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

REPORT

OF

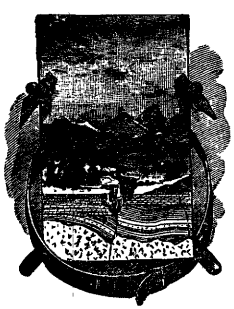
PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1904

PREPARED UNDER THE DIRECTION OF F. H. NEWELL
BY
M. R. HALL, E. JOHNSON, Jr., and JOHN C. HOYT

PART V.—Eastern Mississippi River Drainage



WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., March 2, 1905.

SIR: I transmit herewith the manuscript of Part V of a series of twelve papers which compose the Report of Progress of Stream Measurements for the Calendar Year 1904. Parts I to VI of this report contain the results of the data collected in the territory east of the Mississippi River. Parts VII to XII are devoted to the data collected in the territory west of the Mississippi River.

The larger part of the original data for this report was collected under the direction of district hydrographers M. R. Hall and E. Johnson, jr. Mr. Hall covered the territory south of and including Tennessee River and was assisted by Warren E. Hall, J. M. Giles, and B. S. Drane. Mr. Johnson had the northern portion of the drainage and was assisted by F. W. Hanna and R. W. Pratt. The assembling of the data and its preparation for publication were done under the direction of John C. Hoyt, who has been assisted by R. H. Bolster, Robert Follansbee, Willis E. Hall, A. H. Horton, H. D. Comstock, F. H. Tillinghast, and H. M. Morse.

I request that this manuscript be published as one of the series of Water-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL, *Chief Engineer.*

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

PROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART V.

By M. R. HALL, E. JOHNSON, JR., and JOHN C. HOYT.

INTRODUCTION.

The hydrographic work of the United States Geological Survey includes the collection of facts concerning and the study of conditions affecting the behavior of water from the time it reaches the earth as rain or snow until it joins the oceans or great navigable rivers. These investigations became a distinct feature of the work of the Survey in the fall of 1888, when an instruction camp was established at Embudo, N. Mex. Since that date the work has been continually and gradually extended as larger funds became available. The first distinctive appropriation for gaging streams was made by the act of August 18, 1894, which contained an item of $12,500, "for gaging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and semiarid sections." (Digest of Appropriations for 1895, p. 270.)

Since that time a similar act has been passed each year and the appropriations have gradually increased, as shown in the following table:

Annual appropriations for hydrographic surveys.

Year ending June 30, 1895	$12,500
Year ending June 30, 1896	25,000
Year ending June 30, 1897	50,000
Year ending June 30, 1898	50,000
Year ending June 30, 1899	50,000
Year ending June 30, 1900	50,000
Year ending June 30, 1901	100,000
Year ending June 30, 1902	100,000
Year ending June 30, 1903	200,000
Year ending June 30, 1904	200,000
Year ending June 30, 1905	200,000
Year ending June 30, 1906	200,000

