26	10.75	7.00	5.00	5.08	4.95	4.80	5.30	....
27	10.25	7.00	4.96	5.08	4.95	4.80	5.30	....
28	9.90	7.00	4.96	5.85	4.86	4.80	5.30	....
29	9.55	7.10	5.60	6.10	4.85	4.86	5.30	....
30	9.10	7.06	5.70	6.05	4.83	5.00	5.30	....
31	....	6.82	....	5.85	4.83	....	5.30	....

NOTE.—Ice present from Jan. to Mar. 31, and from Nov. 16 to Dec. 31.

Daily discharge, in second-feet, of Little Fork River at Little Fork, Minn., for 1909–10.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.							1909.						
1	....	240	247	1,030	708	1,360	16	....	160	3,980	247	598	......
2	....	237	224	900	634	1,240	17	....	156	3,650	242	630	......
3	....	224	208	757	614	1,170	18	....	164	3,120	228	687	......
4	....	208	215	667	518	1,090	19	....	189	2,070	237	698	......
5	....	199	237	940	463	980	20	....	193	1,860	247	778	......
6	....	193	291	512	393	932	21	....	193	1,260	268	1,230	......
7	....	184	304	440	371	864	22	....	197	1,080	288	2,010	......
8	....	184	502	405	344	802	23	377	193	932	366	2,340	......
9	....	178	852	371	347	621	24	360	184	908	382	2,700	......
10	....	166	896	330	377	680	25	333	252	908	640	2,700	......
11	....	148	1,650	291	422	750	26	307	294	868	920	2,560	......
12	....	137	3,760	286	472	694	27	296	307	852	988	2,410	......
13	....	141	4,120	266	487	598	28	281	347	868	988	2,180	......
14	....	166	4,380	266	487	......	29	268	358	1,050	920	1,860	......
15	....	160	4,240	254	518	......	30	261	328	1,080	802	1,600	......
							31	....	286	1,140	......	1,490	......

Daily discharge, in second-feet, of Little Fork River at Little Fork, Minn., for 1909–10—Continued.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1910.								
1		1,390	565	201	271	91	119	176
2		1,290	512	186	215	92	176	158
3		1,190	457	146	180	96	197	172
4		1,080	457	105	172	79	208	176
5		1,000	472	123	172	40	197	197
6		900	457	110	156	72	197	
7		816	472	86	128	79	176	
8		768	518	83	119	92	176	
9		732	502	75	119	86	166	
10		650	442	79	110	94	152	
11	2,200	578	411	112	94	94	137	
12	1,940	581	358	119	110	96	137	
13	1,750	546	344	119	110	102	152	
14	1,600	512	330	99	102	99	146	
15	1,490	487	278	123	116	86	137	
16	1,720	457	247	123	110	73	128	
17	2,310	442	237	146	105	72	119	
18	4,580	457	228	156	110	86	119	
19	5,000	454	210	102	116	83	193	
20	4,770	451	193	102	116	80	156	
21	4,610	524	172	99	112	102	160	
22	4,200	575	158	137	110	112	156	
23	3,430	647	148	146	107	100	154	
24	2,870	680	137	123	110	86	156	
25	2,510	698	126	123	110	86	176	
26	2,280	647	119	133	110	86	176	
27	2,040	647	112	133	110	86	176	
28	1,860	647	112	304	96	86	176	
29	1,690	680	242	371	94	96	176	
30	1,490	667	266	358	91	119	176	
31		588		304	91		176	

NOTE.—Discharges computed from a rating curve well defined below 1,000 second-feet.

Monthly discharge of Little Fork River at Little Fork, Minn., for 1909–10.

[Drainage area, 1,720 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
June 23–30	377	261	310	0.180	0.05	A.
July	358	137	212	.123	.14	A.
August	4,380	208	1,540	.895	1.03	C.
September	1,030	228	516	.300	.33	B.
October	2,700	344	1,080	.628	.72	B.
Nov. 1–13	1,360	598	680	.395	.19	B.
1910.						
Apr. 11–30		1,490	2,720	1.58	1.17	B.
May	1,390	442	703	.409	.47	A.
June	565	112	309	.180	.20	A.
July	371	75	149	.087	.10	A.
August	271	91	125	.073	.08	A.
September	119	40	88.4	.051	.06	A.
October	208	119	163	.095	.11	A.
November			160	.093	.10	B.

NOTE.—Mean discharge, Mar. 6 to 30, estimated at 157 second-feet.

BIG FORK RIVER.

GENERAL FEATURES OF AREA DRAINED.

Big Fork River, the second largest tributary of Rainy River from the Minnesota side, rises in Jessie Lake in T. 147 N., R. 25 W., in Itasca County, at an elevation of about 1,320 feet above sea level. It flows into Bowstring Lake, thence north into Wabatawangang Lake and thence east and north into Rainy River near Laurel. Its chief tributaries are Caldwell Brook, Sturgeon River, Deer Lake outlet, and Rice River. The entire length of river is about 160 miles.

The following drainage areas have been measured in the basin:

Drainage areas in basin of Big Fork River.

	Square miles.
Above Lake Wabatawangang	259
Above Big Falls	1,320
Above mouth	1,840

The entire basin is covered with a sheet of blue till. In a large part of the area the till is covered with deposits of lacustrine clay from the glacial Lake Agassiz. So thick is the drift that rock outcrops are not found except in a few places along the river.

Underlying the glacial deposits are crystalline schists and gneisses and greenstones. Some outcrops of Cretaceous rocks are also found. The big falls where the river descends 30 feet in a few hundred yards are caused by an outcrop of Archean schist.

The region is very flat and so poorly drained that, except in a comparatively narrow strip along Big Fork River, the area is swampy. There is very little cleared land in the basin, as settlers are few, and the entire area is heavily forested. Altitudes range from 1,080 to 1,325 feet above sea level. There are practically no lakes in the basin below the outlet of Lake Wabatawangang, but above that point about 15 per cent of the area is water surface.

Owing to a lack of records within the basin the mean annual rainfall is not precisely known, but records at stations farther south indicate that the average precipitation is about 26 inches; of this amount $4\frac{1}{2}$ inches occurs as snow.

The winters are severe. The river flows under ice several feet thick and the ground is covered with several feet of snow. There are no winter thaws and the sources of supply are the ground water and the lakes on the headwaters. The flow is very uniform, decreasing gradually till midwinter, when it is a minimum.

The chain of lakes on the headwaters of the Big Fork afford a possible storage reservoir, and as the drainage area at their outlet is between 400 and 500 square miles, the control of the flow above that point would considerably increase the low-water flow. Aside from the headwaters, there are no lakes in the basin. The topography is too flat to admit of the presence of reservoir sites, and except at Big Falls there is little concentrated fall. No water powers are developed in the basin.

Big Fork River is used extensively for log driving, and at different points, notably the Big Falls, jams occur, which cause backwater for considerable periods. There are no logging dams to control the flow.

Although the records of the only gaging station maintained in the basin, namely at Big Falls, extend back only to 1909, it is probable that the flow of 1910 was the lowest in many years, owing to the very low rainfall.

In order to determine the availability of Big Fork River for power development, a survey was made in 1912 from Stanley to the mouth. From the data collected on this survey sheets have been prepared showing a profile of the water surface, a plan of the river, and the contours along the bank. These sheets have been published separately, and may be obtained by applying to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn.

BIG FORK RIVER AT BIG FALLS, MINN.

This station, which is located on the Minnesota & International Railroad bridge crossing Big Fork River from Big Falls to Grand Falls, was established August 27, 1909, for the purpose of obtaining data concerning the power available at the falls, a short distance below the station.

The nearest important tributary is Sturgeon River, which enters Big Fork about 3 miles below Big Falls.

Like most of the streams in northern Minnesota, Big Fork is used in the spring for log driving, and the log jams that frequently occur may cause temporary backwater at the gage and render it impossible to make discharge measurements. However, conditions at the head of the falls (which is the control point for the gage section) are such that the logs simply float on the water surface for the most part and cause little or no backwater. This is shown by a comparison of gage heights with the Little Fork station, which is free from log jams. The two stations show the same general fluctuations of water surface, which would not be the case were one of them seriously affected by backwater. The stream is icebound from December to April.

The bridge from which the discharge measurements are made is oblique to the current. The datum of the staff gage, which is located at the measuring section, has remained unchanged since the gage was installed. Owing to the possibility of slight backwater from log jams and to the uncertainty in the lower part of the rating curve, records of flow at this station can be considered only fair.

Discharge measurements of Big Fork River at Big Falls, Minn., in 1909-10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Aug. 27	G. A. Gray	266	1,510	4.66	960
Oct. 1	....do	246	1,210	4.01	535
1910.					
July 22	Robert Follansbee			2.78	*a* 65

a Estimated from rough measurement.

Daily gage height, in feet, of Big Fork River at Big Falls, Minn., for 1910.

[Mark St. Louis, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	6.90	6.32	4.76	3.49	2.95	2.69	3.26	3.52
2	7.15	6.24	4.72	3.41	2.90	2.65	3.29	3.48
3	7.25	5.98	4.65	3.36	2.86	2.80	3.35	3.39
4	7.20	6.35	4.52	3.34	2.91	2.82	3.31	3.32
5	6.80	6.10	4.68	3.28	2.86	2.92	3.24	3.29
6	6.82	6.05	4.82	3.38	2.80	2.96	3.20	3.22
7	6.95	6.12	4.79	3.31	2.75	2.91	3.16	3.16
8	6.88	6.02	4.68	3.26	2.70	2.86	3.19	3.12
9	6.86	5.92	4.59	3.20	2.69	2.85	3.21	3.04
10	6.60	5.85	4.52	3.16	2.65	2.94	3.25	2.92
11	6.42	5.60	4.41	3.42	2.66	2.95	3.28	2.89
12	6.25	5.32	4.39	3.35	2.80	2.91	3.35	2.81
13	6.18	5.08	4.56	3.28	2.86	2.89	3.42	
14	6.08	4.86	4.51	3.22	2.82	2.98	3.50	
15	6.12	4.72	4.41	3.11	2.79	2.95	3.62	
16	6.30	5.02	4.35	3.00	2.76	2.92	3.61	
17	7.45	5.38	4.30	2.94	2.74	2.91	3.59	
18	8.22	5.56	4.26	2.86	2.70	2.98	3.55	
19	8.68	5.62	4.21	2.80	2.66	2.94	3.65	
20	8.62	5.48	4.11	2.75	2.64	2.91	3.78	
21	8.58	5.35	3.96	2.75	2.86	2.89	3.81	
22	8.19	5.28	4.15	2.74	2.81	2.96	3.79	
23	7.60	5.42	4.00		2.74	3.00	3.75	
24	7.32	5.34	3.89	2.94	2.68	2.98	3.72	
25	7.00	5.26	3.81	2.95	2.79	2.94	3.69	
26	6.58	5.20	3.76	2.90	2.71	2.96	3.69	
27	6.40	5.15	3.71	2.85	2.62	3.01	3.76	
28	6.28	5.05	3.64	2.96	2.80	3.11	3.75	
29	6.15	4.94	3.60	2.96	2.80	3.19	3.71	
30	6.28	4.88	3.54	2.91	2.76	3.25	3.69	
31		4.81		3.00	2.71		3.61	

NOTE.—Ice present from Jan. 1 to Mar. 31 and from Nov. 13 to Dec. 31.

Daily discharge, in second-feet, of Big Fork River at Big Falls, Minn., for 1909-10.

Day.	Aug.	Sept.	Oct.	Nov.	Day.	Aug.	Sept.	Oct.	Nov.
1909.					1909.				
1		812	536	1,140	17		395	910	
2		731	492	1,070	18		375	910	
3		628	470	1,000	19		430	948	
4		574	465	955	20		470	1,100	
5		530	460	918	21		514	1,340	
6		481	460	854	22		616	1,820	
7		465	445	805	23		738	2,140	
8		415	445	770	24		784	2,140	
9		400	470	770	25		777	2,100	
10		375	552	738					
					26		718	1,960	
11		366	679	712	27	978	653	1,780	
12		348	784	628	28	1,040	604	1,600	
13		360	840	580	29	1,110	580	1,430	
14		360	840	552	30	1,060	552	1,310	
15		375	840	525	31	948		1,210	
16		385	875						

Daily discharge, in second-feet, of Big Fork River at Big Falls, Minn., for 1909-10—Con.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1910.								
1	2,960	2,390	1,030	281	108	48	196	293
2	3,200	2,320	1,000	249	95	40	206	277
3	3,300	2,070	948	231	86	72	227	242
4	3,260	2,420	854	224	98	77	214	217
5	2,860	2,180	970	203	86	100	189	206
6	2,880	2,140	1,080	238	72	110	175	182
7	3,000	2,200	1,050	214	61	98	163	163
8	2,940	2,110	970	196	50	86	172	151
9	2,920	2,020	903	175	48	84	179	130
10	2,660	1,960	854	163	40	105	192	100
11	2,490	1,730	777	253	42	108	203	94
12	2,330	1,490	764	228	72	98	227	74
13	2,260	1,280	882	203	86	93	253	....
14	2,170	1,110	847	182	77	115	285	....
15	2,200	1,000	777	148	70	108	334	....
16	2,380	1,240	738	120	63	100	329	....
17	3,500	1,540	705	105	59	98	321	....
18	4,310	1,690	779	86	50	115	305	....
19	4,790	1,750	646	72	42	105	347	....
20	4,730	1,620	586	61	38	98	410	....
21	4,690	1,510	503	61	86	93	425	....
22	4,280	1,450	610	59	74	110	415	....
23	3,660	1,570	525	82	59	120	395	....
24	3,380	1,500	465	105	46	115	380	....
25	3,060	1,440	425	108	70	105	366	....
26	2,640	1,380	400	95	52	110	366	....
27	2,470	1,340	375	84	34	122	400	....
28	2,360	1,260	343	110	72	148	395	....
29	2,230	1,170	325	110	72	172	375	....
30	2,360	1,120	301	98	63	192	366	....
31	....	1,070	....	120	52	....	329	....

NOTE.—Discharge based on a rating curve not well defined.

Monthly discharge of Big Fork River at Big Falls, Minn., for 1909-10.

[Drainage area, 1,320 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
August 27-31	1,110	948	1,030	0.780	0.15	B.
September	812	348	527	.399	.45	B.
October	2,140	445	1,040	.788	.91	B.
November	1,140	....	660	.500	.56	C.
1910.						
April	4,790	2,170	3,080	2.33	2.60	D.
May	2,420	1,000	1,650	1.25	1.44	C.
June	1,080	301	714	.541	.60	C.
July	281	59	150	.114	.13	C.
August	108	34	65.3	.049	.06	C.
September	192	40	105	.080	.09	C.
October	425	163	295	.223	.26	B.
November 1-12	293	74	177	.134	.06	C.

NOTE.—Mean for Nov. 16 to 30, 1909, estimated at 520 second-feet.

UPPER MISSISSIPPI RIVER DRAINAGE BASIN.

GENERAL FEATURES.

Mississippi River drains the greater part of the territory of the United States lying between the Alleghenies and the Rockies. Its basin, irregular in shape, occupies the central part of the United States, and is best described as an oblong, with the major axis, 1,700 miles in length, running southeastward from the northwestern part of Montana, through North Dakota, Nebraska, Missouri, and Tennessee, into the northwestern corner of Alabama. On each side of this line the basin spreads out from 300 to 500 miles, and on the east is a large protuberance from the general outline extending to the Alleghenies. The basin comprises about 1,240,000 square miles, and includes wholly or in part 30 States, besides a small area in the Dominion of Canada. Of the total area, about 527,000 square miles drain to the Missouri, about 171,500 square miles to the upper Mississippi above the mouth of the Missouri, and about 204,000 square miles to the Ohio. The mean annual flow of the Missouri is about 100,000 second-feet; of the upper Mississippi, about 125,000 second-feet; of the Ohio, about 300,000 second-feet.

Immediately beneath the covering of drift at the sources of the Mississippi lie the oldest rocks known to the geologist. Its mouth is surrounded by the soft marshes of its own delta now forming. Between these two extremes rocks of all geologic ages are represented.

All varieties of topography are likewise exhibited in the drainage basin, mountain and prairie, arid plain, and alluvial bottom covered with vegetation, being fully represented; but the greater part of its broad extent is very uniform in contour.

For convenience in publication of reports the basin of Mississippi River has been divided into the upper Mississippi, Missouri River, lower Mississippi, and Ohio drainage basins. The upper Mississippi Basin, as considered in this discussion, is that portion lying above the mouth of the Missouri. The upper Mississippi Basin therefore occupies the north-central part of the United States, including Minnesota, Wisconsin, Iowa, Illinois, Indiana, Missouri, and a few square miles in South Dakota and the northern peninsula of Michigan. The sources of this branch of the great river are almost exactly in the center of the continent on an east and west line.

The Mississippi rises, not in Lake Itasca, so long considered the source, but in a smaller lake called Hernando de Soto, which is situated in the northeastern part of Becker County, Minn., and which drains into Lake Itasca through Nicollet Creek. From these lakes to the mouth of Crow Wing River it flows almost in a circle, as at this point it is only 75 miles from its sources, while the distance following the river is 350 miles. Leaving the lakes its course is northward, but below the junction with the Crow Wing it turns to the south and continues in this direction until it finally reaches the Gulf of Mexico.

The total length of the river is about 2,555 miles; from the source to the mouth of the Ohio is about 1,500 miles.[1]

The important tributaries of the upper Mississippi, beginning at the source and following down the west bank, are Leech Lake, Willow, Pine, Crow Wing, Sauk, Crow, Minnesota, Cannon, Zumbro, Root, Turkey, Wapsipinicon, Iowa, Des Moines, and Missouri rivers; on the east bank are Prairie, Elk, Rum, St. Croix, Chippewa, Black, La Crosse, Wisconsin, Rock, Illinois, Kaskaskia, Big Muddy, and Ohio rivers.

From Lake Hernando de Soto to the Falls of St. Anthony the river flows almost exclusively through a drift-covered region. Down to Pokegama Falls it occupies a valley which is in some places narrow, in others broad and savanna-like, with many rapids in the narrower and with gentle or sluggish currents in the broader portions. In this part of its course it drains a number of lakes, among which Bemidji, Cass, Winnibigoshish, and Leech are the most important. The first rock in place is at Pokegama Falls, and thence to the mouth of Crow Wing River, which enters from the west, the average width of the stream is 300 feet, the valley is less winding, and the current is good, with many rapids of small extent.

Below the mouth of the Crow Wing the river flows in a general southeasterly direction for about 475 miles. Within this stretch are several rapids—the chief being Little Falls and Sauk Rapids—and many timbered islands. The banks are abrupt, of clay or sandy loam, and lead to meadows that stand 60 feet above the river. At the falls of St. Anthony the river pitches down a vertical fall and rapids amounting to 80 feet in half a mile, and in so doing leaves the prairie and clay banks for a channel that lies between rocky bluffs of limestone and sandstone, which continue for many miles, gradually increasing to a height of 500 feet as the bed sinks below the general prairie level. The sides of the bluff are not vertical bare surfaces of rock, but are composed of easily eroded stone and drift, which form well-wooded or grassy slopes. It is believed by geologists that the gorge from the mouth of the Minnesota River to St. Anthony Falls was caused by the gradual wearing away of the falls, which were originally at the mouth of the Minnesota.

Minnesota River enters the Mississippi about 16 miles below St. Anthony Falls, and below its mouth the width of the main stream averages 1,000 feet. From this point to the mouth of the Missouri it

[1] The Twenty-second Annual Report of the United States Geological Survey, pt. 4, p. 210, contains a detailed description of the Mississippi from the sources to St. Paul, taken from the Reports of the Chief of Engineers, U. S. Army. The hydrographic investigations of the United States Engineer Corps on the upper Mississippi extend over a period of 32 years, from 1866 to 1898, and form, according to the Report of the Chief of Engineers for 1897, "the largest continuous record over large drainage areas that has been made in the United States."

is a broad, placid stream, containing innumerable islands, the entire width of the valley averaging 1 mile. In many places, especially where tributaries enter, fertile flats lie between the river and the bluffs. Fifty-five miles below the mouth of the Minnesota is Lake Pepin, an expansion of the river apparently caused by the immense quantities of sand brought down by the Chippewa. At two places exceptions occur to the otherwise placid character of the river. At Rock Island, Ill., 384 miles from St. Paul, there are rapids by which the river falls about 20 feet in 12 miles; and at Keokuk, Iowa, 509 miles from St. Paul, is the foot of the Des Moines Rapids, where in a distance of 11 miles the river falls about 22 feet.

The following table, compiled chiefly from the charts of the Mississippi River Commission, shows the elevations at different points of the upper river. (The distances are measured along the river channel.)

Elevations and distances along Mississippi River.

	Distance below Lake Itasca.	Elevation.
	Miles.	*Feet.*
Lake Itasca	0	1,472
Lake Bemidji, above dam	42	1,340
Winnibigoshish Lake, above dam	85	1,304
Leech Lake River	117	1,285
Ball Club River	120	1,282
Vermilion River	142	1,278
Rice Creek	149	1,277
Above Pokegama dam	158	1,277
Above Grand Rapids dam	161	1,268
Prairie River	164	1,246
Swan River	203	1,229
Dinky Rapids	215	1,225
Oxbow Rapids	226	1,217
Sandy River	234	1,212
Willow River	262	1,203
Aitkin	282	1,194
Indian Lake outlet	309	1,189
Pine River	313	1,180
Above Brainerd dam	334	1,172
Buffalo Creek	340	1,152
Crow Wing River	347	1,149
Pipe Island	358	1,138
Above Little Falls dam	372	1,102
Pike Creek	374	1,078
Two Rivers	383	1,032
Above Sartell dam	404	1,014
Sauk River	407	992
Above St. Cloud dam	410	978
Clearwater River	422	936
Silver Creek	430	929
Monticello	439	897
Elk River	450	859
Crow River	456	843
Rum River	464	827
Above St. Anthony Falls, upper dam	482	796
Below St. Anthony Falls, lower dam	482	728
Below United States Lock and Dam No. 2	485	702
Minnesota River	490	692
St. Paul	496	689
Lake St. Croix	522	673
Red Wing	542	668
Frontenac	553	667
Chippewa River	570	664
Wabasha	574	663
Whitewater River	590	652
Winona	608	643
Root River	638	628
State line	658	615

The headwaters of the main stream and its tributaries which lie in Wisconsin and in Minnesota north of a line drawn diagonally through Douglas, Stevens, Meeker, McLeod, Sibley, Lesueur, Rice, and Dakota counties are in a region that was originally forested. Most of this area has been cut over extensively, though a comparatively small proportion has been cleared, except in the southern part of the area, where agriculture is making rapid progress. The remainder of the drainage area is prairie land.

The entire basin, at least as far south as the southern boundary of Minnesota, is covered with glacial drift of varying thickness. The tributaries north of St. Anthony Falls at Minneapolis flow over the drift without uncovering the underlying rock, while those farther south have worn deep valleys through both the drift and the rock. Along these bluffs are found many springs.

Rainfall records have been kept in the upper basin for many years, and from them the following data have been compiled:

Mean annual rainfall at points in upper Mississippi basin.

	Inches.
Lake Winnibigoshish, 1888–1909	26.5
Leech Lake, 1888–1909	27.4
Pokegama Falls, 1888–1909	27.9
Sandy Lake, 1893–1909	27.1
Pine River dam, 1888–1909	28.2
Park Rapids, 1885–1909	26.7
Long Prairie, 1893–1909	26.1
Collegeville, 1893–1909	23.3
New London, 1897–1909	23.8
St. Paul, 1837–1909	27.8
Red Wing, 1886–1909	30.2
Wabasha, 1893–1909	30.5
Winona, 1886–1909	30.5

The winters in Wisconsin, Minnesota, and Iowa are severe; snowfall is heavy throughout the greater part of this area, the snow lasts for considerable periods, ice forms to thickness of 1 to 2 feet, and lasts for three to four months. In other parts of the drainage basin the winters are milder.

According to some authorities the basin of the upper Mississippi contains from 5,000 to 6,000 lakes, nearly all of which are near the sources of the main river and its northern tributaries. In addition, there are vast swamp areas in this region, so that there is great natural storage for steadying the flow of the river. Practically none of this swamp land has been drained at the present time. By building comparatively low dams it will be possible to create reservoirs on many of the lakes.

The river is navigable as far up as St. Anthony Falls, and above that there are navigable stretches from 10 miles below Brainerd to

Grand Rapids; from Cohasset to Pokegama Lake and Ball Club; on Winnibigoshish and Cass lakes; and on Lake Bemidji, Lake Irving, and Lake Plantagenet.

The United States Engineer Corps has built six reservoirs on the Mississippi headwaters for the purpose of aiding navigation during the low-water open season. These reservoirs have the following storage capacity:

	Feet head.	Cubic feet.
Winnibigoshish	14	44,000,000,000
Leech Lake	5.7	33,000,000,000
Pokegama Lake	7.5	5,300,000,000
Sandy Lake	9.4	3,200,000,000
Pine River dam	16.2	7,700,000,000
Gull Lake	3	2,700,000,000

Although the reservoirs are operated primarily in the interest of navigation, water power and flood control are also benefited. The operation during the winter, or nonnavigation season, is based on the necessity for having 39,000,000,000 cubic feet empty storage capacity on April 1 to take care of the spring high water. Thus if the preceding year has been very dry and the storage has been nearly exhausted, the reservoirs allow only the normal minimum winter flow (as determined previous to building the reservoirs) to pass down the river. If the preceding navigation season has not drawn heavily on the reservoirs, the winter flow is increased by a sufficient amount to make possible the required empty storage capacity April 1.

That there are valuable power sites on Mississippi River is shown by the facts that plants at Bemidji, Grand Rapids, Brainerd, Little Falls, Sartell, St. Cloud, and Minneapolis develop about 80,000 horsepower. Besides these there are several other points where a heavy fall occurs within a comparatively short distance, especially between Minneapolis and Brainerd. The United States Government is building a 30-foot dam on the Mississippi just above the mouth of the Minnesota, which will develop a large amount of power, and a dam is being built at Keokuk which will develop one of the largest powers in the country.

The river is used extensively for logging as far down as Minneapolis, and log jams frequently occur on the various bars that cause more or less backwater for short periods.

The quality of the water in the portion of the Mississippi basin lying in Minnesota has been investigated by the United States Geological Survey, and the results published in Water-Supply Paper 193, entitled "The quality of surface waters in Minnesota."

Records of discharge of Mississippi River have been kept for many years. Since 1892 the year of least flow has been 1895 and that of greatest flow 1906. The greatest flood flow, however, occurred in 1897.

MISSISSIPPI RIVER ABOVE SANDY RIVER, MINN.

This station, which was established September 1, 1895, is located a short distance above the mouth of Sandy River, near Libby post office, in Aitkin County, and is maintained by the United States Engineer Corps.

The discharge represents chiefly the water from the Government reservoirs at Winnibigoshish, Leech, and Pokegama lakes, as the streams between the lower reservoir and the gaging stations are relatively small. The largest are Prairie and Swan rivers, which drain 501 and 340 square miles, respectively. The flow from the other two reservoirs in the system—Sandy Lake and Pine River—is shown by the tables on pages 136–148 and 149–159. The sum of the discharge at the three stations represents the flow of the upper Mississippi as affected by the reservoir systems.

Frequent discharge measurements are made throughout the year by an employee stationed at Sandy Lake dam. The daily discharge is computed almost directly from discharge measurements.

The daily discharge and monthly mean discharge for this station have been compiled from unpublished records in the United States engineer office at St. Paul. The run-off per square mile, depth in inches on drainage area, and total run-off in millions of cubic feet have been computed by the Geological Survey.

Daily discharge, in second-feet, of Mississippi River above Sandy River, Minn., for 1895–1910.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1895.					1895.				
1	2,192	2,322	2,128	1,216	16	2,206	2,059	2,087	668
2	2,193	2,375	1,866	1,161	17	2,207	1,870	2,047	653
3	2,194	2,256	1,908	1,106	18	2,208	1,988	2,007	638
4	2,195	2,281	1,951	1,070	19	2,209	2,008	1,967	636
5	2,196	2,240	1,993	1,034	20	2,210	2,009	1,880	634
6	2,197	2,295	1,974	999	21	2,211	2,011	1,794	633
7	2,198	2,350	1,954	963	22	2,212	2,183	1,707	620
8	2,199	2,429	1,995	923	23	2,213	1,982	1,620	606
9	2,200	2,193	2,036	883	24	2,213	2,012	1,533	592
10	2,201	2,177	2,077	843	25	2,213	2,042	1,447	579
11	2,201	2,240	2,118	804	26	2,214	1,911	1,360	565
12	2,202	2,293	2,159	768	27	2,214	1,977	1,333	552
13	2,203	2,218	2,200	733	28	2,215	2,043	1,306	538
14	2,204	2,142	2,229	698	29	2,251	2,109	1,278	518
15	2,205	2,248	2,258	683	30	2,286	2,176	1,251	498
					31		2,163		477

Daily discharge, in second-feet, of Mississippi River above Sandy River, Minn., for 1895–1910—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1896.												
1	430	438	230	600	5,011	....	2,065	1,687	1,965	2,120	3,133	1,055
2	400	435	235	620	5,376	....	2,120	1,754	1,985	2,059	3,181	1,009
3	380	432	230	610	....	....	2,180	1,821	2,080	2,103	3,230	963
4	400	429	225	585	....	....	2,210	1,890	2,175	2,148	3,245	918
5	450	426	210	565	....	....	2,190	1,957	2,270	2,193	3,235	895
6	480	423	185	545	....	3,840	2,160	2,024	2,365	2,238	3,200	874
7	420	419	180	516	....	3,763	2,077	2,091	2,323	2,282	2,600	853
8	380	416	165	530	....	3,687	1,994	2,157	2,348	2,327	2,030	832
9	410	413	165	535	....	3,611	1,911	2,223	2,367	2,372	1,900	810
10	410	410	175	555	....	3,534	1,829	2,289	2,450	2,417	1,785	808
11	410	407	183	610	....	3,458	1,746	2,357	2,400	2,462	1,755	806
12	410	404	200	950	....	3,382	1,663	2,423	2,350	2,507	1,745	804
13	465	392	230	1,750	....	3,305	1,580	2,489	2,300	2,551	1,740	803
14	465	380	258	2,150	....	3,229	1,544	2,555	2,250	2,596	1,740	801
15	445	368	290	2,425	....	3,153	1,509	2,558	2,200	2,641	1,740	799
16	440	460	330	2,550	....	3,077	1,473	2,562	2,150	2,686	1,740	807
17	460	445	348	2,655	....	3,000	1,438	2,565	2,100	2,731	1,694	816
18	460	415	350	2,750	....	2,924	1,402	2,569	2,050	2,775	1,648	824
19	420	270	350	2,826	....	2,848	1,367	2,572	2,100	2,820	1,603	833
20	470	180	360	2,925	....	2,800	1,331	2,575	2,150	2,865	1,557	841
21	520	130	365	2,820	....	2,750	1,291	2,531	2,200	2,910	1,511	850
22	520	115	365	2,400	....	2,860	1,251	2,487	2,250	2,955	1,466	858
23	445	125	375	2,350	....	2,925	1,210	2,443	2,300	3,000	1,420	867
24	490	130	385	2,675	....	2,675	1,170	2,400	2,350	3,000	1,374	901
25	530	145	405	2,960	....	2,375	1,172	2,356	2,400	3,000	1,329	935
26	520	160	422	3,250	....	1,814	1,175	2,312	2,420	3,000	1,283	969
27	520	175	439	3,547	....	1,920	1,210	2,239	2,360	3,000	1,237	1,002
28	520	200	455	3,913	....	1,975	1,300	2,166	2,300	3,000	1,192	1,036
29	495	225	484	4,279	....	2,025	1,390	2,094	2,240	3,000	1,146	1,070
30	425	....	513	4,645	....	2,000	1,485	2,021	2,180	3,043	1,100	1,104
31	438	....	541	....	....	....	1,590	1,948	....	3,085	....	1,138
1897.												
1	1,010	900	690	1,417	3,062	2,754	2,999	4,685	2,174	2,756	....	2,958
2	906	860	694	1,590	3,023	2,680	2,758	4,464	2,199	2,794	....	2,971
3	802	851	681	1,764	2,983	2,605	3,714	4,242	2,224	2,832	....	2,889
4	699	843	668	2,104	2,944	2,531	4,671	4,020	2,333	2,869	....	2,846
5	595	834	654	2,444	2,904	2,457	5,627	3,798	2,443	2,907	....	2,742
6	590	833	641	2,784	3,174	2,382	5,793	3,576	2,552	2,607	....	2,733
7	585	831	633	3,124	3,444	2,308	5,960	3,468	2,661	2,307	....	2,621
8	580	830	625	3,464	3,582	2,535	6,126	3,359	2,736	2,007	....	2,625
9	585	828	616	3,804	3,719	2,762	6,292	3,251	2,811	2,105	....	2,612
10	590	769	638	4,143	3,857	2,989	6,459	3,142	2,886	2,203	....	2,526
11	594	710	658	4,483	3,771	3,210	6,625	3,116	2,961	2,301	....	2,405
12	599	651	662	4,823	3,686	3,432	6,791	3,090	2,935	2,256	....	2,345
13	603	662	667	5,163	3,600	3,653	6,957	3,064	2,908	2,210	....	2,272
14	606	674	671	5,503	3,486	3,591	7,124	3,069	2,882	2,165	....	2,280
15	609	685	675	5,843	3,371	3,529	7,290	3,073	2,878	2,119	....	2,190
16	702	696	679	5,443	3,256	3,467	7,456	3,078	2,874	2,155	....	2,117
17	796	693	686	5,040	3,141	3,405	7,623	3,082	2,870	2,192	....	2,018
18	890	690	692	4,863	2,914	3,561	7,789	3,051	2,866	2,228	....	1,872
19	905	687	699	4,683	2,686	3,717	7,567	3,021	2,862	2,264	....	1,576
20	920	688	706	4,503	2,459	3,873	7,346	2,990	2,859	2,420	....	1,339
21	922	689	736	4,323	2,232	3,828	7,124	2,903	2,870	2,576	....	1,473
22	924	690	765	4,143	2,176	3,739	6,902	2,817	2,881	2,732	....	1,659
23	926	691	800	3,962	2,119	3,763	6,681	2,730	2,893	2,811	....	1,746
24	928	692	836	3,782	2,063	3,695	6,459	2,643	2,902	2,890	....	1,785
25	930	689	871	3,602	2,007	3,650	6,237	2,557	2,915	2,969	....	1,828
26	893	685	906	3,422	1,951	3,517	6,015	2,470	2,789	3,048	....	1,832
27	900	681	947	3,342	1,894	3,384	5,794	2,383	2,662	3,030	....	1,815
28	908	685	987	3,262	1,838	3,252	5,572	2,296	2,536	3,011	....	1,802
29	915	....	1,028	3,182	2,168	3,119	5,350	2,010	2,609	2,993	....	1,794
30	923	....	1,069	3,102	2,498	2,878	5,129	2,123	2,683	3,060	....	1,768
31	930	....	....	....	2,828	....	4,907	2,148	....	3,127	....	1,746
1898.												
1	1,716	1,257	1,289	1,472	1,514	2,377	3,481	3,278	3,156	2,971	3,597	2,042
2	1,693	1,207	1,289	1,467	1,608	2,344	3,558	3,278	3,276	2,976	3,551	2,037
3	1,670	1,207	1,289	1,472	1,737	2,592	3,580	3,225	3,446	3,025	3,538	2,037
4	1,647	1,217	1,289	1,502	1,876	3,584	3,851	3,198	3,557	3,038	3,591	2,037
5	1,577	1,227	1,300	1,513	1,725	4,261	3,851	3,104	3,589	2,957	3,371	2,032

Daily discharge, in second-feet, of Mississippi River above Sandy River, Minn., for 1895–1910—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1898.												
6	1,507	1,237	1,322	1,513	1,647	4,404	3,941	2,872	3,602	2,949	3,432	2,032
7	1,507	1,237	1,324	1,475	1,636	4,490	3,986	2,740	3,616	2,980	3,612	2,008
8	1,393	1,299	1,303	1,511	1,626	4,547	4,053	2,770	3,580	2,989	3,619	1,930
9	1,291	1,361	1,282	1,500	1,626	4,633	3,615	2,604	3,304	2,976	3,698	1,933
10	1,291	1,361	1,259	1,511	1,748	4,088	3,570	2,538	3,304	2,998	3,724	1,845
11	1,302	1,350	1,297	1,404	1,814	4,112	4,121	2,478	3,281	2,989	3,671	1,724
12	1,313	1,339	1,335	1,457	1,876	4,121	4,121	2,527	3,255	2,958	3,797	1,680
13	1,324	1,328	1,373	1,393	1,898	4,178	4,008	2,461	3,188	2,954	3,739	1,629
14	1,335	1,316	1,411	1,404	1,937	4,236	3,940	2,394	3,121	2,940	3,693	1,619
15	1,337	1,328	1,327	2,193	2,110	4,207	4,396	2,527	2,121	2,904	3,660	1,566
16	1,369	1,340	1,238	1,515	2,227	4,441	4,283	2,758	3,167	2,895	3,613	1,457
17	1,401	1,352	1,327	1,280	2,367	4,465	4,211	3,023	3,390	2,900	3,654	1,423
18	1,403	1,364	1,351	1,216	2,439	4,438	4,170	3,023	3,591	2,904	3,594	1,330
19	1,405	1,379	1,375	1,173	2,371	4,385	4,361	2,748	3,672	2,936	3,555	1,386
20	1,407	1,327	1,399	1,146	2,019	4,383	4,361	2,714	3,563	2,945	3,407	1,352
21	1,409	1,275	1,423	1,194	2,098	4,192	4,057	2,682	3,384	2,954	3,414	1,322
22	1,448	1,266	1,447	1,221	2,282	4,001	3,852	2,781	3,362	2,927	3,731	1,327
23	1,487	1,257	1,471	1,424	2,008	3,830	3,757	2,847	3,312	2,913	3,513	1,118
24	1,487	1,248	1,495	1,595	2,297	3,619	3,668	2,815	3,401	2,904	3,506	1,084
25	1,426	1,237	1,519	1,708	2,593	3,449	3,536	2,749	3,289	2,895	1,821	1,050
26	1,365	1,255	1,543	1,745	2,570	3,404	3,504	2,749	3,070	2,891	1,953	1,033
27	1,304	1,273	1,567	1,836	2,394	3,285	3,468	2,742	3,047	2,895	2,059	1,011
28	1,304	1,291	1,591	1,809	2,148	3,276	3,445	2,762	3,114	2,886	2,442	958
29	1,305	......	1,594	1,574	2,386	3,324	3,423	2,874	3,204	2,878	2,488	934
30	1,306	......	1,514	1,499	2,341	3,349	3,577	2,894	3,460	2,869	2,521	929
31	1,306	......	1,476	......	2,263	......	3,541	2,841	......	2,846	......	900
1899.												
1	1,378	1,228	1,122	1,322	4,299	7,705	6,446	2,697	4,824	3,381	4,546	2,153
2	1,353	1,228	1,122	1,365	4,567	7,730	6,317	2,783	4,912	3,437	4,437	2,101
3	1,341	1,256	1,132	1,396	4,706	7,788	6,168	2,761	4,906	3,480	4,394	2,084
4	1,335	1,251	1,122	1,368	4,674	7,843	5,760	3,031	4,580	3,462	4,286	1,984
5	1,329	1,194	1,122	1,381	4,744	7,896	5,178	3,385	4,416	3,391	4,205	1,481
6	1,329	1,222	1,122	1,368	4,728	7,897	4,291	3,540	4,384	3,479	4,080	1,226
7	1,304	1,216	1,101	1,385	4,728	7,942	4,548	3,498	4,416	3,422	4,722	1,187
8	1,292	1,211	1,074	1,350	4,811	7,987	4,496	3,427	4,427	3,026	4,624	1,468
9	1,304	1,183	1,013	1,387	4,806	8,026	4,496	3,498	4,267	2,985	4,510	1,705
10	1,297	1,172	1,022	1,297	4,891	8,045	4,535	3,554	4,354	3,125	4,661	1,890
11	1,292	1,044	1,050	1,345	5,025	8,064	4,405	3,786	4,403	3,054	4,590	2,136
12	1,297	1,016	1,103	1,396	5,293	8,080	4,217	3,786	4,234	3,295	4,487	2,351
13	1,292	992	1,145	1,448	5,346	8,097	4,185	3,545	4,234	3,379	4,521	2,515
14	1,292	1,019	1,134	1,506	5,336	8,113	4,191	3,428	4,278	3,379	4,494	2,644
15	1,286	1,019	1,155	1,539	5,325	8,123	4,081	3,335	4,229	4,725	4,195	2,653
16	1,280	1,101	1,207	1,539	5,114	8,134	3,971	3,271	4,523	4,202	4,033	2,631
17	1,300	1,101	1,137	1,452	5,141	8,154	3,862	3,568	4,464	5,916	4,112	2,686
18	1,281	1,101	1,127	1,409	5,151	8,161	3,756	3,342	4,172	6,581	3,947	2,734
19	1,281	1,090	1,127	1,478	5,307	8,160	3,691	3,696	4,112	7,629	3,887	2,764
20	1,323	1,079	1,112	1,591	5,285	8,158	3,659	4,193	4,074	4,853	3,752	2,734
21	1,323	1,079	1,112	1,808	5,864	8,157	3,551	4,590	4,052	6,057	3,714	2,592
22	1,317	1,011	1,112	1,855	5,907	8,156	3,499	4,788	4,211	6,085	3,654	2,424
23	1,262	994	1,133	1,778	5,182	8,153	3,454	5,432	4,205	6,531	3,627	2,338
24	1,268	971	1,143	1,795	5,000	8,146	3,369	4,232	4,297	6,474	3,578	2,338
25	1,268	960	1,143	1,907	5,214	8,139	3,279	4,430	4,134	6,375	3,627	2,351
26	1,268	971	1,164	2,098	5,144	8,125	3,326	4,430	4,030	6,304	3,638	2,179
27	1,262	1,099	1,136	2,135	5,214	8,109	3,191	4,381	3,970	5,724	3,835	1,869
28	1,267	1,122	1,177	2,223	4,984	8,099	3,012	4,317	3,954	5,511	3,803	1,857
29	1,261	......	1,363	2,283	4,808	8,084	2,851	4,203	4,103	5,369	3,765	1,964
30	1,328	......	1,519	2,314	4,650	8,064	2,657	3,664	4,081	5,040	3,760	2,029
31	1,316	......	1,612	......	4,821	......	2,440	3,487	......	4,757	......	2,007
1900.												
1	2,062	1,672	1,323	1,385	2,090	2,054	1,288	891	4,230	5,774	2,586	852
2	2,036	1,637	1,323	1,416	1,833	2,084	1,087	763	3,573	5,792	2,490	852
3	1,949	1,602	1,323	1,426	1,511	2,017	1,035	750	3,408	5,574	2,539	831
4	1,924	1,595	1,323	1,472	1,384	1,447	1,020	555	3,077	5,384	2,645	831
5	1,915	1,547	1,340	1,477	1,909	1,384	1,370	549	3,392	5,121	2,653	831
6	1,876	1,528	1,340	2,097	2,119	1,495	1,258	1,072	3,901	5,216	2,463	831
7	1,841	1,528	1,340	2,188	773	1,510	1,191	1,535	3,599	5,216	2,456	661
8	1,808	1,500	1,350	2,199	843	1,517	1,153	1,877	3,599	4,673	2,421	639
9	1,788	1,550	1,350	2,364	983	1,613	1,459	1,837	3,484	4,655	2,396	618
10	1,759	1,563	1,390	2,558	913	1,532	1,691	1,780	3,069	4,854	2,526	618

Daily discharge, in second-feet, of Mississippi River above Sandy River, Minn., for 1895–1910—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1900.												
11	1,720	1,550	1,400	2,722	1,406	1,405	1,616	2,088	3,562	5,081	2,474	728
12	1,635	1,578	1,408	2,917	1,763	1,290	1,213	2,129	3,890	4,914	2,552	719
13	1,635	1,557	1,397	2,851	1,588	1,186	1,377	1,909	4,745	4,823	2,443	694
14	1,625	1,524	1,365	2,569	1,641	1,179	1,675	2,083	4,903	4,642	2,376	578
15	1,615	1,524	1,276	2,220	1,697	1,428	1,474	2,124	7,023	4,724	2,300	574
16	1,823	1,459	1,276	2,210	1,851	1,461	1,571	2,117	7,516	4,497	2,224	574
17	1,842	1,452	1,349	2,664	1,920	1,350	1,871	2,365	9,078	4,279	2,259	653
18	1,818	1,438	1,412	2,631	2,176	1,266	1,802	2,419	9,145	3,999	2,295	641
19	1,777	1,438	1,449	2,210	2,071	1,282	1,340	2,365	9,391	3,808	2,219	641
20	1,767	1,452	1,439	1,954	2,127	1,245	974	2,461	9,572	3,618	2,043	641
21	1,762	1,433	1,439	1,918	2,043	1,208	959	2,588	9,196	3,446	1,990	673
22	1,757	1,424	1,449	1,800	2,022	1,106	1,257	2,823	9,032	3,876	1,937	673
23	1,757	1,390	1,459	1,775	2,064	1,001	1,422	3,125	8,994	3,577	1,919	673
24	1,757	1,355	1,314	2,224	2,022	1,067	1,496	3,660	9,032	3,215	1,902	696
25	1,752	1,335	1,345	2,173	1,952	1,284	1,489	3,528	8,966	2,762	1,866	704
26	1,752	1,387	1,371	2,265	2,003	1,309	1,272	3,628	8,999	2,566	1,849	713
27	1,792	1,387	1,401	2,332	1,994	1,346	994	3,716	8,900	2,502	1,813	704
28	1,816	1,387	1,401	2,614	1,939	1,309	1,054	3,628	8,834	2,539	1,803	694
29	1,635	......	1,417	2,152	1,904	1,264	994	3,501	8,538	2,883	1,778	694
30	1,625	......	1,466	2,148	1,911	1,153	758	3,333	7,552	3,155	932	694
31	1,596	......	1,476	......	1,848	......	549	3,360	......	2,901	......	633
1901.												
1	601	753	1,533	2,053	5,851	4,640	6,878	3,176	3,346	2,683	3,700	2,325
2	610	763	1,453	2,053	6,025	4,640	6,905	3,255	3,306	2,648	3,694	2,334
3	610	770	1,388	2,104	6,129	4,681	6,950	2,860	3,219	2,708	3,717	2,325
4	633	780	1,348	2,171	6,185	4,647	6,950	2,662	3,158	2,825	3,717	2,136
5	633	813	1,348	2,293	6,206	4,640	6,950	2,544	3,102	3,030	3,717	2,127
6	628	913	1,284	2,324	6,185	4,536	6,591	2,480	2,790	3,124	3,759	2,001
7	584	997	1,228	2,293	6,192	4,509	6,546	2,423	2,734	3,453	3,653	1,992
8	584	851	1,448	2,113	6,241	4,446	6,495	2,692	2,632	3,553	3,688	1,974
9	584	753	1,414	2,688	6,234	4,315	6,428	3,292	2,880	3,574	3,747	2,001
10	584	858	1,430	2,837	6,486	3,887	6,332	3,324	2,900	3,609	3,747	2,001
11	627	901	1,612	3,154	6,430	3,566	6,265	2,250	2,900	3,344	3,717	2,046
12	627	964	1,620	3,458	6,402	3,465	5,318	2,242	2,900	3,385	3,653	2,046
13	627	1,047	1,724	3,995	6,354	3,472	5,177	2,336	2,773	3,385	3,571	2,046
14	619	1,080	1,741	4,267	6,399	3,437	5,161	2,423	2,763	3,397	3,453	2,023
15	628	1,118	1,821	4,416	6,301	3,499	5,054	2,352	2,712	3,408	3,453	1,978
16	646	1,052	1,813	4,687	6,176	3,983	5,542	2,344	2,773	3,322	3,453	1,955
17	650	1,079	1,829	4,772	4,657	4,363	4,918	2,348	2,834	3,310	3,629	1,739
18	519	1,146	1,749	4,901	4,490	4,577	4,188	2,316	2,854	3,310	3,559	1,622
19	528	1,196	1,765	5,030	4,072	4,674	3,860	2,308	2,854	3,281	3,489	1,626
20	519	1,319	2,006	5,192	4,404	4,736	3,287	2,143	2,720	3,287	3,489	1,622
21	510	1,419	1,894	5,289	3,972	4,770	3,062	2,158	2,720	3,639	3,489	1,604
22	510	1,523	1,861	5,354	4,002	4,575	2,787	2,474	2,730	3,639	3,489	1,595
23	528	1,543	1,820	5,464	4,049	4,630	3,087	2,774	2,565	3,645	3,489	1,595
24	546	1,620	2,286	5,587	4,243	6,598	3,059	2,940	2,550	3,651	3,489	1,595
25	598	1,519	2,334	5,677	3,922	7,344	2,468	3,035	2,550	3,641	3,489	1,654
26	620	1,485	2,286	5,768	3,797	7,682	2,412	4,028	2,580	3,629	3,489	1,659
27	643	1,519	2,181	5,826	4,335	7,979	2,446	3,972	2,889	3,617	3,489	1,659
28	629	1,519	2,119	5,890	4,238	8,256	2,480	3,845	2,848	3,374	3,789	1,659
29	633	......	2,031	5,993	4,203	8,588	2,835	3,727	2,848	3,386	3,676	1,659
30	633	......	1,951	6,220	4,342	8,823	2,779	3,178	2,865	3,421	3,541	1,668
31	633	......	1,859	......	3,819	......	2,756	2,996	......	3,433	......	1,673
1902.												
1	1,656	1,492	1,448	3,192	1,962	4,541	2,588	1,708	2,272	2,374	3,110	2,943
2	1,656	1,397	1,448	3,046	2,104	4,413	2,525	2,059	2,450	2,425	3,625	2,950
3	1,656	1,216	1,490	2,783	2,245	4,447	2,404	2,163	2,552	2,297	4,165	2,936
4	1,629	1,238	1,396	2,385	2,822	4,233	2,404	1,629	2,640	2,168	4,449	2,936
5	1,614	1,365	1,438	2,269	2,570	4,062	2,549	1,492	2,692	2,156	4,839	2,975
6	1,595	1,444	1,475	2,648	2,750	4,021	2,404	1,540	2,705	2,068	5,372	3,038
7	1,536	1,311	1,469	2,789	2,678	4,124	2,353	1,586	2,679	2,042	5,709	3,153
8	1,517	1,311	1,470	2,473	2,678	4,166	2,258	1,673	2,660	2,119	5,744	3,194
9	1,507	1,295	1,474	2,064	3,038	4,121	2,529	1,653	2,609	2,223	6,011	3,289
10	1,324	1,271	1,506	2,251	2,750	4,164	2,626	1,595	2,596	2,334	6,153	3,309
11	1,324	1,192	1,513	2,286	2,822	4,206	2,684	1,589	2,558	2,231	6,330	2,543
12	1,314	1,128	1,463	2,222	2,827	4,181	2,684	1,524	2,341	2,231	6,508	2,556
13	1,522	1,176	1,500	2,269	2,834	4,085	2,684	1,511	2,379	2,532	6,597	2,556
14	1,522	1,161	1,645	2,123	3,036	3,999	2,684	1,452	2,328	2,467	6,543	2,550
15	1,512	1,136	1,708	2,006	3,097	3,914	1,990	1,417	2,407	2,377	6,561	2,425

Daily discharge, in second-feet, of Mississippi River above Sandy River, Minn., for 1895–1910—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902.												
16	1,517	1,107	1,856	2,035	3,025	3,768	1,844	1,423	2,280	2,300	6,685	2,495
17	1,470	1,117	1,909	2,153	3,025	3,717	1,699	1,469	2,191	2,303	6,898	2,448
18	1,460	1,139	1,909	2,018	3,025	3,657	1,546	1,438	2,203	2,329	6,845	2,373
19	1,355	1,148	1,877	1,988	2,998	3,512	1,626	1,399	2,170	2,393	6,863	2,349
20	1,435	1,148	1,937	1,842	3,358	4,027	1,577	1,399	2,166	2,604	6,863	2,274
21	1,416	1,155	2,008	1,813	5,305	3,864	1,516	1,386	2,102	2,617	6,898	2,233
22	1,416	1,161	2,036	1,334	6,257	3,676	1,929	1,568	2,259	2,668	6,898	2,220
23	1,449	1,202	2,036	1,936	6,257	3,574	2,171	1,490	2,297	2,642	7,076	2,064
24	1,521	1,270	2,056	1,936	6,185	3,351	2,050	1,470	2,386	2,152	6,987	2,131
25	1,422	1,301	1,961	1,936	5,990	3,420	1,923	1,433	2,386	2,203	7,005	2,030
26	1,427	1,301	1,945	1,982	6,084	2,949	1,583	1,550	2,223	2,345	6,863	1,960
27	1,436	1,321	2,130	1,982	6,293	3,137	1,316	1,582	2,236	2,384	6,754	1,838
28	1,415	1,439	2,262	1,935	5,048	2,795	1,024	1,861	2,299	2,504	6,666	1,743
29	1,348	......	2,246	1,509	4,954	2,539	1,243	2,185	2,484	2,607	6,524	1,671
30	1,401	......	2,458	1,771	4,735	2,009	1,365	2,822	2,420	2,716	6,524	1,641
31	1,434	......	2,342	......	4,198	......	1,729	2,831	......	2,819	......	1,573
1903.												
1	1,880	1,133	1,119	1,199	2,736	2,818	1,739	1,961	1,592	2,621	2,464	796
2	1,760	1,162	1,047	1,045	2,690	2,714	1,836	1,879	1,581	2,612	2,371	775
3	1,754	1,147	1,137	1,342	2,649	2,061	1,756	1,825	1,638	2,644	2,442	771
4	1,716	1,123	1,122	1,557	3,169	2,622	1,473	1,809	1,581	3,092	2,362	778
5	1,753	1,104	1,107	1,342	3,160	2,529	1,461	1,833	1,694	3,360	2,373	778
6	1,696	1,088	929	1,557	3,119	2,889	1,955	1,864	1,700	3,437	1,821	778
7	1,658	1,078	899	1,749	3,032	2,341	1,909	1,910	1,564	3,987	1,797	777
8	1,620	1,073	869	1,966	3,032	1,948	2,273	1,852	1,587	4,473	1,761	775
9	1,431	1,154	951	2,184	2,968	1,948	2,544	1,813	1,899	4,802	1,591	775
10	1,399	1,149	966	2,280	3,278	1,928	2,656	1,754	2,075	4,949	1,602	777
11	1,361	1,125	921	2,606	3,597	1,936	2,542	1,697	2,166	4,974	1,625	775
12	1,595	1,115	906	2,990	3,907	2,107	2,258	1,631	2,602	5,041	1,474	773
13	1,563	1,130	803	3,451	4,103	2,047	1,773	1,558	2,868	4,919	1,431	771
14	1,544	1,120	863	4,078	4,103	1,967	1,557	1,374	3,056	4,198	1,409	771
15	1,531	1,115	878	4,750	4,166	2,007	1,518	1,324	3,181	4,785	1,389	775
16	1,466	1,091	893	4,366	4,212	2,007	1,602	1,370	3,368	4,308	1,236	773
17	1,434	1,085	977	4,142	4,234	1,887	1,568	1,455	3,425	4,398	1,226	771
18	1,396	1,051	1,007	4,346	4,234	1,867	1,630	1,366	3,571	4,487	1,215	780
19	1,371	1,037	1,127	4,462	4,266	1,795	1,710	1,339	3,747	4,430	1,389	780
20	1,402	1,075	1,217	4,590	4,234	1,611	1,718	1,331	3,809	4,308	1,409	783
21	1,472	1,065	1,232	4,750	4,156	1,454	1,792	1,265	3,550	4,116	1,376	781
22	1,292	1,041	1,232	4,462	4,002	1,204	1,780	1,323	3,818	3,912	912	783
23	1,273	1,020	985	4,209	3,806	1,124	1,650	1,257	3,829	3,845	1,018	785
24	1,241	986	1,015	3,958	3,496	1,132	1,734	1,121	3,454	3,685	998	786
25	1,235	976	1,015	3,803	3,883	1,132	2,035	1,160	3,519	3,436	947	774
26	1,281	964	1,015	3,803	3,564	1,313	1,972	1,183	3,269	3,116	837	772
27	1,268	964	1,113	3,585	3,482	1,477	1,548	1,140	3,070	2,445	837	760
28	1,287	964	1,128	3,234	3,214	1,473	1,485	1,319	2,969	1,984	837	772
29	1,249	......	1,143	3,213	3,451	1,521	1,457	1,346	2,923	1,741	837	642
30	1,190	......	1,095	2,986	3,396	1,525	1,468	1,346	2,906	2,357	686	642
31	1,158	......	1,185	......	3,269	......	1,911	1,321	......	2,805	......	641
1904.												
1	654	698	636	818	3,491	2,212	1,993	1,756	1,835	2,162	2,242	647
2	707	644	638	842	3,468	2,306	1,971	1,851	2,145	2,123	1,911	875
3	721	638	653	870	3,451	2,118	2,100	1,818	2,155	2,069	1,806	875
4	730	583	657	917	3,422	2,102	2,181	1,588	2,195	1,960	1,826	858
5	725	583	654	853	3,371	2,443	1,916	1,679	1,955	1,830	1,747	834
6	663	550	651	1,284	3,360	2,244	1,970	1,919	1,486	1,867	2,014	823
7	654	568	629	1,463	3,377	2,424	1,862	2,039	1,788	1,890	2,219	823
8	673	604	624	1,750	3,434	2,707	1,674	1,833	1,888	1,780	1,984	806
9	668	610	653	1,901	3,434	2,809	1,592	1,891	1,888	1,795	1,931	744
10	654	604	653	2,090	3,392	2,707	1,754	1,824	1,948	1,780	1,973	702
11	664	610	676	2,261	3,392	2,644	1,819	1,790	2,087	1,920	1,658	768
12	664	646	683	2,412	3,375	2,400	1,685	1,869	2,087	2,075	1,642	778
13	664	628	618	2,554	3,255	2,174	1,831	1,786	1,888	2,194	1,616	803
14	664	628	659	2,701	3,232	2,072	1,734	1,800	1,788	2,227	1,768	796
15	739	634	649	2,809	3,187	2,245	1,535	2,162	1,718	2,281	1,673	790
16	734	616	647	2,890	3,311	2,127	1,535	2,315	1,626	2,406	1,636	793
17	720	536	611	2,961	3,260	1,925	1,913	2,287	1,647	2,571	1,521	779
18	776	584	606	3,003	3,197	1,806	1,676	1,970	1,827	2,594	1,411	786
19	773	612	583	3,098	2,998	1,927	1,471	1,717	1,638	2,726	1,603	768
20	773	624	614	3,216	2,644	1,718	1,493	1,780	1,568	2,804	1,687	768

Daily discharge, in second-feet, of Mississippi River above Sandy River, Minn., for 1895–1910—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.												
21	749	642	614	3,278	2,559	1,888	1,638	1,795	1,638	2,827	1,645	771
22	593	621	660	3,278	2,479	1,932	1,527	1,780	1,698	2,858	1,520	847
23	640	633	609	3,311	2,700	1,751	1,678	1,607	1,781	3,030	1,483	820
24	659	633	592	3,344	2,683	1,701	1,732	1,799	1,936	2,859	1,310	813
25	754	633	740	3,754	2,711	1,875	1,732	1,909	1,966	2,587	1,257	837
26	722	615	779	3,590	2,711	1,987	1,376	1,794	1,956	2,564	1,204	827
27	736	615	751	3,609	2,691	2,079	1,317	1,889	1,896	2,331	1,189	848
28	727	633	677	3,558	2,651	2,074	1,614	1,843	1,906	1,973	948	772
29	706	639	671	3,530	2,623	1,900	1,961	1,848	1,876	1,929	985	758
30	701		665	3,535	2,583	1,746	1,918	1,857	1,836	2,240	1,001	745
31	687		694		2,287		1,691	1,891		2,652		773
1905.												
1	799	668	665	1,570	2,150	3,916	6,579	5,460	5,621	5,331	3,411	3,424
2	826	683	653	1,593	1,605	3,961	6,695	5,661	5,707	5,312	3,424	3,420
3	831	679	653	1,787	1,398	3,943	6,765	6,057	6,057	5,288	3,342	3,440
4	873	682	754	1,880	2,109	3,718	7,067	6,425	6,094	5,263	3,273	3,450
5	873	679	720	2,010	2,490	3,817	7,394	7,495	6,051	5,227	3,264	3,455
6	528	675	712	2,263	2,514	3,799	7,644	7,816	5,991	5,309	3,361	3,458
7	528	679	733	2,428	2,526	4,121	7,851	8,139	5,974	4,923	3,329	3,460
8	523	679	745	2,506	2,701	3,911	7,955	8,278	5,974	4,156	3,264	3,465
9	738	637	745	2,512	2,781	4,271	8,123	8,299	5,975	3,361	3,220	3,470
10	737	658	698	2,529	2,997	4,121	8,254	8,203	5,986	3,146	3,100	3,472
11	735	565	671	2,576	3,294	4,308	8,278	7,920	5,991	3,128	2,911	3,480
12	735	565	671	2,593	3,636	3,836	8,254	7,796	6,003	3,116	3,012	3,475
13	733	565	556	2,608	4,034	3,535	8,087	7,559	6,108	3,041	3,037	3,465
14	737	588	512	2,602	4,262	3,926	7,897	7,331	6,163	3,004	2,980	3,460
15	741	721	769	2,593	4,311	3,975	7,571	7,264	6,176	3,151	3,018	3,455
16	748	634	736	2,587	4,343	4,122	7,198	7,136	6,163	3,360	3,031	3,450
17	721	617	725	2,581	4,419	5,076	6,889	7,020	6,064	3,347	2,974	3,425
18	739	689	715	2,253	4,457	5,847	6,577	6,846	5,991	3,437	2,911	3,420
19	748	689	762	2,175	4,622	6,245	6,460	6,714	5,861	3,511	2,980	3,419
20	686	581	762	2,065	4,654	6,346	6,325	6,617	5,886	3,651	3,012	3,360
21	688	574	762	1,802	4,654	6,386	6,292	6,503	5,892	3,694	3,056	3,360
22	682	591	769	1,620	4,660	6,401	6,037	6,317	5,871	3,731	3,138	3,350
23	693	591	796	1,620	4.419	6,361	5,822	6,243	5,735	3,780	3,163	3,355
24	735	595	791	1,718	4,170	5,873	5,493	6,150	5,612	3,823	3,213	3,340
25	724	595	791	1,840	3,993	6,397	5,754	6,038	5,600	3,909	3,472	3,345
26	728	670	791	1,898	3,673	6,798	5,597	5,963	5,442	4,075	3,711	3,342
27	762	697	818	1,927	3,389	6,857	5,342	5,951	5,436	4,118	3,824	3,420
28	754	586	931	2,001	3,127	6,870	5,330	5,686	5,442	4,051	3,799	3,425
29	758		888	1,972	2,871	6,885	5,330	5,624	5,467	4,032	3,742	3,420
30	684		931	2,001	2,712	6,918	5,330	5,589	5,436	3,971	3,459	3,390
31	641		1,104		2,712		5,330	5,514		3,971		3,420
1906.												
1	3,440	2,578	2,945	2,703	7,306	5,770	4,780	2,440	1,966	2,636	2,793	3,250
2	3,440	2,516	2,929	2,881	7,158	5,526	4,798	2,406	1,971	2,822	2,741	3,232
3	3,450	2,516	2,914	3,060	7,010	5,206	4,786	2,373	1,976	3,008	2,687	3,213
4	3,445	2,496	2,783	3,117	6,862	5,206	4,675	2,339	1,983	3,194	2,683	3,195
5	3,420	2,476	2,651	3,173	6,714	5,215	4,583	2,306	1,985	3,380	2,679	3,176
6	3,415	2,456	2,520	3,230	5,960	5,105	4,127	2,272	1,990	3,570	2,675	3,158
7	3,410	2,436	2,522	3,287	5,206	5,325	3,831	2,239	1,991	3,467	2,672	3,137
8	3,408	2,416	2,524	3,370	5,004	5,580	3,572	2,205	1,798	3,364	2,710	3,119
9	3,329	2,396	2,526	3,525	4,986	5,813	3,492	2,172	1,795	3,261	2,748	3,023
10	3,250	2,397	2,528	3,690	5,056	5,830	3,948	2,138	1,790	3,158	2,787	2,926
11	3,171	2,511	2,571	3,890	4,668	5,860	3,849	2,105	1,832	3,055	2,779	2,830
12	3,092	2,626	2,614	4,170	4,504	5,804	3,868	2,071	1,830	2,952	2,770	2,733
13	2,935	2,741	2,612	4,780	4,488	5,897	3,480	2,037	1,789	2,849	2,762	2,637
14	2,895	2,856	2,610	5,624	4,398	5,890	3,412	2,000	1,748	2,746	2,753	2,540
15	2,855	2,971	2,608	6,150	4,318	5,579	3,412	1,983	1,747	2,741	2,745	2,443
16	2,815	3,086	2,606	6,245	4,475	5,504	3,412	1,966	1,821	2,566	2,736	2,444
17	2,775	3,301	2,604	6,380	4,632	5,409	3,137	1,949	1,895	2,391	2,727	2,446
18	2,735	3,270	2,620	6,646	4,789	5,308	2,957	1,949	1,969	2,216	2,774	2,447
19	2,695	3,240	2,637	6,880	4,948	5,209	2,945	1,861	2,043	2,041	2,822	2,449
20	2,664	3,209	2,654	7,156	4,861	5,062	3,313	1,773	2,117	1,866	2,869	2,450
21	2,663	3,179	2,646	7,310	4,906	4,915	3,288	1,684	2,191	2,044	2,917	2,451
22	2,662	3,045	2,638	7 525	5,157	4,708	3,381	1,685	2,271	2,222	2,964	2,453
23	2,661	2,911	2,630	7,537	5,290	4,618	3,708	1,718	2,275	2,401	3,012	2,418
24	2,655	2,778	2,622	7,549	5,441	4,673	3,936	1,753	2,300	2,579	3,060	2,382
25	2,650	2,844	2,583	7,561	5,583	4,728	3,689	1,787	2,325	2,757	3,087	2,347

Daily discharge, in second-feet, of Mississippi River above Sandy River, Minn., for 1895–1910—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1906.												
26	2,649	2,910	2,544	7,573	5,726	4,783	3,665	1,822	2,350	2,936	3,114	2,311
27	2,649	2,976	2,505	7,585	5,870	4,838	3,517	1,856	2,375	3,118	3,141	2,276
28	2,648	2,926	2,510	7,571	5,854	4,893	3,204	1,891	2,400	3,050	3,168	2,240
29	2,647	......	2,515	7,497	5,396	4,949	2,310	1,925	2,425	2,982	3,195	2,204
30	2,645	......	2,520	7,454	5,304	5,006	2,479	1,960	2,450	2,914	3,222	2,199
31	2,640	......	2,525	......	5,450	......	2,571	1,961	......	2,845	......	2,194
1907.												
1	2,207	2,197	2,007	2,587	4,303	3,490	2,594	4,062	2,364	1,952	2,348	1,295
2	2,221	2,166	2,009	2,627	3,601	3,404	2,456	4,071	2,246	1,951	2,486	1,273
3	2,234	2,126	2,002	2,667	2,900	3,317	2,317	4,081	2,129	1,950	2,578	1,252
4	2,248	2,086	1,994	2,707	2,197	3,231	2,179	4,045	2,011	1,948	2,671	1,230
5	2,263	2,046	1,987	2,747	2,230	3,144	2,041	4,008	1,894	1,946	2,763	1,208
6	2,308	2,006	1,979	2,787	2,263	3,058	1,902	3,972	1,776	1,949	2,856	1,187
7	2,354	1,966	1,972	2,837	2,296	2,971	2,038	3,925	1,658	1,953	2,948	1,166
8	2,399	1,926	1,964	2,887	2,329	2,882	2,174	3,899	1,673	1,956	3,042	1,132
9	2,445	1,885	1,955	2,937	2,362	2,964	2,311	3,862	1,688	1,960	3,136	1,098
10	2,490	1,865	1,954	2,987	2,395	3,045	2,447	3,825	1,703	1,963	3,126	1,064
11	2,536	1,845	1,954	3,037	2,428	3,127	2,584	3,784	1,719	1,967	3,116	1,030
12	2,581	1,824	1,953	3,087	2,590	3,208	2,722	3,743	1,734	1,971	3,106	996
13	2,577	1,804	1,953	3,137	2,751	3,290	2,860	3,702	1,749	1,998	3,096	962
14	2,573	1,784	1,953	3,187	2,912	3,371	2,842	3,661	1,765	2,025	3,086	927
15	2,569	1,763	1,952	3,237	3,073	3,452	2,824	3,620	1,876	2,052	3,076	927
16	2,565	1,742	1,952	3,287	3,235	3,443	2,805	3,579	1,987	2,080	3,066	926
17	2,561	1,799	1,953	3,337	3,396	3,434	2,787	3,538	2,098	2,107	2,966	926
18	2,556	1,816	1,953	3,387	3,558	3,425	2,768	3,481	2,210	2,134	2,866	926
19	2,551	1,853	1,954	3,437	3,665	3,416	2,749	3,423	2,321	2,162	2,766	925
20	2,527	1,890	1,954	3,487	3,772	3,407	2,729	3,366	2,432	2,176	2,666	925
21	2,502	1,927	1,955	3,754	3,879	3,398	2,889	3,308	2,544	2,190	2,566	924
22	2,477	1,964	1,955	4,021	3,986	3,388	3,050	3,251	2,467	2,204	2,466	897
23	2,452	2,001	1,955	4,287	4,093	3,306	3,210	3,193	2,390	2,218	2,366	869
24	2,427	2,002	2,033	4,554	4,200	3,224	3,371	3,136	2,313	2,232	2,216	842
25	2,402	2,003	2,112	4,820	4,306	3,142	3,531	3,043	2,235	2,246	2,066	814
26	2,377	2,004	2,190	5,087	4,190	3,060	3,692	2,949	2,158	2,260	1,916	784
27	2,347	2,005	2,269	5,354	4,073	2,977	3,853	2,856	2,081	2,250	1,766	754
28	2,317	2,006	2,347	5,204	3,957	2,895	3,903	2,762	2,003	2,240	1,616	722
29	2,287	......	2,426	5,154	3,840	2,812	3,953	2,669	1,978	2,230	1,466	720
30	2,257	......	2,507	5,004	3,724	2,732	4,003	2,575	1,953	2,220	1,316	718
31	2,227	......	2,547	......	3,607	......	4,053	2,481	......	2,210	......	716
1908.												
1	691	597	835	869	2,208	3,501	3,644	2,847	1,822	2,475	1,934	1,053
2	667	597	838	888	2,400	3,501	3,634	2,827	1,842	2,480	1,861	1,054
3	642	596	841	906	2,315	3,501	3,624	2,807	1,862	2,485	1,787	1,055
4	618	596	844	925	2,230	3,501	3,614	2,787	1,884	2,492	1,714	1,056
5	617	596	848	935	2,145	3,501	3,501	2,767	1,904	2,499	1,641	1,057
6	616	595	851	945	2,060	3,501	3,387	2,747	1,909	2,506	1,567	1,035
7	615	595	855	955	1,975	3,601	3,274	2,727	1,914	2,513	1,492	1,013
8	614	595	857	965	1,890	3,701	3,160	2,707	1,919	2,520	1,452	991
9	613	596	859	975	1,805	3,801	3,047	2,557	1,924	2,527	1,412	969
10	612	597	861	985	1,885	3,901	2,934	2,407	1,929	2,534	1,372	947
11	611	598	863	995	1,965	4,001	2,819	2,257	1,934	2,466	1,332	925
12	610	599	865	1,000	2,045	4,101	2,786	2,107	1,939	2,397	1,292	903
13	609	600	867	1,005	2,125	4,201	2,753	1,957	1,949	2,329	1,252	923
14	608	600	870	1,010	2,205	4,181	2,720	1,807	1,959	2,260	1,212	943
15	607	600	864	1,015	2,285	4,161	2,686	1,657	1,969	2,192	1,202	963
16	606	642	858	1,020	2,365	4,141	2,653	1,652	1,979	2,123	1,192	983
17	605	684	852	1,025	2,358	4,121	2,620	1,647	1,989	2,055	1,182	1,003
18	604	726	846	1,030	2,351	4,101	2,586	1,642	1,999	2,058	1,172	1,023
19	603	768	840	1,035	2,344	4,081	2,633	1,637	2,009	2,061	1,162	1,043
20	602	810	834	1,040	2,337	4,060	2,680	1,632	2,072	2,064	1,152	1,028
21	601	853	828	1,045	2,330	4,007	2,727	1,627	2,135	2,067	1,142	1,013
22	600	860	831	1,050	2,323	3,953	2,775	1,622	2,198	2,070	1,132	997
23	600	856	834	1,055	2,316	3,900	2,822	1,642	2,261	2,073	1,122	982
24	600	852	837	1,060	2,485	3,846	2,869	1,662	2,324	2,077	1,112	967
25	600	847	841	1,065	2,654	3,793	2,917	1,682	2,387	2,067	1,102	951
26	600	843	844	1,255	2,823	3,739	2,907	1,702	2,450	2,057	1,092	935
27	600	839	847	1,446	2,992	3,684	2,897	1,722	2,455	2,047	1,082	928
28	598	834	851	1,636	3,161	3,674	2,887	1,742	2,460	2,037	1,072	921
29	598	832	855	1,827	3,330	3,664	2,877	1,762	2,465	2,027	1,062	914
30	598	......	859	2,017	3,500	3,654	2,867	1,782	2,470	2,017	1,052	907
31	597	......	863	......	3,670	......	2,857	1,802	......	2,007	......	900

Daily discharge, in second-feet, of Mississippi River above Sandy River, Minn., for 1895–1910—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	893	887	770	989	1,210	2,241	1,950	1,400	3,500	2,920	2,700	2,200
2	886	864	765	994	1,371	2,227	1,949	1,400	3,200	3,000	2,800	2,100
3	885	841	761	999	1,531	2,213	1,949	1,500	3,000	2,900	2,800	2,100
4	884	818	757	1,016	1,692	2,119	1,900	1,400	2,800	2,840	2,700	2,000
5	883	795	753	1,034	1,853	2,163	1,855	1,200	2,700	2,760	2,700	2,000
6	882	772	748	1,052	2,014	2,113	1,740	1,300	2,580	2,780	2,656	1,991
7	881	779	755	1,069	2,175	2,063	1,580	1,400	2,500	2,720	2,550	1,982
8	880	782	763	1,087	2,337	2,013	1,600	1,500	2,500	2,660	2,450	1,973
9	879	794	770	1,105	2,346	1,960	1,600	1,900	2,520	2,623	2,480	1,964
10	878	801	778	1,124	2,355	1,960	1,622	1,700	2,450	2,500	2,480	1,955
11	876	808	785	1,106	2,364	1,860	1,800	2,100	2,100	2,380	2,490	1,943
12	874	816	793	1,087	2,373	1,823	1,900	2,700	2,100	2,280	2,500	1,943
13	872	824	800	1,069	2,382	1,821	1,700	2,800	2,100	2,350	2,480	1,943
14	869	822	812	1,050	2,391	1,819	1,700	3,000	2,100	2,220	2,500	1,943
15	867	819	824	1,031	2,399	1,817	1,850	3,400	2,100	2,075	2,500	1,943
16	862	817	836	1,013	2,376	1,815	1,700	3,670	2,000	2,075	2,800	1,943
17	882	814	848	992	2,353	1,813	1,610	3,870	2,000	2,100	2,800	1,942
18	902	812	860	1,013	2,330	1,811	1,700	3,980	1,900	2,200	2,700	1,942
19	922	808	872	1,034	2,304	1,810	1,700	4,150	1,850	2,300	2,800	1,891
20	942	804	884	1,055	2,281	1,852	1,900	4,380	1,800	2,400	2,600	1,840
21	962	801	894	1,076	2,258	1,894	2,000	4,550	1,700	2,450	2,500	1,789
22	982	797	904	1,097	2,237	1,936	2,100	4,590	1,900	2,480	2,500	1,738
23	1,003	794	914	1,118	2,241	1,978	2,200	4,650	2,100	2,400	2,500	1,687
24	990	790	924	1,139	2,245	2,020	2,300	4,800	2,250	2,500	2,500	1,646
25	976	786	934	1,140	2,249	2,062	2,400	5,000	2,300	2,600	2,500	1,459
26	963	782	944	1,135	2,253	2,063	2,100	4,800	2,450	2,590	2,500	1,450
27	949	778	954	1,130	2,257	2,063	1,710	4,700	2,500	2,650	2,500	1,441
28	936	774	964	1,145	2,261	2,040	1,700	4,500	2,500	2,731	2,500	1,431
29	922	......	970	1,130	2,261	2,000	1,580	4,200	2,600	2,750	2,500	1,422
30	907	......	980	1,200	2,260	1,950	1,400	4,000	2,750	2,780	2,500	1,413
31	910	......	985	......	2,255	......	1,310	3,800	......	2,800	......	1,403
1910.												
1	1,393	1,125	1,363	2,485	2,876	2,107	2,131	2,328	2,792	2,354	2,381	663
2	1,348	1,126	1,351	2,485	2,843	2,085	2,137	2,367	2,834	2,304	2,194	663
3	1,303	1,127	1,339	2,499	2,810	2,063	2,144	2,405	2,876	2,255	2,007	664
4	1,258	1,128	1,327	2,513	2,777	2,040	2,151	2,444	2,918	2,205	1,810	665
5	1,213	1,129	1,314	2,527	2,744	2,063	2,159	2,482	2,960	2,156	1,623	667
6	1,168	1,166	1,363	2,541	2,711	2,086	2,166	2,521	3,002	2,106	1,440	667
7	1,123	1,203	1,412	2,555	2,710	2,110	2,173	2,559	2,965	2,056	1,349	668
8	1,112	1,240	1,461	2,569	2,615	2,133	2,181	2,598	2,928	2,006	1,257	669
9	1,107	1,277	1,510	2,574	2,520	2,156	2,189	2,636	2,891	1,955	1,229	669
10	1,102	1,314	1,559	2,479	2,425	2,180	2,186	2,676	2,854	1,905	1,220	672
11	1,097	1,351	1,608	2,384	2,330	2,204	2,183	2,716	2,817	1,871	1,171	672
12	1,092	1,353	1,613	2,289	2,235	2,194	2,180	2,756	2,779	1,832	1,143	680
13	1,087	1,352	1,697	2,194	2,140	2,180	2,177	2,796	2,728	1,793	1,115	670
14	1,082	1,352	1,781	2,099	2,137	2,165	2,174	2,835	2,676	1,754	1,087	670
15	1,081	1,352	1,865	2,004	2,211	2,151	2,170	2,834	2,625	1,715	1,058	678
16	1,079	1,352	1,949	2,000	2,285	2,137	2,167	2,832	2,573	1,676	1,030	680
17	1,077	1,352	2,033	2,188	2,359	2,122	2,164	2,831	2,521	1,636	1,002	682
18	1,075	1,352	2,117	2,376	2,433	2,107	2,160	2,829	2,468	1,567	974	684
19	1,073	1,352	2,118	2,564	2,507	2,106	2,157	2,828	2,416	1,498	946	684
20	1,071	1,355	2,396	2,752	2,581	2,105	2,153	2,826	2,415	1,429	918	686
21	1,069	1,355	2,674	2,940	2,584	2,104	2,150	2,824	2,414	1,359	890	688
22	1,068	1,360	2,952	3,128	2,529	2,103	2,147	2,816	2,413	1,290	861	690
23	1,076	1,360	3,230	3,132	2,473	2,102	2,144	2,808	2,412	1,220	832	692
24	1,084	1,365	3,508	3,095	2,418	2,101	2,163	2,800	2,411	1,370	804	693
25	1,092	1,365	3,786	3,058	2,362	2,101	2,183	2,792	2,410	1,420	776	687
26	1,100	1,368	3,787	3,021	2,307	2,106	2,203	2,784	2,409	2,076	747	681
27	1,108	1,370	3,570	2,984	2,251	2,111	2,223	2,776	2,408	2,426	718	675
28	1,116	1,375	3,353	2,947	2,195	2,116	2,243	2,768	2,407	2,506	700	669
29	1,117	......	3,136	2,910	2,170	2,121	2,263	2,760	2,405	2,576	681	663
30	1,120	......	2,919	2,909	2,145	2,126	2,283	2,752	2,403	2,500	662	657
31	1,125	......	2,702	......	2,120	......	2,290	2,750	......	2,568	......	651

Monthly discharge of Mississippi River above Sandy River, Minn., for 1895–1910.

[Drainage area, 4,510 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in millions of cubic feet.
1895.						
September	2,286	2,192	2,209	0.490	0.55	5,730
October	2,429	1,870	2,148	.476	.55	5,750
November	2,258	1,251	1,849	.410	.46	4,790
December	1,216	477	751	.167	.19	2,000
1896.						
January	530	380	452	.100	.12	1,210
February	460	115	323	.072	.08	809
March	541	165	311	.069	.08	833
April	4,645	516	2,003	.444	.50	5,190
May						
June (6–30)	3,840	1,814	2,431	.539	.50	5,040
July	2,210	1,170	1,613	.358	.41	4,320
August	2,575	1,687	2,288	.507	.58	6,130
September	2,450	1,965	2,246	.498	.56	5,820
October	3,085	2,059	2,641	.586	.68	7,070
November	3,245	1,100	1,919	.425	.47	4,970
December	1,138	799	900	.200	.23	2,410
1897.						
January	1,010	580	783	.174	.20	2,100
February	900	651	740	.164	.18	1,790
March	1,069	616	743	.165	.19	1,990
April	5,843	1,417	3,770	.836	.93	9,770
May	3,857	1,838	2,866	.635	.73	7,680
June	3,873	2,308	3,209	.712	.79	8,320
July	7,789	2,999	6,101	1.35	1.56	16,300
August	4,685	2,010	3,088	.685	.79	8,270
September	2,961	2,174	2,722	.604	.67	7,060
October	3,127	2,007	2,579	.572	.66	6,910
November						
December	2,971	1,339	2,167	.480	.55	5,800
1898.						
January	1,716	1,291	1,420	.315	.36	3,800
February	1,379	1,207	1,290	.286	.30	3,120
March	1,594	1,238	1,387	.308	.36	3,710
April	2,193	1,146	1,490	.330	.37	3,860
May	2,593	1,514	2,041	.453	.52	5,470
June	4,633	2,344	3,867	.857	.96	10,000
July	4,396	3,423	3,847	.853	.98	10,300
August	3,278	2,394	2,806	.622	.72	7,510
September	3,672	3,047	3,347	.742	.83	8,680
October	3,038	2,846	2,936	.651	.75	7,860
November	3,797	1,821	3,318	.736	.82	8,600
December	2,042	900	1,541	.342	.39	4,130
The year	4,633	900	2,441	.541	7.36	77,000
1899.						
January	1,378	1,261	1,301	.288	.33	3,480
February	1,256	960	1,104	.245	.26	2,670
March	1,612	1,022	1,158	.257	.30	3,100
April	2,314	1,297	1,615	.358	.40	4,190
May	5,907	4,299	5,034	1.12	1.29	13,500
June	8,161	7,705	8,044	1.78	1.99	20,800
July	6,446	2,440	4,093	.908	1.05	11,000
August	5,432	2,697	3,744	.830	.96	10,000
September	4,912	3,954	4,308	.955	1.07	11,200
October	7,629	2,983	4,659	1.03	1.19	12,500
November	4,722	3,578	4,116	.913	1.02	10,700
December	2,764	1,187	2,163	.480	.55	5,790
The year	8,161	960	3,445	.764	10.41	109,000

Monthly discharge of Mississippi River above Sandy River, Minn., for 1895–1910—Contd.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in millions of cubic feet.
1900.						
January	2,062	1,596	1,781	0.395	0.46	4,770
February	1,672	1,335	1,492	.331	.34	3,610
March	1,476	1,276	1,377	.305	.35	3,690
April	2,917	1,385	2,153	.477	.53	5,580
May	2,176	773	1,752	.389	.45	4,690
June	2,084	1,087	1,396	.310	.35	3,620
July	1,871	549	1,279	.284	.33	3,430
August	3,716	549	2,276	.505	.58	6,100
September	9,572	3,069	6,400	1.42	1.58	16,600
October	5,792	2,502	4,192	.929	1.07	11,200
November	2,653	932	2,205	.489	.55	5,720
December	852	574	698	.155	.18	1,870
The year	9,572	549	2,250	.499	6.77	70,900
1901.						
January	650	510	597	.132	.15	1,600
February	1,620	753	1,117	.248	.26	2,700
March	2,334	1,228	1,747	.387	.45	4,680
April	6,220	2,053	4,129	.916	1.02	10,700
May	6,486	3,797	5,236	1.16	1.34	14,000
June	8,823	3,437	5,131	1.14	1.27	13,300
July	6,950	2,412	4,705	1.04	1.20	12,600
August	4,028	2,143	2,803	.622	.72	7,510
September	3,346	2,550	2,843	.630	.70	7,370
October	3,651	2,648	3,345	.742	.86	8,960
November	3,789	3,453	3,601	.798	.89	9,330
December	2,334	1,595	1,869	.414	.48	5,010
The year	8,823	510	3,094	.686	9.34	97,800
1902.						
January	1,656	1,314	1,477	.327	.38	3,960
February	1,492	1,107	1,248	.278	.29	3,020
March	2,458	1,396	1,787	.396	.46	4,790
April	3,192	1,334	2,165	.480	.54	5,610
May	6,293	1,962	3,772	.836	.96	10,100
June	4,541	2,009	3,755	.833	.93	9,730
July	2,684	1,024	2,048	.454	.52	5,480
August	2,831	1,386	1,674	.371	.43	4,480
September	2,705	2,102	2,399	.532	.59	6,220
October	2,819	2,042	2,375	.527	.61	6,360
November	7,076	3,110	6,135	1.36	1.52	15,900
December	3,309	1,573	2,464	.546	.63	6,600
The year	7,076	1,024	2,608	.578	7.86	82,200
1903.						
January	1,880	1,158	1,460	.324	.37	3,910
February	1,162	964	1,076	.238	.25	2,600
March	1,232	803	1,028	.228	.26	2,750
April	4,750	1,145	3,136	.695	.78	8,130
May	4,266	2,649	3,568	.792	.91	9,560
June	2,889	1,124	1,879	.416	.46	4,870
July	2,656	1,457	1,816	.403	.46	4,860
August	1,961	1,121	1,507	.334	.39	4,040
September	3,829	1,564	2,733	.606	.68	7,080
October	5,041	1,741	3,737	.829	.96	10,000
November	2,464	686	1,455	.323	.36	3,770
December	796	641	763	.169	.19	2,040
The year	5,041	641	2,013	.446	6.07	63,600
1904.						
January	776	593	700	.155	.18	1,870
February	698	536	616	.137	.15	1,540
March	779	583	653	.145	.17	1,750
April	3,754	818	2,516	.558	.62	6,520
May	3,491	2,287	3,056	.678	.78	8,180
June	2,809	1,701	2,135	.473	.53	5,530
July	2,181	1,317	1,738	.385	.44	4,650
August	2,315	1,588	1,861	.413	.48	4,980
September	2,195	1,486	1,855	.411	.46	4,810
October	3,030	1,780	2,289	.508	.59	6,130
November	2,242	948	1,614	.358	.40	4,180
December	875	647	794	.176	.20	2,130
The year	3,754	536	1,652	.366	5.00	52,300

Monthly discharge of Mississippi River above Sandy River, Minn., for 1895–1910—Contd.

Month.	Discharge in second-feet. Maximum.	Minimum.	Mean.	Per square mile.	Run-off. Depth in inches on drainage area.	Total in millions of cubic feet.
1905.						
January	873	523	723	0.160	0.19	1,940
February	721	565	637	.141	.15	1,540
March	1,104	512	752	.167	.19	2,010
April	2,608	1,570	2,137	.474	.53	5,540
May	4,660	1,398	3,409	.756	.87	9,130
June	6,918	3,535	5,085	1.13	1.26	13,200
July	8,278	5,330	6,759	1.50	1.73	18,100
August	8,299	5,460	6,761	1.50	1.73	18,100
September	6,176	5,436	5,859	1.30	1.45	15,200
October	5,331	3,004	3,975	.881	1.02	10,600
November	3,824	2,911	3,248	.720	.80	8,420
December	3,480	3,340	3,422	.759	.88	9,160
The year	8,299	512	3,564	.790	10.80	113,000
1906.						
January	3,450	2,640	2,961	.657	.76	7,930
February	3,301	2,396	2,788	.618	.64	6,740
March	2,945	2,505	2,620	.581	.67	7,020
April	7,585	2,703	5,504	1.22	1.36	14,300
May	7,306	4,318	5,397	1.20	1.38	14,500
June	5,897	4,618	5,274	1.17	1.30	13,700
July	4,798	2,310	3,617	.802	.92	9,690
August	2,440	1,684	2,020	.448	.52	5,410
September	2,450	1,747	2,046	.454	.51	5,300
October	3,570	1,866	2,810	.623	.72	7,530
November	3,222	2,672	2,860	.634	.71	7,410
December	3,250	2,194	2,655	.589	.68	7,110
The year	7,585	1,684	3,379	.749	10.17	107,000
1907.						
January	2,581	2,207	2,381	.528	.61	6,380
February	2,197	1,742	1,939	.430	.45	4,690
March	2,547	1,952	2,053	.455	.52	5,500
April	5,354	2,587	3,584	.795	.89	9,290
May	4,306	2,197	3,294	.730	.84	8,820
June	3,490	2,732	3,200	.710	.79	8,290
July	4,053	1,902	2,891	.641	.74	7,740
August	4,081	2,481	3,479	.771	.89	9,320
September	2,544	1,658	2,038	.452	.50	5,280
October	2,260	1,946	2,087	.463	.53	5,590
November	3,136	1,316	2,584	.573	.64	6,700
December	1,295	716	972	.287	.33	2,600
The year	5,354	716	2,542	.564	7.73	80,200
1908.						
January	691	597	611	.135	.16	1,640
February	860	595	696	.154	.17	1,740
March	870	828	849	.188	.22	2,270
April	2,017	869	1,099	.244	.27	2,850
May	3,670	1,805	2,415	.535	.60	6,470
June	4,201	3,501	3,835	.850	.95	9,940
July	3,644	2,586	2,972	.659	.76	7,960
August	2,847	1,622	2,062	.457	.53	5,520
September	2,470	1,822	2,077	.461	.51	5,380
October	2,534	2,007	2,245	.498	.57	6,010
November	1,934	1,052	1,311	.291	.32	3,400
December	1,057	900	980	.217	.25	2,620
The year	4,201	595	1,763	.391	5.33	55,800
1909.						
January	1,003	862	909	.202	.23	2,430
February	887	772	806	.179	.19	1,950
March	985	748	841	.186	.21	2,250
April	1,200	989	1,074	.238	.27	2,780
May	2,399	1,210	2,168	.481	.55	5,810
June	2,241	1,810	1,977	.438	.49	5,120
July	2,400	1,310	1,810	.401	.46	4,850
August	5,000	1,200	3,172	.703	.81	8,490
September	3,500	1,700	2,362	.524	.58	6,120
October	3,000	2,075	2,543	.564	.65	6,810
November	2,800	2,450	2,583	.573	.64	6,700
December	2,200	1,403	1,820	.404	.47	4,870
The year	5,000	748	1,839	.408	5.55	58,200

Monthly discharge of Mississippi River above Sandy River, Minn., for 1895–1910—Contd.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in millions of cubic feet.
1910.						
January	1,393	1,068	1,129	0.250	0.29	3,020
February	1,375	1,125	1,295	.287	.30	3,130
March	3,787	1,314	2,219	.492	.57	5,940
April	3,132	2,000	2,607	.578	.64	6,760
May	2,876	2,120	2,445	.542	.62	6,550
June	2,204	2,040	2,119	.470	.52	5,490
July	2,290	2,131	2,180	.483	.56	5,840
August	2,835	2,328	2,701	.599	.69	7,230
September	3,002	2,403	2,638	.585	.65	6,840
October	2,576	1,220	1,915	.425	.49	5,130
November	2,381	662	1,154	.256	.29	2,990
December	693	651	674	.149	.17	1,800
The year	3,787	651	1,923	.426	5.79	60,700

MISSISSIPPI RIVER NEAR FORT RIPLEY, MINN.

This station, which is located at the highway bridge 1 mile north of Fort Ripley, was established June 25, 1909, to obtain data for use in determining the power available on the upper Mississippi.

The nearest tributary, Nokasippi River, enters the main stream a short distance below the bridge. The nearest dams are at Little Falls below and at Brainerd above Fort Ripley.

The flow at Fort Ripley, as at all stations on the upper Mississippi, is controlled by the Government dams on the headwaters for the purpose of increasing the low-water open flow for navigation.

During the open-water season the river is used extensively for driving logs which are likely to form jams on the rapids a few hundred feet below the bridge and cause temporary backwater at the gage. This effect became so pronounced during 1910 that the station was discontinued September 30. Ice is present and observations at this station are discontinued from December to March.

Discharge measurements are made from the bridge to which the staff gage is attached. A gage belonging to the United States Weather Bureau is also fastened to the pier that holds the Geological Survey gage. The datum of the Weather Bureau gage is 1.40 feet higher than that of the survey gage. The datum of the staff gage has remained unchanged since the station was established.

Owing to the changeable conditions of flow no estimates of daily discharge have been made and only the base data are published herewith.

Discharge measurements of Mississippi River near Fort Ripley, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 23	G. A. Gray	363	2,410	7.66	8,700
May 20	....do	352	1,870	6.21	4,930
July 23	Robert Follansbee	....	1,550	[a] 5.45	2,530

[a] Backwater from log jam.

Daily gage height, in feet, of Mississippi River near Fort Ripley, Minn., for 1910.

[Observer, L. A. White.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	....	6.78	6.66	6.18	5.34	5.06	5.75
2	....	6.64	6.66	6.08	5.22	5.35	5.75
3	....	6.52	6.59	6.04	5.12	5.35	5.81
4	....	6.61	6.51	6.05	4.98	5.34	5.76
5	....	7.41	6.50	6.04	5.04	5.32	5.78
6	....	6.82	6.48	6.04	5.26	5.30	5.90
7	....	6.95	6.48	6.04	5.15	5.25	5.86
8	....	6.98	6.38	5.90	5.22	5.22	5.85
9	....	6.92	6.38	5.78	5.28	5.45	5.84
10	....	6.79	6.38	5.72	5.24	5.44	5.84
11	....	6.78	6.30	5.72	5.18	5.44	5.78
12	....	6.76	6.18	5.66	5.48	5.49	5.72
13	....	6.65	6.14	5.62	5.42	5.56	5.91
14	....	6.50	6.08	5.70	5.46	5.55	5.92
15	8.12	6.56	6.05	5.62	5.38	5.52	5.85
16	8.92	6.61	6.05	5.70	5.41	5.78	5.98
17	8.26	6.70	6.15	5.79	5.35	5.72	5.94
18	7.76	6.85	6.11	5.86	5.22	5.69	5.89
19	7.96	7.11	6.10	5.85	5.51	5.72	5.70
20	7.45	7.21	6.11	5.75	5.45	5.69	5.68
21	7.52	7.25	6.15	5.88	5.42	5.62	5.59
22	7.64	7.31	6.08	5.54	5.42	5.58	5.55
23	7.66	7.31	6.12	5.28	5.38	5.79	5.51
24	7.65	7.40	6.24	5.18	5.46	5.72	5.50
25	7.65	7.30	6.25	5.18	5.41	5.69	5.45
26	7.65	7.15	6.25	5.15	5.50	5.65	5.52
27	7.61	7.09	6.28	5.18	5.04	5.68	5.94
28	7.60	6.99	6.29	5.41	5.01	5.62	6.02
29	7.48	6.88	6.22	5.36	5.00	5.54	5.98
30	7.24	6.76	6.22	5.34	5.08	5.81	6.02
31	6.96	....	6.28	....	5.04	5.81	....

NOTE.—Gage heights were seriously affected by log jams below the station.

MISSISSIPPI RIVER AT ANOKA, MINN.

This station, which is located at the highway bridge connecting Anoka with Champlin, Minn., was established May 8, 1905, to obtain data for use in studies of power, sewage disposal and navigation problems. The station was temporarily discontinued from July 20 to August 10, 1906.

Rum River enters a short distance below the station.

The nearest dam is at Minneapolis, but owing to the intervening fall of the river the influence of the dam does not extend to the Anoka station. The first dam above Anoka is at St. Cloud. The flow of the river is controlled by Government dams on the upper river for the purpose of increasing the low-water open-season flow in the interest of navigation.

Although the river is used extensively for log driving, there is very little backwater except that caused for a few days by log jams forming below the station. The river is frozen and observations are discontinued from December to March, inclusive.

The winter flow at this station can be estimated very closely from the records of Mississippi River at Minneapolis as kept by the St. Anthony Falls Water Power Co. by rating the spillway as a weir and noting the amount of water passing the wheels. From these records a quantity, depending on the year, has been subtracted to allow for the flow of Rum River and a few other small streams which enter the Mississippi between the Anoka station and Minneapolis.

The original United States Geological Survey staff gage was set to read the same as the United States Engineer Corps gage placed on the same pier in 1896. This latter gage was read for one year, during which time frequent discharge measurements were made. The staff has since been replaced by a chain gage attached to the bridge. The gage datum is the same as that used by the engineers of the Army corps in 1896 and 1897, and has not been changed since the station was established.

Discharge measurements are made from the highway bridge. Although no measurements were made during 1907 and 1908; those made in 1909 and 1910 indicate no change in the rating curve as developed in 1897, 1905, and 1906, and it can therefore be applied to all gage heights since the station was established.[1] This permanence of condition indicates that the records of flow are reliable.

The daily discharges and monthly estimates for all years prior to 1910, inclusive, have been published in "Report of water resources investigation of Minnesota during 1909–10," by the State Drainage Commission, St. Paul, Minn.

Discharge measurements of Mississippi River at Anoka, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 14	G. A. Gray	724	3,160	0.81	5,910
Aug. 13	Robert Follansbee	683	2,360	-.36	3,470

[1] Gage heights for 1905 to 1908 have been published in Water-Supply Papers 171, p. 53; 207, p. 44; and 245, pp. 71 and 72.

Daily gage height, in feet, of Mississippi River at Anoka, Minn., for 1897.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	7.12	3.50	1.17	2.60	4.20	0.90	16	5.97	1.82	1.84	6.24	1.52	......
2	8.22	......	1.37	2.68	4.12	.88	17	5.74	1.98	1.92	5.96	1.53	......
3	8.36	3.23	1.47	2.84	4.03	.90	18	5.45	1.95	2.11	5.52	1.48	......
4	9.08	3.04	1.70	4.10	3.90	.92	19	5.25	1.92	2.27	5.20	1.44	......
5	9.66	2.88	1.76	4.80	3.72	1.16	20	5.15	2.00	2.48	5.00	1.40	......
6	9.30	2.70	1.96	5.14	3.48	1.21	21	5.02	1.82	2.60	4.92	1.36	......
7	8.80	2.50	1.70	7.34	3.48	1.18	22	4.84	1.70	2.69	4.80	1.40	......
8	8.31	2.36	1.82	8.26	3.37	1.15	23	......	1.62	2.51	4.70	1.38	......
9	7.94	2.18	1.70	8.38	3.14	1.12	24	4.59	1.48	2.41	4.70	1.36	......
10	7.55	2.06	1.70	8.50	2.81	1.10	25	4.40	1.42	2.28	5.14	1.35	......
11	7.30	2.02	1.70	8.22	2.42	......	26	4.20	1.30	2.12	5.08	1.31	......
12	6.98	1.96	1.66	7.77	2.26	......	27	4.00	1.39	2.00	......	1.20	......
13	6.67	1.98	1.82	7.42	1.98	......	28	3.86	1.30	2.26	4.60	1.09	......
14	......	1.96	1.80	6.92	1.72	......	29	3.75	1.30	2.36	4.41	1.10	......
15	6.12	1.86	1.81	6.60	1.68	......	30	3.52	1.32	2.47	4.39	1.12	......
							31	......	1.31	......	4.34	.93	......

NOTE.—Gage heights are taken from unpublished records in the United States Engineer Office at St. Paul.

Daily gage height, in feet, of Mississippi River at Anoka, Minn., for 1910.

[B. J. Witte, jr., observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	1.77	1.05	0.53	0.02	-0.45	-0.30	-0.21	-0.36
2	....	1.65	1.07	.60	.05	-.50	-.30	-.18	-.30
3	....	1.40	.95	.57	-.10	-.35	-.30	-.10	-.15
4	....	1.47	.87	.69	....	-.48	-.30	.08	-.08
5	....	1.30	.85	.75	....	-.40	-.30	.05	-.15
6	....	1.33	.91	.60	-.35	-.41	-.30	.10	-.18
7	....	1.45	.87	.39	-.18	-.32	-.30	.08	-.25
8	....	1.40	.84	.41	-.12	-.50	-.30	.03	-.17
9	....	1.27	.88	.44	.18	-.50	-.30	.02	-.28
10	....	1.23	.84	.45	.30	-.52	-.30	-.18	-.25
11	....	1.30	.65	.25	.52	-.42	-.30	.00	-.35
12	....	1.23	.74	.13	.52	-.45	-.30	-.12	-.60
13	....	1.21	.78	.20	.60	-.42	-.30	-.10	-.40
14	1.25	1.23	.81	.11	.48	-.26	-.30	-.18	-.52
15	2.07	.99	.60	.03	-.26	-.32	-.30	-.28	-.65
16	2.25	.90	.59	.07	-.32	-.28	-.35	-.36	-.58
17	2.27	1.05	.80	.04	-.50	-.32	-.20	-.42	-.80
18	2.89	1.10	.68	-.01	-.40	-.26	-.15	-.30	-.85
19	2.87	1.25	.58	-.06	-.48	-.26	-.22	-.40	-.75
20	3.23	1.37	.62	-.10	-.48	-.32	-.16	-.50	....
21	3.29	1.50	.65	-.09	-.40	-.23	-.25	-.48	-.80
22	3.09	1.55	.65	-.27	-.38	-.35	-.32	-.52	-.85
23	2.90	1.55	.85	-.07	-.39	-.29	-.34	-.52	-.44
24	2.35	1.50	.65	-.10	-.52	-.37	-.34	-.55	-.72
25	2.53	1.56	.57	-.15	-.50	-.25	-.45	-.55	-.80
26	2.51	1.67	.77	-.10	-.61	-.25	-.35	-.50	-.72
27	2.45	1.47	.69	-.06	-.52	-.34	-.38	-.52	-.65
28	2.35	1.40	.69	-.17	-.54	-.22	-.38	-.66	-.62
29	2.15	1.29	.64	-.29	-.35	-.30	-.22	-.70	-.60
30	2.17	1.21	.57	.01	-.48	-.34	-.10	-.66	-.60
31	1.95	....	.60	....	-.50	-.32	....	-.58	....