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

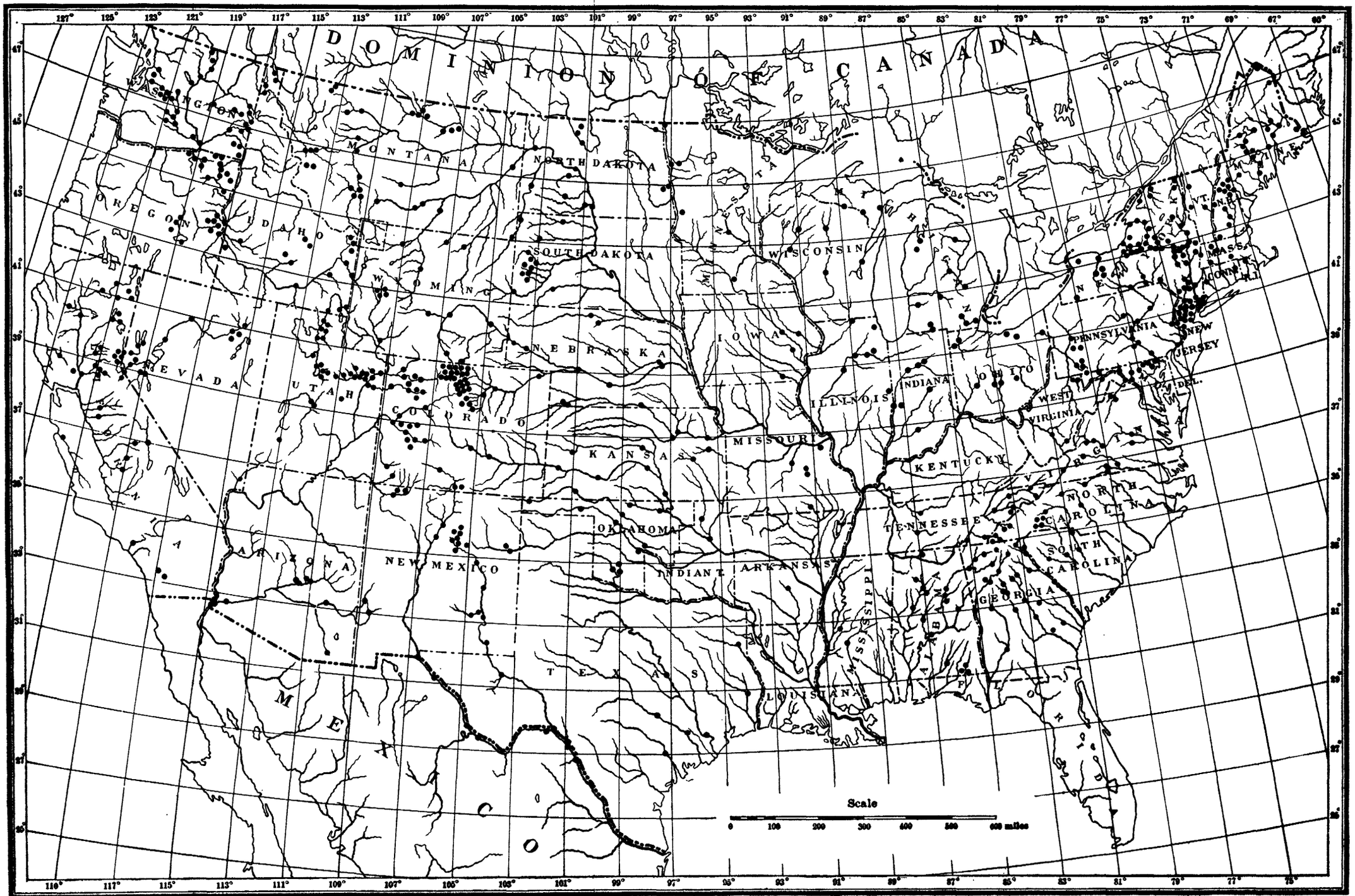
As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic Manual, U. S. Geol. Survey.)