NOTE.—Ice present from Jan. 1 to Mar. 13 and from Dec. 1 to 31. Gage heights for Nov. 14 to 30 were affected by backwater.

Daily discharge, in second-feet, of Mississippi River at Anoka, Minn., for 1897 and 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1897.[a]												
1	3,700	2,780	2,880	35,500	17,400	7,310	13,200	20,700	6,340	......	......	......
2	3,740	2,800	2,790	41,300	16,800	8,090	13,600	20,300	6,280	......	......	......
3	3,700	2,820	2,710	42,000	16,100	8,490	14,300	19,900	6,340	......	......	......
4	3,600	2,840	2,780	45,900	15,200	9,430	20,200	19,300	6,410	......	......	......
5	3,500	2,850	2,740	49,100	14,500	9,680	23,600	18,400	7,270	......	......	......
6	3,450	2,700	2,700	47,100	13,700	10,500	25,300	17,300	7,460	......	......	......
7	3,420	2,600	2,720	44,400	12,800	9,430	36,700	17,300	7,340	......	......	......
8	3,390	2,450	2,740	41,800	12,200	9,920	41,500	16,700	7,230	......	......	......
9	2,930	2,300	2,750	39,800	11,400	9,430	42,200	15,700	7,120	......	......	......
10	2,830	2,600	2,740	37,800	10,900	9,430	42,800	14,200	7,040	......	......	......
11	2,720	2,800	2,720	36,500	10,800	9,430	41,300	12,500	......	......	......	......
12	2,620	3,010	2,540	34,800	10,500	9,270	38,900	11,800	......	......	......	......
13	2,790	2,950	2,560	33,200	10,600	9,920	37,100	10,600	......	......	......	......
14	2,810	2,900	2,580	3,180	10,500	9,840	34,500	9,510	......	......	......	......
15	2,830	2,840	2,610	30,300	10,100	9,880	32,800	9,350	......	......	......	......
16	2,650	2,790	2,650	29,500	9,920	10,000	30,900	8,690	......	......	......	......
17	2,610	2,750	2,650	28,400	10,600	10,300	29,500	8,730	......	......	......	......
18	2,570	2,710	2,650	26,900	10,500	11,100	27,300	8,530	......	......	......	......
19	2,530	2,800	3,040	25,900	10,300	11,800	25,600	8,370	......	......	......	......
20	2,490	2,890	3,440	25,400	10,700	12,700	24,600	8,210	......	......	......	......
21	2,550	2,670	3,850	24,700	9,920	13,200	24,200	8,050	......	......	......	......
22	2,610	2,450	4,260	23,800	9,430	13,600	23,600	8,210	......	......	......	......
23	2,670	2,230	4,670	23,200	9,100	12,800	23,200	8,130	......	......	......	......
24	2,700	2,470	4,090	22,600	8,530	12,400	23,200	8,050	......	......	......	......
25	2,720	2,720	5,520	21,700	8,290	11,900	25,300	8,010	......	......	......	......
26	2,730	2,740	6,210	20,700	7,810	11,200	25,000	7,850	......	......	......	......
27	2,810	2,760	6,900	19,700	8,170	10,700	23,800	7,420	......	......	......	......
28	2,900	2,820	12,600	19,100	7,810	11,800	22,700	7,000	......	......	......	......
29	2,980	......	18,300	18,500	7,810	12,200	21,700	7,040	......	......	......	......
30	2,900	......	24,000	17,400	7,890	12,700	21,600	7,120	......	......	......	......
31	2,840	......	29,700	......	7,850	......	21,400	6,440	......	......	......	......
1910.[b]												
1	......	......	3,800	9,720	6,860	5,280	4,130	3,220	3,490	3,660	3,380	......
2	......	......	3,800	9,220	6,930	5,450	4,190	3,140	3,490	3,720	3,490	......
3	......	......	3,900	8,210	6,510	5,380	3,880	3,400	3,490	3,880	3,780	......
4	......	......	3,900	8,490	6,240	5,690	3,720	3,170	3,490	4,250	3,920	......
5	......	......	4,000	7,810	6,180	5,870	3,560	3,310	3,490	4,190	3,780	......
6	......	......	4,000	7,930	6,370	5,450	3,400	3,290	3,490	4,300	3,720	......
7	......	......	4,200	8,410	6,240	4,940	3,720	3,450	3,490	4,250	3,580	......
8	......	......	4,200	8,210	6,150	4,980	3,840	3,140	3,490	4,150	3,740	......
9	......	......	4,500	7,690	6,280	5,000	4,470	3,140	3,490	4,130	3,530	......
10	......	......	4,500	7,540	6,150	5,080	4,730	3,110	3,490	3,720	3,580	......
11	......	......	5,000	7,810	5,580	4,620	5,250	3 280	3 490	4,080	3,400	......
12	......	......	5,000	7,540	5,840	4,360	5,250	3,220	3,490	3,840	2,980	......
13	......	......	6,000	7,460	5,960	4,510	5,450	3,280	3,490	3,880	3,310	......
14	......	......	7,620	7,540	6,050	4,320	5,150	3,570	3,490	3,720	3,000	......
15	......	......	11,000	6,650	5,450	4,150	3,570	3,450	3,490	3,530	2,900	......
16	......	......	11,700	6,340	5,420	4,230	3,450	3,530	3,400	3,380	2,800	......
17	......	......	11,800	6,860	6,020	4,170	3,140	3,450	3,680	3,280	2,700	......
18	......	......	14,500	7,040	5,670	4,060	3,310	3,570	3,780	3,490	2,600	......
19	......	......	14,400	7,620	5,400	3,960	3,170	3,570	3,640	3,310	2,500	......
20	......	......	16,100	8,090	5,500	3,880	3,170	3,450	3,760	3,140	2,300	......
21	......	......	16,400	8,610	5,580	3,900	3,310	3,620	3,580	3,170	2,250	......
22	......	......	15,400	8,820	5,580	3,550	3,350	3,400	3,450	3,110	2,250	......
23	......	......	14,600	8,820	6,180	3,940	3,330	3,510	3,420	3,110	2,250	......
24	......	......	12,200	8,610	5,580	3,880	3,110	3,360	3,420	3,060	2,250	......
25	......	......	12,900	8,860	5,380	3,780	3,140	3,580	3,220	3,060	2,250	......
26	......	......	12,800	9,310	5,930	3,880	2,960	3,580	3,400	3,140	2,250	......
27	......	......	12,600	8,490	5,690	3,960	3,110	3,420	3,350	3,110	2,250	......
28	......	......	12,200	8,210	5,690	3,740	3,080	3,640	3,350	2,890	2,250	......
29	......	......	11,300	7,770	5,560	3,510	3,400	3,490	3,640	2,830	2,200	......
30	......	......	11,400	7,460	5,380	4,110	3,170	3,420	3,880	2,890	2,200	......
31	......	......	10,500	......	5,450	......	3,140	3,450	......	3,010	......	......

[a] Daily discharges computed on a rating curve that is well defined below 25,000 second-feet. Daily discharge from Jan. 1 to Mar. 31 based directly on frequent discharge measurements.

[b] Daily discharges for 1910 based on a well-defined rating curve. November 14 to 30 estimated by comparison with other stations.

Monthly discharge of Mississippi River at Anoka, Minn., for 1897 and 1910.

[Drainage area, 17,100 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1897.						
January	3,740	2,490	2,940	0.172	0.20	
February	3,010	2,230	2,720	.159	.17	
March	29,700	2,540	5,650	.330	.38	
April	49,100	17,400	31,300	1.83	2.04	
May	17,400	7,810	10,900	.637	.73	
June	13,600	7,310	10,600	.620	.69	
July	42,800	13,200	27,500	1.61	1.86	
August	20,700	6,440	11,600	.678	.78	
Sept. 1-10	4,760	6,280	6,880	.402	.15	
1910.						
January			[a] 3,980	.233	.27	C.
February			[a] 3,800	.222	.23	C.
March	16,400		9,230	.540	.62	C.
April	9,720	6,340	8,040	.470	.52	A.
May	6,930	5,380	5,900	.345	.40	A.
June	5,870	3,510	4,460	.261	.29	A.
July	5,450	2,960	3,730	.218	.25	A.
August	3,640	3,110	3,390	.198	.23	A.
September	3,880	3,220	3,510	.205	.23	A.
October	4,300	2,830	3,320	.206	.24	A.
November	3,920	2,200	2,913	.170	.19	A.
December			[b] 1,930	.113	.13	C.
The year	16,400		4,530	.265	3.60	

[a] Estimated from records kept by the St. Anthony Falls Water Power Co., at Minneapolis.
[b] Estimated from United States engineer records at Lock and Dam 2, below Minneapolis.

MISSISSIPPI RIVER AT ST. PAUL, MINN.

This station is located at the upper end of the Diamond Jo Line wharf, at the foot of Jackson Street, St. Paul. At the lower end of the same dock is the United States Engineer Corps gage, the datum of which is 0.5 foot higher than that of the Weather Bureau gage. All data in the following records are referred to the Weather Bureau gage.

The nearest important tributary, Minnesota River, enters several miles above the gaging station.

The flow of the river is controlled to a certain extent by the Government reservoirs on the headwaters, but the effect of these reservoirs is felt very gradually at St. Paul. The nearest dam is at Minneapolis and it is possible that the operation of the wheel gates at that point may cause some daily fluctuations of stage at St. Paul. The Weather Bureau gage is read once a day. The mean gage height for the day may therefore be somewhat in error, although occasional additional readings indicate that the natural storage of the river channel between the two points obviates grave errors.

Previous to 1900 the United States engineer office made many discharge measurements at St. Paul, the results of which are published by the Mississippi River Commission. Although the base data for computing the daily flow of the river are available prior to 1892, the reservoir system was not in complete operation at that time, and as this system has had a marked influence on the regimen of the river, it is evident that the earlier records have lost much of their value in indicating the probable future flow. Accordingly, no estimates have been made covering periods earlier than 1892. Between 1892 and 1899 the daily discharge for the open season has been computed by means of rating tables based on the United States engineer office measurements and the Weather Bureau gage heights. Between 1899 and 1909 no discharge measurements were made, but measurements made in 1909 and 1910 by the United States Geological Survey indicate that the old rating tables no longer apply. Estimates from 1900 to 1908 have been based on the assumption that the change between the older and later ratings took place uniformly. The 1909 and 1910 estimates are based on the present rating of the station and the Weather Bureau gage heights.

Discharge measurements are made from the Omaha railway bridge 2 miles above the station.

From December to March the river is frozen over and the open-season rating curve does not apply. Computations of monthly flow during this period are based on the records of the St. Anthony Falls Water Power Co., at Minneapolis, and those of the United States Engineer Corps at Lock and Dam 2 below Minneapolis, an allowance being made for the flow of the Minnesota, which enters a few miles above the St. Paul station.

The highest recorded discharge occurred July 22, 1867, and amounted to 117,000 second-feet. Since 1891 the highest discharge was 80,800 second-feet, occurring April 6, 1897. The winter flow has fallen nearly as low as 1,000 second-feet.

Discharge measurements of Mississippi River at St. Paul, Minn., in 1909-10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Sept. 4	Gray and Emerson	1,090	4,630	4.45	10,800
22	G. A. Gray	799	2,210	3.35	7,540
1910.					
Mar. 17	Gray and Emerson	1,190	12,100	10.21	32,400
Apr. 9	Emerson and Smith	1,130	5,580	5.66	14,500
May 10	Follansbee and Gray	872	4,030	4.10	9.790
June 8	Adams and Gray	838	3,060	3.02	7,650
27	C. J. Emerson	745	2,210	1.72	4,920
Aug. 4	Follansbee and Gray	370	1,410	.80	4,020
Oct. 27	Adams and Emerson	372	1,360	.82	3,940

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1892.[a]												
1	......	......	......	5.0	4.1	11.5	8.4	6.4	3.6	3.0	2.1	......
2	......	......	......	5.3	4.4	11.1	7.9	6.2	3.6	3.1	2.1	......
3	......	......	......	5.7	4.5	10.8	7.7	6.6	4.0	3.0	2.0	......
4	......	......	......	5.7	4.6	10.5	7.4	6.6	3.9	3.0	2.0	......
5	......	......	......	5.0	4.6	10.2	7.1	5.8	3.8	2.9	2.0	......
6	......	......	......	5.0	5.0	9.0	6.8	5.6	3.7	3.0	2.0	......
7	......	......	3.9	5.1	5.2	9.7	6.6	5.4	3.7	2.9	2.0	......
8	......	......	3.2	5.2	5.4	9.4	6.4	5.5	3.6	2.9	2.0	......
9	......	......	3.0	5.1	5.0	9.8	6.1	5.3	3.6	2.9	2.0	......
10	......	......	4.4	5.0	6.1	9.1	5.8	5.2	3.6	2.8	2.0	......
11	......	......	5.0	4.8	6.5	9.6	5.5	5.0	3.7	2.8	1.9	......
12	......	......	5.0	4.4	6.7	8.7	5.3	4.9	4.0	2.8	1.9	......
13	......	......	5.0	4.3	6.7	8.7	5.1	4.7	4.0	2.8	2.0	......
14	......	......	4.3	5.0	6.9	8.7	4.9	4.7	4.1	2.7	2.0	......
15	......	......	4.2	4.9	7.1	8.6	4.6	4.5	4.0	2.7	1.9	......
16	......	......	4.0	4.7	7.2	9.0	4.6	4.5	3.8	2.7	1.7	......
17	......	......	3.8	4.5	7.2	9.5	4.5	4.4	3.6	2.6	1.4	......
18	......	......	3.4	4.2	7.3	9.5	4.5	4.2	3.5	2.8	1.3	......
19	......	......	3.4	4.1	7.5	9.7	5.0	4.1	3.3	2.7	1.4	......
20	......	......	3.3	4.4	9.3	9.7	5.0	4.0	3.2	2.6	1.4	......
21	......	......	3.0	3.9	10.4	9.8	5.1	3.9	3.2	2.6	1.3	......
22	......	......	3.1	3.5	11.0	9.7	5.0	3.8	3.2	2.5	1.3	......
23	......	......	2.9	3.5	11.6	9.5	5.1	3.7	3.1	2.5	1.3	......
24	......	......	2.7	3.3	12.1	9.1	5.0	3.6	3.1	2.4	1.0	......
25	......	......	2.8	3.1	12.5	8.9	4.9	3.6	3.0	2.4	1.5	......
26	......	......	2.0	3.4	12.6	8.7	4.9	3.5	3.0	2.4	2.0	......
27	......	......	2.2	3.3	12.5	8.7	6.5	3.4	3.0	2.3	......	......
28	......	......	2.4	3.3	12.4	8.8	6.7	3.4	2.9	2.3	......	......
29	......	......	2.5	3.7	12.2	8.7	6.4	3.3	3.0	2.2	......	......
30	......	......	4.0	4.0	11.9	8.6	6.5	3.6	3.1	2.2	......	......
31	......	......	4.7	......	11.8	......	6.5	3.7	......	2.2	......	......
1893.[b]												
1	......	......	......	7.3	12.9	9.5	4.2	2.3	2.8	2.8	3.0	1.7
2	......	......	......	8.1	13.7	9.2	4.0	2.3	3.0	2.9	2.6	1.6
3	......	......	......	8.6	14.2	8.9	3.9	2.3	3.0	2.8	2.9	1.8
4	......	......	......	9.4	14.5	8.6	3.9	2.2	2.8	2.7	2.7	1.8
5	......	......	......	10.2	14.7	8.4	4.0	2.2	2.8	2.8	2.6	1.7
6	......	......	......	10.5	14.7	8.1	3.9	2.2	2.9	3.0	2.6	1.9
7	......	......	......	10.6	14.7	8.0	3.7	2.2	2.8	3.1	2.8	1.9
8	......	......	......	10.6	14.6	7.8	3.9	2.2	2.7	3.1	2.8	1.9
9	......	......	......	10.8	14.4	7.5	3.9	2.0	2.7	3.0	2.7	1.9
10	......	......	......	10.9	14.1	7.2	3.8	1.9	2.9	3.0	2.5	2.0
11	......	......	......	10.7	13.7	7.0	3.9	1.8	2.8	2.9	2.4	2.0
12	......	......	......	10.7	13.3	6.8	4.0	1.9	2.9	2.9	2.4	......
13	......	......	......	10.6	12.9	6.6	4.0	2.0	2.9	2.9	2.3	......
14	......	......	......	10.3	12.7	6.3	4.0	2.1	3.0	2.9	2.3	......
15	......	......	......	10.2	12.2	6.1	4.0	2.3	3.0	2.9	2.3	......
16	......	......	......	9.9	11.9	5.9	3.9	2.3	3.0	2.9	2.3	......
17	......	......	......	9.9	11.7	5.8	3.8	2.3	3.0	3.0	2.1	......
18	......	......	......	9.8	11.5	5.6	3.7	2.3	3.0	3.0	2.0	......
19	......	......	......	9.6	11.2	5.4	3.6	2.2	3.1	3.0	1.8	......
20	......	......	......	9.6	11.0	5.3	3.5	2.2	3.1	3.0	1.3	......
21	......	......	......	9.6	10.7	5.2	3.3	2.2	3.0	3.0	1.2	......
22	......	......	......	9.4	10.3	5.1	3.2	2.2	2.9	3.0	1.3	......
23	......	......	......	9.1	10.0	4.9	3.1	2.2	2.9	3.0	1.2	......
24	......	......	......	9.1	9.7	4.8	2.9	2.1	2.9	3.0	1.1	......
25	......	......	......	9.2	9.7	4.7	2.8	2.2	2.9	3.0	1.0	......
26	......	......	......	9.7	10.0	4.7	2.7	2.0	2.9	2.9	.6	......
27	......	......	......	10.5	10.1	4.7	2.7	1.9	2.9	2.9	1.2	......
28	......	......	......	11.1	10.2	4.7	2.6	2.0	2.9	2.9	1.8	......
29	......	......	......	11.8	10.2	4.5	2.6	2.4	2.8	2.9	1.9	......
30	......	......	......	12.4	10.0	4.4	2.3	2.5	2.9	2.9	1.9	......
31	......	......	......	......	9.8	......	2.4	2.6	......	3.0	......	......

[a] Ice present from Jan. 1 to Mar. 6 and from Nov. 25 to Dec. 31.
[b] Ice present from Jan. 1 to Mar. 31 and from Dec. 6 to 31.

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1894. [a]												
1	......	......	......	3.6	9.0	7.1	2.8	0.5	1.6	1.7	2.1	......
2	......	......	......	3.4	9.1	6.9	2.8	.4	1.4	2.0	2.1	......
3	......	......	......	3.4	9.3	6.6	2.7	.4	1.6	2.0	2.2	......
4	......	......	......	2.9	9.4	6.4	2.6	.6	1.6	2.0	2.2	......
5	......	......	......	3.0	9.3	6.3	2.5	.4	1.6	2.0	2.2	......
6	......	......	......	3.0	9.4	6.1	2.4	.2	1.5	1.9	2.1	......
7	......	......	......	2.9	9.3	5.8	2.3	.4	1.6	2.1	2.2	......
8	......	......	4.3	2.9	9.3	5.6	2.1	.5	1.7	2.1	2.2	......
9	......	......	4.5	2.9	9.2	5.3	2.0	.3	1.8	2.0	2.1	......
10	......	......	4.1	3.2	9.2	5.1	2.0	.5	1.8	2.0	2.0	0.9
11	......	......	3.9	3.3	9.1	4.9	2.0	1.2	1.7	2.1	1.9	.8
12	......	......	3.5	3.5	8.8	4.7	2.0	1.4	1.8	2.2	1.8	.8
13	......	......	3.3	3.6	8.4	4.6	1.9	1.7	1.8	2.1	1.9	.8
14	......	......	3.4	3.7	8.4	4.4	1.8	1.9	1.8	2.0	1.9	.8
15	......	......	3.4	3.8	8.3	4.2	1.8	1.7	1.8	1.9	1.9	......
16	......	......	3.4	4.1	8.6	4.1	1.7	1.8	1.9	1.8	1.9	......
17	......	......	3.4	4.6	9.4	4.0	1.5	1.7	1.9	1.8	1.0	......
18	......	......	3.4	5.4	10.1	3.9	1.5	1.5	1.9	1.6	1.0	.8
19	......	......	3.5	6.5	11.3	3.8	1.5	1.7	1.7	1.6	1.1	.8
20	......	......	3.8	7.5	11.7	3.7	1.7	1.8	1.6	1.7	1.8	.8
21	......	......	4.0	8.5	11.8	3.5	1.6	1.8	1.5	2.0	2.0	.8
22	......	......	4.1	9.3	11.7	3.5	1.3	1.9	1.5	1.8	1.8	......
23	......	......	4.1	10.0	11.3	3.3	1.2	1.9	1.6	1.8	1.2	......
24	......	......	4.1	10.4	10.7	3.0	1.3	2.0	1.6	1.7	1.2	.6
25	......	......	3.3	10.6	10.1	3.0	1.3	1.9	1.7	1.8	1.5	......
26	......	......	2.7	10.4	9.5	3.0	1.0	1.8	1.7	1.7	1.5	......
27	......	......	2.3	10.1	8.8	2.9	1.0	1.8	1.5	1.6	1.4	......
28	......	......	2.0	9.7	8.4	2.9	.9	1.9	1.5	1.6	2.3	......
29	......	......	3.0	9.3	7.9	2.8	.8	1.5	1.5	1.8	2.6	......
30	......	......	3.5	9.1	7.6	2.9	.2	1.6	1.6	1.9	......	......
31	......	......	4.0	......	7.4	......	.6	1.7	......	2.1	......	......
1895. [b]												
1	......	......	......	1.0	.7	1.8	3.7	1.4	1.8	2.4	1.4	......
2	......	......	......	1.0	.8	2.0	3.8	1.3	1.5	2.1	1.2	......
3	......	......	......	1.0	.9	2.8	3.7	1.0	1.7	2.2	1.2	......
4	......	......	......	.9	1.1	2.7	3.4	1.0	1.7	2.2	1.2	......
5	......	......	......	1.0	1.3	2.6	3.1	.9	1.8	2.1	1.4	......
6	......	......	......	1.0	1.4	2.9	3.1	1.1	1.8	2.2	1.5	......
7	......	......	......	1.0	1.9	2.8	3.0	.8	1.9	2.1	1.2	......
8	......	......	......	.9	2.0	2.9	3.0	.9	2.0	2.2	1.4	......
9	......	......	......	1.0	2.1	3.0	3.1	1.0	1.9	2.2	1.5	......
10	......	......	......	.8	2.1	3.1	3.1	1.3	2.0	2.1	1.4	......
11	......	......	......	1.0	2.5	3.9	2.8	1.6	2.0	2.1	1.3	......
12	......	......	......	1.2	2.3	4.1	2.7	1.7	2.0	2.1	1.5	......
13	......	......	......	1.0	2.3	4.1	2.6	1.8	2.0	1.9	1.4	......
14	......	......	......	1.0	2.2	4.4	2.4	1.9	1.9	1.7	1.4	......
15	......	......	......	.9	2.0	4.5	2.5	2.3	1.7	1.9	1.5	......
16	......	......	......	.9	2.2	4.6	2.4	2.0	1.5	1.8	1.5	......
17	......	......	......	.8	2.0	4.6	2.3	2.0	1.9	1.9	1.4	......
18	......	......	......	.8	2.0	4.5	2.6	2.2	1.7	1.8	1.3	......
19	......	......	......	.7	1.8	4.3	2.5	2.0	1.8	1.7	1.4	......
20	......	......	......	.7	1.5	4.0	2.3	2.2	1.8	1.7	1.5	......
21	......	......	......	.7	1.8	3.8	2.1	2.0	1.9	1.5	.9	......
22	......	......	.2	.8	1.7	3.7	1.9	1.8	2.1	1.7	.6	......
23	......	......	.3	.9	1.5	3.6	1.9	1.7	2.3	1.5	.6	......
24	......	......	.5	.6	1.5	3.5	1.8	1.8	2.5	1.6	.5	......
25	......	......	.6	.5	1.5	3.4	1.8	1.8	2.4	1.5	.6	......
26	......	......	.6	.6	1.6	3.4	1.8	1.7	2.3	1.5	.6	......
27	......	......	1.0	.9	1.5	3.4	1.8	1.9	2.2	1.4	.9	......
28	......	......	1.4	.6	1.7	3.5	1.7	1.8	2.2	1.2	......	......
29	......	......	1.3	.3	1.8	3.6	1.5	1.8	2.2	1.5	......	......
30	......	......	1.3	.9	1.8	3.7	1.8	1.7	2.1	1.4	......	......
31	......	......	1.3	......	1.7	......	1.5	1.7	......	1.4	......	......

[a] Ice present from Jan. 1 to Mar. 7 and from Nov. 28 to Dec. 9 and Dec. 25 to 31.
[b] Ice present from Jan. 1 to Mar. 21 and from Nov. 27 to Dec. 31

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1896.[a]												
1				0.7	7.9	9.1	5.7	1.9	2.1	2.1	2.5	
2				.0	8.3	8.7	5.4	1.8	1.8	2.1	2.5	
3				−.1	8.6	8.5	5.3	1.8	1.7	2.0	2.9	
4				.4	8.9	8.1	5.2	2.1	1.4	2.1	2.8	
5				1.0	9.1	8.0	5.1	1.7	1.4	1.9	2.8	
6				1.4	9.2	7.6	4.8	1.7	1.3	2.2	2.8	
7				1.7	9.3	8.0	4.7	1.8	1.4	1.9	2.9	
8				1.8	9.1	8.1	4.6	2.1	1.6	1.8	3.0	
9				1.8	9.0	8.3	4.3	2.0	1.7	1.8	2.9	
10			−0.2	1.8	8.8	8.6	4.2	2.0	1.9	1.9	2.9	
11			−.4	2.1	8.7	8.8	4.1	2.2	2.0	1.9	2.6	
12			−.3	2.7	8.4	8.9	4.1	2.3	1.9	2.1	2.2	
13			−.2	3.9	8.4	8.9	4.0	2.5	1.8	2.2	1.9	
14			0	7.0	8.4	8.7	3.9	2.6	1.8	2.2	2.0	
15			.0	8.3	8.5	8.4	3.8	2.6	1.9	2.3	2.1	
16			−.5	9.5	8.6	8.0	3.5	2.5	2.2	2.2	1.8	
17			−.2	10.5	9.2	7.6	3.2	2.4	2.3	2.2	2.0	
18			−.4	10.7	9.6	7.2	3.0	2.3	2.3	2.1	2.0	
19			−.9	10.4	10.0	6.9	2.9	2.2	2.3	2.1	2.0	
20			−.9	9.9	10.3	6.7	2.8	2.1	2.2	2.2	1.6	
21			−.8	9.5	10.5	6.5	2.9	2.1	2.1	2.2	1.5	
22			−.9	9.0	10.5	6.1	2.7	2.0	2.0	2.1	1.8	
23			−.8	8.6	10.4	6.2	2.7	2.1	2.0	2.0	3.7	
24			−.4	8.3	10.2	6.4	2.6	2.1	2.0	2.0	2.7	
25			−.4	7.8	10.0	6.6	2.6	2.2	1.9	2.1	3.0	
26			−.2	7.6	9.7	6.7	2.5	2.0	2.0	2.0	3.3	
27			−.2	7.4	9.5	6.8	2.4	2.0	2.1	1.9	3.5	
28			−.1	7.1	9.5	6.6	2.1	2.0	2.1	2.0		
29			.1	7.2	9.5	6.2	2.0	1.9	2.1	1.9		
30			.2	7.5	9.5	6.0	1.9	1.8	2.0	2.3		
31			.7		9.3		1.8	1.9		2.5		
1897.[b]												
1				15.3	10.0	5.2	6.5	8.9	4.5	4.9	3.8	
2				16.4	9.8	5.5	6.6	8.7	4.5	4.8	3.9	
3				17.1	9.6	5.5	6.7	8.6	4.6	4.7	3.9	3.2
4				17.4	9.1	5.5	6.8	8.4	4.6	4.5	3.9	
5				17.9	8.8	5.7	7.9	8.2	4.6	4.6	3.8	
6				18.0	8.5	5.8	8.9	8.0	4.7	4.5	3.8	
7				17.8	8.2	5.9	9.9	7.7	4.7	4.5	3.8	
8				17.7	7.9	6.0	12.0	7.8	4.6	4.4	3.8	
9				17.8	7.6	5.9	13.0	7.6	4.6	4.4	3.8	
10				17.7	7.3	5.9	13.3	7.2	4.5	4.3	3.7	4.1
11				17.5	7.1	6.0	13.6	6.9	4.5	4.1	3.6	
12				17.1	7.0	5.9	13.5	6.6	4.5	4.2	3.6	
13				16.6	6.8	5.7	13.3	6.3	4.6	4.2	3.6	
14				16.2	6.7	5.8	13.0	6.0	4.9	4.1	3.6	
15				15.7	6.6	5.8	12.6	5.8	5.1	4.0	3.6	
16				15.2	6.5	5.9	13.3	5.6	5.2	4.0	3.6	
17				14.9	6.4	5.9	11.8	5.5	5.5	4.0	3.5	4.0
18				14.6	6.4	6.0	11.3	5.4	5.5	3.9	3.5	
19				14.0	6.4	6.2	10.8	5.4	5.5	4.0	3.4	
20				13.7	6.4	6.4	10.4	5.3	5.4	4.1	3.3	
21			4.9	13.3	6.4	6.6	10.2	5.2	5.3	4.1	3.2	
22			5.5	13.0	6.2	6.7	9.9	5.2	5.4	4.1	3.2	
23			6.5	12.8	6.0	6.8	9.7	5.1	5.4	4.1	2.9	
34			7.6	12.4	5.8	6.7	9.6	5.0	5.3	4.2	2.6	3.9
25			8.4	12.1	5.7	6.6	9.5	5.0	5.2	4.1	2.5	
26			9.1	11.7	5.6	6.3	9.8	5.0	5.0	4.1	2.4	
27			9.5	11.4	5.6	6.1	9.8	4.8	5.0	4.0	2.3	
28			9.9	11.0	5.5	6.1	9.6	4.7	5.0	3.9		
29			10.1	10.6	5.4	6.2	9.4	4.6	5.0	3.9		
30			12.2	10.3	5.3	6.4	9.1	4.5	4.9	3.8		
31			13.5		5.3		9.0	4.5		3.8		3.5

[a] Ice from Jan. 1 to Mar. 9 and from Nov. 23 to Dec. 31.
[b] Ice from Jan. 1 to Mar. 20 and from Nov. 28 to Dec. 31.

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1898.[a]												
1				3.8	3.2	5.2	4.8	3.8	3.2	3.1	3.9	
2				3.6	3.3	5.2	5.0	3.8	3.1	2.9	3.9	
3				3.6	3.4	5.2	4.9	3.6	2.9	2.8	3.8	
4				3.6	3.4	5.0	4.9	3.5	2.8	2.8	3.8	
5				3.8	3.6	5.1	5.0	3.3	2.8	2.8	3.8	
6				3.9	3.6	8.9	5.2	3.8	2.8	2.9	3.7	
7				3.9	3.7	10.3	5.5	3.4	2.8	3.1	3.5	
8			3.7	3.9	3.6	10.7	5.6	3.4	2.7	3.2	3.5	
9			3.8	3.9	3.4	10.7	5.7	3.3	2.7	3.2	3.5	
10			4.1	3.8	3.4	10.5	6.1	3.2	2.7	3.3	3.4	
11			4.2	3.8	3.1	10.2	6.4	3.0	2.9	3.6	3.4	
12			4.1	4.0	3.1	9.9	6.7	3.0	2.8	3.5	3.3	
13			3.6	4.0	2.9	9.6	6.9	3.0	2.8	3.8	3.3	
14			3.1	3.9	2.9	9.4	6.6	2.8	3.0	4.0	3.1	
15			4.2	4.1	3.1	9.0	6.2	2.7	3.1	4.0	3.1	
16			3.9	4.1	3.0	8.4	5.9	3.0	3.1	4.1	3.1	
17			3.8	4.0	3.0	7.9	5.5	2.8	3.0	4.1	3.1	
18			3.7	3.9	3.0	7.5	5.3	2.8	3.0	4.2	3.1	
19			4.0	3.9	3.1	7.2	5.1	2.8	2.8	4.2	3.1	
20			3.9	3.9	3.2	6.9	5.0	2.7	2.8	4.3	3.2	
21			3.8	3.8	3.3	6.6	4.8	2.8	2.8	4.4	3.1	
22			3.8	3.7	3.8	6.4	4.6	2.8	2.8	4.5	3.1	
23			3.7	3.5	4.0	6.3	4.4	2.8	2.9	4.6		
24			3.0	3.4	4.3	6.0	4.3	2.9	2.9	4.6		
25			3.4	3.1	4.6	5.7	4.2	3.0	3.1	4.6		
26			3.8	3.2	4.7	5.3	4.2	3.0	3.1	4.5		
27			3.9	3.0	4.5	5.1	4.2	3.0	3.1	4.5		
28			3.6	3.0	4.7	5.0	4.0	3.1	3.1	4.4		
29			2.8	3.0	4.8	4.8	3.9	3.2	3.1	4.2		
30			2.8	3.0	5.0	4.7	3.9	3.3	3.2	4.1		
31			3.4		5.0		4.0	3.3		4.0		
1899.[b]												
1					6.4	5.7	8.7	4.0	7.5	4.4	7.2	4.7
2					6.6	6.6	8.7	3.8	7.2	4.3	7.1	4.7
3					6.8	7.7	8.5	3.7	6.9	4.2	7.0	4.6
4					7.0	8.2	8.3	3.7	6.7	4.2	6.8	4.5
5					7.1	8.5	8.0	3.6	6.4	4.2	6.7	4.2
6					7.2	8.7	7.8	3.5	6.2	4.1	6.6	3.2
7					7.5	9.2	7.5	3.5	6.2	4.1	6.5	2.5
8				5.0	7.6	9.6	7.3	3.5	6.1	4.1	6.4	2.5
9				6.9	7.5	9.7	7.0	3.5	5.9	4.0	6.2	3.2
10				7.4	7.2	9.8	6.8	3.7	5.8	4.0	6.1	4.2
11				7.5	6.9	9.9	6.5	3.9	5.7	4.0	6.0	4.6
12				8.1	6.7	9.7	6.2	4.0	5.7	4.1	6.0	4.4
13				9.8	6.5	9.9	6.0	4.1	5.7	4.1	5.9	
14				10.5	6.2	10.0	5.9	3.8	5.6	4.3	5.8	
15				10.3	6.1	10.3	5.9	3.8	5.6	4.4	5.7	
16				10.4	6.0	10.5	6.0	3.8	5.6	4.6	5.6	
17				10.4	6.1	10.6	5.7	4.0	5.3	5.3	5.5	
18				10.4	6.1	10.8	5.4	4.0	5.2	5.8	5.4	
19				10.1	6.0	10.9	5.2	4.0	5.1	6.7	5.4	
20				9.5	5.9	10.9	5.1	4.3	5.0	7.5	5.3	
21				8.8	5.9	10.9	5.0	4.6	5.0	8.0	5.2	
22				8.0	5.9	11.0	5.0	5.8	5.0	8.4	5.1	
23				7.4	5.9	11.0	5.0	6.6	5.0	8.7	5.0	
24				7.0	5.8	10.9	4.8	8.0	5.0	8.8	5.0	
25				6.7	5.8	10.7	4.7	8.7	4.9	8.7	5.0	
26				6.5	5.8	10.3	4.6	8.8	4.9	8.6	5.0	
27				6.3	5.7	9.9	4.5	8.7	4.8	8.2	4.9	
28				6.1	5.8	9.5	4.3	8.5	4.8	8.0	4.9	
29				6.1	5.8	9.2	4.2	8.3	4.7	7.8	4.8	
30				6.2	5.7	8.8	4.1	8.0	4.5	7.6	4.8	
31					5.7		4.0	7.7		7.4		

[a] Ice from Jan. 1 to Mar. 7 and from Nov. 23 to Dec. 31.
[b] Ice from Jan. 1 to Apr. 7 and from Dec. 10 to 31.

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1900.[a]												
1	......	......	......	3.4	3.7	3.2	0.8	1.1	5.4	5.8	4.5	2.0
2	......	......	......	3.0	3.7	3.0	.7	1.2	5.3	5.8	4.5	2.0
3	......	......	......	3.2	3.8	2.9	1.0	1.2	5.0	5.9	4.5	2.0
4	......	......	......	3.7	3.8	2.7	2.0	1.2	4.8	5.9	4.5	2.2
5	......	......	......	3.8	3.8	2.6	2.6	1.0	4.7	6.3	4.6	2.3
6	......	......	......	4.6	3.7	2.5	2.9	1.0	4.5	6.5	4.6	2.3
7	......	......	......	5.6	3.5	2.5	2.9	1.0	4.2	6.6	4.6	2.2
8	......	......	......	5.6	3.4	2.4	3.0	1.1	4.0	6.3	4.5	1.9
9	......	......	......	5.2	3.3	2.4	2.9	1.2	3.9	6.2	4.4	1.9
10	......	......	......	5.0	3.5	2.4	2.9	1.5	4.2	6.0	4.3	1.8
11	......	......	......	4.8	3.2	1.8	2.8	2.2	4.4	5.9	4.2	2.4
12	......	......	......	4.5	3.0	1.8	2.8	2.8	5.3	5.8	4.1	3.6
13	......	......	......	4.3	2.9	1.9	3.0	2.9	5.8	5.7	4.0	3.5
14	......	......	......	4.2	2.8	1.9	3.0	3.5	5.7	5.7	3.8	2.8
15	......	......	......	4.1	2.8	1.5	2.8	3.7	5.5	5.4	3.5	1.8
16	......	......	......	4.0	2.8	1.5	2.8	4.0	5.3	5.3	2.7	2.6
17	......	......	......	4.4	2.8	1.4	2.6	4.2	5.2	5.3	2.1	2.4
18	......	......	......	4.6	2.9	1.3	2.5	4.3	5.1	5.3	2.0	2.7
19	......	......	......	4.8	2.9	1.3	2.3	4.2	5.0	5.2	2.0	3.3
20	......	......	......	4.6	2.6	1.2	2.2	4.0	5.2	5.1	2.1	3.0
21	......	......	......	4.4	2.5	1.2	2.2	3.8	5.5	5.0	2.1	2.7
22	......	......	......	4.2	2.7	1.2	2.2	3.7	5.7	4.8	2.1	2.4
23	......	......	......	4.0	2.8	1.2	2.2	3.7	5.9	4.8	2.0	2.3
24	......	......	......	4.0	2.8	1.2	2.1	3.9	5.9	4.6	1.9	2.2
25	......	......	......	4.0	2.8	1.0	1.8	4.1	6.0	4.5	1.6	......
26	......	......	......	3.9	2.7	1.0	1.5	4.5	6.0	4.5	1.3	......
27	......	......	......	3.8	2.8	1.0	1.1	4.7	6.0	4.3	1.8	......
28	......	......	......	3.8	2.8	.9	1.1	5.0	6.0	4.5	2.1	......
29	......	......	......	3.8	3.2	.9	1.3	5.4	5.9	4.6	2.0	......
30	......	......	......	3.7	3.3	.8	1.0	5.5	5.8	4.5	2.0	......
31	......	......	......	......	3.3	......	1.0	5.4	......	4.3	......	......
1901.[b]												
1	......	......	......	5.4	6.0	5.0	6.0	3.8	2.6	2.6	2.7	2.0
2	......	......	......	5.6	6.0	4.9	6.3	3.7	2.8	2.6	2.7	2.1
3	......	......	......	5.6	6.1	4.8	6.4	3.4	2.7	2.6	2.8	1.8
4	......	......	......	5.8	6.1	4.8	6.5	3.3	2.7	2.7	2.7	......
5	......	......	......	6.1	6.8	4.7	6.5	3.1	2.6	2.7	2.7	......
6	......	......	......	6.5	6.9	4.7	6.6	3.0	2.6	2.6	2.7	......
7	......	......	......	6.4	7.1	4.5	6.7	3.0	2.6	2.4	2.6	......
8	......	......	......	6.5	7.2	4.3	6.9	2.9	2.5	2.4	2.6	......
9	......	......	......	6.8	7.3	4.2	7.0	2.8	2.4	2.4	2.5	......
10	......	......	......	7.2	7.3	4.1	7.1	2.7	2.5	2.4	2.5	......
11	......	......	......	7.3	7.3	4.2	7.2	2.6	2.6	2.5	2.5	......
12	......	......	......	7.5	7.1	4.3	7.2	2.4	2.7	2.6	2.6	......
13	......	......	......	7.2	7.0	4.3	7.2	2.3	2.5	2.6	2.5	......
14	......	......	......	6.7	7.0	4.1	7.0	2.5	2.5	2.7	2.5	......
15	......	......	......	6.5	6.9	4.3	6.9	2.7	2.4	2.9	2.5	......
16	......	......	......	6.5	6.8	4.3	6.8	2.9	2.3	3.1	2.4	......
17	......	......	......	6.7	6.7	4.1	6.7	2.9	2.3	3.0	1.9	......
18	......	......	......	6.6	6.7	4.0	6.6	2.8	2.2	3.0	1.5	......
19	......	......	......	6.6	6.6	4.0	6.4	2.7	2.1	2.9	1.6	......
20	......	......	......	6.6	6.5	4.2	6.1	2.6	2.1	2.9	1.6	......
21	......	......	......	6.5	6.4	4.4	5.8	2.6	2.1	2.9	1.6	......
22	......	......	......	6.5	6.2	5.0	5.5	2.6	2.0	2.8	1.6	......
23	......	......	......	6.5	6.2	5.5	5.3	2.5	2.0	2.8	1.7	......
24	......	......	......	6.4	6.1	5.6	5.0	2.5	2.0	2.7	1.7	......
25	......	......	5.4	6.4	5.9	5.7	4.8	2.5	2.1	2.7	1.3	......
26	......	......	5.8	6.3	5.8	5.7	4.5	2.4	2.2	2.6	1.6	......
27	......	......	5.7	6.3	5.6	5.7	4.3	2.5	2.3	2.6	1.5	......
28	......	......	5.4	6.3	5.4	5.6	4.1	2.6	2.4	2.6	1.4	......
29	......	......	5.2	6.2	5.3	6.1	4.0	2.6	2.5	2.6	1.3	......
30	......	......	5.3	6.1	5.2	6.2	3.9	2.6	2.4	2.7	1.5	......
31	......	......	5.3	......	5.1	......	3.9	2.6	......	2.7	......	......

[a] Ice from Jan. 1 to Mar. 31 approximately and from Dec. 4 to 31.
[b] Ice from Jan. 1 to Mar. 24 and from Dec. 1 to 31.

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902.[a]												
1				2.1	1.9	6.3	4.7	3.4	1.5	1.9	2.4	3.4
2				2.1	2.0	6.1	4.6	3.1	1.6	2.0	2.4	3.1
3				2.2	1.9	6.0	4.4	2.9	2.0	2.0	2.5	3.0
4				2.2	2.1	6.1	4.3	2.6	2.4	2.1	2.6	
5				2.1	2.1	6.4	4.2	2.6	2.7	2.1	2.7	
6				2.0	2.2	6.6	4.2	2.3	2.9	2.1	3.0	
7				1.8	2.2	6.7	4.0	2.	3.1	2.2	3.2	
8				1.8	2.3	6.7	3.9	2.4	2.9	2.2	3.4	
9				1.9	2.4	6.8	3.9	2.4	3.0	2.2	3.5	
10			1.1	2.0	2.8	6.8	4.1	2.8	3.0	2.2	3.5	
11			1.2	1.9	4.1	6.7	4.3	2.4	2.9	2.2	3.5	
12			1.2	1.8	4.3	6.7	4.3	2.2	2.7	2.2	3.5	
13			1.2	1.7	4.5	6.7	4.3	2.2	2.5	2.0	3.6	
14			1.5	1.7	4.4	6.6	4.1	2.1	2.2	2.0	3.6	
15			1.8	1.6	4.3	6.4	3.9	2.1	2.0	2.0	3.6	
16			2.1	1.6	4.2	6.2	3.8	2.0	2.1	1.9	3.6	
17				1.7	4.2	6.1	4.0	2.0	2.2	1.9	3.7	
18				1.5	4.3	6.0	3.8	1.8	2.2	1.8	3.9	
19			1.5	1.4	4.3	5.8	3.5	1.7	2.1	1.8	4.1	
20			1.9	1.3	4.4	5.6	3.4	1.7	2.0	1.7	4.3	
21			2.1	1.2	4.4	5.5	3.0	1.6	2.2	1.7	4.5	
22			2.2	1.3	4.5	5.4	2.8	1.8	2.1	1.8	4.5	
23			2.2	1.3	5.6	5.2	2.6	1.8	2.2	1.8	4.6	
24			2.3	1.2	6.9	5.1	2.5	1.8	2.2	1.8	4.5	
25			2.6	1.2	7.4	5.1	2.5	1.5	2.1	1.8	4.5	
26			2.7	1.7	7.5	4.9	2.7	1.6	2.0	1.8	4.4	
27			2.8	1.8	7.5	4.8	2.8	1.6	2.0	1.8	4.4	
28			2.6	1.7	7.3	4.8	2.8	1.5	1.9	1.9	4.2	
29			2.4	1.7	7.0	4.8	2.9	1.4	1.8	2.1	3.8	
30			2.3	1.8	6.7	4.7	3.3	1.4	1.8	2.3	3.6	
31			2.1		6.5		3.4	1.4		2.3		
1903.[b]												
1				7.5	6.9	10.5	3.2	5.3	3.8	8.8	7.1	5.0
2				7.1	6.9	11.3	3.2	5.5	3.8	8.3	6.8	5.5
3			2.8	7.0	6.8	11.9	3.5	5.7	3.9	8.6	6.5	5.6
4		2.5		7.0	6.8	11.9	4.5	6.0	4.0	8.0	6.2	5.6
5				7.0	6.8	11.5	5.9	6.1	4.2	8.0	6.1	5.3
6				6.9	6.9	10.8	6.4	6.2	4.2	8.3	6.1	5.4
7				7.2	7.0	10.2	6.7	6.2	4.2	9.5	6.1	5.2
8	2.9		3.6	7.2	7.1	9.5	6.7	6.3	4.3	10.8	6.0	5.0
9				7.1	7.2	8.9	6.7	6.2	4.4	11.6	6.0	4.8
10				6.9	7.1	8.3	7.0	6.0	4.4	12.2	5.8	
11			4.2	7.1	7.1	7.6	7.3	5.8	4.3	12.7	5.5	
12				7.4	7.6	6.8	7.6	5.6	4.6	13.0	5.4	
13				7.8	8.3	6.0	7.7	5.3	7.3	13.3	5.4	
14		2.6	5.6	8.1	9.0	5.5	7.5	5.1	8.6	13.5	5.4	
15			6.0	8.4	9.6	5.4	7.2	5.0	9.4	13.4	5.4	
16			6.1	8.6	10.1	5.3	7.0	4.9	10.0	13.1	5.3	4.4
17	2.7		6.3	8.8	10.4	5.1	7.0	4.8	10.5	12.8	5.2	
18			6.2	8.9	10.8	4.8	7.0	4.8	10.8	12.5	5.0	
19			6.3	8.8	10.9	4.6	6.5	4.8	11.1	12.1	4.6	
20			7.1	8.7	10.8	4.5	6.2	4.8	11.5	11.6	3.8	
21		2.8	7.4	8.5	10.6	4.4	6.0	4.8	11.7	11.1	3.2	
22			7.7	8.2	10.4	4.3	5.9	4.8	11.9	10.7	3.0	
23			7.7	7.9	10.1	4.2	5.9	4.6	11.9	10.2	3.0	
24	2.6		7.9	7.8	9.6	4.1	5.8	4.5	11.9	9.8	3.3	
25			8.1	7.5	9.4	3.9	5.7	4.3	11.7	9.4	3.6	3.8
26			8.3	7.3	9.3	3.8	5.4	4.1	11.3	9.0	4.6	
27			8.3	7.2	9.3	3.7	5.4	3.9	10.9	8.6	4.6	
28		3.0	8.3	7.2	9.5	3.6	5.2	3.8	10.4	8.3	5.2	
29			8.1	7.1	9.5	3.6	5.1	4.0	9.9	8.0	5.5	
30	2.5		7.8	7.1	9.5	3.4	5.1	4.1	9.3	7.6	5.0	
31			7.7		9.8		5.2	3.9		7.3		3.6

[a] Ice from Jan. 1 to Mar. 9 and from Dec. 4 to 31.
[b] Ice from Jan. 1 to Mar. 14 and from Dec. 1 to 31.

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.[a]												
1				5.8	8.3	5.7	5.2	3.5	2.9	3.2	6.5	3.2
2				5.6	8.2	5.6	5.2	3.5	2.8	3.5	6.2	3.0
3			3.2	5.5	8.0	5.7	5.1	3.4	3.6	3.6	5.9	2.8
4				5.8	7.8	5.9	5.1	3.3	4.2	3.7	5.6	2.7
5		3.0		6.2	7.5	6.2	5.0	3.2	4.4	3.5	5.5	2.6
6	3.1			6.5	7.4	6.3	4.9	3.2	4.6	3.4	5.4	2.6
7				8.4	7.4	6.8	4.8	3.1	5.1	3.4	5.4	2.7
8			3.2	8.8	7.5	7.2	4.8	2.9	5.2	3.6	5.3	3.0
9				9.0	7.4	7.5	4.8	2.9	5.2	3.7	5.0	3.2
10				9.7	7.3	7.7	5.0	3.0	5.2	4.0	4.7	3.5
11				9.9	7.2	7.8	4.9	3.0	5.2	4.2	4.8	3.7
12		3.1		9.9	7.4	7.7	4.7	3.0	5.0	5.8	4.8	3.7
13				9.8	7.5	7.6	4.5	3.0	4.7	6.0	4.6	
14	3.2			9.6	7.4	7.5	4.4	3.0	4.3	6.0	4.5	
15				9.4	7.3	7.3	4.2	3.0	3.9	6.4	4.5	
16			3.5	9.4	7.2	6.9	4.1	2.9	3.8	6.7	4.4	
17				9.2	7.0	6.6	4.0	2.8	3.7	6.9	4.3	
18				8.9	6.8	6.3	3.9	2.7	3.6	6.8	4.1	
19		3.0		8.7	6.7	5.9	3.9	2.6	3.4	6.8	4.1	
20				8.5	6.6	5.6	3.9	2.9	3.3	7.0	4.0	
21				8.4	6.4	5.4	3.8	3.1	3.1	7.1	3.9	
22	3.1		4.5	8.2	6.3	5.3	3.7	3.2	3.0	7.5	3.9	
23				8.2	6.2	5.1	3.8	3.5	2.9	7.7	3.8	
24				8.1	6.1	5.0	3.8	3.7	2.9	7.5	3.8	
25				8.1	6.1	5.0	3.7	3.8	2.9	7.6	3.8	
26		3.2	5.6	8.1	6.1	4.9	3.6	3.7	2.8	7.7	3.8	
27				8.4	6.1	5.0	3.5	3.8	2.8	7.8	3.7	
28				8.5	6.2	5.1	3.4	3.8	3.0	7.8	3.7	
39			5.7	8 6	6.2	5.3	3.3	3.8	3.0	7.5	3.6	
30	3.0		5.6	8.5	6.0	5.2	3.4	3.5	2.9	7.2	3.4	
21			6.0		5.8		3.5	3.2		6.8		
1905.[b]												
1				4.8	3.8	7.6	11.6	7.8	6.3	5.9	5.4	
2				4.8	3.7	7.1	11.5	7.5	6.1	5.8	5.3	
3	2.8			4.8	3.7	6.9	11.6	7.3	6.1	5.6	5.2	
4				4.9	3.8	6.9	11.7	7.2	6.0	5.6	5.2	
5				5.4	4.2	7.0	12.0	7.2	6.0	5.6	5.1	6.0
6				5.2	4.8	7.0	12.5	7.3	5.9	5.5	5.2	
7		2.1	5.4	5.8	6.2	7.4	13.1	7.0	5.9	5.5	5.4	
8			5.1	6.4	7.0	7.9	13.8	7.0	5.8	5.4	5.4	
9	2.4		4.9	6.6	6.8	8.1	14.3	7.0	5.8	5.3	5.5	
10			5.5	6.7	6.8	8.1	14.6	7.0	5.8	5.3	5.6	6.4
11			4.8	6.7	7.2	8.4	14.8	7.1	5.6	5.2	5.5	6.5
12			4.0	6.7	8.0	8.4	14.7	7.1	5.6	5.2	5.6	6.6
13			3.7	6.3	8.7	8.3	14.5	7.0	5.5	5.1	5.4	6.4
14		2.0	3.5	6.1	8.9	8.3	14.3	7.0	5.4	5.0	5.4	6.5
15			3.4	5.8	10.0	8.1	14.0	7.0	5.7	5.0	5.3	7.1
16	2.4		3.5	5.7	10.8	8.0	13.7	7.0	5.7	4.9	5.2	7.6
17			3.5	5.2	11.2	8.5	13.2	7.1	5.8	4.8	5.1	7.4
18			3.5	5.1	11.7	8.9	12.7	7.9	5.7	5.1	5.0	7.3
19			3.4	4.9	11.7	9.5	12.3	8.0	6.5	5.3	5.0	6.9
20			3.4	4.8	11.6	10.1	11.8	8.0	7.0	5.4	4.9	6.8
21		2.0	3.8	4.7	11.5	10.4	11.4	8.2	7.4	5.6	4.9	6.6
22			4.2	4.5	11.2	10.5	11.1	7.9	7.3	5.7	4.8	6.4
23	2.5		4.8	4.4	11.0	10.4	10.7	7.8	7.2	5.9	4.8	6.3
24			5.2	4.2	10.8	10.3	10.4	7.6	7.0	5.9	4.8	7.0
25			5.3	4.0	10.6	10.3	10.1	7.5	6.9	5.9	5.0	8.2
26			5.4	3.9	10.3	10.4	9.8	7.5	6.7	6.0	5.3	9.2
27		2.5	5.6	3.9	9.9	10.7	9.5	7.2	6.5	5.9	5.4	8.0
28			5.9	3.8	9.4	11.1	9.4	6.9	6.3	5.8	5.6	7.8
29			5.4	3.8	9.0	11.4	9.0	6.7	6.2	5.7	5.9	7.3
30	2.3		5.0	3.8	8.6	11.6	8.7	6.6	6.0	5.7		7.1
31			4.8		8.1		8.2	6.4		5.6		

[a] Ice from Jan. 1 to Mar. 31 and from Dec. 1 to 31.
[b] Ice from Jan. 1 to Mar. 6 and from Nov. 30 to Dec. 31.

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1906.[a]												
1				7.5	9.0	12.0	10.3	6.0	8.4	8.0	7.8	6.4
2				7.2	8.8	12.0	10.3	5.9	8.4	7.9	7.9	6.0
3				7.8	8.9	12.0	10.4	5.8	8.2	7.7	7.9	5.5
4				8.3	8.9	11.8	10.5	5.6	8.0	7.6	7.8	5.1
5				9.0	8.8	11.7	10.5	5.5	7.8	7.4	7.7	5.1
6				10.0	8.8	11.8	10.6	5.4	7.6	7.2	7.6	5.1
7		5.2		10.2	8.6	12.1	10.4	5.4	7.4	7.0	7.6	
8	6.7			11.0	8.4	12.3	10.2	5.3	7.2	6.8	7.6	
9			6.1	11.4	8.4	12.5	10.0	5.7	7.0	6.6	7.6	
10				11.2	8.4	12.7	9.8	6.4	6.8	6.3	7.6	
11				10.9	8.2	13.1	9.5	6.7	6.7	6.2	7.5	
12				10.9	8.0	13.3	9.2	6.8	6.5	6.1	7.4	5.5
13				10.8	8.1	13.2	9.0	6.7	6.5	5.9	7.3	
14	6.8	5.4		10.9	8.0	13.0	8.6	6.7	6.4	5.8	7.2	5.5
15				11.2	7.9	12.6	8.3	6.7	6.3	5.6	7.0	5.4
16				11.5	7.8	12.2	8.0	6.8	6.3	5.5	6.9	6.6
17			6.0	11.8	7.7	11.8	7.8	6.9	6.2	5.4	6.9	
18				11.9	7.6	11.3	7.5	6.9	6.2	5.2	7.0	
19				12.0	7.5	10.9	7.3	6.8	6.2	5.1	6.5	7.3
20				11.9	7.5	10.6	7.1	6.7	6.2	5.1	6.2	
21		5.5		11.8	7.7	10.6	6.9	6.5	6.5	5.1	5.7	
22				11.5	8.4	10.5	6.8	6.3	6.6	5.0	5.5	
23				11.2	9.0	10.4	6.6	6.5	7.0	5.0	5.2	
24	5.4		6.1	10.9	9.8	10.3	6.5	6.7	7.2	5.2	5.2	
25				10.6	10.0	10.2	6.2	6.8	7.6	5.6	5.0	
26				10.3	10.3	10.2	6.1	7.2	8.0	6.1	5.7	6.2
27				10.0	10.8	10.1	5.9	7.6	8.2	6.6	5.9	
28		5.7		9.6	11.2	10.2	6.0	7.9	8.3	6.9	6.1	
29				9.4	11.6	10.2	6.2	8.1	8.2	7.1	6.2	
30	5.8		6.8	9.1	11.8	10.3	6.1	8.3	8.1	7.5	6.3	
31					12.0		6.1	8.4		7.7		
1907.[b]												
1				13.0	7.3	8.9	10.1	5.7	5.2	5.0	3.8	2.6
2	5.8			13.2	7.4	8.9	9.9	5.5	5.1	5.0	3.9	2.0
3				13.1	7.4	8.8	9.8	5.4	4.8	5.0	3.9	1.9
4				13.3	7.3	8.6	9.4	5.3	4.7	5.0	4.0	1.6
5				13.0	7.1	8.4	9.0	5.1	4.6	5.1	4.0	1.7
6		6.2	6.1	12.8	6.9	8.3	8.6	4.9	4.6	4.9	4.1	1.4
7				12.7	6.7	8.1	8.4	4.9	4.2	4.8	4.2	1.3
8				12.6	6.7	7.9	8.1	4.8	3.9	4.8	4.1	1.4
9	5.8			12.2	6.7	7.7	7.9	4.9	3.8	4.7	4.1	2.0
10				11.9	6.5	7.6	8.1	4.9	3.8	4.7	4.0	2.0
11				11.7	6.4	8.2	6.8	4.7	3.8	4.6	4.0	
12				11.6	6.2	8.9	6.4	4.6	3.7	4.5	3.9	
13		5.8	5.8	11.3	6.2	9.5	6.1	4.3	3.6	4.5	3.9	
14				11.1	6.1	10.0	6.0	4.6	3.6	4.3	3.8	
15				10.8	6.0	10.4	6.3	4.4	3.6	4.2	3.3	
16	5.3		6.0	10.3	6.2	10.6	6.2	4.2	3.6	4.1	3.3	
17				10.0	6.3	10.9	6.2	4.5	3.7	4.1	3.4	2.6
18				9.7	6.3	11.0	6.2	4.4	4.2	4.0	3.5	
19				9.4	6.3	11.0	6.2	4.5	4.5	4.0	3.3	
20		6.0	6.5	9.2	6.2	10.9	6.2	4.7	5.0	4.0	3.3	
21				9.0	6.2	10.8	6.2	5.1	5.3	4.0	3.4	
22				8.7	6.3	10.8	6.3	5.5	5.7	4.0	3.4	
23	5.4		8.8	8.5	6.3	10.8	6.2	5.5	6.0	3.9	3.4	
24			8.6	8.3	6.2	10.8	6.2	5.4	6.2	3.9	3.4	3.0
25			8.8	8.0	6.2	10.9	6.7	5.2	6.3	4.0	3.2	
26			9.1	7.9	6.6	10.8	6.5	5.0	6.3	4.0	3.1	
27		6.3	10.1	7.8	7.0	10.8	6.4	4.9	6.0	4.0	3.0	
28			11.1	7.5	7.5	10.7	6.3	4.9	5.7	4.0	3.0	
29			11.3	7.5	8.0	10.7	6.2	5.0	5.5	3.9	3.1	
30	5.8		11.8	7.3	8.5	10.4	6.0	5.0	5.2	3.8	2.8	2.8
31			12.3		8.7		5.9	5.3		3.8		

[a] Ice from Jan. 1 to Mar. 31 and from Dec. 1 to 31.
[b] Ice from Jan. 1 to Mar. 23 and from Dec. 1 to 31.

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.[a]												
1				5.9	7.4	13.6	16.4	7.3	3.8	3.9	3.9	3.0
2				5.4	7.5	14.5	16.0	7.1	4.0	3.9	3.9	
3				5.1	7.5	15.1	15.5	6.9	3.9	3.9	3.9	
4		2.6		5.3	7.4	15.3	15.0	6.5	3.9	3.9	3.9	1.6
5				5.3	7.1	15.2	14.4	6.4	3.9	3.9	3.8	
6				5.4	7.1	14.9	13.9	6.2	4.0	3.8	3.8	
7		2.5		5.4	6.7	14.5	13.4	6.0	3.9	3.9	3.8	
8				5.5	6.4	14.4	12.9	5.9	3.6	3.9	3.8	3.2
9	2.6			5.6	6.1	14.0	12.7	5.7	3.6	3.9	3.9	
10				5.5	5.9	14.2	12.3	5.4	3.5	3.9	3.3	
11				5.5	5.8	14.4	11.8	5.0	3.3	3.7	3.2	2.8
12				5.5	5.6	14.6	11.6	5.3	3.2	3.6	3.4	
13				5.5	5.8	14.9	11.3	5.1	3.6	3.6	3.2	
14		3.4		5.4	5.7	15.0	11.0	4.9	3.2	3.7	3.0	
15	2.2			5.4	6.0	14.8	10.6	4.8	3.2	3.5	3.0	3.0
16			3.8	5.3	6.4	14.5	10.3	4.5	3.0	3.4	3.0	
17	2.4		3.6	5.1	6.8	14.1	10.1	4.5	3.1	3.4	2.9	
18		3.3	3.4	5.1	7.0	13.6	10.0	4.4	3.4	3.3	2.8	2.8
19			4.3	5.0	7.1	13.3	9.7	4.6	3.4	3.0	2.7	
20			4.1	5.0	7.3	12.9	9.5	4.5	3.3	3.4	2.7	
21	2.2	3.2	4.1	4.8	7.8	12.5	9.2	4.4	3.2	3.4	2.7	
22			4.4	5.2	8.1	12.2	9.1	4.3	3.1	3.4	2.6	2.8
23			4.4	5.0	8.2	12.2	9.0	4.1	3.5	3.4	2.6	
24	2.7		4.6	5.0	8.5	12.2	8.8	4.0	3.5	3.4	2.6	
25		3.2	4.8	5.1	9.1	12.3	8.6	4.0	3.6	3.5	2.7	
26			5.1	5.4	9.4	13.0	8.3	3.9	3.2	3.5	2.8	2.8
27			5.1	5.8	9.9	14.7	8.0	3.9	3.6	3.8	3.0	
28	2.3	3.1	5.4	6.2	10.5	16.3	7.6	4.0	3.4	3.9	3.0	
29			5.5	6.7	11.1	16.8	7.5	3.9	3.5	3.8	3.0	
30			5.7	7.1	11.8	16.7	7.6	3.9	3.8	4.0	3.0	2.9
31	2.4		5.7		12.5		7.4	3.8		4.0		
1909.[b]												
1				10.5	7.4	6.9	7.2	4.4	4.7	3.6	2.8	5.1
2		3.5	2.8	11.4	7.4	7.4	7.4	4.3	4.5	3.6	3.0	5.4
3				12.4	7.3	7.8	7.4	4.0	4.5	3.6	3.1	5.6
4				13.0	7.3	8.1	7.3	3.9	4.3	3.4	2.9	5.8
5	3.1	3.6	2.7	13.0	7.4	8.2	7.4	3.8	4.2	3.3	3.1	5.8
6				12.8	7.4	8.5	7.4	3.8	4.0	3.2	3.5	
7				12.7	7.4	8.7	7.3	3.5	3.0	3.3	3.7	
8	3.2			12.5	7.6	8.8	7.2	3.5	3.9	3.3	3.7	
9		3.6	3.5	12.2	7.6	8.5	7.1	3.5	3.8	3.2	3.6	
10				11.9	7.6	8.4	6.8	3.5	3.7	3.2	3.5	4.1
11				11.8	7.5	8.2	6.5	3.5	3.5	3.5	3.5	
12	3.1		3.8	11.4	7.4	7 9	6.5	3.5	3.4	3.4	3.3	
13		3.4		11.0	7.2	7.6	6.3	4.0	3.8	3.6	3.4	
14				10.5	7.0	7.8	5.9	4.5	4.0	3.5	3.4	5.1
15	3.0		4.9	10.2	6.8	8.0	5.6	5.4	3.9	3.4	3.6	
16		3.6	5.0	9.8	6.8	8.0	5.1	5.7	3.7	3.3	3.8	
17			5.3	9.5	6.7	8.1	5.1	6.1	3.6	3.3	3.9	5.0
18			5.1	9.3	6.7	8.2	5.0	6.3	3.5	3.2	3.9	
19	3.1	3.4	4.7	9.1	6.8	8.1	4.7	6.3	3.4	3.2	3.8	
20			4.4	8.8	6.8	8.0	4.5	6.3	3.2	3.2	3.8	
21			4.5	8.6	6.8	7.9	4.5	6.2	3.2	3.2	4.2	4.9
22	3.0		4.3	8.3	6.8	7.8	4.5	6.0	3.7	3.1	4.4	
23		3.4	4.5	8.2	6.8	7.6	4.7	5.7	4.0	3.2	4.5	
24			4.9	8.0	6.8	7.4	4.7	5.5	4.1	3.2	4.3	4.8
25			5.5	7.8	6.8	7.2	5.4	5.4	4.0	3.3	4.2	
26	3.0	3.0	5.8	7.7	6.8	7.2	5.5	5.4	4.0	3.2	4.4	
27			6.4	7.6	6.8	7.2	5.3	5.3	4.0	3.3	4.6	
28			7.8	7.5	6.8	7.2	5.2	5.2	4.0	3.2	4.9	
29	3.0		8.3	7.4	6.8	7.2	5.1	5.1	3.9	3.3	4.9	
30			8.7	7.4	6.9	7.2	5.0	4.9	3.6	3.3	5.0	
31			9.6		6.9		4.7	4.7		2.9		

[a] Ice from Jan. 1 to Mar. 15 and from Nov. 25 to Dec. 31.
[b] Ice from Jan. 1 to Mar. 14 and from Nov. 21 to Dec. 31.

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910.[a]												
1				7.0	5.0	3.2	1.6	0.6	0.9	1.0	0.3	−0.2
2		3.2		6.6	4.9	3.0	1.8	.6	.9	1.0	.3	
3	4.0			6.4	4.5	3.0	1.5	.8	1.0	1.0	.5	
4		3.2		6.0	4.3	3.2	1.3	.8	1.1	1.0	1.1	
5				5.9	4.2	3.0	1.4	.6	1.0	1.3	1.0	
6	3.8			5.6	4.1	3.0	1.2	.6	.9	1.3	1.1	−.1
7				5.6	4.1	3.0	0.9	.7	.9	1.7	1.0	
8		3.2	4.5	5.6	4.1	3.0	.8	.7	1.0	1.8	1.0	
9			5.4	5.7	4.0	3.0	.8	.8	1.0	1.8	1.0	.3
10			6.0	5.5	4.0	3.0	1.2	.7	1.0	1.7	.9	
11	3.7	3.3	6.8	5.4	4.0	3.0	.9	.6	1.0	1.6	.8	
12			7.3	5.4	3.9	2.8	.9	.6	.9	1.6	.5	
13			7.0	5.2	3.8	2.3	1.0	.7	1.0	1.5	.4	.2
14	3.3		7.5	5.1	3.8	2.7	.9	.7	.9	1.5	.3	
15			8.8	5.1	3.7	2.5	.9	.7	.9	1.5	.6	.8
16		3.3	9.4	4.9	3.5	2.3	1.0	.8	1.0	1.5	.5	
17			9.9	4.8	3.4	2.0	.9	.8	1.0	1.3	.3	
18	3.3	3.2	10.3	4.8	3.6	2.3	.8	.8	1.0	.9	.2	
19			10.6	4.8	3.6	2.1	.8	.8	1.0	.8	−.3	
20			10.4	4.8	3.7	2.0	.7	.9	1.0	.8	−.2	.4
21	3.1	3.4	10.6	5.1	3.7	2.0	.6	1.0	1.0	.8	−.1	
22			10.4	5.2	3.8	1.9	.6	.9	1.0	.8	.1	.3
23			10.2	5.3	3.5	1.8	.6	1.0	.9	.8	.1	
24			9.9	5.3	3.8	1.6	1.1	.9	.9	.7	0	
25	3.2	3.4	9.3	5.4	3.8	1.8	.7	.9	.9	.7	0	
26			8.7	5.4	3.4	1.8	.6	.9	.9	.8	0	
27			8.5	5.5	3.8	1.8	.5	.9	.9	.6	0	.4
28	3.1		8.1	5.4	3.4	1.8	.5	.9	.9	.6	.1	
29			7.8	5.3	3.6	1.7	.5	.8	.9	.5		
30			7.5	5.1	3.4	1.4	.8	.8	1.0	.5		.3
31			7.3		3.2		.8	.8		.3		

[a] Ice from Jan. 1 to Mar. 7 and from Nov. 29 to Dec. 31.

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for 1892–1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
1892.												
1			4,000	10,600	8,520	39,500	23,900	15,200	7,520	6,440	5,060	
2			4,000	11,400	9,180	37,400	21,600	14,400	7,520	6,620	5,060	
3			4,000	12,700	9,400	35,800	20,700	16,000	8,300	6,640	4,920	
4			5,000	12,700	9,640	34,300	19,400	16,000	8,100	6,640	4,920	
5			5,000	10,600	9,640	32,700	18,000	13,000	7,900	6,280	4,920	
6			5,000	10,600	10,600	26,800	16,800	12,300	7,700	6,440	4,920	
7			8,100	10,900	11,200	30,200	16,000	11,700	7,700	6,280	4,920	
8			6,790	11,200	11,700	28,800	15,200	12,000	7,520	6,280	4,920	
9			6,440	10,900	10,600	30,700	14,000	11,400	7,520	6,280	4,920	
10			9,180	10,600	14,000	27,300	13,000	11,200	7,520	6,120	4,920	
11			10,600	10,100	15,600	29,700	12,000	10,600	7,700	6,120	4,780	
12			10,600	9,180	16,400	25,400	11,400	10,400	8,300	6,120	4,780	
13			10,600	8,950	16,400	25,400	10,900	9,880	8,300	6,120	4,920	
14			8,950	10,600	17,200	25,400	10,400	9,880	8,520	5,960	4,920	
15			8,730	10,400	18,000	24,900	9,640	9,400	8,300	5,960	4,780	
16			8,300	9,880	18,500	26,800	9,640	9,400	7,900	5,960	4,500	
17			7,900	9,400	18,500	29,200	9,400	9,180	7,520	5,800	4,110	
18			7,140	8,730	18,900	29,200	9,400	8,730	7,330	6,120	3,980	
19			7,140	8,520	19,800	30,200	10,600	8,520	6,960	5,960	4,110	
20			6,960	9,180	28,300	30,200	10,600	8,300	6,790	5,800	4,110	
21			6,440	8,100	33,800	30,700	10,900	8,100	6,790	5,800	3,980	
22			6,620	7,330	36,800	30,200	10,600	7,900	6,790	5,640	3,980	
23			6,280	7,330	40,100	29,200	10,900	7,700	6,620	5,640	3,980	
24			5,960	6,960	42,800	27,300	10,600	7,520	6,620	5,500	3,610	
25			6,120	6,620	45,100	26,300	10,400	7,520	6,440	5,500	3,600	

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1892.												
26	......	......	4,920	7,140	45,700	25,400	10,400	7,330	6,440	5,500	3,500	......
27	......	......	5,200	6,960	45,100	25,400	15,600	7,140	6,440	5,340	3,500	......
28	......	......	5,500	6,960	44,500	25,800	16,400	7,140	6,280	5,340	3,400	......
29	......	......	5,640	7,700	43,400	25,400	15,200	6,960	6,440	5,200	3,400	......
30	......	......	8,300	8,300	41,700	24,900	15,600	7,520	6,620	5,200	3,400	......
31	......	......	9,880	......	41,200	......	15,600	7,700	......	5,200	......	......
1893.												
1	......	......	......	18,900	47,500	29,200	8,410	4,900	5,740	5,740	6,100	3,980
1	......	......	......	22,500	52,400	27,800	8,000	4,900	6,100	5,920	5,400	3,840
3	......	......	......	24,900	55,600	26,300	7,800	4,900	6,100	5,740	5,920	4,130
4	......	......	......	28,800	57,500	24,900	7,800	4,740	5,740	5,560	5,560	4,130
5	......	......	......	32,700	58,800	23,900	8,000	4,740	5,740	5,740	5,400	3,980
6	......	......	......	34,300	58,800	22,500	7,800	4,740	5,920	6,100	5,400	4,280
7	......	......	......	34,800	58,800	22,100	7,410	4,740	5,740	6,280	5,740	4,280
8	......	......	......	34,800	58,200	21,100	7,800	4,740	5,560	6,280	5,740	4,280
9	......	......	......	35,800	56,800	19,800	7,800	4,430	5,560	6,100	5,560	4,280
10	......	......	......	36,300	54,900	18,500	7,600	4,280	5,920	6,100	5,220	......
11	......	......	......	35,300	52,400	17,600	7,800	4,130	5,740	5,920	5,060	......
12	......	......	......	35,300	49,900	16,800	8,000	4,280	5,920	5,920	5,060	......
13	......	......	......	34,800	47,500	15,900	8,000	4,430	5,920	5,920	4,900	......
14	......	......	......	33,200	46,300	14,700	8,000	4,580	6,100	5,920	4,900	......
15	......	......	......	32,700	43,400	14,000	8,000	4,900	6,100	5,920	4,900	......
16	......	......	......	31,200	41,700	13,200	7,800	4,900	6,100	5,920	4,900	......
17	......	......	......	31,200	40,600	12,800	7,600	4,900	6,100	6,100	4,580	......
18	......	......	......	30,700	39,500	12,200	7,410	4,900	6,100	6,100	4,430	......
19	......	......	......	29,700	37,900	11,500	7,220	4,740	6,280	6,100	4,130	......
20	......	......	......	29,700	36,800	11,200	7,020	4,740	6,280	6,100	3,400	......
21	......	......	......	29,700	35,300	10,900	6,640	4,740	6,100	6,100	3,260	......
22	......	......	......	28,800	33,200	10,600	6,460	4,740	5,920	6,100	3,400	......
23	......	......	......	27,300	31,700	10,100	6,280	4,740	5,920	6,100	3,260	......
24	......	......	......	27,300	30,200	9,800	5,920	4,580	5,920	6,100	3,120	......
25	......	......	......	27,800	30,200	9,550	5,740	4,740	5,920	6,100	2,980	......
26	......	......	......	30,200	31,700	9,550	5,560	4,430	5,920	5,920	2,440	......
27	......	......	......	34,300	32,200	9,550	5,560	4,280	5,920	5,920	3,260	......
28	......	......	......	37,400	32,700	9,550	5,400	4,430	5,920	5,920	4,130	......
29	......	......	......	41,200	32,700	9,070	5,400	5,060	5,740	5,920	4,280	......
30	......	......	......	44,500	31,700	8,840	4,900	5,220	5,920	5,920	4,280	......
31	......	......	......	......	30,700	......	5,060	5,400	......	6,100	......	......
1894.												
1	......	......	4,000	7,220	26,800	18,000	5,740	2,310	3,840	3,980	4,580	3,450
2	......	......	4,000	6,840	27,300	17,200	5,740	2,180	3,540	4,430	4,580	3,400
3	......	......	4,000	6,840	28,300	15,900	5,560	2,180	3,840	4,430	4,740	3,350
4	......	......	5,000	5,920	28,800	15,100	5,400	2,440	3,840	4,430	4,740	3,300
5	......	......	5,000	6,100	28,300	14,700	5,220	2,180	3,840	4,430	4,740	3,200
6	......	......	5,000	6,100	28,800	14,000	5,060	1,920	3,690	4,280	4,580	3,150
7	......	......	6,000	5,920	28,300	12,800	4,900	2,180	3,840	4,580	4,740	3,100
8	......	......	8,620	5,920	28,300	12,200	4,580	2,310	3,980	4,580	4,740	3,050
9	......	......	9,070	5,920	27,800	11,200	4,430	2,050	4,130	4,430	4,580	3,000
10	......	......	8,200	6,460	27,800	10,600	4,430	2,310	4,130	4,430	4,430	2,950
11	......	......	7,800	6,640	27,300	10,100	4,430	3,260	3,980	4,580	4,280	2,820
12	......	......	7,020	7,020	25,800	9,550	4,430	3,540	4,130	4,740	4,130	2,820
13	......	......	6,640	7,220	23,900	9,310	4,280	3,980	4,130	4,580	4,280	2,820
14	......	......	6,840	7,410	23,900	8,840	4,130	4,280	4,130	4,430	4,280	2,820
15	......	......	6,840	7,600	23,500	8,410	4,130	3,980	4,130	4,280	4,280	2,820
16	......	......	6,840	8,200	24,900	8,200	3,980	4,130	4,280	4,130	4,280	2,820
17	......	......	6,840	9,310	28,800	8,000	3,690	3,980	4,280	4,130	2,980	2,820
18	......	......	6,840	11,500	32,200	7,800	3,690	3,690	4,280	3,840	2,980	2,820
19	......	......	7,020	15,500	38,400	7,600	3,690	3,980	3,980	3,840	3,120	2,820
20	......	......	7,600	19,800	40,600	7,410	3,980	4,130	3,840	3,980	4,130	2,820
21	......	......	8,000	24,400	41,200	7,020	3,840	4,130	3,690	4,430	4,430	2,820
22	......	......	8,200	28,300	40,600	7,020	3,400	4,280	3,690	4,130	4,130	2,750
23	......	......	8,200	31,700	38,400	6,640	3,260	4,280	3,840	4,130	3,260	2,690
24	......	......	8,200	33,800	35,300	6,100	3,400	4,430	3,840	3,980	3,260	2,590
25	......	......	6,640	34,800	32,200	6,100	3,400	4,280	3,980	4,130	3,690	2,500
26	......	......	5,560	33,800	29,200	6,100	2,980	4,130	3,980	3,980	3,690	2,400
27	......	......	4,900	32,200	25,800	5,920	2,980	4,130	3,690	3,840	3,540	2,300
28	......	......	4,430	30,200	23,900	5,920	2,840	4,280	3,690	3,840	3,500	2,200
29	......	......	6,100	28,300	21,600	5,740	2,710	3,690	3,690	4,130	3,500	2,100
30	......	......	7,020	27,300	20,200	5,920	1,920	3,840	3,840	4,280	3,500	2,000
31	......	......	8,000	......	19,400	......	2,440	3,980	......	4,580	......	1,900

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1895.												
1	1,900	......	......	3,610	3,230	4,640	7,700	4,110	4,640	5,500	4,110	......
2	1,830	......	......	3,610	3,370	4,920	7,900	3,980	4,240	5,060	3,860	......
3	1,760	......	......	3,610	3,490	6,120	7,700	3,610	4,500	5,200	3,860	......
4	1,710	1,060	......	3,490	3,730	5,960	7,140	3,610	4,500	5,200	3,860	......
5	1,680	1,320	......	3,610	3,980	5,800	6,620	3,490	4,640	5,060	4,110	......
6	1,650	1,300	......	3,610	4,110	6,280	6,620	3,730	4,640	5,200	4,240	......
7	1,620	......	......	3,610	4,780	6,120	6,440	3,370	4,780	5,060	3,860	......
8	1,590	......	......	3,490	4,920	6,280	6,440	3,490	4,920	5,200	4,110	......
9	1,560	......	......	3,610	5,060	6,440	6,620	3,610	4,780	5,200	4,240	......
10	1,310	......	......	3,360	5,060	6,620	6,620	3,980	4,920	5,060	4,110	......
11	1,420	1,220	......	3,610	5,640	8,100	6,120	4,370	4,920	5,060	3,980	......
12	1,530	1,370	......	3,860	5,340	8,520	5,960	4,500	4,920	5,060	4,240	......
13	1,590	1,460	......	3,610	5,340	8,520	5,800	4,640	4,920	4,780	4,110	......
14	1,650	1,360	......	3,610	5,200	9,180	5,500	4,780	4,780	4,500	4,110	......
15	1,710	......	......	3,490	4,920	9,400	5,640	5,340	4,500	4,780	4,240	......
16	1,660	......	......	3,490	5,200	9,640	5,500	4,920	4,240	4,640	4,240	......
17	1,610	......	......	3,370	4,920	9,640	5,340	4,920	4,780	4,780	4,110	......
18	1,560	......	......	3,370	4,920	9,400	5,800	5,200	4,500	4,640	3,980	......
19	1,500	......	......	3,230	4,640	8,950	5,640	4,920	4,640	4,500	4,110	......
20	1,540	......	......	3,230	4,240	8,300	5,340	5,200	4,640	4,500	4,240	......
21	1,590	......	......	3,230	4,640	7,900	5,060	4,920	4,780	4,240	3,490	......
22	1,550	......	2,630	3,370	4,500	7,700	4,780	4,640	5,060	4,500	3,110	......
23	1,340	......	2,750	3,490	4,240	7,520	4,780	4,500	5,340	4,240	3,110	......
24	1,400	......	2,990	3,110	4,240	7,330	4,640	4,640	5,640	4,370	2,990	......
25	1,380	......	3,110	2,990	4,240	7,140	4,640	4,640	5,500	4,240	3,110	......
26	1,400	......	3,110	3,110	4,370	7,140	4,640	4,500	5,340	4,240	3,110	......
27	1,420	......	3,610	3,490	4,240	7,140	4,640	4,780	5,200	4,110	3,110	......
28	1,440	......	4,110	3,110	4,500	7,330	4,500	4,640	5,200	3,860	3,000	......
29	1,520	......	3,980	2,750	4,640	7,520	4,240	4,640	5,200	4,240	3,000	......
30	1,250	......	3,980	3,490	4,640	7,700	4,640	4,500	5,060	4,110	3,000	......
31	1,200	......	3,980	......	4,500	......	4,240	4,500	......	4,110	......	......
1896.												
1	......	......	......	3,230	21,600	27,300	12,700	4,780	5,060	5,060	5,640	4,500
2	......	......	......	2,400	23,500	25,400	11,700	4,640	4,640	5,060	5,640	5,000
3	......	......	......	2,280	24,900	24,400	11,400	4,640	4,500	4,920	6,280	4,580
4	......	......	......	2,870	26,300	22,500	11,200	5,060	4,110	5,060	6,120	4,490
5	......	......	......	3,600	27,300	22,100	10,900	4,500	4,110	4,780	6,120	4,550
6	......	......	......	4,110	27,800	20,200	10,100	4,500	3,980	5,200	6,120	4,510
7	......	......	......	4,500	28,300	22,100	9,880	4,640	4,110	4,780	6,280	4,470
8	......	......	......	4,640	27,300	22,500	9,640	5,060	4,370	4,640	6,440	4,430
9	......	......	......	4,640	26,800	23,500	8,950	4,920	4,500	4,640	6,280	4,390
10	......	......	2,170	4,640	25,800	24,900	8,730	4,920	4,780	4,780	6,280	4,300
11	......	......	1,950	5,060	25,400	25,800	8,520	5,200	4,920	4,780	5,800	4,290
12	......	......	2,060	5,960	23,900	26,300	8,520	5,340	4,780	5,060	5,200	4,290
13	......	......	2,170	8,100	23,900	26,300	8,300	5,640	4,640	5,200	4,780	4,280
14	......	......	2,400	17,600	23,900	25,400	8,100	5,800	4,640	5,200	4,920	4,280
15	......	......	2,400	23,500	24,400	23,900	7,900	5,800	4,780	5,340	5,060	4,270
16	......	......	1,840	29,200	24,900	22,100	7,330	5,640	5,200	5,200	4,640	4,270
17	......	......	2,170	34,300	27,800	20,200	6,790	5,500	5,340	5,200	4,920	4,260
18	......	......	1,950	35,300	29,700	18,500	6,440	5,340	5,340	5,060	4,920	4,260
19	......	......	1,420	33,800	31,700	17,200	6,280	5,200	5,340	5,060	4,920	4,250
20	......	......	1,420	31,200	33,200	16,400	6,120	5,060	5,200	5,200	4,370	4,250
21	......	......	1,520	29,200	34,300	15,600	6,280	5,060	5,060	5,200	4,240	4,240
22	......	......	1,420	26,800	34,300	14,000	5,960	4,920	4,920	5,060	4,640	4,530
23	......	......	1,520	24,900	33,800	14,400	5,960	5,060	4,920	4,920	4,200	4,150
24	......	......	1,950	23,500	32,700	15,200	5,800	5,060	4,920	4,920	4,200	4,260
25	......	......	1,950	21,100	31,700	16,000	5,800	5,200	4,780	5,060	4,200	4,360
26	......	......	2,170	20,200	30,200	16,400	5,640	4,920	4,920	4,920	4,200	4,460
27	......	......	2,170	19,400	29,200	16,800	5,500	4,920	5,060	4,780	4,000	4,570
28	......	......	2,280	18,000	29,200	16,000	5,060	4,920	5,060	4,920	4,000	4,670
29	......	......	2,520	18,500	29,200	14,400	4,920	4,780	5,060	4,780	4,000	4,550
30	......	......	2,630	19,800	29,200	13,700	4,780	4,640	4,920	5,340	4,000	4,430
31	......	......	3,230	......	28,300	......	4,640	4,780	......	5,640	......	4,500
1897.												
1	5,300	3,400	3,250	60,800	29,800	10,200	14,400	24,600	8,500	10,100	7,600	......
2	5,340	3,450	3,300	68,700	28,800	11,000	14,800	23,700	8,500	9,800	7,800	......
3	5,200	3,320	3,360	74,000	27,900	11,000	15,200	23,300	8,720	9,550	7,800	......
4	5,100	3,330	3,340	76,300	25,600	11,000	15,600	22,400	8,720	9,070	7,800	......
5	4,950	3,400	3,310	80,100	24,200	11,600	20,200	21,500	8,720	9,310	7,600	......

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1897.												
6	4,810	3,400	3,170	80,800	22,800	11,900	24,600	20,600	8,940	9,070	7,600	......
7	5,010	3,420	3,220	79,300	21,500	12,300	29,300	19,300	8,940	9,070	7,600	......
8	5,210	3,440	3,270	78,600	20,200	12,600	40,100	19,700	8,720	8,840	7,600	......
9	5,100	3,460	3,320	79,300	18,900	12,300	45,900	18,900	8,720	8,840	7,600	......
10	5,170	3,480	3,150	78,600	17,600	12,300	47,700	17,200	8,500	8,620	7,410	......
11	5,240	3,500	3,230	77,000	16,800	12,600	49,600	16,000	8,500	8,200	7,220	......
12	4,500	3,550	3,320	74,000	16,400	12,300	48,900	14,800	8,500	8,410	7,220	......
13	4,520	3,490	3,000	70,200	15,600	11,600	47,700	13,700	8,720	8,410	7,220	......
14	4,560	3,450	3,060	67,300	15,200	11,900	45,900	12,600	9,400	8,200	7,220	......
15	4,600	3,410	3,120	63,600	14,800	11,900	43,500	11,900	9,900	8,000	7,220	......
16	4,390	3,380	3,180	60,100	14,400	12,300	47,700	11,300	10,900	8,000	7,220	......
17	4,340	3,270	3,160	58,000	14,100	12,300	39,000	11,000	11,800	8,000	7,020	......
18	4,290	3,170	3,320	56,000	14,100	12,600	36,300	10,700	11,800	7,800	7,020	......
19	4,240	3,130	4,250	52,100	14,100	13,300	33,700	10,700	11,800	8,000	6,840	......
20	4,080	3,180	5,440	50,200	14,100	14,100	31,800	10,400	11,500	8,200	6,640	......
21	3,880	3,230	9,400	47,700	14,100	14,800	30,800	10,200	11,200	8,200	6,460	......
22	3,680	3,280	11,000	45,900	13,300	15,200	29,300	10,200	11,500	8,200	6,460	......
23	3,480	3,350	14,400	44,700	12,600	15,600	28,400	9,900	11,500	8,200	5,920	......
24	3,440	3,390	18,900	42,400	11,900	15,200	27,900	9,650	11,200	8,410	5,400	......
25	3,400	3,270	22,400	40,600	11,600	14,800	27,400	9,650	10,900	8,200	5,220	......
26	3,350	3,190	25,600	38,400	11,300	13,700	28,800	9,650	10,300	8,200	5,060	......
27	3,300	3,120	27,400	36,800	11,300	13,000	28,800	9,160	10,300	8,000	4,900	......
28	3,340	3,200	29,300	34,700	11,000	13,000	27,900	8,940	10,300	7,800	4,900	......
29	3,050	......	30,300	32,700	10,700	13,300	27,000	8,720	10,300	7,800	4,800	......
30	3,200	......	41,200	31,300	10,400	14,100	25,600	8,500	10,100	7,600	4,700	......
31	3,300	......	48,900	......	10,400	......	25,100	8,500	......	7,600	......	......
1898.												
1	......	......	4,000	7,900	6,790	11,200	10,100	7,900	6,790	6,620	8,100	......
2	......	......	4,000	7,520	6,960	11,200	10,600	7,900	6,620	6,280	8,100	......
3	......	......	4,000	7,520	7,140	11,200	10,400	7,520	6,280	6,120	7,900	......
4	......	......	5,000	7,520	7,140	10,600	10,400	7,330	6,120	6,120	7,900	......
5	......	......	5,000	7,900	7,520	10,900	10,600	6,960	6,120	6,120	7,900	......
6	......	......	5,000	8,100	7,520	26,300	11,200	7,900	6,120	6,280	7,700	......
7	......	......	5,000	8,100	7,700	33,200	12,000	7,140	6,120	6,620	7,330	......
8	......	......	7,700	8,100	7,520	35,300	12,300	7,140	5,960	6,790	7,330	......
9	......	......	7,900	8,100	7,140	35,300	12,700	6,960	5,960	6,790	7,330	......
10	......	......	8,520	7,900	7,140	34,300	14,000	6,790	5,960	6,960	7,140	......
11	......	......	8,730	7,900	6,620	32,700	15,200	6,440	6,280	7,520	7,140	......
12	......	......	8,520	8,300	6,620	31,200	16,400	6,440	6,120	7,330	6,960	......
13	......	......	7,520	8,300	6,280	29,700	17,200	6,440	6,120	7,900	6,960	......
14	......	......	6,620	8,100	6,280	28,800	16,000	6,120	6,440	8,300	6,620	......
15	......	......	8,730	8,520	6,620	26,800	14,400	5,960	6,620	8,300	6,620	......
16	......	......	8,100	8,520	6,440	23,900	13,300	6,440	6,620	8,520	6,620	......
17	......	......	7,900	8,300	6,440	21,600	12,000	6,120	6,440	8,520	6,620	......
18	......	......	7,700	8,100	6,440	19,800	11,400	6,120	6,440	8,730	6,620	......
19	......	......	8,300	8,100	6,620	18,500	10,900	6,120	6,120	8,730	6,620	......
20	......	......	8,100	8,100	6,790	17,200	10,600	5,960	6,120	8,950	6,790	......
21	......	......	7,900	7,900	6,960	16,000	10,100	6,120	6,120	9,180	6,620	......
22	......	......	7,900	7,700	7,900	15,200	9,640	6,120	6,120	9,400	6,620	......
23	......	......	7,700	7,330	8,300	14,800	9,180	6,120	6,280	9,640	6,000	......
24	......	......	6,440	7,140	8,950	13,700	8,950	6,280	6,280	9,640	6,000	......
25	......	......	7,140	6,620	9,640	12,700	8,730	6,440	6,620	9,640	6,000	......
26	......	......	7,900	6,790	9,880	11,400	8,730	6,440	6,620	9,400	5,000	......
27	......	......	8,100	6,440	9,400	10,900	8,730	6,440	6,620	9,400	5,000	......
28	......	......	7,520	6,440	9,880	10,600	8,300	6,620	6,620	9,180	5,000	......
29	......	......	6,120	6,440	10,100	10,100	8,100	6,790	6,620	8,730	5,000	......
30	......	......	6,120	6,440	10,600	9,880	8,100	6,960	6,790	8,520	5,000	......
31	......	......	7,140	......	10,600	......	8,300	6,960	......	8,300	......	......
1899.												
1	......	......	......	8,000	15,200	12,700	25,400	8,300	19,800	9,180	18,500	9,880
2	......	......	......	8,000	16,000	16,000	25,400	7,900	18,500	8,950	18,000	9,880
3	......	......	......	8,000	16,800	20,700	24,400	7,700	17,200	8,730	17,600	9,640
4	......	......	......	9,000	17,600	23,000	23,500	7,700	16,400	8,730	16,800	9,400
5	......	......	......	9,000	18,000	24,400	22,100	7,520	15,200	8,730	16,400	8,730
6	......	......	......	9,000	18,500	25,400	21,100	7,330	14,400	8,520	16,000	8,730
7	......	......	......	9,000	19,800	27,800	19,800	7,330	14,400	8,520	15,600	5,640
8	......	......	......	10,600	20,200	29,700	18,900	7,330	14,000	8,520	15,200	5,640
9	......	......	......	17,200	19,800	30,200	17,600	7,330	13,300	8,300	14,400	6,790
10	......	......	......	19,400	18,500	30,700	16,800	7,700	13,000	8,300	14,000	6,790

Daily discharge, in second feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1899.												
11				19,800	17,200	31,200	15,600	8,100	12,700	8,300	13,700	6,790
12				22,500	16,400	30,200	14,400	8,300	12,700	8,520	13,700	6,790
13				30,700	15,600	31,200	13,700	8,520	12,700	8,520	13,300	
14				34,300	14,400	31,700	13,300	7,900	12,300	8,950	13,000	
15				33,200	14,000	33,200	13,300	7,900	12,300	9,180	12,700	
16				33,800	13,700	34,300	13,700	7,900	12,300	9,640	12,300	
17				33,800	14,000	34,800	12,700	8,300	12,000	11,400	12,000	
18				33,800	14,000	35,800	11,700	8,300	11,400	13,000	11,700	
19				32,200	13,700	36,300	11,200	8,300	11,200	16,400	11,700	
20				29,200	13,300	36,300	10,900	8,950	10,900	19,800	11,400	
21				25,800	13,300	36,300	10,600	9,640	10,600	22,100	11,200	
22				22,100	13,300	36,800	10,600	13,000	10,600	23,900	10,900	
23				19,400	13,300	36,800	10,600	16,000	10,600	25,400	10,600	
24				17,600	13,000	36,300	10,100	22,100	10,600	25,800	10,600	
25				16,400	13,000	35,300	9,880	25,400	10,400	25,400	10,600	
26				15,600	13 000	33,200	9,640	25,800	10,400	24,900	10,600	
27				14,800	12,700	31,200	9,400	25,400	10,100	23,000	10,400	
28				14,000	13,000	29,200	8,950	24,400	10,100	22,100	10,400	
29				14,000	13,000	27,800	8,730	23,500	9,880	21,100	10,100	
30				14,400	12,700	25,800	8,520	22,100	9,400	20,200	10,100	
31					12,700		8,300	20,700		19,400		
1900.												
1				7,140	7,700	6,790	3,370	3,730	11,700	13,000	9,400	
2				6,440	7,700	6,440	3,260	3,860	11,400	13,000	9,400	
3				6,790	7,900	6,280	3,610	3,860	10,600	13,300	9,400	
4				7,700	7,900	5,960	4,920	3,860	10,100	13,300	9,400	
5				7,900	7,900	5,800	5,800	3,610	9,880	14,800	9,640	
6				9,640	7,700	5,640	6,280	3,610	9,400	15,600	9,640	
7				12,300	7,330	5,640	6,280	3,610	8,730	16,000	9,640	
8				12,300	7,140	5,500	6,440	3,730	8,300	14,800	9,400	
9				11,200	6,960	5,500	6,280	3,860	8,100	14,400	9,180	
10				10,600	7,330	5,500	6,280	4,240	8,700	13,700	8,950	
11				10,100	6,790	4,640	6,120	5,200	9,180	13,300	8,730	
12				9,400	6,440	4,640	6,120	6,120	11,400	13,000	8,520	
13				8,950	6,280	4,780	6,440	6,280	13,000	12,700	8,300	
14				8,730	6,120	4,780	6,440	7,330	12,700	12,700	7,900	
15				8,520	6,120	4,240	6,120	7,700	12,000	11,700	7,330	
16				8,300	6,120	4,240	6,120	8,300	11,400	11,400	5,960	
17				9,180	6,120	4,110	5,800	8,730	11,200	11,400	5,060	
18				9,640	6,280	3,980	5,640	8,950	10,900	11,400	4,920	
19				10,100	6,280	3,980	5,340	8,730	10,600	11,200	4,920	
20				9,640	5,800	3,860	5,200	8,300	11,200	10,900	5,060	
21				9,180	5,640	3,860	5,200	7,900	12,000	10,600	5,060	
22				8,730	5,960	3,860	5,200	7,700	12,700	10,100	5,060	
23				8,300	6,120	3,860	5,200	7,700	13,300	10,100	4,920	
24				8,300	6,120	3,860	5,060	8,100	13,300	9,640	4,780	
25				8,300	6,120	3,610	4,640	8,520	13,700	9,400	4,370	
26				8,100	5,960	3,610	4,240	9,400	13,700	9,400	3,980	
27				7,900	6,120	3,610	3,730	9,880	13,700	8,950	4,640	
28				7,900	6,120	3,490	3,730	10,600	13,700	9,400	5,060	
29				7,900	6,790	3,490	3,980	11,700	13,300	9,640	4,920	
30				7,700	6,960	3,370	3,610	12,000	13,000	9,400	4,920	
31					6,960		3,610	11,700		8,950		
1901.												
1				11,700	13,700	10,600	13,700	7,900	5,800	5,800	5,960	
2				12,300	13,700	10,400	14,800	7,700	6,120	5,800	5,960	
3				12,300	14,000	10,100	15,200	7,140	5,960	5,800	6,120	
4				13,000	14,000	10,100	15,600	6,960	5,960	5,960	5,960	
5				14,000	16,800	9,880	15,600	6,620	5,800	5,960	5,960	
6				15,600	17,200	9,880	16,000	6,440	5,800	5,800	5,960	
7				15,200	18,000	9,400	16,400	6,440	5,800	5,500	5,800	
8				15,600	18,500	8,950	17,200	6,280	5,640	5,500	5,800	
9				16,800	18,900	8,730	17,600	6,120	5,500	5,500	5,640	
10				18,500	18,900	8,520	18,000	5,960	5,640	5,500	5,640	
11				18,900	18,900	8,730	18,500	5,800	5,800	5,640	5,640	
12				19,800	18,000	8,950	18,500	5,500	5,960	5,800	5,800	
13				18,500	17,600	8,950	18,500	5,340	5,640	5,800	5,640	
14				16,400	17,600	8,520	17,600	5,640	5,640	5,960	5,640	
15				15,600	17,200	8,950	17,200	5,960	5,500	6,280	5,640	

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901.												
16				15,600	16,800	8,950	16,800	6,280	5,340	6,620	5,500	
17				16,400	16,400	8,520	16,400	6,280	5,340	6,440	4,780	
18				16,000	16,400	8,300	16,000	6,120	5,200	6,440	4,240	
19				16,000	16,000	8,300	15,200	5,960	5,060	6,280	4,370	
20				16,000	15,600	8,730	14,000	5,800	5,060	6,280	4,370	
21				15,600	15,200	9,180	13,000	5,800	5,060	6,280	4,370	
22				15,600	14,400	10,600	12,000	5,800	4,920	6,120	4,370	
23				15,600	14,400	12,000	11,400	5,640	4,920	6,120	4,500	
24				15,200	14,000	12,300	10,600	5,640	4,920	5,960	4,500	
25			11,700	15,200	13,300	12,700	10,100	5,640	5,060	5,960	3,980	
26			13,000	14,800	13,000	12,700	9,400	5,500	5,200	5,800	4,370	
27			12,700	14,800	12,300	12,700	8,950	5,640	5,340	5,800	4,240	
28			11,700	14,800	11,700	12,300	8,520	5,800	5,500	5,800	4,110	
29			11,200	14,400	11,400	14,000	8,300	5,800	5,640	5,800	3,980	
30			11,400	14,000	11,200	14,400	8,100	5,800	5,500	5,960	4,240	
31			11,400		10,900		8,100	5,800		5,960		
1902.												
1			3,000	5,060	4,780	14,800	9,880	7,140	4,240	4,780	5,500	7,140
2			3,100	5,060	4,920	14,000	9,640	6,620	4,370	4,920	5,500	6,620
3			3,200	5,200	4,780	13,700	9,180	6,280	4,920	4,920	5,640	6,440
4			3,300	5,200	5,060	14,000	8,950	5,800	5,500	5,060	5,800	
5			3,400	5,060	5,060	15,200	8,730	5,800	5,960	5,060	5,960	
6			3,400	4,920	5,200	16,000	8,730	5,340	6,280	5,060	6,440	
7			3,500	4,640	5,200	16,400	8,300	5,340	6,620	5,200	6,790	
8			3,500	4,640	5,340	16,400	8,100	5,500	6,280	5,200	7,140	
9			3,600	4,780	5,500	16,800	8,100	5,500	6,440	5,200	7,330	
10			3,730	4,920	6,120	16,800	8,520	6,120	6,440	5,200	7,330	
11			3,860	4,780	8,520	16,400	8,950	5,500	6,280	5,200	7,330	
12			3,860	4,640	8,950	16,400	8,950	5,200	5,960	5,200	7,330	
13			3,860	4,500	9,400	16,400	8,950	5,200	5,640	4,920	7,520	
14			4,240	4,500	9,180	16,000	8,520	5,060	5,200	4,920	7,520	
15			4,640	4,370	8,950	15,200	8,100	5,060	4,920	4,920	7,520	
16			5,060	4,370	8,730	14,400	7,900	4,920	5,060	4,780	7,520	
17			4,400	4,500	8,730	14,000	8,300	4,920	5,200	4,780	7,700	
18			4,400	4,240	8,950	13,700	7,900	4,640	5,200	4,640	8,100	
19			4,240	4,110	8,950	13,000	7,330	4,500	5,060	4,640	8,520	
20			4,780	3,980	9,180	12,300	7,140	4,500	4,920	4,500	8,950	
21			5,060	3,860	9,180	12,000	6,440	4,370	5,200	4,500	9,400	
22			5,200	3,980	9,400	11,700	6,120	4,640	5,060	4,640	9,400	
23			5,200	3,980	12,300	11,200	5,800	4,640	5,200	4,640	9,640	
24			5,340	3,860	17,200	10,900	5,640	4,640	5,200	4,640	9,400	
25			5,800	3,860	19,400	10,900	5,640	4,240	5,060	4,640	9,400	
26			5,960	4,500	19,800	10,400	5,960	4,370	4,920	4,640	9,180	
27			6,120	4,640	19,800	10,100	6,120	4,370	4,920	4,640	9,180	
28			5,800	4,500	18,900	10,100	6,120	4,240	4,780	4,780	8,730	
29			5,400	4,500	17,600	10,100	6,280	4,110	4,640	5,060	7,900	
30			5,340	4,640	16,400	9,880	6,960	4,110	4,640	5,340	7,520	
31			5,060		15,600		7,140	4,110		5,340		
1903.												
1			2,000	20,600	18,200	34,700	7,170	12,300	8,390	26,300	19,000	
2			2,000	19,000	18,200	39,100	7,170	13,000	8,390	24,000	17,800	
3			2,200	18,600	17,800	42,500	7,760	13,700	8,610	22,700	16,600	
4			2,200	18,600	17,800	42,500	10,000	14,700	8,830	22,700	15,500	
5			2,400	18,600	17,800	40,200	14,400	15,100	9,300	22,700	15,100	
6			2,600	18,200	18,200	36,400	16,200	15,500	9,300	24,000	15,100	
7			3,000	19,400	18,600	33,200	17,400	15,500	9,300	29,600	15,100	
8			4,000	19,400	19,000	29,600	17,400	15,800	9,540	36,400	14,700	
9			5,000	19,000	19,400	26,800	17,400	15,500	9,790	40,800	14,700	
10			6,000	18,200	19,000	24,000	18,600	14,700	9,790	44,200	14,000	
11			7,000	19,000	19,000	21,000	19,800	14,000	9,540	47,100	13,000	
12			8,000	20,200	21,000	17,800	21,000	13,300	10,300	48,800	12,600	
13			9,000	21,800	24,000	14,700	21,400	12,300	19,800	50,600	12,600	
14			10,000	23,200	27,200	13,000	20,600	11,700	25,400	51,800	12,600	
15			14,700	24,500	30,100	12,600	19,400	11,400	29,200	51,200	12,600	
16			15,100	25,400	32,600	12,300	18,600	11,100	32,200	49,400	12,300	
17			15,800	26,300	34,200	11,700	18,600	10,800	34,700	47,600	12,000	
18			15,500	26,800	36,400	10,800	18,600	10,800	36,400	45,900	11,400	
19			15,800	26,300	36,900	10,300	16,600	10,800	38,000	43,600	10,300	
20			19,000	25,800	36,400	10,000	15,500	10,800	40,200	40,800	8,390	

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
21	......	......	20,200	24,900	35,300	9,790	14,700	10,800	41,300	38,000	7,170	......
22	......	......	21,400	23,600	34,200	9,540	14,400	10,800	42,500	35,800	6,800	......
23	......	......	21,400	22,300	32,600	9,300	14,400	10,300	42,500	33,200	6,800	......
24	......	......	22,300	21,800	30,100	9,060	14,000	10,000	42,500	31,100	7,360	......
25	......	......	23,200	20,600	29,200	8,610	13,700	9,540	41,300	29,200	7,970	......
26	......	......	24,000	19,800	28,700	8,390	12,600	9,060	39,100	27,200	8,830	......
27	......	......	24,000	19,400	28,700	8,180	12,600	8,610	36,900	25,400	10,300	......
28	......	......	24,000	19,400	29,600	7,970	12,000	8,390	34,200	24,000	12,000	......
29	......	......	23,200	19,000	29,600	7,970	11,700	8,830	31,600	22,700	13,000	......
30	......	......	21,800	19,000	29,600	7,560	11,700	9,060	28,700	21,000	11,400	......
31	......	......	12,400	......	31,100	......	12,000	8,610	......	19,800	......	......
1904.												
1	......	......	......	14,000	24,000	13,700	12,000	7,760	6 620	7,170	16,600	......
2	......	......	......	13,300	23,600	13,300	12,000	7,760	6,440	7,760	15,500	......
3	......	......	......	13,000	22,700	13,700	11,700	7,560	7,970	7,970	14,400	......
4	......	......	......	14,000	21,800	14,400	11,700	7,360	9,300	8,180	13,300	......
5	......	......	......	15,500	20,600	15,500	11,400	7,170	9,790	7,760	13,000	......
6	......	......	......	16,600	20,200	15,800	11,100	7,170	10,300	7,560	12,600	......
7	......	......	......	24,500	20,200	17,800	10,800	6,980	11,700	7,560	12,600	......
8	......	......	......	26,300	20,600	19,400	10,800	6,620	12,000	7,970	12,300	......
9	......	......	......	27,200	20,200	20,600	10,800	6,620	12,000	8,180	11,400	......
10	......	......	......	30,600	19,800	21,400	11,400	6,800	12,000	8,830	10,600	......
11	......	......	......	31,600	19,400	21,800	11,100	6,800	12,000	9,300	10,800	......
12	......	......	......	31,600	20,200	21,400	10,600	6,800	11,400	14,000	10,800	......
13	......	......	......	31,100	20,600	21,000	10,000	6,800	10,600	14,700	10,300	......
14	......	......	......	30,100	20,200	20,600	9,790	6,800	9,540	14,700	10,000	......
15	......	......	......	29,200	19,800	19,800	9,300	6,800	8,610	16,200	10,000	......
16	......	......	......	29,200	19,400	18,200	9,060	6,620	8,390	17,400	9,790	......
17	......	......	......	28,200	18,600	17,000	8,830	6,440	8,180	18,200	9,540	......
18	......	......	......	26,800	17,800	15,800	8,610	6,270	7,970	17,800	9,060	......
19	......	......	......	25,800	17,400	14,400	8,610	6,100	7,560	17,800	9,060	......
20	......	......	......	24,900	17,000	13,300	8,610	6,620	7,360	18,600	8,830	......
21	......	......	......	24,500	16,200	12,600	8,390	6,980	6,980	19,000	8,610	......
22	......	......	......	23,600	15,800	12,300	8,180	7,170	6,800	20,600	8,610	......
23	......	......	......	23,600	15,500	11,700	8,390	7,760	6,620	21,400	8,390	......
24	......	......	......	23,200	15,100	11,400	8,390	8,180	6,620	20,600	8,390	......
25	......	......	......	23,200	15,100	11,400	8,180	8,390	6,620	21,000	8,390	......
26	......	......	......	23,200	15,100	11,100	7,970	8,180	6,440	21,400	8,390	......
27	......	......	......	24,500	15,100	11,400	7,760	8,390	6,440	21,800	8,180	......
28	......	......	......	24,900	15,500	11,700	7,560	8,390	6,800	21,800	8,180	......
29	......	......	......	25,400	15,500	12,300	7,360	8,390	6,800	20,600	7,970	......
30	......	......	......	24,900	14,700	12,000	7,560	7,760	6,620	19,400	7,560	......
31	......	......	......	......	14,000	......	7,760	7,170	......	17,800	......	......
1905.												
1	......	......	2,500	10,800	8,390	21,000	40,800	21,800	15,800	14,400	12,600	......
2	......	......	2,600	10,800	8,180	19,000	40,200	20,600	15,100	14,000	12,300	......
3	......	......	2,700	10,800	8,180	18,200	40,800	19,800	15,100	13,300	12,000	......
4	......	......	2,800	11,100	8,390	18,200	41,300	19,400	14,700	13,300	12,000	......
5	......	......	3,000	12,600	9,300	18,600	43,000	19,400	14,700	13,300	11,700	......
6	......	......	5,000	12,000	10,800	18,600	45,900	19,800	14,400	13,000	12,000	......
7	......	......	12,600	14,000	15,500	20,200	49,400	18,600	14,400	13,000	12,600	......
8	......	......	11,700	16,200	18,600	22,300	53,600	18,600	14,000	12,600	12,600	......
9	......	......	11,100	17,000	17,800	23,200	56,700	18,600	14,000	12,300	13,000	......
10	......	......	13,000	17,400	17,800	23,200	58,500	18,600	14,000	12,300	13,300	......
11	......	......	10,800	17,400	19,400	24,500	59,800	19,000	13,300	12,000	13,000	......
12	......	......	8,830	17,400	22,700	24,500	59,200	19,000	13,300	12,000	13,300	......
13	......	......	8,180	15,800	25,800	24,000	57,900	18,600	13,000	11,700	12,600	......
14	......	......	7,760	15,100	26,800	24,000	56,700	18,600	12,600	11,400	12,600	......
15	......	......	7,560	14,000	32,200	23,200	54,800	18,600	13,700	11,400	12,300	......
16	......	......	7,760	13,700	36,400	22,700	53,000	18,600	13,700	11,100	12,000	......
17	......	......	7,760	12,000	38,500	24,900	50,000	19,000	14,000	10,800	11,700	......
18	......	......	7,760	11,700	41,300	26,800	47,100	22,300	13,700	11,700	11,400	......
19	......	......	7,560	11,100	41,300	29,600	44,800	22,700	16,600	12,300	11,400	......
20	......	......	7,560	10,800	40,800	32,600	41,900	22,700	18,600	12,600	11,100	......
21	......	......	8,390	10,600	40,200	34,200	39,600	23,600	20,200	13,300	11,100	......
22	......	......	9,300	10,000	38,500	34,700	38,000	22,300	19,800	13,700	10,800	......
23	......	......	10,800	9,790	37,400	34,200	35,800	21,800	19,400	14,400	10,800	......
24	......	......	12,000	9,300	36,400	33,700	34,200	21,000	18,600	14,400	10,800	......
25	......	......	12,300	8,830	35,300	33,700	32,600	20,600	18,200	14,400	11,400	......

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1905.												
26	......	......	12,600	8,610	33,700	34,200	31,100	20,600	17,400	14,700	12,300	......
27	......	......	13,300	8,610	31,600	35,800	29,600	19,400	16,600	14,400	12,600	......
28	......	......	14,400	8,390	29,200	38,000	29,200	18,200	15,800	14,000	13,300	......
29	......	......	12,600	8,390	27,200	39,600	27,200	17,400	15,500	13,700	14,400	......
30	......	......	11,400	8,390	25,400	40,800	25,800	17,000	14,700	13,700	13,000	......
31	......	......	10,800	......	23,200	......	23,600	16,200	......	13,300	......	......
1906.												
1	......	......	......	20,600	27,200	43,000	33,700	14,700	24,500	22,700	21,800	......
2	......	......	......	19,400	26,300	43,000	33,700	14,400	24,500	22,300	22,300	......
3	......	......	......	21,800	26,800	43,000	34,200	14,000	23,600	21,400	22,300	......
4	......	......	......	24,000	26,800	41,900	34,700	13,300	22,700	21,000	21,800	......
5	......	......	......	27,200	26,300	41,300	34,700	13,000	21,800	20,200	21,400	......
6	......	......	......	32,200	26,300	41,900	35,300	12,600	21,000	19,400	21,000	......
7	......	......	......	33,200	25,400	43,600	34,200	12,600	20,200	18,600	21,000	......
8	......	......	......	37,400	24,500	44,800	33,200	12,300	19,400	17,800	21,000	......
9	......	......	......	39,600	24,500	45,900	32,200	13,700	18,600	17,000	21,000	......
10	......	......	......	38,500	24,500	47,100	31,100	16,200	17,800	15,800	21,000	......
11	......	......	......	36,900	23,600	49,400	29,600	17,400	17,400	15,400	20,600	......
12	......	......	......	36,900	22,700	50,600	28,200	17,800	16,600	15,100	20,200	......
13	......	......	......	36,400	23,200	50,000	27,200	17,400	16,600	14,400	19,800	......
14	......	......	......	36,900	22,700	48,800	25,400	17,400	16,200	14,000	19,400	......
15	......	......	......	38,500	22,300	46,500	24,000	17,400	15,800	13,300	18,600	......
16	......	......	......	40,200	21,800	44,200	22,700	17,800	15,800	13,000	18,200	......
17	......	......	......	41,900	21,400	41,900	21,800	18,200	15,500	12,600	18,200	......
18	......	......	......	42,500	21,000	39,100	20,600	18,200	15,500	12,000	18,600	......
19	......	......	......	43,000	20,600	36,900	19,800	17,800	15,500	11,700	16,600	......
20	......	......	......	42,500	20,600	35,300	19,000	17,400	15,500	11,700	15,500	......
21	......	......	......	41,900	21,400	35,300	18,200	16,600	16,600	11,700	13,700	......
22	......	......	......	40,200	24,500	34,700	17,800	15,800	17,000	11,400	13,000	......
23	......	......	......	38,500	27,200	34,200	17,000	16,600	18,600	11,400	12,000	......
24	......	......	......	36,900	31,100	33,700	16,600	17,400	19,400	12,000	12,000	......
25	......	......	......	35,300	32,200	33,200	15,500	17,800	21,000	13,300	11,400	......
26	......	......	......	33,700	33,700	33,200	15,100	19,400	22,700	15,100	13,700	......
27	......	......	......	32,200	36,400	32,600	14,400	21,000	23,600	17,000	14,400	......
28	......	......	......	30,100	38,500	33,200	14,700	22,300	24,000	18,200	15,100	......
29	......	......	......	29,200	40,800	33,200	15,500	23,200	23,600	19,000	15,500	......
30	......	......	......	27,700	41,900	33,700	15,100	24,000	23,200	20,600	15,800	......
31	......	......	......	......	43,000	......	15,100	24,500	......	21,400	......	......
1907.												
1	......	......	......	48,800	19,800	26,800	32,600	10,600	12,000	11,400	8,390	......
2	......	......	......	50,000	20,200	26,800	31,600	13,000	11,700	11,400	8,610	......
3	......	......	......	49,400	20,200	26,300	31,100	12,600	10,800	11,400	8,610	......
4	......	......	......	50,600	19,800	25,400	29,200	12,300	10,600	11,400	8,830	......
5	......	......	......	48,800	19,000	24,500	27,200	11,700	10,300	11,700	8,830	......
6	......	......	......	47,600	18,200	24,000	25,400	11,100	10,300	11,100	9,060	......
7	......	......	......	47,100	17,400	23,200	24,500	11,100	9,300	10,800	9,300	......
8	......	......	......	46,500	17,400	22,300	23,200	10,800	8,610	10,800	9,060	......
9	......	......	......	44,200	17,400	21,400	22,300	11,100	8,390	10,600	9,060	......
10	......	......	......	42,500	16,600	21,000	23,200	11,100	8,390	10,600	8,830	......
11	......	......	......	41,300	16,200	23,600	17,800	10,600	8,390	10,300	8,830	......
12	......	......	......	40,800	15,500	26,800	16,200	10,300	8,180	10,000	8,610	......
13	......	......	......	39,100	15,500	29,600	15,100	9,540	7,970	10,000	8,610	......
14	......	......	......	38,000	15,100	32,200	14,700	10,300	7,970	9,540	8,390	......
15	......	......	......	36,400	14,700	34,200	15,800	9,790	7,970	9,300	7,360	......
16	......	......	......	33,700	15,500	35,300	15,500	9,300	7,970	9,060	7,360	......
17	......	......	......	32,200	15,800	36,900	15,500	10,000	8,180	9,060	7,560	......
18	......	......	......	30,600	15,800	37,400	15,500	9,790	9,300	8,830	7,760	......
19	......	......	......	29,200	15,800	37,400	15,500	10,000	10,000	8,830	7,360	......
20	......	......	......	28,200	15,500	36,900	15,500	10,600	11,400	8,830	7,360	......
21	......	......	......	27,200	15,500	36,400	15,500	11,700	12,300	8,830	7,560	......
22	......	......	......	25,800	15,800	36,400	15,800	13,000	13,700	8,830	7,560	......
23	......	......	......	24,900	15,800	36,400	15,500	13,000	14,700	8,610	7,560	......
24	......	......	25,400	24,000	15,500	36,400	15,500	12,600	15,500	8,610	7,560	......
25	......	......	26,300	22,700	15,500	36,900	17,400	12,000	15,800	8,830	7,170	......
26	......	......	27,700	22,300	17,000	36,400	16,600	11,400	15,800	8,830	6,980	......
27	......	......	32,600	21,800	18,600	35,400	16,200	11,100	14,700	8,830	6,800	......
28	......	......	38,000	20,600	20,600	35,800	15,800	11,100	13,700	8,830	6,800	......
29	......	......	39,100	20,600	22,700	35,800	15,500	11,400	13,000	8,610	6,980	......
30	......	......	41,900	19,800	24,900	34,200	14,700	11,400	12,000	8,390	6,440	......
31	......	......	44,800	......	25,800	......	14,400	12,300	......	8,390	......	......

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
1	......	......	......	15,300	20,900	52,500	70,400	20,500	9,030	9,270	9,270	......
2	......	......	......	13,600	21,400	58,000	67,700	19,700	9,520	9,270	9,270	......
3	......	......	......	12,700	21,400	61,900	64,400	18,900	9,270	9,270	9,270	......
4	......	......	......	13,300	20,900	63,200	61,200	17,400	9,270	9,270	9,270	......
5	......	......	......	13,300	19,700	62,500	57,400	17,000	9,270	9,270	9,030	......
6	......	......	......	13,600	19,700	60,600	54,300	16,300	9,520	9,030	9,030	......
7	......	......	......	13,600	18,200	58,000	51,300	15,600	9,270	9,270	9,030	......
8	......	......	......	13,900	17,000	57,400	48,400	15,300	8,560	9,270	9,030	......
9	......	......	......	14,200	16,000	54,900	47,200	14,600	8,560	9,270	9,270	......
10	......	......	......	13,900	15,300	56,200	45,000	13,600	8,340	9,270	7,910	......
11	......	......	......	13,900	14,900	57,400	42,200	12,400	7,910	8,790	7,700	......
12	......	......	......	13,900	14,200	58,700	41,100	13,300	7,700	8,560	8,120	......
13	......	......	......	13,900	14,900	60,600	39,500	12,700	8,560	8,560	7,700	......
14	......	......	......	13,600	14,600	61,200	37,900	12,000	7,700	8,790	7,300	......
15	......	......	......	13,600	15,600	60,000	35,800	11,800	7,700	8,340	7,300	......
16	......	......	9,030	13,300	17,000	58,000	34,300	10,900	7,300	8,120	7,300	......
17	......	......	8,560	12,700	18,500	55,600	33,300	10,900	7,500	8,120	7,110	......
18	......	......	8,120	12,700	19,300	52,500	32,800	10,600	8,120	7,910	6,920	......
19	......	......	10,300	12,400	19,700	50,700	31,400	11,200	8,120	7,300	6,740	......
20	......	......	9,780	12,400	20,500	48,400	30,400	10,900	9,910	8,120	6,740	......
21	......	......	9,780	11,800	22,600	46,100	29,000	10,600	7,700	8,120	6,740	......
22	......	......	10,600	13,000	23,900	44,400	28,500	10,300	7,500	8,120	6,560	......
23	......	......	10,600	12,400	24,400	44,400	28,000	9,780	8,340	8,120	6,560	......
24	......	......	11,200	12,400	25,700	44,400	27,100	9,520	8,340	8,120	6,560	......
25	......	......	11,800	12,700	28,500	45,000	26,200	9,520	8,560	8,340	6,500	......
26	......	......	12,700	13,600	29,900	48,900	24,800	9,270	7,700	8,340	6,500	......
27	......	......	12,700	14,900	32,300	59,300	23,500	9,270	8,560	9,030	6,500	......
28	......	......	13,600	16,300	35,300	69,700	21,800	9,520	8,120	9,270	6,300	......
29	......	......	13,900	18,200	38,400	73,000	21,400	9,270	8,340	9,030	6,300	......
30	......	......	14,600	19,700	42,200	72,400	21,800	9,270	9,030	9,520	6,100	......
31	......	......	14,600	......	46,100	......	20,900	9,030	......	9,520	......	......
1909.												
1	......	......	......	35,300	20,900	18,900	20,100	10,600	11,500	8,560	6,920	......
2	......	......	......	40,000	20,900	20,900	20,900	10,300	10,900	8,560	7,300	......
3	......	......	......	45,500	20,500	22,600	20,900	9,520	10,900	8,560	7,500	......
4	......	......	......	48,900	20,500	23,900	20,500	9,270	10,300	8,120	7,110	......
5	......	......	......	48,900	20,900	24,400	20,900	9,030	10,000	7,910	7,500	......
6	......	......	......	47,800	20,900	25,700	20,900	9,030	9,520	7,700	8,340	......
7	......	......	......	47,200	20,900	26,600	20,500	8,340	9,270	7,910	8,790	......
8	......	......	......	46,100	21,800	27,100	20,100	8,340	9,270	7,910	8,790	......
9	......	......	......	44,400	21,800	25,700	19,700	8,340	9,030	7,700	8,560	......
10	......	......	......	42,700	21,800	25,300	18,500	8,340	8,790	7,700	8,340	......
11	......	......	......	42,200	21,400	24,400	17,400	8,340	8,340	8,340	8,340	......
12	......	......	......	40,000	20,900	23,100	17,400	8,340	8,120	8,120	7,910	......
13	......	......	......	37,900	20,100	21,800	16,700	9,520	9,030	8,560	8,120	......
14	......	......	......	35,300	19,300	22,600	15,300	10,900	9,520	8,340	8,120	......
15	......	......	12,000	33,800	18,500	23,500	14,200	13,600	9,270	8,120	8,560	......
16	......	......	12,400	31,800	18,500	23,500	12,700	14,600	8,790	7,910	9,030	......
17	......	......	13,300	30,400	18,200	23,900	12,700	16,000	8,560	7,910	9,270	......
18	......	......	12,700	29,400	18,200	24,400	12,400	16,700	8,340	7,700	9,270	......
19	......	......	11,500	28,500	18,500	23,900	11,500	16,700	8,120	7,700	9,030	......
20	......	......	10,600	27,100	18,500	23,500	10,900	16,700	7,700	7,700	9,030	......
21	......	......	10,900	26,200	18,500	23,100	10,900	16,300	7,700	7,700	10,000	......
22	......	......	10,300	24,800	18,500	22,600	10,900	15,600	8,790	7,500	10,000	......
23	......	......	10,900	24,400	18,500	21,800	11,500	14,600	9,520	7,700	10,000	......
24	......	......	12,000	23,500	18,500	20,900	11,500	13,900	9,780	7,700	10,000	......
25	......	......	13,900	22,600	18,500	20,100	13,600	13,600	9,520	7,910	10,000	......
26	......	......	14,900	22,200	18,500	20,100	13,900	13,600	9,520	7,700	10,000	......
27	......	......	17,000	21,800	18,500	20,100	13,300	13,300	9,520	7,910	10,000	......
28	......	......	22,600	21,400	18,500	20,100	13,000	13,000	9,520	7,700	10,000	......
29	......	......	24,800	20,900	18,500	20,100	12,700	12,700	9,270	7,910	10,000	......
30	......	......	26,600	20,900	18,900	20,100	12,400	12,000	8,560	7,910	9,000	......
31	......	......	30,900	......	18,900	......	11,500	11,500	......	7,110	......	......
1910.												
1	......	......	4,650	19,300	12,400	7,700	4,940	3,650	3,990	4,110	3,320	......
2	......	......	4,700	17,800	12,000	7,300	5,240	3,650	3,990	4,110	3,320	......
3	......	......	4,800	17,000	10,900	7,300	4,790	3,870	4,110	4,110	3,540	......
4	......	......	5,000	15,600	10,300	7,700	4,510	3,870	4,240	4,110	4,240	......
5	......	......	6,000	15,300	10,000	7,300	4,650	3,650	4,110	4,510	4,110	......

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910.												
6			7,000	14,200	9,780	7,300	4,370	3,650	3,990	4,510	4,240	
7			8,000	14,200	9,780	7,300	3,990	3,760	3,990	5,090	4,140	
8			10,900	14,200	9,780	7,300	3,870	3,760	4,110	5,240	4,140	
9			13,600	14,600	9,520	7,300	3,870	3,870	4,110	5,240	4,140	
10			15,600	13,900	9,520	7,300	4,370	3,760	4,110	5,090	3,990	
11			18,500	13,600	9,520	7,300	3,990	3,650	4,110	4,940	3,870	
12			20,500	13,600	9 270	6,920	3,990	3,650	3,990	4,940	3,540	
13			19,300	13,000	9,030	6,050	4,110	3,760	4,110	4,790	3,430	
14			21,400	12,700	9,030	6,740	3,990	3,760	3,990	4,790	3,320	
15			27,100	12,700	8,790	6,390	3,990	3,760	3,990	4,790	3,650	
16			29,900	12,000	8,340	6,050	4,110	3,870	4,110	4,790	3,540	
17			32,300	11,800	8,120	5,560	3,990	3,870	4,110	4,510	3,320	
18			34,300	11,800	8,560	6,050	3,870	3,870	4,110	3,990	3,210	
19			35,800	11,800	8,560	5,720	3,870	3,870	4,110	3,870	2,690	
20			34,800	11,800	8,790	5,560	3,760	3,990	4,110	3,870	2,790	
21			35,800	12,700	8,790	5,560	3,650	4,110	4,110	3,870	2,890	
22			34,800	13,000	9,030	5,400	3,650	3,990	4,110	3,870	3,100	
23			33,800	13,300	8,340	5,240	3,650	4,110	3,990	3,870	3,100	
24			32,300	13,300	9,030	4,940	4,240	3,990	3,990	3,760	2,990	
25			29,400	13,600	9,030	5,240	3,760	3,990	3,990	3,760	2,990	
26			26,600	13,600	8,120	5,240	3,650	3,990	3,990	3,870	2,990	
27			25,700	13,900	9,030	5,240	3,550	3,990	3,990	3,650	2,990	
28			23,900	13,600	8,120	5,240	3,550	3,990	3,990	3,650	2,990	
29			22,600	13,300	8,560	5,090	3,550	3,870	3,990	3,550	2,950	
30			21,400	12,700	8,120	4,650	3,870	3,870	4,110	3,550	2,900	
31			20,500		7,700		3,870	3,870		3,350		

Monthly discharge of Mississippi River at St. Paul, Minn., for 1892–1910.

[Drainage area, 35,700 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1892.					
March	10,600	4,000	6,940	0.194	0.22
April	12,700	6,620	9,350	.262	.29
May	45,700	8,520	24,300	.682	.79
June	39,500	24,900	29,000	.812	.91
July	23,900	9,400	13,700	.384	.44
August	16,000	6,960	10,000	.280	.32
September	8,520	6,280	7,350	.206	.23
October	6,640	5,200	5,930	.166	.19
November	5,060		4,360	.122	.14
1893.					
April	44,500	18,900	31,900	.894	1.00
May	58,800	30,200	43,500	1.22	1.41
June	29,200	8,840	15,800	.443	.49
July	8,410	4,900	7,040	.197	.23
August	5,400	4,130	4,710	.132	.15
September	6,280	5,560	5,940	.166	.19
October	6,280	5,560	5,990	.168	.19
November	6,100	2,440	4,560	.128	.14
1894.					
March	9,070	4,000	6,590	.185	.21
April	34,800	5,920	15,600	.437	.49
May	41,200	19,400	29,000	.812	.94
June	18,000	5,740	9,650	.270	.30
July	5,740	1,920	4,020	.113	.13
August	4,430	1,920	3,430	.096	.11
September	4,280	3,540	3,930	.110	.12
October	4,740	3,840	4,260	.119	.14
November	4,740	2,980	4,060	.114	.13
December			*a* 2,790	.078	.09

a Estimated.

Monthly discharge of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1895.					
January	1,900	1,200	1,540	0.043	0.05
February			a 1,300	.036	.04
March (22-31)	4,110	2,630	3,420	.096	.04
April	3,860	2,750	3,420	.096	.11
May	5,640	3,230	4,540	.127	.15
June	9,640	4,640	7,440	.208	.23
July	7,900	4,240	5,720	.160	.18
August	5,340	3,370	4,410	.124	.14
September	5,640	4,240	4,860	.136	.15
October	5,500	3,860	4,690	.131	.15
November	4,240	2,990	3,760	.105	.12
1896.					
March (10-31)	3,230	1,420	2,060	.058	.02
April	35,300	2,280	19,900	.557	.62
May	34,300	21,600	28,100	.787	.91
June	27,300	13,700	20,300	.569	.63
July	12,700	4,640	7,740	.217	.25
August	5,800	4,500	5,050	.141	.16
September	5,340	3,980	4,800	.134	.15
October	5,640	4,640	5,020	.141	.16
November	6,440	4,000	5,080	.142	.16
December	5,000	4,150	4,410	.124	.14
1897.					
January	5,340	3,050	4,300	.120	.14
February	3,550	3,120	3,340	.094	.10
March	48,900	3,000	11,200	.314	.36
April	80,800	31,300	59,300	1.66	1.85
May	29,800	10,400	16,600	.465	.54
June	15,600	10,200	12,800	.359	.40
July	49,600	14,400	32,200	.902	1.04
August	24,600	8,500	14,100	.395	.46
September	11,800	8,500	9,910	.278	.31
October	10,100	7,600	8,180	.229	.26
November	7,800	4,700	6,700	.188	.21
1898.					
March	8,730	4,000	6,980	.195	.22
April	8,520	6,440	7,670	.215	.24
May	10,600	6,280	7,740	.217	.25
June	35,300	9,880	19,800	.555	.62
July	17,200	8,100	11,200	.314	.36
August	7,900	5,960	6,680	.187	.22
September	6,790	5,960	6,340	.178	.20
October	9,640	6,120	8,020	.225	.26
November	8,100	5,000	6,680	.187	.21
1899.					
April	34,300	8,000	19,500	.546	.61
May	20,200	12,700	15,200	.426	.49
June	36,800	12,700	30,100	.843	.94
July	25,400	8,300	14,500	.406	.47
August	25,800	7,330	12,500	.350	.40
September	19,800	9,400	12,600	.353	.39
October	25,800	8,300	14,600	.409	.47
November	18,500	10,100	13,100	.367	.41
December (1-9)	9,880	5,640	8,260	.231	.08
1900.					
January			a 3,950	.111	.13
February			a 3,100	.087	.09
March			a 3,500	.098	.11
April	12,300	6,440	8,900	.249	.28
May	7,900	5,640	6,670	.187	.22
June	6,790	3,370	4,630	.130	.14
July	6,440	3,260	5,160	.145	.17
August	12,000	3,610	7,060	.198	.23
September	13,700	8,100	11,400	.319	.36
October	16,000	8,950	11,800	.331	.38
November	9,640	3,980	6,950	.195	.22
December			a 3,500	.098	.11
The year	16,000		6,380	.179	2.44

a Estimated.

Monthly discharge of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1901.					
January			*a* 2,250	0.063	0.07
February			*a* 2,200	.062	.06
March	13,000		*a* 6,550	.183	.21
April	19,800	11,700	15,500	.434	.48
May	18,900	10,900	15,400	.431	.50
June	14,400	8,300	10,200	.286	.32
July	18,500	8,100	14,100	.395	.46
August	7,900	5,340	6,100	.171	.20
September	6,120	4,920	5,490	.154	.17
October	6,620	5,500	5,940	.166	.19
November	6,120	3,980	5,100	.143	.16
December			*a* 3,000	.084	.10
The year	19,800		7,650	.214	2.91
1902.					
January			*a* 2,950	.083	.10
February			*a* 2,950	.083	.09
March	6,120	3,000	4,430	.124	.14
April	5,200	3,860	4,530	.127	.14
May	19,800	4,780	10,200	.286	.33
June	16,800	9,880	13,600	.381	.43
July	9,880	5,640	7,690	.215	.25
August	7,140	4,110	5,060	.142	.16
September	6,620	4,240	5,340	.150	.17
October	5,340	4,500	4,900	.137	.16
November	9,640	5,500	7,710	.216	.24
December			*a* 4,000	.112	.13
The year	19,800		6,110	.171	2.34
1903.					
January			*a* 2,850	.080	.09
February			*a* 2,300	.064	.07
March	24,000	2,000	13,200	.370	.43
April	26,800	18,200	21,300	.597	.67
May	36,900	17,800	26,500	.742	.86
June	42,500	7,560	19,000	.532	.59
July	21,400	7,170	15,100	.423	.49
August	15,800	8,390	11,800	.331	.38
September	42,500	8,390	24,900	.697	.78
October	51,800	19,800	34,800	.975	1.12
November	19,000	6,800	12,200	.342	.38
December			*a* 4,550	.127	.15
The year	51,800		15,700	.440	6.01
1904.					
January			*a* 3,520	.099	.11
February			*a* 2,730	.076	.08
March			*a* 4,600	.129	.15
April	31,600	13,000	24,200	.678	.76
May	24,000	14,000	18,400	.515	.59
June	21,800	11,100	15,600	.437	.49
July	12,000	7,360	9,540	.267	.31
August	8,390	6,100	7,250	.203	.23
September	12,000	6,440	8,550	.239	.27
October	21,800	7,170	14,900	.417	.48
November	16,600	7,560	10,400	.291	.32
December			*a* 3,980	.111	.13
The year	31,600		10,300	.289	3.92

a Estimated from records kept by the St. Anthony Falls Water Power Co. at Minneapolis.

Monthly discharge of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1905.					
January			*a* 3,090	0.087	0.10
February			*a* 2,510	.070	.07
March	14,400	2,500	8,920	.250	.29
April	17,400	8,390	12,100	.339	.38
May	41,300	8,180	26,000	.728	.84
June	40,800	18,200	27,300	.765	.85
July	59,800	23,600	43,300	1.21	1.40
August	23,600	16,200	19,800	.555	.64
September	20,200	12,600	15,500	.434	.48
October	14,700	10,800	13,000	.364	.42
November	14,400	10,800	12,200	.314	.35
December			*a* 8,700	.244	.28
The year	59,800		16,000	.447	6.10
1906.					
January			*a* 7,100	.199	.23
February			*a* 6,350	.178	.19
March			*a* 8,000	.224	.26
April	43,000	19,400	34,500	.966	1.08
May	43,000	20,600	27,400	.768	.89
June	50,600	32,600	40,500	1.13	1.26
July	35,300	14,400	24,200	.678	.78
August	24,500	12,300	17,200	.482	.56
September	24,500	15,500	19,500	.546	.61
October	22,700	11,400	16,100	.451	.52
November	22,300	11,400	17,900	.501	.56
December			*a* 9,900	.277	.32
The year	50,600		19,100	.533	7.26
1907.					
January			*a* 8,480	.238	.27
February			*a* 8,050	.225	.23
March	44,800	8,000	15,500	.434	.50
April	50,600	19,800	35,200	.986	1.10
May	25,800	14,700	17,700	.496	.57
June	37,400	21,000	31,100	.871	.97
July	32,600	14,400	19,400	.543	.63
August	13,000	9,300	11,200	.314	.36
September	15,800	7,970	11,000	.308	.34
October	11,700	8,390	9,690	.271	.31
November	9,300	6,440	7,970	.223	.25
December			*a* 4,600	.129	.15
The year	50,600		15,000	.420	5.68
1908.					
January			*a* 3,500	.098	.11
February			*a* 3,680	.103	.11
March	14,600		*a* 7,800	.218	.25
April	19,700	11,800	13,800	.387	.43
May	46,100	14,200	22,900	.641	.74
June	73,000	44,400	56,500	1.58	1.76
July	70,400	20,900	38,700	1.08	1.24
August	20,500	9,030	12,600	.353	.41
September	9,520	7,300	8,380	.235	.26
October	9,520	7,300	8,730	.245	.28
November	9,270	6,100	7,600	.213	.24
December			*a* 5,350	.150	.17
The year	73,000		15,800	.442	6.00

a Estimated from records kept by the St. Anthony Falls Water Power Co. at Minneapolis.

Monthly discharge of Mississippi River at St. Paul, Minn., for 1892–1910—Continued.

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1909.					
January			a 3,500	0.098	0.11
February			a 3,500	.098	.10
March	30,900	4,000	10,400	.291	.34
April	48,900	20,900	33,700	.944	1.05
May	21,800	18,200	19,600	.549	.63
June	27,100	18,900	22,800	.639	.71
July	20,900	10,900	15,500	.434	.50
August	16,700	8,340	12,000	.336	.39
September	11,500	7,700	9,230	.259	.29
October	8,560	7,110	7,930	.222	.26
November	10,000	6,920	8,610	.241	.27
December			a 6,500	.182	.21
The year	48,900		12,800	.358	4.86
1910.					
January			a 5,100	.143	.16
February			a 4,650	.130	.14
March	35,800	4,650	21,300	.597	.69
April	19,300	11,800	13,800	.387	.43
May	12,400	7,700	9,220	.258	.30
June	7,700	4,650	6,270	.176	.20
July	5,240	3,550	4,040	.113	.13
August	4,110	3,650	3,850	.108	.12
September	4,240	3,990	4,060	.114	.13
October	5,240	3,350	4,260	.119	.14
November	4,240	2,690	3,410	.096	.11
December			b 2,250	.063	.07
The year	35,800		6,850	.192	2.62

a Estimated from records kept by the St. Anthony Falls Water Power Co. at Minneapolis.
b Estimated from United States engineer records at Lock and Dam 2, below Minneapolis.

NOTE.—From 1892 to 1899 the monthly mean values are considered good; from 1900 to 1908, fair; and for 1909 and 1910, good. All estimates during the frozen period are considered fair.

SANDY RIVER.

SANDY RIVER BELOW SANDY LAKE RESERVOIR, MINN.

This station is located 1 mile above the mouth of Sandy River at the Sandy Lake dam, near Libby post office, in Aitkin County. It was established July 7, 1893, and is maintained by the United States Engineer Corps for the purpose of measuring the flow from Sandy Lake reservoir, which is one unit in the Government reservoir system on the headwaters of the Mississippi. The area of the water surface of the reservoir at low stage is 8 square miles; at high stage the area is 16.5 square miles. These areas, with a range of 9.4 feet, give a capacity of about 3,157,900,000 cubic feet.

In connection with the records of the Mississippi above Sandy River and of Pine River below Pine River reservoir these records are of value in determining the power and navigation possibilities of the upper Mississippi River.

At extreme flood stages the Mississippi drowns out the dam and fills Sandy Lake reservoir as much as 3 feet higher than was intended.

If the Mississippi is at a fairly high stage and the dam is open, there is frequently a considerable reverse flow into the reservoir, but the amount of this flow has not been computed in the records.

The daily discharge is based upon the flow through the openings of the dam and also on frequent discharge measurements made by an employee who resides near the dam.

The daily discharge for this station has been compiled from unpublished records in the United States engineer office at St. Paul. The monthly estimates have been computed by the Geological Survey.

Daily discharge, in second-feet, of Sandy River below Sandy Lake reservoir, Minn., for 1893–1910.

[0=no flow from reservoir.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1893.												
1	......	......	......	......	......	......	......	0	124	0	42	127
2	......	......	......	......	......	......	......	0	124	0	220	121
3	......	......	......	......	......	......	......	0	93	0	258	107
4	......	......	......	......	......	......	......	0	67	0	250	90
5	......	......	......	......	......	......	......	0	0	0	250	89
6	......	......	......	......	......	......	......	0	0	0	138	66
7	......	......	......	......	......	......	238	0	0	0	146	66
8	......	......	......	......	......	......	219	365	0	0	192	68
9	......	......	......	......	......	......	208	368	0	0	202	80
0	......	......	......	......	......	......	203	361	0	0	148	71
11	......	......	......	......	......	......	188	348	0	0	0	51
12	......	......	......	......	......	......	185	348	0	0	0	51
13	......	......	......	......	......	......	131	381	0	0	89	57
14	......	......	......	......	......	......	0	455	0	0	249	51
15	......	......	......	......	......	......	0	439	0	0	341	51
16	......	......	......	......	......	......	0	293	0	0	331	57
17	......	......	......	......	......	......	36	0	0	0	287	57
18	......	......	......	......	......	......	80	0	0	0	274	47
19	......	......	......	......	......	......	79	0	0	0	298	47
20	......	......	......	......	......	......	116	0	0	0	260	46
21	......	......	......	......	......	......	433	0	0	0	245	46
22	......	......	......	......	......	......	429	0	0	0	224	34
23	......	......	......	......	......	......	420	0	0	0	194	53
24	......	......	......	......	......	......	244	0	0	0	176	26
25	......	......	......	......	......	......	0	59	0	0	172	35
26	......	......	......	......	......	......	0	193	0	0	162	35
27	......	......	......	......	......	......	210	214	0	0	176	26
28	......	......	......	......	......	......	349	164	0	0	152	26
29	......	......	......	......	......	......	459	170	0	31	151	26
30	......	......	......	......	......	......	436	152	0	75	153	26
31	......	......	......	......	......	......	447	81	......	106	......	26
1894.												
1	19	0	0	0	1,241	(a)	0	0	(a)	0	0	226
2	0	0	0	0	1,100	(a)	0	(a)	(a)	0	0	230
3	0	0	0	0	1,097	(a)	0	(a)	(a)	0	0	213
4	0	0	0	0	1,097	(a)	0	(a)	(a)	0	0	193
5	0	0	0	0	1,097	(a)	0	(a)	0	0	0	176
6	0	0	0	0	1,110	(a)	0	(a)	0	0	40	170
7	0	0	0	0	1,100	(a)	0	(a)	0	0	84	97
8	0	0	0	0	1,090	0	0	(a)	(a)	0	204	0
9	0	0	0	0	1,084	0	0	(a)	(a)	0	176	0
10	0	0	0	0	1,144	0	0	(a)	(a)	(a)	155	0
11	0	0	0	0	1,137	0	0	(a)	(a)	(a)	155	0
12	0	0	0	0	1,141	0	0	(a)	(a)	(a)	b— 84	0
13	0	0	0	0	1,111	0	0	(a)	(a)	(a)	0	0
14	0	0	0	0	1,091	0	0	(a)	(a)	(a)	0	0
15	0	0	0	0	992	0	0	(a)	0	(a)	0	0

a Dam open, but no record of discharge.

b Flow from river into reservoir.

Daily discharge, in second-feet, of Sandy River below Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1894.												
16	0	0	0	0	877	0	0	(a)	0	(a)	0	0
17	0	0	0	0	560	0	0	(a)	0	(a)	62	0
18	0	0	0	(a)	1,034	0	0	(a)	0	(a)	260	0
19	0	0	0	(a)	1,013	0	0	(a)	0	(a)	233	0
20	0	0	0	(a)	1,070	0	0	(a)	0	(a)	219	0
21	0	0	0	(a)	1,013	0	0	(a)	0	(a)	192	0
22	0	0	0	(a)	939	0	0	(a)	0	(a)	170	0
23	0	0	0	(a)	859	0	0	(a)	0	(a)	198	0
24	0	0	0	(a)	864	0	0	(a)	0	(a)	204	0
25	0	0	0	(a)	847	0	0	(a)	0	0	200	0
26	0	0	0	(a)	852	0	0	(a)	0	0	237	0
27	0	0	0	(a)	(a)	0	0	(a)	0	0	235	0
28	0	0	0	(a)	(a)	0	0	(a)	0	0	263	0
29	0	......	0	(a)	(a)	0	0	(a)	0	0	254	0
30	0	......	0	(a)	(a)	0	0	(a)	0	0	255	0
31	0	......	0	......	(a)	......	0	(a)	......	0	......	0
1895.												
1	0	0	0	0	(a)	0	(a)	112	(a)	282	201	0
2	0	0	0	0	(a)	0	(a)	114	303	309	184	0
3	0	0	0	0	(a)	0	(a)	109	(a)	277	167	0
4	0	0	0	0	(a)	0	(a)	125	287	365	167	0
5	0	0	0	0	(a)	0	(a)	109	(a)	330	154	0
6	0	0	0	0	(a)	0	(a)	215	(a)	334	154	0
7	0	0	0	0	(a)	0	(a)	322	283	339	123	0
8	0	0	0	0	(a)	(a)	(a)	308	(a)	324	151	0
9	0	0	0	0	(a)	(a)	(a)	308	(a)	391	154	0
10	0	0	0	0	(a)	(a)	(a)	297	176	289	167	0
11	0	0	0	0	(a)	(a)	(a)	297	(a)	288	181	0
12	0	0	0	0	0	(a)	(a)	287	333	287	b−53	0
13	0	0	0	0	0	(a)	(a)	302	329	275	0	0
14	0	0	0	0	0	(a)	(a)	277	305	263	0	0
15	0	0	0	0	0	(a)	(a)	298	(a)	261	0	0
16	0	0	0	0	0	(a)	(a)	277	(a)	262	109	0
17	0	0	0	0	0	(a)	(a)	137	274	263	83	0
18	0	0	0	0	0	(a)	(a)	137	(a)	261	15	0
19	0	0	0	0	0	(a)	(a)	137	(a)	275	0	0
20	0	0	0	0	0	(a)	(a)	138	(a)	272	0	0
21	0	0	0	0	0	0	(a)	139	(a)	269	b−260	0
22	0	0	0	0	0	(a)	(a)	139	(a)	203	b−318	0
23	0	0	0	0	0	(a)	(a)	140	(a)	210	0	0
24	0	0	0	0	0	(a)	(a)	141	(a)	211	0	0
25	0	0	0	0	0	(a)	(a)	142	(a)	213	0	0
26	0	0	0	0	0	(a)	(a)	142	263	249	0	0
27	0	0	0	0	0	(a)	(a)	143	289	247	0	0
28	0	0	0	(a)	0	(a)	(a)	144	290	246	0	0
29	0	......	0	(a)	0	(a)	(a)	144	(a)	244	0	0
30	0	......	0	(a)	0	0	(a)	145	(a)	242	0	0
31	0	......	0	......	0	......	(a)	145	......	230	......	0
1896.												
1	0	152	0	0	1,012	1,073	0	623	0	468	0	0
2	0	160	0	0	768	1,075	0	174	802	404	0	0
3	0	163	0	0	771	1,095	0	150	791	388	0	0
4	0	112	0	0	782	1,153	0	124	780	372	0	0
5	0	111	0	0	727	1,255	0	101	770	356	0	0
6	0	107	0	0	522	1,347	252	345	756	400	0	0
7	0	109	0	0	460	1,438	1,161	357	742	351	59	0
8	0	108	0	0	506	1,442	142	438	728	351	510	0
9	0	100	0	0	549	1,448	0	420	735	351	531	41
10	0	97	0	0	592	1,534	0	403	743	308	573	329
11	0	96	0	0	642	1,514	85	408	750	281	581	379
12	0	98	0	0	675	0	0	444	727	267	405	362
13	0	97	0	0	711	0	86	346	704	188	399	341
14	0	95	0	0	720	0	0	0	682	203	369	322
15	0	92	0	0	629	0	0	451	659	240	342	302

[a] Dam open, but no record of discharge.

[b] Flow from river into reservoir.

Daily discharge, in second-feet, of Sandy River below Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1896.												
16	0	89	0	0	615	0	0	437	648	167	273	304
17	0	87	0	0	597	875	0	424	636	146	312	257
18	0	84	0	0	573	1,005	0	510	625	119	325	255
19	0	80	0	0	563	126	0	481	613	84	286	253
20	0	0	0	0	533	0	0	453	604	84	276	238
21	0	0	0	0	483	0	0	445	600	84	301	224
22	0	0	0	0	428	107	0	436	853	84	296	210
23	0	0	0	0	388	0	0	427	780	0	251	195
24	0	0	0	0	388	0	0	418	708	0	128	174
25	0	0	0	0	......	0	0	465	696	0	0	153
26	0	0	0	0	......	0	0	513	685	0	0	152
27	0	0	0	0	......	0	0	299	673	0	0	151
28	0	0	0	0	......	0	0	0	661	0	0	150
29	0	0	0	(a)	......	0	0	0	597	0	0	149
30	0	......	0	(a)	......	0	10	0	532	0	0	148
31	0	......	0	......	......	......	216	0	......	0	......	148
1897.												
1	0	112	71	101	779	384	378	2,894	0	877	0	0
2	0	111	73	82	782	405	369	2,428	0	854	0	0
3	0	110	75	47	786	427	620	2,297	0	830	0	0
4	0	109	76	0	790	448	1,706	2,226	0	538	0	0
5	0	106	75	0	793	511	1,146	1,096	0	783	0	0
6	0	102	76	0	771	575	2,013	0	912	789	0	0
7	0	100	74	0	749	638	3,210	0	826	795	0	0
8	0	97	72	0	726	624	3,063	1	1,071	801	0	0
9	0	100	70	0	703	610	2,792	1	1,056	737	0	0
10	0	102	69	0	680	595	3,675	2	1,041	673	0	0
11	0	102	68	0	896	602	3,709	4	1,026	609	0	0
12	0	103	68	0	647	609	3,738	5	1,009	561	0	0
13	0	103	68	0	614	616	3,697	7	991	514	0	0
14	21	102	67	0	582	618	3,576	9	974	466	0	0
15	205	100	66	0	574	619	3,311	9	990	427	0	0
16	202	95	65	0	566	621	3,086	12	1,007	387	0	0
17	199	89	68	0	557	623	2,841	321	1,023	366	0	0
18	196	88	70	98	550	620	2,634	327	983	344	0	0
19	193	87	72	197	544	616	2,488	333	943	304	0	0
20	190	87	74	295	538	635	2,401	339	903	307	0	0
21	180	83	76	393	531	626	2,368	345	907	156	0	0
22	171	80	77	492	517	617	2,328	352	922	0	0	0
23	161	75	79	590	504	557	2,425	359	897	0	0	0
24	152	72	82	688	490	487	2,329	366	871	0	0	0
25	142	72	83	787	477	421	2,494	372	846	0	0	0
26	137	72	84	1,084	463	356	2,537	0	820	0	0	0
27	131	72	85	1,747	443	368	2,520	0	794	0	0	0
28	126	72	90	1,661	423	379	2,494	0	1,024	0	0	0
29	123	......	96	1,575	402	368	2,510	0	975	0	0	0
30	119	......	108	1,489	382	357	2,444	0	926	0	0	0
31	116	......	120	......	362	......	2,700	0	......	0	......	0
1898.												
1	0	0	0	0	0	0	0	0	0	385	0	0
2	0	0	0	0	0	0	0	0	0	482	227	0
3	0	0	0	0	0	0	0	0	0	385	219	0
4	0	0	0	0	0	0	0	0	0	382	210	0
5	0	0	0	0	0	0	0	0	0	379	204	0
6	0	0	0	0	0	0	0	0	0	376	198	0
7	0	0	0	0	0	0	0	0	0	375	191	50
8	0	0	0	0	0	0	0	0	0	369	0	201
9	0	0	0	0	0	0	0	0	0	363	0	167
10	0	0	0	0	0	0	0	0	0	357	0	225
11	0	0	0	0	0	0	0	0	0	360	0	276
12	0	0	0	0	0	0	0	0	0	364	0	281
13	0	0	0	0	0	0	0	0	0	420	0	225
14	0	0	0	0	0	0	0	0	0	387	0	276
15	0	0	0	0	0	0	0	0	0	355	0	242
16	0	0	0	0	0	0	0	0	0	332	0	270
17	0	0	0	0	0	0	0	0	0	310	0	298
18	0	0	0	0	0	0	0	0	0	0	0	288
19	0	0	0	0	0	0	0	0	0	0	0	284
20	0	0	0	0	0	0	0	0	0	0	0	264

[a] Dam open, but no record of discharge.

Daily discharge, in second-feet, of Sandy River below Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1898.												
21	0	0	0	0	0	0	0	0	0	0	0	253
22	0	0	0	0	0	0	0	0	0	0	0	127
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0	......	0	0	0	0	0	0	0	0	0	0
30	0	......	0	0	0	0	0	0	0	0	0	0
31	0	......	0	......	0	......	0	0	......	0	......	0
1899.												
1	0	0	0	0	0	0	1,474	0	1,149	0	1,607	0
2	0	0	0	0	0	184	1,451	0	1,115	0	1,497	0
3	0	0	0	0	0	632	1,429	0	1,119	0	1,428	0
4	0	0	0	0	0	573	1,206	0	568	0	1,223	0
5	0	0	0	0	0	847	709	0	585	0	1,332	0
6	0	0	0	0	0	359	300	0	580	0	1,279	0
7	0	0	0	0	0	379	0	0	576	0	1,239	0
8	0	0	0	0	0	637	788	0	572	0	1,191	0
9	0	0	0	0	0	963	768	0	571	0	1,141	0
10	0	0	0	0	0	815	604	0	564	0	1,098	0
11	0	0	0	0	0	506	0	0	555	0	1,053	0
12	0	0	0	0	0	357	0	0	324	0	1,005	0
13	0	0	0	0	0	145	0	0	328	0	1,072	0
14	0	0	0	0	0	357	0	0	328	0	1,027	0
15	0	0	0	0	0	357	0	0	327	646	636	0
16	0	0	0	0	0	887	0	0	332	594	0	0
17	0	0	0	0	0	686	0	152	337	863	0	0
18	0	0	0	0	0	901	0	820	345	968	0	0
19	0	0	0	0	0	903	0	604	349	1,159	0	0
20	0	0	0	0	198	983	0	567	353	2,888	0	0
21	0	0	0	0	727	899	0	702	353	2,072	0	0
22	0	0	0	0	806	1,059	0	918	354	1,154	0	0
23	0	0	0	0	0	978	0	1,244	354	1,716	0	0
24	0	0	0	0	0	974	0	2,073	0	1,684	0	0
25	0	0	0	0	314	967	0	2,099	0	1,635	0	0
26	0	0	0	0	1,257	1,034	0	2,065	0	1,571	0	0
27	0	0	0	0	114	1,336	0	2,067	0	1,490	0	0
28	0	0	0	0	0	1,318	0	2,026	0	1,369	0	0
29	0	......	0	0	0	1,309	0	2,000	0	1,288	0	0
30	0	......	0	0	0	1,499	0	1,123	0	1,703	0	0
31	0	......	0	......	0	......	0	1,155	......	1,622	......	0
1900.												
1	0	0	0	0	0	454	153	0	0	0	0	0
2	0	0	0	0	0	394	149	0	0	300	0	0
3	0	0	0	0	0	446	155	0	0	0	0	0
4	0	0	0	0	0	552	149	0	0	0	0	0
5	0	0	0	0	318	536	119	0	0	0	0	0
6	0	0	0	0	822	473	127	0	0	0	0	0
7	0	0	0	0	873	329	113	0	0	0	0	0
8	0	0	0	0	867	271	123	0	0	0	0	0
9	0	0	0	0	1,041	293	64	0	0	0	0	0
10	0	0	0	0	1,004	299	29	0	0	556	0	0
11	0	0	0	0	955	301	0	0	0	474	0	0
12	0	0	0	0	931	354	79	0	0	0	0	0
13	0	0	0	0	892	387	104	0	0	0	0	0
14	0	0	0	0	743	363	0	0	0	0	0	0
15	0	0	0	0	725	272	75	0	(a)	0	0	0
16	0	0	0	0	685	221	57	0	(a)	0	0	0
17	0	0	0	0	655	235	0	0	(a)	0	0	0
18	0	0	0	0	766	297	0	0	(a)	0	0	0
19	0	0	0	0	738	278	0	0	(a)	0	0	0
20	0	0	0	0	714	85	0	0	(a)	0	0	0
21	0	0	0	0	700	278	0	0	(a)	0	0	0
22	0	0	0	0	668	204	0	0	(a)	0	0	0
23	0	0	0	0	628	203	0	0	(a)	0	0	0
24	0	0	0	0	616	136	0	0	(a)	0	0	0
25	0	0	0	0	566	139	0	0	(a)	0	0	0

[a] Dam open; water flowing from river into lake.

Daily discharge, in second-feet, of Sandy River below Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1900.												
26	0	0	0	0	551	0	0	0	(a)	0	0	0
27	0	0	0	0	522	0	0	0	0	0	0	0
28	0	0	0	229	501	42	0	0	0	0	0	0
29	0	0	0	0	580	49	0	0	0	0	0	0
30	0	......	0	0	563	121	0	0	0	0	0	0
31	0	......	0	......	550	......	0	0	......	0	......	0
1901.												
1	0	0	206	600	0	479	1,257	606	579	0	0	0
2	0	0	207	593	0	407	1,612	781	534	0	0	0
3	0	0	166	568	0	387	2,144	0	529	0	0	0
4	0	0	166	544	0	381	2,148	0	318	0	0	0
5	0	0	167	516	927	373	2,414	0	314	0	0	0
6	0	0	165	508	964	371	2,414	0	0	0	0	0
7	0	0	166	434	1,075	369	2,490	0	0	0	0	0
8	0	0	219	406	1,149	365	2,666	285	0	0	0	0
9	0	0	219	532	964	371	2,368	833	0	0	0	0
10	0	0	262	485	1,001	0	2,181	827	0	0	0	0
11	0	0	279	465	1,102	0	2,170	1,045	0	0	0	0
12	0	0	276	417	1,001	0	2,139	1,057	0	0	0	0
13	0	0	271	187	1,001	0	2,127	1,124	0	0	0	0
14	0	0	270	0	1,445	0	2,337	1,207	0	0	0	0
15	0	0	268	0	1,001	0	2,278	1,160		0	0	0
16	0	0	265	0	1,267	0	1,775	1,204	0	0	0	0
17	0	0	286	0	1,445	0	1,070	1,192	0	0	0	0
18	0	0	287	0	1,651	0	374	1,125	0	0	0	0
19	0	0	286	0	1,166	0	427	1,231	0	0	0	0
20	0	0	263	0	1,236	109	0	1,290	0	0	0	0
21	0	76	277	0	861	409	0	1,203	0	0	0	0
22	0	145	280	0	1,524	396	0	1,005	0	0	0	0
23	0	148	278	0	1,370	290	745	978	0	0	0	0
24	0	215	670	0	821	0	745	560	0	0	0	0
25	0	210	651	0	681	0	0	497	0	0	0	0
26	0	210	648	0	706	0	0	454	0	0	0	0
27	0	207	642	0	665	0	0	456	0	0	0	0
28	0	207	636	0	665	0	0	449	0	0	0	0
29	0	......	643	0	640	927	0	442	0	0	0	0
30	0	......	626	0	891	927	0	433	0	0	0	0
31	0	......	614	......	416	......	0	593	......	0	......	0
1902.												
1	0	0	0	0	0	954	0	83	0	103	(a)	0
2	0	0	0	0	0	969	0	459	0	0	(a)	0
3	0	0	0	0	0	958	138	498	0	0	(a)	0
4	0	0	0	0	0	921	779	526	0	102	(a)	0
5	0	0	0	0	0	1,003	133	530	0	130	(a)	0
6	0	0	0	0	0	985	0	513	0	132	(a)	0
7	0	0	0	0	0	937	0	496	0	122	(a)	0
8	0	0	0	0	0	987	0	468	0	0	(a)	0
9	0	0	0	0	301	987	0	516	0	0	(a)	0
10	0	0	0	0	0	987	0	505	0	0	(a)	0
11	0	0	0	0	0	948	0	542	0	0	(a)	0
12	0	0	0	0	0	931	352	536	226	0	(a)	0
13	0	0	0	0	0	915	378	517	222	0	(a)	0
14	0	0	0	0	0	1,032	350	508	220	0	0	0
15	0	0	0	0	0	866	0	477	378	0	0	357
16	0	0	0	0	0	874	0	473	212	122	0	347
17	0	0	0	0	512	833	0	478	206	82	0	345
18	0	0	0	0	517	785	0	584	0	0	0	341
19	0	0	0	0	0	785	0	601	0	0	0	338
20	0	0	0	0	0	823	0	534	0	0	0	334
21	0	0	0	0	0	809	0	519	201	0	0	332
22	0	0	0	0	0	749	0	463	201	0	0	324
23	0	0	0	0	0	742	0	449	0	0	0	397
24	0	0	0	442	0	781	0	450	0	138	0	280
25	0	0	0	199	0	710	0	438	0	196	0	544
26	0	0	0	0	498	545	0	516	205	0	0	371
27	0	0	0	0	713	511	0	343	0	0	232	517
28	0	0	0	0	904	555	0	343	0	0	231	507
29	0	0	0	0	871	645	0	0	0	0	229	432
30	0	......	0	0	922	481	0	0	207	0	0	422
31	0	......	0	......	959	......	0	0	......	0	......	416

a Dam open; water flowing from river into lake.

Daily discharge, in second-feet, of Sandy River below Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1	290	70	63	0	0	408	434	412	377	417	732	0
2	404	0	63	0	0	208	426	415	374	439	804	0
3	282	0	0	0	1,012	0	429	403	366	442	817	0
4	278	0	0	0	801	887	400	403	408	419	839	0
5	245	69	0	0	812	0	399	399	403	394	992	0
6	242	71	62	0	814	302	368	392	388	399	1,220	0
7	240	70	62	0	829	0	365	382	418	373	1,210	0
8	237	70	0	0	1,559	0	392	337	427	332	1,206	0
9	198	0	0	0	1,000	0	385	368	395	308	1,184	0
10	196	0	0	0	1,117	0	443	407	384	303	1,112	0
11	194	69	61	0	1,079	0	446	410	383	320	1,207	0
12	163	0	0	0	1,170	316	416	404	375	432	1,202	0
13	162	0	60	0	1,080	0	422	401	314	469	1,198	0
14	160	68	0	0	1,088	0	430	410	348	509	1,161	0
15	0	68	0	0	1,216	0	434	411	398	654	1,128	0
16	136	67	0	0	1,205	684	428	404	387	600	1,105	0
17	133	0	0	0	1,194	0	394	409	410	724	1,074	0
18	131	67	62	0	1,175	0	392	406	457	781	1,034	0
19	129	66	64	0	1,334	33	381	411	446	787	908	0
20	0	0	65	0	1,324	0	360	404	453	806	820	0
21	128	0	65	0	1,339	0	363	378	414	832	823	0
22	90	65	65	0	1,365	0	362	367	759	967	0	0
23	89	0	65	0	1,094	0	366	391	716	996	0	0
24	88	65	65	0	794	0	378	373	432	1,007	0	0
25	87	64	65	0	794	426	356	396	453	993	0	0
26	89	64	65	369	433	412	392	385	425	962	0	0
27	88	63	65	0	441	406	430	377	454	997	0	90
28	0	63	65	0	445	404	433	433	396	947	0	119
29	88	......	66	0	366	437	431	429	399	971	0	119
30	71	......	66	0	369	434	426	423	400	806	0	118
31	......	......	67	......	375	......	427	384	......	743	......	118
1904.												
1	118	120	208	92	1,204	623	0	0	257	89	131	196
2	131	151	204	91	935	303	0	0	276	87	156	192
3	161	152	200	91	933	723	0	0	269	85	123	192
4	157	151	198	123	925	795	0	326	268	145	123	194
5	156	149	178	167	923	703	0	308	301	136	128	195
6	157	135	173	276	907	822	0	282	329	133	119	190
7	156	134	177	0	903	608	0	268	0	133	115	190
8	153	133	166	0	495	382	0	127	0	128	127	189
9	158	131	161	0	578	588	0	356	0	123	131	190
10	157	141	157	0	786	824	0	359	0	128	129	193
11	154	139	168	0	786	819	0	331	0	133	129	189
12	153	137	164	313	881	1,015	0	231	0	0	133	184
13	152	121	245	362	928	915	0	0	0	0	130	186
14	151	119	232	527	919	864	0	0	0	0	129	186
15	149	118	227	661	915	728	0	0	0	0	133	185
16	144	117	192	714	906	208	0	0	0	0	133	162
17	139	118	178	674	842	448	0	0	106	0	137	165
18	145	116	170	651	791	0	0	0	317	144	139	165
19	144	115	163	556	817	0	0	0	319	151	153	190
20	143	120	154	508	877	0	0	304	316	160	147	189
21	143	170	152	413	1,012	0	0	293	302	166	146	186
22	142	198	132	492	889	0	0	288	279	168	132	186
23	141	190	124	592	619	0	0	144	217	178	134	165
24	139	195	116	712	523	0	0	0	177	170	136	165
25	138	190	134	296	521	0	0	0	366	566	202	162
26	131	183	126	0	329	0	0	0	259	677	203	172
27	129	184	113	307	438	0	0	0	181	322	203	169
28	129	176	99	943	552	0	0	292	181	0	202	159
29	121	174	97	814	480	0	0	282	128	0	201	169
30	120	......	92	814	537	0	0	244	126	123	232	168
31	120	......	92	......	730	......	0	259	......	85	......	168
1905.												
1	147	102	62	111	0	625	1,152	61	66	494	6	229
2	146	100	63	67	0	351	1,030	61	66	494	6	421
3	146	97	63	0	0	356	1,158	61	75	511	6	404
4	130	96	65	0	0	367	905	81	75	503	6	389
5	136	95	65	(a)	0	330	738	81	75	499	6	405

a Dam open; water flowing from river into lake.

Daily discharge, in second-feet, of Sandy River below Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1905.												
6	149	93	65	(a)	0	329	859	81	75	6	6	395
7	151	92	65	(a)	0	326	1,026	81	75	6	6	387
8	149	91	63	(a)	0	326	1,150	437	75	6	6	404
9	139	91	66	(a)	0	381	1,047	437	75	6	6	389
10	133	89	63	0	0	381	743	437	331	6	6	410
11	134	89	65	0	0	452	744	425	323	6	6	408
12	132	89	64	0	0	454	744	418	310	6	6	408
13	131	86	64	0	0	459	1,173	415	485	6	6	418
14	128	79	65	0	0	441	1,442	83	499	6	6	378
15	126	73	65	245	0	0	1,429	75	494	6	6	384
16	127	75	66	242	0	0	1,155	75	509	6	6	388
17	126	74	64	241	952	0	1,614	75	522	6	6	390
18	123	61	62	0	854	550	1,465	75	539	6	6	390
19	122	68	66	0	982	687	134	75	463	6	6	401
20	131	73	70	0	0	827	134	75	482	410	6	413
21	132	73	70	0	0	757	134	75	477	400	6	339
22	129	71	70	0	0	721	134	75	480	397	6	358
23	125	66	70	408	0	757	134	70	591	398	6	6
24	122	62	70	0	0	754	132	70	555	396	6	6
25	121	68	114	0	0	565	132	70	519	389	6	6
26	120	62	114	0	0	1,709	130	70	477	414	6	71
27	118	48	116	0	0	1,037	130	70	478	404	6	204
28	93	60	126	0	0	997	129	70	477	418	6	201
29	90	......	137	0	0	1,010	958	68	499	418	6	129
30	104	......	135	0	0	1,022	970	66	497	418	6	111
31	104	......	143	......	660	......	787	66	......	6	......	110
1906.												
1	109	106	529	329	230	567	858	10	10	916	370	12
2	109	105	533	329	230	645	992	10	10	741	334	12
3	108	100	479	342	287	354	1,004	10	10	893	344	12
4	108	100	478	342	364	350	823	10	10	791	340	12
5	111	100	480	386	402	300	829	10	10	572	10	12
6	106	98	452	425	497	319	399	10	10	604	10	12
7	106	98	453	459	563	318	362	10	10	787	840	12
8	105	257	441	528	643	522	334	10	10	10	631	12
9	105	285	463	527	703	641	337	10	10	10	10	12
10	104	317	467	454	785	738	352	458	10	10	810	12
11	100	313	410	543	931	815	357	502	10	10	10	12
12	105	293	394	601	917	878	442	495	10	10	10	12
13	105	343	400	525	949	928	483	532	10	10	10	12
14	103	325	387	0	748	911	524	485	10	10	10	20
15	105	504	501	0	544	536	768	475	10	10	10	20
16	105	507	458	0	455	586	823	10	10	10	10	20
17	105	485	442	0	741	606	896	10	10	10	10	20
18	103	474	390	230	730	427	809	10	10	10	10	20
19	100	464	380	220	831	374	821	10	10	10	10	20
20	100	465	364	228	630	370	811	10	517	10	10	20
21	100	573	364	228	609	387	842	10	472	10	10	20
22	100	464	352	230	615	407	775	10	839	823	10	20
23	105	512	308	230	587	439	767	10	828	780	10	20
24	100	479	313	228	611	500	805	10	726	10	10	20
25	100	458	307	220	587	494	221	387	773	317	10	20
26	96	525	287	230	582	564	219	410	804	306	12	20
27	102	454	277	230	610	570	224	10	901	300	12	20
28	103	448	274	228	598	576	251	10	945	692	12	20
29	104	......	274	230	381	696	10	10	1,016	695	12	20
30	103	......	286	230	316	706	10	10	876	710	12	20
31	105	......	315	......	712	......	10	10	......	727	......	20
1907.												
1	25	421	604	295	1,020	1,505	761	0	590	612	179	340
2	25	423	581	330	473	1,505	538	0	590	936	0	330
3	25	430	561	287	436	1,530	481	0	538	936	0	300
4	25	429	561	268	400	1,404	590	0	638	936	0	280
5	25	442	574	287	412	1,394	514	0	538	757	0	260
6	25	444	571	287	404	1,403	628	0	481	602	0	250
7	25	443	544	300	412	1,402	513	0	481	641	0	240
8	217	434	515	286	412	1,402	313	0	538	641	0	220
9	225	439	456	286	387	1,402	258	0	590	602	0	210
10	223	439	504	300	400	1,401	182	0	590	602	0	200

a Dam open; water flowing from river into lake.

Daily discharge, in second-feet, of Sandy River below Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
11	220	435	472	278	1,050	989	258	0	638	602	0	190
12	217	436	462	286	1,048	938	182	0	313	440	0	180
13	215	449	444	273	972	938	182	0	313	253	0	170
14	214	443	433	278	723	540	182	0	313	0	0	160
15	212	443	433	158	723	380	182	0	0	0	253	150
16	213	445	374	260	686	380	182	0	0	179	0	150
17	211	634	417	246	595	380	258	0	0	0	0	150
18	209	766	422	232	340	492	182	0	0	0	0	150
19	208	748	372	246	340	539	313	0	0	253	0	150
20	206	745	389	286	442	539	313	0	0	358	0	150
21	204	800	350	320	340	583	182	0	0	253	0	140
22	429	755	420	340	395	558	182	0	590	309	655	130
23	396	514	373	340	442	594	(a)	182	638	309	645	120
24	439	767	467	260	484	594	(a)	182	522	358	635	110
25	423	729	413	286	442	731	(a)	182	10	358	620	100
26	414	689	359	340	279	695	(a)	258	590	358	600	90
27	407	659	284	340	340	583	(a)	313	830	358	580	80
28	403	635	284	360	484	744	(a)	538	830	309	570	80
29	405	......	274	473	523	761	(a)	481	864	309	550	80
30	403	......	250	523	624	869	(a)	538	901	309	350	80
31	411	......	238	......	1,332	......	(a)	481	......	253	......	80
1908.												
1	80	70	67	2	2	150	700	10	10	0	40	70
2	80	70	66	2	2	150	650	10	10	0	40	65
3	80	70	65	2	2	150	770	10	10	0	50	65
4	80	70	64	2	2	200	750	10	10	0	50	60
5	80	70	63	2	3	200	730	15	10	0	50	60
6	80	70	62	2	450	200	700	20	10	10	50	55
7	80	70	61	2	500	200	700	20	10	10	60	55
8	80	70	60	2	419	100	650	30	10	10	60	55
9	80	70	60	2	410	0	550	40	10	10	35	55
10	80	70	60	2	400	0	500	50	10	10	30	55
11	80	70	60	2	400	0	376	75	0	10	40	55
12	80	72	60	2	400	0	350	50	0	20	35	55
13	80	73	60	2	2	50	300	60	0	20	35	55
14	80	74	60	2	2	300	250	75	0	20	30	55
15	80	75	60	2	2	500	225	60	10	20	35	55
16	80	75	60	2	200	846	200	60	10	20	50	55
17	80	75	60	400	200	900	200	70	10	20	55	55
18	70	75	60	2	400	925	175	50	0	20	60	55
19	70	76	60	2	400	925	150	30	0	10	60	55
20	70	75	60	2	400	1,005	10	20	0	10	60	55
21	70	74	60	2	400	1,000	10	20	10	10	65	55
22	70	75	60	2	400	975	10	10	20	10	65	55
23	70	76	60	2	400	960	10	10	60	10	70	55
24	70	76	60	2	400	950	10	10	10	10	70	55
25	70	75	60	2	400	950	25	10	10	10	70	55
26	70	74	60	2	350	925	100	10	10	10	70	55
27	70	70	60	2	325	900	100	10	10	10	70	55
28	70	69	60	2	150	900	90	10	20	25	70	55
29	70	68	60	2	150	850	75	10	20	30	70	55
30	70	......	60	2	150	800	50	10	10	30	70	55
31	70	......	60	......	150	......	10	10	......	35	......	55
1909.												
1	55	35	35	20	20	360	40	550	750	0	0	50
2	55	35	35	10	25	320	100	479	900	0	0	50
3	55	35	35	10	30	320	179	420	900	20	0	60
4	55	35	35	20	40	320	170	420	900	20	0	80
5	55	35	35	20	20	477	160	420	900	50	0	80
6	55	35	35	10	10	477	145	400	800	40	0	90
7	55	35	35	15	15	465	130	300	800	80	0	90
8	55	35	35	15	30	465	0	300	700	90	0	85
9	55	35	35	20	40	470	0	200	602	150	0	85
10	55	35	35	15	60	475	0	200	550	200	0	80
11	50	35	35	15	75	475	0	0	700	250	0	65
12	50	35	25	20	80	312	0	0	750	320	0	60
13	50	35	0	20	80	312	0	0	500	250	0	60
14	50	35	0	20	125	310	55	0	300	330	0	60
15	40	35	15	30	291	300	20	40	250	350	0	60

a Dam open; water flowing from river into lake.

Daily discharge, in second-feet, of Sandy River below Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
16	35	35	15	35	310	300	50	30	200	351	400	70
17	30	35	15	40	310	290	60	100	100	300	700	80
18	30	35	15	40	310	300	40	75	150	100	650	85
19	30	35	0	40	320	249	20	75	150	0	600	90
20	30	35	0	40	330	249	15	75	200	0	0	95
21	30	35	0	40	300	250	15	30	175	0	0	95
22	30	35	15	15	290	245	20	30	50	0	0	95
23	30	35	20	35	300	240	30	15	0	20	0	95
24	30	35	20	40	290	235	20	0	0	0	30	100
25	30	35	20	40	290	230	10	0	0	0	0	100
26	30	35	0	40	285	20	180	15	0	0	0	100
27	30	35	0	40	285	0	460	100	0	0	0	100
28	35	35	15	40	280	0	550	220	0	0	60	100
29	35	......	15	40	369	10	600	220	0	0	81	100
30	35	......	15	30	369	20	500	250	0	0	45	100
31	35	......	20	......	360	......	550	741	......	0	......	100
1910.												
1	100	75	20	160	260	0	(a)	(a)	0	0	0	10
2	100	75	20	160	250	0	0	(a)	0	0	0	10
3	100	75	25	175	320	0	0	(a)	0	0	0	10
4	100	75	25	180	290	20	0	(a)	0	0	0	10
5	100	75	25	200	330	20	0	(a)	0	0	0	10
6	100	75	25	200	360	20	(a)	(a)	0	0	0	10
7	100	75	25	290	340	20	(a)	(a)	0	0	175	10
8	100	75	25	390	350	10	(a)	(a)	0	0	150	10
9	100	75	25	390	340	10	(a)	(a)	0	0	150	10
10	95	75	25	390	340	10	(a)	(a)	0	0	150	10
11	95	70	25	390	360	10	(a)	(a)	0	0	17	10
12	95	70	0	390	340	10	(a)	(a)	0	0	0	10
13	95	70	0	400	330	10	(a)	(a)	0	0	0	10
14	95	70	0	400	437	10	(a)	(a)	0	0	0	10
15	95	70	0	400	415	10	(a)	(a)	0	0	0	10
16	95	70	0	504	400	10	(a)	(a)	0	0	0	10
17	100	70	0	500	0	10	(a)	(a)	0	0	0	10
18	100	70	0	480	(a)	10	(a)	(a)	0	0	0	10
19	100	70	0	475	(a)	10	(a)	(a)	0	0	0	10
20	90	65	0	470	(a)	10	(a)	(a)	0	0	0	10
21	90	65	0	445	(a)	10	(a)	(a)	0	0	0	10
22	90	65	0	420	(a)	10	(a)	(a)	0	0	0	10
23	90	60	0	390	(a)	10	(a)	(a)	0	0	0	10
24	90	60	0	370	(a)	10	(a)	(a)	0	0	0	10
25	90	50	0	360	(a)	(a)	(a)	(a)	0	50	0	10
26	80	35	0	360	(a)	(a)	(a)	(a)	0	0	0	10
27	80	20	80	360	20	(a)	(a)	(a)	0	0	0	10
28	80	20	150	360	20	(a)	(a)	(a)	0	0	0	10
29	80	......	160	320	20	(a)	(a)	(a)	0	0	0	10
30	80	......	170	269	0	(a)	(a)	0	0	0	0	10
31	80	......	175	......	0	......	(a)	0	......	0	......	10

a Dam open; water flowing into river from lake.

Monthly outflow from Sandy Lake reservoir, Minn., for 1893–1910.

Month.	Discharge in second-feet.			Run-off (total in millions of cubic feet).
	Maximum.	Minimum.	Mean.	
1893.				
July (25 days)	459	0	204	441
August	455	0	142	380
September	124	0	13.6	35.2
October	106	0	6.8	18.2
November	341	0	193	500
December	127	26	56.7	152
The period				1,530

Monthly outflow from Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Month.	Discharge in second-feet.			Run-off (total in millions of cubic feet).
	Maximum.	Minimum.	Mean.	
1894.				
January	19	0	0.6	1.6
February	0	0	0	0
March	0	0	0	0
April (17 days)	0	0	0	0
May (26 days)	1,241	560	1,020	2,290
June (23 days)	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	263	0	127	329
December	230	0	42.1	113
The period				2,730
1895.				
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April (27 days)	0	0	0	0
May (20 days)	0	0	0	0
June (9 days)	0	0	0	0
July	0	0	0	0
August	322	109	189	506
September (11 days)			285	271
October	365	210	275	736
November	201	0	67	174
December	0	0	0	0
The period				1,690
1896.				
January	0	0	0	0
February	163	0	70.2	176
March	0	0	0	0
April (28 days)	0	0	0	0
May (24 days)	1,012	388	610	1,260
June	1,534	0	550	1,430
July	1,161	0	63	169
August	623	0	326	873
September	853	0	676	1,750
October	468	0	184	493
November	581	0	207	537
December	379	0	169	453
The period				7,140
1897.				
January	205	0	89.2	239
February	112	72	93	225
March	120	65	77.3	207
April	1,747	0	378	980
May	896	362	601	1,610
June	638	356	531	1,380
July	3,738	369	2,500	6,690
August	2,894	0	455	1,220
September	1,071	0	791	2,050
October	877	0	391	1,050
November	0	0	0	0
December	0	0	0	0
The year	3,738	0	492	15,700
1898.				
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	482	0	206	552
November	227	0	41.6	108
December	298	0	120	321
The year	482	0	30.6	981

Monthly outflow from Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Month.	Discharge in second-feet.			Run-off (total in millions of cubic feet).
	Maximum.	Minimum.	Mean.	
1899.				
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	1,257	0	110	296
June	1,499	0	761	1,970
July	1,474	0	282	755
August	2,099	0	633	1,700
September	1,149	0	572	1,480
October	2,888	0	788	2,110
November	1,607	0	594	1,540
December	0	0	0	0
The year	2,888	0	312	9,850
1900.				
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	229	0	7.6	19.8
May	1,041	0	619	1,660
June	552	0	267	692
July	155	0	48.3	129
August	0	0	0	0
September	0	0	0	0
October	556	0	42.9	115
November	0	0	0	0
December	0	0	0	0
The year	1,041	0	82.1	2,620
1901.				
January	0	0	0	0
February	215	0	50.6	122
March	670	165	344	921
April	600	0	208	539
May	1,651	0	891	2,390
June	927	0	219	568
July	2,660	0	1,220	3,270
August	1,290	0	711	1,900
September	579	0	75.8	196
October	0	0	0	0
November	0	0	0	0
December	0	0	0	0
The year	2,660	0	310	9,910
1902.				
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	442	0	21.4	55.4
May	959	0	200	536
June	1,032	481	834	2,160
July	779	0	68.7	184
August	601	0	431	1,150
September	378	0	75.9	197
October	196	0	36.4	97.5
November	232	0	40.7	56.3
December	544	0	213	570
The year	1,032	0	160	5,010
1903.				
January	404	0	155	415
February	71	0	40.7	98.5
March	67	0	41.3	111
April	369	0	12.3	31.9
May	1,559	0	891	2,390
June	887	0	179	464
July	446	356	403	1,080
August	433	337	398	1,070
September	759	314	425	1,100
October	1,007	303	649	1,740
November	1,220	0	726	1,880
December	119	0	18.2	48.7
The year	1,559	0	328	10,400

Monthly outflow from Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Month.	Discharge in second-feet.			Run-off (total in millions of cubic feet).
	Maximum.	Minimum.	Mean.	
1904.				
January	161	118	143	383
February	198	115	147	368
March	245	92	160	428
April	943	0	373	967
May	1,204	438	770	2,060
June	1,015	0	379	982
July	0	0	0	0
August	359	0	151	404
September	366	0	166	430
October	677	0	136	364
November	232	115	148	384
December	196	159	180	482
The year	1,204	0	229	7,250
1905.				
January	151	90	128	343
February	102	48	79.4	192
March	143	62	79.2	212
April	408	0	43.8	114
May	982	0	111	297
June	1,709	0	566	1,470
July	1,614	129	762	2,040
August	437	61	141	378
September	591	66	355	920
October	511	6	228	611
November	6	6	6	15.6
December	421	6	302	809
The year	1,709	0	233	7,400
1906.				
January	111	96	104	279
February	573	98	345	835
March	533	274	395	1,060
April	601	0	292	757
May	949	230	593	1,590
June	928	300	551	1,430
July	1,004	10	553	1,480
August	532	10	128	343
September	1,016	10	296	767
October	916	10	349	935
November	840	10	130	337
December	20	12	16	42.8
The year	1,004	0	313	9,860
1907.				
January	439	25	235	629
February	800	421	551	1,330
March	604	238	432	1,160
April	523	158	302	783
May	1,332	279	560	1,500
June	1,530	380	906	2,350
July	761	182	238	637
August	538	0	102	273
September	901	0	431	1,120
October	936	0	414	1,110
November	655	0	188	487
December	340	80	172	461
The year	1,530	0	378	11,800
1908.				
January	80	70	75.5	202
February	76	68	72.3	181
March	67	60	60.9	163
April	400	2	15.3	39.7
May	500	2	251	672
June	1,005	0	533	1,382
July	770	10	304	814
August	75	10	28.6	76.6
September	60	0	10.3	26.7
October	36	0	13.2	35.3
November	70	30	53.8	139
December	70	55	56.5	151
The year	1,005	0	123	3,880

Monthly outflow from Sandy Lake reservoir, Minn., for 1893–1910—Continued.

Month.	Discharge in second-feet.			Run-off (total in millions of cubic feet).
	Maximum.	Minimum.	Mean.	
1909.				
January	55	30	41.8	112
February	35	35	35	84.7
March	35	0	19.7	52.8
April	40	10	27.2	71.1
May	369	10	192	514
June	477	0	283	734
July	600	0	133	356
August	741	0	184	493
September	900	0	378	980
October	351	0	94.2	262
November	700	0	85.6	222
December	100	50	82.6	221
The year	900	0	130	4,100
1910.				
January	100	80	93.1	252
February	75	20	65.0	157
March	175	0	32.3	86.5
April	504	160	353	915
May	437	0	178	477
June	20	0	8.3	21.8
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	50	0	16.1	4.3
November	175	0	21.4	55.5
December	10	10	10	26.8
The year	504	0	64.8	2,000

PINE RIVER.

PINE RIVER BELOW PINE RIVER RESERVOIR, MINN.

This station is located just below the dam at the outlet of Cross Lake, which is 15 miles above the mouth of Pine River, in the central part of Crow Wing County, in T. 137 N., R. 27 W.

It is maintained by the United States Engineer Corps for the purpose of measuring the flow from Pine River reservoir, the lowest unit in the present system of government reservoirs on the headwaters of the Mississippi.

In connection with the records of the Mississippi above Sandy River and of Sandy River below Sandy Lake reservoir, these records are of value in determining the availability of the upper Mississippi for power and navigation.

The dam is located at the outlet of Cross Lake and raises the water level in Cross, Pine, Daggett, Rush, Whitefish, Trout, and Hay lakes by varying amounts. The area of water surface at low water is 18 square miles; at high water the area is 24 square miles. These areas, with a range of 16.15 feet, give a capacity of 7,732,900,000 cubic feet.

Though the discharge of the dam represents the flow from the reservoir it does not represent the entire flow of Pine River at its mouth, because between the two points the drainage area of the river is increased from 452 to 691 square miles by Little Pine River and one or two other minor tributaries.

The daily discharge is based upon daily gage heights representing the head at the dam and upon the various sized openings in the dam. These data have been compiled from unpublished records in the United States engineer office at St. Paul. The monthly estimates have been computed by the Geological Survey.

Daily discharge, in second-feet, of Pine River below Pine River reservoir, Minn., for 1895–1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1895.												
1	3	3	5	5	537	536	477	7	423	229	97	2
2	3	3	5	5	464	376	274	7	426	222	95	2
3	3	3	5	5	507	425	259	390	419	214	92	2
4	3	3	5	5	481	419	261	604	417	207	104	2
5	3	3	5	175	469	177	262	639	418	202	124	2
6	3	3	5	174	498	9	263	637	418	198	134	2
7	3	3	5	174	440	9	260	640	418	191	134	2
8	3	3	5	174	478	9	8	700	415	186	130	2
9	3	3	5	174	469	9	8	772	416	180	123	2
10	3	3	4	174	493	9	348	837	413	180	123	2
11	3	3	4	175	463	9	476	796	408	178	123	2
12	3	3	4	176	457	9	314	845	402	174	144	2
13	3	3	4	177	464	9	8	656	397	178	144	2
14	3	3	4	177	443	9	7	648	399	168	141	2
15	3	3	4	177	443	9	7	641	399	163	138	2
16	3	3	4	177	438	9	7	634	393	156	123	2
17	3	5	4	177	438	9	7	646	286	150	124	2
18	3	5	4	176	438	9	7	657	279	152	124	2
19	3	5	4	176	236	9	7	751	271	142	120	2
20	3	5	4	176	244	9	7	566	261	133	118	2
21	3	5	4	194	518	9	7	512	257	124	3	2
22	3	5	24	194	577	452	7	543	257	114	3	3
23	3	5	67	194	62	520	7	510	281	109	3	3
24	3	5	4	326	9	18	7	431	264	106	2	3
25	3	5	4	625	9	254	7	398	250	105	2	3
26	3	5	4	224	10	412	7	424	247	102	2	3
27	3	5	4	189	10	329	7	421	223	108	2	3
28	3	5	4	190	10	445	7	422	243	105	2	3
29	3	......	4	190	10	50	7	417	244	103	2	2
30	3	......	4	191	441	451	7	416	237	103	2	2
31	3	......	4	......	524	......	7	417	......	99	......	2
1896.												
1	2	103	114	66	5	33	(a)	648	190	142	187	171
2	2	103	113	66	5	33	(a)	622	197	142	187	168
3	2	103	113	66	5	33	(a)	646	190	142	220	171
4	2	103	95	67	5	33	(a)	611	186	124	228	178
5	3	102	113	66	5	33	(a)	704	201	127	228	186
6	3	102	113	66	5	33	(a)	698	202	127	228	198
7	3	102	114	66	5	33	(a)	752	193	127	232	198
8	3	102	110	66	5	30	(a)	511	193	127	231	194
9	3	107	110	66	5	30	(a)	665	191	130	235	194
10	3	107	109	66	9	30	(a)	470	191	175	235	194
11	3	107	109	66	9	30	877	439	191	177	232	194
12	3	107	109	66	9	30	710	389	187	177	232	190
13	3	107	109	66	9	30	722	354	187	171	227	181
14	3	107	109	68	9	20	714	340	183	171	227	181
15	3	107	119	62	9	20	719	338	187	171	250	193
16	3	119	119	64	9	20	735	409	190	169	245	198
17	3	119	119	64	9	(a)	704	389	187	171	245	193
18	3	119	119	65	9	(a)	657	366	187	171	241	189
19	3	119	119	4	9	(a)	684	351	187	171	241	181
20	3	118	118	4	9	(a)	758	341	207	171	236	181

[a] Crevasse formed on June 17. Only part of water passed through dam. This continued into July.

Daily discharge, in second-feet, of Pine River below Pine River reservoir, Minn., for 1895–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1896.												
21	3	118	118	4	9	(a)	447	320	202	169	232	177
22	3	118	69	4	9	(a)	401	287	194	169	222	185
23	3	113	70	4	9	(a)	300	307	181	164	222	185
24	3	113	70	4	17	(a)	166	291	168	164	214	181
25	3	113	65	4	17	(a)	14	286	159	150	211	177
26	3	113	65	5	17	(a)	14	281	157	147	219	177
27	3	113	65	5	17	(a)	302	263	152	147	214	177
28	3	113	65	5	17	(a)	528	253	149	143	211	174
29	3	113	65	5	21	(a)	519	239	140	143	202	174
30	3	......	65	5	21	(a)	541	229	137	180	190	170
31	57	......	66	......	21	(a)	649	220	......	183	......	170
1897.												
1	170	238	204	303	778	428	653	9	9	9	14	11
2	177	235	204	317	760	475	574	9	9	9	14	11
3	179	230	201	383	728	556	784	9	9	9	14	11
4	196	230	201	534	698	465	530	9	9	9	14	11
5	215	223	201	827	629	325	235	9	9	9	14	11
6	215	215	201	843	612	238	5	9	9	9	14	11
7	206	211	201	847	600	189	5	9	9	9	14	11
8	206	207	204	890	614	217	5	9	9	9	14	11
9	199	204	204	959	579	333	5	9	9	9	14	11
10	195	200	201	1,043	581	473	5	9	9	9	14	11
11	195	212	197	1,131	583	530	5	9	9	9	14	11
12	199	207	201	1,206	582	533	5	9	9	9	14	11
13	195	200	201	1,165	611	561	5	9	9	9	14	11
14	192	232	207	1,117	629	193	5	9	9	9	14	10
15	192	236	207	1,117	634	191	5	9	9	9	14	10
16	188	232	204	1,181	611	403	5	9	9	9	14	10
17	195	232	200	1,048	563	657	5	9	9	9	14	10
18	266	228	220	1,010	5	715	6	9	9	9	14	10
19	447	228	234	971	5	652	6	9	9	9	14	10
20	430	225	256	905	5	733	6	9	9	9	14	10
21	401	221	270	854	5	549	6	9	9	9	14	10
22	357	217	270	817	5	492	6	9	337	9	14	10
23	328	217	266	786	5	724	6	9	767	9	11	10
24	308	217	266	757	5	705	6	9	622	11	11	10
25	288	213	259	751	832	690	6	9	610	11	11	10
26	262	209	255	741	844	636	6	9	506	11	11	10
27	247	204	259	725	490	667	6	9	35	11	11	10
28	240	204	260	753	387	635	6	9	9	11	11	10
29	239	......	264	743	327	621	6	9	9	11	11	13
30	234	......	280	737	465	755	6	9	9	11	11	13
31	234	......	290	......	377	......	6	9	......	11	......	13
1898.												
1	13	14	18	19	19	19	27	145	930	740	415	3
2	13	14	18	19	19	19	27	146	913	793	396	3
3	13	14	18	19	19	193	27	146	896	774	349	3
4	13	14	18	19	19	852	96	146	880	763	340	3
5	13	14	18	19	19	988	197	145	864	764	332	3
6	13	14	18	19	19	1,398	981	146	849	750	315	4
7	13	14	18	19	19	1,475	932	400	836	745	302	4
8	13	14	18	19	19	1,479	1,292	426	821	719	324	4
9	13	17	18	19	19	1,479	1,379	134	804	703	315	4
10	13	17	18	19	19	1,478	1,054	437	789	685	308	4
11	13	17	18	19	19	331	895	647	775	661	295	4
12	13	17	18	19	19	30	714	728	761	703	289	4
13	13	17	18	19	19	30	624	618	749	509	280	4
14	13	17	18	19	19	30	723	714	740	657	277	4
15	13	17	19	19	19	30	729	777	731	666	263	4
16	13	17	19	19	19	30	419	802	721	622	261	4
17	13	17	19	19	19	30	419	791	708	557	258	4
18	14	17	19	19	19	27	418	809	699	572	253	4
19	14	17	19	19	19	27	421	795	734	582	221	4
20	14	17	19	19	19	27	595	787	772	568	217	4
21	14	17	19	19	19	27	320	840	754	552	161	4
22	14	17	19	19	19	27	320	1,085	770	531	3	4
23	14	18	19	19	19	27	458	1,064	784	509	3	4
24	14	18	19	19	19	27	1,099	1,056	776	493	3	6
25	14	18	19	19	19	27	895	1,043	773	449	3	6

a Crevasse formed on June 17. Only part of water passed through dam. This continued into July.

Daily discharge, in second-feet, of Pine River below Pine River reservoir, Minn., for 1895–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1898.												
26	14	18	19	19	19	27	854	1,022	757	433	3	6
27	14	18	19	19	19	27	361	1,001	754	416	3	6
28	14	18	19	19	19	27	356	988	745	406	3	6
29	14	......	19	19	19	27	353	972	778	442	3	6
30	14	......	19	19	19	27	263	957	758	435	3	6
31	14	......	19	......	19	......	145	944	......	425	......	6
1899.												
1	6	9	13	16	19	19	306	651	38	60	268	48
2	6	9	13	16	19	19	579	840	193	60	270	87
3	6	11	13	16	19	19	578	826	192	55	270	208
4	6	11	13	16	19	19	581	709	193	55	270	206
5	6	11	13	16	19	19	581	529	192	55	270	206
6	6	11	13	16	19	19	579	40	192	55	270	173
7	6	11	13	16	19	19	295	40	574	119	310	48
8	6	11	13	16	19	19	73	40	614	208	310	48
9	6	11	13	16	19	19	568	40	546	208	310	75
10	6	11	13	16	19	19	565	366	288	208	190	156
11	6	11	16	18	19	19	449	561	288	208	48	156
12	9	11	16	18	19	19	30	580	208	363	48	156
13	9	11	16	18	19	19	30	622	69	363	48	154
14	9	11	16	18	19	19	30	614	38	363	48	101
15	9	11	16	18	19	19	54	369	38	363	48	48
16	9	11	16	18	19	19	620	35	38	1,171	113	48
17	9	11	16	18	19	19	646	159	144	1,168	490	48
18	9	11	16	18	19	19	641	625	270	1,167	668	48
19	9	11	16	18	19	19	457	632	270	1,164	666	48
20	9	11	16	18	19	19	436	639	270	965	503	48
21	9	13	16	18	19	19	375	777	296	359	310	48
22	9	13	16	18	19	19	40	905	415	495	182	48
23	9	13	16	18	19	19	35	918	415	629	48	93
24	9	13	16	18	19	19	35	863	415	629	48	156
25	9	13	16	19	19	19	498	688	313	629	48	156
26	9	13	16	19	19	19	581	366	208	627	48	156
27	9	13	16	19	19	19	576	35	208	627	48	156
28	9	13	16	19	19	348	570	35	130	627	48	156
29	9	......	16	19	19	425	561	35	60	627	48	156
30	9	......	16	19	19	30	546	30	60	625	48	156
31	9	......	16	......	19	......	537	30	......	625	......	156
1900.												
1	156	52	41	41	39	589	531	764	429	601	406	52
2	154	52	41	41	199	52	381	747	432	444	406	52
3	154	52	41	41	579	52	52	730	433	65	406	52
4	154	52	41	41	578	52	52	717	428	65	406	52
5	154	52	41	41	576	52	795	718	425	55	406	52
6	112	52	41	104	575	52	794	742	423	55	406	52
7	52	52	41	206	576	52	860	487	420	55	406	52
8	52	52	41	206	575	52	943	489	709	55	405	52
9	52	52	41	309	575	52	913	496	704	307	405	52
10	52	52	41	313	575	52	891	514	706	561	403	52
11	52	52	41	414	735	52	877	526	706	561	403	52
12	52	52	41	414	611	52	870	528	690	559	403	52
13	52	52	41	414	608	510	870	531	688	558	271	52
14	52	52	41	414	769	727	861	533	675	558	52	52
15	52	52	41	328	602	52	850	533	691	284	52	52
16	52	52	41	208	445	52	842	531	730	285	52	52
17	52	52	41	132	284	52	830	457	727	285	52	52
18	52	52	41	42	282	52	813	462	723	285	52	52
19	52	52	41	42	321	273	807	467	792	285	52	52
20	52	41	41	42	735	631	795	474	869	285	52	52
21	52	41	41	42	654	628	783	481	985	285	52	52
22	52	41	41	42	172	627	781	422	1,109	285	52	52
23	52	41	41	42	52	622	777	488	902	286	52	52
24	52	41	41	42	52	890	769	492	718	286	52	52
25	52	41	41	42	52	911	759	518	674	285	52	52
26	52	41	41	42	52	963	742	520	615	406	52	52
27	52	41	41	42	52	1,011	804	526	613	406	52	52
28	52	41	41	42	52	773	795	778	611	406	52	52
29	52	......	41	42	52	553	791	769	606	406	52	52
30	52	......	41	42	377	541	785	770	605	406	52	52
31	52	......	41	......	783	......	777	565	......	406	......	52

Daily discharge, in second-feet, of Pine River below Pine River reservoir, Minn., for 1895–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901.												
1	52	56	56	56	53	460	1,280	56	397	738	452	241
2	52	56	56	56	53	78	1,239	56	498	669	435	240
3	52	56	56	56	53	78	1,002	53	520	802	419	240
4	52	56	56	56	53	72	1,045	53	507	796	418	238
5	52	56	56	56	53	72	1,230	53	493	789	383	238
6	52	56	56	56	53	65	1,222	53	533	774	372	235
7	52	56	56	56	53	65	1,216	519	481	831	361	236
8	52	56	56	56	53	65	1,271	873	573	814	356	238
9	52	56	56	56	53	65	1,271	862	667	856	347	237
10	52	56	56	56	53	65	1,262	853	793	897	339	232
11	52	56	56	56	53	512	1,249	778	852	928	327	227
12	52	56	56	56	53	544	1,239	425	657	924	321	217
13	52	56	56	56	53	576	1,037	422	647	896	327	211
14	52	56	56	56	53	610	1,033	421	635	925	327	207
15	52	56	56	56	53	70	541	427	625	938	313	202
16	52	56	56	56	53	72	714	421	619	956	307	201
17	52	56	56	56	53	628	767	420	608	910	297	200
18	52	56	56	56	53	896	803	421	601	844	294	199
19	52	56	56	56	53	931	784	421	579	820	112	196
20	52	56	56	56	53	932	495	420	651	790	301	195
21	52	56	56	56	53	952	604	418	821	893	277	197
22	52	56	56	56	53	1,054	477	418	871	838	272	184
23	52	56	56	53	53	1,167	579	416	844	816	272	189
24	52	56	56	53	53	1,245	451	414	824	781	266	192
25	52	56	56	53	379	1,346	453	413	814	711	265	192
26	52	56	56	53	657	1,342	446	411	808	662	264	198
27	52	56	56	53	653	1,337	73	408	794	619	258	199
28	52	56	56	53	647	1,357	73	406	780	573	252	203
29	56	......	56	53	650	1,586	396	404	765	535	247	201
30	56	......	56	53	371	1,293	498	402	744	505	242	197
31	56	......	56	......	372	......	277	399	......	476	......	192
1902.												
1	188	181	183	36	43	57	61	568	334	319	296	295
2	185	181	183	36	43	57	61	553	334	318	295	295
3	189	181	184	36	36	537	61	541	333	318	295	293
4	179	181	184	36	36	536	62	510	333	319	296	293
5	181	180	186	36	36	525	62	501	332	318	297	292
6	180	180	186	37	148	516	62	491	323	317	297	308
7	179	180	184	37	148	525	63	464	322	316	298	308
8	178	180	184	37	148	286	63	468	322	314	300	306
9	176	182	185	37	38	57	206	533	322	313	300	306
10	175	182	186	37	38	58	345	537	322	312	300	305
11	177	182	187	37	38	312	334	537	322	331	301	305
12	179	181	189	37	38	565	195	531	321	330	301	304
13	179	179	189	38	38	574	175	531	323	328	302	297
14	180	179	192	38	39	317	61	526	323	327	305	295
15	182	177	190	38	39	583	61	526	323	326	305	291
16	182	179	191	38	39	574	61	500	321	325	305	291
17	179	179	193	38	50	768	61	492	321	322	305	291
18	184	180	193	38	50	760	61	273	320	314	305	291
19	186	179	195	36	51	759	61	273	318	312	305	291
20	186	179	195	36	51	749	61	274	332	311	305	297
21	186	179	20	36	57	58	284	273	329	309	305	296
22	186	179	21	36	61	59	489	274	328	307	306	296
23	184	179	22	36	61	59	488	326	328	306	306	295
24	184	179	27	36	62	59	478	326	328	306	306	295
25	186	178	32	36	62	59	470	326	327	308	305	294
26	186	180	33	43	64	59	657	325	325	307	305	294
27	186	180	34	43	64	60	648	325	319	308	305	295
28	184	183	35	43	64	60	628	323	319	308	305	294
29	184	......	36	43	65	61	628	322	318	308	297	294
30	183	......	36	43	65	61	616	332	319	308	297	294
31	183	......	36	......	56	......	606	332	......	308	......	294
1903.												
1	293	239	211	21	45	289	528	643	92	516	110	106
2	290	238	211	22	39	41	526	639	92	516	110	106
3	298	238	211	23	41	41	528	583	92	103	110	106
4	298	236	212	39	41	41	522	35	93	105	110	106
5	297	235	213	41	41	41	514	36	95	106	110	110

Daily discharge, in second-feet, of Pine River below Pine River reservoir, Minn., for 1895–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
6	296	234	214	42	41	42	504	36	95	107	110	110
7	295	231	223	43	42	42	497	36	96	109	109	110
8	295	230	224	44	42	43	292	89	96	110	109	110
9	294	227	225	45	40	43	713	89	97	111	109	110
10	287	224	226	47	40	43	706	89	98	105	109	110
11	285	222	227	39	40	43	695	89	99	106	109	110
12	283	217	229	41	41	43	684	89	89	107	110	106
13	283	211	231	43	41	43	449	90	91	107	110	106
14	283	230	229	46	41	331	438	90	92	108	110	106
15	281	224	227	48	43	607	234	91	92	108	110	106
16	279	223	228	49	39	602	36	91	93	109	110	106
17	285	223	229	49	40	592	37	91	94	111	110	106
18	281	221	231	40	40	587	37	91	95	111	110	106
19	284	221	232	40	287	312	37	91	88	112	110	106
20	284	221	235	40	527	274	37	91	89	112	110	106
21	283	219	237	41	523	497	37	91	89	113	107	106
22	280	221	237	41	278	493	461	92	89	113	107	106
23	278	221	238	41	40	485	37	92	89	113	107	106
24	244	222	238	42	41	478	37	92	89	107	107	106
25	229	222	239	41	41	470	37	92	89	107	107	106
26	228	222	241	42	302	563	37	93	89	107	107	106
27	227	222	242	43	556	558	38	93	89	107	107	106
28	226	214	244	43	553	553	38	94	89	108	105	106
29	225	......	244	44	553	543	527	92	90	108	106	106
30	224	......	244	44	548	536	619	92	90	108	106	106
31	239	......	245	......	543	......	604	92	......	109	......	106
1904.												
1	106	263	416	420	483	121	127	159	354	503	284	302
2	104	306	416	420	483	121	594	159	359	500	286	291
3	104	345	416	420	483	128	581	158	361	498	286	291
4	104	374	422	414	483	129	572	158	359	498	296	289
5	104	400	422	413	483	130	565	153	359	497	296	289
6	104	395	421	413	490	130	561	153	357	848	296	289
7	104	391	407	413	491	337	124	153	361	841	296	289
8	105	306	407	449	491	596	124	153	223	838	296	289
9	104	108	406	481	491	595	124	152	139	838	296	283
10	104	108	406	486	264	592	126	152	139	839	296	283
11	104	108	407	496	108	588	578	195	139	839	290	283
12	104	108	406	496	108	545	572	356	139	836	288	281
13	104	111	406	496	168	610	561	470	139	833	288	281
14	104	111	409	496	167	603	554	531	139	831	288	281
15	104	111	409	501	167	597	554	529	139	813	288	281
16	106	111	407	502	166	591	554	529	141	811	288	279
17	106	111	407	502	167	583	553	529	530	810	288	279
18	106	111	399	491	168	576	558	528	529	807	298	279
19	106	111	399	491	168	567	556	523	527	806	298	279
20	106	113	397	491	115	559	549	523	525	804	298	277
21	106	113	414	491	115	123	674	523	522	803	298	277
22	106	152	431	483	115	123	778	523	520	800	298	277
23	107	191	430	483	116	123	731	689	527	815	298	272
24	107	191	430	483	116	124	727	685	525	589	296	272
25	107	254	427	498	116	125	119	455	525	587	304	272
26	107	315	427	498	117	126	120	510	506	596	304	272
27	107	367	427	498	120	126	120	306	506	595	304	272
28	116	418	428	498	120	127	120	304	504	593	304	272
29	154	416	428	485	120	127	159	354	504	410	304	272
30	186	......	426	485	120	127	159	354	504	228	302	267
31	217	......	426	......	120	......	159	354	......	284	......	267
1905.												
1	267	253	245	649	70	700	900	1,400	1,080	445	385	230
2	267	253	245	649	65	680	900	1,400	1,046	425	380	291
3	267	251	244	655	65	675	900	1,350	1,046	420	380	290
4	267	248	244	655	70	681	910	1,350	1,040	415	362	290
5	267	248	244	653	70	680	950	1,315	1,040	410	360	295
6	271	248	244	675	65	680	1,000	1,315	1,020	450	355	300
7	271	248	244	673	75	670	1,220	1,300	1,000	470	355	305
8	271	247	244	670	80	675	1,220	1,300	779	470	345	465
9	271	247	244	668	70	680	1,220	1,300	775	465	340	470
10	271	245	241	666	65	673	1,250	1,250	770	460	340	470

Daily discharge, in second-feet, of Pine River below Pine River reservoir, Minn., for 1895–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1905.												
11	271	245	241	662	60	670	1,250	1,152	770	450	329	470
12	271	245	241	658	50	660	1,250	1,300	760	440	325	460
13	263	245	241	667	50	660	1,250	1,402	750	430	320	450
14	261	245	241	660	50	600	1,405	1,400	725	345	315	430
15	261	245	241	654	50	600	1,400	1,200	612	340	310	410
16	261	245	241	646	60	600	1,400	1,100	612	340	310	400
17	261	241	238	640	70	700	1,400	1,050	600	345	310	390
18	261	241	462	634	85	700	1,400	1,350	578	340	299	380
19	261	241	458	350	660	700	1,400	1,227	600	330	295	370
20	257	241	579	94	700	700	1,400	1,227	575	320	290	360
21	257	241	576	61	738	720	1,375	1,227	570	388	285	350
22	257	241	572	63	740	720	1,375	1,350	564	375	280	352
23	257	241	650	65	740	720	1,375	1,248	564	370	275	350
24	257	245	646	66	735	790	1,375	1,248	564	365	270	340
25	257	245	643	67	740	790	1,400	1,200	560	365	239	330
26	257	245	638	67	700	790	1,520	1,200	550	365	133	320
27	253	245	634	67	675	800	1,500	1,180	540	365	245	310
28	253	245	632	68	675	800	1,500	1,175	530	396	240	300
29	253	......	631	68	670	800	1,492	1,150	520	390	235	324
30	253	......	657	68	665	908	1,450	1,140	450	390	230	320
31	253	......	652	......	739	......	1,400	1,100	......	390	......	316
1906.												
1	312	304	270	270	360	800	516	20	20	32	50	175
2	308	302	262	270	360	701	527	20	20	30	50	180
3	305	302	270	273	365	10	723	20	20	28	50	180
4	300	300	274	280	380	6	725	20	400	20	45	180
5	311	299	275	310	486	200	725	20	500	22	45	180
6	308	298	277	327	854	4	725	20	750	20	40	185
7	306	298	278	340	570	3	730	20	750	a 600	40	185
8	304	298	280	350	700	0	725	20	750	a 650	40	196
9	302	281	295	360	500	0	500	20	740	a 650	40	198
10	300	280	295	420	597	0	760	20	740	a 650	40	198
11	300	280	293	480	350	0	761	20	730	a 650	40	200
12	307	280	293	560	530	0	500	20	730	a 650	40	200
13	307	280	293	690	575	0	500	20	730	700	40	205
14	306	277	293	700	575	0	750	20	730	802	834	210
15	306	276	288	720	600	0	750	20	614	800	805	261
16	305	260	286	740	600	4	740	20	720	700	815	261
17	304	259	285	765	650	0	730	20	700	750	805	261
18	304	258	285	785	1,048	5	870	20	690	790	795	262
19	305	256	278	790	612	0	840	20	200	609	110	262
20	305	256	278	867	1,000	0	432	30	200	749	105	262
21	305	254	277	870	625	581	50	20	200	846	100	262
22	305	252	277	870	650	600	30	20	200	678	89	254
23	305	275	272	840	650	590	30	20	200	670	92	254
24	305	275	272	815	1,000	580	30	20	200	150	95	250
25	305	273	273	795	1,010	300	30	20	150	75	105	250
26	306	272	273	800	890	0	28	20	180	65	125	250
27	306	272	273	801	950	669	25	20	30	60	134	250
28	306	270	270	785	960	731	20	20	30	60	157	250
29	306	......	268	760	960	700	20	20	35	55	165	252
30	306	......	269	375	950	600	20	20	35	55	170	252
31	305	......	269	......	955	......	20	20	......	55	......	250
1907.												
1	252	365	585	1,011	30	321	40	25	20	490	613	316
2	255	378	604	1,012	30	327	35	25	20	490	613	315
3	256	376	556	1,012	30	333	35	35	20	489	612	312
4	256	372	541	1,012	30	339	35	35	20	490	603	310
5	249	372	656	1,055	30	50	35	35	20	489	607	308
6	249	372	643	1,012	30	40	33	35	20	513	602	306
7	249	370	620	1,013	30	35	30	35	20	513	583	305
8	248	270	617	1,046	30	344	30	35	20	513	582	305
9	248	355	639	1,047	30	575	30	35	20	513	583	304
10	240	352	639	1,047	30	622	30	35	500	673	582	303
11	238	351	1,028	1,047	30	772	30	400	459	665	582	302
12	246	350	1,020	1,047	30	780	30	770	455	665	580	300
13	246	350	1,011	1,059	30	400	30	760	455	660	580	298
14	246	347	1,005	1,046	30	525	30	755	455	661	582	296
15	246	347	996	1,035	30	410	30	750	454	662	581	294

a Repairing gates, estimate probably too low.

Daily discharge, in second-feet, of Pine River below Pine River reservoir, Minn., for 1895–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
16	396	335	993	1,035	30	400	30	748	454	657	322	296
17	390	335	1,023	1,034	30	540	30	745	452	658	322	295
18	383	335	1,023	1,012	30	775	30	780	452	653	324	294
19	383	338	1,012	1,012	30	778	30	785	452	654	326	293
20	383	338	1,012	1,045	30	775	30	1,032	455	648	326	292
21	383	338	1,001	1,011	30	300	30	1,020	536	648	327	292
22	380	338	971	1,000	30	150	30	1,005	535	649	327	291
23	380	301	990	150	30	780	405	1,072	534	648	328	290
24	375	300	979	125	30	350	770	1,060	530	642	326	289
25	375	298	1,012	100	30	785	765	1,050	528	638	324	288
26	385	298	1,012	75	30	778	775	1,040	525	638	322	287
27	385	298	1,011	60	30	785	770	1,030	520	867	321	288
28	380	361	1,000	50	318	360	765	30	518	861	320	287
29	375		1,000	50	465	50	760	20	515	861	319	289
30	370		1,002	40	465	50	755	20	512	613	317	290
31	368		1,000		315		35	20		613		292
1908.												
1	291	263	314	290	119	136	123	130	580	800	330	142
2	290	265	312	143	120	137	727	130	575	455	332	143
3	289	270	310	145	121	137	124	129	570	450	333	143
4	288	276	308	130	121	138	125	128	20	448	335	144
5	287	282	306	132	122	138	125	126	520	446	337	144
6	287	300	304	135	122	139	124	124	525	444	338	144
7	285	310	309	138	121	137	124	122	535	440	339	144
8	283	324	309	125	121	134	123	120	540	436	338	144
9	281	324	308	128	120	129	123	120	546	432	337	143
10	280	325	308	130	120	126	122	120	700	429	336	143
11	281	326	307	123	121	124	121	120	699	427	335	143
12	279	326	306	124	122	122	121	120	698	426	332	143
13	278	325	305	126	123	120	122	120	705	424	331	143
14	277	326	306	128	123	120	122	120	720	421	329	144
15	276	327	306	130	124	120	927	120	750	418	327	144
16	275	325	305	131	125	121	127	122	770	415	325	143
17	274	324	305	132	125	121	126	122	835	413	323	143
18	275	323	304	115	124	120	126	825	830	415	321	144
19	274	322	303	116	125	120	128	820	832	417	319	144
20	272	321	302	117	126	121	130	818	826	600	317	145
21	270	320	302	118	126	121	132	815	820	610	142	146
22	269	319	303	120	127	122	785	808	815	618	142	146
23	268	318	304	122	128	122	780	970	812	622	141	147
24	266	317	305	124	129	121	775	960	810	627	141	148
25	267	316	300	127	130	121	773	950	806	625	140	149
26	266	315	298	126	131	120	770	940	804	620	140	149
27	265	314	295	125	132	121	768	960	805	615	141	149
28	264	313	300	124	133	121	765	583	806	610	141	149
29	263	344	299	123	134	122	129	585	805	336	141	149
30	262		298	121	135	122	128	588	803	332	142	149
31	263		295		136		127	585		328		149
1909.												
1	149	147	245	406	210	219	120	72	76	528	131	134
2	148	148	247	404	212	220	118	73	75	527	131	134
3	150	147	248	402	214	221	115	74	74	526	130	135
4	152	147	249	405	215	222	115	75	73	524	130	134
5	154	148	250	409	216	223	114	76	75	522	131	136
6	156	148	316	412	217	223	114	77	77	520	130	138
7	158	148	315	415	218	224	115	78	80	518	131	190
8	210	149	314	418	219	225	114	78	475	516	132	192
9	214	149	313	421	221	224	113	79	480	514	133	194
10	214	150	312	424	224	224	113	79	485	516	134	196
11	213	150	311	424	226	225	115	80	490	518	134	198
12	213	151	310	423	228	225	118	80	495	520	135	198
13	212	152	308	423	230	226	120	81	500	522	136	198
14	212	154	310	424	232	665	124	82	510	524	135	199
15	211	156	312	423	233	700	126	82	115	526	135	199
16	210	158	314	422	230	725	128	82	110	540	134	199
17	209	160	316	422	224	960	532	83	514	538	133	200
18	208	248	422	423	221	855	530	83	513	536	132	200
19	148	249	424	424	218	815	528	83	520	130	131	200
20	147	250	426	425	215	731	526	83	541	127	132	201

Daily discharge, in second-feet, of Pine River below Pine River reservoir, Minn., for 1895–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
21	146	249	424	425	212	705	524	83	540	125	132	201
22	145	248	422	426	210	700	360	84	539	123	133	201
23	144	247	420	426	211	690	75	84	538	121	133	202
24	144	246	418	427	212	500	72	85	537	123	134	202
25	144	245	416	428	213	230	72	85	536	125	133	202
26	145	244	415	429	214	228	73	86	535	126	134	203
27	145	243	413	202	215	225	74	87	534	127	134	204
28	146	243	412	204	216	223	73	88	533	128	134	206
29	146	....	410	206	217	224	73	88	532	130	135	208
30	147	....	409	208	218	225	73	89	530	131	135	210
31	147	....	408	....	219	....	73	88	....	131	....	212
1910.												
1	212	500	675	675	642	640	123	275	65	470	71	68
2	213	505	672	679	644	646	120	180	10	473	71	69
3	214	510	668	678	646	651	121	69	10	474	72	70
4	214	515	665	676	648	658	123	68	10	475	72	70
5	215	519	662	675	650	657	125	67	10	474	73	70
6	215	519	656	673	652	656	127	66	10	475	73	70
7	216	519	652	671	654	654	129	66	10	440	73	70
8	216	515	648	669	655	653	130	66	10	400	73	70
9	216	515	642	667	656	651	133	67	10	395	73	70
10	217	560	635	665	657	650	133	67	10	360	73	70
11	217	615	630	663	658	649	134	67	10	310	73	70
12	218	655	622	662	659	650	134	68	10	290	73	71
13	218	656	625	660	660	651	135	68	62	71	73	71
14	219	657	628	658	661	655	135	68	62	70	72	71
15	219	658	630	656	658	658	136	67	62	69	72	72
16	222	660	632	654	656	662	136	67	62	69	72	72
17	225	662	636	652	652	665	132	67	67	70	71	72
18	230	664	640	650	650	670	128	66	67	70	71	73
19	235	666	643	646	645	660	125	66	67	70	71	73
20	400	668	647	643	640	640	122	66	67	71	70	74
21	415	672	655	640	637	600	120	66	68	71	69	75
22	419	674	660	635	637	575	117	66	68	71	69	75
23	430	676	675	632	637	525	115	66	68	71	68	76
24	450	678	682	633	637	450	118	67	68	71	68	77
25	460	680	688	634	636	426	120	67	69	71	67	77
26	470	681	693	634	637	420	125	67	70	71	67	78
27	480	680	690	635	636	430	300	67	160	71	67	77
28	490	678	685	636	636	426	287	67	590	71	68	78
29	493	....	680	638	635	125	285	66	688	71	68	77
30	495	....	675	640	636	125	283	66	630	71	67	78
31	498	....	670	....	637	....	283	66	....	71	....	78

Monthly discharge of Pine River below Pine River reservoir, Minn., for 1895–1910.

[Drainage area, 452 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in millions of cubic feet.
1895.						
January	3	3	3.0	0.0066	0.008	8.03
February	5	3	3.9	.0086	.009	9.43
March	67	4	7.0	.015	.02	18.7
April	625	5	178	.394	.44	462
May	577	9	357	.789	.91	956
June	536	9	167	.369	.41	433
July	477	7	108	.239	.28	289
August	837	7	548	1.21	1.38	1,468
September	426	223	339	.749	.84	878
October	229	99	154	.341	.39	412
November	144	2	83	.184	.21	215
December	3	2	2.2	.0048	.006	5.89
The year	837	2	162	.359	4.90	5,160

Monthly discharge of Pine River below Pine River reservoir, Minn., for 1895–1910—Con.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in millions of cubic feet.
1896.						
January	57	2	4.6	0.010	0.01	12.3
February	119	102	110	.243	.26	276
March	119	65	97.9	.216	.25	262
April	68	4	41.2	.091	.10	107
May	21	5	10.3	.023	.03	27.6
June 1–17	33	20	29.4	.065	.41	43.2
July 11–31	877	14	558	1.23	.96	1,012
August	704	220	420	.930	1.07	1,125
September	207	137	182	.403	.45	472
October	183	127	156	.345	.40	418
November	250	187	224	.496	.55	581
December	198	168	183	.405	.47	490
The periods						4,830
1897.						
January	447	170	245	.542	.62	656
February	238	200	219	.485	.50	530
March	290	197	229	.507	.58	613
April	1,206	303	849	1.88	2.10	2,200
May	844	5	469	1.04	1.20	1,260
June	755	191	511	1.13	1.26	1,320
July	784	5	94.1	.208	.24	252
August	9	9	9.0	.020	.02	24.1
September	767	9	103	.228	.03	267
October	11	9	9.5	.021	.02	25.4
November	14	11	13.2	.029	.03	34.2
December	13	10	10.7	.024	.03	28.6
The year	1,206	5	230	.509	6.63	7,210
1898.						
January	14	13	13.5	.030	.03	36.2
February	18	14	16.4	.036	.04	39.7
March	19	18	18.6	.041	.05	49.8
April	19	19	19.0	.042	.05	49.2
May	19	19	19.0	.042	.05	50.9
June	1,479	19	341	.754	.84	884
July	1,379	27	561	1.24	1.43	1,500
August	1,085	134	668	1.48	1.71	1,790
September	930	699	787	1.74	1.94	2,040
October	793	406	601	1.33	1.53	1,610
November	415	3	207	.458	.51	537
December	6	3	4.4	.097	.11	11.8
The year	1,479	3	271	.600	8.29	8,600
1899.						
January	9	6	7.9	.017	.02	21.2
February	13	9	11.4	.025	.03	27.6
March	16	13	15.0	.033	.04	40.2
April	19	16	17.5	.039	.04	45.4
May	19	19	19.0	.042	.05	50.9
June	425	19	43.9	.097	.11	114
July	646	30	402	.889	1.02	1,080
August	918	30	439	.972	1.12	1,180
September	614	38	239	.529	.59	619
October	1,171	55	480	1.06	1.22	1,290
November	668	48	210	.465	.52	544
December	208	48	114	.252	.29	305
The year	1,171	6	167	.369	5.05	5,320
1900.						
January	156	52	70.5	.156	.18	189
February	52	41	48.4	.107	.11	117
March	41	41	41.0	.091	.10	110
April	414	41	140	.310	.35	363
May	769	39	406	.898	1.04	1,090
June	1,011	52	368	.814	.91	954
July	943	52	748	1.66	1.91	2,000
August	778	422	573	1.27	1.46	1,530
September	1,109	420	661	1.46	1.63	1,710
October	601	55	325	.719	.83	870
November	406	52	201	.445	.50	521
December	52	52	52	.115	.13	139
The year	1,109	39	303	.670	9.15	9,590

Monthly discharge of Pine River below Pine River reservoir, Minn., for 1895–1910—Con.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in millions of cubic feet.
1901.						
January	56	52	52.4	0.116	0.13	140
February	56	56	56	.124	.13	135
March	56	56	56	.124	.14	150
April	56	53	55.2	.122	.14	142
May	657	53	161	.356	.41	431
June	1,586	65	651	1.44	1.61	1,690
July	1,280	73	807	1.79	2.06	2,160
August	873	53	404	.894	1.03	1,080
September	871	397	667	1.48	1.65	1,730
October	938	476	784	1.74	2.00	2,100
November	452	112	314	.695	.78	814
December	241	184	212	.469	.54	568
The year	1,586	52	352	.779	10.62	11,100
1902.						
January	189	175	182	.403	.46	487
February	183	178	180	.398	.41	435
March	195	20	132	.292	.34	353
April	43	36	37.8	.084	.09	98
May	148	36	59	.131	.15	158
June	768	57	32.4	.072	.08	84
July	657	61	263	.582	.67	704
August	568	273	423	.938	1.08	1,130
September	334	318	325	.719	.80	842
October	331	306	315	.697	.80	844
November	306	295	302	.668	.74	783
December	308	291	297	.657	.76	795
The year	768	20	212	.470	6.38	6,710
1903.						
January	298	224	273	.604	.70	731
February	239	211	225	.498	.52	544
March	245	211	230	.509	.59	616
April	49	21	40.8	.090	.10	106
May	556	39	178	.394	.45	477
June	607	41	309	.684	.76	801
July	713	36	338	.748	.86	905
August	643	35	135	.299	.34	362
September	99	88	92	.204	.23	238
October	516	103	135	.299	.34	362
November	110	105	109	.241	.27	283
December	110	106	107	.237	.27	287
The year	713	21	181	.399	5.43	5,710
1904.						
January	217	104	113	.250	.29	303
February	418	108	225	.498	.54	564
March	431	397	415	.918	1.06	1,110
April	502	413	473	1.05	1.17	1,230
May	491	108	240	.531	.61	643
June	610	121	332	.735	.82	861
July	778	119	418	.925	1.07	1,120
August	689	152	365	.808	.93	977
September	530	139	370	.819	.91	959
October	848	228	684	1.52	1.75	1,830
November	304	284	295	.653	.73	765
December	302	267	280	.620	.72	750
The year	848	104	351	.777	10.60	11,100
1905.						
January	271	253	262	.580	.67	702
February	253	241	245	.542	.56	593
March	657	238	405	.896	1.03	1,080
April	675	61	431	.954	1.06	1,120
May	740	50	334	.739	.85	894
June	908	600	707	1.56	1.74	1,830
July	1,520	900	1,280	2.83	3.26	3,430
August	1,402	1,050	1,260	2.79	3.22	3,370
September	1,080	450	720	1.59	1.77	1,870
October	470	320	396	.876	1.01	1,060
November	385	133	304	.673	.75	788
December	470	230	359	.794	.92	961
The year	1,520	50	558	1.24	16.84	17,700

Monthly discharge of Pine River below Pine River reservoir, Minn., for 1895–1910—Con.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in millions of cubic feet.
1906.						
January	312	300	305	0.675	0.78	817
February	304	252	278	.615	.64	672
March	295	262	279	.617	.71	747
April	870	270	600	1.33	1.48	1,560
May	1,010	350	687	1.52	1.75	1,840
June	800	0	236	.522	.58	612
July	870	20	446	.987	1.14	1,190
August	30	20	20.3	.045	.05	54.4
September	750	20	400	.885	.99	1,040
October	846	20	409	.905	1.04	1,100
November	834	40	202	.447	.50	524
December	262	175	226	.500	.58	605
The year	1,010	0	341	.754	10.24	10,800
1907.						
January	396	238	317	.701	.81	849
February	378	298	344	.761	.79	832
March	1,028	585	877	1.94	2.24	2,350
April	1,059	40	777	1.72	1.92	2,010
May	465	30	76.6	.170	.20	205
June	798	35	451	1.00	1.12	1,170
July	775	30	209	.462	.53	560
August	1,072	20	491	1.09	1.26	1,310
September	536	20	349	.772	.86	905
October	867	489	627	1.39	1.60	1,680
November	613	317	458	1.01	1.13	1,190
December	316	287	298	.659	.76	798
The year	1,072	20	440	.973	13.22	13,900
1908.						
January	291	262	276	.611	.70	739
February	327	263	312	.690	.74	782
March	314	295	304	.673	.78	814
April	290	115	132	.292	.33	342
May	136	119	125	.277	.32	335
June	139	120	126	.279	.31	327
July	927	121	317	.701	.81	849
August	970	120	429	.949	1.09	1,150
September	835	20	695	1.54	1.72	1,800
October	800	328	487	1.08	1.24	1,300
November	339	140	268	.593	.66	695
December	149	142	145	.321	.37	388
The year	970	20	301	.667	9.07	9,520
1909.						
January	214	144	171	.378	.44	458
February	250	147	190	.420	.44	460
March	426	245	349	.772	.89	935
April	429	202	391	.865	.97	1,010
May	233	210	219	.484	.56	586
June	960	219	410	.907	1.01	1,060
July	532	72	179	.396	.46	479
August	89	72	81.5	.180	.21	218
September	541	73	388	.859	.96	1,010
October	540	121	358	.792	.91	959
November	136	130	133	.294	.33	345
December	212	134	188	.416	.48	503
The year	960	72	255	.564	7.66	8,020
1910.						
January	498	212	311	.688	.79	833
February	681	500	613	1.36	1.42	1,480
March	693	622	657	1.45	1.67	1,760
April	679	632	654	1.45	1.62	1,700
May	661	635	647	1.43	1.65	1,730
June	670	125	573	1.27	1.42	1,490
July	300	115	153	.338	.39	410
August	275	66	77.2	.171	.20	207
September	688	10	106	.235	.26	275
October	475	69	206	.456	.53	552
November	73	67	70.7	.156	.17	183
December	78	68	73	.162	.19	195
The year	693	10	345	.764	10.31	10,800

CROW WING RIVER.

GENERAL FEATURES OF AREA DRAINED.

The area drained by Crow Wing River lies a little northwest of the center of Minnesota and embraces part or all of Cass, Hubbard, Wadena, Becker, Ottertail, Douglas, and Todd counties. The source of Crow Wing River is found in the southern part of Hubbard County in a remarkable chain of a dozen lakes of considerable size, extending about 30 miles in a northeast-southwest direction. These lakes occupy a river-like valley with abrupt sides 20 to 40 feet high. From the outlet of the lakes the Crow Wing flows southward and after crossing the line into Wadena County receives the waters of Shell River which heads in Shell Lake in Becker County. Below Shell River the Crow Wing takes a general southerly though very winding course until it is joined by Leaf and Partridge rivers; it then turns and flows southeastward to its junction with the Mississippi on the boundary between Cass and Morrison counties. The length of the river from the outlet of the lakes to the mouth is 89 miles.

Its only important tributaries, aside from those mentioned, are Long Prairie River, which enters from the south, and Gull River, which enters from the north near its mouth.

For 20 miles below the lake outlet the river winds between low swampy banks about 175 feet apart. Farther down the height of the banks and the width of the river gradually increase. In its lower course the stream flows 400 feet wide between banks some 30 feet high.

The following drainage areas have been measured on the Crow Wing and its tributaries.

Drainage areas in Crow Wing River basin.

River.	Above—	Drainage area.
		Sq. miles.
Crow Wing	Shell River	242
Do	Nimrod	1,010
Do	Oyelen	1,160
Do	Motley	2,140
Do	Pillager	3,230
Do	Mouth	3,580
Shell	do	612
Fish Hook	do	215
Leaf	Wing River	338
Do	Mouth	755
Long Prairie River	do	975
Gull	Gull Lake outlet	238
Do	Mouth	312

Altitudes within the basin range from 1,200 to 1,500 feet above sea level, and the gently undulating surface lies no great distance above the streams.

The entire basin is covered with blue till, consisting chiefly of sand, gravel, and clay, resting on Cretaceous rocks in the northern part and on the Archean and Cambrian granites, gneisses, slates, and quartzites in the southern. In some parts of the area are deposits of sand and gravel from which the clay has been removed and these deposits yield water to the many springs found along the ravines and valleys and on the banks of the lakes. Nowhere in the basin does rock outcrop.

The upper part of the basin is heavily forested; the lower part is less densely timbered with jack pine. Lumbering has been carried on for many years, but although much of the area has been cut over little of the land has been cleared. Crow Wing River is used extensively for driving logs, both to Motley and to points on the lower Mississippi.

Rainfall records in the basin, extending back to 1885, indicate a mean annual precipitation of 28 inches. Of this amount 3 inches occurs during the winter months in the form of snow which remains throughout the season. The streams are frozen over from December to March with ice 1 foot or more in thickness. During this time the natural flow is very uniform, being fed entirely from the ground water, and the streams are not subject to winter freshets. The minimum flow usually occurs during February.

The basin contains 100 lakes, nearly all in the 850 square miles above the mouth of Shell River, where they comprise 5 to 10 per cent of total area. Most of these lakes are too far up on the headwaters to be of value as storage reservoirs, as their tributary run-off is small. At the outlet of Crow Wing Lakes is a dam which raises the water level about 8 feet for the purpose of driving logs in the spring. The operation of this dam increases the inequality of flow of the river instead of tending to equalize it, as the water is stored during the winter months (the natural low-water period) for the purpose of increasing the spring and early summer flow. After the driving is finished the dam is not used for storage until the next fall or winter. At the outlet of Fish Hook Lake is a dam used to furnish power for Park Rapids, and at the outlet of Gull Lake the United States Government is building a dam which will add a sixth unit to the reservoir system on the headwaters of the Mississippi.

In order to determine the availability of Crow Wing River for power development a survey was made during 1909 from the outlet of Crow Wing Lakes to the mouth of the river. From the data collected on this survey sheets have been prepared showing a profile of the water surface, a plan of the river, and the contours along the river bank. The results of this survey have been published on separate sheets and may be had upon application to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn. From this survey the table following of elevations and distances has been compiled.

Elevations and distances along Crow Wing River.

Place.	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
Mississippi River	0	1,148
Gull River	4	1,156
Pillager Bridge	11	1,177
	15	1,188
Long Prairie River	20	1,205
Motley Bridge	22	1,212
	27	1,221
Swan Creek	32	1,230
Red Crow Wing Bridge	37	1,238
Thomastown Bridge	41	1,243
Farnum Creek	49	1,253
Township line 135-136 N	54	1,261
Oyelen Bridge	57	1,276
Beaver Creek	61	1,300
Nimrod Bridge	65	1,317
Westers Rapids, foot	66	1,320
Westers Rapids, head	67	1,330
Carters Ford	72	1,346
Fivemile bend	78	1,352
Huntersville Bridge	82	1,356
Crow Wing dam, tail-water	89	1,362

None of the available horsepower on the river has been developed. The natural storage of the many lakes is increased by areas of swamp scattered throughout the drainage basin. It is estimated from the reports of county officials that about 60,000 acres of land have been benefited by drainage.

CROW WING RIVER AT NIMROD, MINN.

This station, which was established April 15, 1910, is located at the steel highway bridge at Nimrod post office, sec. 32, T. 137 N., R. 33 W. It is about 12 miles east of Sebeka, the nearest railroad point.

The chain gage is attached to the bridge, and discharge measurements are made at that section.

The nearest tributaries are Cat River, which enters nearly a mile below Nimrod, and Willow Creek, which enters about a mile above. The drainage area above the station is 1,010 square miles.

The river is used for log driving, and a dam at the outlet of Lower Crow Wing Lake controls the water from that portion of the drainage area. Since the establishment of the station there has been no trouble from log jams.

Crow Wing River has considerable fall near the station and one mile above there is a fall of 12 feet known as Westers Rapids.

As the station has not been established sufficiently long to be completely rated, no estimates of flow have been made, and only the base data are given.

From November to March the river is frozen over and observations are discontinued.

On May 19, 1910, the gage datum was lowered 1.20 feet, and the previous readings have been corrected to the new datum.

Discharge measurements of Crow Wing River at Nimrod, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 19	G. A. Gray	142	370	5.08	498
July 14	Robert Follansbee	139	305	4.60	198
Oct. 11	C. R. Adams	142	353	4.96	468

Daily gage height, in feet, of Crow Wing River at Nimrod, Minn., in 1910.

[W. H. Wintermute, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		5.04	5.60	4.55	4.50	4.45	5.40	4.72
2		5.02	5.60	4.55	4.50	4.45	5.40	4.72
3		5.08	5.85	4.55	4.50	4.45	5.40	4.72
4		5.10	5.55	4.55	4.50	4.45	5.40	4.71
5		5.10	5.05	4.60	4.50	4.48	5.32	4.70
6		5.10	4.85	4.60	4.50	4.46	5.22	4.70
7		5.08	4.80	4.60	4.50	4.45	5.15	5.08
8		5.05	4.78	4.68	4.50	4.45	5.10	5.35
9		5.04	4.71	4.68	4.50	4.45	5.09	5.35
10		5.02	4.70	4.65	4.50	4.45	5.04	5.35
11		5.01	4.70	4.70	4.50	4.45	4.96	5.38
12		5.00	4.70	4.65	4.54	4.45	4.92	5.40
13		5.00	4.70	4.60	4.58	[a] 4.88	4.91	5.28
14		5.00	4.68	4.60	4.58	5.35	4.90	5.10
15	5.10	5.00	4.62	4.59	4.55	5.48	4.86	5.10
16	5.15	5.04	4.60	4.54	4.51	5.45	4.81	5.20
17	5.22	5.11	4.60	4.50	4.48	5.00	4.76	
18	5.31	5.12	4.60	4.50	4.45	4.50	4.72	
19	5.38	5.09	4.60	4.50	4.45	4.45	4.78	
20	5.40	5.10	4.59	4.50	4.44	4.45	4.80	
21	5.34	5.16	4.56	4.50	4.42	4.42	4.85	
22	5.30	[a] 5.19	4.54	4.50	4.46	4.35	4.88	
23	5.30	5.18	4.51	4.52	4.45	4.40	4.88	
24	5.30	5.38	4.50	4.55	4.42	4.40	4.86	
25	5.30	5.58	4.54	4.55	4.42	[a] 4.95	4.85	
26	5.26	5.75	4.52	4.55	4.42	5.40	4.84	
27	5.21	5.85	4.55	4.54	4.42	5.42	4.82	
28	5.16	5.88	4.55	4.52	4.42	5.42	4.80	
29	5.09	6.00	4.55	4.52	4.42	5.42	4.79	
30	5.06	5.68	4.55	4.50	4.42	5.40	4.76	
31		5.60		4.50	4.42		4.75	

[a] Gates in logging dam opened.

NOTE.—Ice present from Nov. 7 to Dec. 31.

CROW WING RIVER AT PILLAGER, MINN.

This station, which is located at the highway bridge half a mile south of Pillager, in sec. 20, T. 133 N., R. 30 W., was established June 11, 1909, on account of the power available on Crow Wing River.

The nearest tributary, Pillager Creek, enters the river a short distance below the station.

There are no dams near the station, as the only one on the river is a logging dam at the outlet of Lower Crow Wing Lake.

From December to March the river is frozen over at the gage and discharge measurements are made through the ice to determine the winter discharge. The staff gage is located at the bridge from which measurements are made. The datum of the gage has remained unchanged since the station was established.

Conditions at this station are favorable for good results, although the river bed may shift somewhat during high water and thus necessitate the use of more than one rating curve. The records should therefore be reliable.

Discharge measurements of Crow Wing River at Pillager, Minn., in 1909–1910.

Date.	Hydrographer.	Witdh.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 23	G. A. Gray	215	1,000	6.84	1,670
23	C. B. Gibson	215	1,000	6.82	1,660
Aug. 5	Follansbee and Emerson	215	865	6.33	1,260
Sept. 1	C. J. Emerson	215	837	6.61	1,320
10	G. A. Gray	211	716	6.05	904
Nov. 3	....do	211	642	6.10	976
1910.					
Feb. 1	G. A. Gray	211	618	[a] 7.11	776
25	....do	209	490	[b] 7.01	591
Mar. 25	....do	218	1,360	8.05	2,890
May 18	....do	215	908	6.30	1,170
June 25	C. R. Adams	211	548	5.15	398
Oct. 12	....do	214	511	5.59	616
Dec. 22	....do	....	311	[c] 5.95	383

[a] Gage height to surface of water; thickness of ice, 1.3 feet.
[b] Gage height to surface of water; thickness of ice, 1.7 feet.
[c] Gage height to surface of water; thickness of ice, 1 foot.

Daily gage height, in feet, of Crow Wing River at Pillager, Minn., for 1910.

[Miss Augusta Sterling, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.92	7.11		7.09	6.62	6.34	5.04	4.88	4.76	5.98	5.46	
2		7.11	7.15	6.99	6.51	6.30	5.01	4.86	4.86	5.89	5.44	
3				6.89	6.48	6.32	5.00	4.86	4.92	5.94	5.41	5.75
4				7.00	6.42	6.42		4.85	5.00	5.82	5.40	
5	6.9	7.1	7.12	7.12	6.39	6.44		4.84	5.01	5.76		
6				7.02	6.36	6.35	5.08	4.85	5.00	5.70		
7				6.85	6.31	5.96	5.06	4.89	5.00	5.70		5.85
8	6.9			6.79	6.26	5.88	5.18	4.88	4.95	5.71		
9		7.12		6.71	6.20	5.79	5.22	4.88	4.89	5.69	5.66	
10				6.64	6.18	5.72	5.21	4.85	4.91	5.56		5.80
11				6.55	6.14	5.69	5.21	4.84	4.90	5.52		
12		7.02		6.49	6.09	5.65	5.20	4.79	4.90	5.52		
13	6.95		7.82	6.35	6.06	5.59	5.24	4.86	4.86	5.50	5.98	
14			8.25	6.32	6.04	5.54	5.30	4.86	4.86	5.50	5.95	5.90
15	6.95		8.40	6.69	6.00	5.48	5.30	4.92	5.45	5.46	5.80	
16		7.0	8.75	7.12	6.08	5.41	5.24	4.94	5.72	5.45	5.54	
17			9.02	7.55	6.20	5.39	5.15	4.94	5.84	5.39	5.69	5.90
18			9.18	7.75	6.29	5.32	5.08	4.89	5.84	5.40	5.70	
19		6.95	9.34	7.96	6.29	5.30	5.01	4.82	5.31	5.50	5.70	
20	7.0		8.90	8.14	6.22	5.29	5.00	4.80	5.01	5.54	5.81	
21			8.76	8.20	6.18	5.24	5.04	4.79	4.96	5.56	5.72	5.95
22	7.0		8.41	8.10	6.06	5.20	4.99	4.79	4.91	5.60	5.70	
23		7.0	8.25	7.95	6.08	5.19	4.99	4.81	4.92	5.59	5.84	
24			8.08	7.78	6.11	5.18	5.00	4.89	5.00	5.55	5.92	5.95
25		7.01	7.88	7.64	6.19	5.16	5.00	4.88	5.02	5.58	5.98	
26		7.05	7.74	7.42	6.28	5.15	4.98	4.86	5.22	5.55	5.99	
27	7.08		7.58	7.19	6.44	5.14	4.96	4.84	5.85	5.51	5.95	
28			7.46	7.05	6.49	5.12	4.91	4.81	5.95	5.50	5.75	
29	7.10		7.35	6.85	6.42	5.11	4.90	4.78	5.98	5.48	5.60	
30			7.30	6.68	6.42	5.09	4.89	4.92	5.99	5.49	5.50	
31			7.19		6.42		4.86	4.81		5.49		6.00

NOTE.—Ice from Jan. 1 to Mar. 12, varying in thickness from 0.8 to 1.3 feet; also during November and and December. Thickness of ice during December ranged from 0.55 to 1.7 feet.

Daily discharge, in second-feet, of Crow Wing River at Pillager, Minn., for 1909–10.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.[a]											
1						1,050	1,370	1,360	920	980	
2						1,040	1,290	1,320	920	980	
3						887	1,250	1,250	890	965	
4						770	1,200	1,230	862	965	
5						722	1,200	1,150	855	935	
6						699	1,160	1,130	827	928	
7						660	1,110	1,080	855	928	
8						628	1,200	1,030	876	905	
9						600	1,610	995	920	890	
10						611	1,650	972	1,020	890	
11					1,610	611	2,170	928	1,140	890	
12					1,380	600	2,810	890	1,170	890	
13					1,330	600	3,320	876	1,130	935	
14					1,290	600	3,580	876	1,120	1,070	
15					1,610	595	3,800	890	1,100	614	
16					1,760	622	3,960	890	1,080	698	
17					1,760	740	3,840	876	1,080	1,060	
18					1,700	600	3,540	827	1,050	1,200	
19					1,800	575	3,120	890	1,030	1,270	
20					1,760	710	2,620	958	1,030	1,200	
21					1,780	1,380	2,320	1,020	1,090	1,040	
22					1,700	2,260	2,100	1,280	1,150	1,220	
23					1,660	3,020	1,940	1,380	1,160	1,200	
24					1,640	2,900	1,980	1,330	1,120	1,190	
25					1,560	2,720	2,020	1,290	1,140	1,180	
26					1,430	2,670	1,920	1,270	1,120	1,160	
27					1,310	2,390	1,800	1,180	1,080	1,200	
28					1,260	2,040	1,700	1,130	1,030	1,350	
29					1,170	1,800	1,570	1,050	1,020	1,220	
30					1,110	1,580	1,480	972	1,000	1,140	
31						1,480	1,410		980		
1910.[b]											
1	c 776	600	1,830	1,390	1,150	351	291	253	876	548	
2		615	1,730	1,290	1,120	339	285	285	813	537	
3		615	1,640	1,270	1,140	335	285	305	848	520	
4		625	1,740	1,220	1,220	346	282	335	764	515	
5		625	1,860	1,190	1,230	356	278	339	724	500	
6		650	1,760	1,170	1,160	367	282	335	685	500	
7		700	1,600	1,130	862	359	295	335	685	500	
8		800	1,540	1,090	806	411	291	316	692	500	
9		1,000	1,470	1,040	744	429	291	295	679	500	
10		1,250	1,410	1,020	698	424	282	302	603	500	
11		1,500	1,330	995	679	424	278	298	581	500	
12		2,000	1,280	958	655	420	262	298	581	500	
13		2,620	1,160	935	620	438	285	285	570	500	
14		3,140	1,140	920	592	465	285	285	570	500	
15		3,320	1,450	890	559	465	305	542	548	500	
16		3,780	1,860	950	520	438	313	698	542	500	
17		4,140	2,320	1,040	510	398	313	778	510	500	
18		4,350	2,540	1,110	475	367	295	778	515	500	
19		4,580	2,790	1,110	465	339	272	470	570	500	
20		3,980	3,000	1,060	460	335	265	339	592	500	
21		3,790	3,080	1,020	438	351	262	320	603	500	
22		3,340	2,960	935	420	331	262	302	625	500	c 383
23		3,140	2,780	950	416	331	268	305	620	500	
24		2,930	2,580	972	411	335	295	335	598	500	
25	c 591	2,690	2,420	1,030	402	335	291	343	614	500	
26		2,530	2,170	1,100	398	328	285	429	598	500	
27		2,350	1,930	1,230	393	320	278	785	576	500	
28		2,220	1,790	1,280	384	302	268	855	570	500	
29		2,100	1,600	1,220	380	298	259	876	559	500	
30		2,040	1,440	1,220	371	295	305	883	564	500	
31		1,930		1,220		285	268		564		

[a] Daily discharge computed from two well-defined rating curves except that from Nov. 15–30, which was estimated on account of presence of ice.
[b] Daily discharge computed from a well-defined curve, except that for Mar. 1–12 and Nov. 1–30, which is estimated.
[c] Discharge measurement.

Monthly discharge of Crow Wing River at Pillager, Minn., for 1909–10.

[Drainage area, 3,230 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
January						
February						
March						
April						
May						
June 11–30	1,800	1,110	1,530	0.474	0.35	B.
July	3,020	575	1,230	.381	.44	B.
August	3,960	1,110	2,130	.659	.76	B.
September	1,380	827	1,080	.334	.37	A.
October	1,170	827	1,020	.316	.36	A.
November	1,350	614	1,040	.322	.36	B.
December			a 925	.286	.33	C.
1910.						
January			a 770	.238	.27	C.
February			a 670	.207	.22	C.
March	4,580	600	2,260	.700	.81	B.
April	3,080	1,140	1,940	.601	.67	B.
May	1,390	890	1,100	.341	.39	B.
June	1,230	371	656	.203	.23	A.
July	465	285	365	.113	.13	A.
August	313	259	283	.088	.10	A.
September	883	253	443	.137	.15	A.
October	876	510	627	.194	.22	A.
November	548	a 500	504	.156	.17	C.
December			a 440	.136	.16	D.
The year	4,580		838	.260	3.52	

a Estimated.

LONG PRAIRIE RIVER NEAR MOTLEY, MINN.

Long Prairie River rises in Lake Irene and flows through Lakes Miltona, Ida, Louise, Darling, L'Homme Dieu, and Carlos; thence east and north into Crow Wing River just east of Motley. Its chief tributaries are Belle and Fish Trap rivers, and Eagle, Calamas, and Turtle creeks.

The gaging station, which is located at the highway bridge 1 mile south of Motley, in sec. 19, T. 133 N., R. 31 W., and 2 miles above the mouth of the river, was established June 10, 1909, as a check, in connection with the records of the station on the Crow Wing at Motley, on the records of the Crow Wing at Pillager, a few miles below.

Owing to the fall of the Long Prairie no backwater from the Crow Wing is recorded at the gage except possibly for a few days in the spring, when the Crow Wing is ice gorged. There are no dams on the river to affect its flow at the gaging station.

Discharge measurements are made from the bridge except during low stages, when they are made by wading a short distance upstream.

The datum of the staff gage, which is located about 200 feet above the bridge on the left bank, has remained unchanged since the gage was installed.

Conditions at this station are favorable for good results and the records should be reliable.

From November to March the river is frozen over at the gage, and during that period observations are discontinued.

Discharge measurements of Long Prairie River near Motley, Minn., for 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 24	C. B. Gibson	110	268	5.88	439
Aug. 4[a]	Robert Follansbee	103	135	5.12	153
Sept. 1[a]	C. J. Emerson	102	131	5.16	128
11[a]	G. A. Gray	97	111	5.08	113
1910.					
Mar. 24	G. A. Gray	112	287	6.20	587
July 15[a]	Robert Follansbee	80	89.1	4.92	83.2

[a] Wading section.

Daily gage height, in feet, of Long Prairie River near Motley, Minn., for 1910.

[John Greene, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		5.75	5.54	5.25	4.80	4.76	4.90	4.98	4.90
2		5.72	5.45	5.22	4.80	4.78	4.92	4.99	4.90
3		5.70	5.49	5.22	4.78	4.79	4.95	4.98	4.90
4		5.69	5.48	5.25	4.80	4.76	4.98	4.95	4.88
5		5.70	5.45	5.29	4.80	4.78	4.95	4.94	4.90
6		5.70	5.45	5.36	4.85	4.78	4.94	4.92	4.90
7		5.70	5.42	5.39	4.84	4.79	4.94	4.92	4.86
8		5.65	5.40	5.34	4.86	4.78	4.92	4.91	4.85
9		5.61	5.38	5.32	4.85	4.75	4.90	4.91	4.92
10		5.60	5.35	5.30	4.90	4.75	4.90	4.92	4.92
11		5.55	5.31	5.28	4.92	4.75	4.88	4.90	4.90
12		5.52	5.30	5.26	4.95	4.76	4.86	4.90	5.06
13		5.50	5.30	5.22	4.95	4.80	4.85	4.90	4.89
14		5.49	5.30	5.20	4.94	4.82	4.85	4.89	4.88
15		5.64	5.29	5.18	4.92	4.88	4.85	4.90	4.88
16		5.85	5.38	5.12	4.90	4.89	4.88	4.90	4.89
17	6.98	6.00	5.44	5.09	4.89	4.85	4.88	4.92	
18	7.40	6.09	5.49	5.04	4.86	4.86	4.89	4.92	
19	7.10	6.18	5.46	5.00	4.82	4.86	4.90	4.92	
20	6.50	6.25	5.42	5.00	4.82	4.85	4.86	4.95	
21	6.52	6.25	5.39	4.96	4.86	4.82	4.86	4.95	
22	6.50	6.24	5.35	4.95	4.85	4.82	4.90	4.96	
23	6.38	6.20	5.34	4.92	4.85	4.85	4.90	4.99	
24	6.18	6.15	5.32	4.96	4.82	4.85	4.90	4.98	
25	6.08	6.08	5.30	4.95	4.80	4.85	4.90	4.94	
26	5.99	5.89	5.31	4.91	4.80	4.85	5.00	4.94	
27	5.95	5.82	5.30	4.91	4.80	4.85	5.02	4.92	
28	5.89	5.71	5.28	4.90	4.80	4.84	5.05	4.90	
29	5.85	5.64	5.25	4.86	4.79	4.82	5.02	4.88	
30	5.81	5.60	5.24	4.85	4.78	4.90	5.00	4.92	
31	5.80		5.25			4.89		4.90	

NOTE.—Ice present from Jan. 1 to Mar. 16 and from Nov. 17 to Dec. 31.

Daily discharge, in second-feet, of Long Prairie River near Motley, Minn., for 1909–10.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.									
1					258	143	135	151	132
2					250	135	132	145	132
3					242	132	132	140	132
4					231	127	132	135	127
5					220	122	132	135	125
6					220	122	122	127	122
7					212	125	125	132	125
8					212	163	122	135	122
9					198	195	122	143	122
10				572	192	192	122	163	127
11				534	185	292	120	175	125
12				463	181	395	117	178	122
13				410	178	426	110	172	122
14				385	172	395	113	163	163
15				347	163	347	117	160	160
16				347	163	301	122	148	205
17				385	163	275	120	143	175
18				385	154	242	117	140	181
19				395	154	227	122	135	185
20				436	172	209	125	154	235
21				463	212	195	163	148	181
22				479	275	185	205	148	163
23				490	267	178	212	145	148
24				416	216	185	212	143	140
25				361	198	178	220	145	145
26				332	181	175	212	143	154
27				310	175	163	216	127	205
28				296	160	154	195	127	216
29				288	154	148	175	127	205
30				271	148	145	163	132	178
31					148	135		135	
1910.									
1		361	267	163	64	59	80	95	80
2		347	231	154	64	61	84	97	80
3		337	246	154	61	63	90	95	80
4		332	242	163	64	59	95	89	77
5		337	231	175	64	61	90	88	80
6		337	231	198	72	61	88	84	80
7		337	220	209	70	63	88	84	74
8		314	212	192	74	61	84	82	72
9		296	205	185	72	58	80	82	84
10		292	195	178	80	58	80	84	84
11		271	181	172	84	58	77	80	80
12		258	178	166	90	59	74	80	113
13		250	178	154	90	64	72	80	78
14		246	178	148	88	67	72	78	77
15		310	175	143	84	77	72	80	77
16		410	205	127	80	78	77	80	78
17	1,060	490	227	120	78	72	77	84	
18	1,330	640	246	108	74	74	78	84	
19	1,140	589	235	99	67	74	80	84	
20	770	628	220	99	67	72	74	89	
21	782	628	209	91	74	67	74	89	
22	770	622	195	90	72	67	80	91	
23	699	600	192	84	72	72	80	97	
24	589	572	185	91	67	72	80	95	
25	534	534	178	90	64	72	80	88	
26	485	431	181	82	64	72	99	88	
27	463	395	178	82	64	72	104	84	
28	431	342	172	80	64	70	110	80	
29	410	310	163	74	63	67	104	77	
30	390	292	160	72	61	80	99	84	
31	385		163		60	78		80	

NOTE.—Daily discharge computed from a well-defined rating curve.

Monthly discharge of Long Prairie River near Motley, Minn., for 1909–10.

[Drainage area, 973 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
June 10–30	572	271	398	0.409	0.32	B.
July	275	148	195	.200	.23	B.
August	426	122	207	.213	.25	B.
September	220	110	148	.152	.17	A.
October	178	127	145	.149	.17	A.
November	235	122	156	.160	.18	B.
1910.						
Mar. 17–31	1,330	385	682	.701	.39	A.
April	640	246	404	.415	.46	A.
May	267	160	203	.209	.24	A.
June	209	72	131	.135	.15	A.
July	90	60	71.4	.073	.08	A.
August	80	58	67.4	.069	.08	A.
September	110	72	84.1	.086	.10	A.
October	97	77	85.5	.088	.10	A.
Nov. 1–16	113	72	80.9	.083	.05	A.

SAUK RIVER.

GENERAL FEATURES OF AREA DRAINED.

Sauk River drains an area comprising 821 square miles lying south of the basin of Crow Wing River and north of that of the Crow. The Sauk rises in Osakis Lake, in the southwestern part of Todd County, and flows southeastward to its junction with the Mississippi about 2 miles above St. Cloud. Its tributaries are not important.

In its upper course Sauk River flows through a number of small lakes, such as Gurney, Roberts, Little Sauk, Saul, and Horseshoe. In all there are about 75 lakes in the basin, comprising 1 per cent of the drainage area. Many of these lakes are small and have no visible outlet.

The surface of the basin is rolling and is in general 40 to 80 feet above the level of the Sauk. Altitudes range from 1,050 to 1,400 feet above sea level. The entire area is covered with blue till—a mixture of sand, gravel, and clay laid down during the glacial epoch—underlain by Cretaceous sandstones and shales or Archean granite and syenites. Rocks outcrop at a few places in the basin, notably near St. Cloud, where granite is quarried. The sands and gravels of the drift yield water to the springs that emerge along the stream and also to shallow wells.

For half its length the Sauk forms the dividing line between the prairie district and the region of original forest which lies north of the river as far south as Richmond. The country below Richmond was formerly included in the timbered belt, but the proportion of forested area has been greatly reduced by clearing. By far the greater part of the drainage basin in now under cultivation.

Rainfall records maintained at various points in the basin and extending over 10 years indicate that the mean annual precipitation in the upper part of the area is 26 inches; the lower part lies in a small zone where the rainfall as determined at three points is about 23 inches. During the winter months the average precipitation (equal to 2½ inches of rainfall) is in the form of snow which remains until spring. The streams in the basin are frozen over from December to March with ice 1 foot or more thick. During this time the natural flow is very uniform, slightly decreasing until midwinter, when it is lowest. As there are no thaws during the winter the source of supply is the ground water.

The basin contains no important reservoir sites, as the lakes are too small and too far upstream to be of value in regulating the flow of the river. During the low-water period the operation of the power plants has an effect on the flow of the river, holding a part of it back for some hours and then releasing it to augment the natural flow for the remainder of the day.

Water power is developed as follows:

Developed water powers in Sauk River basin.

Place.	Fall utilized.	Average horsepower.
	Feet.	
Sauk Center	11	150
Melrose	14	200
Cold Spring	8	100
Near Mouth	8	60

The following table of approximate elevations and distances has been compiled chiefly from the reports of the Minnesota Geological Survey:

Elevations and distances along Sauk River.

Place.	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
Mississippi River	0	992
Great Northern Ry	5	1,035
Sec. 6, T. 123 N., R. 31 W	37	1,100
Great Northern Ry	62	1,172
Melrose (Great Northern Ry.)	68	1,201
Sauk Center (Great Northern Ry.)	76	1,212
Sauk Lake outlet	79	1,220
Little Sauk Lake outlet	90	1,240
Osakis Lake outlet	104	1,310

SAUK RIVER NEAR ST. CLOUD, MINN.

This station, which is located at the highway bridge 3 miles west of St. Cloud in sec. 9, T. 124 N., R. 28 W., and about 2 miles above the mouth of the river, was established July 8, 1909, in connection with the general investigation of the water resources of Minnesota.

The nearest tributary enters Sauk River at Rockville, 10 miles or more above the station. The nearest dam is at the mouth of the river and is 9 feet high. Not only is the station above the influence of this dam, but the dam itself prevents backwater from Mississippi River reaching the station. The first dam above the station is at Cold Springs, 15 miles distant. The opening and shutting of the turbine gates at Cold Springs affect the flow at the gaging station during the low-water season.

Discharge measurements are made at the bridge section, where is located the chain gage. Gage heights are read twice a day, and the mean of the readings is taken as the mean for the day.

From December to March the river is frozen completely over in the vicinity of the gaging station and discharge measurements are made through the ice to develop an approximate winter rating.

On account of the daily fluctuations of the stage of the river due to control of flow by dams above the station, the mean daily gage height during the low-water season is subject to some error, and the records for that period can not be considered better than fair.

Discharge measurements of Sauk River near St. Cloud, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 8	G. A. Gray	94	176	....	224
Aug. 3	Robert Follansbee	94	166	6.14	174
18	C. J. Emerson	94	171	6.27	217
Sept. 2	.....do	92	143	5.93	145
Oct. 19	G. A. Gray	87	108	5.74	88.9
1910.					
Jan. 6	G. A. Gray	80	120	[a] 7.00	108
Feb. 28	.....do	99	86.9	[b] 6.80	61.0
Mar. 27	.....do	102	274	7.20	612
June 24	C. R. Adams	93	147	5.97	131
Aug. 2	G. A. Gray	77	85.8	5.63	72.9
Dec. 21	C. R. Adams	....	54.5	[c] 6.10	12.8

[a] Gage height to water surface; thickness of ice, 1.25 feet.
[b] Gage height to water surface; thickness of ice, 1.90 feet.
[c] Gage height to water surface; thickness of ice 1.3 feet.

Daily gage height, in feet, of Sauk River near St. Cloud, Minn., for 1910.

[Ida Waite, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.7	7.3	7.2	7.45	5.85	5.55	5.55	5.2	5.4	5.9	5.2	
2				7.45	5.85	5.5	5.45	5.45	5.4	5.95	5.2	
3				7.4	5.9	5.4	5.5	5.2	5.5	5.9	5.2	6.0
4	6.9			7.2	5.95	5.4	5.4	5.3	5.2	5.8	5.2	
5		7.25	8.0	7.15	5.95	5.4	5.45	5.3	5.15	5.6	5.2	
6	7.0			6.9	5.95	5.55	5.35	5.3	5.15	5.6	5.2	
7				6.55	6.05	6.05	5.2	5.25	5.15	5.6	5.25	
8	7.35	7.4	8.2	6.65	6.0	6.1	5.3	5.2	5.1	5.4	5.2	6.0
9				6.4	6.0	6.0	5.35	5.2	5.75	5.3	5.2	
10				6.35	6.0	6.05	5.65	5.25	5.8	5.3	5.4	
11	6.9			6.2	5.95	6.1	5.25	5.3	5.15	5.7	5.2	
12			8.5	6.25	5.95	5.95	5.1	5.55	5.2	5.7	5.2	
13				6.3	5.9	5.45	5.1	5.6	5.3	5.72	5.4	
14				6.4	5.9	5.3	5.1	5.6	5.3	5.7	5.4	
15	6.9	7.35	8.95	6.55	5.8	5.3	5.15	5.6	5.4	5.72	5.35	
16				6.55	5.8	5.3	5.1	5.65	5.4	5.6	5.15	
17				6.5	5.7	5.3	5.1	5.95	5.4	5.4	5.25	
18	6.95			6.5	5.45	5.3	5.1	5.6	5.5	5.3	5.3	6.0
19		6 8	7.85	6.45	5.35	5.35	5.1	5.45	5.6	5.2	5.4	
20			7.65	6.4	5.35	5.3		5.2	5.55	5.2	5.2	
21			7.55	6.45	5.45	5.35	5.4	5.2	5.6	5.2	5.15	6.1
22	6.7	6.7	7.4	6.45	5.35	5.4	5.1	5.25	5.45	5.2	5.5	
23			6.45	6.5	5.35	5.5	5.1	5.2	5.6	5.2	5.6	
24			6.3	6.6	5.45	5.5	5.1	5.35	5.6	5.2	5.6	
25	7.1		6.75	6.55	5.45	5.5	5.15	5.25	5.35	5.4	5.5	6.0
26		7.1	6.55	6.45	5.55	5.55	5.2	5.2	5.65	5.38	6.15	
27			6.85		5.5	5.55	5.6	5.6	5.65	5.2	5.6	
28		6.8	6.9		5.6	5.55	5.7	5.4	5.6	5.35		
29			7.0		5.55	5.6	5.6	5.2	5.6	5.4		6.1
30			7.2		5.5	5.6	5.65	5.3	5.9	5.25		
31			7.15		5.55		5.6	5.4		5.3		

NOTE.—Ice present from Jan. 1 to Mar. 15 and from Nov. 21 to Dec. 31.

Daily discharge, in second-feet, of Sauk River near St. Cloud, Minn., for 1909–10.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1								154	109	101	71	
2								166	99	93	85	
3								166	99	85	95	
4								250	95	71	98	
5								161	95	71	93	
6								78	51	78	103	
7								110	70	85	99	
8							266	142	105	85	93	
9							400	220	77	85	161	
10							425	212	91	85	112	
11							400	226	63	88	118	
12							670	226	42	93	98	
13							400	206	42	101	101	
14							425	206	63	93	88	
15							555	135	63	95	85	
16							400	67	77	91	93	
17							400	78	91	66	120	
18							266	67	99	70	131	
19							317	74	109	63	179	
20							317	74	152	74	206	
21							500	74	77	85	220	
22							500	74	63	85	220	
23							378	70	77	82	214	
24							378	74	77	85	220	
25							317	176	91	85	192	
26							250	152	84	78	206	
27							250	63	79	82	220	
28							250	51	84	58	220	
29							220	51	84	78	220	
30							166	26	84	78	220	
31							154	63		58		

Daily discharge, in second-feet, of Sauk River near St. Cloud, Minn., for 1909–10—Contd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910.												
1	......	......	90	762	110	64	64	30	47	120	30	......
2	......	......	100	762	110	58	52	52	47	131	30	......
3	......	......	115	730	120	47	58	30	58	120	30	......
4	......	......	130	610	131	47	47	38	30	101	30	......
5	......	......	150	582	131	47	52	38	27	71	30	......
6	a 108	......	190	450	131	64	42	38	27	71	30	......
7	......	......	210	300	154	154	30	34	27	71	34	......
8	......	......	250	336	142	166	38	30	24	47	30	......
9	......	......	350	250	142	142	42	30	93	38	30	......
10	......	......	450	235	142	154	78	34	101	38	47	......
11	......	......	550	192	131	166	34	38	27	85	30	......
12	......	......	600	206	131	131	24	64	30	85	30	......
13	......	......	600	220	120	52	24	71	38	88	47	......
14	......	......	650	250	120	38	24	71	38	85	47	......
15	......	......	700	300	101	38	27	71	47	88	42	......
16	......	......	700	300	101	38	24	78	47	71	27	......
17	......	......	800	282	85	38	24	131	47	47	34	......
18	......	......	850	282	52	38	24	71	58	38	38	......
19	......	......	950	266	42	42	24	52	71	30	47	......
20	......	......	990	250	42	38	36	30	64	30	30	......
21	......	......	828	266	52	42	47	30	71	30	27	a 13
22	......	......	730	266	42	47	24	34	52	30	30	......
23	......	......	266	282	42	58	24	30	71	30	30	......
24	......	......	220	317	52	58	24	42	71	30	30	......
25	......	......	378	300	52	58	27	34	42	47	30	......
26	......	......	300	266	64	64	30	30	78	45	30	......
27	......	......	425	235	58	64	71	71	78	30	30	......
28	......	a 61	450	204	71	64	85	47	71	42	30	......
29	......	......	500	172	64	71	71	30	71	47	30	......
30	......	......	610	141	58	71	78	38	120	34	30	......
31	......	......	582	......	64	......	71	47	......	38	......	......

a Discharge measurement.

NOTE.—Daily discharge computed from a well-defined rating curve, except that for Mar. 1–21 and Nov. 22–30, 1910, when the discharges are estimated, because of presence of ice.

Monthly discharge of Sauk River near St. Cloud, Minn., for 1909–10.

[Drainage area, 816 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
July 8–31	670	154	358	0.439	0.39	B.
August	250	26	126	.154	.18	B.
September	152	42	83.1	.102	.11	B.
October	101	58	81.5	.100	.12	B.
November	220	71	146	.179	.20	C.
December	....	....	a 100	.123	.14	C.
1910.						
January	....	....	a 100	.123	.14	C.
February	....	....	a 80.0	.098	.10	D.
March	990	90	475	.582	.67	C.
April	762	141	334	.409	.46	B.
May	154	42	92.2	.113	.13	B.
June	166	38	72.0	.088	.10	B.
July	85	24	42.6	.052	.06	B.
August	131	30	47.2	.058	.07	B.
September	120	24	55.8	.068	.08	B.
October	131	30	59.9	.073	.08	B.
November	47	30	33.0	.040	.04	B.
December	....	....	a 20.0	.025	.03	C.
The year	990	....	118	.144	1.96	

a Estimated.

CROW RIVER.

GENERAL FEATURES OF AREA DRAINED.

The area drained by Crow River lies in Stevens, Kandiyohi, Meeker, Renville, McLeod, Wright, and Hennepin counties, between the basins of the Sauk and the Minnesota. Crow River proper is a short stream, being formed by the junction of the North and South Branches 2 or 3 miles above Rockford. Throughout its course it forms the boundary between Hennepin and Wright counties, and it discharges into the Mississippi at Dayton. The North Branch, which is the longer of the two, rises in McLeod and Grove lakes in the eastern part of Pope County. These lakes together are about 4 miles long and average one-third mile wide. From the outlet of the lakes the general course of the North Branch is southeastward through Rice and Cedar lakes, both of which are of considerable size. At Manannah it receives the Middle Branch, which rises in Crow Lake, in the southwestern part of Stevens County, and flows southward through Green Lake (area several square miles) and then eastward to its junction with the North Branch. Below the Middle Branch it receives one or two small tributaries which also head in lakes. The South Branch heads in a number of lakes in the southeastern part of Kandiyohi County, from which it takes a general easterly course, flowing through Otter Lake.

The following drainage areas have been measured in this basin:

Drainage areas in Crow River basin.

River.	Above—	Drainage area.
		Sq. miles.
North Branch	Cedar Lake	303
Do	Junction with South Branch	1,310
South Branch	Junction with North Branch	1,170
Crow	Rockford	2,520
Do	Mouth	2,590

The valley of the North Branch lies 40 to 50 feet below the general surface level; that of the South Branch is from 30 to 40 feet below the surface and one-fourth to one-half mile wide. The basin of the North Branch contains about 70 lakes, comprising approximately 3 per cent of its drainage area; that of the South Branch contains 120 lakes, comprising 2 per cent of the total area drained. Many of these lakes are small and have no apparent outlet. Altitudes range from 900 to 1,300 feet above sea level.

The entire basin is covered by blue till, of glacial origin, and scattered through it, especially in the western portion, are deposits of modified drift composed of sand and gravel. These deposits being porous form ground-water reservoirs which give rise to springs, though such springs are not of great importance in the Crow River basin. In the western part of the area the drift rests on Cretaceous rocks; in the eastern part it is underlain by Archean granites and upper Cambrian sandstones. Rock outcrops are found nowhere in the basin.

The lower part of the area, east of the west line of Wright County, lies in the district that was originally forested; the upper part is in the prairie region. Very little of the area is forested at the present time. The land is nearly all under cultivation.

The mean annual rainfall in the northern part of the basin is about 23 inches; in the rest of the basin it is 27.5 inches. Of this amount about 3 inches occurs in the form of snow, which remains on the ground until spring. The rivers are frozen over during the winter and their flow is very uniform, decreasing gradually until midwinter, when it is at its minimum. There are no winter thaws to cause freshets.

The lakes in the basin are so small and have so little tributary run-off that they are of little value as reservoir sites.

Water power is developed at the following points in the basin:

Developed water power in Crow River basin.

Run.	Place.	Fall utilized.	Average horsepower.
		Feet.	
North Branch	Manannah		50
Do	Forest City		50
Do	Kingston		50
Do	French Lake		50
Middle Branch	Green Lake	7	75
Do	New London	12	100
South Branch	Hutchinson	8	60
Crow River	Rockford	7	20
Do	Hanover	7	60
Do	Bernings Mill	5.5	40

Considerable drainage work has been done in the flatter parts of the basin, with the result that more than 50,000 acres have been reclaimed, of which nearly 40,000 are in Kandiyohi County.

NORTH FORK OF CROW RIVER NEAR ROCKFORD, MINN.

This station, which is located 3 miles west of Rockford at the first highway bridge above the forks, 1½ miles distant, in sec. 23, T. 119 N., R. 25 W., was established June 15, 1909, because of the power available on the river and also to obtain records to check (in connection with the South Fork station) the records at Rockford on the main stream. The drainage area above this station is 1,310 square miles.

No tributaries enter the North Fork within several miles of the station. The nearest dam is that at Rockford, which backs the water up to a point beyond the gage.

The river is icebound from December to March, inclusive, and during that period observations are discontinued, but the minimum flow can be roughly estimated by comparing drainage areas and records of the minimum run-off per square mile of drainage area at the Rockford station.

The datum of the staff gage, which is located at the bridge, has remained unchanged since the station was established; but from July 27 to August 10, 1909, when the dam at Rockford was open for repairs, the conditions of flow were temporarily changed.

Owing to the changeable conditions of flow, no estimate of daily discharge has been made, and only the base data are given. The station was discontinued June 30, 1910.

Discharge measurements of North Fork of Crow River near Rockford, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 17	C. J. Emerson	142	808	6.88	1,210
June 4	G. A. Gray	124	438	3.90	108

Daily gage height, in feet, of North Fork of Crow River near Rockford, Minn., for 1910.

[Miss Grace Wandersee, observer.]

Day.	Mar.	Apr.	May.	June.	Day.	Mar.	Apr.	May.	June.
1		5.05	4.15	3.85	16	7.05	4.18	4.00	3.80
2		4.95	4.15	3.89	17	6.85	4.30	4.02	3.78
3		4.82	4.12	3.90	18	6.72	4.42	4.05	3.70
4		4.70	4.10	3.86	19	6.58	4.45	4.05	3.70
5		4.60	4.10	3.85	20	6.45	4.40	4.10	3.62
6		4.60	4.10	3.85	21	6.25	4.40	4.10	3.55
7		4.58	4.10	3.85	22	6.08	4.35	4.10	3.52
8		4.50	4.10	3.82	23	5.95	4.30	4.08	3.60
9		4.42	4.08	3.80	24	5.75	4.35	4.04	3.55
10	5.20	4.40	4.05	3.80	25	5.62	4.30	4.04	3.52
11	5.42	4.40	4.02	3.80	26	5.52	4.30	4.00	3.65
12	5.72	4.40	4.00	3.80	27	5.40	4.30	4.00	3.80
13	6.20	4.36	4.00	3.80	28	5.30	4.25	3.99	3.78
14	6.62	4.35	4.00	3.80	29	5.24	4.22	3.90	3.75
15	7.30	4.22	4.00	3.80	30	5.15	4.20	3.90	3.60
					31	5.05		3.86	

CROW RIVER AT ROCKFORD, MINN.

This station, which is located at the highway bridge at Rockford, was established June 4, 1909, to determine the power available on Crow River.

A little more than a mile above the station is the junction of the North and South forks. Between the forks and the station two very small streams—the outlets of Rebecca Lake and Lake Sarah—enter the river. Stations were originally established on both branches above their junction to be used as a check on the Rockford records, but the conditions on the North Branch were so unsatisfactory that the station was discontinued June 30, 1910.

During high and medium stages discharge measurements are made from the bridge at which the staff gage is located; at low stages measurements are made from a boat and cable several hundred yards downstream.

About 400 feet above the station is the 7-foot dam of a flour mill, which operates intermittently. As the turbine has used but a small portion of the flow since the establishment of the station the effect of shutting it down is inappreciable at the gage except during extreme low water. At that time four readings per day are taken to determine the mean flow.

Owing to the proximity of the dam to the station the relation between gage height and discharge is not greatly affected by ice, the stream remaining open through the greater part of the section and for a distance of several hundred yards below. Winter measurements show that the open rating curve applies throughout the year.

The datum of the gage has remained unchanged since the station was established.

Conditions at this station are favorable for excellent results, and the records should be reliable.

Discharge measurements of Crow River at Rockford, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 26	G. A. Gray	273	181	5.27	245
Mar. 17	C. J. Emerson	285	1,250	9.33	2,990
July 14[a]	G. A. Gray	182	191	4.75	71.1

[a] Made at wading section.

Daily gage height, in feet, of Crow River at Rockford, Minn., for 1910.

[Geo. W. Florida, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.38	5.24	5.17	6.38	5.42	5.08	4.88	4.71	4.72	4.66	4.80	4.83
2	5.38	5.24	5.16	6.32	5.41	5.08	4.83	4.71	4.72	4.63	4.80	4.82
3	5.38	5.22	5.16	6.22	5.36	5.06	4.81	4.68	4.73	4.70	4.80	4.84
4	5.37	5.22	5.14	6.18	5.32	5.04	4.81	4.69	4.72	4.70	4.80	4.76
5	5.38	5.22	5.20	6.10	5.32	5.04	4.78	4.68	4.73	4.68	4.82	4.82
6	5.38	5.21	5.28	6.06	5.32	5.08	4.77	4.68	4.73	4.69	4.76	4.80
7	5.37	5.20	5.47	6.00	5.33	5.04	4.79	4.69	4.71	4.70	4.80	4.80
8	5.36	5.20	5.60	5.98	5.37	5.02	4.77	4.68	4.71	4.71	4.75	4.80
9	5.36	5.20	6.25	5.91	5.38	5.00	4.79	4.65	4.71	4.61	4.80	4.78
10	5.38	5.20	6.72	5.87	5.31	4.92	4.78	4.66	4.69	4.70	4.79	4.79
11	5.38	5.20	7.22	5.82	5.28	5.00	4.76	4.65	4.69	4.71	4.78	4.75
12	5.38	5.18	7.80	5.77	5.29	4.99	4.76	4.64	4.68	4.70	4.76	4.78
13	5.36	5.18	8.40	5.72	5.26	4.94	4.75	4.68	4.67	4.69	4.76	4.77
14	5.35	5.20	9.10	5.66	5.26	4.96	4.74	4.72	4.68	4.68	4.80	4.77
15	5.35	5.18	10,10	5.70	5.26	4.96	4.74	4.73	4.68	4.69	4.80	4.78
16	5.36	5.18	9.84	5.67	5.30	4.94	4.74	4.75	4.68	4.64	4.78	4.76
17	5.36	5.17	9.35	5.66	5.40	4.92	4.74	4.75	4.69	4.68	4.78	4.77
18	5.37	5.18	9.10	5.73	5.34	4.90	4.76	4.74	4.67	4.70	4.80	4.75
19	5.37	5.20	8.86	5.74	5.36	4.87	4.74	4.74	4.68	4.68	4.82	4.78
20	5.37	5.18	8.70	5.76	5.40	4.84	4.74	4.73	4.66	4.72	4.80	4.76
21	5.34	5.18	8.34	5.75	5.44	4.81	4.75	4.72	4.66	4.74	4.82	4.76
22	5.34	5.16	8.04	5.74	5.40	4.82	4.74	4.72	4.65	4.75	4.84	4.74
23	5.32	5.16	7.82	5.74	5.38	4.80	4.74	4.72	4.65	4.75	4.84	4.74
24	5.30	5.18	7.58	5.71	5.34	4.79	4.71	4.72	4.63	4.76	4.80	4.72
25	5.28	5.16	7.35	5.65	5.30	4.82	4.71	4.71	4.61	4.78	4.84	4.66
26	5.27	5.16	7.16	5.60	5.24	4.91	4.72	4.71	4.67	4.79	4.84	4.66
27	5.26	5.18	6.95	5.58	5.21	5.02	4.73	4.71	4.67	4.80	4.81	4.72
28	5.26	5.18	6.80	5.58	5.16	5.00	4.72	4.71	4.65	4.81	4.84	4.72
29	5.26	....	6.68	5.52	5.13	4.97	4.73	4.71	4.65	4.81	4.84	4.72
30	5.26	....	6.58	5.47	5.10	4.91	4.71	4.73	4.65	4.75	4.84	4.72
31	5.24	....	6.46	....	5.08	....	4.71	4.73	....	4.80	....	4.72

NOTE.—Relation between gage height and discharge at this station not affected by ice.

Daily discharge, in second-feet, of Crow River at Rockford, Minn., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	291	233	206	833	309	172	107	64	67	54	85	93
2	291	233	202	797	304	172	93	64	67	49	85	90
3	291	225	202	737	283	165	88	58	69	62	85	96
4	287	225	194	713	266	158	88	60	67	62	85	76
5	291	225	217	665	266	158	80	58	69	58	90	90
6	291	221	249	643	266	172	78	58	69	60	76	85
7	287	217	332	610	270	158	83	60	64	62	85	85
8	283	217	395	599	287	151	78	58	64	64	73	85
9	283	217	755	560	291	144	83	52	64	45	85	80
10	291	217	1,040	538	261	118	80	54	60	62	83	83
11	291	217	1,370	511	249	144	76	52	60	64	80	73
12	291	209	1,790	484	253	141	76	51	58	62	76	80
13	283	209	2,270	456	241	125	74	58	56	60	76	78
14	278	217	2,860	425	241	131	71	67	58	58	85	78
15	278	209	3,760	445	241	131	71	69	58	60	85	80
16	283	209	3,530	430	257	125	71	74	58	51	80	76
17	283	206	3,080	425	300	118	71	74	60	58	80	78
18	287	209	2,860	462	274	112	76	71	56	62	85	73
19	287	217	2,640	467	283	104	71	71	58	58	90	80
20	287	209	2,510	478	300	96	71	69	54	67	85	76
21	274	209	2,220	472	318	88	74	67	54	71	90	76
22	274	202	1,980	467	300	90	71	67	52	74	96	71
23	266	202	1,810	467	291	85	71	67	52	74	96	71
24	257	209	1,630	450	274	83	64	67	49	76	85	67
25	249	202	1,460	420	257	90	64	64	45	80	96	54
26	245	202	1,330	395	233	115	67	64	56	83	96	54
27	241	209	1,190	385	221	151	69	64	56	85	88	67
28	241	209	1,100	385	202	144	67	64	52	88	96	67
29	241		1,020	355	190	134	69	64	52	88	96	67
30	241		953	332	179	115	64	69	52	74	96	67
31	233		881		172		64	69		85		67

NOTE.—These discharges are based on a well-defined rating curve.

Monthly discharge of Crow River at Rockford, Minn., for 1910.

[Drainage area, 2,520 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	291	233	274	0.109	0.13	B.
February	233	202	214	.085	.09	B.
March	3,760	194	1,490	.591	.68	A.
April	833	332	514	.204	.23	A.
May	318	172	261	.104	.12	A.
June	172	83	130	.052	.06	A.
July	107	64	75.2	.030	.03	A.
August	74	51	63.5	.025	.03	B.
September	69	45	58.5	.023	.03	B.
October	88	45	66.3	.026	.03	B.
November	96	73	86.3	.034	.04	B.
December	96	54	76.2	.030	.04	B.
The year	3,760	45	276	.109	1.51	

SOUTH FORK OF CROW RIVER NEAR ROCKFORD, MINN.

This station, which is located at the highway bridge 3½ miles southwest of Rockford, in sec. 1, T. 118 N., R. 25 W., and 2 miles above the junction of the North and South forks, was established June 15, 1909, on account of power available on the river, and also to obtain a check (in connection with the North Fork station) on the records at Rockford on the main stream.

No tributaries enter within several miles of the station. The nearest dam is that at Delano, which is used merely as a diversion dam for the Great Northern Railway. The station is slightly within the influence of the dam at Rockford on the main river, but as there are no flashboards on this dam and no sluice gates, the control is nearly permanent as long as the dam remains unchanged.

During all stages except low, discharge measurements are made from the bridge at which the staff gage is located; at low stages measurements are made by wading a short distance upstream.

Ice is present at this station from December to March, inclusive, and observations are then discontinued.

The datum of the gage has remained unchanged since the gage was installed, but from July 27 to August 10, 1909, when the dam at Rockford was open for repairs, conditions of flow were temporarily changed.

Conditions at this station are favorable for good results, and the records should be reliable.

Discharge measurements of South Fork of Crow River near Rockford, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 16	C. J. Emerson	135	734	7.40	1,920
July 14 [a]	G. A. Gray	92	89.9	1.40	57.8
Sept. 9 [a]	C. R. Adams	9	2.9	.60	2.5

[a] Wading measurement.

Daily gage height, in feet, of South Fork of Crow River near Rockford, Minn., for 1910.

[Jacob Horsch, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	3.11	2.16	1.88	1.70	0.75	0.72	0.62	1.22
2	....	3.02	2.18	1.88	1.74	.66	.72	.62	1.21
3	....	2.91	2.12	1.90	1.74	.70	.70	.66	1.22
4	....	2.86	2.08	1.89	1.70	.70	.69	.70	1.21
5	....	2.79	2.09	1.89	1.70	.69	.69	.74	1.18
6	2.50	2.76	2.10	1.90	1.68	.70	.65	.79	1.25
7	2.78	2.70	2.10	1.90	1.58	.69	.64	.76	1.26
8	3.18	2.62	2.10	1.84	1.48	.69	.65	.79	1.31
9	3.98	2.60	2.08	1.81	1.45	.69	.60	.85	1.36
10	4.32	2.54	2.02	1.86	1.60	.70	.60	.90	1.32
11	4.86	2.50	2.01	1.88	1.58	.68	.60	.90	1.21
12	5.48	2.45	2.00	1.86	1.54	.68	.60	.90	1.18
13	6.28	2.45	1.98	1.82	1.50	.94	.60	.90	1.24
14	7.10	2.38	1.96	1.85	1.42	.96	.60	.89	1.30
15	8.60	2.36	1.95	1.81	1.35	1.09	.60	.89	1.30
16	7.52	2.31	1.96	1.76	1.35	.99	.60	1.01	1.28
17	6.90	2.38	2.02	1.74	1.35	1.00	.60	1.02	1.30
18	6.50	2.42	2.02	1.72	1.34	1.01	.60	1.06	1.28
19	6.11	2.41	2.04	1.76	1.31	.96	.60	1.21	1.22
20	5.70	2.42	2.11	1.74	1.26	1.01	.60	1.21	1.24
21	5.32	2.44	2.15	1.71	1.26	1.10	.60	1.22	1.26
22	4.94	2.46	2.12	1.70	1.15	1.06	.60	1.29	1.24
23	4.68	2.46	2.10	1.68	1.14	.94	.60	1.39	1.32
24	4.38	2.44	2.09	1.66	1.30	.82	.60	1.36	1.44
25	4.15	2.38	2.04	1.66	1.28	.76	.60	1.32	1.44
26	3.98	2.34	1.99	1.85	1.22	.75	.68	1.35	1.41
27	3.71	2.30	1.99	1.91	1.12	.72	.68	1.32	1.51
28	3.52	2.29	1.98	1.84	1.10	.70	.66	1.29	1.42
29	3.45	2.29	1.95	1.79	1.08	.71	.62	1.22	....
30	3.25	2.22	1.92	1.71	.95	.74	.62	1.32	....
31	3.18	....	1.89	....	.76	.70	....	1.31	....

NOTE.—Ice present from Jan. 1 to Mar. 5 and from Nov. 24 to Dec. 31.

Daily discharge, in second-feet, of South Fork of Crow River near Rockford, Minn., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	315	136	100	79	8	6.8	3.2	34
2	....	295	139	100	83	4.6	6.8	3.2	33
3	....	270	131	102	83	6	6	4.6	34
4	....	260	125	101	79	6	5.6	6	33
5	....	245	127	101	79	5.6	5.6	7.6	31
6	190	239	128	102	77	6	4.2	9.6	36
7	243	227	128	102	66	5.6	3.9	8.4	37
8	331	212	128	95	56	5.6	4.2	9.6	41
9	525	208	125	91	54	5.6	2.5	12	45
10	626	197	118	97	68	6	2.5	14	42
11	801	190	116	100	66	5.3	2.5	14	33
12	1,040	182	115	97	62	5.3	2.5	14	31
13	1,390	182	112	92	58	16	2.5	14	35
14	1,800	170	110	96	51	17	2.5	14	40
15	2,650	167	108	91	44	24	2.5	14	40
16	2,020	159	110	86	44	18	2.5	19	38
17	1,700	170	118	83	44	19	2.5	20	40
18	1,500	176	118	81	44	20	2.5	23	38
19	1,310	175	120	86	41	17	2.5	33	34
20	1,130	176	129	83	37	20	2.5	33	35
21	978	180	135	80	37	25	2.5	34	37
22	829	183	131	79	28	23	2.5	39	35
23	738	183	128	77	28	16	2.5	48	42
24	644	180	127	75	40	11	2.5	45	....
25	575	170	120	75	38	8.4	2.5	42	....
26	525	163	114	96	34	8	5.3	44	....
27	458	157	114	103	26	6.8	5.3	42	....
28	412	156	112	95	25	6	4.6	39	....
29	395	156	108	89	24	6.4	3.2	34	....
30	348	145	105	80	16	7.6	3.2	42	....
31	331	....	101	....	8.4	6	....	41	....

NOTE.—Daily discharge computed from a fairly well-defined rating curve.

Monthly discharge of South Fork of Crow River near Rockford, Minn., for 1910.

[Drainage area, 1,160 square miles.]

Month	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
March (6-31)	2,650	190	903	0.778	0.75	B.
April	315	145	196	.169	.19	B.
May	139	101	121	.104	.12	B.
June	103	75	91.2	.079	.09	B.
July	83	8.4	49	.042	.05	B.
August	25	4.6	11.1	.0096	.01	A.
September	6.8	2.5	3.57	.0031	.003	A.
October	48	3.2	23.4	.020	.02	B.
November	45	....	[a]37	.032	.04	C.

[a] Mean discharge Nov. 24 to 30 estimated at 38 second-feet.

RUM RIVER.

GENERAL FEATURES OF AREA DRAINED.

The area drained by Rum River lies east of the central part of Minnesota, chiefly in Mille Lacs, Isanti, and Anoka counties. Rum River rises in Lake Mille Lacs (207 square miles in area), and for 16 miles flows through three lakes bordered by flat, marshy shores; the entire fall in this distance being not more than 2 feet. Below the lakes the river winds southward as far as Princeton, where it is joined by the West Branch. Below Princeton it flows eastward in a still more winding course until it reaches Cambridge, where it turns to the south and enters the Mississippi at Anoka.

For a distance of 50 miles below the lakes the fall of the river is heavy, but from Bogus Brook to the St. Francis Dam the fall is slight. From St. Francis to Cedar Creek, a distance of 10 miles, there is considerable fall, but below this point the slope is very flat, as the influence of the Anoka dam reaches nearly to this point. Along the upper stretch of the river the banks are low, but their height gradually increases and at Page they are 20 to 30 feet above the water surface. They continue high to Princeton, are low between that point and Cambridge, and below Cambridge rise again to a general height of 20 feet or more.

The principal tributaries are West Branch, Tibbetts, Bogus, and Spencer brooks, and Upper and Lower Stanchfield and Cedar creeks. With the exception of the West Branch the streams are small.

The following drainage areas have been measured in the basin:

Drainage areas, in square miles, in Rum River basin.

River.	Above—	Drainage area.
		Sq. miles.
Rum River	Mille Lacs Lake outlet	378
Do	Onamia	414
Do	Sec. 10, T. 39 N., R. 27 W	544
Do	Sec. 27, T. 39 N., R. 27 W	601
Do	Sec. 34, T. 37 N., R. 26 W	721
Do	Cambridge	1,160
Do	Cedar Creek	1,360
Do	Mouth	1,550

The general surface of the basin is level or gently undulating. There are but few lakes except Mille Lacs and 20 small lakes in the immediate vicinity, which have a combined water surface of 240 square miles. Altitudes range from 850 to 1,300 feet above sea level. The area is covered by a thick glacial deposit of red till, beneath which are Archean granites and gneisses or Upper Cambrian sandstones and limestones. Along the Rum River valley are deposits of modified drift composed of sand and gravel. Rock is exposed only at a few places along upper Rum River and the West Branch.

Below Princeton the greater part of the area is under cultivation, but between Princeton and Milaca the proportion of cleared and cultivated land becomes smaller, and above Milaca, except for isolated clearings and farms along the river, the area is covered with brush.

The mean annual rainfall is about 27 inches, of which 3 inches are precipitated in the form of snow that remains throughout the winter. The streams are frozen over from December to March and during that period the flow is very uniform. As no thaws occur during the winter there are no freshets. The flow gradually decreases to midwinter when it is minimum, remaining constant until the spring breakup.

Lake Mille Lacs forms a natural reservoir for Rum River, tending to equalize its flow. In years of very low flow, however, this regulation is detrimental to the river, as of the area at the outlet more than half is comprised within the lake surface itself, where evaporation exceeds precipitation by 6 inches or more. This loss must be made up from the small tributary run-off. The effect of this is seen in the period of low rainfall from the spring of 1910 to the summer of 1911. The run-off at Onamia, which included not only Mille Lacs but the three small lakes below its outlet, was very small and ceased entirely during the winter. During the greater portion of this period there was said to be no flow from Mille Lacs, the flow past Onamia representing the area below the lake.

In order to determine the storage available in Lake Mille Lacs a survey was made in 1909. From the data collected on this survey a map has been prepared, showing the shore line of the lake, adjacent topography, and the depth of the lake in many places. This map may be had by applying to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn.

In order to determine the availability of Rum River for power development, a survey was made during 1909 from Anoka to the outlet of Lake Onamia at Onamia. From the data collected on this survey sheets have been prepared showing a profile of the water surface, a plan of the river, and the contours along the river bank. The results of this survey have been published in separate sheets which may be obtained by applying to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn. From this survey the following table of elevations and distances has been compiled:

Elevations and distances along Rum River.

Point.	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
Mississippi River	0	832
Anoka, tailwater	1	833
Anoka, headwater	1	845
Range line 24–25 W	10	848
Gillespie Bridge	16	865
Seely Brook	19	873
St. Francis, tailwater	22	885
St. Francis, headwater	22	894
Bethel Bridge	27	895
Isanti Bridge	34	896

Elevations and distances along Rum River—Continued.

Point.	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
Cambridge Bridge	42	899
Lower Stanchfield Creek	49	903
Range line 23–24 W	53	907
Findell Bridge	59	912
Range line 24–25 W	65	919
Spencer Brook	72	930
Isanti-Sherburne County line	78	938
Sherburne-Mille Lacs County line	84	947
Princeton Bridge	87	951
Section line 9–16	93	960
Bogus Brook	100	973
Section line 15–22	103	987
Vandell Brook	105	996
Township line 37–38 N	110	1,028
Milaca, tailwater	112	1,040
Milaca, headwater	112	1,045
Highway Bridge	114	1,057
Mike Dreur Brook	117	1,085
Whitney Brook	122	1,121
Page Brook	126	1,152
Hanson Brook	132	1,193
Highway Bridge	136	1,225
Onamia Bridge	142	1,249

Water power is utilized at St. Francis, where a fall of 10 feet develops 75 horsepower, and at Anoka, where a fall of 14 feet furnishes 250 horsepower.

Logging dams exist at various points, but they have been abandoned, as logs are no longer driven down the river.

RUM RIVER AT ONAMIA, MINN.

This station, which is located at the steel highway bridge about 300 feet below the "Soo" Railway bridge at Onamia and 200 yards below the outlet of Lake Onamia, was established September 24, 1909, to ascertain the run-off from Lake Mille Lacs and the chain of three lakes into which it discharges. A station was established at the outlet of Mille Lacs proper, 12 miles above Onamia, but conditions of flow were so unstable that the gage heights did not serve as a true index of the flow and that station was therefore abandoned in favor of the station at Onamia. The records will show the run-off from Lake Onamia that would be available for storage and indicate the flow throughout the upper portion of Rum River—the section of river having the greatest fall—available for hydraulic development.

The nearest important tributary, Bradbury Brook, enters Rum River 5 miles below the station.

Two miles below Onamia is an abandoned logging dam which raises the water level about 3 feet but does not control the flow, and owing to the fall of the river the influences of this dam do not reach the gaging station.

The gage was located originally at the wooden highway bridge just below the "Soo" Railway bridge, but May 4, 1910, this bridge was destroyed and the gage moved downstream to the steel highway bridge. The new gage was set to read the same as the old one.

Discharge measurements are made from the steel highway bridge.

Owing to the natural storage afforded by the lakes the range of stage at Onamia is slight.

At the original location there was practically no ice during the winter and discharge measurements showed that the open-season rating curve applied. At the present location, however, the river freezes over.

Conditions of flow are favorable for good results and the records of flow should be reliable, as the station is well rated.

Discharge measurements of Rum River at Onamia, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Sept. 24	Follansbee and Adams	39	29.0	0.72	103
Nov. 8	C. J. Emerson	72	66.3	.73	98.4
1910.					
Jan. 28	G. A. Gray	55	60.0	.68	68.3
Mar. 30	.....do	71	139	1.22	386
May 4	.....do	74	108	1.05	261
5	.....do	74	105	1.00	246
July 19[a]	Robert Follansbee	28	12.6	.48	20.6
20[a]	.....do	23	12.6	.49	20.3
Sept. 24[a]	C. R. Adams	20	3.8	.14	3.9

[a] Wading section.

Daily gage height, in feet, of Rum River at Onamia, Minn., in 1910.

[R. Swedburg, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.58	0.68	0.68	1.22	1.05	0.98	0.65	0.50	0.32	0.25	0.28	0.12
2	......	.68	.68	1.20	1.05	.98	.62	.50	.32	.25	.28	.12
3	......	.68	.68	1.18	1.05	.95	.60	.50	.30	.25	.25	.12
4	......	.68	.68	1.18	1.05	.95	.60	.50	.28	.22	.25	.12
5	.58	.68	.68	1.20	1.02	.92	.58	.48	.28	.22	.22	.10
6	......	.68	.68	1.20	1.02	.90	.55	.48	.25	22	20	.10
7	......	.68	.68	1.20	1.02	.90	.52	.48	.25	.20	.20	.10
8	.60	.68	.70	1.18	1.02	.88	.50	.48	.25	.20	.20	......
9	......	.68	.70	1 15	1 00	88	.50	.48	.22	.18	.20	......
10	......	.68	.70	1.15	1.00	.85	.50	.45	.22	.18	.18	......
11	......	.68	.70	1.15	.98	.85	.50	.45	.22	.18	.18	......
12	.60	.68	.70	1.15	.95	.82	.50	.48	.22	.20	.18	......
13	......	.65	.72	1.15	.95	.82	.48	.48	.20	.20	.15	......
14	......	.65	.75	1.15	.92	.80	.48	.48	.20	.20	.15	......
15	.65	.65	.78	1.18	.92	.80	.50	.45	.20	.20	.15	......
16	.65	.65	.80	1.20	.92	.78	.50	.42	.20	.20	.15	......
17	.65	.65	.85	1.20	.95	.75	.50	.42	.20	.20	.15	......
18	.65	.65	.88	1.18	.95	.72	.50	.42	.20	.20	.15	......
19	.68	.65	.90	1.18	.95	.70	.50	.42	.20	.22	.15	......
20	.70	.65	.95	1.15	.95	.68	.50	.40	.18	.22	.15	......
21	.70	.65	1.00	1.15	.95	.68	.50	.40	.18	.22	.15	......
22	.68	.65	1.05	1.15	.92	.62	.50	.40	.15	.22	.15	......
23	.68	.65	1.08	1.12	92	.58	.50	.40	.15	.25	.15	......
24	.68	.68	1.10	1.10	.92	.58	.50	.38	.12	.25	.15	......
25	.68	.68	1.15	1.10	.95	.55	.50	.38	.12	.28	.15	......
26	.68	.68	1.20	1.10	.95	.58	.50	.38	.12	.28	.15	......
27	.68	.68	1.20	1.08	.98	.60	.50	.38	.15	.30	.12	......
28	.68	.68	1.22	1.08	.98	.62	.50	.38	.18	.30	.12	......
29	.68	......	1.22	1.08	1.00	.65	.50	.35	.20	.30	.12	......
30	.68	......	1.22	1.08	1.00	.68	.50	.35	.24	.30	.12	......
31	.68	......	1.22	......	1.00	......	.50	.35	......	.30	......	......

NOTE.—No ice until Dec. 8, when river froze over. Ice from Dec. 8–Dec. 31.

Daily discharge, in second-feet, of Rum River at Onamia, Minn., for 1909–10.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	......	......	......	......	......	......	......	......	......	94	94	154
2	......	......	......	......	......	......	......	......	......	94	94	154
3	......	......	......	......	......	......	......	......	......	94	94	180
4	......	......	......	......	......	......	......	......	......	94	94	180
5	......	......	......	......	......	......	......	......	......	94	94	167
6	......	......	......	......	......	......	......	......	......	94	94	154
7	......	......	......	......	......	......	......	......	......	94	94	141
8	......	......	......	......	......	......	......	......	......	94	94	128
9	......	......	......	......	......	......	......	......	......	94	94	108
10	......	......	......	......	......	......	......	......	......	94	106	88
11	......	......	......	......	......	......	......	......	......	106	106	68
12	......	......	......	......	......	......	......	......	......	106	106	68
13	......	......	......	......	......	......	......	......	......	128	106	68
14	......	......	......	......	......	......	......	......	......	180	119	68
15	......	......	......	......	......	......	......	......	......	239	138	57
16	......	......	......	......	......	......	......	......	......	180	154	57
17	......	......	......	......	......	......	......	......	......	170	154	57
18	......	......	......	......	......	......	......	......	......	154	154	57
19	......	......	......	......	......	......	......	......	......	154	154	55
20	......	......	......	......	......	......	......	......	......	138	138	54
21	......	......	......	......	......	......	......	......	......	138	138	52
22	......	......	......	......	......	......	......	......	......	128	138	50
23	......	......	......	......	......	......	......	......	......	119	138	50
24	......	......	......	......	......	......	......	......	94	106	138	50
25	......	......	......	......	......	......	......	......	94	94	128	50
26	......	......	......	......	......	......	......	......	94	94	128	50
27	......	......	......	......	......	......	......	......	94	94	128	48
28	......	......	......	......	......	......	......	......	94	94	128	47
29	......	......	......	......	......	......	......	......	94	94	138	45
30	......	......	......	......	......	......	......	......	94	94	138	45
31	......	......	......	......	......	......	......	......	......	94	......	45
1910.												
1	45	78	78	387	272	227	68	25	9.6	7.0	7.9	3.5
2	45	78	78	372	272	227	57	25	9.6	7.0	7.9	3.5
3	45	78	78	359	272	210	50	25	8.5	7.0	7.0	3.5
4	45	78	78	359	272	210	50	25	7.9	6.1	7.0	3.5
5	45	78	78	372	252	192	45	23	7.9	6.1	6.1	3.0
6	47	78	78	372	252	180	38	23	7.0	6.1	5.5	3.0
7	48	78	78	372	252	180	30	23	7.0	5.5	5.5	3.0
8	50	78	85	359	252	170	25	23	7.0	5.5	5.5	3.0
9	50	78	85	338	239	170	25	23	6.1	5.0	5.5	3.0
10	50	78	85	338	239	154	25	20	6.1	5.0	5.0	3.0
11	50	78	85	338	227	154	25	20	6.1	5.0	5.0	3.0
12	50	78	85	338	210	138	25	23	6.1	5.5	5.0	3.0
13	56	68	94	338	210	138	23	23	5.5	5.5	4.2	3.0
14	62	68	106	338	192	128	23	23	5.5	5.5	4.2	3.0
15	68	68	119	359	192	128	25	20	5.5	5.5	4.2	3.0
16	68	68	128	372	192	119	25	16	5.5	5.5	4.2	3.0
17	68	68	154	372	210	106	25	16	5.5	5.5	4.2	3.0
18	68	68	170	359	210	94	25	16	5.5	5.5	4.2	3.0
19	78	68	180	359	210	85	25	16	5.5	6.1	4.2	3.0
20	85	68	210	338	210	78	25	14	5.0	6.1	4.2	3.0
21	85	68	239	338	210	78	25	14	5.0	6.1	4.2	3.0
22	78	68	272	338	192	57	25	14	4.2	6.1	4.2	3.0
23	78	68	292	318	192	45	25	14	4.2	7.0	4.2	3.0
24	78	78	305	305	192	45	25	13	3.5	7.0	4.2	3.0
25	78	78	338	305	210	38	25	13	3.5	7.9	4.2	3.0
26	78	78	372	305	210	45	25	13	3.5	7.9	4.2	2.5
27	78	78	372	292	227	50	25	13	4.2	8.5	3.5	2.5
28	78	78	387	292	227	57	25	13	5.0	8.5	3.5	2.5
29	78	......	387	292	239	68	25	11	5.5	8.5	3.5	2.5
30	78	......	387	292	239	78	25	11	6.7	8.5	3.5	2.5
31	78	......	387	......	239	......	25	11	......	8.5	......	2.5

NOTE.—Daily discharge computed from a well-defined rating curve, except during December, 1910, for which period it is estimated.

Monthly discharge of Rum River at Onamia, Minn., for 1909–10.

[Drainage area, 414 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
Sept. 24-30	94	94	94.0	0.227	0.06	B.
October	239	94	118	.285	.33	B.
November	154	94	121	.292	.33	B.
December	180	45	83.7	.202	.23	B.
1910.						
January	85	45	64.1	.155	.18	B.
February	78	68	74.1	.179	.19	B.
March	387	78	189	.457	.53	B.
April	387	292	341	.824	.92	B.
May	272	192	226	.546	.63	B.
June	227	38	122	.295	.33	A.
July	68	23	30.1	.073	.08	A.
August	25	11	18.1	.044	.05	A.
September	9.6	3.5	5.92	.014	.02	A.
October	8.5	5.0	6.47	.016	.02	A.
November	7.9	3.5	4.86	.012	.01	A.
December	3.5	2.5	[a]3.00	.007	.008	D.
The year	387	2.5	90.4	.218	2.97	

[a] Estimated.

RUM RIVER AT CAMBRIDGE, MINN.

This station, which is located at the highway bridge one-half mile west of Cambridge, was established June 12, 1909, to obtain data for use in studies of power and sewage-disposal problems on Rum River.

No tributary enters within several miles of Cambridge. At St. Francis, 20 miles below Cambridge by river, there is a 10-foot dam and power plant. Between the crest of the dam and the water surface at the gaging station there is a difference in elevation of about 6 feet. The fact that the morning and evening gage heights during the low-water period show no consistent change, being for the most part the same, indicates that the St. Francis dam has little effect on the flow at this point, even though the flow may fall below the crest during certain portions of the day. The only dam above Cambridge is one at Milaca, which is used to form a pool from which water is pumped.

From December to March discharge measurements are made through the ice to determine the winter flow.

The staff gage is located at the bridge from which the discharge measurements are made. Its datum has remained unchanged since the station was established. As conditions at this station are favorable the results should be good and the records should be reliable.

Discharge measurements of Rum River at Cambridge, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 12	G. A. Gray	111	599	6.45	1,040
July 10	.....do	97	319	3.90	330
Aug. 31	Robert Follansbee	80	227	3.14	146
1910.					
Jan. 15	G. A. Gray	84	297	[a] 4.20	170
Mar. 1	.....do	99	214	[b] 4.20	137
Apr. 1	.....do	110	421	5.40	741
June 21	Robert Follansbee	84	174	2.82	131
Aug. 3	G. A. Gray	62	142	2.50	74.2
Dec. 28	C. R. Adams	90	114	[c] 2.95	44.3

[a] Gage height to water surface; thickness of ice, 0.94 foot.
[b] Gage height to water surface; thickness of ice, 1.44 feet.
[c] Gage height to water surface; thickness of ice, 0.90 foot.

Daily gage height, in feet, of Rum River at Cambridge, Minn., for 1910.

[Martin Lofstrom, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.22		4.20	5.39	3.99	3.28	2.84	2.50	2.54	2.65	2.50	2.65
2		4.32	4.20	5.30	3.92	3.25	2.79	2.52	2.55	2.65	2.52	2.60
3				5.21	3.91	3.22	2.72	2.52	2.56	2.61	2.52	2.58
4				5.10	3.88	3.20	2.70	2.46	2.58	2.60	2.52	
5	4.20		4.32	4.98	3.85	3.21	2.68	2.45	2.56	2.59	2.54	
6		4.30		4.88	3.78	3.29	2.66	2.44	2.58	2.52	2.45	2.62
7				4.85	3.64	3.30	2.62	2.46	2.58	2.56	2.46	
8	4.18			4.82	3.69	3.28	2.61	2.48	2.54	2.51	2.45	
9		4.25	4.65	4.72	3.64	3.25	2.60	2.51	2.52	2.50	2.55	2.70
10				4.61	3.62	3.21	2.61	2.44	2.52	2.50	2.35	
11				4.50	3.61	3.16	2.61	2.45	2.51	2.48	2.45	
12	4.18	4.20	5.00	4.45	3.56	3.10	2.62	2.48	2.52	2.48	2.36	
13			5.35	4.42	3.52	3.08	2.62	2.51	2.52	2.48	2.51	2.70
14			5.65	4.36	3.52	3.04	2.60	2.54	2.52	2.48	2.58	
15	4.20		5.92	4.35	3.49	3.00	2.59	2.56	2.50	2.48	2.48	
16		4.18	6.42	4.31	3.45	2.98	2.55	2.59	2.50	2.46	2.46	2.75
17			7.06	4.29	3.52	2.94	2.52	2.68	2.50	2.48	2.38	
18			7.42	4.32	3.65	2.89	2.52	2.70	2.48	2.49	2.49	
19	4.28	4.12	7.22	4.38	3.68	2.85	2.52	2.68	2.48	2.60	2.56	
20			7.16	4.40	3.74	2.81	2.50	2.65	2.48	2.56	2.58	2.80
21			7.15	4.45	3.72	2.80	2.48	2.65	2.50	2.56	2.55	
22	4.28		7.10	4.45	3.72	2.75	2.48	2.64	2.48	2.55	2.51	
23		4.18	6.99	4.32	3.71	2.71	2.52	2.59	2.45	2.55	2.55	2.88
24			6.78	4.31	3.69	2.66	2.64	2.58	2.45	2.55	2.58	
25			6.55	4.38	3.64	2.69	2.62	2.58	2.48	2.55	2.56	
26	4.30	4.18	6.32	4.39	3.58	2.70	2.59	2.59	2.62	2.55	2.55	
27			6.19	4.28	3.58	2.72	2.56	2.55	2.70	2.55	2.54	2.95
28			6.00	4.18	3.54	2.79	2.58	2.52	2.69	2.54	2.64	2.95
29	4.30		5.84	4.09	3.45	2.84	2.56	2.51	2.70	2.52	2.48	
30			5.68	4.05	3.38	2.85	2.54	2.54	2.64	2.50	2.58	2.95
31			5.52		3.34		2.54	2.54		2.52		

NOTE.—Ice present from Jan. 1 to Mar. 11 and from Dec. 4 to 31.

Daily discharge, in second-feet, of Rum River at Cambridge, Minn., for 1909–10.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	......	......	......	......	......	......	724	314	156	297	227	......
2	......	......	......	......	......	......	667	280	156	290	240	......
3	......	......	......	......	......	......	583	259	156	278	242	......
4	......	......	......	......	......	......	527	252	149	273	236	......
5	......	......	......	......	......	......	485	236	153	273	236	......
6	......	......	......	......	......	......	458	220	158	264	236	......
7	......	......	......	......	......	......	418	209	145	249	231	......
8	......	......	......	......	......	......	391	227	145	242	227	......
9	......	......	......	......	......	......	352	229	162	245	220	......
10	......	......	......	......	......	......	327	249	156	254	227	......
11	......	......	......	......	......	......	317	292	156	259	227	......
12	......	......	......	......	......	1,040	337	302	166	283	220	......
13	......	......	......	......	......	956	330	317	168	268	220	......
14	......	......	......	......	......	898	314	399	179	273	302	......
15	......	......	......	......	......	855	300	428	183	290	373	......
16	......	......	......	......	......	826	276	394	170	290	434	......
17	......	......	......	......	......	812	256	352	162	278	485	......
18	......	......	......	......	......	797	242	314	164	278	472	......
19	......	......	......	......	......	797	227	283	187	268	460	......
20	......	......	......	......	......	754	245	252	185	256	448	......
21	......	......	......	......	......	696	409	240	283	266	438	......
22	......	......	......	......	......	667	469	213	535	254	429	......
23	......	......	......	......	......	870	431	205	547	249	419	......
24	......	......	......	......	......	1,030	472	200	544	249	410	......
25	......	......	......	......	......	1,130	502	191	510	249	400	......
26	......	......	......	......	......	1,160	463	187	444	242	391	......
27	......	......	......	......	......	1,130	409	183	401	233	442	......
28	......	......	......	......	......	1,060	365	183	365	227	455	......
29	......	......	......	......	......	942	375	183	340	227	381	......
30	......	......	......	......	......	840	352	176	322	231	391	......
31	......	......	......	......	......	......	332	156	......	227	......	......
1910.												
1	......	......	135	742	372	211	130	78	84	99	78	100
2	......	......	135	717	354	205	121	81	85	99	81	92
3	......	......	135	692	352	199	110	81	86	94	81	89
4	......	......	140	661	344	195	107	73	89	92	81	......
5	......	......	140	629	337	197	104	72	86	91	84	......
6	......	......	150	602	320	213	101	71	89	81	72	......
7	......	......	200	594	287	215	95	73	89	86	73	......
8	......	......	250	585	299	211	94	76	84	79	72	......
9	......	......	300	558	287	205	92	79	81	78	85	......
10	......	......	400	530	283	197	94	71	81	78	60	......
11	......	......	500	501	280	187	94	72	79	76	72	......
12	......	......	634	488	269	176	95	76	81	76	61	......
13	......	......	731	480	260	172	95	79	81	76	79	......
14	......	......	815	465	260	165	92	84	81	76	89	......
15	a 170	......	892	462	254	158	91	86	78	76	76	......
16	......	......	1,040	452	246	154	85	91	78	73	73	......
17	......	......	1,230	446	260	147	81	104	78	76	64	......
18	......	......	1,340	454	290	138	81	107	76	77	77	......
19	......	......	1,280	470	296	132	81	104	76	92	86	......
20	......	......	1,260	475	311	125	78	100	76	86	89	......
21	......	......	1,260	488	306	123	76	100	78	86	85	......
22	......	......	1,240	488	306	115	76	98	76	85	79	......
23	......	......	1,210	454	303	109	81	91	72	85	85	......
24	......	......	1,140	452	299	101	98	89	72	85	89	......
25	......	......	1,080	470	287	106	95	89	76	85	86	......
26	......	......	1,010	472	274	107	91	91	95	85	85	......
27	......	......	970	444	274	110	86	85	107	85	84	......
28	......	......	915	419	265	121	89	81	106	84	98	a 44
29	......	......	869	396	246	130	86	79	107	81	76	......
30	......	......	823	386	231	132	84	84	98	78	89	......
31	......	......	779	......	223	......	84	84	......	81	......	......

a Discharge measurement.

NOTE.—Daily discharge computed from a fairly well defined rating curve, except Mar. 1 to 11, 1910, for which period it was estimated.

Monthly discharge of Rum River at Cambridge, Minn., for 1909–10.

[Drainage area, 1,160 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
June 12–30	1,160	667	908	0.783	0.55	A.
July	724	227	399	.344	.40	A.
August	428	156	256	.221	.25	A.
September	547	145	252	.217	.24	A.
October	297	227	260	.224	.26	A.
November	485	220	337	.291	.32	B.
December			a210	.181	.21	C.
1910.						
January			a155	.134	.15	C.
February			a145	.125	.13	C.
March	1,340	135	742	.640	.74	B.
April	742	386	516	.445	.50	B.
May	372	223	290	.250	.29	B.
June	215	101	159	.137	.15	A.
July	130	76	92.5	.080	.09	A.
August	107	71	84.8	.073	.08	A.
September	107	72	84.2	.073	.08	A.
October	99	73	83.3	.072	.08	A.
November	98	60	79.6	.067	.07	A.
December	100		a55.0	.047	.05	D.
The year	1,340		207	.178	2.41	

a Estimated.

MINNESOTA RIVER.

GENERAL FEATURES OF AREA DRAINED.

Minnesota River, by far the largest tributary of the Mississippi in the State of Minnesota, drains an area comprising 16,600 square miles and extending nearly across the southern part of the State from west to east. The river rises on the eastern slope of the Dakota foothills (Coteau des Prairies) in the northeastern part of Marshall County, S. Dak., about 30 miles west of Lake Traverse, at an approximate elevation of 1,896 feet above sea level, and flows southeastward to the State border, where it enters Big Stone Lake, a body of water 26 miles long, 1 to 1½ miles wide, and exceeding 15 feet in depth at only a few places. In this portion of its course it is a mere mountain torrent, whose fall in 40 miles is about 900 feet and whose bed is often entirely dry; for this reason perhaps Big Stone Lake has commonly been considered its source. Emerging from Big Stone Lake at Ortonville the Minnesota flows southeastward 225 miles to Mankato, where it turns abruptly and flows northeastward to its junction with the Mississippi a few miles below the falls of St. Anthony, between the cities of Minneapolis and St. Paul.

From Big Stone Lake to the upper end of Marsh Lake, a distance of 22 miles, the river winds through a valley 1½ miles wide and 50 to 100 feet below the general level of the basin. About one-half the bottom land in this stretch is under cultivation and the other half is marshy. At Marsh Lake, which was formed by the alluvium deposited at its lower end by Pomme de Terre River, the valley broadens to 3 miles. The lake, which is 4 miles long by 1 mile wide, is mostly filled with marsh grass, and the greater portion of the valley surface is marshy. From Marsh Lake to Lac Qui Parle, which was formed by Lac Qui Parle River as Marsh Lake was formed by the Pomme de Terre, the valley is 1 to 1½ miles wide. At Lac Qui Parle, which is about 8 miles long and three-fourths mile wide, the valley is 1½ miles wide and lies 100 feet below the general surface level. From the outlet of Lac Qui Parle to the line between ranges 30 and 40, the valley is three-fourths of a mile wide. Much of the area consists of marsh and ponds and not more than a third of it is under cultivation. In the next 6 miles the valley widens out to 2 miles and its character changes, as granite outcrops at many places. Little of the land is under cultivation. From the lower end of this wide section in T. 115 N., R. 39 W., to Mankato, the average width of the valley is 1 mile, its depth below the general level increases to 200 feet, and most of the land is under cultivation. Below Mankato the valley averages a mile in width and lies 100 to 150 feet below the surface level. From Chaska to the mouth little land is under cultivation, as it is marshy.

From Big Stone Lake to Granite Falls the slope of the river is 0.6 foot per mile except at the outlet of the lake, where the fall is heavy for a short distance. At Granite Falls and at Minnesota Falls, where granite outcrops, the river descends in falls and rapids 41 feet in a distance of 4 miles. In the 30 miles below Minnesota Falls the average slope is 1.3 feet per mile, but thence to the mouth of Cottonwood River the slope becomes much less, being only 0.5 foot per mile. From Cottonwood River to Faxon the slope increases to 1 foot per mile, but below that very point the water surface is very nearly level.

The following drainage areas have been measured on the Minnesota and its tributaries:

Drainage areas in Minnesota River basin.

River.	Above—	Drainage area.
		Sq. miles.
Minnesota	Big Stone Lake outlet	846
Do	Odessa	1,560
Do	Montevideo	6,300
Do	Sec. 30, T. 114 N., R. 36 W	7,800
Do	Sec. 33, T. 109 N., R. 28 W	11,100
Do	Mankato	14,600
Do	Mouth	16,600
Whetstone	do	441
Yellow Bank	do	536
Pomme de Terre	do	847
Lac Qui Parle	Lac Qui Parle	677
Do	Mouth	739
Chippewa	East Branch	875
Do	Mouth	1,990
Stony Run	do	176
Yellow Medicine	do	550
Hawk Creek	do	437

Drainage areas in Minnesota River basin—Continued.

River.	Above—	Drainage area.
		Sq. miles.
Redwood	Mouth	748
Cottonwood	Sleepy Eye Creek	864
Do	Mouth	1,200
Little Cottonwood	.....do	180
Blue Earth	Watonwan River	1,480
Do	Rapidan Mills	2,260
Do	Mouth	3,430
Watonwan	South Branch	368
Do	Mouth	775
Le Sueur River	.....do	1,160
Le Sueur Creek	.....do	149
Sand Creek	.....do	278

The soil in the Minnesota Valley is alluvial. Above Minneopa the river flows over the drift which covers the basin, but below that point it occupies a preglacial gorge whose bottom, filled with gravel and sand, lies 100 to 200 feet below the present bed of the river.

During the glacial epoch a vast lake, now known as Lake Agassiz, occupied the northwestern portion of the State and had outlet through Lake Traverse into Big Stone Lake, which now lies 8 feet lower than Lake Traverse, and finally into the present valley of the Minnesota. Owing to ice barriers the Minnesota did not follow its present course, but was deflected southward and reached the Mississippi through the valley of the Cannon and other rivers.

The country as a whole is flat or gently undulating, but along the southern border of the basin is a table-land 20 to 30 miles wide that rises several hundred feet above the valley and extends from southeast to northwest across the southwestern part of the State.

Elevations in the basin range from 1,000 in the valleys to 1,900 feet above sea level on the high plateau.

Except in the immediate valley of the Minnesota, the Blue Earth and one or two other tributaries, the area is covered with blue till—a confused mixture of sand, clay, and gravel—of glacial origin. The table-land on the southwestern border is capped with porous deposits of sand and gravel which supply water to the artesian wells and springs in the basin. In the western part of the basin the drift rests on Cretaceous sandstone and shales; farther east it overlies the crystalline schists and gneisses of Archean age. In the vicinity of New Ulm quartzite of Middle Cambrian age is found. Rock outcrops only along the river valleys.

Above Mankato the drainage area is prairie land; below Mankato the land was originally forested, but the greater part of it is now under cultivation.

The chief tributaries of the Minnesota are Pomme de Terre and Chippewa rivers and Chetamba Creek from the north and Lac Qui Parle, Redwood, Cottonwood, and Blue Earth rivers from the south.

Rainfall records covering periods exceeding 15 years are available for different sections of the drainage area. These records indicate that the annual rainfall ranges about 24 inches in the upper part to 28 inches in the central and lower parts. Of this amount 3 inches is precipitated in the form of snow which remains throughout the winter. The rivers are frozen over from December to March with ice 1 foot and more in thickness. The flow during the winter months is very uniform. It decreases gradually till midwinter, when the flow is a minimum. There are no winter thaws to cause sudden rises.

Big Stone Lake, which takes its name from the conspicuous granite outcrops found in the valley from 1 to 3 miles below the lake, is nearly surrounded by bluffs, and were it not for the small drainage area tributary to it, would make an excellent reservoir site. Marsh Lake and Lac Qui Parle, through which the Minnesota flows, afford reservior sites having considerably larger tributary drainage areas than Big Stone Lake. In addition to the lake in the main channel of the river, there are lakes in the upper sections of the areas drained by the Pomme de Terre and Chippewa rivers and the extreme upper parts of the basins drained by Redwood, Cottonwood, and Blue Earth rivers. Below Mankato the basin contains more lakes, many of them small and without visible outlet.

A survey of the river was made in 1909–10 by the United States Engineer Corps for the purpose of determining the feasibility of building a reservoir to increase the low-water flow, as the lower portion of the Minnesota is navigable, although it carries little traffic at present. The following table of elevations and distances has been compiled from this survey:

Elevations and distances along Minnesota River.

Place.	Distance below Big Stone Lake.	Elevation above sea level.
	Miles.	*Feet.*
Big Stone Lake	0	966
Whetstone River	2	956
Bridge southwest of Odessa	11	944
Yellow Bank River	15	940
Marsh Lake Bridge	22	936
Pomme de Terre River	29	935
Bridge southwest of Appleton	31	931
Lac Qui Parle Bridge	36	926
Lac Qui Parle River	46	924
First bridge below Lac Qui Parle	48	923
Bridge southwest of Watson	51	921
Bridge northwest of Montevideo	55	917
Chippewa River	62	913
Bridge at Montevideo	62	913
Bridge at Myers	70	910
Great Northern Ry., above Granite Falls	79	907
Pond above dam	80	906
Highway Bridge, Granite Falls	81	891
Pond above dam, Minnesota Falls	84	883
Yellow Medicine River	96	861
Hawk Creek	96	860
Sacred Heart Bridge	103	848
Sacred Heart Creek	109	835
Bridge north of Delhi	111	831

Elevations and distances along Minnesota River—Continued.

Place.	Distance below Big Stone Lake.	Elevation above sea level.
	Miles.	*Feet.*
North Redwood Bridge	122	820
Morton	132	810
Bridge south of Franklin	141	803
Fort Ridgely Bridge	158	793
Henderman Bridge	164	791
Bridge below New Ulm	189	784
Cottonwood River	192	780
Courtland Bridge	198	774
Judson Bridge	212	762
Blue Earth River	224	757
St. Peter	243	730
Ottawa	250	723
Le Sueur	258	716
Henderson	268	710
Faxon	282	700
Belle Plaine	289	696
Crest of Little Rapids	303	693
Carver	308	690
Bloomington Ferry	323	690
Mendota Bridge	339	690

Water power is developed at the following points in the drainage basin:

Developed water powers in Minnesota River basin.

Place.	Fall utilized.	Average horsepower.
	Feet.	
Minnesota River at Granite Falls	14	350
Minnesota River at Minnesota Falls	16	250
Pomme de Terre River at Appleton	14	80
Chippewa River at Millerville		50
Chippewa River at Hagan	8	45
Chippewa River at Montevideo	7	75
East Branch Chippewa River at Swift Falls	20	45
East Branch Chippewa River at Terrace	16	40
Redwood River at Redwood Falls	85	150
Redwood River at North Redwood		50
Cottonwood River at New Ulm	8.5	35
Blue Earth at Rapidan Mills	56	1,800

The bottom land of the Minnesota Valley is subject to overflow to such an extent that considerable tracts of it are not now under cultivation. The 1908 flood did an immense amount of damage. At that time the Mankato gage read 21.2 feet, the maximum reading since its establishment in 1903. In 1909 a survey was made by the State drainage commission for the purpose of devising a method of flood prevention, but the results of the survey have not yet been published. A report of an examination of the valley, which was made by the United States Engineer Corps, has been published as House Document 76, Forty-third Congress, second session. The only maps of the area published by the United States Geological Survey are the Barretts sheet, which includes the upper Pomme de Terre basin, and the St. Paul, Minneapolis, and Minnetonka sheets, which cover the mouth of the Minnesota.

Discharge records maintained since 1903 indicate 1910 as the driest year and 1908 the wettest year of the period. The ratio of run-off during these two years was 1 to 4.1

The quality of the water in the Minnesota Valley is described in a report entitled "The quality of surface waters in Minnesota," pubished by the United States Geological Survey as Water-Supply Paper 193.

An examination of Big Stone Lake as a possible reservoir site was made by the United States Engineer Corps and the results published in House Document 127, Fifty-second Congress, first session, and House Document 539, Fifty-eighth Congress, second session.

MINNESOTA RIVER NEAR ODESSA, MINN.

This station, which is located at the highway bridge 1 mile southwest of Odessa in sec. 32, T. 121 N., R. 45 W., was established July 4, 1909, for the purpose of determining the run-off from Big Stone Lake available for storage. A station was also established on Whetstone River, which enters the Minnesota above Odessa, for the purpose of determining the amount of water passing Odessa from that source.

Owing to its extreme flatness the valley immediately below Big Stone Lake is subject to overflow during high water, and it was therefore not possible to locate a satisfactory gaging station above Odessa. Even at this station some water overflows around one end of the bridge at extremely high stages, but this is only a small percentage of the entire flow.

The nearest tributary is Stony Run, a very small stream that enters from the north a half mile above the station.

The flow at Odessa is entirely uncontrolled, as the nearest dam is at Granite Falls. The river is frozen over and observations are discontinued from December to March. The flow during that period may be roughly estimated by utilizing the run-off per square mile of drainage area above Montevideo.

Since the establishment of the gage, which is attached to the bridge from which the discharge measurements are made, the datum has remained unchanged.

Conditions at this station are favorable for excellent results, and the records, therefore, should be reliable.

Discharge measurements of Minnesota River near Odessa, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 4	Robert Follansbee	36	76.5	2.98	52.7
24	G. A. Gray	33	36.9	2.65	32.8
Aug. 15	C. J. Emerson	34	40.6	2.78	42.2
Sept. 17	G. A. Gray	34	47.0	2.88	44.9
1910.					
Mar. 14	G. A. Gray	61	371	8.45	520
23	C. J. Emerson	60	252	6.54	350
Apr. 29	Robert Follansbee	61	306	7.45	435
July 9	do	31	43.6	2.26	18.0
Oct. 13 [a]	C. R. Adams	32	31.1	2.50	25.5

[a] Wading measurement.

Daily gage height, in feet, of Minnesota River near Odessa, Minn., for 1910.

[Claud Shellenbarger, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		5.38	7.16	3.92	2.41	2.19	2.64	2.87	2.78
2		5.20	6.66	3.84	2.46	2.20	2.46	2.76	2.75
3		5.04	6.40	3.74	2.41	2.20	2.64	2.80	2.72
4		5.29	6.17	3.75	2.34	2.18	2.63	2.86	2.95
5		5.49	5.78	3.74	2.28	2.18	2.93	2.74	3.05
6		5.15	5.63	3.78	2.36	2.19	2.66	2.69	3.05
7		5.08	5.57	3.62	2.32	2.20	2.46	2.68	2.82
8		4.99	5.52	3.52	2.30	2.24	2.83	2.66	2.72
9	11.60	4.95	5.43	3.64	2.30	2.20	2.80	2.66	2.66
10	10.36	4.88	5.37	3.80	2.24	2.20	2.76	2.62	2.65
11	9.62	4.80	5.30	3.71	2.26	2.21	2.74	2.67	2.60
12	9.31	4.70	5.17	3.68	2.24	2.21	2.70	2.63	2.64
13	8.92	4.56	5.04	3.68	2.21	2.22	2.64	2.63	2.70
14	8.45	4.75	4.89	3.51	2.20	2.32	2.70	2.66	2.79
15	8.28		4.80	3.38	2.16	2.39	2.70	2.68	2.71
16	8.06	5.36	4.90	3.24	2.14	2.42	2.63	2.61	2.78
17	7.85	5.56	5.04	3.14	2.11	2.39	2.60	2.68	2.82
18	7.75	5.32	5.12	3.17	2.09	2.36	2.80	2.66	2.90
19	7.42	4.96	4.84	3.04	2.06	2.35	2.76	2.81	2.96
20	7.16	4.99	4.70	2.94	2.04	2.35	2.68	3.42	
21	6.88	5.68	4.63	2.84	2.02	2.40	2.63	3.18	
22	6.68	6.74	4.50	2.75	2.00	2.42	2.63	2.82	
23	6.56	7.18	4.44	2.78	2.08	2.42	2.83	2.78	
24	6.45	8.08	4.63	2.71	2.14	2.45	2.73	2.81	
25	6.22	8.42	4.53	2.78	2.20	2.54	2.83	2.81	
26	5.96	8.10	4.19	2.82	2.19	2.54	3.03	2.92	
27	5.76	7.98	4.09	2.77	2.16	2.52	3.13	3.15	
28	5.78	7.72	4.09	2.68	2.14	2.40	2.84	3.12	
29	5.52	7.40	4.36	2.58	2.12	2.40	2.74	3.05	
30	5.70	7.16	4.06	2.48	2.11	2.45	2.80	2.85	
31	5.46		3.97		2.11	2.62		2.86	

NOTE.—Ice present from Jan. 1 to Mar. 8, and from Nov. 20 to Dec. 31.

Daily discharge, in second-feet, of Minnesota River near Odessa, Minn., for 1909–10.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.									
1						28	31	53	65
2						24	31	60	65
3						30	34	60	63
4					54	31	37	58	62
5					49	26	36	59	64
6					49	23	36	55	58
7					46	42	36	57	64
8					49	58	36	59	59
9					53	56	36	77	52
10					52	49	40	87	57
11					48	44	36	98	58
12					64	40	31	115	59
13					57	41	32	88	64
14					53	43	37	74	75
15					51	45	47	65	156
16					46	39	53	63	122
17					42	41	47	66	106
18					39	42	47	61	102
19					33	40	52	56	92
20					32	37	43	64	92
21					34	39	53	65	92
22					41	37	63	60	92
23					37	37	59	66	91
24					31	32	59	58	97
25					27	33	57	65	98
26					28	29	53	65	97
27					28	34	50	63	97
28					24	32	58	59	97
29					28	32	59	51	96
30					25	29	59	56	95
31					28	30		66	
1910.									
1		241	407	114	22	16	33	46	41
2		224	360	108	24	16	24	40	39
3		210	336	101	22	16	33	42	37
4		233	314	102	20	16	32	46	51
5		252	278	101	18	16	50	38	57
6		220	265	104	21	16	34	35	57
7		213	259	92	20	16	24	35	43
8		205	255	85	19	17	44	34	37
9	850	202	246	94	19	16	42	34	34
10	726	195	240	105	17	16	40	32	34
11	652	188	234	99	18	16	38	34	31
12	621	179	221	97	17	16	36	32	33
13	582	166	210	97	16	17	33	32	36
14	535	184	196	85	16	20	36	34	41
15	518	212	188	77	15	22	36	35	37
16	496	239	197	68	15	23	32	32	41
17	475	258	210	62	14	22	31	35	43
18	465	236	217	64	14	21	42	34	48
19	432	202	192	56	13	20	40	43	52
20	407	205	179	50	13	20	35	79	
21	381	269	173	44	12	22	32	65	
22	362	368	161	39	12	23	32	43	
23	351	409	156	41	14	23	44	41	
24	341	498	173	37	15	24	38	43	
25	319	532	164	41	16	28	44	43	
26	295	500	135	43	16	28	56	49	
27	276	488	127	40	15	27	62	63	
28	278	462	127	35	15	22	44	61	
29	255	430	149	30	14	22	38	57	
30	271	407	125	25	14	24	42	45	
31	249		118		14	32		46	

NOTE.—Daily discharge computed from a well-defined rating curve, except that for the last half of November, 1909, for which it is estimated.

Monthly discharge of Minnesota River near Odessa, Minn., for 1909-10.

[Drainage area, 1,560 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
July (4-31)	64	24	41.0	0.026	0.03	B.
August	58	24	36.9	.024	.03	B.
September	63	31	44.9	.029	.03	B.
October	115	51	66.1	.042	.05	B.
November	156	52	83.6	.054	.06	B.
1910.						
March (9-31)	850	249	441	.283	.24	B.
April	532	166	288	.185	.21	A.
May	407	118	213	.137	.16	A.
June	114	25	71.2	.046	.05	A.
July	24	12	16.5	.011	.01	A.
August	32	16	20.4	.013	.02	A.
September	62	24	38.2	.024	.03	A.
October	79	32	42.8	.027	.03	A.
November (1-19)	57	31	41.7	.027	.02	A.

MINNESOTA RIVER NEAR MONTEVIDEO, MINN.

This station, which is located at the highway bridge about 1 mile south of Montevideo, in sec. 19, T. 117 N., R. 40 W., was established July 23, 1909, to obtain information concerning the power available on Minnesota River at Granite Falls, a few miles below. The records will also afford data of value in connection with studies of flood prevention, navigation, and sewage disposal.

Chippewa River enters the Minnesota a short distance above the station. The nearest dam, that above Granite Falls, is not more than 6 or 8 feet high, and its influence does not extend to the Montevideo station. There is no dam above the station.

The discharge of Chippewa River is so much less than that of the Minnesota that the control of the former by a dam at Montevideo has very little effect on the Minnesota gage heights.

The river is frozen entirely across at this station from December to March, during which period discharge measurements are made through the ice to determine the approximate winter discharge.

The chain gage is attached to the bridge from which the discharge measurements are made. The datum of the gage was lowered 2 feet September 16, 1909, and again lowered 1 foot in 1910 to avoid negative readings. All readings have been corrected to conform to the datum established in 1910.

Conditions at this station are excellent, and the results should therefore be reliable.

Discharge measurements of Minnesota River near Montevideo, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 3	G. A. Gray	120	296	*a* 4.15	164
Mar. 22	C. J. Emerson	121	819	9.07	2,150
Apr. 14	G. A. Gray	102	491	6.18	1,060
July 7	Robert Follansbee	82	142	2.68	175
8	.....do	82	143	2.66	172
29	.....do	54	78.1	1.79	66.1
Oct. 14	C. R. Adams	59	82.7	1.89	71.5

a Gage height to water surface; thickness of ice, 1.26 feet.

Daily gage height, in feet, of Minnesota River near Montevideo, Minn., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	4.00	4.00	7.66	7.16	4.37	2.80	1.70	1.95	2.06	2.21	2.66
2	......	......	......	7.49	7.17	4.38	2.82	1.85	1.70	1.93	2.16	2.65
3	4.28	4.15	......	7.18	7.04	4.16	2.74	1.94	1.87	1.87	2.11	2.71
4	......	4.32	5.40	7.36	6.90	4.12	2.62	2.07	1.83	2.17	1.98	2.66
5	......	......	5.95	7.38	6.73	4.00	2.54	1.90	1.77	1.97	2.26	2.69
6	......	......	6.10	7.14	6.66	4.14	2.74	1.74	1.84	2.17	2.26	2.60
7	3.80	......	7.15	7.08	6.42	4.00	2.63	1.74	1.80	2.03	2.24	2.49
8	......	4.05	7.76	7.06	6.22	4.12	2.65	1.74	1.79	1.97	2.29	2.52
9	......	......	8.10	7.02	6.37	3.98	2.58	1.77	1.99	1.97	2.34	2.60
10	......	......	7.45	6.72	6.27	3.90	2.42	1.83	1.80	1.87	2.29	2.61
11	4.20	4.02	8.66	6.84	6.08	4.02	2.58	1.67	1.61	1.91	2.26	2.60
12	......	......	8.85	6.60	5.89	4.00	2.54	1.60	1.83	1.87	2.22	2.65
13	......	......	9.32	6.38	5.86	4.26	2.38	1.63	1.80	1.85	2.21	2.64
14	4.40	......	8.95	6.26	5.70	4.16	2.28	1.71	1.79	1.99	2.20	......
15	......	......	8.72	6.31	5.28	4.00	2.39	1.73	1.80	1.80	2.28	2.66
16	......	3.75	9.54	6.76	5.48	3.83	2.32	1.74	1.81	1.95	2.34	2.62
17	......	......	9.74	6.88	5.66	3.78	2.24	1.95	1.71	1.91	2.36	2.61
18	4.30	3.92	9.36	6.92	5.54	3.69	2.16	1.90	1.87	1.89	2.31	2.66
19	......	......	9.22	6.88	5.45	3.48	2.01	1.87	1.83	2.02	2.26	2.66
20	......	......	9.14	7.02	5.58	3.40	2.04	2.00	1.84	2.28	2.24	2.62
21	4.20	......	9.14	7.38	5.48	3.40	2.11	1.96	1.85	2.02	2.34	2.54
22	......	4.05	9.07	7.71	5.48	3.32	2.12	1.97	1.77	2.01	2.31	......
23	......	......	8.94	8.12	5.45	3.29	1.99	2.05	1.87	2.02	2.29	......
24	......	......	8.89	7.85	5.51	3.24	1.94	1.97	1.91	2.06	2.32	2.60
25	4.05	4.10	8.78	7.80	5.35	3.23	2.19	2.10	1.89	2.08	2.35	......
26		......	8.66	7.73	5.22	3.09	1.98	2.09	2.00	2.14	2.48	......
27		......	8.24	7.67	5.01	2.99	1.96	2.07	2.11	2.28	2.38	......
28	4.02	......	8.32	7.60	4.90	2.94	1.70	1.77	1.95	2.45	2.52	2.60
29	......	......	7.99	7.50	4.70	2.87	1.79	1.83	1.90	2.32	2.56	......
30	......	......	7.91	7.43	4.91	2.82	1.86	1.69	1.86	2.08	2.61	......
31	......	......	7.88	......	4.60	......	1.90	1.95	......	2.15	......	2.72

NOTE.—Ice present from Jan. 1 to Mar. 5, and from Nov. 28 to Dec. 31.

Daily discharge, in second-feet, of Minnesota River near Montevideo, Minn., for 1910.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	150	1,600	1,410	508	181	58	83	95	111
2	....	150	1,530	1,410	511	184	73	58	81	106
3	*a* 164	160	1,420	1,360	452	173	82	75	75	100
4	....	700	1,480	1,310	441	158	96	71	107	86
5	....	850	1,490	1,250	410	149	78	65	85	117
6	....	1,030	1,400	1,230	446	173	62	72	107	117
7	....	1,310	1,380	1,140	410	160	62	68	91	114
8	....	1,640	1,370	1,070	441	162	62	67	85	120
9	....	1,770	1,360	1,120	405	154	65	87	85	125
10	....	1,520	1,250	1,090	384	134	71	68	75	120

a Discharge measurement.

Daily discharge, in second-feet, of Minnesota River near Montevideo, Minn., for 1910—Continued.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
11		1,990	1,290	1,030	415	154	55	50	79	117
12		2,060	1,200	964	410	149	49	71	75	112
13		2,250	1,130	954	478	130	52	68	73	111
14		2,100	1,090	902	452	119	59	67	87	110
15		2,010	1,100	770	410	131	61	68	68	119
16		2,340	1,260	832	367	123	62	69	83	125
17		2,420	1,310	889	355	114	83	59	79	128
18		2,260	1,320	851	334	106	78	75	77	122
19		2,210	1,310	822	288	89	75	71	90	117
20		2,180	1,360	864	271	92	88	72	119	114
21		2,180	1,490	832	271	100	84	73	90	125
22		2,150	1,620	832	256	101	85	65	89	122
23		2,100	1,780	822	250	87	94	75	90	120
24		2,080	1,670	841	242	82	85	79	95	123
25		2,030	1,650	792	241	109	99	77	97	126
26		1,990	1,630	751	220	86	98	88	103	142
27		1,820	1,600	688	206	84	96	100	119	130
28		1,850	1,580	656	199	58	65	83	138	130
29		1,730	1,540	599	190	67	71	78	123	130
30		1,690	1,510	659	184	74	57	74	97	130
31		1,680		571		78	83		116	

NOTE.—Daily discharge computed from a well-defined rating curve, except from Mar. 1 to 5 and Nov. 28 to 30, which were estimated.

Monthly discharge of Minnesota River near Montevideo, Minn., for 1910.

[Drainage area, 6,300 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January			*a* 200	0.032	0.04	C.
February			*a* 150	.024	.02	C.
March	2,420	150	1,690	.268	.31	B.
April	1,780	1,090	1,420	.225	.25	A.
May	1,410	571	946	.150	.17	A.
June	511	184	348	.055	.06	A.
July	184	58	121	.019	.02	A.
August	98	49	73.8	.012	.01	A.
September	100	50	72.5	.012	.01	A.
October	138	73	92.7	.015	.02	A.
November	142	86	119	.019	.02	B.
December			*a* 65	.010	.01	D.
The year	2,420		442	.070	.94	

a Estimated.

MINNESOTA RIVER NEAR MANKATO, MINN.

This station, which is located at Sibley Park, 2 miles above the center of Mankato and a few hundred yards below the mouth of Blue Earth River, the nearest tributary, was established May 20, 1903.[1] Since 1906 the gage has been maintained by the United State Engineer Corps. The daily readings are taken by the United States Weather Bureau and furnished through the courtesy of that office.

[1] Gage heights for 1903 and 1904 have been published in Water-Supply Papers 99, p. 17, and 130, p. 53.

The nearest dam on the river is at Minnesota Falls, a short distance below Granite Falls, where 264 horsepower is developed under a head of 16 feet. There is no dam below the gaging station.

Discharge measurements are made from a boat and cable near the gage. Since the establishment of the station the datum of the gage has remained unchanged.

Ice is usually present at this station from December to March, and during that period the gage heights are taken through a hole in the ice. Therefore the open-water rating curve is not applicable. Owing to a lack of measurements, few winter estimates have been made.

Measurements made during the earlier years indicated changing conditions of flow, and accordingly the discharge for years previous to 1907 was obtained largely by the indirect method. These results can not be considered as accurate as the later ones which were based on a well-defined rating curve with fairly permanent conditions.

The estimates given herewith supersede those for 1905 and 1906, published in Water-Supply Papers 171, page 57, and 207, page 49.

The highest known stage of the river occurred in 1881 and is shown by a well-marked line in Mankato. The stage was approximately 27 feet above the zero of the present gage. This value was corroborated by Mr. M. B. Haynes, civil engineer of Mankato, who states that the high water occurred after the ice went out and was not caused by backwater. The corresponding discharge was approximately 65,000 second-feet. Since the establishment of the gage the highest stage recorded was 21.2 feet on June 26, 1908. The lowest stage recorded was during the summer of 1910, when the flow was about 165 second-feet.

Discharge measurements of Minnesota River near Mankato, Minn., in 1903–1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 20	E. Johnson, jr			9.20	7,630
June 23	W. R. Hoag			4.95	2,120
July 30	....do			5.11	3,010
Sept. 7	L. R. Stockman			5.15	3,260
Oct. 15	....do			10.45	12,300
Nov. 27	....do			3.30	1,280
1904.					
Jan. 17	E. Johnson, jr	365	1,130	2.30	580
Apr. 21	E. F. Chandler	302	2,000	6.48	4,910
June 28	....do	286	1,040	3.74	2,170
July 26	R. Richards	282	773	2.70	1,090
Aug. 31	....do	270	614	2.09	548
Oct. 18	E. F. Chandler	270	616	2.24	665
Dec. 30	R. Richards	220	498	[a] 2.20	315
1905.					
Apr. 3	R. Richards	295	1,400	5.08	3,280
May 10	E. F. Chandler	294	1,040	4.26	2,450
July 18	R. Richards	310	2,520	8.75	8,180
Sept. 12	....do	285	877	2.93	1,350
Nov. 1	E. F. Chandler	298	815	2.84	1,240
Dec. 29	R. Richards	297	811	[b] 3.85	1,070

[a] Gage height to water surface; thickness of ice, 0.6 foot.
[b] Gage height to water surface; thickness of ice, 0.8 foot.

Discharge measurements of Minnesota River near Mankato, Minn., in 1903–1910—Contd.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
1906.					
Apr. 11	A. H. Horton	310	1,890	7.59	6,020
May 24	M. S. Brennan	308	1,730	5.81	4,300
1909.					
Sept. 13	G. A. Gray	277	953	1.80	804
1910.					
Feb. 8	G. A. Gray	304	526	[a] 3.98	636
Mar. 15	C. J. Emerson	317	3,520	11.32	16,000
19	.....do	315	2,830	9.36	10,600
26	.....do	310	2,210	7.34	6,800
May 24	G. A. Gray	295	864	3.13	1,560
July 13	.....do	287	412	1.35	494
Oct. 29	C. J. Emerson	281	291	.98	253
Dec. 27	C. R. Adams	210	260	([b])	175

[a] Gage height to water surface; thickness of ice, 0.65 foot.
[b] Ice present. Gage height somewhat less than 0.8 foot, as water had receded from Weather Bureau gage.

Daily gage height, in feet, of Minnesota River near Mankato, Minn., for 1905–1910.

Day[a]	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1905.[a]												
1	2.0	2.0	4.05	5.2	2.95	6.05	6.35	5.4	3.35	2.95	2.9	4.15
2	1.9	2.0	4.25	5.25	2.95	5.9	7.65	5.25	3.3	2.9	2.8	8.2
3	1.9	2.0	4.5	5.1	3.0	5.75	7.95	5.15	3.25	2.85	2.85	7.95
4	1.95	2.0	5.5	5.05	3.35	5.6	8.95	4.95	3.2	2.8	2.8	7.55
5	1.95	2.0	5.7	5.2	3.9	5.45	9.55	4.8	3.15	2.8	2.9	7.45
6	1.9	2.0	6.1	5.25	4.0	5.3	10.75	4.65	3.1	2.7	3.25	7.65
7	1.9	2.0	5.9	5.25	3.95	5.15	11.85	4.6	3.0	2.7	3.35	7.45
8	1.9	2.0	5.5	5.2	3.8	4.9	12.35	4.45	3.0	2.7	3.55	7.15
9	1.9	2.0	5.3	5.1	3.75	4.8	12.65	4.35	2.95	2.65	3.65	6.85
10	1.9	2.0	4.8	4.9	4.2	4.7	12.15	4.25	2.9	2.8	3.65	6.25
11	1.9	2.0	4.2	4.7	5.15	4.6	11.95	4.15	2.9	2.7	3.65	6.15
12	2.0	2.1	4.1	4.5	6.1	4.55	11.35	4.0	2.9	2.65	3.65	6.05
13	2.0	2.15	4.4	4.35	6.4	4.4	11.85	3.85	2.85	2.6	3.6	5.95
14	2.0	2.15	3.6	4.2	7.1	4.35	10.35	3.85	2.8	2.65	3.6	5.65
15	2.0	2.2	3.8	4.1	8.1	4.2	9.95	3.85	2.9	2.85	3.55	5.5
16	2.0	2.2	3.95	3.9	9.3	4.25	9.45	3.85	2.85	2.9	3.5	5.25
17	2.0	2.2	4.0	3.9	9.9	4.4	9.15	3.65	2.9	2.9	3.4	5.1
18	2.0	2.2	4.1	3.8	10.1	4.3	8.85	3.85	2.9	2.95	3.4	5.0
19	2.0	2.2	5.4	3.7	10.0	4.4	8.55	3.85	4.6	2.85	3.35	4.75
20	2.0	2.2	5.9	3.6	9.9	4.35	8.25	3.75	3.9	2.95	3.35	4.65
21	2.0	2.1	6.3	3.5	9.7	4.3	7.95	3.7	3.65	2.95	3.3	4.6
22	2.0	2.1	6.5	3.35	9.3	4.15	7.75	3.65	3.6	3.0	3.25	4.55
23	2.0	2.4	6.8	3.3	8.9	4.1	7.45	3.55	3.5	3.05	3.2	4.25
24	2.0	2.5	6.8	3.3	8.3	4.05	7.15	4.0	3.4	3.05	3.55	4.0
25	2.0	3.1	6.7	3.2	7.9	4.85	6.95	3.85	3.2	3.0	3.75	4.05
26	2.0	3.6	6.5	3.2	7.5	5.7	6.75	3.7	3.1	3.0	3.9	4.05
27	2.0	3.8	6.2	3.1	7.5	6.2	6.45	3.65	3.1	2.95	3.95	4.0
28	2.0	4.5	6.1	3.05	6.7	6.3	6.15	3.65	3.05	2.95	5.2	3.95
29	2.0	......	5.8	3.0	6.5	6.0	6.05	3.6	3.0	2.95	5.75	3.85
30	2.0	......	5.6	2.95	6.3	5.9	5.75	3.55	2.95	2.95	4.55	3.75
31	2.0	......	5.4	......	6.15	......	5.55	3.4	......	2.9	......	3.75

[a] These gage heights supersede those published in Water-Supply Paper 171, p. 57.

Daily gage height, in feet, of Minnesota River near Mankato, Minn., for 1905–1910—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1906.[a]												
1	3.7	3.4	5.0	7.1	6.3	8.2	8.0	4.9	7.7	6.8	6.9	5.1
2	3.7	3.5	5.0	7.6	6.45	8.3	7.9	4.8	7.6	6.6	6.8	4.6
3	3.7	3.5	5.15	8.1	6.55	8.3	7.9	4.8	7.6	6.4	6.8	4.5
4	3.7	3.2	5.05	7.6	6.6	8.3	7.9	4.7	7.6	6.2	6.8	4.8
5	3.7	3.4	5.0	7.4	6.55	8.5	7.8	4.5	7.7	5.9	6.7	4.9
6	3.7	3.3	5.1	7.1	6.45	8.7	7.7	4.5	7.6	5.8	6.7	4.8
7	3.65	3.3	5.0	7.0	6.3	8.8	7.6	4.4	7.5	5.6	6.7	4.2
8	3.65	3.25	5.1	6.8	6.25	8.95	7.5	4.7	7.3	5.4	6.9	6.2
9	3.65	3.2	5.6	7.1	6.15	9.1	7.3	5.8	7.1	5.2	6.9	6.4
10	3.65	3.2	5.6	7.4	6.0	9.2	7.2	6.0	6.8	5.0	6.8	6.4
11	3.6	3.15	5.4	8.0	5.85	9.2	7.1	6.8	6.5	4.9	6.8	6.2
12	3.6	3.1	5.1	7.45	5.75	9.15	6.9	7.8	6.3	4.7	6.6	6.4
13	3.6	3.1	4.9	7.8	5.65	9.05	6.7	7.5	6.1	4.6	6.5	6.4
14	3.6	3.1	4.7	8.85	5.55	8.95	6.5	7.3	5.9	4.5	6.3	6.4
15	3.55	3.1	4.6	8.9	5.4	8.9	6.3	7.3	5.7	4.4	6.2	5.8
16	3.6	3.1	4.35	9.2	5.3	8.8	6.1	7.1	5.7	4.3	6.0	5.8
17	3.6	3.1	4.15	9.3	5.3	8.7	5.9	7.0	5.7	4.1	6.1	5.7
18	3.6	3.1	3.8	9.25	5.5	8.55	5.8	6.9	5.7	4.1	6.0	5.2
19	3.55	3.1	3.8	9.1	5.55	8.65	5.6	6.8	5.8	4.0	5.7	5.0
20	3.55	3.3	3.8	8.85	5.55	8.6	5.5	6.7	5.9	3.9	5.7	4.9
21	3.55	3.4	3.5	8.6	5.35	8.45	5.3	6.4	6.2	3.9	5.6	4.7
22	3.55	3.6	3.5	8.3	5.75	8.4	5.2	6.1	6.5	3.9	5.6	4.5
23	3.5	4.2	3.6	7.9	5.55	8.4	5.0	6.2	6.7	3.9	5.4	4.4
24	3.45	4.65	3.3	7.5	5.7	8.3	4.9	6.4	6.9	4.1	5.4	4.3
25	3.4	4.6	3.3	7.3	5.75	8.2	4.7	6.6	7.0	4.7	5.1	4.2
26	3.25	4.6	3.45	7.05	5.8	8.1	4.7	7.0	7.1	5.1	5.3	4.3
27	3.2	4.7	4.5	6.8	6.15	8.1	4.5	7.5	7.2	5.6	5.4	4.1
28	3.2	4.8	4.45	6.55	6.55	8.1	4.6	7.8	7.1	6.2	5.3	4.0
29	3.25	......	4.85	6.45	7.0	8.1	4.8	8.0	7.1	6.5	5.2	4.0
30	3.4	......	5.3	6.3	7.6	8.1	4.9	8.0	7.0	6.7	5.2	4.0
31	3.4	......	5.65	......	8.0	......	5.0	7.9	......	6.8	......	4.0
1907.[b]												
1	4.0	3.2	6.2	9.0	5.9	7.1	11.2	6.2	5.7	3.6	2.6	2.8
2	4.0	3.1	6.0	9.3	5.9	7.0	10.5	5.8	5.4	3.6	3.0	2.7
3	4.0	3.1	5.8	10.1	5.9	6.8	10.2	5.5	5.1	3.9	3.4	2.6
4	3.9	3.2	5.6	10.5	6.0	6.5	9.8	5.2	4.8	3.7	3.6	2.5
5	3.9	3.2	5.4	10.8	6.1	6.4	9.5	5.1	4.6	3.8	3.6	2.4
6	3.9	3.2	5.4	10.7	6.0	6.2	9.2	4.9	4.2	4.0	3.6	2.4
7	3.9	3.2	5.4	10.5	6.0	6.2	8.8	4.8	4.1	4.0	3.4	2.4
8	3.8	3.3	5.3	10.3	6.0	6.2	8.4	4.6	4.0	3.9	3.4	2.5
9	3.8	3.3	5.2	10.0	5.9	6.4	8.1	4.6	3.9	3.7	3.3	2.6
10	3.8	3.3	5.1	9.7	5.8	8.7	7.7	4.6	3.7	3.6	3.2	2.6
11	3.7	3.2	4.9	9.3	5.7	10.0	7.4	4.4	3.7	3.3	3.2	2.3
12	3.7	3.2	4.9	9.1	5.5	11.3	6.9	4.3	3.6	3.2	3.1	2.6
13	3.7	3.2	4.9	8.8	5.5	12.2	6.4	4.2	3.4	3.1	2.9	2.6
14	3.6	3.3	4.9	8.5	5.4	12.5	6.3	4.0	3.3	3.1	2.7	2.6
15	3.6	3.4	4.9	8.3	5.3	12.5	7.0	3.9	3.3	3.0	2.7	2.6
16	3.6	3.7	5.7	8.1	5.4	12.4	7.2	3.8	3.2	3.0	2.6	2.7
17	3.6	4.2	6.5	8.0	5.5	12.2	7.3	3.7	3.4	2.9	2.8	2.7
18	3.6	5.3	7.1	7.8	5.5	13.1	7.5	3.6	3.6	2.9	2.9	2.7
19	3.6	5.8	7.4	7.4	5.5	13.5	7.9	3.6	4.0	2.8	2.9	2.7
20	3.6	6.5	8.2	7.2	5.5	14.0	7.8	4.4	4.3	2.8	2.9	2.5
21	3.5	7.3	8.1	7.1	5.5	14.1	8.2	4.7	5.6	2.7	2.8	2.5
22	3.5	7.3	9.1	6.8	5.4	14.1	8.8	4.6	6.0	2.7	2.8	2.3
23	3.5	7.3	9.3	6.5	5.3	13.7	8.9	4.4	5.6	2.7	2.8	2.5
24	3.5	7.0	8.8	6.3	5.2	13.6	8.9	4.2	5.1	2.7	2.8	2.5
25	3.5	6.8	8.5	6.2	5.4	13.7	8.8	4.0	4.7	2.6	2.8	2.5
26	3.4	6.6	8.7	6.1	6.0	13.8	8.5	3.8	4.4	2.6	2.8	2.5
27	3.4	6.4	8.7	6.0	6.5	13.4	7.8	4.4	4.2	2.6	2.8	2.3
28	3.3	6.3	8.7	6.0	7.1	12.9	7.7	5.3	3.9	2.6	2.8	2.2
29	3.3	......	8.8	5.9	7.2	12.4	7.3	5.7	3.8	2.6	2.8	2.2
30	3.2	......	8.8	5.9	7.3	11.8	7.0	5.8	3.7	2.6	2.8	2.2
31	3.2	......	8.9	......	7.2	......	6.6	5.7	......	2.6	......	2.5

[a] These gage heights supersede those published in Water-Supply Paper No. 207, p. 49.
[b] The following corrections have been made to the United States Weather Bureau gage heights, owing to change in gage datum: Jan. 1–Feb. 28 +0.4; Mar. 1–Aug. 9 +0.5; Aug. 10–Dec. 31 +0.6.

Daily gage height, in feet, of Minnesota River near Mankato, Minn., for 1905–1910—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.[a]												
1	2.8	2.4	3.6	5.3	6.9	17.2	17.0	7.7	3.5	2.4	3.0	3.3
2	3.0	2.4	3.6	5.2	6.7	16.6	16.5	7.4	3.3	2.4	3.0	3.0
3	2.9	2.4	3.6	5.1	6.6	15.8	15.8	7.1	3.2	2.5	2.9	2.8
4	2.9	2.4	3.6	5.2	6.3	14.6	15.0	6.9	3.1	2.5	2.9	3.0
5	2.9	2.4	3.4	5.2	6.5	14.1	14.4	6.5	3.1	2.5	2.9	2.9
6	2.2	2.4	3.3	5.1	5.9	13.7	14.5	6.1	3.0	2.5	2.8	2.9
7	2.4	2.4	3.3	5.2	5.7	13.5	14.5	5.9	2.9	2.5	2.8	2.9
8	2.6	2.4	3.2	5.2	5.7	13.3	14.2	5.7	2.8	2.5	2.7	2.9
9	2.6	2.4	3.2	5.2	5.7	12.8	14.0	5.5	2.8	2.5	2.6	2.9
10	2.6	2.4	3.2	5.1	5.7	12.6	13.8	5.5	2.7	2.5	2.5	2.9
11	2.6	2.5	4.0	5.1	5.5	12.2	13.3	5.0	2.6	2.4	2.4	2.9
12	2.6	2.6	5.4	5.0	5.5	11.9	12.6	4.9	2.6	2.4	2.3	2.8
13	2.6	2.8	4.3	5.2	5.3	11.7	12.3	4.8	2.5	2.4	2.3	2.7
14	2.6	3.2	4.3	5.2	5.4	11.3	11.9	4.6	2.5	2.4	2.3	2.7
15	2.6	3.2	5.2	5.0	6.3	10.9	11.5	4.5	2.5	2.4	2.3	2.7
16	2.6	3.4	5.8	5.0	7.1	10.6	11.1	4.5	2.5	2.4	2.3	2.7
17	2.6	3.4	6.0	5.0	7.6	10.2	11.0	4.4	2.5	2.3	2.3	2.7
18	2.4	3.4	5.7	5.1	8.2	10.1	11.1	4.3	2.5	2.3	2.3	2.7
19	2.4	3.4	5.6	5.5	8.7	10.3	11.4	4.3	2.5	2.3	2.3	2.7
20	2.4	3.4	5.4	5.7	9.0	10.3	11.3	4.2	2.4	2.3	2.3	2.7
21	2.4	3.8	5.6	5.7	10.1	11.9	10.8	4.1	2.4	2.4	2.3	2.7
22	2.4	3.7	5.5	5.6	11.8	12.1	10.3	4.0	2.4	2.4	2.3	2.7
23	2.4	3.7	5.4	5.4	12.6	16.0	9.7	3.9	2.4	2.4	2.3	2.7
24	2.4	3.7	5.5	5.3	12.4	18.4	9.0	3.8	2.4	2.5	2.5	2.7
25	2.4	3.7	5.4	5.4	12.8	21.0	8.4	3.7	2.4	2.5	2.7	2.7
26	2.4	3.6	5.3	5.8	13.0	21.2	7.8	3.6	2.4	2.6	2.8	2.7
27	2.4	3.6	5.3	6.0	13.2	20.5	8.7	3.5	2.3	2.7	2.9	2.6
28	2.4	3.6	5.3	6.6	14.0	19.6	8.8	3.6	2.3	2.7	2.9	2.6
29	2.4	3.6	5.3	6.9	15.0	18.9	9.0	3.8	2.3	2.7	2.9	2.5
30	2.4	......	5.2	6.9	17.2	17.8	8.7	3.8	2.4	2.8	3.1	2.5
31	2.4	......	5.1	......	17.5	......	8.0	3.7	......	2.9	......	2.5
1909.[b]												
1	2.6	4.1	3.1	16.8	7.9	7.6	10.9	3.0	2.2	1.8	1.6	7.0
2	2.6	4.1	3.1	16.4	8.3	8.0	10.9	2.8	2.1	1.8	1.7	7.0
3	2.6	4.1	3.2	15.9	8.2	8.5	10.9	2.7	2.1	1.7	1.7	7.1
4	2.6	4.1	3.2	15.5	8.2	8.7	10.7	2.6	2.1	1.6	1.7	7.1
5	2.6	4.3	3.2	15.1	8.1	8.8	10.3	2.5	2.0	1.6	3.5	7.1
6	2.6	4.1	3.3	14.8	7.9	8.9	9.8	2.4	2.0	1.5	3.5	6.1
7	2.6	3.9	3.3	14.5	7.6	8.7	9.4	2.3	1.9	1.5	3.3	6.7
8	2.6	3.7	3.3	13.9	7.3	8.5	9.0	2.3	1.9	1.4	3.1	7.1
9	2.6	3.5	3.3	13.3	6.9	8.3	8.4	2.3	1.9	1.4	2.9	7.1
10	2.6	3.4	3.5	12.8	6.5	8.1	8.0	2.3	1.9	1.5	2.7	7.1
11	2.6	3.3	5.3	12.2	6.1	7.9	7.6	2.2	1.9	1.6	2.5	7.1
12	2.6	3.1	7.1	12.0	5.8	7.8	7.2	2.5	1.9	1.6	2.5	7.1
13	2.6	3.0	7.1	11.9	5.6	8.0	6.7	2.7	1.9	1.6	2.5	7.1
14	2.6	3.0	7.3	11.7	5.3	8.3	6.5	3.1	1.9	1.7	3.1	7.1
15	2.6	3.0	7.5	11.5	5.2	8.4	6.1	3.9	1.9	1.8	3.7	7.0
16	2.6	3.0	7.7	11.1	5.2	8.1	5.9	4.3	1.9	1.8	4.7	7.0
17	2.6	3.0	7.7	10.8	5.2	8.3	5.6	4.7	1.8	1.8	4.9	6.9
18	2.6	3.0	7.8	10.3	5.3	8.1	5.3	4.6	1.8	1.8	4.6	6.7
19	2.6	3.0	7.9	10.1	5.5	8.0	5.4	4.3	1.8	1.8	4.7	6.5
20	2.6	3.0	8.1	9.9	5.5	7.8	5.5	4.1	1.7	1.7	4.8	6.3
21	2.6	3.0	8.2	9.6	5.5	7.5	5.3	4.0	1.7	1.7	4.8	6.1
22	2.6	3.1	8.3	9.4	5.5	7.1	4.2	3.7	1.9	1.7	4.8	5.9
23	2.9	3.1	8.5	9.2	5.3	7.0	4.6	3.5	1.9	1.7	4.8	5.7
24	3.1	3.1	9.5	9.0	5.2	7.5	4.3	3.2	1.9	1.7	4.9	5.5
25	3.1	3.1	11.7	8.8	5.2	7.6	4.1	3.1	2.0	1.7	4.9	5.3
26	3.1	3.1	12.7	8.6	5.3	7.3	3.9	3.0	2.1	1.7	4.9	5.1
27	3.0	3.1	13.6	8.2	6.7	8.1	3.5	2.8	2.0	1.6	5.3	5.0
28	3.0	3.1	16.3	8.1	6.0	9.0	3.5	2.7	2.0	1.6	5.6	5.0
29	4.3	......	17.3	7.8	6.5	10.1	3.4	2.5	2.0	1.6	6.7	5.0
30	4.2	......	17.3	7.9	6.8	10.6	3.2	2.5	1.9	1.6	6.9	4.9
31	4.1	......	17.1	......	7.2	......	3.1	2.3	......	1.6	......	4.8

[a] The following correction has been applied to the United States Weather Bureau gage heights, owing to change in gage datum: Jan. 1–17 +0.6.
[b] The following correction has been made to the United States Weather Bureau gage heights, owing to change in gage datum, Jan. 1–Dec. 31, +0.1.

Daily gage height, in feet, of Minnesota River near Mankato, Minn., for 1905–1910—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910.[a]												
1	4.8	4.2	3.7	5.4	4.6	3.0	2.0	1.0	0.9	1.0	1.0	1.0
2	4.7	4.1	3.7	5.3	4.4	2.9	1.9	1.0	.9	.9	1.0	1.0
3	4.7	4.1	3.8	5.2	4.2	2.9	1.9	1.0	.9	.9	1.0	1.0
4	4.7	4.0	3.9	5.0	4.0	2.8	1.8	1.0	1.0	.9	1.0	1.0
5	4.7	4.0	4.0	4.8	3.8	2.7	1.8	1.0	1.0	1.0	1.1	1.0
6	4.6	4.0	5.6	4.6	3.7	2.7	1.7	.9	.9	.9	1.1	1.0
7	4.6	4.0	8.1	4.6	3.7	2.6	1.7	.9	.9	.9	1.1	.9
8	4.6	4.0	8.5	4.6	3.6	2.6	1.6	.9	.9	.9	1.1	.9
9	4.5	4.0	9.2	4.6	3.6	2.6	1.6	.8	.9	.9	1.1	.9
10	4.5	4.0	11.0	4.5	3.6	2.5	1.6	.8	.9	.9	1.1	.9
11	4.4	4.0	12.2	4.5	3.6	2.5	1.5	.8	.8	.9	1.1	.9
12	4.4	4.0	14.85	4.5	3.6	2.4	1.5	.8	.8	.9	1.1	.9
13	4.4	4.0	13.1	4.4	3.6	2.5	1.5	.8	.8	.9	1.1	.9
14	4.4	4.0	12.1	4.2	3.6	2.4	1.4	.8	.8	.9	1.1	.9
15	4.3	3.9	11.4	4.0	3.6	2.3	1.3	.8	.8	.9	1.1	.9
16	4.3	3.9	11.0	4.0	3.6	2.3	1.3	.8	.9	.9	1.1	.9
17	4.3	3.8	11.4	4.0	3.6	2.2	1.3	1.0	.9	.9	1.0	.9
18	4.3	3.8	9.9	3.9	3.6	2.4	1.2	1.0	.9	.9	1.0	......
19	4.2	3.8	9.4	3.9	3.5	2.4	1.2	1.0	.9	.9	1.0	......
20	4.2	3.8	9.1	3.9	3.4	2.2	1.2	1.3	.9	.9	1.0	......
21	4.2	3.8	8.8	3.9	3.4	2.2	1.1	1.4	.9	.9	1.0	......
22	4.2	3.8	8.5	3.9	3.4	2.2	1.1	1.2	.9	.9	1.0	......
23	4.2	3.7	8.4	3.9	3.3	2.2	1.1	1.0	.9	.9	1.0	......
24	4.2	3.7	7.9	3.9	3.3	2.1	1.1	1.0	.9	1.0	1.0	......
25	4.2	3.7	7.7	3.9	3.2	2.1	1.1	1.0	.9	1.0	1.0	......
26	4.2	3.7	7.4	4.1	3.2	2.0	1.0	1.0	1.0	1.0	1.0	......
27	4.2	3.7	7.1	4.3	3.1	1.0	1.0	1.0	1.0	1.0	1.0	......
28	4.2	3.7	6.8	4.4	3.1	2.0	1.0	1.0	1.0	1.0	1.0	......
29	4.2	3.7	6.4	4.6	3.1	2.0	1.0	1.0	1.0	1.0	1.0	......
30	4.2	......	6.2	4.8	3.0	2.0	1.0	.9	1.0	1.0	1.0	......
31	4.2	......	6.0	......	3.0	......	1.0	.9	......	1.0	......	......

[a] The following correction has been made to the United States Weather Bureau gage heights, owing to change in gage datum, Jan. 1–Mar. 7, +0.10, Sept. 16–Dec. 31, +0.10. Ice conditions from Jan. 1 to Mar. 14, and from Dec. 1 to 31.

Daily discharge, in second-feet, of Minnesota River near Mankato, Minn., for 1903–1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.[a]												
1						27,200	3,710	3,100	2,980	5,760	3,650	1,340
2						23,000	3,900	2,930	3,770	5,610	3,460	1,260
3						18,900	4,350	2,880	3,460	5,460	3,340	1,220
4						15,800	6,960	2,980	4,090	6,060	3,220	1,260
5						13,400	6,540	3,400	4,160	6,140	3,100	1,260
6						11,300	6,620	3,840	4,160	6,460	2,980	1,300
7						9,530	6,540	4,090	2,980	15,600	2,760	1,300
8						7,380	6,460	3,840	3,460	18,900	2,660	1,300
9						6,700	6,300	3,340	3,580	20,500	2,540	1,300
10						6,700	6,380	3,100	3,840	20,400	2,490	1,300
11						5,910	6,300	2,880	4,220	18,600	2,440	1,300
12						5,460	5,760	2,760	5,610	17,200	2,390	1,260
13						5,180	5,460	2,660	8,120	15,500	2,340	1,260
14						4,760	5,320	2,660	13,500	13,900	2,280	1,220
15						4,480	4,760	3,960	17,800	12,200	2,230	1,190
16						3,960	4,220	4,350	22,700	10,800	1,930	1,190
17						3,710	4,160	5,460	27,300	10,100	1,380	1,190
18						3,220	4,690	5,180	25,100	9,110	1,220	1,160
19						3,100	4,960	4,760	22,600	8,310	1,090	1,160
20					9,530	2,930	5,460	4,220	19,500	7,930	1,030	1,160
21					8,500	2,930	6,060	4,090	17,200	7,380	970	1,160
22					7,650	2,880	5,610	3,960	14,800	6,790	1,000	1,160
23					7,560	2,880	5,540	3,460	13,200	6,220	1,000	1,160
24					7,650	2,760	5,040	3,100	11,300	5,910	1,100	1,160
25					10,800	2,710	4,690	2,880	10,100	5,320	1,100	1,160
26					14,900	2,540	4,220	2,660	8,800	5,040	1,200	1,160
27					22,300	2,540	4,090	2,540	8,220	4,760	1,300	1,160
28					30,800	2,490	4,220	2,490	6,700	4,480	1,300	1,160
29					38,700	2,440	3,710	2,930	5,610	4,220	1,260	1,160
30					36,800	2,540	3,460	2,930	6,140	3,960	1,380	1,160
31					32,000	......	2,980	2,930	......	3,770	......	1,000

[a] Daily discharge computed from a fairly well-defined rating curve. The gage heights were published in Water-Supply Paper 99, p. 17.

Daily discharge, in second-feet, of Minnesota River near Mankato, Minn., for 1903–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904. [a]												
1	1,160			3,220	4,760	1,420	1,940	1,120	550	470	870	600
2	1,160			3,100	4,420	1,460	1,820	1,090	750	470	840	
3	1,160			2,930	4,220	1,700	1,780	1,000	910	470	840	
4	1,030			2,880	3,960	1,930	1,730	930	750	470	840	
5	980			2,880	3,710	2,910	1,700	900	750	470	810	
6	860			2,760	3,770	3,040	1,640	840	720	470	810	
7	740			2,660	3,840	2,350	1,520	810	690	470	810	
8	680			2,540	3,710	2,350	1,490	810	690	470	780	
9	660			3,710	3,580	2,400	1,430	910	690	470	780	
10	640			5,180	3,460	2,400	1,520	940	630	530	780	
11	630			6,540	3,340	2,480	1,520	890	630	580	750	
12	630			7,740	3,100	2,430	1,400	820	630	580	750	
13	620			7,740	2,980	2,370	1,400	820	605	580	750	
14	620			7,380	2,880	2,320	1,400	760	580	580	750	
15	600			6,960	2,660	2,260	1,320	760	580	580	750	
16	590			6,540	2,540	2,070	1,240	720	580	580	750	
17	580			6,220	2,440	1,970	1,140	720	580	580	690	
18	580			5,760	2,280	1,970	1,140	700	530	665	690	
19	580			5,460	2,130	1,920	1,140	700	530	720	690	
20	580			5,180	2,080	1,920	1,060	670	530	870	690	
21	580			4,900	2,030	1,880	1,060	650	510	940	690	
22	580			5,180	1,930	1,830	980	650	510	1,010	690	
23	570			5,760	1,880	1,840	950	620	490	1,050	690	
24	570			6,220	1,840	1,790	950	600	490	1,010	690	
25	570			6,220	1,740	1,820	950	600	470	1,010	655	
26	560			6,060	1,740	2,120	1,090	540	470	975	655	
27	560			6,060	1,640	2,220	1,050	540	470	940	625	
28	560			5,760	1,600	2,170	1,020	540	470	940	625	
29	560			5,320	1,560	2,130	1,020	540	470	940	625	
30	560			5,100	1,510	2,020	1,120	540	470	940	625	315
31	560				1,460		1,160	540		905		
1905. [b]												
1			2,160	3,460	1,180	4,550	4,960	3,460	1,690	1,340	1,300	
2			2,370	3,520	1,180	4,340	6,950	3,280	1,640	1,300	1,220	
3			2,640	3,340	1,220	4,150	7,460	3,160	1,610	1,260	1,260	
4			3,830	3,280	1,510	3,960	9,400	2,930	1,560	1,220	1,220	
5			4,080	3,460	2,010	3,770	10,700	2,760	1,510	1,220	1,300	
6			4,620	3,520	2,110	3,580	13,500	2,600	1,470	1,140	1,590	
7			4,340	3,520	2,060	3,400	16,400	2,540	1,400	1,140	1,680	
8			3,830	3,460	1,920	3,100	17,700	2,390	1,400	1,140	1,860	
9			3,580	3,340	1,870	2,980	18,600	2,280	1,370	1,100	1,950	
10			2,980	3,100	2,320	2,860	17,100	2,180	1,340	1,220	1,950	
11			2,320	2,860	3,400	2,750	16,600	2,100	1,340	1,140	1,950	
12			2,210	2,640	4,620	2,700	14,900	2,050	1,340	1,100	1,950	
13			2,530	2,480	5,040	2,530	16,300	1,960	1,260	1,060	1,900	
14			1,730	2,320	6,090	2,480	12,200	1,960	1,220	1,100	1,900	
15			1,920	2,210	7,730	2,320	11,100	1,960	1,300	1,260	1,860	
16			2,060	2,010	10,100	2,370	9,900	1,960	1,260	1,300	1,810	
17			2,110	2,010	11,500	2,530	9,150	1,380	1,300	1,300	1,720	
18			2,210	1,920	11,900	2,420	8,180	1,960	1,300	1,340	1,720	
19			3,700	1,820	11,700	2,530	7,820	1,960	2,930	1,260	1,680	
20			4,340	1,730	11,500	2,480	7,270	1,870	2,200	1,340	1,680	
21			4,900	1,640	11,000	2,420	6,760	1,820	1,950	1,340	1,630	
22			5,180	1,510	10,100	2,260	6,450	1,380	1,900	1,380	1,590	
23			5,620	1,460	9,290	2,210	5,960	1,680	1,810	1,420	1,540	
24			5,620	1,460	8,110	2,160	5,540	2,260	1,720	1,420	1,860	
25			5,480	1,380	7,380	3,040	5,400	2,120	1,540	1,380	1,500	
26			5,180	1,380	6,710	4,080	5,120	1,940	1,460	1,380	1,500	
27			4,760	1,300	6,710	4,760	4,720	1,890	1,460	1,340	1,500	
28			4,620	1,260	5,480	4,900	4,340	1,890	1,420	1,340	1,500	
29			4,220	1,220	5,180	4,480	4,210	1,850	1,380	1,340	1,500	1,070
30			3,960	1,180	4,900	4,340	3,850	1,800	1,340	1,340	1,500	
31			3,700		4,680		3,650	1,730		1,300		

[a] Daily discharge computed by means of an indirect application of the rating table, owing to changing conditions. The gage heights have been published in Water-Supply Paper 130, p. 53.

[b] Daily discharge computed from a fairly well-defined rating curve, which is applied indirectly after July 9.

Daily discharge, in second-feet, of Minnesota River near Mankato, Minn., for 1903–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1906.[a]												
1	......	......	......	5,300	4,580	7,960	7,600	3,260	7,090	5,700	5,840	3,490
2	......	......	......	6,050	4,770	8,140	7,430	3,150	6,930	5,420	5,700	2,930
3	......	......	......	6,830	4,970	8,140	7,430	3,150	6,930	5,140	5,700	2,820
4	......	......	......	6,050	5,050	8,140	7,430	3,040	6,930	4,860	5,700	3,150
5	......	......	......	5,730	4,970	8,520	7,260	2,820	7,090	4,470	5,560	3,260
6	......	......	......	5,300	4,900	8,910	7,090	2,820	6,930	4,340	5,560	3,150
7	......	......	......	5,150	4,680	9,110	6,930	2,720	6,770	4,090	5,560	2,500
8	......	......	......	5,870	4,610	9,420	6,770	3,040	6,460	3,840	5,840	......
9	......	......	......	5,300	4,510	9,730	6,460	4,340	6,140	3,600	5,840	......
10	......	......	......	5,740	4,320	9,940	6,300	4,600	5,700	3,380	5,700	......
11	......	......	......	6,690	4,120	9,940	6,140	5,700	5,280	3,260	5,700	......
12	......	......	......	5,900	4,050	9,840	5,840	7,260	5,000	3,040	5,420	......
13	......	......	......	6,450	3,910	9,620	5,560	6,770	4,730	2,930	5,280	......
14	......	......	......	8 340	3,800	9,420	5,280	6,460	4,470	2,820	5,000	......
15	......	......	......	8,510	3,680	9,310	5,000	6,460	4,220	2,720	4,860	......
16	......	......	......	9,100	3,550	9,110	4,730	6,140	4,220	2,610	4,600	......
17	......	......	......	9,290	3,550	8,910	4,470	6,000	4,220	2,400	4,730	......
18	......	......	......	9,210	3,860	8,620	4,340	5,840	4,220	2,400	4,600	......
19	......	......	......	8,990	3,910	8,810	4,090	5,700	4,340	2,300	4,220	......
20	......	......	......	8,520	3,910	8,710	3,960	5,560	4,470	2,200	4,220	......
21	......	......	......	8,120	3,780	8,420	3,720	5,140	4,860	2,200	4,090	......
22	......	......	......	7,540	4,280	8,330	3,600	4,730	5,280	2,200	4,090	......
23	......	......	......	6,840	4,030	8,330	3,380	4,860	5,560	2,200	3,840	......
24	......	......	......	6,080	4,220	8,140	3,260	5,140	5,840	2,400	3,840	......
25	......	......	......	5,940	4,280	7,960	3,040	5,420	6,000	3,040	3,490	......
26	......	......	......	5,550	4,340	7,780	3,040	6,000	6,140	3,490	3,720	......
27	......	......	......	5,230	4,810	7,780	2,820	6,770	6,300	4,090	3,840	......
28	......	......	......	4,860	5,340	7,780	2,930	7,260	6,140	4,860	3,720	......
29	......	......	......	4,720	6,000	7,780	3,150	7,600	6,140	5,280	3,600	......
30	......	......	......	4,580	6,930	7,780	3,260	7,600	6,000	5,560	3,600	......
31	......	......	......	......	7,600	......	3,380	7,430	......	5,700	......	......
1907.[a]												
1	......	......	......	9,520	4,470	6,140	14,600	4,860	4,220	1,900	1,060	......
2	......	......	......	10,200	4,470	6,000	12,900	4,340	3,840	1,900	1,380	......
3	......	......	......	12,000	4,470	5,700	12,200	3,960	3,490	2,200	1,720	......
4	......	......	......	12,900	4,600	5,280	11,300	3,600	3,150	2,000	1,900	......
5	......	......	......	13,600	4,730	5,140	10,600	3,490	2,930	2,100	1,900	......
6	......	......	......	13,400	4,600	4,860	9,940	3,260	2,500	2,300	1,900	......
7	......	......	......	12,900	4,600	4,860	9,110	3,150	2,400	2,300	1,720	......
8	......	......	......	12,400	4,600	4,860	8,330	2,930	2,300	2,200	1,720	......
9	......	......	......	11,700	4,470	5,140	7,780	2,930	2,200	2,000	1,630	......
10	......	......	......	11,000	4,340	8,910	7,090	2,930	2,000	1,900	1,540	......
11	......	......	......	10,200	4,220	11,700	6,610	2,720	2,000	1,630	1,540	......
12	......	......	......	9,730	3,960	14,800	5,840	2,610	1,900	1,540	1,460	......
13	......	......	......	9,110	3,960	17,100	5,140	2,500	1,720	1,460	1,300	......
14	......	......	......	8,520	3,840	17,800	5,000	2,300	1,630	1,460	1,140	......
15	......	......	......	8,140	3,720	17,800	6,000	2,200	1,630	1,380	1,140	......
16	......	......	......	7,780	3,840	17,600	6,300	2,100	1,540	1,380	1,060	......
17	......	......	......	7,600	3,960	17,100	6,460	2,000	1,720	1,300	1,220	......
18	......	......	......	7,260	3,960	19,400	6,770	1,900	1,900	1,300	1,300	......
19	......	......	......	6,610	3,960	20,400	7,430	1,900	2,300	1,220	1,300	......
20	......	......	......	6,300	3,960	21,800	7,260	2,720	2,610	1,220	1,300	......
21	......	......	7,780	6,140	3,960	22,100	7,960	3,040	4,090	1,140	1,220	......
22	......	......	9,730	5,700	3,840	22,100	9,110	2,930	4,600	1,140	1,220	......
23	......	......	10,200	5,280	3,720	21,000	9,310	2,720	4,090	1,140	1,220	......
24	......	......	9,110	5,000	3,600	20,700	9,310	2,500	3,490	1,140	1,220	......
25	......	......	8,520	4,860	3,840	21,000	9,110	2,300	3,040	1,060	1,220	......
26	......	......	8,910	4,730	4,600	21,300	8,520	2,100	2,720	1,060	1,220	......
27	......	......	8,910	4,600	5,280	20,200	7,260	2,720	2,500	1,060	1,220	......
28	......	......	8,910	4,600	6,140	18,900	7,090	3,720	2,200	1,060	1,220	......
29	......	......	9,110	4,470	6,300	17,600	6,460	4,220	2,100	1,060	1,220	......
30	......	......	9,110	4,470	6,460	16,100	6,000	4,340	2,000	1,060	1,220	......
31	......	......	9,310	......	6,300	......	5,420	4,220	......	1,060	......	......

[a] Daily discharge computed from a fairly well-defined rating curve, which is applied indirectly prior to May 20, 1906.

Daily discharge, in second-feet, of Minnesota River near Mankato, Minn., for 1903–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.[a]												
1	......	......	......	3,720	5,840	31,100	30,500	7,090	1,810	911	1,380	......
2	......	......	......	3,600	5,560	29,300	29,000	6,610	1,630	911	1,380	......
3	......	......	......	3,490	5,420	26,900	26,900	6,140	1,540	987	1,300	......
4	......	......	......	3,600	5,000	23,500	24,600	5,840	1,460	987	1,300	......
5	......	......	......	3,600	5,280	22,100	22,900	5,280	1,460	987	1,300	......
6	......	......	......	3,490	4,470	21,000	23,200	4,730	1,380	987	1,220	......
7	......	......	......	3,600	4,220	20,400	23,200	4,470	1,300	987	1,220	......
8	......	......	......	3,600	4,220	19,900	22,400	4,220	1,220	987	1,140	......
9	......	......	......	3,600	4,220	18,600	21,800	3,960	1,220	987	1,060	......
10	......	......	......	3,490	4,220	18,100	21,300	3,960	1,140	987	987	......
11	......	......	......	3,490	3,960	17,100	19,900	3,380	1,060	911	911	......
12	......	......	......	3,380	3,960	16,400	18,100	3,260	1,060	911	835	......
13	......	......	......	3,600	3,720	15,800	17,400	3,150	987	911	835	......
14	......	......	......	3,600	3,840	14,800	16,400	2,930	987	911	835	......
15	......	......	......	3,380	5,000	13,900	15,400	2,820	987	911	835	......
16	......	......	4,340	3,380	6,140	13,100	14,400	2,820	987	911	835	......
17	......	......	4,600	3,380	6,930	12,200	14,100	2,720	987	835	835	......
18	......	......	4,220	3,490	7,960	12,000	14,400	2,610	987	835	835	......
19	......	......	4,090	3,960	8,910	12,400	15,100	2,610	987	835	835	......
20	......	......	3,840	4,200	9,520	12,400	14,800	2,500	911	835	835	......
21	......	......	4,090	4,200	12,000	16,400	13,600	2,400	911	911	835	......
22	......	......	3,960	4,090	16,100	16,800	12,400	2,300	911	911	835	......
23	......	......	3,840	3,840	18,100	27,500	11,000	2,200	911	911	835	......
24	......	......	3,960	3,720	17,600	34,900	9,520	2,100	911	987	835	......
25	......	......	3,840	3,840	18,600	43,200	8,330	2,000	911	987	835	......
26	......	......	3,720	4,340	19,200	43,800	7,260	1,900	911	1,060	835	......
27	......	......	3,720	4,600	19,700	41,600	8,910	1,810	835	1,140	835	......
28	......	......	3,720	5,420	21,800	38,700	9,110	1,900	835	1,140	835	......
29	......	......	3,720	5,840	24,600	36,500	9,520	2,100	835	1,140	835	......
30	......	......	3,600	5,840	31,100	33,000	8,910	2,100	911	1,220	835	......
31	......	......	3,490	......	32,000	......	7,600	2,000	......	1,300	......	......
1909.[b]												
1	......	......	......	29,900	7,600	7,070	14,000	1,440	925	695	585	......
2	......	......	......	28,700	8,340	7,780	14,000	1,300	865	695	640	......
3	......	......	......	27,200	8,150	8,720	14,000	1,240	865	640	640	......
4	......	......	......	26,000	8,150	9,120	13,500	1,170	865	585	640	......
5	......	......	......	24,900	7,960	9,320	12,600	1,100	805	585	1,820	......
6	......	......	......	24,000	7,600	9,520	11,500	1,040	805	530	1,820	......
7	......	......	......	23,200	7,070	9,120	10,600	985	750	530	1,660	......
8	......	......	......	21,500	6,560	8,720	9,730	985	750	475	1,520	......
9	......	......	......	19,900	5,920	8,340	8,530	985	750	475	1,370	......
10	......	......	......	18,600	5,310	7,960	7,780	985	750	530	1,240	......
11	......	......	......	17,100	4,730	7,600	7,070	925	750	585	1,100	......
12	......	......	......	16,600	4,310	7,420	6,400	1,100	750	585	1,100	......
13	......	......	......	16,400	4,040	7,780	5,610	1,240	750	585	1,100	......
14	......	......	......	15,900	3,650	8,340	5,310	1,520	750	640	1,520	......
15	......	......	......	15,400	3,520	8,530	4,730	1,370	750	695	2,000	......
16	......	......	7,240	14,400	3,520	7,960	4,450	2,540	750	695	2,950	......
17	......	......	7,240	13,700	3,520	8,340	4,040	2,950	695	695	3,170	......
18	......	......	7,420	12,600	3,650	7,960	3,650	2,840	695	695	2,840	......
19	......	......	7,600	12,100	3,900	7,780	3,780	2,540	695	695	2,950	......
20	......	......	7,960	11,700	3,900	7,420	3,900	2,350	640	640	3,060	......
21	......	......	8,150	11,000	3,900	6,900	3,650	2,260	640	640	3,060	......
22	......	......	8,340	10,600	3,900	6,240	2,440	2,000	750	640	3,060	......
23	......	......	8,720	10,200	3,650	6,080	2,840	1,820	750	640	3,060	......
24	......	......	10,800	9,730	3,520	6,900	2,540	1,590	750	640	3,170	......
25	......	......	15,900	9,320	3,520	7,070	2,350	1,520	805	640	3,170	......
26	......	......	18,400	8,920	3,650	6,560	2,170	1,440	865	640	3,170	......
27	......	......	20,700	8,150	5,610	7,960	1,820	1,300	805	585	3,650	......
28	......	......	28,400	7,960	4,590	9,730	1,820	1,240	805	585	4,040	......
29	......	......	31,400	7,420	5,310	12,100	1,740	1,100	805	585	5,610	......
30	......	......	31,400	7,600	5,760	13,300	1,590	1,100	750	585	5,920	......
31	......	......	30,800	......	6,400	......	1,520	985	......	585	......	......

[a] These discharges are based on a fairly well defined rating curve.

[b] Daily discharge computed from a fairly well defined rating curve. The estimates have been revised since they were published in "Report of Water Resources Investigation of Minnesota during 1909–10."

Daily discharge, in second-feet, of Minnesota River near Mankato, Minn., for 1903–1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910.[a]												
1	......	......	500	3,780	2,840	1,440	805	265	215	265	265	......
2	......	......	500	3,650	2,640	1,370	750	265	215	215	265	......
3	......	......	600	3,520	2,440	1,370	750	265	215	215	265	......
4	......	......	600	3,280	2,260	1,300	695	265	265	215	265	......
5	......	......	700	3,060	2,080	1,240	695	265	265	265	315	......
6	......	......	1,500	2,840	2,000	1,240	640	215	215	215	315	......
7	......	......	4,000	2,840	2,000	1,170	640	215	215	215	315	......
8	......	......	4,500	2,840	1,910	1,170	585	215	215	215	315	......
9	......	......	5,000	2,840	1,910	1,170	585	165	215	215	315	......
10	......	......	7,000	2,740	1,910	1,100	585	165	215	215	315	......
11	......	......	10,000	2,740	1,910	1,100	530	165	165	215	315	......
12	......	......	20,000	2,740	1,910	1,040	530	165	165	215	315	......
13	......	......	18,000	2,640	1,910	1,100	530	165	165	215	315	......
14	......	......	16,000	2,440	1,910	1,040	475	165	165	215	315	......
15	......	......	15,200	2,260	1,910	985	420	165	165	215	315	......
16	......	......	14,200	2,260	1,910	985	420	165	215	215	315	......
17	......	......	15,200	2,260	1,910	925	420	265	215	215	265	......
18	......	......	11,700	2,170	1,910	1,040	365	265	215	215	265	......
19	......	......	10,600	2,170	1,820	1,040	365	265	215	215	265	......
20	......	......	9,940	2,170	1,740	925	365	420	215	215	265	......
21	......	......	9,320	2,170	1,740	925	315	475	215	215	265	......
22	......	......	8.720	2,170	1,740	925	315	365	215	215	265	......
23	......	......	8,530	2,170	1,660	925	315	265	215	215	265	......
24	......	......	7,600	2,170	1,660	865	315	265	215	265	265	......
25	......	......	7,240	2,170	1,590	865	315	265	215	265	265	......
26	......	......	6,730	2,350	1,590	805	265	265	265	265	265	......
27	......	......	6,240	2,540	1,520	805	265	265	265	265	265	175
28	......	......	5,760	2,640	1,520	805	265	265	265	265	265	......
29	......	......	5,160	2,840	1,520	805	265	265	265	265	265	......
30	......	......	4,870	3,060	1,440	805	265	215	265	265	265	......
31	......	......	4,590	......	1,440	......	265	215	......	265	......	......

[a] Daily discharge computed from a fairly well-defined rating curve. The estimates have been revised since they were published in "Report of Water Resources Investigation of Minnesota during 1909–10."

Monthly discharge of Minnesota River near Mankato, Minn., for 1903–1910.

[Drainage area, 14,600 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1903.						
May (20–31)	38,700	7,560	18,900	1.29	0.58	C.
June	27,200	2,440	6,980	.478	.53	B.
July	6,960	2,980	5,110	.350	.40	B.
August	5,460	2,490	3,430	.235	.27	B.
September	27,300	2,980	10,200	.699	.78	B.
October	20,500	3,770	9,430	.646	.74	B.
November	3,650	970	2,000	.137	.15	B.
December	1,340	1,160	1,210	.083	.10	C.
1904.						
January	1,160	560	687	.047	.05	C.
February	....	....	[a] 500	.034	.04	D.
April	7,740	2,540	5,130	.351	.39	B.
May	4,760	1,460	2,740	.188	.22	B.
June	3,040	1,420	2,120	.145	.16	B.
July	1,940	950	1,310	.090	.10	B.
August	1,102	540	751	.051	.06	B.
September	910	470	591	.040	.04	B.
October	1,050	470	701	.048	.06	B.
November	870	625	733	.050	.06	B.
December	....	....	[a] 460	.032	.04	C.

[a] Estimated.

Monthly discharge of Minnesota River near Mankato, Minn., for 1903–1910—Continued.

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1905.						
January			[a] 300	0.021	0.02	D.
February			[a] 400	.027	.03	D.
March	5,620	1,730	3,640	.249	.29	C.
April	3,520	1,180	2,330	.160	.18	B.
May	11,900	1,180	5,820	.399	.46	B.
June	4,900	2,160	3,220	.221	.25	B.
July	18,600	3,650	9,430	.646	.74	B.
August	3,460	1,380	2,160	.148	.17	B.
September	2,930	1,220	1,550	.106	.12	B.
October	1,420	1,060	1,270	.087	.10	B.
November	1,950	1,220	1,640	.112	.12	B.
December			[a] 1,250	.086	.10	C.
The year			2,750	.188	2.58	
1906.						
April	9,290	4,580	6,590	.451	.50	C.
May	7,600	3,550	4,560	.312	.36	C.
June	9,940	7,780	8,680	.595	.66	C.
July	7,600	2,820	5,020	.344	.40	B.
August	7,600	2,720	5,250	.360	.42	B.
September	7,090	4,220	5,680	.389	.43	B.
October	5,700	2,200	3,630	.249	.29	B.
November	5,840	3,490	4,780	.327	.36	B.
1907.						
March (21–31)	10,200	7,780	9,050	.620	.25	C.
April	13,600	4,470	8,360	.573	.64	C.
May	6,460	3,600	4,480	.307	.35	C.
June	22,100	4,860	14,400	.986	1.10	B.
July	14,600	5,000	8,140	.558	.64	B.
August	4,860	1,900	3,010	.206	.24	B.
September	4,600	1,540	2,630	.180	.20	B.
October	2,300	1,060	1,510	.103	.12	B.
November	1,900	1,060	1,380	.094	.10	B.
1908.						
March (16–31)	4,600	3,490	3,920	.268	.16	C.
April	5,840	3,380	3,910	.268	.30	C.
May	32,000	3,720	10,900	.747	.86	C.
June	43,800	12,000	23,400	1.60	1.78	C.
July	30,500	7,260	16,500	1.13	1.30	C.
August	7,090	1,810	3,350	.229	.26	C.
September	1,810	835	1,100	.075	.08	C.
October	1,300	835	975	.067	.08	C.
November	1,380	835	969	.066	.07	C.
1909.						
March (16–31)	31,400	7,240	15,700	1.08	.64	C.
April	29,900	7,420	16,000	1.10	1.23	C.
May	8,340	3,520	5,200	.356	.41	C.
June	13,300	6,080	8,250	.565	.63	C.
July	14,000	1,520	6,120	.419	.48	C.
August	2,950	925	1,510	.103	.12	C.
September	925	640	769	.053	.06	C.
October	695	475	613	.042	.05	C.
November	5,920	585	2,390	.164	.18	C.
1910.						
January			[a] 800	.055	.06	D.
February			[a] 575	.039	.04	C.
March	20,000	500	7,760	.532	.61	B.
April	3,780	2,170	2,650	.182	.20	B.
May	2,840	1,440	1,880	.129	.15	B.
June	1,440	805	1,040	.071	.08	B.
July	805	265	462	.032	.04	B.
August	475	165	246	.017	.02	B.
September	265	165	218	.015	.02	B.
Octboer	265	215	231	.016	.02	B.
November	315	265	285	.020	.02	B.
December			[a] 220	.015	.02	C.
The year	20,000		1,370	.094	1.28	

[a] Estimated.

WHETSTONE RIVER NEAR BIG STONE, S. DAK.

Whetstone River enters Minnesota River a short distance below Big Stone Lake. Owing to the character of its drainage basin, which lies almost wholly in the northeastern part of South Dakota, it is a very flashy stream, having very little flow except in the spring and after heavy rain. It has no tributaries near its mouth. The drainage area of the Whetstone River is 441 square miles.

The gaging station, which is located at the State Line bridge, one-fourth of a mile southeast of Big Stone, S. Dak., was established September 18, 1909.

From December to March the relation between gage heights and discharge is affected by ice, and during that time observations are discontniued.

The station has not yet been completely rated, so no estimates of daily discharge are given.

From April 15, 1899, to May 14, 1904, records of flow were maintained by the United States Engineer Corps near the site of the present station. These records have been published in "Report of water resources investigations of Minnesota during 1909–10," by the State drainage commission, St. Paul, Minn.

Discharge measurements of Whetstone River at Big Stone, S. Dak., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 25	G. A. Gray	38	94.6	3.80	14.2
Aug. 16	C. J. Emerson	11	5.9	3.80	9.7
Sept. 18	G. A. Gray	13	5.0	.65	5.0
1910.					
Mar. 15	G. A. Gray	72	249	4.66	399
Apr. 15	do	32	40.5	1.40	65.6
29	Robert Follansbee	32	73.6	3.10	170

NOTE.—After Sept. 18, 1909, inclusive, the gage heights refer to a different gage and section.

Daily gage height, in feet, of Whetstone River at Big Stone, S. Dak., for 1910.

[F. W. Thorndike, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		1.85	2.7	1.0	0.6	0.5	0.6	0.7	0.7
2		1.75	2.55	1.0	.5	.5	.6	.7	.7
3		1.8	2.2	1.0	.5	.5	.6	.7	.7
4		1.8	2.05	.9	.5	.5	.6	.65	.8
5		1.7	2.0	.9	.6	.5	.6	.6	.8
6		1.6	1.9	.9	.6	.5	.6	.6	.8
7		1.6	1.9	.9	.6	.5	.6	.6	.8
8	a11.6	1.6	1.8	.9	.6	.5	.5	.55	.8
9		1.6	1.8	1.1	.6	.5	.5	.5	.85
10		1.55	1.8	1.2	.6	.5	.5	.5	.8
11		1.45	1.7	1.2	.6	.5	.5	.5	1.05
12		1.4	1.6	1.3	.6	.5	.5	.5	.85
13		1.35	1.6	1.3	.6	.6	.5	.5	.85
14		1.3	1.5	1.2	.6	.6	.5	.5	.85
15		1.35	1.4	1.1	.6	.6	.5	.5	.8

a High-water mark.

Daily gage height, in feet, of Whetstone River at Big Stone, S. Dak., for 1910—Contd.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
16	3.75	1.55	1.4	1.0	0.6	0.7	0.5	0.5	1.00
17	3.45	1.55	1.4	.9	.6	.7	.5	.55	.85
18	3.2	1.4	1.4	.9	.5	.7	.5	.6	.8
19	3.05	1.45	1.4	.8	.5	.7	.5	.8	.95
20	3.0	1.55	1.3	.7	.5	.7	.5	.9	.8
21	2.9	2.5	1.3	.7	.5	.7	.5	.9	1.05
22	2.8	8.5	1.3	.6	.5	.7	.5	.9	.85
23	2.65	7.45	1.3	.6	.5	.7	.5	.8	.9
24	2.5	4.9	1.2	.5	.5	.7	.5	.8	.95
25	2.35	4.15	1.2	.5	.5	.6	.55	.8	.8
26	2.25	3.8	1.2	.75	.5	.6	.75	.8	.85
27	2.1	3.6	1.15	.9	.5	.6	.8	.8	.9
28	2.0	3.35	1.1	.75	.5	.6	.8	.7	.9
29	1.95	3.1	1.1	.7	.5	.6	.8	.7	.9
30	2.0	2.85	1.1	.65	.5	.6	.8	.7	.9
31	1.9	....	1.0	....	.5	.6	....	.7	....

NOTE.—Ice present from Jan. 1 to Mar. 7 and from Dec. 1 to 31.

LAC QUI PARLE RIVER AT LAC QUI PARLE, MINN.

Lac Qui Parle River rises in a small lake in the southeastern part of Deuel County, S. Dak., and flows northeastward into the Minnesota in sec. 24, T. 118 N., R. 42 W.

The gaging station, which is located at the highway bridge at the discontinued post office of Lac Qui Parle, in sec. 26, T. 118 N., R. 42 W., was established April 27, 1910, in connection with a general study of the run-off of the Minnesota basin.

The nearest tributary, Threemile Creek, enters the river a short distance below Lac Qui Parle. The drainage area above the station is 677 square miles and above the mouth 739 square miles.

There are no dams on the river which control the flow at the present time.

As the station has not been established sufficiently long to be rated no estimates of flow have been made and only the base data are given.

Records are discontinued from December to March, during which period the river is frozen over.

The gage is located at the bridge and measurements made at the same section.

Discharge measurements of Lac Qui Parle River at Lac Qui Parle, Minn., for 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 27	Robert Follansbee	46	181	3.53	278
July 8	....do	40	74.7	1.13	17.6

Daily gage height, in feet, of Lac Qui Parle River at Lac Qui Parle, Minn., in 1910.

[Chas. A. Gould, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		2.82	1.45	1.38	0.70	0.70	0.85	0.90
2		2.72	1.42	1.28	.72	.70	.85	.88
3		2.62	1.38	1.23	.80	.70	.90	.90
4		2.52	1.38	1.18	.75	.70	.90	1.00
5		2.42	1.38	1.13	.80	.70	.85	1.00
6		2.35	1.40	1.63	.75	.70	.80	1.10
7		2.30	1.42	1.23	.70	.70	.82	1.00
8		2.28	1.42	1.18	.70	.70	.82	.95
9		2.22	1.52	1.13	.70	.70	.80	.90
10		2.18	1.72	1.13	.70	.68	.78	.80
11		2.12	2.02	1.08	.70	.68	.75	.92
12		2.08	2.72	1.18	.65	.65	.75	1.00
13		2.02	2.82	1.18	.72	.68	.75	.90
14		1.98	2.62	1.18	.70	.65	.75	.95
15		1.92	2.38	1.13	.80	.70	.75	.90
16		1.92	2.18	1.13	.85	.68	.75	
17		1.98	1.98	1.08	1.15	.68	.75	
18		1.98	1.78	1.06	1.05	.68	.75	
19		1.98	1.62	.98	.95	.68	.90	
20		2.08	1.52	.93	.90	.68	.82	
21		2.00	1.48	.88	.95	.68	.80	
22		1.95	1.38	.86	1.00	.70	.80	
23		1.92	1.32	.83	.90	.70	.85	
24		1.85	1.28	.80	.95	.70	.90	
25		1.78	1.22	.78	.90	.70	.90	
26		1.72	1.22	.76	.85	.80	.90	
27	3.52	1.68	1.22	.73	.80	.80	.90	
28	3.40	1.62	1.22	.78	.80	.82	.90	
29	3.22	1.58	1.32	.73	.75	.85	.90	
30	3.08	1.50	1.38	.73	.80	.90	.90	
31		1.48		.73	.75		.90	

NOTE.—*Ice present from Nov. 16 to Dec. 31.*

CHIPPEWA RIVER NEAR WATSON, MINN.

Chippewa River rises in T. 131 N., R. 38 W., in Ottertail County, flows southward through Lakes Moses, Aaron, Stowe, and Long, and enters Minnesota River at Montevideo.

The gaging station, which is located at the highway bridge about 2½ miles northeast of Watson, on line between secs. 10 and 15, T. 118 N., R. 41 W., was established July 6, 1909. The records of flow will be of value in devising means for flood prevention.

No important tributary enters between the station and the mouth of the river, about 10 miles distant. Dry Weather Creek enters the Chippewa about 2 miles above the station.

A water-power plant at Montevideo utilizes a head of 7 feet, but the backwater from the dam does not extend to the gaging station. The first dam above the station is at Hagan, but the effect of the control is unappreciable at Watson.

From December to March observations are suspended because of ice.

Since the installation of the gage its datum has remained unchanged.

During 1910 conditions were favorable for accurate results, and therefore the records may be considered reliable.

Discharge measurements of Chippewa River near Watson, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 13	G. A. Gray	116	381	a 8.22	474
23	C. J. Emerson	114	306	7.95	675
Apr. 14	G. A. Gray	88	154	6.18	253
July 8	Robert Follansbee	37	33.5	4.26	14.4

a Backwater from ice jam.

Daily gage height, in feet, of Chippewa River near Watson, Minn., for 1910

[Clifford Bonde, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		6.78	5.20	4.31	4.00	4.00	4.32	4.30
2		6.56	5.12	4.28	4.05	4.00	4.28	4.40
3		6.46	5.08	4.26		4.02	4.32	4.35
4		6.36	5.08	4.31	3.98		4.28	4.35
5		6.22	5.08	4.28	3.92	4.02	4.25	4.32
6		6.10	5.10	4.51	3.92	4.00	4.20	4.35
7		6.00	5.08	4.41	3.90	4.02	4.25	4.30
8		5.98	5.02	4.28	3.90	3.98	4.20	4.32
9		5.88	5.08	4.28	3.90	3.95	4.18	4.32
10	6.50	5.82	5.08		3.98	3.95	4.18	4.28
11	6.51	5.75	5.08		3.95	3.92	4.25	
12	6.42	5.65	5.08	4.42	3.92	3.98	4.22	
13	6.28	5.60	5.02	4.40	4.00	3.98	4.20	
14	6.19	5.58	4.90	4.35	3.95	3.95	4.15	
15	6.52	5.55	4.85	4.32	4.08	3.98	4.18	
16	6.82	5.52	4.78	4.30	4.10	3.98	4.15	
17	6.82	5.65	4.75	4.25	4.10	3.95		
18	6.70	5.65	4.70	4.20	4.00		4.10	
19	7.52	5.62	4.65	4.15	4.00	3.95	4.15	
20	7.92	6.00	4.60	4.10	4.30	3.92	4.30	
21	7.98	6.00	4.50	4.10	4.18	3.90	4.28	
22	8.00	5.98	4.45	4.08	4.10	3.90	4.30	
23	7.68	5.98	4.42	4.05	4.10	3.90	4.30	
24	7.78	5.90	4.40	4.08	4.10	3.90	4.30	
25	7.82	5.78	4.42	4.05	4.10	4.10	4.35	
26	7.85	5.70	4.40	4.10	4.10	4.20	4.35	
27	7.68	5.60	4.35	4.08	4.08	4.15	4.35	
28	7.45	5.48	4.35	4.05	4.08	4.12	4.30	
29	7.18	5.48	4.30	4.02	4.05	4.08	4.22	
30	6.95	5.38	4.28	4.00	4.10	4.00	4.25	
31		5.25		3.95	4.05		4.20	

NOTE.—Ice present from Nov. 11 to Dec. 31.

Daily discharge, in second-feet, of Chippewa River near Watson, Minn., for 1910.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		384	92	15	12	12	15	15
2		336	81	15	12	12	15	17
3		315	75	15	12	12	15	16
4		294	75	15	12	12	15	16
5		266	75	15	11	12	14	15
6		243	78	20	11	12	14	16
7		224	75	17	11	12	14	15
8		220	68	15	11	12	14	15
9		202	75	15	11	12	14	15
10	323	192	75	16	12	12	14	15
11	325	180	75	17	12	11	14	
12	306	162	75	18	11	12	14	
13	278	154	68	17	12	12	14	
14	260	151	53	16	12	12	14	
15	327	146	48	15	13	12	14	

Daily discharge, in second-feet, of Chippewa River near Watson, Minn., for 1910—Contd.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
16	392	141	40	15	13	12	14	
17	392	162	37	14	13	12	13	
18	366	162	32	14	12	12	13	
19	555	157	28	14	12	12	14	
20	651	224	25	13	15	11	15	
21	665	224	20	13	14	11	15	
22	670	220	18	13	13	11	15	
23	593	220	18	12	13	11	15	
24	617	206	17	13	13	11	15	
25	627	185	18	12	13	13	16	
26	634	171	17	13	13	14	16	
27	593	154	16	13	13	14	16	
28	538	135	16	12	13	13	15	
29	474	135	15	12	12	13	14	
30	422	119	15	12	13	12	14	
31		100		12	12		14	

NOTE.—Daily discharges computed from a well-defined rating curve.

Monthly discharge of Chippewa River near Watson, Minn., for 1910.

[Drainage area, 1,940 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
April (10–30)	670	260	477	0.246	0.19	B.
May	384	100	199	.103	.12	A.
June	92	15	47.3	.024	.03	A.
July	20	12	14.5	.0075	.009	A.
August	15	11	12.3	.0063	.007	A.
September	14	11	12.0	.0062	.007	B.
October	16	13	14.5	.0075	.009	B.
November (1–10)	17	15	15.5	.0079	.003	B.

REDWOOD RIVER NEAR REDWOOD FALLS, MINN.

Redwood River rises in T. 108 N., R. 44 W., in Pipestone County and flows northeastward into Minnesota River in T. 113 N., R. 35 W. Its chief tributary is Threemile Creek. Before emptying into the Minnesota, Redwood River falls 80 feet or more at Redwood Falls. This fall has been utilized in lighting that city.

The gaging station, which is located about 3 miles above Redwood Falls at the first highway bridge, was established July 2, 1909, as part of the general plan for investigating the water resources of the Minnesota.

During all stages except low, discharge measurements are made from the bridge; low-water measurements are made by wading at different sections.

The nearest dam, that at Redwood Falls, creates a pond that extends upstream for a considerable distance, but rapids just below the gaging station prevent backwater effects at the gage.

Observations are discontinued from December to March because of ice.

The gage datum has remained unchanged since the gage was established.

Conditions at this station are favorable for excellent results and the records should therefore be reliable.

Discharge measurements of Redwood River near Redwood Falls, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		Feet.	Sq. ft.	Feet.	Sec.-ft.
July 2	Robert Follansbee	88	370	4.20	781
22	G. A. Gray	77	256	2.85	222
Aug. 13[a]	C. J. Emerson	34	57.6	2.18	50.0
1910.					
Mar. 21	C. J. Emerson	80	248	2.86	220
July 6[a]	Robert Follansbee	24	19.1	2.03	21.0
Aug. 19	do			1.71	[b] 4.0

[a] Wading section. [b] Estimated.

Daily gage height, in feet, of Redwood River near Redwood Falls, Minn., for 1910.

[Wallace Stewart, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		2.42	2.22	1.90	1.92	1.70	1.75	1.90	1.95
2		2.40	2.20	1.90	1.88	1.70	1.72	1.92	1.98
3		2.40	2.18	1.90	1.88	1.70	1.72	1.98	1.95
4		2.40	2.10	1.90	1.85	1.70	1.70	2.00	1.92
5		2.40	2.10	1.90	1.85	1.70	1.70	2.00	1.90
6		2.40	2.08	1.90	1.82	1.70	1.70	2.00	1.90
7		2.38	2.02	1.90	1.80	1.70	1.70	2.00	1.90
8		2.38	2.08	1.92	1.80	1.70	1.68	1.98	1.92
9		2.35	2.05	2.00	1.85	1.70	1.68	1.95	1.92
10		2.30	2.05	2.08	1.80	1.70	1.68	1.90	1.90
11		2.30	2.05	2.18	1.80	1.70	1.70	1.92	1.90
12		2.28	2.02	2.25	1.85		1.70	1.92	1.92
13		2.30	2.05	2.30	1.85		1.70	1.90	
14		2.28	2.00	2.25	1.85		1.68	1.90	
15			2.00	2.20	1.82		1.68	1.90	
16			2.00	2.15	1.80		1.70	1.88	
17		2.30	2.05	2.10	1.80		1.75	1.90	
18		2.35	2.00	2.00	1.80		1.75	1.90	
19		2.45	2.00	1.98	1.80	1.72	1.78	1.90	
20		2.40	2.10	1.98	1.80	1.75	1.80	1.98	
21		2.40	2.05	1.98	1.75	1.75	1.80	2.02	
22		2.45	2.00	1.90	1.75	1.75	1.82	2.10	
23		2.45	2.30	1.85	1.75	1.72	1.82	2.08	
24		2.45	2.28	1.85	1.75	1.72	1.82	2.05	
25	2.65	2.45	2.18	2.25	1.70	1.72	1.82	2.02	
26	2.52	2.40	2.10	2.05	1.70	1.72	1.85	2.00	
27	2.52	2.35	2.05	1.90	1.70	1.70	1.82	1.95	
28	2.58	2.32	2.00	1.95	1.70	1.70	1.80	1.92	
29	2.42	2.30	2.00	2.08	1.70	1.70	1.80	1.90	
30	2.42	2.25	1.98	2.08	1.70	1.78	1.85	1.92	
31	2.42		1.92		1.70	1.75		1.92	

NOTE.—Ice present from Nov. 13 to Dec. 31.

Daily discharge, in second-feet, of Redwood River near Redwood Falls, Minn., for 1909–10.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.									
1	....	....	....	....	....	58	33	14	21
2	....	....	....	....	772	52	33	12	18
3	....	....	....	....	720	54	35	12	16
4	....	....	....	....	641	50	32	12	16
5	....	....	....	....	596	50	26	12	16
6	....	....	....	....	538	42	26	12	18
7	....	....	....	....	504	42	26	12	18
8	....	....	....	....	500	40	25	12	18
9	....	....	....	....	454	40	25	15	18
10	....	....	....	....	430	40	23	14	18
11	....	....	....	....	330	40	21	14	18
12	....	....	....	....	338	48	25	14	18
13	....	....	....	....	402	47	23	14	20
14	....	....	....	....	375	65	20	14	20
15	....	....	....	....	308	130	19	14	20
16	....	....	....	....	272	158	16	14	20
17	....	....	....	....	258	176	16	16	20
18	....	....	....	....	279	185	16	14	20
19	....	....	....	....	268	201	17	14	20
20	....	....	....	....	240	207	16	14	42
21	....	....	....	....	224	201	16	14	50
22	....	....	....	....	188	185	17	14	50
23	....	....	....	....	156	161	16	16	50
24	....	....	....	....	133	130	16	16	33
25	....	....	....	....	120	107	16	14	42
26	....	....	....	....	107	92	16	14	50
27	....	....	....	....	92	78	16	14	50
28	....	....	....	....	80	65	16	12	50
29	....	....	....	....	65	54	14	12	50
30	....	....	....	....	65	48	14	13	50
31	....	....	....	....	67	40	....	14	....
1910.									
1	....	97	54	12	14	4	5.5	12	16
2	....	92	50	12	11	4	4.6	14	18
3	....	92	47	12	11	4	4.6	18	16
4	....	92	33	12	9.5	4	4	20	14
5	....	92	33	12	9.5	4	4	20	12
6	....	92	30	12	8	4	4	20	12
7	....	88	23	12	7	4	4	20	12
8	....	88	30	14	7	4	3.5	18	14
9	....	80	26	20	9.5	4	3.5	16	14
10	....	69	26	30	7	4	3.5	12	12
11	....	69	26	47	7	4	4	14	12
12	....	65	23	60	9.5	4	4	14	14
13	....	69	26	69	9.5	4	4	12	....
14	....	65	20	60	9.5	4	3.5	12	....
15	....	66	20	50	8	4	3.5	12	....
16	....	68	20	42	7	4	4	11	....
17	....	69	26	33	7	4	5.5	12	....
18	....	80	20	20	7	4	5.5	12	....
19	....	104	20	18	7	4.6	6.4	12	....
20	....	92	33	18	7	5.5	7	18	....
21	....	92	26	18	5.5	5.5	7	23	....
22	....	104	20	12	5.5	5.5	8	33	....
23	....	104	69	9.5	5.5	4.6	8	30	....
24	....	104	65	9.5	5.5	4.6	8	26	....
25	158	104	47	60	4	4.6	8	23	....
26	122	92	33	26	4	4.6	9.5	20	....
27	122	80	26	12	4	4	8	16	....
28	139	73	20	16	4	4	7	14	....
29	97	69	20	30	4	4	7	12	....
30	97	60	18	30	4	6.4	9.5	14	....
31	97	....	14	....	4	5.5	....	14	....

NOTE.—Daily discharge computed from a fairly well-defined rating curve.

Monthly discharge of Redwood River near Redwood Falls, Minn., for 1909-10.

[Drainage area, 703 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
July (2-31)	772	65	317	0.451	0.50	A.
August	207	40	93.1	.132	.15	A.
September	35	14	21.0	.030	.03	A.
October	16	12	13.6	.019	.02	B.
November	50	16	29.0	.041	.05	B.
1910.						
March (25-31)	158	97	119	.169	.04	B.
April	104	60	83.7	.119	.13	A
May	69	14	30.5	.043	.05	A.
June	69	9.5	26.3	.037	.04	A.
July	14	4.0	7.16	.010	.01	A.
August	6.4	4.0	4.37	.0062	.007	B.
September	9.5	3.5	5.62	.0080	.009	B.
October	33	12	16.9	.024	.03	B.
November (1-12)	18	12	13.8	.020	.009	B.

COTTONWOOD RIVER NEAR NEW ULM, MINN.

Cottonwood River rises in Black Rush Lake, in T. 110 N., R. 42 W., Lyon County, and flows eastward into the Minnesota near New Ulm.

The gaging station, which is located at the Alwin highway bridge, about 2 miles southwest of New Ulm, in sec. 31, T. 110 N., R. 30 W., and about 3½ miles above the mouth of the river, was established July 2, 1909, in accordance with the general plan of studying the water resources of the Minnesota River basin.

The nearest important tributary, Sleepy Eye Creek, enters the river 15 miles above the station.

The dam of the Cottonwood Roller Mill, 2 miles below the station, prevents any possible effect of backwater from the Minnesota reaching the gage. Though the dam itself may be the control for the station, the low-water records show no systematic variation which would indicate such control.

Observations of flow are suspended from December to March because of ice.

Discharge measurements are made from the bridge to which the chain gage is attached.

On August 12, 1909, the datum of the gage was lowered 2.28 feet. All readings prior to that date have been corrected and all gage heights apply to the new datum.

Although the channel changed somewhat during 1910, this change was slight until the latter part of the year, and as the rating table was applied indirectly during that period it is believed the estimates are good.

Discharge measurements of Cottonwood River near New Ulm, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 20	C. J. Emerson	123	238	3.82	610
July 5	Robert Follansbee	48	38.6	1.56	39.0
5	....do	48	38.6	1.56	40.9
Oct. 28	C. J. Emerson	48	29.1	1.42	19.4

Daily gage height, in feet, of Cottonwood River near New Ulm, Minn., for 1910.

[Miss Ester Alwin, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		2.69	2.12	1.74	1.79	1.36	1.28	1.28	1.42
2		2.62	2.01	1.72	1.74	1.38	1.25	1.28	1.42
3		2.59	1.99	1.72	1.65	1.40	1.21	1.30	1.42
4		2.53	1.96	1.70	1.61	1.36	1.20	1.33	1.36
5		2.47	1.94	1.70	1.69	1.28	1.22	1.30	1.26
6		2.42	1.90	1.74	1.68	1.25	1.25	1.30	1.29
7		2.37	1.90	1.73	1.56	1.36	1.25	1.30	1.36
8		2.34	1.87	1.74	1.52	1.38	1.24	1.30	1.41
9		2.29	1.87	1.84	1.59	1.35	1.21	1.30	1.42
10		2.28	1.85	2.04	1.59	1.35	1.18	1.30	1.34
11	8.68	2.20	1.85	2.20	1.56	1.32	1.18	1.32	1.49
12	5.44	2.19	1.83	2.60	1.55	1.30	1.25	1.33	1.49
13	5.21	2.17	1.83	2.88	1.52	1.34	1.22	1.33	1.46
14	4.81	2.10	1.84	2.56	1.55	1.34	1.22	1.33	1.48
15	4.60	2.12	1.85	2.44	1.52	1.36	1.25	1.33	1.48
16	4.44	2.10	1.90	2.31	1.51	1.38	1.25	1.33	1.49
17	4.24	2.14	1.99	2.20	1.49	1.35	1.22	1.33	1.52
18	4.08	2.30	2.03	2.10	1.46	1.34	1.20	1.33	1.62
19	3.98	2.44	2.01	1.94	1.45	1.35	1.20	1.33	1.66
20	3.78	2.40	2.01	1.88	1.42	1.40	1.20	1.36	1.58
21	3.72	2.43	2.04	1.86	1.42	1.38	1.24	1.40	1.58
22	3.58	2.53	2.07	1.82	1.40	1.38	1.22	1.39	1.62
23	3.46	2.56	2.04	1.80	1.39	1.38	1.22	1.38	1.49
24	3.38	2.50	2.00	1.77	1.38	1.35	1.25	1.39	1.42
25	3.29	2.47	1.99	1.74	1.38	1.35	1.26	1.40	1.45
26	3.08	2.40	1.93	1.69	1.35	1.32	1.30	1.42	1.44
27	3.02	2.29	1.91	1.66	1.36	1.31	1.35	1.43	1.41
28	2.92	2.24	1.83	1.65	1.38	1.30	1.32	1.43	1.42
29	2.86	2.18	1.82	1.78	1.36	1.29	1.32	1.42	1.46
30	2.80	2.13	1.80	1.82	1.35	1.29	1.30	1.40	1.51
31	2.74		1.77		1.32	1.30		1.40	

NOTE.—Ice present from Jan. 1 to Mar. 10 and from Dec. 1 to 31.

Daily discharge, in second-feet, of Cottonwood River near New Ulm, Minn., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		224	112	61	67	20	11	9	19
2		207	96	58	61	21	10	9	19
3		200	93	58	51	22	8	10	19
4		187	88	56	47	20	7	11	15
5		174	86	56	55	15	8	10	8
6		164	80	61	54	14	10	10	10
7		155	80	60	42	20	10	10	15
8		149	76	61	38	21	10	10	18
9		140	76	73	45	19	8	10	19
10		139	74	100	45	19	6	10	14
11	3,250	125	74	125	37	17	6	11	27
12	1,380	123	72	202	36	16	10	11	27
13	1,260	120	72	275	34	18	8	11	23
14	1,060	109	73	193	36	18	8	11	26
15	965	112	74	168	34	20	10	11	26

Daily discharge, in second-feet, of Cottonwood River near New Ulm, Minn., for 1910—Continued.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
16	893	109	80	144	33	21	10	11	27
17	803	115	93	125	31	19	8	11	28
18	731	142	98	109	29	18	7	11	37
19	686	168	96	86	28	19	7	11	42
20	597	160	96	78	26	22	7	12	35
21	573	166	100	75	26	21	9	14	35
22	517	187	104	70	24	21	8	14	37
23	469	193	100	68	23	21	8	13	27
24	438	180	94	64	23	19	10	14	19
25	406	174	93	61	23	19	10	14	24
26	334	160	84	55	20	17	12	15	23
27	316	140	81	52	21	17	15	15	18
28	286	132	72	51	23	16	13	15	19
29	269	122	70	66	21	16	13	15	23
30	252	114	68	70	20	15	12	14	28
31	236	....	64	....	18	14	....	14	....

NOTE.—Daily discharge computed from a fairly well-defined rating curve. After July 10 the rating curve was applied indirectly.

Monthly discharge of Cottonwood River near New Ulm, Minn., for 1910.

[Drainage area, 1,190 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
March (11-31)	3,250	236	511	0.429	0.34	B.
April	224	109	297	.250	.28	B.
May	112	64	84.5	.071	.08	B.
June	275	51	92.7	.078	.09	B.
July	67	18	34.5	.029	.03	A.
August	22	14	18.5	.016	.02	B.
September	15	6	9.30	.008	.01	C.
October	15	9	11.8	.01	.01	B.
November	42	8	23.6	.02	.02	B.

BLUE EARTH RIVER AT RAPIDAN MILLS, MINN.

Blue Earth River rises in Kossuth County, Iowa, and flows northward into the Minnesota near Mankato.

The gaging station, which is located at Rapidan Mills, 2 miles west of Rapidan, in sec. 8, T. 107 N., R. 27 W., and 9 miles above the mouth of the river, was originally established, July 20, 1909, at the highway bridge at Rapidan Mills. On April 29, 1910, the bridge station was discontinued, owing to the erection of a dam just below the section which would completely submerge the bridge. At this time a new gage was installed a few hundred yards downstream and below the dam. A cable was erected from which measurements are made. This new station was installed in cooperation with the Consumers' Power Co., which has furnished the gage readings since September, 1910.

The records at this station not only furnish data in regard to the power available on Blue Earth River, but when used in connection with the records of the Minnesota near Mankato will indicate the discharge of Minnesota River above the Blue Earth, information essential in connection with flood-prevention work.

The nearest tributary of appreciable size is Watonwan River, which enters Blue Earth about 3 miles above the gaging station. Between the station and the mouth, Blue Earth River receives Le Sueur River, which drains an area comprising 1,160 square miles, but which at ordinary stages carries a very small run-off.

The river at the gaging station has a heavy fall, which is being utilized by the power plant, and although the dam is 56 feet high, it is stated that the backwater will not extend upstream more than 2 or 3 miles.

It was intended to maintain this station during the winter season of 1909–10, but ice gorging below the gage caused so much backwater and such unstable conditions that the records were discontinued.

On November 14, 1910, the gates in the new dam were closed to fill the reservoir, allowing only a small quantity of water to pass the gage. As this amount does not represent the true flow, observations were temporarily discontinued until the reservoir back of the dam is filled.

The rating table used prior to April 29, 1910, was fairly well defined and was applied directly, except during April, when shifting conditions made it necessary to be applied indirectly. The rating table for the present section is based on numerous weir measurements made during the lowest stages in addition to meter measurements at the higher stages, and therefore the records based on it should be excellent.

Discharge measurements of Blue Earth River near Rapidan Mills, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		Feet.	Sq. ft.	Feet.	Sec.-ft.
July 20	G. A. Gray	128	450	4.28	1,590
Aug. 11	C. J. Emerson	106	234	2.60	243
Sept. 12	G. A. Gray	95	193	2.05	143
1910.					
Mar. 19	C. J. Emerson	150	715	6.14	4,010
26	do	134	520	4.80	1,840
Apr. 4	Robert Follansbee	121	370	3.65	869
May 25[a]	G. A. Gray	174	374	1.65	209
June 16[a]	A. M. Rosenblatt	170	378	1.60	212
22[a]	do	170	298	1.24	113

[a] New station.

Daily gage height, in feet, of Blue Earth River at Rapidan Mills, Minn., for 1910.

[A. M. Rosenblatt, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	3.93	1.64	1.32	1.20	0.90	0.90	1.15	1.12
2	....	3.81	1.60	1.35	1.18	.95	.94	1.12	1.05
3	....	3.71	1.57	1.27	1.16	.98	.92	1.18	1.18
4	....	3.58	1.52	1.32	1.13	.86	.91	1.11	1.20
5	....	3.50	1.50	1.30	1.11	.92	.98	1.05	1.18
6	....	3.45	1.49	1.27	1.12	.82	1.00	.97	1.15
7	....	3.30	1.47	1.30	1.13	.87	.98	1.05	1.23
8	....	3.30	1.45	1.29	1.24	.84	1.00	.95	1.29
9	....	3.10	1.45	1.34	1.22	.82	.91	....	1.38
10	....	....	1.44	1.39	1.20	.83	.92	1.10	1.18
11	....	....	1.41	1.44	1.09	.90	.93	1.10	1.07
12	11.50	....	1.40	1.56	1.07	.90	1.00	1.10	1.05
13	....	....	1.40	1.66	1.02	.92	.90	1.10	....
14	....	....	1.41	1.76	1.03	.94	.85	1.10	....
15	8.60	2.95	1.40	1.71	1.04	1.02	1.04	1.10	....
16	7.90	2.90	1.42	1.60	1.10	1.04	.90	1.10	....
17	7.40	3.00	1.48	1.53	1.10	1.04	.87	1.20	....
18	7.20	2.95	1.47	1.46	1.02	.97	.88	1.15	....
19	6.80	2.97	1.52	1.40	1.01	1.00	1.12	1.15	....
20	5.90	3.00	1.52	1.36	.98	1.28	1.11	1.10	....
21	5.65	3.00	1.53	1.35	.95	1.15	1.12	1.12	....
22	5.45	3.05	1.57	1.24	1.05	1.04	.96	1.12	....
23	5.32	3.05	1.62	1.28	.94	1.00	1.09	1.10	....
24	5.15	3.15	1.63	1.20	1.02	.94	1.08	1.12	....
25	4.98	3.12	1.62	1.24	.98	.92	1.00	1.17	....
26	4.80	3.05	1.62	1.22	.98	.95	1.02	1.17	....
27	4.63	3.07	1.58	1.22	.98	.90	1.04	1.20	....
28	4.46	3.15	1.53	1.22	.90	.90	1.04	1.17	....
29	4.38	a 1.67	1.49	1.20	.93	.90	1.15	1.17	....
30	4.15	1.65	1.45	1.20	.88	.96	1.05	1.20	....
31	4.03	....	1.36	....	.93	.95	....	1.05	....

a New gage installed below dam.

NOTE.—Mar. 12-19 gage heights estimated from temporary gage and may be somewhat in error. From Nov. 13 to Dec. 31 flow controlled by dam above station.

Daily discharge, in second-feet, of Blue Earth River at Rapidan Mills, Minn., for 1909–10

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.a									
1	....	....	....	....	....	310	150	150	148
2	....	....	....	....	....	290	152	141	166
3	....	....	....	....	....	275	152	138	531
4	....	....	....	....	....	257	128	136	1,180
5	....	....	....	....	....	229	136	134	1,240
6	....	....	....	....	....	209	138	132	1,130
7	....	....	....	....	....	200	134	130	957
8	....	....	....	....	....	186	131	127	788
9	....	....	....	....	....	178	127	125	677
10	....	....	....	....	....	206	126	123	689
11	....	....	....	....	....	166	120	120	525
12	....	....	....	....	....	150	133	118	503
13	....	....	....	....	....	154	131	138	565
14	....	....	....	....	....	170	134	170	788
15	....	....	....	....	....	189	141	178	1,390
16	....	....	....	....	....	565	141	164	....
17	....	....	....	....	....	601	145	175	....
18	....	....	....	....	....	609	145	175	....
19	....	....	....	....	....	542	150	152	....
20	....	....	....	....	1,420	481	141	152	....
21	....	....	....	....	990	435	143	145	....
22	....	....	....	....	803	388	164	131	....
23	....	....	....	....	677	352	170	127	....
24	....	....	....	....	601	310	264	127	....
25	....	....	....	....	508	283	310	128	....

a Daily discharge computed from a well-defined rating curve.

Daily discharge, in second-feet, of Blue Earth River at Rapidan Mills, Minn., for 1909–10—Continued.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.									
26					455	249	271	120	
27					388	232	235	123	
28					348	213	209	123	
29					352	195	189	126	
30					352	181	173	123	
31					335	166		143	
1910.[a]									
1		1080	213	115	86	30	30	75	68
2		981	199	123	82	38	36	68	54
3		901	189	103	77	42	33	82	82
4		803	173	115	71	26	32	66	86
5		745	166	110	66	33	42	54	82
6		711	163	103	68	21	45	40	75
7		613	157	110	71	27	42	54	93
8		613	151	108	96	23	45	38	108
9		497	151	120	91	21	32	51	131
10		478	148	133	86	22	33	64	82
11		459	139	148	62	30	34	64	77
12	13100	440	136	186	58	30	45	64	54
13	10000	420	136	221	49	33	30	64	
14	9000	450	139	258	51	36	24	64	
15	8200	380	136	239	53	49	53	64	
16	7010	340	142	199	64	53	30	64	
17	6160	385	160	176	64	53	27	86	
18	5820	335	157	154	49	40	28	75	
19	5140	340	173	136	47	45	68	75	
20	3650	320	173	126	42	105	66	64	
21	3260	320	176	123	38	75	68	68	
22	2960	300	189	96	54	53	39	68	
23	2760	280	206	105	36	45	62	64	
24	2520	300	210	86	49	36	60	68	
25	2280	290	206	96	42	33	45	79	
26	2040	230	206	91	42	38	49	79	
27	1830	235	192	91	42	30	53	86	
28	1620	225	176	91	30	30	53	79	
29	1530	224	163	86	34	30	75	79	
30	1290	217	151	86	28	39	54	86	
31	1170		126		34	38		54	

[a] Daily discharges for 1910 are computed from two rating curves that were well defined at the lower stages, but not so well at the higher stages.

Monthly discharge of Blue Earth River at Rapidan Mills, Minn., for 1909–10.

[Drainage area, 2,260 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
July (20–31)	1420	335	602	0.266	0.12	A.
August	689	150	292	.129	.15	A.
September	310	120	163	.072	.08	A.
October	178	118	139	.062	.07	A.
November			[a] 700	.310	.35	C.
1910.						
March (12–31)	13100	1170	4570	2.02	1.50	C.
April	1080	217	462	.204	.23	B.
May	213	126	168	.074	.09	A.
June	258	86	131	.058	.06	A.
July	96	28	56.8	.025	.03	A.
August	105	21	38.8	.017	.02	A.
September	75	24	44.4	.020	.02	B.
October	86	38	67.3	.030	.03	B.
November (1–12)	131	54	82.6	.037	.02	B.

[a] Estimated.

ST. CROIX RIVER.

GENERAL FEATURES OF AREA DRAINED.

St. Cròix River, which forms throughout the greater part of its length the boundary between Minnesota and Wisconsin, drains an area 7,580 square miles in extent lying in eastern Minnesota and northwestern Wisconsin. The river rises at an elevation of 1,010 feet above sea level, in Lake St. Croix, on the Lake Superior divide, only 20 miles from Lake Superior, and flows southwest and then south till it joins the Mississippi opposite Hastings, Minn. In its total length of 160 miles it descends 338 feet, all but 20 feet in the upper 116 miles.

Its principal tributaries are Manakagon, Yellow, Apple, and Willow rivers from the Wisconsin side, and Tamarack, Kettle, Snake, and Sunrise rivers from the Minnesota side.

Almost the entire basin is so thickly covered with glacial drift that rock outcrops, except near the rivers, are very rare. Probably throughout the greater part of the area the drift is underlain by the pre-Cambrian crystalline rocks, whose intersection with the St. Croix near Taylors Falls, Minn., causes the fall and rapids that extended previously for 6 or 7 miles above that point.

The country for the most part is gently undulating and is deeply trenched by the larger rivers which have cut through the drift and into the underlying rock.

The upper section of the drainage basin is timbered, but much of the growth is merely brush, as logging was carried on extensively in the basin for many years. The lower part of the basin is largely under cultivation.

The annual rainfall is about 30 inches, of which 3½ inches are precipitated as snow, which remains during the winter months. The rivers are frozen over except at rapids from December to March, and the flow is very uniform, decreasing gradually up to midwinter, when it is a minimum. As there are no winter thaws the flow is derived from the lakes and from underground water, and these do not cause winter freshets.

In the Wisconsin portion of the basin lakes are much more numerous than elsewhere. Many of the lakes are without surface outlet, and many others have been dammed to control the outflowing stream for logging.

In the Minnesota portions the lakes comprise less than 1 per cent of the area, and, as logging is no longer carried on, few of these lakes are controlled.

The lakes afford excellent reservoir sites, which could be utilized at a comparatively low cost.

The following table[1] shows the elevation at different points of the St. Croix River, and thus indicates the possibility of power development.

Elevations and distances along St. Croix River.

Place.	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
Prescott	0	667
Kinnickinnic River	5	668
Apple River	28	672
Osceola	42	683
St. Croix Falls (head of navigation)	48	687
St. Croix Falls (crest of dam)	....	750
Trade River	60	753
Sunrise River	65	758
Rush City	75	773
Sec. 35, T. 38 N., R. 20 W	79	782
Snake River	86	790
Kettle River Rapids, foot	89	801
Kettle River	90	816
Kettle River Rapids, head	93	850
Clam River	101	868
Sec. 1, T. 40 N., R. 18 W	104	874
Yellow River	115	888
Namekagon River	127	908
Moose River	139	1,001
Sec. 35, T. 44 N., R. 13 W., below dam	144	1,001
Sec. 35, T. 44 N., R. 13 W., above dam	144	1,005
St. Croix Lake	160	1,010

Water power is developed at one point on the St. Croix River—at Taylors Falls—a head of 56 feet being utilized at a power plant having an installation of 26,000 horsepower.

St. Croix River is navigable from its mouth nearly to Taylors Falls, though little traffic is carried at present.

The United States Geological Survey has investigated the quality of the St. Croix water and published the results in Water-Supply Paper 193, entitled "The quality of surface waters in Minnesota." The only topographic sheet issued by the Survey for this basin is the St. Croix Dalles sheet, which covers the area in the vicinity of Taylors Falls.

The United States Engineer Corps made an examination of the St. Croix and its tributaries, and the results were published in House Document 39, Forty-sixth Congress, second session. The results of a second examination of the St. Croix, made in connection with the proposed Lake Superior and Mississippi canal, were published in House Document 330, Fifty-fourth Congress, first session.

KETTLE RIVER.

GENERAL FEATURES OF AREA DRAINED.

Kettle River, an important tributary of the St. Croix, drains an area in the eastern part of Minnesota, chiefly in Pine and Carlton counties. It rises in T. 49 N., R. 19 W., in Carlton County and flows

[1] From Water-Supply Paper U. S. Geol. Survey No. 156, p. 119.

southward into St. Croix River in T. 39 N., R. 19 W. Its chief tributaries are Moose, Willow, Moose Horn, Dead Moose, Split Rock, Pine, and Grindstone rivers. The following drainage areas have been measured in the basin:

Drainage areas in Kettle River basin.

	Square miles
Kettle River:	
Above Banning	825
Above mouth	1,030

The region is covered with red till—a mixture of sand and gravel and clay deposited by a glacier. In the northern part of the basin the drift is underlain by Archean greenstones and gneisses; in the southern part it rests on Cambrian sandstones, shales, and limestones.

Throughout the lower portion of its course Kettle River has cut through the drift into the sandstones, which yield water to the many springs found along the river.

The general surface of the basin is gently undulating, and the elevations range from 850 to 1,300 feet above sea level. The basin contains about 35 lakes, chiefly in its central part. The combined area of the lakes comprises less than 1 per cent of the drainage area.

The entire basin was originally densely forested, although it is now for the most part covered with brush. Much of the present growth consists of poplar and jack pine. Conditions are favorable for reproduction of the forest, as the forest fires which have occurred at various times have not seriously injured the soil. There is very little cleared land.

The mean annual precipitation in the basin ranges from 27 inches in the northern part to 29 inches in the southern. Of this amount 3½ inches falls as snow which remains on the ground during the winter months. Owing to its heavy fall, Kettle River does not freeze entirely over, but as there are no winter thaws the only source of supply is the ground water and the lakes, and the flow is therefore very uniform, decreasing slowly until midwinter, when it is at a minimum.

Most of the lakes in the Kettle River basin lie so far up on the headwaters that they receive insufficient run-off to make them valuable as storage reservoirs. On Pine Lake is a dam which forms a reservoir for the use of the power plant at Sandstone. Logging is no longer carried on in this basin. Owing to its undulating character, the basin contains little swamp land.

The fall of Kettle River is heavy throughout its course and affords opportunity for water-power development.

The following table, compiled largely from a survey made by the Kettle River Power Co., shows the elevation of the water surface at different points:

Elevations and distances along Kettle River.

Place.	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
St. Croix River	0	816
	1	821
Township line 39-40	3	846
	4	861
	5	871
	6	889
Range line 19-20	9	894
Foot of rapids	18	899
Township line 41-42	19	910
Kettle River Power Co., new dam tail-water	22	913
Kettle River Power Co., new dam headwater	22	938
Kettle River Power Co., old dam, Sandstone, tail-water	24	938
Banning wagon bridge	26	983
Sec. 11, T. 43 N., R. 22 W	29	1,000
Kettle River	34	1,016
Township line T. 45-46	46	1,050
Sec. 8, T. 46 N., R. 20 W	53	1,100
Sec. 9, T. 47 N., R. 20 W	62	1,200
Sec. 35, T. 48 N., R. 20 W	67	1,250
Source	79	1,300

At the present time power is developed at two points near Sandstone, where a 34-foot fall is utilized in obtaining an average of 630 horsepower. At Sandstone are the celebrated Kettle River quarries, from which large quantities of building and paving material are taken elsewhere.

KETTLE RIVER NEAR SANDSTONE, MINN.

This station, which is located at the quarries of the Barber Asphalt Co., at Banning, 3 miles above Sandstone, was established October 18, 1908, by the Kettle River Quarries Co. to obtain data concerning the power available on the river. The gage heights prior to October 1, 1909, have been furnished through the courtesy of the quarries company; but since that date the station has been maintained in cooperation with the United States Geological Survey. The company has also furnished a rating for the section made by current meter, and as the stream flows at the gaging section through solid rock this rating should hold permanently. It has been checked by the Geological Survey.

No important tributaries enter within several miles of the station. The nearest dam is at Sandstone; but as there is a heavy fall in the 3 miles between the two points the station is above its influence.

The gage is 50 feet above decided rapids which remain open except for very short periods of extremely cold weather, when they may freeze and thus cause backwater. As the channel seldom freezes entirely over at the gage, it is probable that the open-channel rating curve is applicable, except for the few days when the rapids freeze, and it has been used in computing the winter flow.

Since the installation of the gage, its datum has remained unchanged. Conditions are exceptionally favorable for excellent results at this station, and the records should therefore be reliable.

Daily gage height, in feet, of Kettle River near Sandstone, Minn., for 1910.

[Fred Elstad, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.0	1.45	1.6	3.3	2.1	1.8	1.25	1.0	1.2	1.5	1.3	1.1
2	2.9	1.45	1.65	3.15	2.1	1.75	1.25	1.0	1.2	1.6	1.25	1.1
3	2.75	1.5	1.7	3.0	2.05	1.7	1.2	1.05	1.2	1.6	1.3	1.1
4	2.7	1.5	1.85	2.95	2.0	1.65	1.2	1.1	1.2	1.5	1.3	1.1
5	2.7	1.45	2.05	3.0	2.0	1.7	1.15	1.1	1.2	1.45	1.3	1.2
6	2.5	1.45	2.1	2.95	1.95	1.75	1.1	1.1	1.25	1.45	1.05	1.2
7	2.3	1.45	2.1	2.9	1.9	1.7	1.1	1.05	1.25	1.4	1.3	1.3
8	2.2	1.45	2.15	2.8	1.85	1.65	1.15	1.1	1.15	1.4	1.2	1.2
9	2.15	1.45	2.2	2.75	1.8	1.6	1.15	1.15	1.15	1.35	1.3	1.15
10	2.0	1.5	2.15	2.7	1.75	1.55	1.1	1.1	1.15	1.3	1.0	1.15
11	1.95	1.5	2.2	2.6	1.7	1.7	1.2	1.05	1.15	1.3	1.2	1.1
12	1.8	1.45	2.25	2.5	1.7	1.85	1.2	1.05	1.15	1.3	1.2	1.1
13	1.8	1.45	2.25	2.45	1.7	1.9	1.2	1.25	1.1	1.25	1.3	1.15
14	1.75	1.45	2.25	2.4	1.65	1.85	1.1	1.25	1.1	1.25	1.2	1.1
15	1.65	1.45	2.4	2.35	1.65	1.7	1.1	1.2	1.1	1.25	1.15	1.1
16	1.6	1.45	2.6	2.35	1.6	1.5	1.1	1.15	1.1	1.25	1.25	1.1
17	1.6	1.5	2.9	2.4	1.7	1.45	1.1	1.15	1.15	1.3	1.25	1.1
18	1.6	1.65	3.0	2.4	1.7	1.45	1.05	1.15	1.15	1.35	1.2	1.15
19	1.55	1.8	3.3	2.5	1.8	1.45	1.05	1.1	1.1	1.4	1.2	1.15
20	1.55	1.7	3.6	2.6	1.9	1.45	1.0	1.1	1.1	1.5	1.15	1.15
21	1.5	1.6	3.7	2.65	1.95	1.45	1.0	1.1	1.1	1.45	1.15	1.1
22	1.5	1.55	3.7	2.6	1.9	1.45	1.0	1.1	1.15	1.4	1.2	1.2
23	1.5	1.5	3.7	2.6	1.85	1.45	.9	1.1	1.15	1.35	1.3	1.15
24	1.5	1.5	3.75	2.5	1.85	1.5	1.15	1.1	1.1	1.35	1.25	1.1
25	1.55	1.5	3.7	2.4	1.9	1.5	1.15	1.1	1.3	1.35	1.2	1.5
26	1.6	1.55	3.65	2.35	1.9	1.45	1.1	1.1	1.8	1.35	1.3	1.3
27	1.6	1.55	3.6	2.3	1.85	1.4	1.05	1.1	1.8	1.35	1.25	1.15
28	1.55	1.55	3.5	2.25	1.8	1.35	1.05	1.05	1.7	1.3	1.2	1.1
29	1.5	....	3.5	2.2	1.8	1.3	1.0	1.05	1.6	1.3	1.3	1.1
30	1.5	....	3.4	2.15	1.85	1.25	1.0	1.2	1.5	1.3	1.2	1.3
31	1.5	....	3.35	....	1.9	....	1.0	1.2	....	1.3	....	1.25

NOTE.—Ice present Jan. 1-15 and also backwater effect at the gage during the latter part of December.

Daily discharge, in second-feet, of Kettle River near Sandstone, Minn., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	190	148	186	1,070	375	250	101	52	90	160	112	70
2	190	148	201	965	375	233	101	52	90	186	101	70
3	190	160	216	860	352	216	90	61	90	186	112	70
4	190	160	269	828	330	201	90	70	90	160	112	70
5	190	148	352	860	330	216	80	70	90	148	112	90
6	190	148	375	828	309	233	70	70	101	148	61	90
7	190	148	375	795	288	216	70	61	101	136	112	112
8	190	148	398	735	269	201	80	70	80	136	90	90
9	190	148	420	705	250	186	80	80	80	124	112	80
10	190	160	398	675	233	173	70	70	80	112	52	80
11	190	160	420	620	216	216	90	61	80	112	90	70
12	190	148	442	565	216	269	90	61	80	112	90	70
13	190	148	442	540	216	288	90	101	70	101	112	80
14	190	148	442	515	201	269	70	101	70	101	90	70
15	190	148	515	490	201	216	70	90	70	101	80	70
16	186	148	620	490	186	160	70	80	70	101	101	70
17	186	160	795	515	216	148	70	80	80	112	101	70
18	186	201	860	515	216	148	61	80	80	124	90	80
19	173	250	1,070	565	250	148	61	70	70	136	90	80
20	173	216	1,300	620	288	148	52	70	70	160	80	80

Daily discharge, in second-feet, of Kettle River near Sandstone, Minn., for 1910—Contd.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	160	186	1,370	648	309	148	52	70	70	148	80	70
22	160	173	1,370	620	288	148	52	70	80	136	90	90
23	160	160	1,370	620	269	148	36	70	80	124	112	80
24	160	160	1,410	565	269	160	80	70	70	124	101	70
25	173	160	1,370	515	288	160	80	70	112	124	90	160
26	186	173	1,330	490	288	148	70	70	250	124	112	112
27	186	173	1,300	465	269	136	61	70	250	124	101	80
28	173	173	1,220	442	250	124	61	61	216	112	90	70
29	160	......	1,220	420	250	112	52	61	186	112	112	70
30	160	......	1,140	398	269	101	52	90	160	112	90	112
31	160	......	1,110	......	288	......	52	90	......	112	......	101

NOTE.—Discharges estimated for Jan. 1 to 15.

Monthly discharge of Kettle River near Sandstone, Minn., for 1910.

[Drainage area, 825 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	190	160	180	0.218	0.25	B.
February	250	148	164	.199	.21	A.
March	1,410	186	784	.950	1.10	A.
April	1,070	398	631	.765	.85	A.
May	375	186	269	.326	.38	A.
June	288	101	184	.223	.25	A.
July	101	36	71.1	.086	.10	A.
August	101	52	72.3	.088	.10	A.
September	250	70	104	.126	.14	A.
October	186	101	129	.156	.18	A.
November	112	52	95.9	.116	.13	A.
December	160	70	83.1	.101	.12	A.
The year	1,410	36	231	.278	3.81	

SNAKE RIVER.

GENERAL FEATURES OF AREA DRAINED.

Snake River, which drains an area lying southwest of Kettle River basin, rises in T. 45 N., R. 23 W., in Aitkin County and flows south and east into St. Croix River in T. 39 N., R. 19 W., in Pine County. Its chief tributaries are Knife, Ann, Groundhouse, and Little Snake rivers. The total area drained by the river is 948 square miles.

In its upper course the river flows through a wide shallow valley, but below Cross Lake the valley becomes deeper and narrower and the stream swifter, although it does not cut through the glacial drift into the underlying rock. The slightly undulating surface is covered with glacial red till, which rests on Archean granites, gneisses, and schists in the upper part of the basin, and on Cambrian sandstones and limestones in the southeastern part. Rock outcrops at various points along the upper river, notably at the upper and lower falls in the northern part of Kanabec County. The upper falls are two-thirds of a mile below the mouth of Cowans Brook and are caused by granite outcrops on both banks of the river, which here flows between vertical walls for a distance of 10 rods, with a fall of about 3 feet. At the lower falls, which are located a short distance farther downstream, the river descends 20 feet in a distance of three-fourths of a mile. The upper part of the area is so flat that considerable tracts are swampy. The basin contains a dozen lakes, comprising less than 1 per cent of the total area.

The basin was originally densely forested, but is now for the most part covered with brush. Conditions are favorable for forest reproduction, as the fires which have occurred at various times have not seriously damaged the soil. Less than 25 per cent of the land is cleared.

The mean annual precipitation is about 29 inches, of which $3\frac{1}{2}$ inches occurs as snow which remains during the winter. Except at rapids, the river freezes over during the winter. As there are no winter thaws, the flow is derived from the lakes and from ground water, and is therefore very uniform, decreasing gradually until midwinter, when it reaches a minimum.

The best reservoir site in the basin is Cross Lake, near Pine City, which has an area of several square miles. A dam at the outlet of this lake backs the water up Snake River for 15 miles, and also in Pokegama Lake, which is tributary to Snake River about 4 miles above Cross Lake. The reservoir thus formed is used for storage for a water-power plant at the outlet of Cross Lake, where a head of 17 feet is utilized. Small storage reservoirs, used in connection with log-driving, are also formed by logging dams at Knife Lake outlet and at White Pine.

The upper stretch of the river affords few water-power sites, but below Cross Lake the stream becomes a series of rapids, falling 147 feet in some 14 miles.

The following table has been compiled from various sources and shows the approximate water-surface elevation at different points.

Elevations and distances along Snake River.

Place.	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
St. Croix River	0	790
Sec. 19, T. 39 N., R. 20 W	9	900
Pine City (Cross Lake)	14	937
Foot Milletts rapids	30	938
Brunswick highway bridge	33	941
Mora	40	947
Highway bridge below Knife River	42	958
Sec. 6, T. 40 N., R. 23 W	50	1,000

SNAKE RIVER AT MORA, MINN.

This station, which is located at the highway bridge three-fourths of a mile south of Mora, in sec. 14, T. 39 N., R. 24 W., was established June 11, 1909, in connection with the general plan for investigating the water resources of Minnesota.

The nearest tributary, Ann River, enters 1 mile below the station. There are two logging dams above Mora—at Knife Lake outlet and at White Pine—but the operation of these dams has not seriously affected the gage heights since the station has been established. The only dam below Mora is at Cross Lake at Pine City and is too far distant to affect the river at Mora.

From December to March discharge measurements are made through the ice to determine the approximate winter flow.

Conditions at this station are excellent, and the records should therefore be reliable.

Discharge measurements of Snake River at Mora, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 13	G. A. Gray	96	125	[a] 6.90	59.8
Mar. 2	do	91	43.1	[b] 7.02	21.7
Apr. 2	do	105	236	7.34	316
June 22[c]	Robert Follansbee	60	40.1	5.60	35.4

[a] Gage height to water surface; thickness of ice, 0.73 foot.
[b] Gage height to water surface; thickness of ice, 1.52 feet.
[c] Wading measurement.

Daily gage height, in feet, of Snake River at Mora, Minn., for 1910.

[Mrs. Alice Lasher, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1			6.90	7.40	6.20	5.78	5.60	5.65	6.65	5.70	5.68	
2		6.90	7.00	7.32	6.16	5.78	5.60	5.62	6.65	5.65	5.65	5.95
3				7.26	6.12	5.78	5.60	5.60	6.25	5.68	5.65	
4		6.90	7.10	7.24	6.10	5.78	5.60	5.60	6.15	5.70	5.62	
5	6.80			7.28	6.06	5.79	5.60	5.60	6.02	5.68	5.60	
6				7.25	6.02	5.90	5.60	5.55	5.92	5.65	5.62	6.00
7	6.90			7.11	6.00	5.90	5.62	5.60	5.88	5.62	5.75	
8		6.80	7.00	7.04	6.00	5.88	5.61	5.60	5.80	5.60	5.65	
9				6.92	5.96	5.85	5.68	5.60	5.80	5.60	5.70	6.00
10				6.81	5.88	5.85	5.66	5.60	5.80	5.60	5.82	
11	6.90	6.80	7.10	6.81	5.80	5.80	5.62	5.60	5.75	5.60	6.00	
12				6.65	5.78	5.78	5.68	5.60	5.70	5.62	5.80	
13	6.90		7.20	6.55	5.78	5.75	5.60	5.72	5.70	5.60	5.75	6.00
14	6.90		7.65	6.58	5.78	5.75	5.60	5.60	5.70	5.60	5.62	
15			8.30	6.48	5.76	5.75	5.60	5.60	5.65	5.60	5.50	
16		6.70	8.65	6.40	5.76	5.75	5.60	5.60	5.60	5.60	5.70	6.20
17			8.35	6.54	5.82	5.70	5.62	5.66	5.60	5.60		
18	6.90		8.30	6.55	5.85	5.70	5.60	5.62	5.60	5.60	5.70	
19		7.00	8.30	6.52	5.88	5.70	5.60	5.60	5.60	5.65		
20			8.20	6.70	5.89	5.65	5.60	5.60	5.60	5.70		6.12
21	6.90		8.20	6.69	5.95	5.60	5.61	5.60	5.60	5.69		
22		7.00	8.10	6.65	6.00	5.60	5.61	5.60	5.60	5.65	5.85	
23			8.10	6.65	5.95	5.60	5.60	5.60	5.60	5.66		6.22
24			8.15	6.58	5.90	5.60	5.68	5.60	5.60	5.65		
25			8.20	6.50	5.90	5.60	5.65	5.60	5.60	5.64	5.80	
26	6.90	6.90	8.10	6.40	5.89	5.70	5.60	5.60	5.85	5.65		
27			7.80	6.38	5.84	5.70	5.60	5.58	5.80	5.65		6.40
28			7.80	7.16	5.80	5.70	5.60	6.80	5.80	5.65		
29	6.90		7.65	6.34	5.80	5.60	5.68	7.28	5.75	5.65	5.90	
30			7.55	6.22	5.80	5.60	5.65	7.30	5.70	5.65		6.30
31			7.50		5.79		5.65	7.00		5.65		

NOTE.—Ice present from Jan. 1 to Mar. 16 and from Nov. 17 to Dec. 31.

Daily discharge, in second-feet, of Snake River at Mora, Minn., for 1910.

Day.	Jan.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		20	345	96	49	36	40	167	43	42
2		22	321	91	49	36	37	167	39	40
3		25	304	86	49	36	36	103	42	40
4		30	298	83	49	36	36	90	43	37
5		30	309	78	50	36	36	73	42	36
6		35	301	73	60	36	33	62	39	37
7		40	264	71	60	37	36	58	37	47
8		70	247	71	58	37	36	51	36	40
9		100	219	67	56	42	36	51	36	43
10		150	197	58	56	40	36	51	36	53
11		150	197	51	51	37	36	47	36	71
12		200	167	49	49	42	36	43	37	51
13	*a* 60	300	150	49	47	36	45	43	36	47
14		500	155	49	47	36	36	43	36	37
15		715	138	48	47	36	36	40	36	30
16		890	125	48	47	36	36	36	36	43
17		740	148	53	43	37	40	36	36	
18		715	150	56	43	36	37	36	36	
19		715	144	58	43	36	36	36	39	
20		665	176	59	40	36	36	36	43	
21		665	174	66	36	37	36	36	42	
22		620	167	71	36	37	36	36	39	
23		620	167	66	36	36	36	36	40	
24		642	155	60	36	42	36	36	39	
25		665	141	60	36	40	36	36	39	
26		620	125	59	43	36	36	56	39	
27		490	122	55	43	36	35	51	39	
28		490	277	51	43	36	195	51	39	
29		431	116	51	36	42	309	47	39	
30		394	99	51	36	40	315	43	39	
31		377		50		40	237		39	

a Discharge measurement.

NOTE.—Daily discharge computed from a well-defined rating curve, except for Mar. 1 to 14, when discharge is estimated.

Monthly discharge of Snake River at Mora, Minn., for 1910.

[Drainage area, 422 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January			60.0	0.142	0.16	C.
February			35.0	.083	.09	D.
March	890	20	391	.927	1.07	C.
April	345	99	197	.467	.52	A.
May	96	48	62.4	.148	.17	A.
June	60	36	45.8	.109	.12	A.
July	42	36	37.5	.089	.10	A.
August	315	33	65.9	.156	.18	A.
September	167	36	56.6	.134	.15	B.
October	43	36	38.6	.091	.10	B.
November	71		38.8	.092	.10	C.
December			18.0	.043	.05	D.
The year			87.2	.207	2.81	

NOTE.—Mean discharge estimated for January, February and December. Mean for Mar. 17 to 30 estimated at 33.5 second-feet.

CANNON RIVER.

GENERAL FEATURES OF AREA DRAINED.

Cannon River drains an area comprising 1,490 square miles, located chiefly in Goodhue, Rice, Le Sueur, and Steele counties, Minn. The river rises in Shields Lake, in the western part of Rice County, flows westward into Le Sueur County, then southward and eastward into Rice County again, passing through several lakes (the largest being 4 miles long and one-half to three-fourths mile wide) and finally taking a general northeasterly course to its junction with the Mississippi a short distance above Red Wing.

Cannon Lake, the last lake on the river, is several square miles in area. From Cannon Lake to Dundas the river flows through a narrow valley 40 to 50 feet below the general surface level. Below Dundas the valley widens and gradually deepens, but a few miles above Cannon Falls it again contracts, and it remains narrow and steep sided until it joins the Mississippi Valley, a few miles above the mouth. Throughout its length the river has considerable fall, much of which has been utilized by power dams.

The following drainage areas have been measured in the basin:

Drainage areas in Cannon River basin.

	Square miles.
Cannon River above Cannon Lake outlet	274
sec. line 27-34, T. 111 N., R. 20 W	884
sec. 14, T. 112 N., R. 19 W	1,020
sec. 10, T. 112 N., R. 17 W	1,230
Welch	1,290
mouth	1,490
Straight River above mouth	443

In general the surface is undulating, but the lower part of the area is deeply cut by the gravel terraced river valleys.

Except in the valleys the area is covered with a red till—a glacial deposit consisting of a mixture of sand, clay, and gravel—which, in the upper part of the basin is underlain by Silurian and Cambrian sandstones, limestones, and shales, and in the lower part by Cambrian sandstones. The sandstones yield water to the many springs along the river. In the southern part of the area the red till gives way to a clay-loam soil.

The principal tributaries of the Cannon are Devil, Wolf, Heath, and Club creeks from the north, and Straight and Little Cannon rivers, and Belle, Hay, and Wells creeks from the south. Straight River, the most important of the tributaries, rises in lakes and springs scattered among the moranic hills in the southern part of the area, flows northward over the drift until it reaches a point about 2 miles north of Owatonna, where it first encounters bedrock, and joins the Cannon just below Cannon Lake.

The annual rainfall in the basin, as determined from a number of records exceeding 15 years in length, is about 29 inches. On this amount 4½ inches is precipitated in the form of snow which remains during the winter. The river is frozen over except at rapids, and as there are no winter thaws the flow is derived from the lakes and from ground water and is very uniform, reaching a minimum usually in about midwinter.

As the sides of the valley are very steep, the rainfall quickly reaches the stream and causes sudden rises which give the stream a somewhat flashy character. Otherwise, as much of the water comes from springs in sandstone, the flow is very uniform during the year.

As Cannon River lies in one of the most thickly settled farming sections of the State, by far the greater part of its drainage area is cultivated land.

The basin contains few lakes below Cannon Lake. Above that point are 25 lakes, lake surface forming about 10 per cent of the 274 miles of drainage area. Except Cannon Lake, which is already utilized as a reservoir in connection with power development, all the lakes are too far up on the headwaters to afford good reservoir sites.

In order to determine the availability of Cannon River for power development, a survey was made during 1909 from the mouth to Cannon Lake, a short distance above Faribault. From the data collected on this survey sheets have been prepared showing a profile of the water surface, a plan of the river, and the contours along the river bank. These sheets have been published separately and may be had on application to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn. From this survey the following table of elevations and distances has been compiled:

Elevations and distances along Cannon River.

	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
Mississippi River	0	666
Chicago, Milwaukee & St. Paul Ry	4	673
Highway bridge	7	679
Range line 15-16 W	9	683
Belle Creek	11	690
Welch, tail-water	14	706
Welch, headwater	14	712
Range line, 16-17 W	18	730
Sec. 10, T. 112 N., R. 17 W	21	750
Pine Creek	23	758
Cannon Falls, tail-water	25	773
Cannon Falls, headwater	25	782
Goodhue Mill, tail-water	26	782
Goodhue Mill, headwater	26	797
Sec. 14, T. 112 N., R. 18 W	28	808
Prairie Creek	30	830
Chicago Great Western Ry	33	850
Wallace, tail-water	34	856
Wallace, headwater	34	866
Highway bridge	37	871
Do	38	876

Elevations and distances along Cannon River—Continued.

	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
Highway bridge	39	879
Waterford, tail-water	40	881
Waterford, headwater	40	888
Northfield, tail-water	42	888
Northfield, headwater	42	899
Dundas, tail-water	45	908
Dundas, headwater	45	917
Highway bridge	53	938
Do	54	941
Chicago, Rock Island & Pacific Ry	57	950
Faribault, tail-water	59	955
Faribault, headwater	59	963
Sheffield, tail-water	61	964
Sheffield, headwater (Cannon Lake)	61	978

Water power is developed at the following points in the drainage basin:

Developed water powers in Cannon River basin.

Place.	Fall utilized.	Average horsepower.
	Feet.	
Cannon Lake	14	300
Faribault	8	90
Dundas	10	125
Northfield	9	150
Waterford	7	150
Above Cannon Falls	58	2,600
Cannon Falls	9	225
Do	14	150
Welch	6	40
Owatonna, Straight River		40
Clinton Falls, Straight River	10	30

CANNON RIVER AT WELCH, MINN.

This station, which is located at the highway bridge at Welch, was established June 7, 1909, to determine the amount of water power available on the river.

The nearest important tributary, Belle Creek, enters 3 miles below Welch. A very small tributary enters the river just above the station.

About 800 feet above the bridge is a dam at which approximately 40 horsepower is developed. This dam leaks so badly that the operation of the turbine has little effect on the flow. The operation of this power plant, together with other plants farther upstream, causes considerable variation in the flow. The gage is read twice daily.

During the period from December to March ice is frequently gorged at the bridge, and reliable winter records are thereby made impossible.

Since the installation of the gage its datum has remained unchanged. In April, 1888, the river reached the eaves of the wheel-house at the mill, a stage representing 20.1 feet above the datum of the present gage. It is stated locally that this rise was not caused by ice gorging. The angle made by the current at the gaging station necessitates a correction, and artificial control of the river causes daily fluctuation of stage; therefore the records can not be considered better than good.

Discharge measurements of Cannon River at Welch, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 7	G. A. Gray	97	448	6.70	637
July 16	.....do	87	270	5.55	224
Aug. 18	.....do	102	478	7 21	1,010
27	C. J. Emerson	91	355	6.06	385
Sept. 10	Robert Follansbee	93	382	6.32	426
Oct. 29	G. A. Gray	96	293	6.20	394
1910.					
Mar. 11	Robert Follansbee	113	632	8.85	1,850
Apr. 26	G. A. Gray	72	325	5.99	320
July 22	.....do	71	306	5.72	224
Sept. 19	Follansbee and Adams	73	242	5.14	96.5

Daily gage height, in feet, of Cannon River at Welch, Minn., for 1910.

[Miss E. J. Norell, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		7.12	6.15	5.80	5.69	5.20	5.32	5.42	5.00
2		7.00	6.12	5.70	5.73	5.37	5.38	5.28	5.60
3		7.02	5.75	5.75	5.58	5.16	5.20	5.28	5.18
4		6.95	5.76	5.75	5.40	5.70	5.05	5.34	5.19
5		6.92	5.68	6.38	5.60	5.46	5.18	5.08	5.28
6		6.88	5.66	6.25	5.73	5.09	5.39	5.32	5.01
7		6.50	5.65	5.80	5.54	5.06	5.32	5.32	5.32
8		6.42	5.35	5.82	5.13	5.36	5.45	5.14	5.28
9	8.70	6.08	5.25	5.79	5.78	5.69	5.42	5.18	5.32
10	8.75	6.16	5.70	5.78	5.18	5.46	5.21	5.45	5.28
11	8.81	6.10	5.80	5.52	5.30	5.13	5.05	5.42	5.32
12	8.69	6.11	5.92	5.84	5.72	5.17	5.12	5.22	5.26
13	9.15	6.42	6.02	5.50	5.33	5.40	5.18	5.20	5.35
14	9.78	6.38	5.95	5.82	5.69	5.47	5.34	5.89	5.40
15	9.60	6.30	5.68	5.80	5.74	5.29	5.28	5.28	5.29
16	9.00	6.00	5.60	5.84	5.48	5.36	5.15	5.06	5.21
17	8.95	5.95	5.60	5.78	5.50	5.49	5.15	5.35	5.25
18	8.72	5.85	5.70	5.94	5.17	5.51	5.15	5.40	5.40
10	8.56	5.62	5.85	5.88	5.34	5.49	5.22	5.09	5.20
20	8.18	5.60	5.88	5.78	5.12	5.45	5.28	5.02	5.10
21	8.15	5.58	6.40	5.85	5.18	5.15	5.18	5.18	5.10
22	8.12	5.82	6.38	5.82	5.53	5.26	5.06	5.30	5.28
23	7.95	5.82	6.32	5.22	5.22	5.50	5.38	5.48	5.34
24	7.80	5.84	6.08	5.58	5.20	5.19	5.15	5.28	5.32
25	7.72	5.82	5.94	5.39	5.05	5.10	5.05	5.10	5.35
26	7.48	5.91	5.85	5.52	5.65	5.27	5.32	5.32	5.35
27	7.35	6.24	5.79	5.40	5.22	5.32	5.40	5.22	5.09
28	7.22	6.30	6.18	5.79	5.38	5.20	5.42	5.02	5.08
29	7.12	6.50	6.10	5.18	5.78	5.28	5.54	5.24	5.00
30	7.25	6.28	6.18	5.70	5.42	5.50	5.34	5.46	5.80
31	7.22		5.80		5.39	5.32		5.10	

NOTE.—Ice present Jan. 1 to Mar. 8, and from Dec. 1 to 31.

Daily discharge, in second-feet, of Cannon River at Welch, Minn., for 1909–10.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.[a]								
1	....	....	....	495	245	272	407	606
2	....	....	....	453	245	276	383	2,160
3	....	....	....	453	308	250	517	2,020
4	....	....	....	394	272	512	272	1,570
5	....	....	....	308	182	489	403	1,020
6	....	....	....	308	182	403	437	701
7	....	....	683	278	245	445	371	667
8	....	....	658	264	200	480	399	667
9	....	....	609	200	200	526	411	639
10	....	....	562	250	237	471	517	489
11	....	....	539	308	224	437	558	467
12	....	....	539	324	725	1,190	620	620
13	....	....	585	358	735	1,970	634	1,500
14	....	....	609	340	2,470	1,020	634	2,350
15	....	....	633	340	3,660	825	554	2,220
16	....	....	633	264	3,320	667	512	2,100
17	....	....	658	302	1,860	696	467	1,980
18	....	....	735	308	869	454	454	2,200
19	....	....	658	196	935	463	480	2,210
20	....	....	539	189	924	445	363	2,090
21	....	....	495	284	995	445	355	1,850
22	....	....	495	293	544	667	449	1,520
23	....	....	495	278	530	995	445	1,530
24	....	....	453	168	453	891	449	1,430
25	....	....	453	200	417	775	454	1,250
26	....	....	453	149	390	687	403	1,320
27	....	....	375	278	375	582	437	1,530
28	....	....	375	229	327	403	411	1,550
29	....	....	413	394	311	411	407	1,530
30	....	....	453	421	324	344	395	1,500
31	....	....	....	394	308	....	403	....
1910.[b]								
1	836	383	256	223	112	135	157	80
2	775	371	226	235	146	148	127	199
3	785	241	241	194	106	112	127	109
4	750	244	241	152	226	88	139	110
5	735	221	480	199	165	109	92	127
6	715	215	424	235	93	150	135	82
7	535	212	256	185	89	135	135	135
8	498	144	263	100	144	164	102	127
9	355	126	253	250	223	157	109	135
10	387	226	250	109	165	114	164	127
11	363	256	180	131	100	88	157	135
12	367	296	269	232	107	98	116	123
13	498	333	175	137	152	109	112	142
14	480	307	263	223	168	139	286	152
15	445	221	256	238	129	127	127	129
16	325	199	269	170	144	103	89	114
17	307	199	250	175	173	103	141	122
18	272	226	303	107	177	103	152	152
19	204	272	282	139	173	116	93	112
20	199	282	250	98	164	127	83	95
21	194	489	272	109	103	109	109	95
22	263	480	263	182	123	89	131	127
23	263	454	116	116	175	148	170	139
24	269	355	194	112	110	103	127	135
25	263	303	152	88	95	88	95	142
26	293	272	180	213	125	135	135	142
27	420	253	154	116	135	152	116	93
28	445	395	253	148	112	157	83	92
29	535	363	109	250	127	185	120	80
30	437	395	226	157	175	139	166	100
31	....	256	....	150	135	....	95	....

[a] Daily discharge computed from two fairly well defined rating curves.
[b] Daily discharge computed from a rating curve that is well defined below 600 second-feet. Discharge on Nov. 30 is estimated.

Monthly discharge of Cannon River at Welch, Minn., for 1909–10.

[Drainage area, 1,290 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
June (7-30)	735	375	546	0.423	0.38	B.
July	495	149	304	.236	.27	B.
August	3,660	182	742	.575	.66	B.
September	1,970	250	616	.478	.53	B.
October	634	272	452	.350	.40	B.
November	2,350	46	1,440	1.12	1.25	D.
1910.						
April	836	194	440	.341	.38	B.
May	489	126	290	.225	.26	B.
June	480	109	244	.189	.21	B.
July	250	88	167	.129	.15	B.
August	226	89	141	.109	.13	B.
September	185	88	124	.096	.11	B.
October	286	83	129	.100	.12	B.
November	199	80	122	.095	.11	B.

CHIPPEWA RIVER.

GENERAL FEATURES OF AREA DRAINED.

The Chippewa River drainage system has its source in more than a hundred lakes, large and small, with many connecting swamps, lying in the northwestern part of Wisconsin, near the Michigan boundary and only 20 miles from Lake Superior. The main line of drainage runs very nearly along the central line of the basin, but the name Chippewa River is not applied to the continuation of the main stream. The river divides 112 miles from the mouth; one branch, the prolongation of the line of drainage, called the Flambeau, rises in the lakes near the Michigan line, at an elevation approximately 1,600 feet above sea level; the other branch, the Chippewa, is formed in the central part of Sawyer County by the union of East and West branches, both of which rise in the southwestern part of Ashland County. The course of the river is general southwestward to its junction with the Mississippi at the foot of Lake Pepin. The Flambeau drains about 1,983 square miles; the Chippewa above its junction with the Flambeau drains only about 1,777 square miles. The total length of the Chippewa is 267 miles. The drainage basin, which is regular in shape, is about 180 miles long and about 60 miles in average width, and comprises about 9,573 square miles, of which over 6,000 square miles include the most unsettled region of northern Wisconsin.

The important tributaries of the Chippewa are as follows: From the west (beginning at the sources), West Branch and Red Cedar rivers; from the east, East Branch, Thornapple, Flambeau, Jump, Yellow, and Eau Claire rivers.

The entire area above Chippewa Falls is covered with glacial drift, the underlying crystalline rocks appearing only in the river bed. In the southern part of the basin the rivers have cut deeply into the drift and rock, but in the northern districts they have not cut much below the surface. The country is level or rolling.

With few exceptions all the many and important water powers on Chippewa River are found in the region of crystalline rocks, but on account of the deep glacial drift the power sites on the upper streams occur at bowlder rapids.

The lakes in this drainage basin form two widely separated groups; one in the extreme northeastern part at the headwaters of the Flambeau, the other in the northwestern part at the headwaters of Chippewa and Red Cedar rivers. The remainder of the area is almost devoid of lakes. The wooded regions, however, include very large areas of cedar and tamarack swamps. The sources of Chippewa River have an elevation of about 1,500 feet above sea level; at Chippewa Falls the elevation is 806 feet; at the mouth of the river it is about 665 feet. The elevation of the sources of Flambeau River is about 1,650 feet; at Ladysmith the elevation is 1,115 feet.

This drainage basin contains the richest forests of both hard and soft woods still standing in Wisconsin. Although lumbering has been carried on actively for many years, considerable pine timber still remains, chiefly at the upper headwaters, but it is fast disappearing. The upper half of the drainage basin may be considered forested.

The mean annual rainfall is about 30 inches. The winters are severe. The snowfall is heavy and lasts for long periods; ice forms on the streams about 2 feet in thickness and remains for three to four months.

This drainage area affords an unusually large number of excellent sites for reservoirs. According to surveys made by the United States Engineer Corps in 1880, 12 reservoir sites were located and surveyed, whose total capacity was approximately 25,000,000,000 cubic feet. The highest dam necessary was about 26 feet. The operation of these reservoirs, it was estimated, would increase the ordinary low-water flow of the river by 3,245 second-feet for 90 days, thus about doubling the present available water power of the river. The main obstacle to building such reservoirs at the present time by the Government is the fact that, owing to the settling of this region, the land that would be flooded has become very valuable. Private enterprise has developed some of the smaller sites.

Several valuable developed water powers and many undeveloped power sites are located on this river and its tributaries. The Dells Paper & Pulp Co.'s mill, near Eau Claire, has a turbine plant of over 8,000 horsepower, and plans have been made to increase the head from 26 to 32 feet by increasing the height of the dam. On the Flambeau and Red Cedar exceptionally good power sites exist. Near

Ladysmith, on the Flambeau, are two plants, one of which has a rated turbine installation of 3,000 horsepower. In a 30-mile stretch of Red Cedar River there are six sites for water power capable of developing about 13,000 horsepower. The utilization of many of the power sites is retarded by the fact that the area is not now thickly settled and many sections lack railroad facilities.

The river and its tributaries are used extensively for running logs, but where railroads are accessible the logs are moved by rail. The extension of railroads in this section will tend to relieve the river of its burden of logs and add correspondingly to the value of the streams for water-power development.

The use of the river for flooding logs modifies the normal flow of the river very materially.

In order to determine the amount of power available along Flambeau River, a survey was made during 1906 from Flambeau to a point near the western border of Lac du Flambeau Indian Reservation; the section from the mouth to Flambeau had been surveyed by the Geological Survey in 1902. From the data collected sheets have been prepared showing a profile of the water surface, a plan of the river, contours along the bank, and prominent natural or artificial features. The results of this survey have been published on separate sheets, and may be had by applying to E. A. Birge, director, Wisconsin Geological and Natural History Survey, Madison, Wis.

From this study the folowing table of elevations and distances has been compiled:

Elevations and distances along Flambeau River.

Place.	Distance above mouth.	Elevation above sea level.
	Miles.	*Feet.*
Chippewa River	0	1,048
Section corner 10-14	4	1,057
Foot of Ducamon rapids	9	1,070
Head of Ducamon rapids	9.5	1,074
Section line 8-17	14	1,085
Foot of Ladysmith dam	20.5	1,098
Crest of Ladysmith dam	20.5	1,115
Section line 6-5	24	1,116
Foot of Little Falls rapids	29	1,133
Head of Little Falls rapids	29.5	1,141
Foot of Big Falls rapids	36	1,178
Head of Big Falls rapids	37	1,210
Section line 7-18	42	1,247
Sawyer-Rusk County line	47	1,280
Head of Flambeau Falls	51	1,298
Head of Porcupine rapids	55	1,317
Babs Island	63	1,340
Pine Creek	74	1,377
Section line 17-16	80	1,387
Section corner 12-14	86	1,413
Highway bridge section line 34-35	93.5	1,443
Foot of dam below Park Falls	95	1,447
Crest of dam below Park Falls	95	1,469
Foot of dam at Park Falls	97	1,482
Crest of dam at Park Falls	97	1,486
Section line 28-21	105.5	1,507
Ashland-Iron County line	111	1,516
Turtle River	115	1,547

CHIPPEWA RIVER AT CHIPPEWA FALLS, WIS.

This station is located at the highway bridge at Chippewa Falls, Wis. The gage was originally established by the Chippewa Lumber & Boom Co. in April, 1899. On June 1, 1906, the United States Geological Survey began taking discharge measurements at this place to determine the amount of water available for water power and storage. The United States Weather Bureau has obtained gage-height records for this station since 1904. The records for April to September, published herewith, were furnished by that bureau.

Duncan Creek is tributary on the right side about 2,500 feet above the station.

The datum of the staff gage has remained unchanged.

The winters are severe in this vicinity, and ice forms on the river about 2 feet in thickness; but owing to the swift water and the proximity of the dam considerable open water is found at the measuring section.

The normal flow of the stream is much modified by logging and by the power plants at Chippewa Falls, which cause great and rapid fluctuations in stage from day to day.

As the station was not visited during 1910 the estimates are withheld until checked by additional measurements.

Daily gage height, in feet, of Chippewa River at Chippewa Falls, Wis., for 1910.

[N. O. Swift, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.0	1.55	1.3	2.8	2.2	1.9	0.7	0.9	0.8	1.2	0.7	0.7
2	3.0	1.5	1.4	2.7	2.3	1.8	1.3	.6	1.0	1.1	.7	.7
3	2.95	1.4	1.3	2.5	1.9	1.8	.7	.7	1.1	1.1	.7	.6
4	2.9	1.35	1.4	2.4	1.8	3.8	.9	.8	.9	1.15	.7	.55
5	2.85	1.3	1.4	2.5	1.7	1.7	1.2	.9	.7	1.2	.7	.5
6	2.8	1.25	1.45	2.6	1.8	1.9	.7	.7	1.1	1.25	.7	.5
7	2.7	1.2	1.55	2.7	1.7	1.6	−.1	.0	1.6	1.2	.7	.55
8	2.7	1.2	1.6	2.6	1.6	1.5	−.2	.8	1.5	1.15	.7	.6
9	2.75	1.35	1.65	2.7	1.5	1.5	−.3	.7	1.2	1.1	.7	.55
10	2.85	1.35	1.75	2.3	1.4	1.4	−.4	.4	1.0	1.15	.7	.5
11	3.0	1.2	1.85	2.0	1.4	1.3	−.1	.5	.8	1.1	.7	.5
12	2.8	1.2	1.9	2.1	1.4	1.0	−.4	.0	1.2	1.15	.7	.5
13	2.6	1.4	1.9	1.9	1.3	1.2	−.5	.2	1.0	1.1	.7	.5
14	2.5	1.35	1.85	1.8	1.4	1.1	+1.0	.0	1.1	1.1	.65	.5
15	2.5	1.3	1.75	1.9	1.0	1.3	−.4	.2	1.2	1.1	.6	.5
16	2.4	1.3	1.7	1.8	1.3	1.0	−.5	.6	1.3	.55	.6	.5
17	2.4	1.25	1.55	1.6	1.4	1.2	−.7	.5	1.2	1.1	.6	.5
18	2.25	1.2	1.55	1.5	2.2	1.3	−.3	.7	.5	.5	.6	.5
19	2.05	1.2	1.8	2.1	3.5	1.0	−.4	.8	1.6	.65	.6	.6
20	1.95	1.3	2.0	2.4	4.0	1.3	−.5	.9	1.5	.8	.5	.7
21	1.7	1.3	2.25	3.9	3.6	1.1	−.6	.2	.4	.8	.5	.8
22	1.55	1.1	3.35	3.6	3.7	1.0	−.6	.3	.3	.6	.5	.7
23	1.5	1.15	3.3	3.2	3.8	.8	−.5	.7	1.0	.7	.5	.6
24	1.45	1.35	3.0	2.8	3.7	1.0	−.8	.6	.9	.7	.5	.7
25	1.45	1.4	3.45	2.9	3.5	1.1	−.1	.7	.5	.7	.5	.7
26	1.65	1.3	3.3	3.2	3.4	.7	+1.0	.6	1.2	.7	.5	.7
27	1.75	1.3	3.3	2.5	3.3	1.0	1.1	.5	.9	.7	.5	.6
28	1.8	1.4	3.0	2.6	3.0	1.0	1.2	.0	1.0	.7	.55	.6
29	1.7	......	2.95	2.4	2.3	.8	1.1	.9	.9	.7	.6	.6
30	1.6	......	3.05	2.5	1.2	.7	.8	1.0	1.0	.7	.65	.7
31	1.6	......	2.95	......	2.0	......	.2	.9	......	.7	......	.7

NOTE.—Ice from Jan. 9 to Mar. 19.

RED CEDAR RIVER AT CEDAR FALLS, WIS.

This station, which is located at the highway bridge on the outskirts of Cedar Falls, Wis., was established in 1908 to replace the station at Menomonie, but gage heights were not obtained until April 1, 1909. The data collected at this station are used in studying water power, water supply, pollution, and storage problems.

No important tributaries enter Red Cedar River in the immediate vicinity of the gage.

Winters are severe in this locality, but the relation between gage height and discharge at the section does not appear to be much modified by ice, probably on account of the rapids a short distance below the station.

The datum of the staff gage has remained unchanged.

The observer at this station is paid by the Chippewa Valley Light & Power Co.

No discharge measurements have been made, and the station has not been visited since the gage was established. Therefore not much is known about existing conditions.

Daily gage height in feet of Red Cedar River at Cedar Falls, Wis., for 1910.

[Olaf Oas, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	2.7	2.2	2.4	2.0	2.0	2.0	2.6	1.6	1.9
2	......	......	......	2.6	2.2	2.4	2.0	2.0	2.0	2.65	2.0	1.6
3	......	3.7	4.9	2.6	2.2	2.4	2.0	2.0	2.0	2.8	2.0	1.7
4	......	......	......	2.5	2.2	2.4	2.0	2.0	2.0	2.8	2.1	2.1
5	......	......	......	2.5	2.2	2.4	2.0	2.0	2.0	2.8	2.2	2.3
6	3.8	......	......	2.5	2.3	2.4	2.0	2.0	2.0	2.8	2.2	2.2
7	......	......	......	2.4	2.3	2.3	2.0	2.0	2.1	2.8	2.2	2.25
8	......	......	......	2.4	2.3	2.3	2.0	2.0	2.1	2.8	2.2	2.2
9	......	......	......	2.4	2.3	2.3	2.0	2.0	2.1	2.3	2.2	2.2
10	......	3.8	5.0	2.4	2.3	2.3	2.0	2.0	2.1	2.9	2.2	2.2
11	......	......	......	2.4	2.3	2.2	2.0	2.0	2.1	2.8	2.2	2.2
12	......	......	......	2.4	2.2	2.2	2.0	2.0	2.1	2.7	1.7	2.15
13	3.7	......	4.55	2.4	2.2	2.2	2.0	2.0	2.1	2.7	1.6	2.35
14	......	......	4.15	2.4	2.2	2.2	2.0	2.0	2.1	2.6	1.7	2.6
15	......	......	3.8	2.4	2.2	2.2	2.0	2.0	2.1	2.55	1.8	2.35
16	......	......	3.6	2.4	2.25	2.2	2.0	2.0	2.1	2.5	2.0	2.2
17	......	3.9	3.55	2.4	2.4	2.2	2.0	2.0	2.0	2.5	2.0	2.1
18	......	......	3.4	2.4	2.55	2.2	2.0	2.0	2.0	2.3	1.4	2.0
19	......	......	3.4	2.4	2.75	2.2	2.0	2.0	2.0	2.3	1.8	2.0
20	3.6	......	3.4	2.35	2.8	2.2	2.0	2.0	2.0	2.4	1.8	2.0
21	......	......	3.35	2.3	2.8	2.2	2.0	2.0	2.0	2.5	2.6	2.0
22	......	......	3.3	2.3	2.7	2.2	2.0	2.0	2.0	2.4	2.6	2.0
23	......	......	3.3	2.3	2.7	2.2	2.0	2.0	2.0	2.4	2.6	2.0
24	......	4.0	3.2	2.3	2.65	2.2	2.0	2.0	2.0	2.4	2.5	2.0
25	......	......	3.2	2.3	2.6	2.1	2.0	2.0	2.05	2.3	2.45	2.0
26	......	......	3.05	2.3	2.55	2.1	2.0	2.0	2.4	2.3	2.4	2.0
27	3.7	......	3.0	2.3	2.5	2.1	2.0	2.0	2.6	2.2	2.4	1.95
28	......	......	2.9	2.3	2.45	2.1	2.0	2.0	2.6	2.2	2.3	1.9
29	......	......	2.8	2.3	2.4	2.1	2.0	2.0	2.6	2.1	2.1	1.9
30	......	......	2.75	2.2	2.4	2.0	2.0	2.0	2.6	2.1	2.0	1.9
31	......	......	2.7	......	2.4	......	2.0	2.0	......	2.1	......	1.9

NOTE.—Ice present from Jan. 1 to Mar. 13, ranging in thickness from 11 to 16 inches.

ZUMBRO RIVER.

GENERAL FEATURES OF AREA DRAINED.

Zumbro River drains an area bounded by the Cannon River basin on the north and the basin of Root River on the south, and located chiefly in Wabasha, Goodhue, Dodge, and Olmstead counties in southeastern Minnesota. The North Branch of Zumbro River rises in the southeastern part of Rice County and flows eastward; the South Branch is formed by a number of small tributaries in the southwestern part of Olmstead County and flows northward, receiving throughout its course many tributaries, the largest being the Middle Branch. In the western part of Wabasha County the two streams unite to form the Zumbro, which takes a general easterly course until it reaches the flood plain of the Mississippi, where it empties into one of the sloughs of the region. The cut-off ditch connects it directly with the river.

The following drainage areas have been measured in the drainage basin:

Drainage areas in Zumbro River basin.

	Square miles.
Zumbro River above Zumbro Falls	1,120
Zumbro River above mouth	1,390
South Branch above mouth	821

The valleys of the North and South branches are cut 100 to 200 feet below the general level of the country and are bordered by bluffs. The valley of lower Zumbro River becomes deeper, and at the mouth of the river is 400 feet deep, and is bounded by rock cliffs, chiefly sandstone. The general width of the valley is 1 to 2 miles. The streams discharging into the Zumbro Valley at the present time deposit on the flood plain more material than the Zumbro itself can carry away, and the valley is being gradually filled up. A great many large springs issue from the bluffs along various streams, and there are many springs and marshes that form the sources of the headwater streams.

The region is in general a gently undulating prairie. Its extreme west end is covered with blue till, a glacial deposit consisting of a mixture of sand, clay, and gravel. Throughout the central part of the area the streams have cut through the till into the underlying limestones, sandstones, and shales of Silurian and Cambrian age. The lower section of the basin, especially below the mouth of the South Branch, is in the Driftless Area and is covered with a clay-loam soil.

Many springs rise from the sandstone strata along the streams. The underground supply from the sandstones is so important that the flow of Zumbro River, aside from sudden freshets, is more uniform than that of any river in Minnesota except the Root, and this despite the fact that its basin contains no lakes.

Very little forest remains in the basin of the Zumbro at the present time, as most of the land is under cultivation.

The annual precipitation is about 30 inches, of which 4½ inches is snow, which remains through the winter. Except at rapids the rivers freeze over from December to March. There are no winter thaws, and the flow, being derived from ground water, remains higher than that of the streams in other sections of the State.

Because of the complete absence of lakes and the general flatness of the uplands, reservoir sites can be obtained only within the valleys of the streams by building dams from bluff to bluff.

A survey of Zumbro River from its mouth to a point 6 miles up the South Fork above its mouth was made in 1911 by the Geological Survey. Sheets showing the results of the survey may be had on application to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn.

Water power has been developed at the following points in the basin:

Developed water powers in Zumbro River basin.

Place.	Fall utilized.	Average horse-power.
Zumbro at Zumbrota	8	10
Zumbro at Forest Mills	11	25
Zumbro at Mazeppa	22	60
Zumbro at Jarretts	11	60
South Branch at Rochester	8	20
South Branch below Rochester	10	30
Middle Branch at Oronoco	15	150

Drainage work has been carried on to a considerable extent, about 34,000 acres, chiefly in Wabasha and Dodge counties, having been ditched.

The river is subject to sudden freshets, as the steep slopes of the valleys cause the rainfall to find its way into the streams quickly. The years of highest water were 1888 and 1908, when the river rose from 20 to 25 feet above low-water stage.

ZUMBRO RIVER AT ZUMBRO FALLS, MINN.

This station, which is located at the highway bridge at Zumbro Falls, was established June 8, 1909, to obtain data for use in studies of power, flood-prevention, and sewage-disposal problems.

The nearest tributary, the South Branch, enters the river about 8 miles above the station. The nearest dam is at Jarretts, but the fall of the river between the two points is so great that the effect of the dam does not extend to the station.

Owing to the rapids a short distance above the station and also to springs the river is open practically throughout the year from the rapids for a distance of several miles downstream. For this reason the daily gage readings are continued during the winter months. A discharge measurement made in February, 1910, gave a result about 15 per cent less than that indicated by the open-season rating curve. However, owing to the manner in which the measurement was made, it is probable that this discrepancy was largely caused by the freezing of the meter. The flow for the winter months has been computed by reducing the open-season rating curve for corresponding gage heights by 5 per cent.

The high water of June, 1908, is marked by a spike in a telegraph pole near the railroad station at Zumbro Falls. This is at an elevation of 26.7 feet above the datum of the gage. The high water of April, 1888, reached an approximate stage of 29.7 feet, as shown by a mark not so well defined as that of the 1908 flood.

Since the installation of the gage its datum has remained unchanged.

Conditions at this station are good and the records of flow should be reliable.

Discharge measurements of Zumbro River at Zumbro Falls, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 8	G. A. Gray	129	279	6.30	618
July 15	Gray and Gibson	129	185	5.52	270
Aug. 26	C. J. Emerson	129	228	5.69	319
Oct. 22	G. A. Gray	129	197	5.50	281
1910.					
Feb. 15	G. A. Gray	130	209	5.68	286
Mar. 10	Robert Follansbee	134	576	8.60	a 1,720
Apr. 27	G. A. Gray	129	220	5.75	344
July 21	.....do	128	143	5.10	164
Sept. 20	Robert Follansbee	127	138	5.00	157

a Possible backwater from ice gorging.

Daily gage height, in feet, of Zumbro River at Zumbro Falls, Minn., for 1910.

[A. H. Sugg, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	5.76	5.56	6.15	5.60	5.48	5.18	5.00	5.16	5.06	5.12	5.04
2	....	5.79	5.55	6.10	5.58	5.46	5.18	5.08	5.12	5.06	5.10	5.08
3	....	5.78	5.65	6.10	5.60	5.42	5.17	5.08	5.08	5.06	5.10	5.11
4	....	5.72	5.70	6.06	5.54	5.43	5.16	5.00	5.07	5.06	5.10	5.05
5	....	5.64	5.98	5.95	5.54	5.40	5.13	5.00	5.10	5.06	5.10	5.08
6	....	5.68	7.12	5.90	5.55	5.42	5.18	5.00	5.13	5.06	5.10	5.05
7	5.96	5.70	9.55	5.90	5.54	5.39	5.16	5.00	5.13	5.06	5.10	5.08
8	6.00	5.75	9.65	5.89	5.51	5.39	5.16	5.00	5.10	5.01	5.10	4.92
9	5.98	....	9.25	5.81	5.50	5.38	5.17	5.00	5.07	5.00	5.09	5.05
10	5.96	....	8.68	5.80	5.50	5.38	5.13	5.00	5.07	5.00	5.09	5.05
11	5.98	5.64	8.65	5.80	5.48	5.38	5.10	5.02	5.10	5.02	5.08	4.98
12	5.88	5.66	8.55	5.78	5.50	5.37	5.16	5.06	5.02	5.02	5.10	4.98
13	5.81	5.62	9.52	5.76	5.50	5.34	5.14	5.08	5.08	5.02	5.06	5.00
14	5.80	5.64	9.77	5.71	5.50	5.33	5.13	5.08	5.08	5.00	5.12	5.02
15	5.79	5.65	8.82	5.75	5.49	5.32	5.12	5.10	5.08	5.00	5.10	5.02
16	5.80	5.61	8.28	5.71	5.46	5.30	5.12	5.18	5.08	5.00	5.10	5.04
17	5.80	5.59	7.92	5.74	5.68	5.32	5.14	5.40	5.07	4.99	5.12	5.06
18	5.79	5.60	7.65	5.71	5.74	5.32	5.07	5.38	5.03	4.99	5.14	5.04
19	5.79	5.59	7.52	5.72	5.75	5.29	5.09	5.38	4.99	5.06	5.15	5.04
20	5.84	5.55	7.52	5.72	5.74	5.23	5.13	5.30	5.02	5.08	5.12	5.01

Daily gage height, in feet, of Zumbro River, at Zumbro Falls, Minn., for 1910—Contd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	5.84	5.54	7.52	5.70	5.72	5.27	5.08	5.20	5.00	5.10	5.08	5.04
22	5.80	5.54	7.34	5.70	5.84	5.26	5.08	5.18	5.06	5.10	5.05	5.05
23	5.80	5.49	7.14	5.69	5.90	5.22	5.08	5.18	5.06	5.10	5.09	5.05
24	5.78	5.50	7.04	5.64	5.88	5.24	5.05	5.16	5.08	5.05	5.11	5.04
25	5.70	5.50	6.85	5.66	5.79	5.22	5.00	5.17	5.03	5.04	5.08	5.01
26	5.71	5.49	6.72	5.70	5.69	5.22	5.04	5.10	5.08	5.05	5.04	5.00
27	5.72	5.45	6.56	5.72	5.65	5.18	5.02	5.10	5.08	5.04	5.05	5.02
28	5.74	5.48	6.49	5.70	5.60	5.18	5.05	5.10	5.08	5.09	5.02	5.04
29	5.78		6.38	5.68	5.54	5.18	5.05	5.09	5.10	5.02	5.00	5.05
30	5.75		6.30	5.62	5.51	5.19	5.04	5.10	5.09	5.04	4.65	5.05
31	5.75		6.21		5.50		5.02	5.12		5.08		5.05

NOTE.—Ice present Jan. 1–6. Gage heights slightly affected by ice in December.

Daily discharge, in second-feet, of Zumbro River at Zumbro Falls, Minn., for 1909–10.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1							465	196	242	271	271	1,100
2							405	196	242	268	765	1,020
3							425	196	242	265	760	1,060
4							425	189	242	253	656	1,190
5							349	189	242	253	539	1,000
6							349	185	233	253	453	652
7							314	179	233	250	405	524
8						575	297	213	233	242	382	520
9						530	281	223	233	248	360	520
10						485	265	242	239	259	331	520
11						508	265	840	239	304	375	515
12						530	281	1,460	765	397	710	510
13						508	265	1,140	970	331	1,270	510
14						445	281	1,460	715	321	2,400	510
15						445	262	1,710	715	311	4,000	510
16						405	250	2,040	584	294	2,500	510
17						445	248	1,140	566	278	1,770	510
18						598	248	890	521	265	1,300	500
19						530	253	775	485	265	1,200	524
20						508	248	598	386	265	1,120	540
21						386	239	375	375	265	1,120	567
22						405	215	375	375	271	1,270	549
23						1,110	213	425	397	265	1,080	540
24						740	220	324	413	259	926	504
25						715	213	304	425	250	895	476
26						598	201	338	413	253	905	444
27						642	208	324	375	250	1,490	460
28						642	201	324	324	239	1,900	456
29						598	201	328	236	236	1,520	420
30						575	201	291	177	239	1,240	428
31							196	271		236		440
1910.												
1	435	331	269	508	297	259	183	150	179	160	171	157
2	430	342	266	485	291	253	183	164	171	160	167	164
3	425	338	296	485	297	242	181	164	164	160	167	169
4	420	318	311	469	278	245	179	150	162	160	167	158
5	415	292	412	425	278	236	173	150	167	160	167	164
6	410	305	981	405	281	242	183	150	173	160	167	158
7	405	311	2,300	405	278	233	179	150	173	160	167	164
8	420	328	2,360	401	268	233	179	150	167	152	167	136
9	412	316	2,140	371	265	231	181	150	162	150	165	158
10	405	304	1,840	367	265	231	173	150	162	150	165	158
11	412	292	1,820	367	259	231	167	153	167	153	164	147
12	374	299	1,770	360	265	228	179	160	153	153	167	147
13	349	286	2,290	353	265	220	175	164	164	153	160	150
14	345	292	2,440	335	265	218	173	164	164	150	171	153
15	342	296	1,920	349	262	215	171	167	164	150	167	153

Daily discharge, in second-feet, of Zumbro River at Zumbro Falls, Minn., for 1909–10—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910.												
16	345	283	1,620	335	253	210	171	183	164	150	167	157
17	345	277	1,420	345	324	215	175	236	162	148	171	160
18	342	280	1,270	335	345	215	162	231	155	148	175	157
19	342	277	1,200	338	349	208	165	231	148	160	177	157
20	359	266	1,200	338	345	194	173	210	153	164	171	152
21	359	263	1,200	331	338	203	164	187	150	167	164	157
22	345	263	1,100	331	382	201	164	183	160	167	158	158
23	345	249	992	328	405	192	164	183	160	167	165	158
24	338	252	937	311	397	196	158	179	164	158	169	157
25	311	252	840	317	363	192	150	181	155	157	164	152
26	314	249	775	331	328	192	157	167	164	158	157	150
27	318	239	695	338	314	183	153	167	164	157	158	153
28	326	247	660	331	297	183	158	167	164	165	153	157
29	338	....	611	324	278	183	158	165	167	153	150	158
30	328	....	575	304	268	185	157	167	165	157	90	158
31	328	....	534	....	265	....	153	171	....	164	....	158

NOTE.—Daily discharge computed from a rating curve that is well defined below 500 second-feet, but somewhat uncertain above. Discharges estimated for December, 1909, and Jan. 1 to 6 and Nov. 30, 1910.

Monthly discharge of Zumbro River at Zumbro Falls, Minn., for 1909–10.

[Drainage area, 1,120 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
June (8–30)	1,110	386	562	0.502	0.43	A.
July	465	196	274	.245	.28	A.
August	2,040	179	572	.511	.59	A.
September	970	177	395	.353	.39	A.
October	397	236	270	.241	.28	A.
November	4,000	271	1,130	1.01	1.13	B.
December	1,190	420	598	.534	.62	B.
1910.						
January	435	311	367	.328	.38	B.
February	342	239	287	.256	.27	B.
March	2,440	266	1,190	1.06	1.22	C.
April	508	304	367	.328	.37	A.
May	405	253	302	.270	.31	A.
June	259	183	216	.193	.22	A.
July	183	150	169	.151	.17	A.
August	236	150	172	.154	.18	A.
September	179	148	163	.146	.16	A.
October	167	148	157	.140	.16	A.
November	177	....	163	.146	.16	A.
December	169	147	156	.139	.16	A.
The year	2,440	....	309	.276	3.76	

ROOT RIVER.

GENERAL FEATURES OF AREA DRAINED.

Root River, which joins the Mississippi about 3 miles below La Crosse, drains an area including the extreme southeastern portion of Minnesota and a very small area, not exceeding a few square miles, in northeastern Iowa. The North Branch, which is the principal tributary, rises in the southeastern part of Dodge County and flows in a general easterly course, being joined by the Middle Branch a few miles below Chatfield and by the South Branch near Lanesboro. Rush Creek enters the main stream near Rushford, and Money Creek and South Root River near Houston.

The North Branch flows to its junction with the Middle Branch through a cultivated valley one-half mile in average width and from 50 to 100 feet below the general surface level. Below the Middle Branch nearly to the mouth of the South Branch near Lanesboro, the valley is narrow and gorgelike, being cut 200 feet or more below the general level. The little bottom land there is in this section is under cultivation. Below the junction with the South Branch the Root flows through a narrow, steep-sided valley, in average width a quarter of a mile, until it reaches Peterson, below which, for the remainder of the course of the stream, the valley spreads out to an average width of three-quarters of a mile, and the bordering bluffs rise 300 to 500 feet above the bottom land. Nearly all the bottom land is under cultivation.

The fall of the North Branch is heavy from the head of the stream to its junction with the South Branch, below which the slope gradually decreases until it practically disappears a short distance above the mouth. The immediate banks of the river are 5 to 15 feet high. The following drainage areas have been measured in the basin:

Drainage areas in Root River basin.

	Square miles.
North Branch above sec. 8, T. 104 N., R. 11 W.	291
North Branch above junction with South Branch	647
Root River above sec. 4 , T. 103 N., R. 9 W.	940
Root River above Houston (above South Root River)	1,560
Root River above mouth	1,660

The region drained is an undulating plateau whose uplands range in altitude from 1,100 to 1,300 feet above sea level. The headwater areas are covered with till, a glacial deposit consisting of a mixture of sand, clay, and gravel, but the greater part of the basin lies in the Driftless Area and is covered with a soil of clay loam or "loess loam." In the Driftless Area the Root and its fanlike tributaries occupy valleys cut through limestones and sandstones of Silurian and Cambrian age. The sandstone beds are all strong water bearers, and to them are due the many springs that issue along the bluffs. The quantity of water reaching the river from these sandstones is so great that the flow of Root River, aside from its sudden freshets, is more uniform than that of any other river in Minnesota, despite the fact that the basin contains no lakes. During the exeedingly dry year of 1910 and early part of 1911, the flow of the Root diminished proportionately less than that of any other river in the State.

By far the greater part of the region drained by the Root is under cultivation, the forested areas being chiefly on the sides of the bluffs.

The annual precipitation for the basin, as shown by a number of records exceeding 10 years in length, is about 32 inches, 5 inches falling as snow, which remains during the winter months. Except at rapids the streams freeze over from December to March. There are no winter thaws, but the ground-water supply prevents the winter flow from falling as low as that of the streams in other portions of the State.

As the basin contains no lakes, reservoirs can be formed only by building dams from bluff to bluff across the gorgelike valleys. One good site of this type is found on the North Branch a short distance above the South Branch.

In order to determine the availability of Root River for power development, a survey was made during 1910 from the mouth to Orion Mill, a point on the North Branch several miles above Chatfield. From the data collected on this survey sheets have been prepared showing a profile of the water surface, a plan of the river, and the contours along the river bank. These sheets have been published separately and may be had upon application to the district engineer, United States Geological Survey, Old Capitol Building, St. Paul, Minn. From this survey the following table of elevations and distances has been compiled:

Elevations and distances along Root River.

Place.	Distance above mouth.	Elevation.
	Miles.	*Feet.*
Mississippi River	0	633
Chicago, Milwaukee & St. Paul Ry	4	635
Do	6	636
Thompson Creek	8	640
Hokah	11	645
Mound Prairie	18	655
Crystal Creek	21	659
Silver Creek	23	662
South Root River	27	669
Money Creek	31	680
Chicago, Milwaukee & St. Paul Ry	34	686
Rushford, tail-water	44	710
Rushford, headwater	47	725
Peterson	52	734
Whalen	62	768
South Branch Root River	66	784
Money Creek	77	856
Trout Creek	81	873
Highway bridge	91	913
Middle Branch Root River	94	927
Chatfield dam, tail-water	94	925
Chatfield dam, headwater	95	939
Chatfield	98	951
Highway bridge	103	990
Orion Mill, tail-water	107	1,018

Water power is developed at the following points in the drainage basin:

Developed water powers in Root River basin.

Place.	Fall utilized.	Average horsepower.
	Feet.	
At Stewartville	13	60
At Simpson		50
At Orion	8	20
Near Chatfield	14	65
At Preston	8	40
At Lanesboro	28	130
At Rushford	12	150
Do		50

Root River is subject to sudden freshets, as the steep slopes of the valleys cause the rainfall to find its way into the streams quickly. When in flood the river inundates large portions of the lands in the lower valley. So frequent have been these inundations that a considerable portion of the bottom land is not under cultivation.

ROOT RIVER NEAR HOUSTON, MINN.

This station, which is located at the first highway bridge 1 mile below Houston, in sec. 34, T. 104 N., R. 6 W., was established May 28, 1909, to obtain data for use in connection with water-power development and studies of flood prevention and sewage disposal.

The nearest tributary, South Root River, enters 1 mile below the bridge. Although this is ordinarily an insignificant stream, during heavy rains it overflows its banks and floods a considerable area.

There is no dam below, and the nearest one above it is at Rushford. As the flow of the river is at all times ample for the power generated at that point, it is not held back during certain portions of the day and thus has no influence on gage heights at Houston.

The river is icebound from December to March, and during that period discharge measurements are made through the ice to determine the approximate winter flow.

Discharge measurements are made from the bridge at which the staff gage is located. Since the establishment of the gage its datum has remained unchanged.

The channel scours out during floods and gradually fills in afterward, and for this reason it is necessary to make more frequent measurements than at other sections. The estimates based on the measurements can probably not be considered better than fair, or possibly good, except during low stages, when no change occurs.

Discharge measurements of Root River near Houston, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 28	J. C. Hoyt	105	302	1.50	615
June 18	G. A. Gray	103	273	1.30	540
18	C. B. Gibson	103	279	1.30	530
July 14	G. A. Gray	102	240	.92	424
Aug. 26	Robert Follansbee	105	424	1.76	605
Sept. 11	....do	104	290	1.11	426
Nov. 11	G. A. Gray	105	288	1.45	596
1910.					
Feb. 10	G. A. Gray	105	279	[a] 2.45	464
Apr. 29	....do	105	279	1.58	482
June 24	Robert Follansbee	104	233	1.20	363
Sept. 21	....do	104	197	1.10	333

[a] Gage height to water surface; thickness of ice, 0.92 foot.

Daily gage height, in feet, of Root River near Houston, Minn., for 1910.

[Olof Larson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	2.08	1.51	1.48	1.11	1.02	1.52	1.16	1.14	......
2	......	......	......	2.02	1.51	1.48	1.13	.96	1.35	1.12	1.15	......
3	2.75	2.45	2.65	1.98	1.49	1.42	1.10	.98	1.25	1.18	1.18	......
4	......	......	......	1.98	1.48	1.42	1.08	.92	1.20	1.11	1.12	......
5	......	......	......	2.20	1.48	1.40	1.10	.92	3.15	1.15	1.12	1.92
6	2.60	......	......	1.98	1.45	1.41	1.04	.92	3.50	1.11	1.15	......
7	......	2.30	6.10	1.90	1.44	1.39	1.08	.90	2.18	1.15	1.10	......
8	......	......	......	1.82	1.44	1.35	1.06	.98	1.82	1.08	1.15	1.45
9	......	......	......	1.82	1.44	1.34	1.06	.98	1.60	1.05	1.12	......
10	......	2.35	6.30	1.78	1.39	1.34	1.04	.98	1.46	1.10	1.12	......
11	2.70	......	4.28	1.78	1.38	1.35	1.10	.95	1.38	1.09	1.12	......
12	......	......	3.96	1.72	1.38	1.31	1.05	.98	1.36	1.08	1.12	1.72
13	2.72	......	4.28	1.71	1.38	1.31	1.05	1.12	1.29	1.08	1.09	......
14	......	2.40	4.85	1.70	1.38	1.30	1.06	1.30	1.28	1.08	1.15	......
15	......	......	4.68	1.70	1.34	1.29	1.08	1.22	1.25	1.08	1.18	......
16	......	......	4.08	1.71	1.39	1.28	1.05	1.18	1.18	1.08	1.15	1.80
17	2.80	2.20	3.55	1.70	1.64	1.28	1.16	1.25	1.12	1.12	1.12	......
18	......	......	3.34	1.76	1.55	1.25	1.11	1.46	1.19	1.12	1.10	......
19	......	......	3.20	1.70	1.59	1.22	1.04	1.32	1.18	1.09	1.12	......
20	2.75	......	3.20	1.68	1.58	1.20	1.02	1.25	1.16	1.12	1.12	1.80
21	......	2.35	3.16	1.68	1.75	1.20	1.00	1.16	1.15	1.16	1.18	......
22	......	......	3.12	1.65	3.15	1.24	1.06	1.20	1.12	1.14	1.15	......
23	......	......	3.02	1.62	2.08	1.20	1.00	1.10	1.15	1.15	1.08	......
24	......	2.30	2.85	1.60	1.94	1.19	1.05	1.10	1.22	1.16	1.18	1.90
25	2.50	......	2.78	1.65	1.85	1.21	1.00	1.10	1.29	1.15	1.15	......
26	......	......	2.60	1.65	1.78	1.20	1.04	1.10	1.26	1.12	1.15	1.90
27	......	2.45	2.49	1.61	1.70	1.21	.98	1.10	1.34	1.10	1.16	......
28	2.55	......	2.40	1.59	1.65	1.25	.98	1.02	1.21	1.15	1.15	......
29	......	......	2.30	1.59	1.58	1.15	.99	.98	1.20	1.12	1.10	2.00
30	......	......	2.21	1.56	1.58	1.15	.96	1.18	1.18	1.10	1.02	......
31	2.40	......	2.12	......	1.52	......	.94	1.70	......	1.09	......	......

NOTE.—Ice present from Jan. 1 to Mar. 9, and from Dec. 1 to 31.

Daily discharge, in second-feet, of Root River near Houston, Minn., for 1909–10.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1909.										
1					575	730	371	440	440	554
2					575	615	385	432	440	583
3					557	547	365	470	435	575
4					682	505	375	465	450	583
5					755	490	365	442	430	651
6					970	475	365	439	425	591
7					849	475	365	430	425	540
8					730	451	355	425	425	526
9					682	460	365	425	425	505
10					660	547	365	455	440	487
11					651	475	1,780	425	440	615
12					615	460	1,410	550	450	637
13					583	440	1,260	505	450	850
14					568	420	5,600	655	440	1,930
15					540	420	2,500	840	440	3,800
16					533	420	1,900	780	435	4,050
17					557	400	1,290	760	457	1,930
18					547	400	1,050	710	435	1,410
19					523	395	1,000	625	432	1,150
20					490	385	930	600	435	1,040
21					490	385	715	475	443	1,000
22					490	395	650	530	440	1,070
23					475	385	614	505	420	1,200
24					505	379	600	500	432	1,020
25					547	375	605	480	432	920
26					512	375	565	465	432	880
27					765	379	534	465	425	1,650
28				615	745	385	512	458	425	1,840
29				615	705	379	482	458	420	1,150
30				607	942	379	465	450	425	1,000
31				583		375	460		430	
1910.										
1		430	686	458	448	338	315	462	350	345
2		430	659	458	448	342	300	405	340	348
3		450	641	452	427	335	305	375	355	355
4		460	641	448	427	330	290	360	337	340
5		500	740	448	420	335	290	1,270	348	340
6		1,000	641	438	424	320	290	1,500	337	348
7		2,500	605	434	417	330	285	731	348	335
8		2,500	573	434	405	325	305	573	330	348
9		2,000	573	434	402	325	305	490	322	340
10	*a* 464	1,800	557	417	402	320	305	441	335	340
11		1,600	557	414	405	335	298	414	332	340
12		1,380	533	414	393	322	305	408	330	340
13		1,560	529	414	393	322	340	387	330	332
14		1,900	525	414	390	325	390	384	330	348
15		1,790	525	402	387	330	366	375	330	355
16		1,450	529	417	384	322	355	355	330	348
17		1,180	525	504	384	350	375	340	340	340
18		1,080	549	472	375	338	441	358	340	335
19		1,020	525	486	366	320	396	355	332	340
20		1,020	518	483	360	315	375	350	340	340
21		1,000	518	545	360	310	350	348	350	355
22		985	508	1,270	372	325	360	340	345	348
23		945	497	686	360	310	335	348	348	330
24		879	490	623	358	322	335	366	350	355
25		853	508	585	363	310	335	387	348	348
26		789	508	557	360	320	335	378	340	348
27		760	494	525	363	305	335	402	335	350
28		734	486	508	375	305	315	363	348	348
29		703	486	483	348	308	305	360	340	335
30		730	476	483	348	300	355	355	335	315
31		700		462		295	525		332	

a Discharge measurement.

NOTE.—Daily discharge computed from a well-defined rating curve. High water estimates based on 1911 measurements.

Monthly discharge of Root River near Houston, Minn., for 1909–10.

[Drainage area, 1,560 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
June	970	475	627	0.402	0.45	A.
July	730	375	442	.283	.33	B.
August	5,600	355	933	.598	.69	B.
September	840	425	522	.335	.37	B.
October	457	420	435	.279	.32	B.
November	4,050	487	1,160	.744	.83	C.
December			*a* 600	.385	.44	C.
1910.						
January			*a* 500	.321	.37	B.
February			*a* 450	.288	.30	B.
March	2,500	430	1,130	.724	.83	C.
April	740	476	553	.354	.40	B.
May	1,270	402	502	.322	.37	A.
June	448	348	389	.249	.28	A.
July	350	295	322	.206	.24	A.
August	525	285	339	.217	.25	A.
September	1,500	340	466	.299	.33	A.
October	355	322	339	.217	.25	A.
November	355	315	343	.220	.25	A.
December			*a* 310	.199	.23	B.
The year	2,500		470	.301	4.10	

a Estimated.

NORTH BRANCH OF ROOT RIVER NEAR LANESBORO, MINN.

This station, which is located at the Casey highway bridge, 2½ miles northeast of Lanesboro and 1 mile above the junction with the South Branch, in sec. 6, T. 103 N., R. 9 W., was established January 30, 1910.

There are no tributaries for a distance of several miles above the station.

The nearest dam is located above the Middle Branch 28 miles above, and its operation has no appreciable effect on the flow at the gaging station.

The drainage area above this station is 647 square miles.

A chain gage is attached to the highway bridge from which discharge measurements are made.

At a distance of 1,000 feet back from the right bank there is an old channel through which the river formerly discharged. At a stage of 6 feet on the gage the river begins to flow in this channel. An extreme flood stage the right bank will be overflowed for a width of one-fourth mile.

As the station has not been established sufficiently long to be completely rated no estimates of flow have been made, and only the base data are given.

Discharge measurements of North Branch of Root River near Lanesboro, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 29	G. A. Gray	103	252	2.28	191
June 24	Robert Follansbee	100	225	2.09	134
Sept. 21	.....do	100	225	2.09	136

Daily gage height, in feet, of North Branch of Root River near Lanesboro, Minn., for 1910.

[Kreston E. Hoium, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		2.80	2.90	3.60	2.20	2.28	2.10	2.08	2.29	2.26	2.18
2		2.80	2.80	3.60	2.20	2.25	2.10	2.10	2.26	2.24	2.18
3		2.80	2.80	3.60	2.30	2.25	2.12	2.10	2.21	2.20	2.19
4		2.70	2.90	3.50	2.30	2.28	2.11	2.12	2.21	2.16	2.19
5		2.70	2.90	3.40	2.20	2.25	2.11	2.12	3.75	2.14	2.18
6		2.70	3.70	3.30	2.25	2.22	2.11	2.12	2.90	2.12	2.19
7		2.70	4.40	3.30	2.30	2.22	2.12	2.15	2.55	2.11	2.16
8		2.80	4.80	3.20	2.20	2.21	2.10	2.18	2.48	2.10	2.16
9		2.60	4.80	3.10	2.30	2.24	2.10	2.21	2.38	2.10	2.19
10		2.60	4.70	3.10	2.30	2.25	2.10	2.25	2.24	2.09	2.19
11		2.60	4.70	3.10	2.30	2.22	2.10	2.25	2.21	2.09	2.18
12		2.60	3.80	3.20	2.20	2.21	2.12	2.20	2.20	2.06	2.16
13		2.60	4.70	3.20	2.20	2.20	2.11	2.20	2.21	2.06	2.21
14		2.70	4.70	3.20	2.25	2.18	2.10	2.30	2.24	2.08	2.21
15		2.70	4.60	3.20	2.20	2.16	2.10	2.24	2.25	2.09	2.21
16		2.60	4.40	3.20	2.30	2.15	2.11	2.26	2.24	2.08	2.19
17		2.60	3.80	3.10	2.40	2.12	2.12	2.29	2.24	2.08	2.19
18		2.60	3.80	3.10	2.40	2.12	2.11	2.30	2.21	2.12	2.20
19		2.60	3.70	3.10	2.40	2.10	2.10	2.32	2.21	2.12	2.21
20		2.70	3.60	3.00	2.40	2.12	2.12	2.30	2.24	2.12	2.22
21		2.70	3.60	3.00	2.40	2.11	2.12	2.28	2.25	2.12	2.24
22		2.60	3.60	3.00	2.50	2.15	2.12	2.28	2.26	2.15	2.28
23		2.60	2.80	3.10	2.50	2.15	2.12	2.30	2.24	2.16	2.28
24		2.60	2.80	3.00	2.42	2.15	2.10	2.26	2.22	2.16	2.22
25		2.60	2.70	2.80	2.45	2.15	2.10	2.25	2.24	2.18	2.22
26		2.70	2.70	2.80	2.40	2.15	2.10	2.22	2.25	2.18	2.20
27		2.90	2.80	2.70	2.38	2.15	2.08	2.20	2.26	2.15	2.20
28		2.90	2.80	2.70	2.35	2.14	2.06	2.20	2.28	2.15	2.18
29			2.90	2.60	2.34	2.11	2.05	2.28	2.26	2.18	2.18
30	2.80		2.90	2.50	2.30	2.10	2.05	2.30	2.26	2.15	2.18
31	2.70		2.80		2.29		2.05	2.30		2.18	

NOTE.—Ice present from Jan. 1 to Mar. 8, and from Dec. 1 to 31.

WISCONSIN RIVER.

GENERAL FEATURES OF AREA DRAINED.

The drainage basin of Wisconsin River, except for a few square miles, lies wholly within the State of Wisconsin. The river rises in Lake Vieux Desert, lying directly on the boundary line between upper Michigan and Wisconsin, whence it flows in a southwesterly direction for about 300 miles to the city of Portage, near the center of Portage County. At this point it turns westward and empties into Mississippi River at Prairie du Chien, Wis., about 40 miles from the southern boundary of the State. The important tributaries beginning at the sources are as follows: On the west or right bank of the river, Tomahawk, Rib, Big Eau Pleine, Eau Pleine, Yellow, Lemonweir, Baraboo, Pine, and Kickapoo rivers; on the left bank, Pelican, Prairie, Eau Claire, and Plover rivers.

The total length of the river is about 429 miles. Its basin is about 225 miles long and about 50 miles average width, and comprises approximately 12,280 square miles.

The river flows, for the most part, in the eastern half of its basin. Below Portage it flows within 10 miles of its southern edge. At Portage the divide between Wisconsin River and Fox River is so low that during high water the current in one of the tributaries of the Wisconsin is reversed and flows into the Fox.

Like all the large rivers of the State, the Wisconsin heads in the high drift-covered region. That part of the basin which lies above Nekoosa, including more than half of the drainage area, is underlain by crystalline rocks, which, by presenting a barrier to erosion, cause numerous rapids that afford excellent sites for water power. Below Nekoosa the crystalline rocks give way to the softer sandstone, the disintegration of which has made the bed of the river a succession of shifting sand bars almost without interruption to its mouth. Where this formation is near the surface in the surrounding country the soil is very light and in places even sterile. North of Nekoosa this sandy belt rapidly narrows, and at Merrill, Wis., about 90 miles above, almost entirely disappears, and is replaced by the clayey loams and loamy clays. North of Tomahawk the clays are again replaced by sandy soils containing gravel and by bowlders and glacial drift.

In general the country is level or undulating. In places decided ridges break the surface, as, for example, the Baraboo ranges of quartzite and the bluffs along the lower river. The northern part of the drainage area is covered with innumerable lakes and swamps which tend to make the flow of the stream uniform and steady.

According to the United States Engineer Corps the elevation of Lake Vieux Desert, the source of the river, is about 1,650 feet above sea level; the elevation at the mouth is about 604 feet; the total fall is therefore about 1,050 feet. About 634 feet of this fall occur in the 150 miles between Rhinelander and Nekoosa, an average of over 4 feet to the mile. This descent is concentrated at many places, producing a large number of valuable water-power sites, many of which are still undeveloped.

The dense growth of pine which covered the upper part of the drainage basin of Wisconsin River has nearly all been cut off, and a thick growth of brush and second-growth timber has taken its place. Large areas have been brought under cultivation. In some places this second growth has been burned over, leaving almost impenetrable thickets of brush and dead timber. The effect of this new growth of brush and timber on the run-off is probably about the same as that of the pine forests which it has replaced.

The mean annual rainfall on the headwaters of the river is about 31 inches; at the lower part of the basin the rainfall is about 34 inches.

The winters, except in the very lowest part of the basin, are severe. The snowfall is comparatively heavy and stays on the ground for long periods, and the streams are covered with ice from 1 to 2 feet in thickness for three or four months. These conditions tend to make the winter season the period of minimum flow, and winter discharge measurements are therefore very valuable.

The basin affords many sites for storage. The United States Engineer Corps located and surveyed eight reservoir sites at the headwaters of Wisconsin River to aid navigation of Mississippi River. The capacity of these reservoirs is about 20,000,000,000 cubic feet, and it was estimated that a flow of 3,000 cubic feet per second could be maintained for three months. Such a flow would nearly double the low-water flow of the river and its resulting water power. Several of these reservoirs have been constructed by private parties for water-power development. The Wisconsin Valley Improvement Co. has been authorized by law to construct, acquire, and maintain a system of reservoirs located on the tributaries of the Wisconsin River north of the south line of township 34, about 6 miles below Tomahawk, for the purpose of producing a uniform flow of water, etc. The law provides that when this company shall have completed reservoirs of a capacity of 2,000,000,000 cubic feet it may collect and receive reasonable tolls from the owner of every improved and operated water power located on the river below such reservoirs. The tolls are to yield not to exceed 6 per cent on the actual investment.

The stream is used quite extensively for logging, but the greater part of the large timber has been cut off and lumbering is decreasing, although considerable pulp wood is being run on the river. Dams at the water-power sites would not interfere seriously with the small run of logs at the present time.

In order to determine the amount of power available along Wisconsin River a survey was made during 1906 between Sauk City and Dekorra and between Lewiston station and Jersey City. From the data collected sheets have been prepared, showing a profile of the water surface, a plan of the river, contour along the bank, and prominent natural or artificial features. The results of this survey have been published on separate sheets and may be obtained by applying to E. A. Birge, director, Wisconsin Geological and Natural History Survey, Madison, Wis. From this survey the following table of distances and elevations has been compiled.

Elevations and distances along Wisconsin River.

Place.	Distance above Sugar Bone Rock.	Elevation above sea level.
	Miles.	*Feet.*
Kilbourn City	3	818
The Narrows	5	819
Lemonweir River	13.5	837
Yellow River	25	858
Little Roche a Cri River	30.5	865
Town line 18-19 N	39	879
Range line 4-5 E	50	896
Section line 20-21	59	905
Foot of rapids below Nekoosa dam	71.3	916
Crest of Nekoosa dam	71.5	939
Foot of dam at Port Edwards	76.5	948
Crest of dam at Port Edwards	76.5	958
Tail-water dam below Grand Rapids	78	960
Headwater dam below Grand Rapids	78	971
Tailwater Grand Rapids dam	80.5	978
Headwater Grand Rapids dam	80.5	1,004
Tail-water dam above Grand Rapids	83	1,006
Headwater dam above Grand Rapids		1,018
Foot of lower dam at Conant Rapids	97	1,035
Crest of lower dam at Conant Rapids	97	1,044
Foot of upper dam at Conant Rapids	97.5	1,044
Crest of upper dam at Conant Rapids		1,061
Foot of rapids below Stevens Point dam	100	1,066
Crest of dam	100	1,077
Knowlton	120	1,095
Foot of Mosinee dam	130	1,111
Crest of Mosinee dam	130	1,126
Crest, Little Bull Falls	130.5	1,129
Eau Claire River	142.5	1,142
Foot of Wausau dam	147	1,158
Crest of Wausau dam	147	1,179
Foot of Brokaw dam	152	1,186
Crest of Brokaw dam	152	1,201
Marathon-Lincoln County line	160.5	1,214
Foot of lower dam at Merrill	167	1,233
Crest of lower dam at Merrill	167	1,245
Foot of upper dam at Merrill	169	1,246
Crest of upper dam at Merrill	169	1,251
Range line 5-6 E	178	1,280
Foot of Grandfather Falls	181	1,300
Crest of Grandfather Falls	182.5	1,385
Foot of Tomahawk dam	194.5	1,417
Crest of Tomahawk dam	194.5	1,431

A survey was also made along Eau Claire River during 1906, from the mouth of the river to Johnson. From the data collected sheets have been prepared, showing a profile of the water surface, a plan of the river, contours along the bank, and prominent natural or artificial features. The results of this survey have been published on separate sheets and may be obtained by applying to E. A. Birge, director Wisconsin Geological and Natural History Survey, Madison, Wis.

WISCONSIN RIVER NEAR RHINELANDER, WIS.[1]

This station, which is located at a highway bridge about 8 miles southwest of Rhinelander, Wis., in sec. 27, T. 36 N., R. 8 E., at Forbes & Wixson's power station, was established December 1, 1905, to obtain data for studies of water power, water supply, pollution, and storage problems.

[1] Information in regard to this station prior to 1908 is contained also in Bulletin 20 of the Wisconsin Geological and Natural History Survey, entitled "Water powers of Wisconsin," by Leonard S. Smith.

Pelican River enters about 8 miles above the station.

The winters in this vicinity are severe, but the operation of the power plant about 400 feet above the bridge prevents the river from freezing at the gaging section, and ice forms only in narrow strips along the shores. The pond above the dam modifies the normal flow, and the total range in gage height is small. The fluctuations of the load on the turbines may also affect discharge measurements.

The station was last visited in July, 1908. As far as known the datum of the gage has remained constant and the records are reliable and accurate.

The gage reader at the station is paid by the Wisconsin Valley Improvement Co., Wausau, Wis.

Daily gage height, in feet, of Wisconsin River near Rhinelander, Wis., for 1910.

[Geo. N. Kramer, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.8	2.8	2.9	3.1	2.6	2.4	2.2	2.3	2.0	2.2	2.3	2.1
2	2.8	2.8	3.0	3.3	3.1	2.2	2.2	2.2	2.7	1.7	2.4	2.1
3	3.1	3.1	3.5	2.0	2.9	2.4	1.1	2.1	2.4	2.1	2.2	1.6
4	2.5	3.1	2.9	2.8	3.0	2.4	1.0	2.1	1.2	2.0	2.2	1.6
5	3.2	3.2	3.5	3.3	3.0	1.7	2.2	2.1	1.8	2.0	2.1	1.9
6	3.0	2.2	2.1	3.4	3.1	2.7	2.2	2.1	2.4	2.8	1.7	2.2
7	2.5	3.2	3.0	3.3	2.9	2.3	2.9	1.2	2.2	2.2	2.3	2.5
8	3.3	2.7	2.7	3.3	1.9	2.8	2.3	2.1	2.4	2.3	2.3	2.3
9	2.8	2.6	2.4	3.0	2.9	2.5	2.2	2.1	2.4	1.6	2.2	2.2
10	2.8	3.1	2.3	2.0	2.2	2.3	1.1	2.4	2.4	2.2	2.3	2.2
11	3.0	2.8	2.5	2.9	2.6	2.3	2.3	2.2	1.7	2.2	2.3	2.2
12	3.0	3.1	2.8	3.0	2.2	1.0	2.3	2.1	2.4	2.2	2.3	2.2
13	3.1	2.8	2.0	2.8	2.2	2.4	2.2	2.3	2.4	2.1	1.8	2.2
14	3.0	2.7	2.8	2.5	2.2	2.5	2.2	2.0	2.5	1.9	2.2	2.2
15	3.1	2.9	2.5	2.8	1.6	2.2	2.3	2.2	2.6	1.9	2.3	2.3
16	2.8	3.4	2.8	2.9	2.4	2.2	2.4	2.3	2.5	1.6	2.3	2.5
17	2.7	2.7	2.7	2.2	2.6	2.2	1.0	2.2	2.5	2.1	2.3	2.4
18	3.1	3.2	2.8	3.0	2.2	2.2	2.3	2.2	1.1	2.1	2.2	2.2
19	2.8	3.3	2.7	3.0	2.6	1.0	2.3	2.0	2.3	2.1	2.2	2.2
20	3.0	2.1	1.8	2.6	2.8	2.2	2.1	1.9	2.4	2.2	1.6	2.3
21	3.0	3.4	2.7	3.0	2.9	2.2	2.3	1.1	2.2	2.2	2.1	2.2
22	2.8	3.3	2.9	2.8	2.3	2.2	2.3	2.0	2.0	2.2	2.1	2.2
23	2.9	2.9	3.0	2.7	3.0	2.1	2.0	2.0	2.0	1.7	2.1	2.2
24	2.7	3.3	3.2	2.1	2.9	2.2	1.7	2.1	2.0	2.1	2.2	1.9
25	2.6	3.4	3.2	2.6	3.0	2.2	2.0	2.1	1.1	2.1	2.2	1.9
26	2.8	3.4	3.2	3.0	3.1	1.0	2.0	2.2	2.1	2.1	2.1	2.2
27	2.6	2.8	2.2	3.0	3.0	2.1	2.4	2.2	2.1	2.6	1.8	2.6
28	2.5	3.4	3.4	3.1	2.9	2.1	2.1	1.7	2.2	2.4	2.4	2.7
29	2.5	......	3.2	3.3	2.1	2.1	2.3	2.0	2.2	2.6	2.2	2.5
30	2.8	......	2.9	3.2	2.9	2.2	2.1	2.0	2.2	1.8	2.2	2.3
31	2.8	......	3.0	......	2.8	......	1.7	2.0	......	2.3	......	2.6

WISCONSIN RIVER AT MERRILL, WIS.[1]

This station, which is located at a highway bridge at the east end of Merrill, Wis., was established November 17, 1902, to obtain data for water power, water supply, pollution, and storage problems.

[1] Information in regard to this station is contained also in Bulletin 20 of the Wisconsin Geological and Natural History Survey, entitled "Water powers of Wisconsin," by Leonard S. Smith.

The bridge is about 1,000 feet below a dam. Prairie River enters from the east about half a mile above the station. The flow is somewhat modified by the dam and power plants above the station.

The current is so swift that ice does not form across the section, and there is open water at the gage the year around, but winters are severe, and the relation between gage height and discharge is affected by backwater caused by ice. The stream is used considerably for log running, and backwater caused by jams below the measuring section may affect the gage heights for short periods.

The datum of the chain gage has remained unchanged; the records are reliable and accurate except as conditions above may affect the readings.

This station was last visited in February, 1909.

The gage reader at this station has been paid by the Wisconsin Valley Improvement Co., Wausau, Wis., since April, 1909.

Daily gage height, in feet, of Wisconsin River at Merrill, Wis., for 1910.

[A. F. Lueck, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.75	4.9	4.8	5.7	5.95	5.25	4.0	3.35	4.35	4.4	3.95	3.85
2	4.65	4.9	5.0	5.8	5.7	4.7	3.95	3.35	4.35	4.3	4.2	3.95
3	4.9	4.9	4.85	5.75	5.65	4.65	3.5	4.3	4.35	4.1	4.6	3.95
4	4.95	5.05	4.95	5.2	5.3	4.5	3.15	4.1	4.25	4.55	4.55	3.85
5	4.8	5.05	5.0	5.0	4.85	4.05	2.95	4.15	4.35	4.2	4.75	3.6
6	4.95	4.85	5.2	6.45	4.8	3.35	3.35	3.95	4.15	4.4	3.9	3.75
7	4.95	4.75	5.3	7.1	4.65	4.65	2.7	3.95	3.95	4.55	3.9	3.9
8	4.95	4.3	4.95	6.9	4.8	4.45	3.35	3.6	4.0	4.65	3.85	3.9
9	4.9	4.9	4.85	6.5	4.95	4.75	4.2	3.85	4.2	4.3	4.35	3.8
10	4.95	4.9	4.55	6.1	4.9	4.8	4.15	3.95	4.5	4.35	3.95	3.95
11	5.05	4.75	4.75	5.85	4.8	4.55	4.1	2.9	4.4	4.3	3.55	4.05
12	4.9	4.9	4.75	5.5	4.65	4.35	3.4	4.0	4.3	4.15	4.35	3.95
13	4.8	4.8	4.75	5.9	4.7	4.5	3.95	2.75	4.1	4.2	4.15	4.05
14	4.85	4.65	4.9	5.75	4.35	4.4	4.1	3.9	4.55	3.7	4.5	4.15
15	4.85	4.7	5.4	5.25	4.2	4.15	4.0	3.4	5.0	4.35	4.2	4.15
16	4.95	4.95	5.25	5.45	4.25	4.05	4.15	3.7	4.6	3.2	4.15	4.05
17	4.8	4.75	5.2	5.7	4.15	3.55	3.95	3.95	3.95	3.95	4.2	4.45
18	4.95	4.75	5.0	6.0	5.35	4.15	3.85	3.95	4.15	4.25	4.2	4.05
19	4.9	4.9	5.2	6.2	5.65	4.15	3.8	4.0	3.65	4.3	4.15	4.2
20	4.95	4.8	5.3	6.15	6.15	3.4	3.95	3.95	4.25	4.5	4.05	4.2
21	4.8	4.65	6.1	6.35	6.1	3.65	3.4	3.85	4.05	4.2	4.05	4.35
22	4.85	4.95	6.2	6.3	6.15	3.9	4.0	3.3	4.1	4.55	3.95	4.4
23	4.8	4.9	6.1	6.0	6.25	3.45	4.05	4.0	3.85	4.65	3.8	4.5
24	4.9	5.05	5.85	6.1	6.05	3.5	3.8	3.85	3.7	4.7	3.9	4.6
25	4.5	4.85	5.8	5.65	5.65	4.0	4.05	4.1	3.95	4.5	3.85	4.65
26	4.75	5.05	6.05	6.05	5.5	3.0	4.05	4.1	4.1	4.1	3.95	4.35
27	4.9	4.9	5.95	6.4	5.55	2.8	4.0	4.25	4.3	4.55	3.95	3.6
28	5.05	4.7	5.7	6.4	5.9	4.05	4.05	4.0	4.2	4.7	4.0	4.25
29	4.65	......	5.75	6.3	5.2	4.05	4.05	3.9	3.65	4.45	4.2	4.3
30	4.65	......	6.0	6.1	4.6	4.05	4.0	4.0	4.4	4.35	3.95	4.4
31	4.8	......	6.35	......	4.95	......	4.05	4.4	......	4.5	......	4.65

WISCONSIN RIVER NEAR NECEDAH, WIS.[1]

This station, which is located at the highway bridge about 3 miles east of Necedah, Wis., on the road from Necedah to Strongs Prairie, was established December 2, 1902, to obtain data for studying water power, water supply, and pollution problems.

Big Roche a Cri Creek enters from the west about 5 miles below the station. The drainage area above the section is about 5,800 square miles.

The winters in this region are severe. Ice forms from 1 to 2 feet in thickness and lasts for about three months. Part of the river bottom is liable to shift in floods. But few discharge measurements have been made since 1906. The 1906 discharge table should not be used for later years.

The datum of the chain gage has remained unchanged. The gage heights are reliable and accurate.

The gage reader at this station has been paid since April, 1909, by the Wisconsin Valley Improvement Co., Wausau, Wis.

Discharge measurements of Wisconsin River near Necedah, Wis., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 20	Stewart and Babcock[a]	210	348	2.10	543
22	do.[a]	282	667	3.80	850
Sept. 9	V. H. Reineking[b]	270	839	4.75	1,800

[a] Meter was held at mid-depth for velocity reading and a coefficient of 0.92 applied to the result to reduce it to the mean velocity of each section. Measurement made by engineers of the Wisconsin Valley Improvement Co.

[b] Mean velocity obtained in each section by the vertical curve method. Measurement made by engineer employed by D. W. Mead.

Daily gage height, in feet, of Wisconsin River near Necedah, Wis., for 1910.

[M. Coughlin, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1				6.9	8.4	6.0	4.85	4.2	4.5	4.4	4.9	6.0
2				7.0	7.95	5.95	4.5	4.75	4.75	4.5	4.9	6.5
3				7.0	7.55	5.8	4.75	4.4	4.7	4.2	5.15	
4		6.55		6.8	7.25	5.7	4.5	4.15	4.85	5.2	5.2	
5			6.65	6.8	6.65	5.6	4.1	4.25	5.15	4.6	5.3	
6				6.45	6.55	5.4	5.0	4.2	5.25	4.75	5.25	
7	6.8			6.8	6.6	5.7	5.4	4.45	4.6	4.9	4.7	
8				8.1	6.45	5.15	4.4	4.1	4.55	4.7	4.65	
9				9.1	6.0	5.4	4.4	4.75	4.85	4.35	4.6	
10				8.85	6.2	5.45	4.35	4.25	4.8	5.3	4.9	
11		6.55	6.8	8.4	6 0	5.3	4.3	4.4	4.35	5.4	5.2	
12				7.95	5.8	5.3	4.45	4.25	4.75	4.85	5.25	5.75
13				7.35	5.65	5.15	4.45	4.4	4.9	5.0	4.95	
14	6.8			7.1	5.5	5.3	4.4	4.55	4.4	4.8	4.9	
15			7.0	6.75	5.65	5.1	4.45	4.1	5.0	4.65	5.25	

[1] Information in regard to this station prior to 1908 is contained also in Bulletin 20 of the Wisconsin Geological and Natural History Survey, entitled "Water powers of Wisconsin," by Leonard S Smith

Daily gage height, in feet, of Wisconsin River, near Necedah, Wis., for 1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16			6.8	6.7	5.35	4.9	4.55	4.5	5.3	4.7	4.75	
17			7.25	6.9	5.7	4.9	4.35	4.4	4.85	4.4	4.65	
18		6.55	6.55	6.6	5.3	4.7	4.7	4.2	4.7	5.0	4.65	
19			6.3	6.95	5.65	4.95	4.3	4.4	4.9	4.6	4.6	5.5
20			6.45	7.75	5.45	4.9	4.2	4.65	5.1	5.0	4.7	
21	6.75		6.25	7.85	6.35	5.1	4.5	4.75	4.5	5.1	4.7	
22			7.95	7.8	6.85	4.85	4.3	4.25	5.1	5.1	5.35	
23			7.55	7.75	6.65	4.8	4.6	4.55	4.95	4.6	5.15	
24			7.65	7.55	6.9	4.8	4.6	4.45	4.85	5.5	4.6	
25		6.5	7.8	7.7	7.1	4.7	4.1	4.25	4.9	4.6	4.55	
26			7.65	8.0	7.1	4.75	4.65	4.45	5.7	4.55	4.6	5.1
27			7.85	8.0	6.8	4.8	4.55	4.4	4.65	4.45	4.95	
28	6.8		7.65	8.2	6.75	4.9	4.35	4.3	4.6	4.6	4.55	
29			7.7	9.0	6.6	4.75	4.2	4.2	4.45	4.3	5.25	
30			7.25	8.85	6.45	4.5	4.35	4.7	4.75	4.35	4.9	
31			7.0		6.3		4.5	4.4		4.15		

NOTE.—Ice present from Jan. 1 to Mar. 14, ranging in thickness from 1.2 to 1.6 feet. Ice existed also from Dec. 3 to 31, its average thickness being approximately 1 foot.

WAPSIPINICON RIVER.

GENERAL FEATURES OF AREA DRAINED.

The drainage basin of Wapsipinicon River lies almost entirely in the northwestern part of Iowa. The river rises a few miles north of the Minnesota State line in Mower County, flows southeastward, and joins the Mississippi along the southern boundary of Clinton County, Iowa, about 10 miles below the city of Clinton, Iowa. The length of the river, not following the numerous bends, is about 220 miles, and the total length by stream course is not far from 300 miles. The drainage basin is approximately 185 miles long and 14 miles in average width.

The tributaries are all small. The more important are the West, Middle, and East branches, which unite above Tripoli in Bremer County, and Little Wapsipinicon River and Buffalo Creek, which enter from the east.

The basin is underlain by limestones which have been thinly covered with glacial drift. The surface of the country is a gently undulating prairie, and the valley of the river is narrow with gently sloping sides. Near Anamosa the valley is narrow and picturesque; the bed and banks are rocky, the banks rising to a good height and in places running abruptly up into bluffs.

The elevation of the sources of the river is about 1,250 feet; at Independence the elevation is about 900 feet; at Stone City, about 780 feet; at the mouth the elevation is 560 feet.

The drainage basin contains no forested areas. The mean annual rainfall is about 32 inches. The winters are severe, snowfall is heavy, and ice forms from 1 to 2 feet in thickness and lasts about three months.

Storage sites have not been investigated, but the toporagphy of the basin is unfavorable and the high value of the land for farming would undoubtedly prohibit the construction of reservoirs.

A number of fair power sites are found along the river, some of which have been developed. Conditions are favorable for building dams, as the banks are as a rule firm, and rock forms the river bed in many places. The geological formation tends to keep the flow of the river fairly uniform and steady, as the glacial drift is thin and much of the rainfall reaches the river through springs.

WAPSIPINICON RIVER AT STONE CITY, IOWA.

This station is located at Stone City, Iowa, at the highway bridge, a short distance above the Chicago, Milwaukee & St. Paul Railway bridge. It was established August 19, 1903, to obtain data for use in studying water power, water supply, and pollution problems.

Buffalo Creek is tributary about 4 miles below the station.

Discharge measurements are made from the highway bridge to which the gage is attached.

Winters are severe; ice forms from 1 to 2 feet in thickness and lasts about three months.

The gage readings at this station are furnished by the courtesy of Mr. Frank Dearborn.

Daily gage height, in feet, of Wapsipinicon River at Stone City, Iowa, for 1910.

[Frank Dearborn, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	4.22	3.50	3.42	2.70	2.30	2.50	2.85	2.52	2.15
2	......	2.95	3.55	4.05	3.30	3.40	2.70	2.30	2.44	2.80	2.50	......
3	......	......	......	3.95	3.40	3.25	2.68	2.30	2.40	2.84	2.48	......
4	......	......	......	3.80	3.38	3.22	2.65	2.28	2.40	2.80	2.45	......
5	3.96	......	......	3.82	3.33	3.18	2.62	2.28	2.48	2.73	2.45	......
6	......	......	4.15	4.45	3.28	3.15	2.62	2.28	2.54	2.73	2.45	......
7	......	......	6.05	4.52	3.20	3.10	2.58	2.25	2.50	2.70	2.42	2.32
8	......	......	6.45	4.23	3.18	3.07	2.53	2.25	2.50	2.70	2.42	......
9	......	3.35	7.05	4.00	3.15	3.08	2.52	2.24	2.54	2.65	2.40	......
10	......	......	7.70	3.85	3.15	3.05	2.50	2.22	2.58	2.65	2.40	......
11	......	......	8.00	3.70	3.13	3.02	2.50	2.22	2.55	2.62	2.40	......
12	......	......	9.05	3.62	3.10	3.00	2.50	2.20	2.50	2.62	2.40	......
13	3.73	......	8.86	3.60	3.08	3.08	2.45	2.18	2.50	2.60	2.40	......
14	......	......	9.30	3.65	3.06	2.95	2.45	2.17	2.58	2.62	2.42	2.25
15	......	3.97	8.85	3.78	3.05	2.92	2.44	2.15	2.52	2.60	2.42	......
16	......	......	10.97	3.80	3.05	2.90	2.42	2.25	2.55	2.60	2.40	......
17	......	......	11.30	3.88	3.25	2.86	2.40	2.22	2.60	2.58	2.45	......
18	......	......	11.00	3.80	3.58	2.85	2.40	2.65	2.58	2.60	2.40	......
19	......	......	10.20	3.66	3.48	2.82	2.40	2.30	2.54	2.55	2.40	......
20	3.69	......	8.92	3.59	3.36	2.80	2.40	2.25	2.50	2.58	2.40	......
21	......	......	8.08	3.55	3.32	2.80	2.40	3.65	2.55	2.60	2.38	2.28
22	......	......	7.35	3.50	3.52	2.78	2.40	2.95	2.50	2.55	2.38	......
23	......	3.70	6.90	3.53	3.80	2.75	2.40	2.73	2.65	2.52	2.35	......
24	3.00	......	6.55	3.62	3.63	2.72	2.38	2.65	2.84	2.55	2.40	......
25	......	......	6.18	3.55	3.70	2.69	2.35	2.62	2.68	2.60	2.42	......
26	......	......	5.92	3.50	3.62	2.68	2.34	2.52	2.95	2.60	2.45	......
27	......	......	5.55	3.48	3.50	2.82	2.34	2.50	3.22	2.60	2.55	......
28	......	......	5.30	3.42	3.42	2.75	2.42	2.50	2.95	2.55	2.70	2.25
29	......	......	4.95	3.40	3.55	2.68	2.38	2.50	2.94	2.55	2.05	......
30	......	......	4.57	3.37	3.65	2.70	2.33	2.50	2.90	2.55	2.10	......
31	......	......	4.32	......	3.58	......	2.31	2.50	......	2.56	......	......

NOTE.—Ice present from Jan. 1 to Mar. 5, ranging in thickness from 10 inches to 13 inches. Ice also covered the river from Dec. 1 to 31, its thickness being about 9 inches.

Daily discharge, in second-feet, of Wapsipinicon River at Stone City, Iowa, for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1			510	830	470	430	162	78	115	204	119	
2			495	745	370	420	162	78	103	189	115	
3			510	695	420	348	157	78	95	201	111	
4			540	620	410	335	150	75	95	189	105	
5			580	630	385	318	142	75	111	170	105	
6			795	945	361	306	142	75	124	170	105	
7			1,850	980	326	286	133	70	115	162	99	
8			2,090	835	318	275	122	70	115	162	99	
9			2,480	720	306	279	119	69	124	150	95	
10			2,910	645	306	268	115	66	133	150	95	
11			3,120	570	298	257	115	66	126	142	95	
12			3,890	530	286	250	115	63	115	142	95	
13			3,740	520	279	279	105	60	115	137	95	
14			4,080	545	272	234	105	59	133	142	99	
15			3,740	610	268	224	103	56	119	137	99	
16			5,490	620	268	218	99	70	126	137	95	
17			5,830	660	348	206	95	66	137	133	105	
18			5,520	620	510	204	95	150	133	137	95	
19			4,820	550	460	195	95	78	124	126	95	
20			3,790	515	400	189	95	70	115	133	95	
21			3,180	495	380	189	95	545	126	137	92	
22			2,680	470	480	184	95	234	115	126	92	
23			2,380	485	620	176	95	170	150	119	86	
24			2,160	530	535	167	92	150	201	126	95	
25			1,930	495	570	160	86	142	157	137	99	
26			1,770	470	530	157	85	119	234	137	105	
27			1,550	460	470	195	85	115	335	137	126	
28			1,400	430	430	176	99	115	234	126	162	
29			1,210	420	495	157	92	115	231	126	45	
30			1,000	405	545	162	83	115	218	126	50	
31			880		510		80	115		128		

NOTE.—Daily discharge computed from a well-defined rating curve based on measurements made from 1904 to 1906, and checked by measurement made in 1911. From Mar. 1 to 5 the discharge was estimated because of the presence of ice.

Monthly discharge of Wapsipinicon River at Stone City, Iowa, for 1910.

[Drainage area, 1,310 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
March	5,830	495	2,480	1.91	2.20	B.
April	980	405	602	.460	.51	B.
May	620	268	407	.311	.36	B.
June	430	157	241	.184	.21	B.
July	162	80	110	.084	.10	B.
August	545	56	110	.084	.10	B.
September	335	95	146	.111	.12	B.
October	204	119	142	.108	.12	B.
November	162	45	98.9	.075	.08	B.

IOWA RIVER.

GENERAL FEATURES OF AREA DRAINED.

The drainage basin of Iowa River and its tributary, Cedar River, occupies the north-central and southeast-central part of the State of Iowa, and parts of Freeborn, Dodge, Steele, and Mower counties in southern Minnesota. The river rises in the northern part of Hancock

County, Iowa, flows southeastward, and joins Mississippi River in the southeastern part of Louisa County. The length of Iowa River is about 270 miles, not following the bends. The total drainage area is about 12,400 square miles.

Cedar River, which is called a tributary of the Iowa, although its drainage area above their junction is much the larger, rises in the southern part of Dodge County, in southern Minnesota, flows southeastward into Iowa, and continues in that direction until it reaches Moscow, in the northern part of Muscatine County, where it makes an abrupt turn to the southwest and joins the Iowa in Louisa County. The river is about 260 miles long, not following the bends. In its upper course it is called Red Cedar River. The drainage area above its mouth is about 7,600 square miles. It is the only important tributary of the Iowa. The principal tributaries of Cedar River are Little Cedar, Shell Rock, and West Fork of Red Cedar rivers, all of which are tributary above Waterloo.

The drainage basin of Iowa River proper is long and narrow. The river rises in a broad, flat, or slightly undulating drift region, and the first rock exposed in its valley is the limestone that forms the rocky banks of the stream in the southwestern corner of Franklin County; from this point to its confluence with the Cedar, the river crosses a succession of sedimentary rocks. The drift which covers this region is well supplied with springs which help maintain the flow of the stream. The surface of the surrounding country is a gently undulating prairie.

The area is thinly covered with glacial drift underlain by limestone, which is exposed at many places along the main stream and its tributaries. The valleys of the upper tributaries are narrow, with gently sloping sides; below the mouth of the Shell Rock the valley is broad and shallow and is separated from the uplands by distinctly defined borders. The surface of the country is a gently undulating prairie, apparently level in some sections. The upper basin is about 50 miles wide, but the lower is much narrower, and at one point below Cedar Rapids it measures only 8 or 9 miles across.

At the headwaters of both Iowa and Cedar rivers are a few lakes, ranging in area from 2 to 10 square miles.

The elevation of the sources of Iowa River is about 1,250 feet above sea level; at Iowa City the elevation is 670 feet; at the mouth of the Cedar it is 565 feet, and at the junction with the Mississippi the elevation is about 522 feet. The elevation of the sources of Cedar River is about 1,300 feet; at Waterloo about 820 feet; at Cedar Rapids about 725 feet, and at the mouth about 565 feet.

The basin contains no large forested areas. The mean annual rainfall is about 32 inches. The winters are severe, especially in the upper part of the basin. The fall of snow is comparatively heavy, and ice forms to considerable thickness on the streams and lasts for three to four months.

It may be possible to make storage reservoirs at the lakes at the headwaters of both Cedar and Iowa rivers, but the overflow damages would undoubtedly prohibit their construction.

Iowa and Cedar rivers are by far the most important streams in Iowa for water power. Power sites of small head are numerous, and a number of them have been developed. Those on Cedar River are more important than those on the Iowa. The numerous rock outcrops furnish good foundations for dams. The flow of the streams is sustained by numerous springs, but during long-continued droughts the flow becomes very low.

CEDAR RIVER NEAR AUSTIN, MINN.

This station, which is located just below the Red Cedar mill dam, 2 miles below Austin, in sec. 15, T. 102 N., R. 18 W., was established May 29, 1909, for the purpose of determining the amount of water power available on Cedar River.

The nearest tributary, Turtle Creek, enters the Cedar 1 mile above the station.

Immediately above the station is the power plant known as Red Cedar Mill. During the low-water season the water is drawn down below the crest of the dam by the end of the 10 or 12 hour run, and after the turbine is closed the water is held back for several hours before it has risen sufficiently to flow over the crest. Consequently the stage of the river changes considerably during each 24 hours. In order to get a mean gage height the gage is read five times daily, as follows: Before the turbine is started in the morning, one hour after starting, at noon, just before shutting down the turbine at night, and half an hour later.

Observations are little affected by ice during the winter months, as the gage is placed near the tailrace of the mill where the river remains open for the most part. A measurement made during February, 1910, gave a result 20 per cent smaller than was indicated by the open channel curve, but it is probable that this discrepancy was largely due to the freezing of the meter, owing to the manner of making the measurement. The winter flow has been computed by reducing the open-season rating 10 per cent.

Since the establishment of the station the datum of the staff gage has remained unchanged.

The natural conditions of flow at this point are excellent, and as there is a favorable measuring section at the highway bridge 100 yards below the gage, excellent results would be obtained were it not for the uncertainty in mean daily gage height resulting from the controlled flow. The system of five daily readings should, however, give the mean with a good degree of accuracy.

Discharge measurements of Cedar River near Austin, Minn., in 1909–10.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 29	J. C. Hoyt	107	136	4.48	128
June 18	G. A. Gray	111	172	4.85	218
18	C. B. Gibson	111	147	4.85	231
July 14	G. A. Gray	108	94.5	3.90	48.6
Aug. 24	Robert Follansbee	113	164	4.67	189
1910.					
Feb. 9	G. A. Gray	99	102	4.62	[a]130
Mar. 12	C. J. Emerson	125	475	6.92	1,110
Apr. 28	G. A. Gray	110	113	4.27	85.6
July 18	.....do	108	100	4.00	49.6

[a] Probably affected by meter freezing.

Daily gage height, in feet, of Cedar River near Austin, Minn., for 1910.

[James C. King, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.73	4.38	4.25	4.64	4.10	4.18	4.04	4.06	4.06	3.97	4.10	3.46
2	3.92	4.44	4.30	4.58	4.15	4.11	4.08	3.96	4.06	3.67	4.06	4.30
3	4.57	4.43	4.42	4.44	4.14	4.08	3.65	4.12	4.04	4.08	4.02	4.00
4	4.49	4.30	4.42	4.56	4.16	4.11	3.68	4.00	3.64	4.00	4.00	3.45
5	4.55	4.34	4.74	4.48	4.03	3.53	4.04	3.83	4.02	4.00	4.04	4.03
6	4.57	4.04	5.33	4.47	4.10	3.96	4.05	4.06	4.10	3.99	3.42	3.46
7	4.54	4.42	6.48	4.44	4.10	4.09	4.00	3.46	4.04	4.00	4.01	4.16
8	4.54	4.36	7.37	4.43	4.08	4.08	3.82	4.00	4.07	4.00	4.00	4.06
9	4.38	4.25	7.44	4.32	4.07	3.95	4.00	4.00	4.06	3.48	4.01	3.41
10	4.48	4.30	6.90	4.09	4.20	4.04	3.92	3.52	4.02	4.10	4.04	4.00
11	4.46	4.32	6.93	4.26	4.10	4.16	3.94	4.02	3.60	4.00	4.06	3.45
12	4.43	4.37	7.00	4.26	4.02	3.80	4.08	4.02	4.07	3.80	3.41	4.02
13	4.41	4.13	8.66	4.28	4.08	4.10	4.11	4.02	4.04	4.02	3.43	4.01
14	4.29	4.39	8.09	4.28	4.04	4.06	4.10	3.50	4.00	4.01	4.02	4.01
15	4.41	4.38	7.14	4.28	3.64	4.06	4.18	4.01	3.98	4.00	4.02	3.41
16	4.30	4.36	6.44	4.28	4.15	4.06	3.94	4.06	4.00	3.53	3.61	4.02
17	4.52	4.32	6.02	4.16	4.38	4.06	3.81	4.03	4.00	4.10	4.08	4.00
18	4.38	4.26	5.75	4.38	4.12	4.04	4.02	4.00	3.51	4.04	4.01	3.45
19	4.34	4.31	5.78	4.32	4.20	3.69	3.94	4.01	4.05	4.08	4.01	4.06
20	4.36	4.17	5.83	4.25	4.26	4.00	4.28	4.04	4.02	4.00	3.50	4.08
21	4.36	4.34	5.79	4.28	4.28	4.04	4.06	3.78	4.00	4.04	4.28	3.41
22	4.35	4.23	5.60	4.31	4.27	3.83	4.05	4.01	4.02	4.00	4.25	3.49
23	4.28	4.34	5.37	4.12	4.20	3.85	4.02	4.04	4.02	3.63	3.49	4.08
24	4.34	4.25	5.30	4.11	4.32	3.90	3.73	4.04	4.02	4.08	3.72	4.04
25	4.34	4.10	5.17	4.37	4.21	3.93	4.02	4.03	3.49	3.80	4.32	3.49
26	4.37	4.22	5.09	4.24	3.80	3.93	4.02	4.02	4.01	4.06	4.24	3.67
27	4.33	4.02	4.92	4.17	4.17	3.96	3.98	4.03	4.01	4.00	3.44	4.07
28	4.32	4.26	4.83	4.20	4.12	3.95	3.98	3.75	4.03	3.96	4.01	4.06
29	4.32	....	4.77	4.22	4.09	4.11	3.59	4.06	4.02	3.98	4.00	3.98
30	4.15	....	4.75	4.21	4.01	4.06	3.90	4.06	3.99	3.92	3.44	3.43
31	4.39	....	4.62	....	4.18	....	3.67	4.00	....	4.08	....	4.08

Daily discharge, in second-feet, of Cedar River near Austin, Minn., for 1909–10.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	......	......	......	......	......	163	181	36	76	70	122	632
2	......	......	......	......	......	146	155	73	70	70	502	632
3	......	......	......	......	......	146	111	62	76	40	443	849
4	......	......	......	......	......	289	84	46	70	48	302	926
5	......	......	......	......	......	309	92	47	48	52	209	424
6	......	......	......	......	......	309	111	18	76	58	144	352
7	......	......	......	......	......	322	96	37	70	63	132	318
8	......	......	......	......	......	302	92	15	63	63	76	254
9	......	......	......	......	......	362	58	34	70	63	92	132
10	......	......	......	......	......	302	111	40	52	63	76	168
11	......	......	......	......	......	251	58	49	58	92	239	138
12	......	......	......	......	......	184	70	70	48	84	774	117
13	......	......	......	......	......	132	38	155	84	122	1,540	138
14	......	......	......	......	......	302	75	1,880	144	84	5,230	138
15	......	......	......	......	......	459	47	2,830	155	76	3,740	128
16	......	......	......	......	......	248	40	1,930	155	76	2,230	117
17	......	......	......	......	......	248	43	1,380	122	63	1,320	117
18	......	......	......	......	......	195	40	1,070	111	84	900	108
19	......	......	......	......	......	144	48	702	48	63	632	98
20	......	......	......	......	......	84	58	474	63	92	565	150
21	......	......	......	......	......	132	38	335	70	92	678	98
22	......	......	......	......	......	84	46	206	63	102	678	117
23	......	......	......	......	......	92	43	195	92	102	523	161
24	......	......	......	......	......	84	43	144	92	48	523	98
25	......	......	......	......	......	144	46	103	84	70	443	68
26	......	......	......	......	......	168	43	122	58	111	750	68
27	......	......	......	......	......	600	44	102	76	76	2,890	98
28	......	......	......	......	......	678	41	100	70	44	2,120	161
29	......	......	......	......	96	462	40	51	70	48	1,270	161
30	......	......	......	......	103	309	37	75	70	48	774	108
31	......	......	......	......	245	......	43	79	......	34	......	108
1910.												
1	169	95	75	165	63	73	56	59	59	49	63	16
2	40	106	82	150	70	64	61	49	59	28	59	82
3	132	104	102	119	68	61	28	66	56	61	54	48
4	115	82	102	146	71	64	30	52	28	52	52	16
5	128	88	192	128	55	23	56	39	54	52	56	50
6	132	52	380	126	63	49	58	59	63	51	19	16
7	125	102	890	119	63	62	52	20	56	52	53	64
8	125	92	1,360	117	61	61	38	52	60	52	52	53
9	95	75	1,400	96	60	48	52	52	59	21	53	14
10	113	82	1,110	62	76	56	46	23	54	63	56	48
11	109	85	1,120	86	63	71	47	54	26	52	59	16
12	104	93	1,160	86	54	37	61	54	60	37	18	50
13	100	60	2,070	89	61	63	64	54	56	54	19	40
14	81	96	1,760	89	56	59	63	22	52	53	54	49
15	100	95	1,240	89	28	59	73	53	50	52	54	14
16	82	92	869	89	70	59	47	59	52	23	26	50
17	121	85	664	71	107	59	38	55	52	63	61	48
18	95	76	544	107	66	56	54	52	22	56	53	16
19	88	84	557	96	76	30	47	53	58	61	53	53
20	92	65	578	84	86	52	89	56	54	52	22	55
21	92	88	561	89	89	56	59	36	52	56	89	14
22	90	72	482	94	87	39	58	53	54	52	84	18
23	79	88	394	66	76	40	54	56	54	28	22	55
24	88	75	369	64	96	44	33	56	54	61	32	52
25	88	57	325	105	78	46	54	55	22	37	96	18
26	93	71	299	82	37	44	54	54	53	59	82	28
27	87	50	245	72	72	49	50	55	53	52	20	54
28	85	76	218	76	66	48	50	34	55	49	53	53
29	85	......	201	79	62	64	26	59	54	50	52	46
30	62	......	195	78	53	59	44	59	51	46	20	15
31	96	......	160	......	73	......	30	52	......	61	......	55

Note.—Daily discharge computed from a well-defined rating curve.

Monthly discharge of Cedar River near Austin, Minn., for 1909–10.

[Drainage area, 425 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
June	678	84	255	0.600	0.67	B.
July	181	37	66.8	.157	.18	A.
August	2,830	15	402	.946	1.09	B.
September	155	48	80.1	.188	.21	B.
October	122	34	71.0	.167	.19	A.
November	5,230	76	997	2.35	2.62	A.
December	926	68	232	.546	.63	B.
1910.						
January	169	40	99.7	.235	.27	B.
February	106	50	81.6	.192	.20	B.
March	2,070	75	636	1.50	1.73	B.
April	165	64	97.3	.229	.26	A.
May	107	28	67.9	.160	.18	A.
June	73	23	53.2	.125	.14	B.
July	73	26	50.7	.119	.14	B.
August	66	20	50.1	.118	.14	B.
September	63	22	51.1	.120	.13	B.
October	63	23	49.5	.116	.13	B.
November	96	18	49.5	.116	.13	B.
December	82	14	39.2	.092	.11	C.
The year	2,070	14	110	.260	3.56	

DES MOINES RIVER.

GENERAL FEATURES OF AREA DRAINED.

Des Moines River rises in the southern part of Minnesota, flows to the south and southeast diagonally across the State of Iowa, and enters the Mississippi near Keokuk, Iowa. Its principal tributaries are East Fork, which enters near Dakotah, in Humboldt County, and Raccoon River, which joins the main stream at Des Moines.

The total drainage area is 14,700 square miles. The area draining in above the Minnesota-Iowa line is 1,220 square miles; above the mouth of the Raccoon, 6,460 square miles. The drainage area of the Raccoon is 3,680 square miles.

The Des Moines throughout its course flows in a well-defined valley eroded for the most part in the glacial drift which covers the entire drainage basin. The depth of the valley increases from 50 to 150 feet, with a width of one-third to two-thirds of a mile between the top of the bluffs along the river. The entire area is within the prairie region and the only timber is found on the borders of the numerous lakes in the upper part of the basin or along the larger streams.

The annual rainfall is about 30 inches. From December to March the streams are frozen over entirely with ice 1 foot or more in thickness.

The Des Moines affords many sites for the development of water power. The lakes in the upper part of the basin aid in regulating the stream flow.

DES MOINES RIVER AT JACKSON, MINN.

This station, which is located at the highway bridge half a mile below the dam at Jackson, was established May 31, 1909, because of the power available on Des Moines River and also as part of the general plan for investigating the water resources of Minnesota.

The nearest tributary is a small stream that enters from the west at a point 300 feet below the station.

At the dam half a mile above the station is a power plant which develops 35 horsepower under a head of 6½ feet. The plant operates only six hours per day on the average, but thus far the morning and evening gage heights do not show any appreciable change in the stage of the river, owing to water being held back in low-water season after the turbines have been shut down.

From December to March observations are discontinued because of ice.

The datum of the gage has remained unchanged since the station was established. Conditions are favorable for good results and the records of flow should be reliable.

Discharge measurements of Des Moines River at Jackson, Minn., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 30	G. A. Gray	77	148	3.95	167
July 19	.....do	70	52.0	2.70	31.3

Daily gage height, in feet, of Des Moines River at Jackson, Minn., for 1910.

[Albert Strobel, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		4.72	3.84	3.08	2.86	2.65	2.60	2.71	2.64
2		4.66	3.79	2.91	3.01	2.64	2.60	2.60	2.78
3		4.60	3.79	2.94	2.81	2.61	2.58	2.68	2.78
4		4.59	3.69	3.02	2.79	2.61	2.60	2.58	2.75
5		4.50	3.69	2.82	2.78	2.59	2.60	2.58	2.72
6		4.39	3.68	2.75	2.78	2.59	2.59	2.64	2.60
7		4.24	3.65	2.78	2.74	2.61	2.58	2.62	2.60
8		4.29	3.60	2.78	2.70	2.61	2.56	2.58	2.70
9		4.28	3.59	3.00	2.72	2.61	2.66	2.58	2.58
10		4.21	3.49	3.62	2.70	2.62	2.65	2.58	2.56
11	6.68	4.16	3.51	3.85	2.78	2.61	2.52	2.54	2.78
12	7.18	4.10	3.50	3.75	2.82	2.60	2.60	2.60	2.72
13	7.30	4.05	3.51	3.54	2.72	2.62	2.70	2.80	2.75
14	7.79	4.00	3.44	3.45	2.72	2.64	2.60	2.75	2.68
15	7.52	4.01	3.40	3.12	2.85	2.62	2.60	2.59	2.64

Daily gage height, in feet, of Des Moines River at Jackson, Minn., for 1910—Continued.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
16	6.64	3.94	3.30	3.21	2.79	2.65	2.72	2.58	2.60
17	6.30	3.98	3.40	3.11	2.75	2.64	2.70	2.69	2.60
18	6.36	3.95	3.46	3.15	2.72	2.66	2.70	2.58	2.58
19	6.16	3.74	3.41	3.02	2.70	2.64	2.58	2.51	2.58
20	6.06	4.02	3.30	2.98	2.72	2.62	2.52	2.55	2.60
21	5.95	4.00	3.34	2.98	2.75	2.61	2.55	2.55	2.68
22	5.88	4.04	3.25	2.90	2.76	2.60	2.55	2.68	2.72
23	5.72	3.92	3.14	2.88	2.76	2.59	2.50	2.75	2.60
24	5.61	3.84	3.12	2.88	2.72	2.60	2.55	2.66	2.78
25	5.45	3.84	3.16	2.80	2.85	2.60	2.55	2.65	2.72
26	5.32	4.08	3.06	2.95	2.69	2.60	2.65	2.68	2.70
27	5.22	4.12	3.14	3.20	2.66	2.60	2.70	2.68	2.70
28	5.12	4.04	3.08	2.98	2.62	2.60	2.72	2.69	2.75
29	5.02	4.02	3.04	2.98	2.65	2.60	2.68	2.65	2.68
30	4.92	3.94	2.94	2.86	2.65	2.58	2.65	2.58	2.70
31	4.82	....	2.98	....	2.65	2.58	....	2.56	....

NOTE.—Ice present from Jan. 1 to Mar. 10 and from Dec. 1 to 31.

Daily discharge, in second-feet, of Des Moines River at Jackson, Minn., for 1910.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	311	145	53	39	29	27	32	29
2	....	299	138	42	48	29	27	27	35
3	....	286	138	43	36	27	26	30	35
4	....	284	122	48	36	27	27	26	34
5	....	265	122	37	35	27	27	26	32
6	....	243	121	34	35	27	27	29	27
7	....	215	116	32	33	27	26	28	27
8	....	224	109	35	31	27	25	26	31
9	....	222	108	47	32	27	29	26	26
10	....	209	94	112	31	28	29	26	25
11	777	200	96	147	35	27	24	25	35
12	909	189	95	132	37	27	27	27	32
13	941	180	96	101	32	28	31	36	34
14	1,070	172	87	88	32	29	27	33	30
15	1,000	174	82	56	38	28	27	27	29
16	766	162	71	63	36	29	32	26	27
17	678	169	82	55	34	29	31	30	27
18	694	164	90	58	32	29	31	26	26
19	642	130	83	48	31	29	26	23	26
20	616	175	71	46	32	28	24	25	27
21	588	172	75	46	34	27	25	25	30
22	570	179	66	41	34	27	25	30	32
23	532	158	57	40	34	27	23	33	27
24	505	145	56	40	32	27	25	29	35
25	468	145	59	36	38	27	25	29	32
26	439	186	51	44	31	27	29	30	31
27	417	193	57	62	29	27	31	30	31
28	395	179	53	46	28	27	32	31	34
29	374	175	50	46	29	27	30	29	30
30	353	162	43	39	29	26	29	26	31
31	332	....	46	....	29	26	....	25	....

NOTE.—Daily discharge computed from a well-defined rating curve.

Monthly discharge of Des Moines River at Jackson, Minn., for 1910.

[Drainage area, 1,160 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
March (11-31)	1,070	332	622	0.536	0.42	B.
April	311	130	199	.172	.19	A.
May	145	43	86.4	.074	.09	A.
June	147	32	57.2	.049	.05	A.
July	48	28	33.6	.029	.03	B.
August	29	26	27.5	.024	.03	B.
September	32	23	27.5	.024	.03	B.
October	36	23	28.1	.024	.03	B.
November	35	26	30.2	.026	.03	B.

ILLINOIS RIVER.

GENERAL FEATURES OF AREA DRAINED.

Illinois River enters the Mississippi from the east about 24 miles above the mouth of the Missouri. Its drainage area, comprising 29,000 square miles, is distributed among three States—Illinois, Wisconsin, and Indiana; 24,700 square miles are in Illinois, extending in a broad band 250 miles long and 100 miles in average width directly across the center of the State in a northeast-southwest direction; 1,080 square miles are in Wisconsin, extending north from the Illinois area; and 3,220 square miles are in Indiana, projecting east from the same area. The eastern projection is the basin of Kankakee River; the northern one contains the basins of Fox and Des Plaines rivers. The name Illinois is applied to the river from the junction of the Kankakee and Des Plaines.

The region drained by the Illinois is level or undulating, and includes some of the finest agricultural land in the United States. Many large and prosperous cities are situated within it, and it is covered with a network of railroads.

The drainage into the Illinois is rather evenly distributed along its course. The more important tributaries are Fox and Spoon rivers from the west, and the Vermilion and Sangamon from the east.

SANGAMON RIVER.

GENERAL FEATURES OF AREA DRAINED.

The drainage basin of Sangamon River lies wholly within the State of Illinois, very nearly in the center of the State. The river rises in the southwestern part of Ford County, flows southwestward to Decatur, in Macon County, thence westward to a point near Springfield, northwestward to its junction with Salt Creek at the northern boundary line of Menard County, and westward to its junction with

Illinois River at the northern boundary of Cass County. Springfield is about 20 miles southwest of the center of the basin, which is roughly a right triangle in shape, with the mouth of the river opposite the vertical. The river is about 180 miles long, not including bends. The total drainage area is 5,410 square miles. The principal tributaries are Salt Creek and South Fork.

The eastern third of the area is somewhat undulating and elevated; the rest is a level prairie. The soil is a very fertile, rich, black loam, especially adapted for raising corn. There are coal mines in the vicinity of Springfield. The bed and banks of the river are soft and insecure. The slope of the river is small. The elevation of its source is about 700 feet above sea level and that of its mouth is about 430 feet. The only timber in this drainage basin is in small groves or along the river banks.

The annual rainfall is about 37 inches. The winters are mild. Ice forms to some extent, and during severe winters attains considerable thickness.

The basin contains many swamp areas and is so level and low that little ground storage is available. High water follows every heavy rain, floods are of frequent occurrence and considerable duration, and as the banks of the river are low large areas are flooded. The drainage of the swamps and the opening up of channels so that flood waters may have an opportunity of returning quickly to the main stream makes the study of flood control and drainage of considerable importance. In some places short sections of the main stream are being straightened in an effort to provide a better channel so that floods will quickly drain off the adjacent land. Such work is of doubtful value, for in a few years at the most the river will return to its former channel or make new channels in order to keep in equilibrium. Any improvement of this kind should take into account the stream as a whole and should be begun at the lower end.

On account of the low slope, floods, low water, and lack of suitable foundations for dams, opportunities for development of water power are lacking.

SANGAMON RIVER NEAR MONTICELLO, ILL.

This station, which is located at the Illinois Central Railroad bridge about half a mile west of Monticello, Ill., was established February 4, 1908, for the purpose of collecting data to be used in studying drainage, water-supply, and flood-control problems.

No important tributaries enter near the station. The principal tributaries below the station are the South Fork of the Sangamon River and Salt Creek.

The relation between gage heights and discharge is somewhat affected by ice during portions of December, January, and February.

Discharge measurements are made from the railroad bridge and a trestle approach on the left bank.

The datum of the chain gage has not been changed; the records are reliable and accurate.

Discharge measurements of Sangamon River at Monticello, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar 11	M. E. McChristie	140	491	5.38	389
11	.....do	140	489	5.38	391
May 14	H. J. Jackson	161	1,010	8.86	1,200
27	.....do	152	773	7.46	767
28	.....do	144	670	6.74	634
Dec. 28	P. S. Monk	147	659	a 6.92	518

a Ice present.

Daily gage height, in feet, of Sangamon River near Monticello, Ill., for 1910.

[Martin Doyle, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.1	5.7	9.0	3.35	......	6.3	4.05	......	2.05	2.4	2.25	2.2
2	3.3	5.4	8.5	3.3	3.75	5.6	3.7	2.1	2.05	......	2.25	2.2
3	3.35	5.9	7.4	......	4.0	5.2	......	2.05	2.0	2.35	2.25	2.2
4	3.35	6.1	6.6	3.35	4.2	4.9	3.3	2.0	......	2.4	2.25	......
5	3.35	6.2	6.5	3.35	4.0	......	3.2	2.0	2.0	2.4	2.25	2.2
6	3.35	......	......	3.4	3.7	4.45	3.1	1.95	3.6	2.8	......	2.2
7	3.35	5.15	6.9	3.3	3.85	4.25	3.0	......	4.45	3.55	2.25	2.15
8	3.25	5.0	6.7	3.25	......	4.0	2.85	1.95	6.0	3.4	2.25	2.15
9	......	5.2	6.2	3.15	4.3	3.6	2.75	1.95	5.6	......	2.25	2.15
10	3.1	4.8	5.75	......	4.3	3.8	......	1.9	4.3	3.0	2.2	2.15
11	3.1	4.6	5.4	3.1	4.3	3.65	2.6	1.9	......	2.85	2.15	......
12	3.15	4.1	5.2	3.1	4.4	......	2.7	1.9	3.2	2.8	2.15	2.15
13	5.6	......	......	3.05	4.45	3.4	2.95	1.9	3.0	2.7	......	2.05
14	8.35	4.25	4.8	3.0	4.3	3.3	3.6	......	3.6	2.6	2.2	2.0
15	8.7	4.3	4.6	3.0	......	3.2	3.3	1.85	3.2	2.55	2.2	2.05
16	......	4.3	4.45	3.05	3.95	3.1	3.15	2.7	2.95	......	2.2	2.0
17	7.7	3.6	4.3	......	3.8	3.05	......	2.8	2.75	2.55	2.2	2.0
18	9.5	4.3	4.25	3.2	3.7	3.0	2.8	3.4	......	2.45	2.2	......
19	9.7	4.9	4.15	3.2	3.6	......	2.65	3.0	2.5	2.4	2.2	2.1
20	10.0	4.0	......	3.15	3.65	2.8	2.5	2.5	2.5	2.4	......	2.0
21	10.2	4.0	4.0	3.1	3.75	2.75	2.45	......	2.4	2.4	2.2	2.0
22	10.2	4.0	3.95	3.1	......	2.7	2.4	2.2	2.35	2.4	2.15	2.05
23	......	3.9	3.85	3.1	7.2	2.6	2.35	2.2	......	......	2.15	2.1
24	9.65	3.8	3.8	......	8.85	2.6	......	2.3	2.4	2.3	2.15	2.0
25	8.7	3.6	3.7	3.1	9.45	2.5	2.2	2.15	......	2.35	2.2	......
26	7.7	3.95	3.7	3.2	9.15	......	2.2	2.05	2.5	2.3	2.2	2.05
27	7.3	......	......	3.25	7.3	4.0	2.15	2.0	2.65	2.3	......	2.05
28	7.2	9.45	3.7	3.4	6.8	6.45	2.15	......	2.6	2.3	2.5	7.35
29	7.25	......	3.6	3.75	......	5.6	2.4	2.0	2.5	2.3	2.4	7.8
30	5.85	......	3.6	3.7	6.4	4.6	2.3	2.0	2.5	......	2.2	5.4
31	5.85	......	......	......	6.7	......	......	2.0	......	2.25	......	5.1

NOTE.—Ice present from Jan. 1 to 17, ranging in thickness from 7 to 9 inches. Also ice from Feb. 17 to 28 and from Dec. 1 to 28. Gage read to top of ice for Jan. 1 to 17 and Feb. 17 to 28.

Daily discharge, in second-feet, of Sangamon River near Monticello, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 30	448	1,240	104	140	562	176	18	13	31	22	b 18
2	40	392	1,070	99	143	429	138	15	13	30	22	18
3	45	486	777	102	170	356	118	13	11	28	22	18
4	45	524	619	104	194	302	99	11	11	31	22	18
5	45	543	600	104	170	266	90	11	11	31	22	18
6	45	445	638	108	138	229	82	10	128	58	22	18
7	45	347	676	99	160	201	74	10	229	123	22	16
8	40	320	638	94	182	170	62	10	505	108	22	16
9	35	356	543	86	208	128	54	10	429	91	22	15
10	30	284	458	84	208	148	48	8	208	74	20	14
11	30	252	392	82	208	133	43	8	149	62	18	13
12	35	182	356	82	222	120	50	8	90	58	18	12
13	429	192	320	78	229	108	70	8	74	50	19	9
14	1,020	201	284	74	208	99	128	8	128	43	20	7
15	1,130	208	252	74	186	90	99	7	90	40	20	8
16	988	208	229	78	164	82	86	50	70	40	20	7
17	846	128	208	84	148	78	72	58	54	40	20	7
18	1,510	c 208	201	90	138	74	58	108	46	34	20	8
19	1,660	302	188	90	128	66	46	74	37	31	20	10
20	1,920	170	179	86	133	58	37	37	37	31	20	7
21	2,120	170	170	82	143	54	34	28	31	31	20	7
22	2,120	170	164	82	439	50	31	20	28	31	18	8
23	1,870	159	154	82	735	43	28	20	30	28	18	10
24	1,620	148	148	82	1,190	43	24	25	31	25	18	7
25	1,130	128	138	82	1,480	37	20	18	34	28	20	8
26	846	164	138	90	1,300	104	20	13	37	25	20	8
27	756	638	138	94	756	170	18	11	46	25	28	9
28	735	1,480	138	108	657	590	18	11	43	25	37	766
29	746	......	128	143	629	429	31	11	37	25	31	870
30	476	......	128	138	581	252	25	11	37	24	20	392
31	476	......	121	......	638	......	22	11	......	22	......	338

a Daily discharge from Jan. 1 to 12 estimated, on account of presence of ice.
b Discharge from Dec. 1 to 27 has been partly estimated, on account of presence of ice in river.
c From Feb. 18 to 28 the daily discharge may be somewhat large on account of presence of ice.

NOTE.—Daily discharge computed from a rating curve well defined by measurements made in 1908, 1909, and 1910.

Monthly discharge of Sangamon River near Monticello, Ill., for 1910.

[Drainage area, 550 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	2,120	....	738	1.32	1.52	B.
February	1,480	128	330	.600	.62	B.
March	1,240	121	369	.671	.77	A.
April	143	74	92.8	.169	.19	A.
May	1,480	128	388	.705	.81	A.
June	590	37	182	.331	.37	A.
July	176	18	61.3	.112	.13	A.
August	108	7	21.3	.039	.04	A.
September	505	11	89.6	.163	.18	A.
October	123	22	42.7	.078	.09	A.
November	37	18	21.4	.039	.04	A.
December	870	7	86.5	.157	.18	C.
The year	2,120	7	202	.349	4.94	

SANGAMON RIVER AT RIVERTON, ILL.

This station, which is located on the Wabash Railroad bridge about one-fourth mile west of the depot at Riverton, Ill., was established February 13, 1908, to obtain data to be used in the study of drainage and flood control problems.

The South Fork joins the Sangamon 2 or 3 miles above the station. Salt Creek and Crane Creek are tributaries below the station.

Relation between gage heights and discharge is slightly affected by ice during a portion of December, January, and February.

Discharge measurements are made from the railroad bridge, to which the chain gage is attached.

The datum of the gage has not been changed. The records are reliable and accurate.

The high water of 1883 reached a height representing approximately 32 feet on the present gage; the high water of 1875 is said to have been about one-half foot lower.

Discharge measurements of Sangamon River at Riverton, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 16	M. E. McChristie	179	1,190	11.88	1,220
May 16	H. J. Jackson	212	2,100	16.47	3,320
20	do	184	1,320	12.83	1,510
31	do	222	2,350	17.54	3,750
June 2	do	200	1,790	15.02	2,520
Dec. 23	P. S. Monk	146	534	8.18	228
24	do	140	476	7.82	167

Daily gage height, in feet, of Sangamon River at Riverton, Ill., for 1910.

[J. H. Steele, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.0	13.8	17.4	10.0	10.6	16.55	12.7	9.2	8.55	8.75	8.1	12.25
2	10.0	13.3	18.1	9.95	10.45	15.1	11.9	8.8	8.2	8.7	8.05	12.25
3	10.1	13.0	18.5	9.0	10.8	14.2	11.1	8.6	7.8	8.45	8.1	12.25
4	10.5	12.9	19.0	9.0	14.6	13.5	10.7	8.4	7.85	8.6	7.95	12.0
5	10.5	12.85	19.3	10.2	15.15	12.9	11.6	8.25	7.8	8.6	7.95	11.15
6	10.25	12.8	19.0	10.4	14.6	12.7	12.2	8.1	7.75	8.85	8.0	9.85
7	10.2	12.7	18.1	10.6	13.95	12.5	11.5	8.0	8.0	9.7	7.95	9.55
8	10.2	12.6	17.1	10.4	13.9	12.1	11.6	7.9	8.5	9.9	8.0	8.65
9	10.3	12.4	16.0	10.2	14.5	11.7	10.9	8.0	11.15	10.4	8.0	8.9
10	10.5	12.1	15.1	10.0	14.55	12.0	10.1	7.9	11.4	10.55	7.95	8.75
11	10.4	12.0	14.2	9.9	14.5	13.1	9.7	7.8	11.75	10.25	7.95	8.55
12	10.1	11.8	13.6	9.8	16.75	11.6	9.6	7.75	11.7	9.9	7.95	8.45
13	10.8	11.7	13.0	9.7	18.0	11.0	10.2	7.7	11.2	9.45	7.95	8.35
14	14.5	11.2	12.6	9.6	17.8	10.65	10.4	7.65	10.35	9.2	8.0	8.4
15	15.9	11.1	12.2	9.6	17.0	10.5	11.0	7.55	9.5	8.95	7.95	8.25
16	16.2	11.2	12.0	9.5	16.6	10.4	12.5	7.7	8.85	8.85	7.75	8.25
17	16.0	10.7	11.8	10.05	15.6	10.3	14.7	7.75	8.7	8.7	7.45	8.25
18	18.4	9.8	11.5	10.4	14.8	10.0	13.8	7.9	8.5	8.55	7.45	8.25
19	20.2	10.2	11.4	11.0	13.6	9.8	12.6	10.0	8.35	8.5	7.4	8.3
20	21.05	10.7	11.2	11.05	12.9	9.7	11.4	9.65	8.2	8.35	7.35	8.15
21	21.2	10.8	11.1	10.7	12.6	10.1	10.5	9.9	8.05	8.25	7.35	7.85
22	21.0	10.5	11.0	10.45	13.2	9.6	9.95	9.85	8.0	8.3	7.35	7.8
23	21.0	10.55	10.9	10.2	14.25	9.3	9.5	9.8	7.9	8.15	7.35	7.95
24	20.7	10.3	10.8	10.0	17.8	9.2	9.3	9.8	7.95	8.3	7.4	7.9
25	20.3	10.1	10.7	9.9	19.5	9.1	9.1	9.85	8.4	8.35	7.35	7.9
26	19.8	10.4	10.5	9.9	20.05	9.1	8.9	9.6	8.45	8.25	7.35	7.9
27	19.1	13.2	10.4	10.05	20.2	10 2	8.7	8.95	8.45	8.3	7.85	7.9
28	18.5	15.9	10.3	10.4	19.9	14.8	8.6	8.6	9.15	8.25	13.25	8.2
29	17.0	......	10.3	10.5	19.6	14.7	8.55	8.2	9.0	8.3	13.8	13.4
30	15.6	......	10.3	10.65	19.2	13.4	8.5	7.95	8.9	8.15	13.35	15.7
31	14.5	......	10.1	......	18.1	......	9.0	7.9	......	8.15	......	15.2

NOTE.—Practically no ice present at this station during 1910 except during the first few days of January.

Daily discharge, in second-feet, of Sangamon River at Riverton, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	300	2,000	4,010	603	792	3,520	1,540	388	262	296	202	1,370
2	400	1,790	4,430	588	744	2,700	1,240	305	214	287	196	1,370
3	500	1,660	4,690	344	856	2,210	955	270	168	247	202	1,370
4	760	1,620	5,040	344	2,430	1,870	824	240	173	270	184	1,280
5	760	1,600	5,260	665	2,730	1,620	1,130	220	168	270	184	972
6	680	1,580	5,040	728	2,430	1,540	1,350	202	163	314	190	557
7	665	1,540	4,430	792	2,080	1,460	1,100	190	190	513	184	473
8	665	1,500	3,840	728	2,050	1,310	1,130	179	254	572	190	278
9	696	1,420	3,200	665	2,380	1,170	888	190	972	728	190	324
10	760	1,310	2,700	603	2,400	1,280	634	179	1,060	776	184	296
11	728	1,280	2,210	572	2,380	1,710	513	168	1,180	680	184	262
12	634	1,200	1,920	542	3,640	1,130	486	163	1,170	572	184	247
13	856	1,170	1,660	513	4,370	920	665	158	990	448	184	234
14	2,380	990	1,500	486	4,250	808	728	153	712	388	190	240
15	3,140	955	1,350	486	3,780	760	920	143	460	334	184	220
16	3,320	990	1,280	460	3,550	728	1,460	158	314	314	163	220
17	3,200	824	1,200	618	2,980	696	2,480	163	287	287	133	220
18	4,620	542	1,100	728	2,540	603	2,000	179	254	262	133	220
19	6,020	665	1,060	920	1,920	542	1,500	603	234	254	128	227
20	6,870	824	990	938	1,620	513	1,060	500	214	234	123	208
21	7,020	856	955	824	1,500	634	760	572	196	220	123	174
22	6,820	760	920	744	1,750	486	588	557	190	227	123	168
23	6,820	776	888	665	2,240	411	460	542	179	208	123	184
24	6,520	696	856	603	4,250	388	411	542	184	227	128	179
25	6,120	634	824	572	5,420	366	366	557	240	234	123	179
26	5,660	728	760	572	5,880	366	324	486	247	220	123	179
27	5,120	1,750	728	618	6,020	665	287	334	247	227	174	179
28	4,690	3,140	696	728	5,740	2,540	270	270	377	220	1,770	214
29	3,780	......	696	760	5,500	2,480	262	214	344	227	2,000	1,830
30	2,980	......	696	808	5,190	1,830	254	184	324	208	1,810	3,040
31	2,380	......	634	......	4,430	......	344	179	......	208	......	2,760

NOTE.—Daily discharge computed from a fairly well-defined rating table based on measurements made, 1908–1910. Discharge for Jan. 1, 2, 3 was estimated on account of ice.

Monthly discharge of Sangamon River at Riverton, Ill., for 1910.

[Drainage area, 2,560 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	7,020	....	3,090	1.21	1.40	B.
February	3,140	634	1,240	.484	.50	B.
March	5,260	634	2,110	.824	.95	B.
April	938	344	641	.250	.28	B.
May	6,020	744	3,160	1.23	1.42	B.
June	3,520	366	1,240	.484	.54	B.
July	2,480	254	869	.339	.39	B.
August	603	143	296	.115	.13	B.
September	1,180	163	399	.156	.17	B.
October	776	208	338	.132	.15	B.
November	2,000	123	334	.131	.15	B.
December	3,040	168	635	.248	.29	C.
The year	7,020	123	1,200	.469	6.37	

SANGAMON RIVER NEAR OAKFORD, ILL.

This station, which is located at the highway bridge about 3 miles northeast of Oakford, Ill., and about 2½ miles upstream from the Chicago, Peoria & St. Louis Railway bridge, was established October 26, 1909, for the purpose of obtaining data for use in studying problems of drainage and flood control.

Crane Creek enters on the right bank about 1¼ miles below, and Salt Creek, also on the right bank, about 6¼ miles above the section. Other tributaries are South Fork of the Sangamon River and Sugar Creek.

Discharge measurements are made from the bridge and the trestle approaches at each end.

The datum of the chain gage has remained unchanged since the gage was installed. Because of the inaccessibility of the gage it has not been possible to procure daily readings, but the records obtained are accurate and reliable.

The relation between gage heights and discharge is affected somewhat by ice in December, January, and February.

The floods of February and March, 1907, and May, 1908, reached a height of about 21 feet on the present gage.

For stages below gage height of 3 feet the discharge table should be used with caution.

Discharge measurements of Sangamon River near Oakford, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 17	M. E. McChristie	255	1,300	6.03	2,260
28	H. J. Jackson	241	913	4.71	1,510
May 18	.....do	277	1,800	8.26	4,180
21	.....do	261	1,310	6.50	2,740
June 1	.....do	324	2,760	11.30	7,130
3	.....do	280	1,910	8.57	4,310
Dec. 26	P. S. Monk	125	248	1.94	342

Daily gage height, in feet, of Sangamon River near Oakford, Ill., for 1910.

[Ed. J. Bonnett, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		9.15	10.4	4.3	5.0	11.25	6.3	2.2	2.4	2.5	1.75	4.45
2			10.5	4.25	4.95	10.0	5.85	2.8	2.4	2.4	1.7	4.35
3		8.25	10.45	4.2	4.8	8.75	5.4	2.9	2.6	2.35	1.7	4.05
4			10.5	4.2	5.0	8.0	4.1	2.4	3.0	2.3	1.7	4.5
5		7.95	10.6	4.3	6.65	7.4	4.4	2.4	4.2	2.35	1.7	4.3
6				4.45	7.3	6.9	4.4	2.4	4.2	2.8	1.7	3.9
7		7.25		4.9	7.1	6.6	4.4	2.4	4.2	2.9	1.65	3.1
8			10.7	4.7	7.0	6.3	4.4	2.5	4.4	3.5	1.6	2.75
9			10.05	4.5	6.9	6.0	4.5	2.6	4.2	3.5	1.6	2.7
10		6.95	9.3	4.35	7.05	6.0	4.2	2.4	4.2		1.6	2.75
11				4.2	7.3	6.5	4.0	2.0	4.2	3.35	1.55	2.65
12		6.5		4.1	7.65	6.45	3.8	2.0	4.2	3.25	1.55	2.45
13			7.3	4.0	8.5	5.6	3.6	1.8	4.2	3.2	1.6	2.45
14		5.7		4.0	9.3	5.15	3.55	1.7	4.2	2.95	1.6	2.3
15	9.4		6.65	3.95	9.35	4.85	3.5	1.6	4.2	2.85	1.65	2.25
16		5.85		4.0	9.2	4.6	4.4	1.8	4.4	2.6	1.65	2.2
17	10.9		6.05	4.2	8.75	4.5	5.6	1.7	4.6	2.5	1.55	2.05
18	11.7	5.0		4.45	8.5	4.3	6.2	2.9	4.0	2.4	1.7	2.1
19	12.6	4.5	5.7	4.7	7.65	4.1	6.1	2.2	3.6	2.3	1.75	2.1
20	13.0			4.8	6.95	4.0	5.1	2.4	3.0	2.2	1.7	2.1
21		5.3	5.4	4.9	6.5	3.85	4.6	2.7		2.2	1.7	2.1
22	14.35			4.75	6.3	3.95	4.15	3.0	2.2	2.1	1.65	2.1
23		4.8		4.55	6.6	4.0	3.7	3.1	2.2	2.05	1.6	2.0
24		4.7	5.2	4.4	7.65	3.85	3.7	3.4	2.15	2.0	1.6	1.9
25		4.75	5.0	4.35	9.5	4.0	3.8	3.2	2.2	1.95	1.6	1.9
26	14.2		4.9	4.35	10.4	4.05	3.0	3.0	2.55	1.9	1.65	1.9
27	13.8			4.35	10.8	4.8	2.9	3.2	2.5	1.9	1.75	1.8
28		7.75	4.7	4.85	11.0	7.0	2.8	2.7	2.55	1.9	2.4	2.15
29	13.0		4.6	5.05	11.2	7.0	2.7	2.2	2.65	1.85	4.05	2.4
30			4.55	4.95	11.5	7.0	2.4	2.0	2.65	1.85	4.75	4.8
31	10.0		4.4		11.9		2.3	2.4		1.8		6.5

NOTE.—Ice present Jan. 1 to 17.

Daily discharge, in second-feet, of Sangamon River near Oakford, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	4,910	6,200	1,290	1,670	7,120	2,540	450	520	555	292	1,360
2	....	4,500	6,300	1,260	1,640	5,780	2,220	660	520	520	275	1,320
3	....	4,080	6,250	1,240	1,560	4,540	1,910	700	590	502	275	1,170
4	....	3,950	6,300	1,240	1,670	3,860	1,200	520	740	485	275	1,390
5	....	3,820	6,410	1,290	2,810	3,380	1,340	520	1,240	502	275	1,290
6	....	3,540	6,450	1,360	3,300	3,000	1,340	520	1,240	660	275	1,100
7	....	3,260	6,480	1,610	3,150	2,770	1,340	520	1,240	700	258	780
8	....	3,180	6,520	1,500	3,070	2,540	1,340	555	1,340	940	240	642
9	....	3,110	5,830	1,390	3,000	2,320	1,390	590	1,240	940	240	625
10	....	3,030	5,060	1,320	3,110	2,320	1,240	520	1,240	910	240	642
11	....	2,860	4,470	1,240	3,300	2,700	1,150	380	1,240	880	222	608
12	....	2,700	3,890	1,200	3,580	2,660	1,060	380	1,240	840	222	538
13	....	2,400	3,300	1,150	4,310	2,040	980	310	1,240	820	240	538
14	....	2,110	3,060	1,150	5,060	1,760	960	275	1,240	720	240	485
15	....	2,160	2,810	1,130	5,110	1,580	940	240	1,240	680	258	468
16	....	2,220	2,580	1,150	4,960	1,440	1,340	310	1,340	590	258	450
17	6,740	1,940	2,360	1,240	4,540	1,390	2,040	275	1,440	555	222	398
18	7,640	1,670	2,240	1,360	4,310	1,290	2,470	700	1,150	520	275	415
19	8,720	1,390	2,110	1,500	3,580	1,200	2,400	450	980	485	292	415
20	9,210	1,620	2,010	1,560	3,030	1,150	1,730	520	740	450	275	415
21	10,100	1,850	1,910	1,610	2,700	1,080	1,440	625	595	450	275	415
22	11,000	1,700	1,870	1,530	2,540	1,130	1,130	740	450	415	258	415
23	11,000	1,560	1,830	1,420	2,770	1,150	1,020	780	450	398	240	380
24	10,900	1,500	1,790	1,340	3,580	1,080	1,020	900	432	380	240	345
25	10,800	1,530	1,670	1,320	5,260	1,150	1,060	820	450	362	240	345
26	10,800	2,240	1,610	1,320	6,200	1,170	740	740	572	345	258	345
27	10,200	2,950	1,560	1,320	6,630	1,560	700	820	555	345	292	310
28	9,700	3,660	1,500	1,580	6,850	3,070	660	625	572	345	520	432
29	9,210	....	1,440	1,700	7,070	3,070	625	450	608	328	1,170	520
30	7,500	....	1,420	1,640	7,400	3,070	520	380	608	328	1,530	1,560
31	5,780	....	1,340	....	7,880	....	485	520	....	310	....	2,700

NOTE.—Discharge interpolated for days of missing gage heights.

Monthly discharge of Sangamon Rievr near Oakford, Ill., for 1910.

[Drainage area, 5,000 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January (17-31)	11,000	5,780	9,290	1.860	1.04	C.
February	4,910	1,390	2,690	.538	.56	B.
March	6,520	1,340	3,500	.700	.81	B.
April	1,700	1,130	1,370	.274	.31	A.
May	7,880	1,560	4,050	.810	.93	A.
June	7,120	1,080	2,410	.482	.54	A.
July	2,540	485	1,300	.260	.30	A.
August	900	240	542	.108	.12	A.
September	1,440	432	902	.180	.20	A.
October	940	310	557	.111	.13	A.
November	1,530	222	339	.068	.08	A.
December	2,700	310	736	.147	.17	B.
The period	11,000	222	2,000	.400	5.19	

SOUTH FORK OF SANGAMON RIVER NEAR TAYLORVILLE, ILL.

This station, which is located at the Wabash Railroad bridge about $3\frac{1}{2}$ miles southwest of Taylorville, Ill., and about one-fourth mile upstream from the highway bridge across the South Fork known as the Half Acre Bridge, was established February 11, 1908, for the purpose of obtaining data for use in studying drainage, flood control, and water-supply problems.

Bear Creek, a small tributary, enters the stream on the left bank a few miles below the station.

In August, 1909, a drainage ditch was dug along the river in this vicinity, straightening the course of the stream but coinciding with the original channel at the gaging station. The cross section of the stream at the gaging station was not altered, but the relation between gage height and discharge was materially changed as the result of the change in slope. The new channel may shift to some extent. The gage heights to August 10, 1909, inclusive, refer to the section before the change; gage heights from August 11 to September 1, 1909, inclusive, are of no value, because the stream was dammed up for purposes of construction during that period. On September 2, 1909, the datum of the chain gage was lowered 2 feet, and the gage heights from that date on refer to the new conditions. In making comparisons between the data for the original and the new conditions it should be noted that the gage datum has been changed.

The records are accurate and reliable.

The relation between gage heights and discharge is liable to be affected by ice in January, February, and December.

Discharge measurements of South Fork of Sangamon River near Taylorville, Ill., in 1910.

Date.	Hydrographer.	Width	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 15	M. E. McChristie	66	275	4.91	154
15	.....do	66	278	4.88	159
18	.....do	64	248	4.66	133
May 12	H. J. Jackson	271	1,050	9.48	923
14	.....do	273	1,240	9.97	1,220
17	.....do	128	491	7.28	339
19	.....do	86	351	6.02	262
20	.....do	76	320	5.62	202
24	.....do	274	1,260	10.14	1,260
July 19	.....do	62	276	4.90	171
Dec. 22	P. S. Monk	68	201	[a] 3.30	58

[a] Ice present.

Daily gage height, in feet, of South Fork of Sangamon River near Taylorville, Ill., for 1910.

[Joseph Ethridge, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.25	4.5	10.95	3.8	3.05	7.05	....	2.55	1.9	2.15	2.65	9.9
2	4.55	4.55	10.7	3.65	4.7	5.9	....	2.5	2.0	2.9	2.5	9.5
3	4.75	4.95	10.25	3.4	7.85	5.7	....	2.4	2.0	2.7	2.6	7.95
4	4.85	5.4	9.95	3.2	8.7	5.85	....	2.35	2.1	3.8	2.45	5.85
5	4.95	5.5	9.6	3.9	8.8	6.0	....	2.3	2.3	3.45	2.4	5.1
6	5.4	5.4	9.15	3.65	8.15	5.65	....	2.2	4.05	4.55	2.65	4.7
7	5.9	5.2	9.0	3.3	7.95	5.2	....	2.1	8.55	5.95	2.7	4.4
8	6.0	4.95	8.1	3.1	8.0	4.8	....	2.2	8.75	6.95	2.7	3.9
9	6.2	4.7	7.75	3.05	8.4	4.9	....	2.25	8.5	6.3	2.65	3.6
10	6.35	4.45	7.1	3.15	8.25	4.45	....	2.2	8.55	4.85	2.7	4.1
11	6.85	4.2	6.8	3.3	9.15	4.0	....	2.25	8.4	4.25	2.65	3.95
12	7.05	3.85	6.05	3.35	9.6	3.95	....	2.05	7.05	3.8	2.7	4.1
13	8.0	3.8	5.5	3.9	10.2	3.8	....	2.00	4.4	3.6	2.65	3.65
14	8.8	3.75	5.1	4.0	9.95	3.9	....	1.95	3.6	3.45	2.7	3.5
15	9.7	3.65	4.95	4.1	9.05	3.8	....	1.95	3.5	3.25	2.75	3.45

Daily gage height, in feet, of South Fork of Sangamon River near Taylorville, Ill., for 1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	10.0	3.55	4.8	4.35	8.45	3.7	......	1.9	3.05	3.2	2.65	3.5
17	10.1	3.7	4.75	5.95	7.4	3.7	......	2.0	2.85	3.0	2.65	3.45
18	10.45	3.7	4.7	6.75	6.75	3.2	......	3.7	2.75	3.05	2.7	3.45
19	10.7	3.9	4.55	7.05	5.85	3.2	5.1	4.6	2.65	3.0	2.7	3.45
20	11.0	3.95	4.6	6.6	5.4	3.2	4.3	5.35	2.6	2.85	2.65	3.2
21	10.85	4.2	4.7	5.9	6.85	3.1	3.85	5.45	2.55	2.8	2.7	3.25
22	10.25	4.25	4.65	4.95	8.4	3.1	3.6	6.8	2.5	2.85	2.65	3.25
23	9.35	3.9	4.5	3.9	10.25	3.1	3.4	7.35	2.45	3.0	2.7	2.9
24	8.65	3.8	4.45	3.65	9.9	3.05	3.25	5.85	2.7	2.95	2.65	2.95
25	7.3	3.85	4.3	3.5	11.0	3.1	3.1	3.95	2.85	2.85	2.6	3.15
26	6.75	4.2	4.2	3.15	10.85	3.2	3.0	2.95	3.2	2.95	2.65	3.15
27	6.35	8.9	4.05	3.0	10.3	3.5	2.9	2.45	3.95	2.85	6.25	3.15
28	6.0	10.0	4.0	3.4	9.45	3.45	2.8	2.25	3.25	2.8	7.95	6.8
29	5.45	......	3.9	3.5	8.65	3.15	2.8	2.2	4.2	2.7	9.15	8.1
30	5.05	......	3.9	3.2	8.0	3.0	2.9	2.15	3.55	2.65	9.9	8.7
31	4.95	......	3.85	......	7.6	......	2.7	1.95	......	2.75	......	9.15

NOTE.—Ice was probably present during portions of January and February. Ice present from Dec. 13 to 17, Dec. 23 to 27, and readings taken to top of ice.

Daily discharge, in second-feet, of South Fork of Sangamon River near Taylorville, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	112	127	1,670	87	52	338	54	32	13	20	36	1,150
2	130	130	1,540	80	140	234	54	30	15	46	30	950
3	144	158	1,320	67	432	217	54	27	15	38	34	447
4	150	193	1,170	58	606	230	54	26	18	87	28	230
5	158	201	999	92	638	243	54	24	24	70	27	169
6	193	193	782	80	481	213	54	21	100	130	36	140
7	234	177	714	62	447	177	54	18	566	238	38	121
8	243	158	472	54	455	147	54	21	622	328	38	92
9	261	140	417	52	530	154	54	22	553	270	36	77
10	274	124	343	56	500	124	54	21	566	150	38	103
11	320	109	315	62	782	97	54	22	530	112	36	94
12	338	90	248	64	999	94	121	16	338	87	38	103
13	455	87	201	92	1,300	87	217	15	121	77	36	64
14	638	84	169	99	1,170	92	353	14	77	70	38	58
15	1,050	80	158	103	736	87	553	14	72	60	40	56
16	1,200	74	147	150	542	82	638	13	52	58	36	58
17	1,240	82	144	238	374	82	397	15	44	50	36	56
18	1,420	82	140	310	310	58	279	82	40	52	38	70
19	1,540	92	130	338	230	58	169	133	36	50	38	70
20	1,700	94	133	297	193	58	115	189	34	44	36	58
21	1,620	109	140	234	320	54	90	197	32	42	38	60
22	1,320	112	136	158	530	54	77	315	30	44	36	60
23	877	92	127	92	1,320	54	67	368	28	50	38	37
24	592	87	124	80	1,150	52	60	230	38	48	36	38
25	363	90	115	72	1,700	54	54	94	44	44	34	45
26	310	109	109	56	1,620	58	50	48	58	48	36	45
27	274	674	100	50	1,340	72	46	28	94	44	266	45
28	243	1,200	97	67	926	70	42	22	60	42	447	315
29	197	......	92	72	592	56	42	21	109	38	782	472
30	165	......	92	58	455	50	46	20	74	36	1,150	606
31	158	......	90	......	397	......	38	14	......	40	......	782

NOTE.—Daily discharge computed from a well-defined rating table based on measurements made in 1908–1910. It is possible that the discharges during January and February may be somewhat large owing to presence of ice. Daily discharge from July 1 to 18, inclusive, has been estimated from known high-water stage which occurred July 16. Daily discharge from Dec. 13 to 17 and from Dec. 23 to 27 reduced 20 per cent on account of ice.

Monthly discharge of South Fork of Sangamon River near Taylorville, Ill., for 1910.

[Drainage area, 427 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	1,700	112	578	1.35	1.56	C.
February	1,200	74	177	.415	.43	A.
March	1,670	90	401	.939	1.08	A.
April	338	50	113	.265	.30	B.
May	1,700	52	686	1.61	1.86	A.
June	338	50	115	.269	.30	B.
July	638	38	131	.307	.35	C.
August	368	13	68.1	.160	.18	A.
September	622	13	147	.344	.38	A.
October	328	20	81.1	.190	.22	A.
November	1,150	27	38.3	.090	.10	A.
December	1,150	37	215	.504	.58	B.
The year	1,700	13	231	.541	7.34	

SALT CREEK NEAR KENNEY, ILL.

Salt Creek is a tributary of Sangamon River.

The gaging station, which is located at the highway bridge about 2 miles west of Kenney, Ill., about three-fourths of a mile below the Vandalia Railroad bridge, was established February 14, 1908, to collect data for use in the study of drainage and flood-control problems.

Tenmile Creek enters on the right bank about 4 miles above the gaging station. Other tributaries of Salt Creek are North and Lake forks and Deer, Sugar, Prairie, and Pike creeks.

The chain gage is attached to the bridge; its datum has not been changed.

The relation between gage heights and discharge is somewhat affected by ice in December, January, and February.

The records are reliable and accurate, but low-water measurements should be used with caution.

The high water of 1882 is said to have been about 1 or 1½ feet higher than that of the spring of 1908, or to have reached a height of about 16 feet on the present gage.

Discharge measurements of Salt Creek near Kenney, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 9	M. E. McChristie	111	300	3.43	355
May 25	H. J. Jackson	112	344	3.96	438
25	do	112	349	3.94	454
Dec. 27	P. S. Monk	78	51.4	*a* 1.25	10.7

a Ice present.

Daily gage height, in feet, of Salt Creek near Kenney, Ill., for 1910.

[Chris McDermott, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.35	3.0	5.5	2.15	2.35	2.75	1.65	1.45	1.2	1.45	1.35	1.6
2	2.35	3.5	4.4	2.1	2.35	2.5	1.6	1.4	1.2	1.4	1.3	1.5
3	2.5	3.6	3.7	2.15	2.9	2.4	1.6	1.3	1.2	1.35	1.3	1.3
4	2.5	3.6	3.7	2.15	2.75	2.35	1.55	1.25	1.3	1.8	1.25	1.3
5	2.45	3.5	3.8	2.45	2.6	2.3	1.5	1.25	1.25	2.5	1.3	1.4
6	2.4	3.3	3.9	2.35	2.45	2.2	1.5	1.2	1.3	2.4	1.25	1.4
7	2.3	3.25	3.95	2.25	2.45	2.2	1.5	1.2	2.05	2.3	1.25	1.3
8	2.25	3.2	3.65	2.15	2.65	2.1	1.5	1.2	1.8	2.1	1.3	1.35
9	2.25	3.1	3.45	2.15	2.7	2.05	1.45	1.2	1.95	2.0	1.3	1.3
10	2.2	2.85	3.2	2.1	2.75	2.0	1.45	1.2	1.9	1.85	1.3	1.2
11	2.2	2.7	3.15	2.05	2.8	2.0	1.4	1.2	1.75	1.8	1.3	1.15
12	2.3	2.95	3.0	2.05	2.95	1.9	1.4	1.2	1.65	1.7	1.35	1.2
13	3.7	2.4	2.95	2.05	2.85	1.85	2.0	1.15	1.6	1.65	1.25	1.2
14	5.6	2.7	2.85	2.0	2.7	1.8	1.9	1.15	1.5	1.6	1.3	1.2
15	5.8	2.8	2.7	2.05	2.55	1.8	1.9	1.15	1.5	1.55	1.25	1.15
16	5.55	2.6	2.85	2.05	2.45	1.75	2.05	1.2	1.45	1.5	1.35	1.2
17	5.2	2.4	2.6	2.25	2.45	1.75	1.7	3.6	1.35	1.5	1.3	1.25
18	7.6	2.4	2.55	2.25	2.4	1.7	1.6	2.2	1.3	1.45	1.4	1.3
19	7.65	2.6	2.5	2.2	2.3	1.7	1.5	1.7	1.3	1.4	1.2	1.3
20	8.1	2.45	2.45	2.2	2.35	1.65	1.5	1.8	1.25	1.35	1.25	1.2
21	8.85	2.5	2.45	2.2	2.35	1.6	1.45	1.6	1.25	1.4	1.25	1.3
22	8.8	2.5	2.4	2.15	2.3	1.6	1.45	1.6	1.15	1.4	1.25	1.3
23	8.05	2.7	2.35	2.15	3.75	1.6	1.35	1.5	1.2	1.35	1.3	1.2
24	6.9	2.65	2.35	2.15	3.95	1.55	1.3	1.4	1.45	1.35	1.35	1.15
25	6.1	2.2	2.25	2.15	3.75	1.5	1.3	1.35	1.6	1.4	1.35	1.20
26	5.4	2.3	2.25	2.2	3.65	1.5	1.25	1.35	1.65	1.6	1.3	1.25
27	5.15	5.7	2.3	2.55	3.15	2.05	1.25	1.3	1.6	1.45	1.6	1.25
28	4.35	6.1	2.3	2.7	2.8	1.85	2.2	1.25	1.55	1.4	1.75	4.0
29	4.1	......	2.25	2.55	3.0	1.75	2.05	1.2	1.5	1.15	1.6	4.7
30	3.85	......	2.2	2.45	3.0	1.7	1.6	1.2	1.45	1.15	1.65	4.0
31	3.65	......	2.15	......	3.0	......	1.5	1.2	......	1.25	......	3.15

NOTE.—Ice present from Jan. 1 to 27, Feb. 17 to 28, and also from Dec. 11-16 and 20 to 27. From Jan. 1 to 27, Dec. 11 to 16, 20 to 27, and 30 to 31 the gage heights were read to the top of ice.

Daily discharge, in second-feet, of Salt Creek near Kenney, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8	208	933	60	88	158	26	16	10	16	14	23
2	8	326	584	54	88	112	23	15	10	15	12	18
3	7	352	379	60	187	96	23	12	10	14	12	12
4	7	352	379	60	158	88	20	11	12	34	11	12
5	7	326	407	104	129	81	18	11	11	117	12	15
6	6	277	436	88	104	67	18	10	12	102	11	15
7	6	265	450	74	104	67	18	10	58	88	11	12
8	7	253	366	60	138	54	18	10	34	64	12	14
9	6	230	314	60	148	48	16	10	48	53	12	12
10	7	177	253	54	158	43	16	10	42	38	12	10
11	30	148	242	48	167	43	15	10	31	34	12	9
12	40	198	208	48	198	33	15	10	26	28	14	9
13	200	96	198	48	177	29	53	9	23	26	11	9
14	500	148	177	43	148	25	42	9	18	23	12	9
15	700	167	148	48	120	25	42	9	18	20	11	9
16	600	129	177	48	104	22	58	10	16	18	14	10
17	600	50	129	74	104	22	28	352	14	18	12	11
18	1,000	20	120	74	96	18	23	75	12	16	15	12
19	1,000	25	112	67	81	18	18	28	12	15	10	12
20	1,500	40	104	67	88	16	18	34	11	14	11	11
21	2,000	50	104	67	88	14	16	23	11	15	11	11
22	1,800	35	96	60	81	14	16	23	9	15	11	11
23	1,500	10	88	60	393	14	14	18	10	14	12	11
24	1,300	10	88	60	450	12	12	15	16	14	14	10
25	1,000	10	74	60	393	10	12	14	23	15	14	10
26	600	15	74	67	366	10	11	14	26	23	12	11
27	600	500	81	120	242	48	11	12	23	16	23	11
28	539	700	81	148	167	29	75	11	20	15	31	465
29	494	......	74	120	208	22	58	10	18	9	23	676
30	422	......	67	104	208	18	23	10	16	9	26	220
31	366	......	60	......	208	......	18	10	......	11	......	150

NOTE.—Daily discharge computed from two rating tables fairly well defined and based on measurements made 1908–1910.

From Jan. 1 to 27, Feb. 17 to 28, and from Dec. 11 to 16, Dec. 21 to 27, and Dec. 30 and 31 the discharges were estimated on account of presence of ice.

Monthly discharge of Salt Creek near Kenney, Ill., for 1910.

[Drainage area, 459 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	2,000	6	544	1.19	1.37	D.
February	700	10	183	.399	.42	B.
March	933	60	226	.492	.57	B.
April	148	43	70.2	.153	.17	B.
May	450	81	174	.379	.44	B.
June	158	10	41.9	.091	.10	B.
July	58	11	25.0	.054	.06	B.
August	352	9	26.5	.058	.07	B.
September	58	9	20.0	.044	.05	C.
October	117	9	29.3	.064	.07	C.
November	31	10	13.9	.030	.03	C.
December	676		59.0	.129	.15	D.
The year	2,000	6	118	.257	3.50	

CAHOKIA CREEK.

GENERAL FEATURES OF AREA DRAINED.

The drainage area of Cahokia Creek lies in the southwestern part of the State of Illinois. The creek rises in the southern part of and about on line between Montgomery and Macoupin counties, flows in a southwesterly direction diagonally across the southeast corner of Macoupin County and the northwest portion of Madison County, past Edwardsville, through East St. Louis, Ill., and empties into Mississippi River.

The creek is very crooked and its length is approximately 55 miles. Its basin is about 45 miles long, 8 miles in average width, and 12 miles maximum width, and comprises 360 square miles. Its principal tributary, Indian Creek, enters from the right bank about three-fourths of a mile north of the Wabash Railroad bridge near Poag, Ill. The area drained is low, level, or undulating, and is crossed by a chain of bluffs just north of Poag, Ill. The sources of the creek are about 680 feet and the mouth about 385 feet above sea level.

The area contains no forested tracts. The mean annual rainfall is about 40 inches. In general the winters are mild. The opportunities for storage and water-power development have not been investigated but are undoubtedly not worthy of consideration. Flood control, especially in its relation to the proposed flood protection works of the East Side levee and sanitary district of East St. Louis, Ill., is the most important problem under consideration at present in connection with this drainage basin.

CAHOKIA CREEK NEAR POAG, ILL.

This station, which is located at the Wabash Railroad bridge about three-fourths of a mile northeast of the Wabash Railroad station at Poag, Ill., was established December 13, 1909. The data collected will be used by the East Side levee and sanitary district of East St. Louis, Ill., in its study of flood control and prevention at that place.

Indian Creek enters on the right bank about three-fourths of a mile above the section.

The relation between gage heights and discharge is apt to be affected by ice in December, January, and February.

The datum of the gage has remained unchanged since the installation of the gage.

The records are accurate and reliable.

Discharge measurements of Cahokia Creek near Poag, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 21	Jackson and McChristie	48	108	3.43	50
24	H. J. Jackson	47	101	3.33	46
Apr. 13	.....do	47	96	3.10	44
May 3	Morgan and Livingston	89	716	12.45	1,100
24	W. H. Morgan	115	847	13.53	1,320
Sept. 6	.....do	96	772	12.70	1,030
7	.....do	73	491	9.30	530
8	.....do	63	310	7.08	256
9	.....do	60	216	5.32	132
Oct. 7	.....do	247	1,730	16.25	[a] 2,890
Dec. 9	Bailey and Monk	45	82.5	[b] 2.99	10

[a] Includes 574 second-feet in flood channel. [b] Ice present.

Daily gage height, in feet, of Cahokia Creek near Poag, Ill., for 1910.

[S. T. Sanders, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.5	2.3	16.6	2.9	3.3	4.2	2.4	2.4	6.0	3.7	3.35	5.95
2	3.2	2.3	14.5	2.8	8.8	3.5	2.3	2.3	3.2	3.3	3.4	5.1
3	3.6	4.0	12.3	3.1	12.8	3.4	3.7	2.3	2.3	2.95	3.6	4.15
4	4.0	5.0	9.0	3.2	10.3	12.1	3.0	2.2	13.0	5.3	3.85	4.2
5	5.0	4.2	6.6	6.4	6.1	13.2	2.8	2.1	13.7	12.0	3.8	4.0
6	6.0	3.8	5.0	5.8	5.0	9.5	2.7	2.1	12.4	15.0	3.65	3.65
7	5.2	3.3	4.3	4.2	6.5	5.6	2.6	2.0	9.7	16.0	3.7	3.3
8	4.2	3.1	4.2	3.6	7.7	4.0	2.5	2.0	7.4	16.3	3.65	3.15
9	3.5	3.0	3.9	3.3	6.1	6.7	2.4	1.9	5.0	11.0	3.7	3.0
10	3.2	2.8	3.6	3.2	5.0	5.0	3.0	1.8	4.2	8.15	3.6	2.9
11	3.0	2.6	3.4	3.0	7.9	4.4	3.8	1.8	3.4	5.6	3.55	2.9
12	8.0	2.4	3.2	3.1	8.5	4.0	4.0	1.7	3.2	4.95	3.6	2.8
13	16.0	2.3	3.1	3.1	7.1	3.6	3.2	1.7	3.0	4.6	3.85	2.8
14	16.4	2.2	3.0	2.9	5.6	4.1	2.8	1.6	2.9	4.4	3.9	2.8
15	16.1	5.0	3.0	3.5	4.2	5.4	2.6	1.6	2.8	4.15	3.9	2.6
16	15.0	4.0	2.9	7.5	4.0	6.3	11.6	1.5	2.7	4.1	3.85	2.6
17	12.0	3.5	2.9	11.1	4.0	4.2	9.0	1.5	2.6	3.95	3.8	2.6
18	13.5	3.4	2.8	6.6	4.2	3.7	6.4	1.4	2.5	3.9	3.75	2.6
19	13.7	3.3	2.8	5.5	3.8	3.4	4.0	1.4	2.4	3.8	3.8	2.5
20	11.4	3.2	2.7	4.5	3.5	3.2	3.2	1.3	2.3	3.65	3.7	2.5
21	6.0	3.0	3.4	4.1	3.2	3.0	2.1	1.3	2.15	3.6	3.75	2.5
22	4.0	2.9	3.3	3.9	3.0	2.8	2.0	1.2	2.2	3.95	3.8	2.4
23	3.1	2.8	3.3	3.7	13.5	2.6	1.9	1.9	2.1	3.9	3.8	2.4
24	3.0	2.7	3.3	3.5	13.3	2.4	1.8	2.8	2.35	3.8	3.75	3.0
25	3.0	2.6	3.2	3.4	13.2	3.5	2.0	2.4	3.6	3.65	4.0	3.4

Daily gage height, in feet, of Cahokia Creek near Poag, Ill., for 1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
26	2.9	4.0	3.2	3.5	8.2	3.0	4.0	2.2	8.15	3.7	4.05	3.2
27	2.8	11.8	3.2	4.5	5.0	4.0	2.8	2.0	14.0	3.55	4.9	3.0
28	2.7	12.9	3.1	4.1	4.5	4.2	3.0	1.8	10.2	3.6	5.55	3.4
29	2.6	....	3.1	3.7	4.0	3.2	2.8	1.6	5.95	3.5	6.9	6.8
30	2.5	....	3.1	3.4	7.4	2.8	2.6	1.4	4.3	3.45	6.8	6.4
31	2.4	....	3.0	....	4.5	....	2.5	1.3	....	3.4	....	6.0

NOTE.—Ice was probably present during portions of January, February, and December.

Daily discharge, in second-feet, of Cahokia Creek near Poag, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	25	21	3,290	33	44	75	23	23	167	56	46	164
2	41	21	1,580	31	460	50	21	21	41	44	47	118
3	53	67	1,060	38	1,170	47	56	21	21	34	53	73
4	67	113	488	41	692	1,020	35	19	1,210	128	61	50
5	113	75	212	196	173	1,260	31	17	1,370	1,000	59	40
6	167	59	113	155	113	562	29	17	1,080	1,740	54	30
7	123	44	79	75	204	143	27	15	592	2,630	56	20
8	75	38	75	53	323	67	25	15	289	2,960	54	10
9	50	35	63	44	173	221	23	13	113	811	56	10
10	41	31	53	41	113	113	35	11	75	377	53	10
11	35	27	47	35	347	83	59	11	47	143	52	10
12	359	23	41	38	420	67	67	9	41	110	53	9
13	2,630	21	38	38	259	53	41	9	35	93	61	9
14	3,070	19	35	33	143	71	31	7	33	83	63	9
15	2,740	113	35	50	75	133	27	7	31	73	63	8
16	1,740	67	33	299	67	188	925	5	29	71	61	8
17	1,000	50	33	830	67	75	488	5	27	65	59	8
18	1,330	47	31	212	75	56	196	4	25	63	58	8
19	1,370	44	31	138	59	47	67	4	23	59	59	7
20	887	41	29	88	50	41	41	3	21	54	56	7
21	167	35	47	71	41	35	17	3	18	53	58	7
22	67	33	44	63	35	31	15	2	19	65	59	6
23	38	31	44	56	1,330	27	13	13	17	63	59	6
24	35	29	44	50	1,280	23	11	31	22	59	58	15
25	35	27	41	47	1,260	50	15	23	53	54	67	30
26	33	67	41	50	383	35	67	19	377	56	69	41
27	31	963	41	88	113	67	31	15	1,440	52	108	35
28	29	1,190	38	71	88	75	35	11	675	53	140	47
29	27	....	38	56	67	41	31	7	164	50	239	230
30	25	....	38	47	289	31	27	4	79	48	230	196
31	23	....	35	....	88	....	25	3	....	47	....	167

NOTE.—Daily discharge computed from a well-defined curve based on 1910 measurements. Discharge during January and February probably somewhat large, owing to presence of ice. From Dec. 4 to 25 the discharge estimated because of ice.

Monthly discharge of Cahokia Creek near Poag, Ill., for 1910.

[Drainage area, 259 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	3,070	23	530	2.05	2.36	C.
February	1,190	19	119	.459	.48	C.
March	3,290	29	252	.973	1.12	A.
April	830	31	102	.394	.44	A.
May	1,330	35	323	1.25	1.44	A.
June	1,260	23	160	.618	.69	A.
July	925	11	81.7	.316	.36	A.
August	31	2	11.8	.046	.05	B.
September	1,440	17	271	1.05	1.17	A.
October	2,960	34	361	1.39	1.60	A.
November	239	46	73.7	.284	.32	A.
December	230	6	44.8	.173	.20	C.
The year	3,290	2	195	.753	10.23	

KASKASKIA RIVER.

GENERAL FEATURES OF AREA DRAINED.

Kaskaskia River, also called the Okaw, lies wholly in the State of Illinois. The river rises in the center of Champaign County, flows southwestward, and empties into the Mississippi in Randolph County, near the city of Chester, Ill. It is about 190 miles long, not following the bends, but as it is very crooked its length by course is not far from 400 miles. The total drainage area is 5,840 square miles. It has few tributaries worthy of mention, the most important being Shoal and Silver creeks, which enter from the north at the lower part of the river.

The drainage basin is long and comparatively narrow, the average width being about 30 miles and the maximum width about 60 miles. The ground is low, level, or undulating, and in consequence the slope of the river is small. The sources of the river are about 740 feet, and its mouth is about 350 feet, above sea level. The soil of the area is mostly black loam. In the lower portion of the drainage area the soil gradually changes to a yellowish brown clay. The only rock exposed along this stream is found about 20 miles above Shelbyville. In this 15 or 20 mile section the banks and bed are mostly soft soil with some gravel.

The basin contains no forested areas. The annual rainfall is about 40 inches. As a rule the winters are mild.

The question of storage has not been investigated to any extent. Opportunities for important water-power development are entirely lacking.

During wet weather the ground-water plane rises to the surface, and the rains run off into the streams very quickly, producing sudden rises and floods; in dry weather, as there is little or no ground water stored, the flow of the stream becomes very small and in some places dries up entirely. The banks of the river are low, and in times of floods large areas are covered with water, delaying the planting of crops and at times destroying growing crops. Storage, land drainage, and flood control are subjects of considerable importance in this basin.

KASKASKIA RIVER NEAR ARCOLA, ILL.

This station, which is located at the highway bridge known as the Bagdad Bridge, about 4 miles west of Arcola, Ill., and about 2¼ miles downstream from the Vandalia Railroad bridge, was established April 11, 1908, for the purpose of obtaining data for use in studying drainage, flood protection, and storage problems.

Lake Fork enters from the west 3 or 4 miles above the gaging station.

The datum of the chain gage has remained unchanged since the gage was installed.

The relation between gage height and discharge is somewhat affected by ice during portions of December, January, and February.

The records are accurate and reliable.

The river at this point is said to go dry at times and was dry for about two months in 1908. The high water of May, 1908, reached a height of 17.3 feet on the gage.

Discharge measurements of Kaskaskia River near Arcola, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 7	M. E. McChristie	205	734	7.78	635
10	.....do	124	441	6.40	392
10	.....do	124	442	6.37	396
May 13	H. J. Jackson	205	686	7.82	619
25	.....do	228	1,230	10.29	1,380
27	.....do	220	1,020	9.43	965
28	.....do	210	778	8.28	678
Dec. 28	P. S. Monk	130	452	[a] 6.84	416

[a] River full of floating ice.

Daily gage height, in feet, of Kaskaskia River near Arcola, Ill., for 1910.

[Lawrence L. Pfeifer, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	6.5	9.7	3.8	......	6.8	6.8	5.4	2.5	2.85	1.95	5.25
2	......	6.4	9.4	3.8	4.65	6.1	5.5	4.6	2.45	3.1	2.6	5.15
3	5.7	6.2	8.9	......	5.2	5.7	5.2	3.7	2.5	3.75	2.55	5.2
4	5.8	6.2	8.7	3.8	5.55	5.4	5.1	3.3	2.35	4.2	2.6	5.15
5	5.9	6.0	8.4	3.8	5.6	5.2	5.1	3.0	3.4	4.55	2.45	5.05
6	6.2	......	......	3.7	5.65	5.1	4.5	2.9	7.6	4.75	2.35	5.05
7	6.2	5.8	7.8	3.7	5.7	4.8	4.0	2.7	7.75	5.0	2.4	5.05
8	6.2	5.6	7.4	3.7	......	4.5	3.8	2.6	7.4	4.95	2.35	5.0
9	......	5.6	7.1	3.6	6.3	4.4	3.6	2.3	7.15	4.3	2.3	4.95
10	6.1	5.7	6.5	......	6.45	4.3	3.4	2.3	7.0	3.55	2.25	4.85
11	7.1	5.4	6.1	3.5	7.1	4.2	3.3	2.2	6.8	3.45	2.25	4.75
12	7.9	5.4	6.0	3.5	7.55	4.0	3.2	2.2	5.95	3.3	2.2	4.75
13	8.2	......	......	3.4	8.0	3.8	3.6	2.05	5.7	3.15	2.15	4.8
14	8.4	4.8	5.7	3.4	8.2	3.7	3.6	2.1	5.35	2.9	2.15	4.65
15	8.8	4.8	5.7	3.4	......	3.5	3.3	1.95	4.9	2.65	2.05	4.65
16	......	4.8	5.6	3.6	6.0	3.4	4.6	3.3	4.6	2.65	2.05	4.55
17	9.8	4.9	5.4	......	5.8	3.4	7.0	5.2	4.05	2.7	2.1	4.55
18	11.3	4.9	5.2	3.8	5.6	3.2	7.3	4.95	4.0	2.55	1.95	4.35
19	12.0	4.9	5.0	3.9	5.4	3.0	6.8	4.9	3.65	2.6	1.95	4.4
20	11.9	......	......	4.1	5.2	2.9	5.7	4.55	3.6	2.45	1.95	4.15
21	11.8	4.9	4.8	4.2	5.3	2.9	4.2	3.2	3.4	2.45	1.85	4.15
22	11.6	......	4.8	4.1	......	2.9	4.0	2.9	3.35	2.5	1.9	4.05
23	......	4.9	4.7	4.0	7.0	2.8	3.9	2.85	3.2	2.45	1.85	3.95
24	9.4	4.9	4.6	......	8.9	2.7	2.3	2.8	2.95	2.4	1.75	3.9
25	9.0	4.3	4.5	4.4	10.2	2.6	3.2	2.85	3.0	2.35	1.75	3.75
26	8.5	4.0	4.5	5.2	10.1	2.5	3.0	2.9	3.4	2.25	1.65	3.75
27	7.5	......	......	5.0	9.4	2.7	4.0	2.8	3.55	2.3	4.6	4.05
28	7.0	9.0	4.3	4.9	8.5	5.4	6.0	2.65	3.35	2.15	5.15	6.25
29	6.8	......	4.1	4.8	7.8	7.6	6.2	2.7	3.2	2.2	5.35	6.7
30	......	......	4.0	4.5	7.3	7.8	8.0	2.55	2.95	2.15	5.25	7.1
31	6.5	......	3.9	......	7.1	......	7.0	2.6	......	2.05	......	7.1

NOTE.—Ice present Jan. 1 to 10 and Dec. 20 to 27. Gage read to top of ice Jan. 6 and 7.

Daily discharge, in second-feet, of Kaskaskia River near Arcola, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	100	386	1,160	114	178	432	432	254	33	50	14	239
2	100	372	1,070	114	182	332	265	178	31	64	38	229
3	150	345	909	114	234	287	234	106	33	110	36	234
4	170	345	850	114	270	254	224	77	27	146	38	229
5	170	320	767	114	276	234	224	58	84	174	31	219
6	170	309	689	106	282	224	170	53	577	192	27	219
7	170	298	620	106	287	196	130	43	609	214	29	219
8	170	276	537	106	320	170	114	38	537	210	27	214
9	200	276	482	98	358	162	98	25	491	154	25	210
10	332	287	386	94	379	154	84	25	465	94	23	200
11	482	254	332	91	482	146	77	21	432	88	23	192
12	642	254	320	91	567	130	70	21	314	77	21	192
13	714	224	304	84	665	114	98	16	287	67	20	196
14	767	196	287	84	714	106	98	18	249	53	20	182
15	879	196	287	84	482	91	77	13	205	40	16	182
16	1,030	196	276	98	320	84	178	77	178	40	16	174
17	1,190	205	254	106	298	84	465	234	134	43	18	174
18	1,710	205	234	114	276	70	518	210	130	36	14	158
19	1,960	205	214	122	254	58	432	205	102	38	14	162
20	1,920	205	205	138	234	53	287	174	98	31	14	142
21	1,890	205	196	146	244	53	146	70	84	31	11	14
22	1,820	205	196	138	338	53	130	33	80	33	12	13
23	1,430	205	187	130	465	48	122	50	70	31	11	126
24	1,070	205	178	146	909	43	25	48	55	29	9	122
25	940	154	170	162	1,330	38	70	50	58	27	9	110
26	794	130	170	234	1,290	33	58	53	84	23	7	110
27	557	386	162	214	1,070	43	130	48	94	25	178	134
28	465	940	154	205	794	254	320	40	80	20	229	352
29	432	......	138	196	620	577	345	43	70	21	249	416
30	408	......	130	170	518	620	665	36	55	20	239	482
31	386	......	122	......	482	......	465	38	......	16	......	482

NOTE.—Daily discharge computed from a rating table that is well defined, and based on measurements made 1908–1910. From Jan. 1 to 10 the discharges are estimated because of presence of ice. Discharge interpolated for days of missing gage heights.

Monthly discharge of Kaskaskia River near Arcola, Ill., for 1910.

[Drainage area, 390 square miles.

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	1,960	....	749	1.92	2.21	C.
February	940	130	278	.713	.74	B.
March	1,170	122	387	.992	1.14	A.
April	234	84	128	.328	.37	A.
May	1,330	178	488	1.25	1.44	A.
June	620	33	171	.438	.49	A.
July	665	25	218	.559	.64	A.
August	254	13	76.6	.196	.23	A.
September	609	27	192	.492	.55	A.
October	214	16	70.9	.182	.21	A.
November	249	7	47.3	.121	.14	A.
December	482	....	212	.544	.63	D.
The year	1,960	7	252	.646	8.79	

KASKASKIA RIVER AT SHELBYVILLE, ILL.

This station, which is located at the highway bridge at the edge of Shelbyville, just above the Chicago & Eastern Illinois and Big Four railroad bridges and just below the pumping station of the City

Water Co. of Shelbyville, was established February 25, 1908, for the purpose of collecting data for use in studying drainage and flood-control problems.

No important tributaries enter the stream near Shelbyville.

The relation between gage height and discharge is likely to be affected by ice during portions of December, January, and February. Gage heights may be affected during high water by backwater caused by the lodging of drift at the two railroad bridges below the gaging station.

The datum has remained unchanged since the gage was installed.

The records are accurate and reliable.

Discharge measurements of Kaskaskia River at Shelbyville, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 14	M. E. McChristie	110	443	7.94	797
May 14	H. J. Jackson	123	770	10.47	1,760
30	.....do	141	866	11.27	2,060
July 25	.....do	105	267	6.50	306
Dec. 31[a]	P. S. Monk	115	507	8.48	952

[a] Not at regular section. River full of floating ice.

Daily gage height, in feet, of Kaskaskia River at Shelbyville, Ill., for 1910.

[Homer Pound, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.6	7.9	14.1	6.5	6.8	9.6	7.8	8.9	5.6	6.25	5.65	9.55
2	7.9	7.7	13.1	6.5	6.7	9.2	7.9	8.35	5.8	6.15	5.8	8.65
3	7.9	7.8	13.3	6.4	7.4	8.8	8.2	7.5	5.65	6.1	5.85	7.75
4	8.2	7.7	13.5	6.4	7.8	8.5	7.1	6.75	5.8	6.15	5.75	7.65
5	8.2	7.7	13.6	6.4	8.2	8.5	7.9	6.5	5.85	6.3	5.8	7.4
6	9.1	7.6	11.6	6.4	8.1	8.1	7.5	6.3	8.9	7.35	5.75	7.15
7	9.1	7.5	11.1	6.3	9.1	7.7	7.25	6.45	10.0	8.45	5.8	6.65
8	9.4	7.6	10.4	6.3	9.8	7.4	6.85	6.1	13.15	8.7	5.75	6.65
9	9.6	7.4	9.9	6.1	9.9	7.3	6.5	5.85	11.8	8.35	5.65	6.75
10	8.5	7.3	9.4	6.1	9.1	7.1	6.3	5.9	10.45	7.9	5.65	6.8
11	7.9	7.2	8.9	6.1	10.5	7.1	6.3	5.8	9.6	7.45	5.65	6.65
12	7.8	7.0	8.5	6.2	11.2	6.9	6.15	5.75	8.6	7.15	5.75	6.55
13	10.5	6.6	8.5	6.2	11.1	6.8	6.85	5.8	7.85	7.0	5.8	6.65
14	13.1	6.9	7.9	6.2	10.5	6.6	6.8	5.65	7.6	6.8	5.65	6.75
15	13.9	6.9	7.6	6.2	10.1	6.5	6.7	5.7	7.05	6.55	5.65	6.7
16	13.5	6.9	7.5	6.6	9.7	6.5	7.9	7.1	6.9	6.8	5.65	6.55
17	12.6	6.7	7.4	6.7	9.2	6.4	8.65	7.75	6.65	6.45	5.65	6.45
18	15.1	6.5	7.3	6.7	8.6	6.4	9.65	8.5	6.5	6.35	5.7	6.25
19	17.0	6.7	7.2	6.7	8.2	6.4	9.2	7.85	6.25	6.3	5.65	6.25
20	18.6	6.6	7.1	6.7	8.1	6.3	8.6	7.5	6.2	6.25	5.65	6.3
21	15.6	7.1	6.9	6.7	7.9	6.1	8.1	6.7	6.15	6.4	5.65	6.15
22	14.0	7.0	6.9	6.6	8.7	5.9	7.35	6.55	6.05	6.25	5.65	6.15
23	13.5	7.0	6.9	6.6	14.1	5.9	6.85	6.5	6.1	6.15	5.7	6.25
24	12.2	6.8	6.8	6.5	15.2	5.9	6.7	7.25	6.15	6.2	5.65	6.65
25	11.2	6.7	6.8	6.5	16.2	5.9	6.45	6.9	6.7	6.05	5.65	6.5
26	10.5	6.7	6.7	6.5	15.8	5.9	6.1	6.5	6.55	6.1	5.65	6.25
27	9.7	11.9	6.7	6.6	13.3	6.4	6.1	6.25	6.45	6.05	13.75	6.05
28	9.1	13.5	6.7	6.7	12.5	6.8	6.15	6.2	6.4	6.05	13.9	7.85
29	8.8	......	6.6	6.9	12.2	7.1	6.4	5.85	6.35	6.0	11.65	9.75
30	8.5	......	6.6	6.8	11.4	7.6	7.85	5.8	6.3	5.85	10.2	9.4
31	8.2	......	6.5	......	10.4	......	8.8	5.65	......	5.8	......	8.95

NOTE.—Ice present from Jan. 3 to 21 and from Feb. 23 to 26. Gage heights for Jan. 18 to 20 read to top of ice.

Daily discharge, in second-feet, of Kaskaskia River at Shelbyville, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	250	774	3,700	290	392	1,450	738	1,150	58	208	66	1,420
2	250	702	3,160	290	358	1,270	774	937	90	176	90	1,050
3	300	738	3,260	256	596	1,110	882	630	66	160	100	720
4	300	702	3,380	256	738	994	494	375	90	176	82	684
5	300	702	3,430	256	882	994	774	290	100	224	90	596
6	300	666	2,400	256	846	846	630	224	1,150	579	82	511
7	300	630	2,150	224	1,230	702	545	273	1,630	975	90	341
8	300	666	1,810	224	1,540	596	409	160	3,180	1,070	82	341
9	350	596	1,580	160	1,580	562	290	100	2,500	937	66	375
10	400	562	1,360	160	1,230	494	224	109	1,840	774	66	392
11	500	528	1,150	160	1,860	494	224	90	1,450	613	66	341
12	738	460	994	192	2,200	426	176	82	1,030	511	82	307
13	1,860	324	994	192	2,150	392	409	90	756	460	90	341
14	3,160	426	774	192	1,860	324	392	66	666	392	66	375
15	3,600	426	666	192	1,680	290	358	73	777	307	66	358
16	3,380	426	630	324	1,490	290	774	494	426	392	66	307
17	2,900	358	596	358	1,270	256	1,050	720	341	273	66	273
18	4,260	290	562	358	1,030	256	1,470	994	290	240	73	208
19	5,330	358	528	358	882	256	1,270	756	208	224	66	208
20	6,360	324	494	358	846	224	1,030	630	192	208	66	224
21	4,540	494	426	358	774	160	846	358	176	256	66	176
22	3,650	460	426	324	1,070	109	579	307	145	208	66	176
23	3,380	460	426	324	3,700	109	409	290	160	176	73	208
24	2,700	392	392	290	4,310	109	358	545	176	192	66	341
25	2,200	358	392	290	4,870	109	273	426	358	145	66	290
26	1,860	358	358	290	4,650	109	160	290	307	160	66	208
27	1,490	2,550	358	324	3,260	256	160	208	273	145	3,510	145
28	1,230	3,380	358	358	2,850	392	176	192	256	145	3,600	756
29	1,110	....	324	426	2,700	494	256	100	240	130	2,420	1,520
30	994	....	324	392	2,300	666	756	90	224	100	1,720	1,360
31	882	....	290	....	1,810	....	1,110	66	....	90	....	1,170

NOTE.—Daily discharge computed from a rating curve well defined and based on discharge measurements made 1908-1910. From Jan. 1 to 11 the discharges are estimated because of presence of ice.

Monthly discharge of Kaskaskia River at Shelbyville, Ill., for 1910.

[Drainage area, 1,030 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	6,360	....	1,910	1.86	2.14	C.
February	3,380	290	682	.662	.69	B.
March	3,700	290	1,220	1.18	1.36	B.
April	426	160	281	.273	.30	A.
May	4,870	358	1,840	1.79	2.06	B.
June	1,450	109	491	.477	.53	A.
July	1,470	160	581	.564	.65	A.
August	1,150	66	359	.349	.40	A.
September	3,180	58	638	.619	.69	A.
October	1,070	90	343	.333	.38	A.
November	3,600	66	439	.426	.48	A.
December	1,520	145	507	.492	.57	C.
The year	6,360	58	778	.755	10.25	

KASKASKIA RIVER AT VANDALIA, ILL.

This station, which is located at the highway bridge at the east end of Main Street, Vandalia, Ill., was established February 26, 1908, to obtain data for use in studying drainage questions, flood protection, and levee construction.

No important tributaries enter the river near Vandalia.

The relation between gage height and discharge during a portion of December, January, and February is likely to be somewhat affected by ice.

The river for some miles above and below Vandalia is leveed along the left bank. It is claimed that these levees, by confining the floods, have caused floods of unusual height on the right side of the river, and a number of lawsuits have been instituted to recover damages to property on the right bank. During extreme floods these levees sometimes give way, thus reducing the flood flow; some of the water passes around the gaging section.

The datum has remained unchanged since the gage was installed.

The records are reliable and accurate.

Discharge measurements of Kaskaskia River at Vandalia, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 26	H. J. Jackson	119	762	4.78	533
May 29	.....do	152	2,010	13.90	4,000
June 4	.....do	126	1,130	8.05	1,570
Dec. 21	P. S. Monk	110	475	[a] 3.40	260

[a] Ice present.

Daily gage height, in feet, of Kaskaskia River at Vandalia, Ill., for 1910.

[W. F. Radcliff, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		6.95	19.7	4.3	4.8	10.75	4.2	5.8	2.6	3.35	2.45	10.65
2		6.85	19.3	4.25	5.25	9.1	5.55	6.35	2.85	3.35	2.4	9.1
3		7.5	18.25	4.2	7.0	8.25	7.5	5.95	3.95	3.35	2.3	8.75
4		7.35	17.35	4.1	11.1	8.15	8.65	5.0	4.6	3.1	2.15	8.65
5		6.15	16.3	4.1	8.05	9.65	7.9	4.55	4.9	6.45	2.15	8.35
6		6.3	14.95	4.0	7.05	8.7	7.35	4.3	4.95	13.7	2.15	7.85
7		6.2	13.35	4.0	7.35	7.15	7.05	3.95	7.0	13.6	2.15	7.55
8	6.3	6.2	11.75	3.9	10.9	6.5	6.6	3.8	8.45	10.6	2.05	7.05
9		6.1	10.05	3.9	11.45	6.1	5.4	3.4	9.6	8.9	2.05	6.7
10		5.8	9.15	3.8	10.05	5.85	4.45	3.05	10.5	8.05	2.05	6.2
11	6.85	5.35	8.4	3.8	9.5	5.8	3.95	3.3	9.4	6.2	2.05	5.5
12	8.35	4.95	8.0	3.8	13.8	5.5	4.95	3.65	8.65	5.65	2.05	4.35
13	10.5	4.9	7.35	3.7	15.25	5.15	4.45	3.0	7.2	5.15	2.05	4.0
14	12.65	4.9	7.0	3.7	13.05	5.0	4.6	4.3	6.45	4.8	2.05	3.65
15	15.0	4.9	6.6	3.7	10.8	4.95	4.1	4.8	6.0	4.4	2.05	3.25
16	14.25	4.8	6.25	4.0	9.35	4.85	13.0	5.15	5.35	4.25	2.05	3.2
17	13.0	4.8	6.05	5.9	8.8	4.65	16.4	5.15	4.55	4.05	2.05	3.1
18	13.45	4.8	5.85	7.0	8.15	4.4	16.9	5.25	4.15	3.85	2.05	3.05
19	17.1	4.8	5.65	7.05	7.55	4.1	13.75	7.15	3.95	3.75	2.05	3.1
20	17.5	4.8	5.45	6.25	7.05	4.2	9.35	7.8	3.6	3.7	2.05	3.0
21	16.65	5.75	5.35	5.45	7.15	4.3	7.6	5.6	3.15	3.5	2.05	3.1
22	16.3	5.55	5.25	4.8	12.8	4.4	6.75	8.2	2.85	3.4	2.05	3.1
23	16.2	5.35	5.1	4.6	15.05	4.5	5.85	6.0	3.3	3.25	2.0	3.1
24	14.55	5.25	5.0	4.5	16.95	4.6	5.2	4.2	3.5	3.15	2.1	2.9
25	13.45	5.15	4.95	4.45	18.55	3.4	4.85	4.3	4.15	3.15	2.0	2.9
26	11.5	5.5	4.8	6.5	18.3	3.95	4.35	4.55	4.25	3.15	2.1	2.8
27	9.9	15.8	4.7	5.75	17.25	6.0	4.15	4.25	4.5	3.15	2.0	2.95
28	8.8	18.2	4.6	5.2	16.05	4.75	3.95	3.7	4.2	3.05	4.45	3.4
29	8.1		4.55	4.95	14.15	4.05	3.5	3.3	4.0	2.85	12.15	5.0
30	7.75		4.5	4.85	14.8	5.0	3.15	3.2	3.5	2.75	11.7	6.45
31	7.3		4.4		13.8		4.5	3.0		2.65		6.85

NOTE.—Ice present from Jan. 1 to 22 and also for a few days during the middle of February.

Daily discharge, in second-feet, of Kaskaskia River at Vandalia, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	400	1,180	6,970	455	575	2,670	431	844	122	246	104	2,630
2	500	1,150	6,770	443	692	1,990	774	999	156	246	99	1,990
3	600	1,370	6,240	431	1,200	1,660	1,370	886	374	246	88	1,850
4	700	1,320	5,800	408	2,820	1,620	1,810	625	527	198	73	1,810
5	800	942	5,270	408	1,580	2,210	1,520	515	600	1,030	73	1,690
6	900	984	4,610	385	1,220	1,830	1,320	455	612	4,010	73	1,500
7	940	956	3,850	385	1,320	1,250	1,220	374	1,200	3,970	73	1,390
8	984	956	3,120	362	2,740	1,040	1,070	340	1,730	2,600	64	1,220
9	1,040	928	2,370	362	2,980	928	732	256	2,190	1,910	64	1,100
10	1,090	844	2,010	340	2,800	858	491	189	2,560	1,580	64	956
11	1,150	718	1,710	340	2,150	844	374	236	2,110	956	64	760
12	1,690	612	1,560	340	4,060	760	612	307	1,810	802	64	467
13	2,560	600	1,320	318	4,750	664	491	180	1,270	664	64	385
14	3,530	600	1,200	318	3,710	625	527	455	1,030	575	64	307
15	4,630	600	1,070	318	2,690	612	408	575	900	479	64	226
16	4,270	575	970	385	2,090	588	3,690	664	718	443	64	216
17	3,690	575	914	872	1,870	539	5,320	664	515	396	64	198
18	3,900	575	858	1,200	1,620	479	5,570	692	420	351	64	189
19	5,670	575	802	1,220	1,390	408	4,040	1,250	374	329	64	198
20	5,870	575	746	970	1,220	431	2,090	1,480	296	318	64	180
21	5,440	830	718	746	1,250	455	1,410	788	207	276	64	198
22	5,270	774	692	575	3,600	479	1,120	1,640	156	256	64	198
23	5,220	718	651	527	4,650	503	858	900	236	226	59	198
24	4,410	692	625	503	5,600	527	678	431	276	207	68	164
25	3,900	664	612	491	6,400	256	580	455	420	207	59	164
26	3,000	760	575	1,040	6,270	374	467	515	443	207	68	149
27	2,310	5,020	551	830	5,740	900	420	443	503	207	59	172
28	1,870	6,220	527	678	5,140	563	374	318	431	189	491	256
29	1,600	......	515	612	4,220	396	276	236	385	156	3,300	625
30	1,460	......	503	588	4,530	625	207	216	276	142	3,090	1,030
31	1,300	......	479	......	4,060	......	503	180	......	128	......	1,150

NOTE.—Daily discharge computed from a rating curve well-defined between 88 and 4,150 second-feet, and based on measurements of 1908 to 1910. Discharge estimated from Jan. 1 to 10 because of presence of ice.

Monthly discharge of Kaskaskia River at Vandalia, Ill., for 1910.

[Drainage area, 1,980 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	5,870	....	2,600	1.31	1.51	C.
February	6,220	575	1,150	.581	.60	A.
March	6,970	479	2,080	1.05	1.21	B.
April	1,220	318	562	.284	.32	A.
May	6,400	575	3,060	1.55	1.79	A.
June	2,670	256	903	.456	.51	A.
July	5,570	207	1,320	.667	.77	A.
August	1,640	180	584	.295	.34	A.
September	2,560	122	762	.385	.43	A.
October	4,010	128	760	.384	.44	A.
November	3,300	59	291	.147	.16	B.
December	2,630	....	760	.384	.44	C.
Tne year	6,970	59	1,240	.626	8.52	

KASKASKIA RIVER AT CARLYLE, ILL.

This station, which is located at the Baltimore & Ohio Southwestern Railroad bridge about one-fourth mile east of the railroad station at Carlyle, Ill., was established March 2, 1908, for the purpose of obtaining data for use in studying drainage, flood control, and water supply problems.

The river receives no important tributaries for 10 miles above and below this station. Shoal Creek comes in on the right bank about 15 miles below the station.

The intake of the water-supply system of Carlyle is above the gaging station. The dam is about 700 feet above the section and is about 3½ feet high. The average amount of water pumped is about 3,500,000 gallons every 30 days, and during June, July, and August the quantity is about 4,500,000 gallons every 30 days. The outfalls of one section of the city sewerage system and some private sewers are above the gaging station, so the diversion is small.

The datum has remained unchanged since the gage was installed. The records are accurate and reliable.

The flood of 1882, which is the highest known, is said to have reached a height of 1½ feet higher than the flood of 1908, or about 32½ feet on the present gage. The stream never goes dry at this point. It has been noticed during periods of low water that the water is hard, a fact that indicates that the flow is maintained by springs.

Discharge measurements of Kaskaskia River at Carlyle, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 25	H. J. Jackson	139	531	9.24	818
May 20	C. T. Bailey	158	1,020	12.70	1,840
27	.....do	522	3,510	20.52	4,710
29	.....do	526	3,910	21.17	5,310
June 2	.....do	526	4,040	21.76	6,150
6	.....do	198	2,150	18.92	3,890
7	.....do	198	1,900	17.66	3,310
8	.....do	166	1,160	13.63	1,940
July 30	H. J. Jackson	132	356	8.05	561
Dec. 7	Bailey and Monk	139	550	9.62	846
20	P. S. Monk	128	293	7.64	440

Daily gage height, in feet, of Kaskaskia River at Carlyle, Ill., for 1910.

[Arnold J. Marcham, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.6	13.7	22.1	8.3	9.2	21.8	8.7	8.8	7.0	8.2	6.9	13.25
2	10.0	12.5	23.8	8.2	8.9	21.7	8.4	9.3	6.9	7.8	6.85	14.5
3	10.3	12.0	24.8	8.1	8.7	21.5	8.6	9.8	6.7	7.5	6.8	14.05
4	10.7	12.7	24.5	8.0	10.0	20.6	9.8	10.0	7.6	7.35	6.65	12.8
5	11.4	13.7	24.1	8.1	11.3	19.7	11.9	10.2	9.1	7.7	6.65	11.45
6	11.6	12.8	23.6	8.2	12.4	18.9	14.1	9.6	9.9	15.9	6.55	10.1
7	12.3	11.9	23.0	8.3	12.2	17.0	13.2	8.9	11.0	19.25	6.7	9.5
8	12.4	11.2	22.6	8.3	13.5	13.9	12.3	8.2	13.4	20.3	6.75	9.0
9	10.5	10.7	22.2	8.1	15.0	12.4	11.0	7.8	15.2	20.95	6.8	8.8
10	11.5	10.5	17.3	7.9	16.3	11.3	10.5	7.6	15.9	21.5	6.8	8.6
11	11.0	10.3	16.1	7.8	16.0	10.7	9.6	7.4	15.8	21.7	6.65	8.4
12	10.9	10.0	14.8	7.7	15.0	10.2	9.2	7.2	15.1	19.9	6.65	8.2
13	16.0	9.8	13.2	7.6	17.1	9.8	8.7	7.1	14.0	17.7	6.55	8.0
14	19.4	9.6	13.0	7.5	18.2	9.4	8.4	6.95	13.1	12.9	6.5	7.8
15	20.4	9.4	12.2	7.5	18.4	9.2	8.2	6.8	11.9	10.9	6.5	7.7

Daily gage height, in feet, of Kaskaskia River at Carlyle, Ill, for 1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	21.0	9.5	11.5	8.7	18.6	9.0	10.3	6.7	10.8	10.5	6.4	7.6
17	21.5	9.9	11.0	10.1	17.1	8.8	14.6	7.2	9.7	10.15	6.4	7.5
18	21.6	10.4	10.6	11.4	15.7	8.6	18.4	7.9	8.5	9.9	6.3	7.45
19	21.8	11.1	10.3	11.2	13.5	8.4	19.2	9.0	8.3	9.4	6.25	7.4
20	21.9	10.5	10.1	10.7	12.6	8.2	19.6	9.7	8.1	8.85	6.3	7.45
21	22.0	10.2	10.0	9.8	11.8	8.0	19.9	10.4	7.9	8.4	6.2	7.3
22	22.1	10.6	9.7	9.3	13.7	7.9	19.1	11.2	7.8	7.85	6.25	7.2
23	22.0	11.8	9.6	8.9	18.0	7.8	17.9	11.6	7.7	7.8	6.15	7.1
24	21.9	13.5	9.5	8.7	19.0	7.75	14.6	12.3	7.6	7.7	6.15	7.05
25	21.8	13.6	9.25	8.5	19.6	7.5	12.2	9.9	7.5	7.55	6.15	7.0
26	21.6	12.2	9.2	8.4	20.2	7.4	10.3	8.5	7.4	7.5	6.1	6.95
27	21.5	16.1	9.05	8.5	20.6	7.8	9.4	8.3	8.0	7.35	7.0	6.9
28	21.4	20.9	8.9	9.2	20.9	8.4	8.8	8.2	8.6	7.3	7.25	7.1
29	20.9	....	8.7	9.9	21.3	10.8	8.3	8.1	9.2	7.2	8.05	7.4
30	17.8	....	8.6	9.6	21.6	9.6	8.1	7.7	8.4	7.05	11.2	7.9
31	15.7	....	8.4	....	21.9	....	8.4	7.4	....	7.0	....	9.5

NOTE.—Ice present from Jan. 1 to 4.

Daily discharge, in second-feet, of Kaskaskia River at Carlyle, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	926	2,060	6,720	590	822	6,270	692	718	280	565	260	1,920
2	1,030	1,710	9,310	565	744	6,110	615	848	260	466	250	2,300
3	1,110	1,570	10,800	540	692	5,810	666	978	220	394	240	2,160
4	1,220	1,770	10,400	515	1,030	4,660	978	1,030	418	358	211	1,790
5	1,410	2,060	9,760	540	1,380	4,110	1,540	1,080	796	442	211	1,420
6	1,460	1,790	9,000	565	1,680	3,760	2,180	926	1,000	2,730	193	1,060
7	1,650	1,540	8,090	590	1,630	3,080	1,910	744	1,300	3,900	220	900
8	1,680	1,350	7,480	590	2,000	2,120	1,650	565	1,970	4,450	230	770
9	1,160	1,220	6,870	540	2,450	1,680	1,300	466	2,510	5,030	240	718
10	1,440	1,160	3,180	490	2,860	1,380	1,160	418	2,730	5,810	240	666
11	1,300	1,110	2,790	466	2,760	1,220	926	370	2,700	6,110	211	615
12	1,270	1,030	2,390	442	2,450	1,080	822	324	2,480	4,220	211	565
13	2,760	978	1,910	418	3,110	978	692	302	2,140	3,320	193	515
14	3,970	926	1,850	394	3,500	874	615	270	1,880	1,820	184	466
15	4,510	874	1,630	394	3,570	822	565	240	1,540	1,270	184	442
16	5,090	900	1,440	692	3,650	770	1,110	220	1,250	1,160	166	418
17	5,810	1,000	1,300	1,060	3,110	718	2,330	324	952	1,070	166	394
18	5,960	1,140	1,190	1,410	2,670	666	3,570	490	640	1,000	148	382
19	6,270	1,330	1,110	1,350	2,000	615	3,880	770	590	874	140	370
20	6,420	1,160	1,060	1,220	1,740	565	4,060	952	540	731	148	382
21	6,570	1,080	1,030	978	1,520	515	4,220	1,140	490	615	132	346
22	6,720	1,190	952	848	2,060	490	3,840	1,350	466	478	140	324
23	6,570	1,520	926	744	3,430	466	3,390	1,460	442	466	124	302
24	6,420	2,000	900	692	3,800	454	2,330	1,650	418	442	124	291
25	6,270	2,020	835	640	4,060	394	1,630	1,000	394	406	124	280
26	5,960	1,630	822	615	4,380	370	1,110	640	370	394	116	270
27	5,810	2,790	783	640	4,660	466	874	590	515	358	280	260
28	5,660	4,970	744	822	4,970	615	718	565	666	346	335	302
29	4,970	....	692	1,000	5,510	1,250	590	540	822	324	528	370
30	3,360	....	666	926	5,960	926	540	442	615	291	1,350	490
31	2,670	....	615	....	6,420	....	615	370	....	280	....	900

NOTE.—Daily discharge computed from a well-defined rating curve based on measurements made 1908-1910.

Monthly discharge of Kaskaskia River at Carlyle, Ill., for 1910.

[Drainage area, 2,680 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	6,720	926	3,790	1.41	1.63	B.
February	4,970	874	1,570	.586	.61	A.
March	10,800	615	3,460	1.29	1.49	A.
April	1,410	394	709	.265	.30	A.
May	6,420	692	2,920	1.09	1.26	A.
June	6,270	370	1,770	.660	.74	A.
July	4,220	540	1,650	.616	.71	A.
August	1,650	220	703	.262	.30	A.
September	2,730	220	1,050	.392	.44	A.
October	6,110	280	1,620	.604	.70	A.
November	1,350	116	243	.091	.10	A.
December	2,300	260	722	.269	.31	A.
The year	10,800	116	1,690	.631	8.59	

KASKASKIA RIVER AT NEW ATHENS, ILL.

This station, which is located at the Illinois Central Railroad bridge, about 600 feet north of the Illinois Central Railroad station at New Athens, Ill., and about 600 feet upstream from the highway bridge, was established November 1, 1909, for the purpose of obtaining data for use in studying problems of drainage, flood control, and navigation.

Silver Creek enters on the right bank about 1 mile above and Lively Creek on the left bank about 3 miles below the gaging station.

The datum of the gage has remained unchanged since the gage was installed. The records are accurate and reliable. The stream is fed by springs and never goes dry at this point. The relation between gage height and discharge is liable to be affected by ice in December, January, and February. The flood of the fall of 1898 reached a height of about 34.5 feet on the present gage datum.

A record of river height at this point from January 23, 1907, to October 28, 1909, inclusive, was kept for the New Athens Journal by C. J. von Roth Roffy. The river height was taken on Wednesday and Thursday mornings of each week, the river height for Thursday being published each Friday with the change in twenty-four hours, as obtained from the river height of Wednesday. This record of stage was kept by the Journal mainly for the information of farmers who lived on the west side of the river and who are cut off from reaching New Athens via the highway bridge when the river reaches a stage of about 30 feet. The record is authentic. These gage heights have been carefully reduced to the datum of the present gage. The maximum error is probably not over 0.4 foot; the lower the stage the greater the error.

Discharge measurements of Kaskaskia River near New Athens, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 23	H. B. Jackson	205	1,220	7.48	1,400
May 21	C. T. Bailey	216	1,780	9.96	2,820
21[a]	do	202	2,030	9.72	2,440
22	do	213	1,580	9.18	2,260
26	do	271	4,250	20.55	11,700
30	do	271	4,420	21.06	11,800
31	do	261	4,210	20.28	10,300
June 1	do	260	4,090	19.77	9,570
5	do	248	3,520	17.63	7,930
7	do	251	3,700	18.32	8,650
Dec. 10	Bailey and Monk	195	945	5.96	902

[a] Measurement made at highway bridge.

Daily gage height, in feet, of Kaskaskia River at New Athens, Ill., for 1910.

[C. J. von Roth Roffy, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.6	16.9	21.85	6.2	7.8	19.95	8.0	5.9	6.1	7.9	4.9	4.9
2	8.45	14.35	22.9	6.05	7.2	19.35	7.0	5.5	5.5	6.4	4.75	9.5
3	9.0	11.6	24.2	6.2	8.7	18.7	7.45	5.3	5.45	5.85	4.7	10.75
4	9.0	10.5	24.7	6.1	9.05	18.0	7.9	5.6	7.0	6.25	4.65	10.5
5	9.1	10.8	25.0	6.55	10.1	17.55	8.35	6.5	17.45	10.5	4.55	9.25
6	10.15	11.9	25.25	7.15	10.95	17.95	10.45	6.65	20.75	18.7	4.5	8.2
7	11.15	11.7	25.15	7.15	13.6	18.25	12.25	6.7	22.8	20.4	4.45	7.3
8	11.6	10.65	24.7	7.6	12.9	18.4	12.65	6.4	23.8	21.35	4.4	6.85
9	11.5	9.55	23.95	7.3	12.65	17.9	11.05	6.0	23.85	21.85	4.4	6.45
10	10.7	8.85	23.1	6.65	13.8	15.3	9.6	5.4	23.65	22.55	4.3	5.9
11	9.7	8.45	22.4	6.3	14.5	12.9	8.4	5.1	23.25	22.9	4.3	5.85
12	8.9	8.2	21.75	6.1	14.45	11.3	9.3	4.9	22.85	23.0	4.2	5.65
13	14.4	7.9	21.1	5.85	13.7	10.65	10.55	4.65	22.15	23.0	4.25	5.55
14	18.9	7.75	20.35	5.6	13.8	10.0	9.0	4.45	21.05	22.55	4.2	5.45
15	20.1	7.85	17.5	6.8	14.9	9.0	7.5	4.3	18.2	21.85	4.1	5.0
16	20.8	8.3	14.5	7.55	14.9	7.95	11.7	4.2	12.55	19.9	4.15	5.0
17	21.65	8.75	10.8	11.65	14.25	7.45	14.65	4.1	9.4	14.4	4.05	4.85
18	22.1	8.4	9.45	13.85	13.75	7.8	15.7	4.1	8.1	9.3	4.05	4.7
19	22.45	8.8	8.85	14.95	12.7	7.4	16.35	4.0	7.25	7.7	4.05	4.65
20	22.65	8.65	8.35	14.85	11.2	6.65	17.1	4.5	6.7	7.05	3.95	4.7
21	22.65	8.7	8.05	12.85	10.1	6.1	17.15	5.8	6.25	6.65	4.0	4.9
22	22.55	8.95	7.75	10.05	9.3	7.6	16.7	7.35	5.9	6.35	3.9	4.4
23	22.45	9.1	7.5	8.45	13.9	7.95	15.7	12.65	5.65	6.1	3.95	4.4
24	22.3	10.0	7.3	7.65	18.65	6.75	14.4	17.45	5.45	5.95	3.95	4.5
25	21.8	11.0	7.4	7.15	19.75	6.0	12.1	18.35	5.55	5.8	3.85	4.65
26	21.2	11.4	7.75	6.8	20.5	5.65	9.55	19.15	6.45	5.65	3.9	4.35
27	20.5	17.9	7.8	6.8	21.4	5.55	8.9	19.15	6.3	5.5	3.85	4.3
28	19.8	......	7.7	6.8	21.5	6.6	8.75	17.95	6.4	5.25	3.85	4.3
29	19.1	......	7.25	6.9	21.4	7.3	7.65	14.95	10.0	5.2	3.85	4.5
30	18.5	......	6.75	7.55	21.15	7.95	7.5	11.25	10.15	5.1	3.8	4.75
31	17.6	......	6.4	......	20.5	......	6.65	7.4	......	4.95	......	5.2

NOTE.—Ice present from Jan. 1 to 3.

Daily discharge, in second-feet, of Kaskaskia River at New Athens, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,510	7,180	15,300	938	1,610	10,300	1,700	836	904	1,650	560	560
2	1,920	5,260	18,900	887	1,340	9,520	1,250	710	710	1,010	527	2,480
3	2,200	3,630	23,400	938	2,050	8,810	1,450	656	696	819	516	3,160
4	2,200	3,020	25,100	904	2,230	8,130	1,650	738	1,250	956	505	3,020
5	2,250	3,190	26,200	1,070	2,800	7,730	1,880	1,050	7,640	3,020	484	2,340
6	2,830	3,800	27,000	1,310	3,270	8,080	3,000	1,110	11,700	8,810	474	1,800
7	3,380	3,680	26,700	1,310	4,790	8,360	3,990	1,130	18,600	11,000	464	1,380
8	3,630	3,110	25,100	1,510	4,370	8,510	4,220	1,010	22,000	13,600	454	1,190
9	3,580	2,500	22,500	1,380	4,220	8,040	3,330	870	22,200	15,300	454	1,030
10	3,140	2,120	19,600	1,110	4,910	5,930	2,530	682	21,500	17,700	434	836

Daily discharge, in second-feet, of Kaskaskia River at New Athens, Ill., for 1910—Contd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	2,580	1,920	17,200	974	5,370	4,370	1,900	606	20,100	18,900	434	819
12	2,150	1,800	14,900	904	5,340	3,460	2,360	560	18,700	19,200	414	754
13	5,300	1,650	12,700	819	4,850	3,110	3,050	505	16,300	19,200	424	724
14	9,010	1,580	10,900	738	4,910	2,750	2,200	464	12,500	17,700	414	696
15	10,500	1,630	7,680	1,170	5,650	2,200	1,470	434	8,310	15,300	396	582
16	11,800	1,850	5,370	1,490	5,650	1,680	3,680	414	4,160	10,200	405	582
17	14,600	2,080	3,190	3,660	5,200	1,450	5,480	396	2,420	5,300	387	549
18	16,100	1,900	2,450	4,940	4,880	1,610	6,230	396	1,750	2,360	387	516
19	17,400	2,100	2,120	5,680	4,250	1,420	6,740	378	1,360	1,560	387	505
20	18,000	2,020	1,880	5,620	3,410	1,110	7,340	474	1,130	1,270	369	516
21	18,000	2,050	1,720	4,340	2,800	904	7,390	802	956	1,110	378	560
22	17,700	2,180	1,580	2,780	2,360	1,510	7,020	1,400	836	992	360	454
23	17,400	2,260	1,470	1,920	4,970	1,680	6,230	4,220	754	904	369	454
24	16,800	2,750	1,380	1,540	8,760	1,150	5,300	7,640	696	853	369	474
25	15,100	3,300	1,420	1,310	10,000	870	3,900	8,460	724	802	352	505
26	13,000	3,520	1,580	1,170	11,100	754	2,500	9,280	1,030	754	360	444
27	11,100	8,040	1,600	1,170	13,700	724	2,150	9,280	974	710	352	434
28	10,100	10,200	1,560	1,170	14,100	1,090	2,080	8,080	1,010	643	352	434
29	9,230	....	1,360	1,210	13,700	1,380	1,540	5,680	2,750	630	352	474
30	8,610	....	1,150	1,490	12,900	1,680	1,470	3,440	2,830	606	344	527
31	7,770	....	1,010	....	11,100	....	1,110	1,420	....	571	....	630

NOTE.—Daily discharge computed from a rating curve well defined between 378 and 15,800 second-feet.

Monthly discharge of Kaskaskia River at New Athens, Ill., for 1910.

[Drainage area, 5,220 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	18,000	1,510	9,000	1.72	1.98	B.
February	10,200	1,580	3,230	.619	.64	A.
March	27,000	1,010	10,500	2.01	2.32	A.
April	5,680	738	1,850	.354	.40	A.
May	14,100	1,340	6,020	1.15	1.33	A.
June	10,300	724	3,940	.755	.84	A.
July	7,390	1,110	3,420	.655	.76	A.
August	9,280	378	2,360	.452	.52	A.
September	22,200	696	6,880	1.32	1.47	A.
October	19,200	571	6,240	1.19	1.37	A.
November	560	344	416	.080	.09	A.
December	3,160	434	949	.182	.21	A.
The year	27,000	344	4,590	.879	11.93	

SHOAL CREEK NEAR BREESE, ILL.

Shoal Creek is tributary to Kaskaskia River in Clinton County about 15 miles below Carlyle.

The gaging station, which is located at the Baltimore & Ohio Southwestern Railroad bridge about 1½ miles east of Breese, Ill., was established November 5, 1909, for the purpose of obtaining data for use in studying problems of drainage, flood control, water supply, and storage.

Beaver Creek enters on the left bank about 3 miles below the gaging section. The intake of the pumping station of the water-supply system of Breese is about one-fourth mile above the gaging section.

The relation between gage height and discharge is apt to be affected by ice during December, January, and February.

The datum of the gage has remained unchanged since the gage was installed. The records are accurate and reliable.

The creek is fed by springs and has not been known to go dry at this point. The flood of 1907 reached a height representing about 22 feet on the present gage.

Discharge measurements of Shoal Creek near Breese, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 25	H. J. Jackson	60	63	1.80	116
May 19	C. T. Bailey	66	98	2.40	270
26 [a]	....do	586	2,440	17.36	4,080
28 [b]	....do	136	1,440	17.12	3,470
31	....do	90	863	11.85	1,940
June 2	....do	74	195	3.95	387
3	....do	70	143	3.24	278
July 29	H. J. Jackson	60	56	1.72	98
Dec. 7 [c]	Bailey and Monk	57	38.4	1.50	42.4

[a] Partly estimated. [b] No flow in flood channel. [c] Slight amount of ice present.

Daily gage height, in feet, of Shoal Creek near Breese, Ill., for 1910.

[John Nordman, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	2.7	17.6	1.7	2.2	6.2	1.9	1.6	1.8	2.4	1.7	1.9
2	3.4	2.3	18.9	1.7	2.15	5.1	1.85	1.4	1.85	2.1	1.6	1.7
3	3.9	2.2	19.0	1.7	7.8	3.0	2.1	1.5	1.8	1.85	1.65	1.55
4	4.2	5.15	18.1	1.65	13.3	5.2	1.9	1.55	13.3	2.7	1.65	1.6
5	5.0	4.9	16.6	1.65	12.1	13.7	4.9	1.5	14.7	5.4	1.6	1.55
6	6.7	3.8	11.4	3.1	10.4	14.5	7.65	1.5	15.75	16.3	1.65	1.55
7	8.4	2.9	7.5	5.15	7.2	7.4	6.8	1.5	16.8	16.95	1.6	1.45
8	6.6	2.6	5.3	2.8	8.0	4.5	3.7	1.5	16.95	18.2	1.65	1.5
9	5.4	2.3	4.0	2.3	10.6	3.7	2.0	1.55	15.8	18.85	1.65	1.5
10	3.85	2.2	3.6	2.1	7.2	4.0	2.1	1.5	12.2	18.0	1.6	1.5
11	3.4	2.15	2.9	1.8	5.1	3.2	2.8	1.5	8.1	10.4	1.6	1.5
12	3.2	2.1	2.55	1.8	4.2	2.6	2.0	1.5	3.3	7.0	1.55	1.45
13	14.4	2.05	2.3	1.8	8.1	2.3	2.1	1.5	2.3	4.2	1.6	1.45
14	16.0	2.0	2.25	1.85	12.4	2.0	2.2	1.5	2.2	3.8	1.6	1.45
15	16.9	2.25	2.15	2.6	7.2	3.2	1.9	1.45	2.15	3.5	1.55	1.4
16	17.1	2.8	2.1	8.2	5.2	5.3	9.9	1.45	2.1	3.2	1.6	1.4
17	17.9	3.7	2.05	13.4	2.9	6.4	13.5	1.5	1.9	2.1	1.55	1.4
18	17.3	3.2	2.0	14.8	2.6	2.3	15.95	2.1	1.85	2.0	1.6	1.4
19	16.6	2.4	2.0	13.55	2.45	2.15	16.2	3.2	1.8	1.95	1.6	1.4
20	16.65	2.2	1.95	7.15	2.25	7.7	11.3	5.1	1.7	1.9	1.55	1.4
21	16.3	2.4	1.9	4.2	2.1	9.0	5.8	3.8	1.7	1.9	1.6	1.4
22	12.2	2.7	1.95	3.1	3.2	4.7	3.4	5.4	1.75	1.9	1.55	1.4
23	7.1	3.8	1.95	2.6	14.0	2.1	3.2	11.2	1.75	1.9	1.6	1.4
24	5.2	3.7	1.9	2.3	15.8	1.9	3.1	16.5	2.1	1.9	1.6	1.4
25	3.9	2.85	1.9	2.4	16.3	1.8	2.0	16.9	4.2	1.85	1.55	1.4
26	3.5	3.2	1.85	2.35	17.1	1.85	1.9	15.6	9.4	1.85	1.6	1.4
27	3.7	7.8	1.85	2.5	17.85	2.9	1.75	7.9	12.6	1.8	1.55	1.4
28	4.1	16.4	1.8	2.7	17.5	6.1	1.4	4.1	12.0	1.8	1.65	1.55
29	3.9	......	1.8	2.5	10.5	3.2	1.7	2.8	4.5	1.75	2.8	2.0
30	3.7	......	1.75	2.25	8.2	2.0	1.65	2.1	2.5	1.7	2.05	5.1
31	3.0	......	1.75	......	12.5	......	1.6	1.9	......	1.65	......	4.7

NOTE.—Ice present Jan. 1 to 18 and Feb 17 to 26. Gage readings from Jan. 10 to 17 are to the top of ice.

Daily discharge, in second-feet, of Shoal Creek near Breese, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	70	197	4,290	90	137	786	106	84	98	161	90	106
2	70	149	5,970	90	132	588	102	72	102	126	84	90
3	70	137	6,100	90	1,070	235	126	78	98	102	87	80
4	70	597	4,930	87	2,190	606	106	81	2,190	197	87	70
5	70	553	3,160	87	1,920	2,270	553	78	2,500	642	84	60
6	60	366	1,780	251	1,580	2,450	1,050	78	2,790	3,000	87	50
7	60	222	1,020	597	966	1,000	894	78	3,340	3,510	84	42
8	60	185	624	209	1,110	485	349	78	3,510	5,060	87	42
9	70	149	400	149	1,620	349	115	81	2,810	5,900	87	42
10	70	137	332	126	966	400	126	78	1,940	4,800	84	42
11	70	132	222	98	588	267	209	78	1,130	1,580	84	42
12	100	126	179	98	434	185	115	78	283	930	81	42
13	2,430	120	149	98	1,130	149	126	78	149	434	84	42
14	2,880	115	143	102	1,990	115	137	78	137	366	84	42
15	3,450	143	132	185	966	267	106	75	132	315	81	40
16	3,690	209	126	1,150	606	624	1,480	75	126	267	84	40
17	4,670	349	120	2,210	222	822	2,230	78	106	126	81	40
18	3,930	267	115	2,520	185	149	2,860	126	102	115	84	40
19	3,160	161	115	2,240	167	132	2,960	267	98	110	84	40
20	3,200	137	110	957	143	1,060	1,760	588	90	106	81	40
21	3,000	161	106	434	126	1,300	714	366	90	106	84	40
22	1,940	197	110	251	267	519	299	642	94	106	81	40
23	948	366	110	185	2,340	126	267	1,740	94	106	84	40
24	606	349	106	149	2,810	106	251	3,100	126	106	84	40
25	383	216	106	161	3,000	98	115	3,450	434	102	81	40
26	315	267	102	155	3,690	102	106	2,740	1,380	102	84	40
27	349	1,070	102	173	4,600	222	94	1,090	2,030	98	81	40
28	417	3,050	98	197	4,170	768	72	417	1,900	98	87	81
29	383	......	98	173	1,600	267	90	209	485	94	209	115
30	349	......	94	143	1,150	115	87	126	173	90	120	588
31	235	......	94	......	2,010	......	84	106	......	87	......	519

NOTE.—Daily discharge computed from a rating curve fairly well defined between 90 and 3,930 second-feet, and based on measurements made during 1909 and 1910. Daily discharge Jan. 1 to 12 and Dec. 4 to 31 estimated on account of presence of ice.

Monthly discharge of Shoal Creek near Breese, Ill., for 1910.

[Drainage area, 760 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	4,670	....	1,170	1.54	1.78	C.
February	3,050	115	362	.476	.50	B.
March	6,100	94	1,000	1.32	1.52	B.
April	2,520	87	448	.59	.66	B.
May	4,600	126	1,420	1.87	2.16	B.
June	2,450	98	552	.726	.81	B.
July	2,960	72	571	.751	.87	B.
August	3,450	72	526	.692	.80	B.
September	3,510	90	951	1.25	1.40	B.
October	5,900	87	934	1.23	1.42	B.
November	209	81	89.5	.118	.13	B.
December	588	....	84.4	.111	.13	B.
The year	5,900	....	682	.897	12.18	

SILVER CREEK NEAR LEBANON, ILL.

Silver Creek is tributary to Kaskaskia River about 1 mile above New Athens, Ill.

The gaging station, which is located at the highway bridge at Wrights Crossing, about 2 miles west of Lebanon, Ill., between the Baltimore & Ohio Southwestern and East St. Louis & Suburban railway bridges across Silver Creek, was established March 3, 1908, for the purpose of collecting data for use in studying drainage and flood-control problems.

The creek receives no tributaries near the gaging station.

The relation between gage height and discharge is apt to be affected somewhat by ice during parts of December, January, and February.

The datum of the gage has remained unchanged since the gage was installed. From March 3, 1908, to May 10, 1909, this gage was so situated that 2 feet was the lowest obtainable reading, and the gage reader recorded the stream dry whenever the water surface was below 2 feet. On inquiry he stated that the stream was dry for only one week during 1908. To obviate this difficulty the position of the gage was changed on May 10, 1909. Except as noted above, the records are accurate and reliable.

Discharge measurements of Silver Creek near Lebanon, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 22	H. J. Jackson	31	100	3.00	42
May 27	C. T. Bailey	354	1,260	11.75	[a] 1,000
28	do	53	395	9.24	466
Dec. 8[b]	Bailey and Monk	32	102	3.01	8.9

[a] Flow in three flood channels estimated to be 53 second-feet. [b] Ice present.

Daily gage height, in feet, of Silver Creek near Lebanon, Ill., for 1910.

[E. C. Turner, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.1	3.6	14.6	2.7	3.0	3.8	2.2	2.5	2.25	2.5	3.5	3.25
2	5.4	3.75	13.8	2.6	2.9	3.0	2.2	2.0	2.05	2.5	3.4	3.15
3	5.4	4.0	13.0	2.6	5.0	2.8	4.1	1.9	......	2.45	3.4	3.1
4	6.2	5.8	12.3	2.7	8.7	2.8	3.2	1.8	......	3.1	3.4	3.15
5	7.0	6.5	11.6	3.6	8.2	9.5	2.7	1.8	......	3.1	3.35	3.1
6	8.0	4.7	8.6	4.9	4.5	11.0	2.45	1.6	13.4	11.55	3.45	3.1
7	7.9	3.9	5.6	4.8	5.1	12.0	2.2	2.4	13.2	12.5	3.4	3.1
8	7.7	3.7	4.7	3.8	8.6	11.5	2.1	2.2	12.6	14.4	3.5	2.95
9	6.9	3.6	4.2	3.1	8.1	8.1	2.2	2.25	12.2	13.3	3.45	3.0
10	4.7	3.6	3.9	2.9	5.4	9.5	4.75	2.1	9.7	12.4	3.5	2.85
11	4.9	3.55	3.7	2.7	4.2	6.4	3.2	1.8	4.7	10.75	3.45	2.85
12	7.1	3.5	3.6	2.9	5.5	4.8	6.7	1.65	3.5	5.2	3.05	2.9
13	11.2	3.5	3.5	2.8	6.0	3.4	5.6	1.5	3.0	3.85	3.1	2.85
14	13.9	3.5	3.4	2.7	5.5	3.05	3.4	1.5	2.9	3.55	3.05	......
15	14.3	4.1	3.25	3.6	4.7	3.1	2.55	1.45	2.6	3.35	3.1	......

Daily gage height, in feet, of Silver Creek near Lebanon, Ill., for 1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	13.2	5.1	3.2	9.6	3.2	4.3	3.65	1.7	2.7	3.2	3.05	......
17	12.8	7.6	3.2	10.3	3.1	4.65	8.9	1.7	2.45	3.2	3.1	......
18	12.2	6.1	3.2	10.6	3.2	3.2	10.4	1.7	2.25	3.15	3.1	......
19	11.9	5.3	3.2	8.1	3.1	2.9	9.6	1.9	2.4	3.2	3.1	......
20	12.3	4.9	3.2	5.0	2.9	2.7	4.5	2.2	2.4	3.2	3.15	3.0
21	11.9	4.4	3.15	4.0	2.7	2.9	2.9	2.0	2.4	3.15	3.15	......
22	11.5	4.5	3.1	3.5	2.6	3.9	2.35	1.7	2.3	3.35	3.15	......
23	8.7	4.9	3.0	3.3	11.6	2.9	2.2	11.9	2.4	3.25	3.15	......
24	5.8	4.9	3.0	3.2	13.2	2.5	2.7	11.7	2.65	3.3	3.15	......
25	4.5	4.5	3.0	3.1	13.8	2.35	2.25	13.7	2.7	3.3	3.2	......
26	4.5	4.5	3.0	3.1	12.7	2.5	2.85	13.0	2.85	3.25	3.2	......
27	4.5	11.0	2.9	3.5	12.0	2.6	3.45	11.9	5.0	3.3	3.2	2.9
28	4.5	11.9	2.9	3.4	9.3	4.7	2.6	5.4	4.9	3.25	3.3	3.35
29	4.6	......	2.9	3.4	7.4	3.25	2.3	3.55	3.6	3.3	3.6	3.65
30	4.3	......	2.8	3.2	5.1	2.55	2.9	2.7	3.2	3.4	3.5	4.0
31	4.0	......	2.8	......	4.6	......	2.6	2.5	......	3.45	......	3.75

NOTE.—Ice present Jan. 1 to 10 and Dec. 8 to 28. From Jan. 1 to 10 gage was read to top of ice.

Daily discharge, in second-feet, of Silver Creek near Lebanon, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	20	69	3,820	29	41	80	14	23	16	23	64	52
2	100	77	2,980	26	37	41	14	10	11	23	59	47
3	100	92	2,180	26	157	33	98	8	11	22	59	45
4	150	219	1,490	29	504	33	49	7	2,000	45	59	35
5	200	280	1,050	69	447	600	29	7	2,300	45	56	25
6	300	136	492	150	122	860	22	5	2,580	1,030	62	15
7	300	86	203	143	164	1,240	14	20	2,380	1,680	59	11
8	250	74	136	80	492	1,010	12	14	1,780	3,610	64	9
9	200	69	104	45	436	436	14	16	1,400	2,480	62	9
10	120	69	86	37	187	600	140	12	626	1,580	64	9
11	150	66	74	29	104	271	49	7	136	803	62	9
12	335	64	69	37	195	143	298	5.5	64	171	43	9
13	915	64	64	33	235	59	203	4	41	83	45	9
14	3,080	64	59	29	195	43	59	4	37	66	43	9
15	3,500	98	52	69	136	45	24	3.5	26	56	45	9
16	2,380	164	49	613	49	110	72	6	29	49	43	9
17	1,980	385	49	712	45	132	528	6	22	49	45	9
18	1,400	244	49	770	49	49	730	6	16	47	45	9
19	1,190	179	49	436	45	37	613	8	20	49	45	9
20	1,490	150	49	157	37	29	122	14	20	49	47	9
21	1,190	116	47	92	29	37	37	10	20	47	47	9
22	1,010	122	45	64	26	86	18	6	17	56	47	9
23	504	150	41	54	1,050	37	14	1,190	20	52	47	9
24	219	150	41	49	2,380	23	29	1,090	28	54	47	9
25	122	122	41	45	2,980	18	16	2,880	29	54	49	9
26	122	122	41	45	1,880	23	35	2,180	35	52	49	9
27	122	860	37	64	1,240	26	62	1,190	157	54	49	9
28	122	1,190	37	59	576	136	26	187	150	52	54	25
29	129	......	37	59	365	52	17	66	69	54	69	74
30	110	......	33	49	164	24	37	29	49	59	64	92
31	92	......	33	......	129	......	26	23	......	62	......	77

NOTE.—Daily discharge computed from a rating curve fairly well defined between 29 and 1,780 second-feet. Daily discharge Jan. 1 to 10 and Dec. 3 to 28 estimated, on account of presence of ice.

Monthly discharge of Silver Creek near Lebanon, Ill., for 1910.

[Drainage area, 335 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	3,500		707	2.11	2.43	C.
February	1,190	64	196	.585	.61	B.
March	3,820	33	438	1.31	1.51	B.
April	770	26	137	.409	.46	B.
May	2,980	26	468	1.40	1.61	B.
June	1,240	18	210	.627	.70	B.
July	730	12	110	.328	.38	B.
August	2,880	3.5	291	.869	1.00	B.
September	2,580	11	470	1.41	1.57	B.
October	3,610	22	405	1.21	1.40	B.
November	69	43	53.1	.158	.18	B.
December			21.9	.065	.07	C.
The year	3,820	3.5	294	.878	11.92	

BIG MUDDY RIVER.

GENERAL FEATURES OF AREA DRAINED.

The drainage basin of Big Muddy River lies in southern Illinois. The river rises in the northwestern part of Jefferson County, flows southward to the town of Zeigler, in Franklin County, thence westward to Murphysboro, in Jackson County, and then southward to its junction with the Mississippi about 40 miles above Cairo, Ill. Below Zeigler the river is extremely crooked. The river is about 100 miles long, including bends. The total drainage area is 2,390 square miles. The principal tributaries are Beaucoup Creek, Little Muddy River, Caseys Creek, and Middle Fork Creek, all small streams.

The basin is elliptical in shape, with a major axis about 70 miles long and a minor axis about 50 miles long. The country is level or undulating. The soil is known as "mulatto soil"—a yellowish-brown clay. Winter wheat is the staple crop. The southeastern part is underlain with valuable coal veins, and coal mining is carried on extensively.

The slope of the river is small. Its sources are about 710 feet, and its mouth is about 310 feet above sea level. The banks and bed of the stream are soft and insecure.

The area is timberless except for scattered groves and the growth along the banks of the stream.

The mean annual rainfall is about 42 inches. The winters are mild. Ice does not form very thick, and, as a rule, the snowfall is light and does not last long.

The subject of storage has not been investigated, but owing to the growing demand for water in this section it should receive careful attention.

The basin offers no opportunities for power development. Like the other rivers in central and southern Illinois this stream is subject to high floods and very low water. During floods some sections resemble lakes, high water overflowing the land on each bank for 2 or 3 miles. Backwater from the Mississippi frequently extends to Murphysboro, said to be 60 miles distant following the river, and floods reach the height of 30 feet above low water.

BIG MUDDY NEAR CAMBON, ILL.

This station, which is located at the Chicago, Burlington & Quincy Railroad bridge, about 1 mile north of Cambon railroad station and about 1½ miles east of Plumfield, Ill., was established June 16, 1908, to obtain data for use in studying the problems of drainage, flood control, and navigation.

The Middle Fork of the Big Muddy enters on the left bank about one-fourth mile above the station.

The relation between gage height and discharge may be somewhat affected by ice during parts of December, January, and February.

The datum of the gage has not been changed. The records are reliable and accurate, but records of low-water measurements should be used with caution as collections of drift and trash make such measurements difficult.

Discharge measurements of Big Muddy River near Cambon, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 23	C. T. Bailey	75	274	6.52	311
24	.....do	91	358	7.56	457
25	.....do	100	509	9.00	782
June 4	.....do	41	31.4	2.30	19.3
Dec. 12	Bailey and Monk	39	27.3	[a]2.21	14.4

a Ice present.

Daily gage height, in feet, of Big Muddy River near Cambon, Ill., for 1910.

[Robert Tackitt, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.45	4.2	18.95	2.25	5.15	2.8	4.1	3.2	3.55			
2	2.7	3.9	21.35	2.25	5.35	2.3	3.1	3.2	3.25			
3	3.2	3.75	22.35	2.15	3.9	2.3	3.2	2.85	3.9			
4	4.0	3.7	22.15	2.2	5.45	2.25	4.2	2.6				
5	4.5	3.65	21.25	2.25	5.85	2.25	4.7	2.35				
6	6.25	4.0	19.9	2.3	6.55	2.3	5.4	2.25				
7	7.65	4.8	18.2	2.3	5.55	2.4	5.65	2.2				
8		4.35	17.4	2.35	4.95	2.35	4.35	2.2				
9		4.2	15.3	2.55	5.25	2.35	4.2	2.1				
10		3.05	10.5	2.6	5.7	2.4	3.0	2.5				
11	4.2	3.7	6.15	2.45	6.05	2.5	3.8	2.3				
12		3.6	4.8	2.4	6.45	2.2	3.4	2.0				2.2
13	7.0	3.35	4.1	2.35	6.15	2.15	3.1	2.2				2.2
14	8.3	3.4	3.75	4.25	4.1	2.15	2.85	2.0				2.15
15	12.25	3.65	3.4	3.9	4.2	2.15	3.25	1.95				2.15

Daily gage height, in feet, of Big Muddy River near Cambon, Ill., for 1910—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	13.7	3.75	3.25	4.55	3.85	2.1	5.2	1.9				2.6
17	14.1	3.95	3.2	7.85	3.6	2.1	5.9	1.8				2.6
18	14.9	4.4	3.05	10.15	3.3	2.1	6.3	1.85				2.7
19	15.0	4.75	2.95		3.05	2.5	6.85	1.85				2.5
20	14.9	4.8	2.9	7.7	2.9	2.0	6.45	1.8				2.5
21	14.8		2.75	6.0	2.7	2.0	6.0	1.8				2.4
22	14.7		2.8		2.55	2.0	5.8	1.7				2.4
23	14.05	9.1	2.65	4.25	4.75	1.95	3.85	3.3				2.5
24	13.9	10.9	2.6	3.8	6.3	1.95	3.1	4.3				2.6
25	9.9	11.65	2.65	3.8	8.6	1.95	3.0	6.2				2.6
26	6.55	10.6	2.55	4.15	9.3	1.9	2.9	6.65				2.8
27	5.7	14.75	2.55	6.55	7.9	1.9	2.9	5.05				2.15
28	5.05	16.4	2.45	8.05	4.7	5.3	3.0	4.85				2.25
29	5.0		2.35	7.7	3.9	3.2	5.5	4.45				3.8
30	5.0		2.35	6.15	3.4	5.9	4.3	4.0				6.4
31	4.65		2.35		3.1		4.0	3.8				9.15

NOTE.—Ice present from Jan. 8 to 13 and Feb. 16 to 23. No gage reader from Sept. 4 to Dec. 11.

Daily discharge, in second-feet, of Big Muddy River near Cambon, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10	94	4,700	16	162	35	89	51	65			
2	31	79	6,860	16	181	17	47	51	53			
3	51	73	7,900	12	79	17	51	37	79			
4	84	71	7,690	14	191	16	94	27				
5	110	69	6,760	16	234	16	124	18				
6	280	84	5,490	17	318	17	186	16				
7	461	132	4,120	17	201	20	212	14				
8	350	102	3,560	18	144	18	102	14				
9	240	94	2,400	25	171	18	94	11				
10	160	45	960	27	217	20	43	23				
11	94	71	268	22	256	23	75	17				
12	206	67	132	20	304	14	59	8				14
13	376	57	89	18	268	12	47	14				14
14	558	59	73	96	89	12	37	8				12
15	1,350	69	59	79	94	12	53	6				12
16	1,780	50	53	114	77	11	166	5				27
17	1,920	50	51	489	67	11	239	3				27
18	2,240	25	45	890	55	11	286	4				31
19	2,280	40	41	662	45	23	356	4				23
20	2,240	50	39	468	39	8	304	3				23
21	2,200	80	33	250	31	8	250	3				20
22	2,160	100	35	157	25	8	228	1				20
23	1,900	698	29	96	128	6	77	55				23
24	1,850	1,050	27	75	286	6	47	99				27
25	842	1,210	29	75	608	6	43	274				27
26	318	982	25	92	734	5	39	330				35
27	217	2,180	25	318	496	5	39	152				12
28	152	2,950	22	518	124	176	43	136				16
29	148		18	468	79	51	196	107				75
30	148		18	268	59	239	99	84				298
31	120		18		47		84	75				707

NOTE.—Daily discharge computed from a fairly well-defined rating curve based on measurements made 1908–1910. Discharge from Jan. 8 to 10 and from Feb. 16 to 22 estimated on account of presence of ice

Monthly discharge of Big Muddy River near Cambon, Ill., for 1910.

[Drainage area 735 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	2,280		802	1.09	1.26	B.
February	2,950		380	.517	.54	B.
March	7,900	18	1,660	2.26	2.61	B.
April	890	12	178	.242	.27	B.
May	734	25	187	.254	.29	B.
June	239	5	28.0	.038	.04	B.
July	356	37	123	.167	.19	B.
August	330	1	53.2	.072	.08	B.
December (12-31)	707	12	72.2	.098	.07	B.

BEAUCOUP CREEK NEAR PINCKNEYVILLE, ILL.

Beaucoup Creek is tributary to Big Muddy River about 5 miles above Murphysboro in Jackson County.

The gaging station, which is located at the Illinois Central Railroad bridge about 1½ miles east of Pinckneyville, Ill., was established June 17, 1908, for the purpose of obtaining data for use in studying drainage and flood-control problems.

Little Beaucoup Creek enters on the left bank below the gaging station, and Galum Creek on the right bank about 10 miles below the station.

The datum of the gage has remained unchanged since the gage was installed.

The relation between gage height and discharge may be somewhat affected by ice during parts of December, January, and February.

The flood of 1902 reached a height representing about 27.5 feet on the present gage. The creek goes dry at times; the water then stands in pools near the gage.

Discharge measurements of Beaucoup Creek near Pinckneyville, Ill., in 1910.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 22	C. T. Bailey	65	75	2.41	9.2
24	....do	122	538	7.24	373
25	....do	104	309	5.28	147
Dec. 13[a]	Bailey and Monk	5	1.4	2.27	1.3

[a] Not at regular gaging section.

Daily gage height, in feet, of Beaucoup Creek near Pinckneyville, Ill., for 1910.

[R. C. Huggins, observer.]

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.1	2.85	19.85	2.15	2.9	2.1	....	2.1	1.95	2.15	2.25	2.45
2	2.4	2.7	17.25	2.2	2.8	2.1	1.9	2.05	2.0	....	2.15	2.35
3	2.55	2.8	15.9	2.15	4.0	2.05	....	2.0	2.3	2.05	2.2	2.35
4	4.2	2.95	9.45	2.2	8.15	2.0	5.2	1.9	....	10.25	2.15	2.35
5	3.8	3.0	6.2	2.25	5.1	....	6.0	1.9	8.65	....	2.15	2.35
6	4.0	3.1	5.45	2.95	3.75	2.1	5.7	1.8	13.8	15.7	....	2.35
7	5.4	3.0	4.4	2.3	3.85	2.05	....	....	15.2	16.1	2.2	2.35
8	4.2	3.05	3.85	2.2	....	2.0	3.5	1.9	17.9	17.0	2.15	2.35
9	3.8	2.8	3.45	2.4	5.55	2.25	2.75	1.8	17.4	....	....	2.3
10	2.4	2.75	3.3	2.3	4.2	2.4	....	1.8	17.0	3.75	....	2.3
11	2.5	2.7	3.1	2.25	3.55	2.25	2.6	1.8	4.65	....	....	2.3
12	2.35	2.6	2.95	2.6	3.6	2.15	....	1.8	3.45	2.75	....	2.3
13	7.55	2.75	2.95	2.35	3.55	2.1	2.25	1.7	2.9	2.65	....	2.3
14	13.2	2.9	2.8	2.95	3.25	2.1	2.25	....	2.55	2.5	....	2.3
15	14.8	3.0	2.8	2.9	3.05	2.1	2.2	1.7	2.4	2.4	....	2.25
16	10.3	3.05	2.65	3.15	2.7	2.1	2.7	1.75	2.3	....	....	2.25
17	5.55	3.15	2.6	....	3.0	2.05	5.7	1.75	2.25	2.3	....	2.25
18	8.0	3.35	2.55	5.25	2.45	2.0	3.75	1.75	2.2	2.25	2.1	2.25
19	14.05	3.4	2.55	4.15	2.4	1.95	....	....	2.1	2.3	....	2.25
20	9.8	3.5	2.55	....	2.65	1.9	....	1.7	....	2.3	2.1	2.2
21	7.3	3.5	2.45	3.25	2.6	1.9	....	....	2.1	2.3	2.1	2.2
22	6.2	4.6	2.45	3.0	2.4	1.9	2.05	1.7	2.05	2.3	....	....
23	4.45	6.05	2.45	2.75	3.7	1.8	2.0	2.1	2.05	....	....	....
24	3.45	5.35	2.4	2.7	7.0	1.8	....	9.8	2.0	2.25	....	....
25	3.2	5.0	2.4	2.65	5.4	1.75	2.0	6.5	....	2.3	....	2.25
26	3.1	4.15	2.35	2.65	3.7	....	2.0	4.8	2.1	....	....	2.25
27	3.0	14.2	2.3	3.3	3.05	1.7	2.0	3.3	....	2.2	....	2.2
28	3.45	21.1	2.3	4.05	2.7	2.9	3.25	....	....	2.25	....	2.5
29	4.0	....	2.25	3.85	2.45	2.2	2.65	2.55	....	....	....	2.8
30	3.6	....	2.25	3.25	2.3	2.05	2.4	2.3	....	2.2	....	4.05
31	2.95	....	2.2	....	2.2	....	....	2.2	....	2.15	....	4.8

NOTE.—Relation between gage height and discharge slightly affected by ice during February; ice present during December.

Daily discharge, in second-feet, of Beaucoup Creek near Pinckneyville, Ill., for 1910.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4	26	2,000	5	28	4	4	4	3	5	7	8
2	11	20	1,640	6	24	4	3	3.5	3	4	5	7
3	16	24	1,450	5	80	4	80	3	8	3.5	6	7
4	92	30	574	6	430	3	163	3	240	672	5	6
5	70	32	245	7	155	4	227	3	484	1,050	5	6
6	80	36	183	30	68	4	203	2	1,150	1,420	6	5
7	179	32	105	8	72	4	129	2	1,350	1,470	6	5
8	92	34	72	6	126	3	55	3	1,730	1,600	5	4
9	70	24	52	11	191	7	22	2	1,660	834	4	3
10	11	22	45	8	92	11	20	2	1,600	68	4	2
11	14	20	36	7	58	7	17	2	122	45	4	2
12	10	17	30	17	60	5	12	2	52	22	4	1
13	368	22	30	10	58	4	7	2	28	18	4	1
14	1,070	28	24	30	42	4	7	2	16	14	4	1
15	1,290	32	24	28	34	4	6	2	11	11	4	1
16	679	34	18	38	20	4	20	2	8	10	4	1
17	191	38	17	92	32	4	203	2	7	8	4	1
18	413	48	16	167	12	3	68	2	6	7	4	1
19	1,190	50	16	89	11	3	52	2	4	8	4	1
20	616	55	16	65	18	3	36	2	4	8	4	1
21	344	55	12	42	17	3	20	2	4	8	4	1
22	245	119	12	32	9	3	3	2	3.5	8	4	1
23	108	232	12	22	65	2	3	4	3.5	8	4	1
24	52	175	11	20	317	2	3	616	3	7	4	1
25	40	147	11	18	179	2	3	272	4	8	6	1
26	36	89	10	18	65	2	3	133	4	7	6	1
27	32	1,210	8	45	34	2	3	45	4	6	8	1
28	52	2,170	8	83	20	28	42	16	4	7	10	8
29	80	....	7	72	12	6	18	16	4	6	10	24
30	60	....	7	42	8	4	11	8	4	6	11	83
31	30	....	6	....	6	....	8	6	....	5	....	133

NOTE.—Daily discharge computed from a rating curve fairly well defined below 640 second-feet. Daily discharge during November was interpolated, and during December estimated because of presence of ice.

Monthly discharge of Beaucoup Creek near Pinckneyville, Ill., for 1910.

[Drainage area, 227 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
January	1,290	4	243	1.07	1.23	B.
February	2,170	17	172	.758	.79	C.
March	2,000	6	216	.952	1.10	C.
April	167	5	34.3	.151	.17	B.
May	430	6	75.6	.333	.38	B.
June	28	2	4.8	.021	.02	C.
July	227	3	46.2	.204	.24	B.
August	616	2	37.7	.166	.19	B.
September	1,730	3	284	1.25	1.40	B.
October	1,600	4	237	1.04	1.20	B.
November	11	4	5.33	.023	.03	C.
December	133		10.3	.045	.05	D.
The year	2,170		114	.502	6.80	

MISCELLANEOUS MEASUREMENTS.

HUDSON BAY DRAINAGE BASIN.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
1910.				*Feet.*	*Sec.-ft.*
Nov. 20	St. Mary River	Belly River	Kimball, Alberta	3.12	681
Dec. 13	Red River	Nelson River	Grand Forks above Red Lake River.	3.74	101
July 2	Red Lake River	Red River	Just below Clearwater River.		716
Aug. 10	do	do		6.50	393
Oct. 16	do	do		6.10	328
Aug. 20	do	do	Just above mouth	3.37	214

UPPER MISSISSIPPI RIVER DRAINAGE BASIN.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
Mar. 30	Spoon River	Illinois River	Seville, Ill	(a)	627
31	do	do	Maquon, Ill	(b)	302
Apr. 1	do	do	Dahinda, Ill	(c)	235
1	do	do	Elmore, Ill	(d)	155
2	do	do	Near Wyoming, Ill	(e)	86
5	Sugar Creek	Sangamon River	Hartsburg, Ill	(f)	76

[a] 30.65 feet to water surface from top of downstream end of third-floor beam from right abutment of Toledo, Peoria & Western Railway bridge east of Seville.

[b] 25.70 feet to water surface from base of rail 135 feet from face of coping of right abutment. Downstream side of Chicago, Burlington & Quincy Railroad bridge.

[c] 26.04 feet to water surface from top of handrail on downstream side of bridge; 59 feet from center of right tubular pier.

[d] 22.61 feet to water surface from top of downstream end of floor beam 79 feet from base of left abutment. Bridge is East Bridge above mouth of Walnut Creek.

[e] 15.26 feet to water surface from top of northeast corner of upstream end of floor beam 39 feet from face of left plank abutment.

[f] 17.55 feet to water surface from top of third-floor beam left end of bridge, downstream side.

SUMMARY OF MEAN DISCHARGE PER SQUARE MILE.

The following summary of discharge per square mile is given to allow ready comparison of relative rates of run-off from different areas in the Hudson Bay and upper Mississippi drainage basins.

It shows in a general way the seasonal distribution of run-off, and the effect of snow, ground, surface, and artificial storage. The most important fact worth noting is the almost entire lack of uniformity or agreement between any two streams, which indicates that the discharge of each stream is a law unto itself, and that all projects dependent upon stream flow, if they are to be developed along the safest and most economical lines, must be based on records of stream flow collected with great care over a long series of years as near the location of the project under consideration as possible.

Summary of discharge, in second-feet per square mile, in Hudson Bay and upper Mississippi River basins for 1910.

	Drainage area.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
	Sq. mi.													
St. Mary River near Babb, Mont	177	0.51	0.56	0.96	2.93	7.06	7.80	4.48	2.05	1.44	3.24	2.45	1.09	2.88
St. Mary River, below Swiftcurrent Creek	298	....	....	....	....	....	6.34	3.83	1.77	1.40	3.46	2.15	.93	....
St. Mary River near Cardston, Alberta	452	.33	.35	1.17	2.63	5.13	4.96	2.59	1.28	1.22	2.30	1.64	.65	2.03
Swiftcurrent Creek near Babb, Mont	101	.40	.45	1.34	4.47	....	....	....	....	....	....	....	....	....
Ottertail River near Fergus Falls, Minn	1,310	.25	.17	.22	.33	.32	.22	.12	.05	.02	.04	.06	.06	.16
Red River at Fargo, N. Dak	6,020	....	....	.35	.24	.16	.08	.04	.01	.01	.01	.01	....	....
Red River at Grand Forks, N. Dak	25,000	.06	.05	.34	.31	.17	.08	.03	.02	.02	.02	.02	.01	.09
Pelican River near Fergus Falls, Minn	433	.29	.18	.42	.43	.34	.16	.04	.02	.01	.02	.03	.01	.16
Wild Rice River at Twin Valley, Minn	805	....	....	....	.69	.70	.34	.07	.03	.03	.03	.03	.02	....
Red Lake River at Thief River Falls	3,430	.16	.16	.64	.66	.39	.23	.12	....	....	....	....	....	....
Red Lake River at Crookston, Minn	5,320	.14	.13	.68	.77	.37	.20	.10	.07	.06	.06	.04	.04	.22
Thief River near Thief River Falls	1,010	.10	.04	.33	1.14	.43	.16	.11	.04	.01	.00	.00	.00	.20
Clearwater River at Red Lake Falls, Minn	1,310	.17	.09	.51	.99	.25	.09	.03	.03	.03	.04	.04	.04	.19
Pembina River at Neche, N. Dak	2,940	....	....	....	.06	.04	.02	.01	.00	.00	.00	....	....	....
Mouse River at Minot, N. Dak	8,400	.00	.00	.02	.02	.01	.01	.00	.00	.00	.00	.00	.00	.00
Little Fork River at Little Fork, Minn	1,720	....	....	....	....	.41	.18	.09	.07	.05	.10	.09	....	....
Big Fork River at Big Falls, Minn	1,320	....	....	....	2.33	1.25	.54	.11	.05	.08	.22	....	....	....
Mississippi River above Sandy River, Minn	4,510	.25	.29	.49	.58	.54	.47	.48	.60	.58	.42	.26	.15	.43
Mississippi River at Anoka, Minn	17,100	.23	.22	.54	.47	.34	.26	.22	.20	.20	.21	.17	.11	.26
Mississippi River at St. Paul, Minn	35,700	.14	.13	.60	.39	.26	.18	.11	.11	.11	.12	.10	.06	.19
Pine River below Pine River reservoir, Minn	452	.69	1.36	1.45	1.45	1.43	1.27	.34	.17	.24	.46	.16	.16	.76
Crow Wing River at Pillager, Minn	3,230	.24	.21	.70	.60	.34	.20	.11	.09	.14	.19	.16	.14	.26
Long Prairie River near Motley, Minn	973	....	....	....	.42	.21	.14	.07	.07	.09	.09	....	....	....
Sauk River near St. Cloud, Minn	816	.12	.10	.58	.41	.11	.09	.05	.06	.07	.07	.04	.02	.14
Crow River at Rockford, Minn	2,520	.11	.08	.59	.20	.10	.05	.03	.02	.02	.03	.03	.03	.11
South Fork of Crow River near Rockford, Minn	....	....	....	....	.17	.10	.08	.04	.01	.00	.02	.03	....	....
Rum River at Onamia, Minn	414	.16	.18	.46	.82	.55	.30	.07	.04	.01	.02	.01	.01	.22
Rum River at Cambridge, Minn	1,160	.13	.12	.64	.44	.25	.14	.08	.07	.07	.07	.07	.05	.18
Minnesota River near Odessa, Minn	1,560	....	....	....	.18	.14	.05	.01	.01	.02	.03	....	....	....
Minnesota River near Montevideo, Minn	6,300	.03	.02	.27	.22	.15	.06	.02	.01	.01	.02	.02	.01	.07
Minnesota River near Mankato, Minn	14,600	.06	.04	.53	.18	.13	.07	.03	.02	.02	.02	.02	.02	.09
Chippewa River near Watson, Minn	1,940	....	....	....	....	.10	.02	.01	.01	.01	.01	....	....	....
Redwood River near Redwood Falls, Minn	703	....	....	....	.12	.04	.04	.01	.01	.01	.02	....	....	....
Cottonwood River near New Ulm, Minn	1,190	....	....	....	.25	.07	.08	.03	.02	.01	.01	.02	....	....
Blue Earth River at Rapidan Mills, Minn	2,260	....	....	....	.20	.07	.06	.02	.02	.02	.03	....	....	....
Kettle River near Sandstone, Minn	825	.22	.20	.95	.76	.33	.22	.09	.09	.13	.16	.12	.10	.28
Snake River at Mora, Minn	422	.14	.08	.93	.47	.15	.11	.09	.16	.13	.09	.09	.04	.21
Cannon River at Welch, Minn	1,290	....	....	....	.34	.22	.19	.13	.11	.10	.10	.10	....	....
Zumbro River at Zumbro Falls, Minn	1,120	.33	.26	1.06	.33	.27	.19	.15	.15	.15	.14	.15	.14	.28
Root River near Houston, Minn	1,560	.32	.29	.72	.35	.32	.25	.21	.22	.30	.22	.22	.20	.30

Summary of discharge, in second-feet per square mile, in Hudson Bay and upper Mississippi River basins for 1910—Continued.

	Drainage area.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
	Sq. mi.													
Wapsipinicon River at Stone City, Iowa	1,310	....	....	1.91	0.46	0.31	0.18	0.08	0.08	0.11	0.11	0.08	....	....
Cedar River near Austin, Minn	425	0.24	0.19	1.50	.23	.16	.12	.12	.12	.12	.12	.12	0.09	0.26
Des Moines River at Jackson, Minn	1,160	....	....	....	.17	.07	.05	.03	.02	.02	.02	.03	....	....
Sangamon River near Monticello, Ill	550	1.32	.60	.67	.17	.70	.33	.11	.04	.16	.08	.04	.16	.35
Sangamon River at Riverton, Ill	2,560	1.21	.49	.82	.25	1.23	.48	.34	.12	.16	.13	.13	.25	.47
Sangamon River near Oakford, Ill	5,000	1.86	.54	.70	.27	.81	.48	.26	.11	.18	.11	.07	.15	.40
South Fork Sangamon River near Taylorville, Ill	427	1.35	.42	.94	.26	1.61	.27	.31	.16	.34	.19	.09	.50	.54
Salt Creek near Kenney, Ill	459	1.19	.40	.49	.15	.38	.09	.05	.06	.04	.06	.03	.13	.26
Cahokia Creek near Poag, Ill	259	2.05	.46	.97	.39	1.25	.62	.32	.05	1.05	1.39	.28	.17	.75
Kaskaskia River near Arcola, Ill	390	1.92	.71	.99	.33	1.25	.44	.56	.20	.49	.18	.12	.54	.65
Kaskaskia River at Shelbyville, Ill	1,030	1.86	.66	1.18	.27	1.79	.48	.56	.35	.62	.33	.43	.49	.76
Kaskaskia River at Vandalia, Ill	1,980	1.31	.58	1.05	.28	1.55	.46	.67	.30	.38	.38	.15	.38	.63
Kaskaskia River at Carlyle, Ill	2,680	1.41	.59	1.29	.26	1.09	.66	.62	.26	.39	.60	.09	.27	.63
Kaskaskia River at New Athens, Ill	5,220	1.72	.62	2.01	.35	1.15	.76	.66	.45	1.32	1.19	.08	.18	.88
Shoal Creek near Breese, Ill	760	1.54	.48	1.32	.59	1.87	.73	.75	.69	1.25	1.23	.12	.11	.90
Silver Creek near Lebanon, Ill	335	2.11	.58	1.31	.41	1.40	.63	.33	.87	1.41	1.21	.16	.06	.88
Big Muddy River at Cambon, Ill	735	1.09	.52	2.26	.24	.25	.04	.17	.07	....	....	....	....	....
Beaucoup Creek near Pinckneyville, Ill	227	1.07	.76	.95	.15	.33	.02	.20	.17	1.25	1.04	.02	.04	.50

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