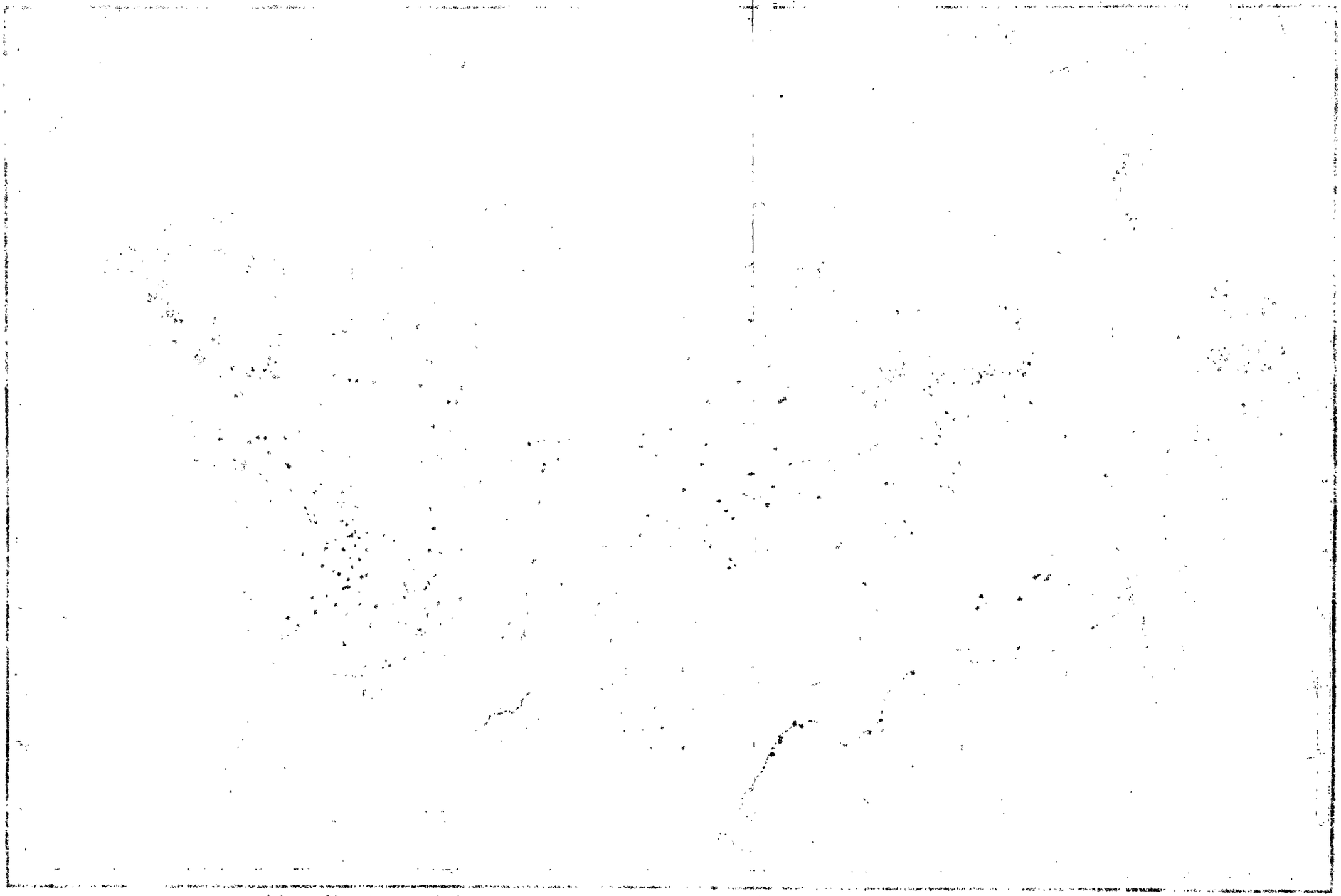
The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time at typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observation.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations, and, second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is



MAP OF THE UNITED STATES, SHOWING LOCATION OF PRINCIPAL RIVER STATIONS MAINTAINED DURING 1904.



swift some appliance, generally a secondary cable, is necessary to hold the meter below the surface.

Gaging stations are generally located at bridges, if the channel conditions are satisfactory, as from them the meter can be easily manipulated, and the cost of the equipment is comparatively small. The stations are located as far as possible at points where the channel is straight, both above and below the gaging section, and where there are no cross currents, backwater, or boils. The bed of the stream should be as clear as possible from large projections and of a permanent character. The banks should be high, and should overflow at high stages only. At stations with shifting beds more measurements are made, and special methods of computing daily discharges are employed. Great care is taken in the selection and equipment of gaging stations in order that the data may have the required degree of accuracy.

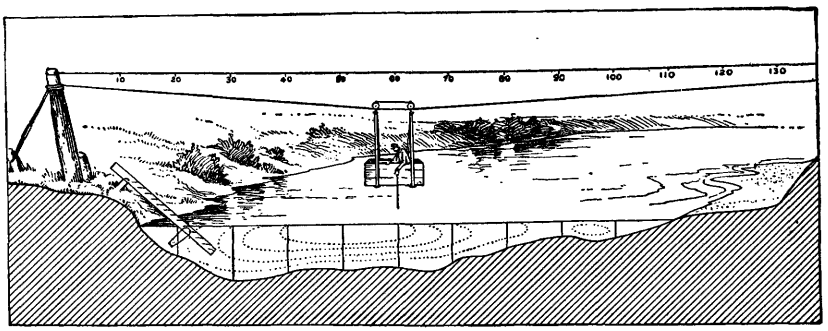


FIG. 1.—Cable station, showing section of river, car, gage, etc.

On many of the larger rivers, where water power is developed by dams, estimates of flow are obtained by observing the head on the crest and using a weir formula. On the smaller streams sharp-crested weirs are in some cases erected.

The principal instrument used in stream-measurement work is the current meter, by which the velocity of the flow of water is determined. After years of experience the Survey has adopted the Price current meter for general work. This meter, as is shown on Pl. II, is made in two sizes, known as the large and small Price. The small Price has been largely developed by the officers of the Survey, using the Price acoustic meter as a basis.

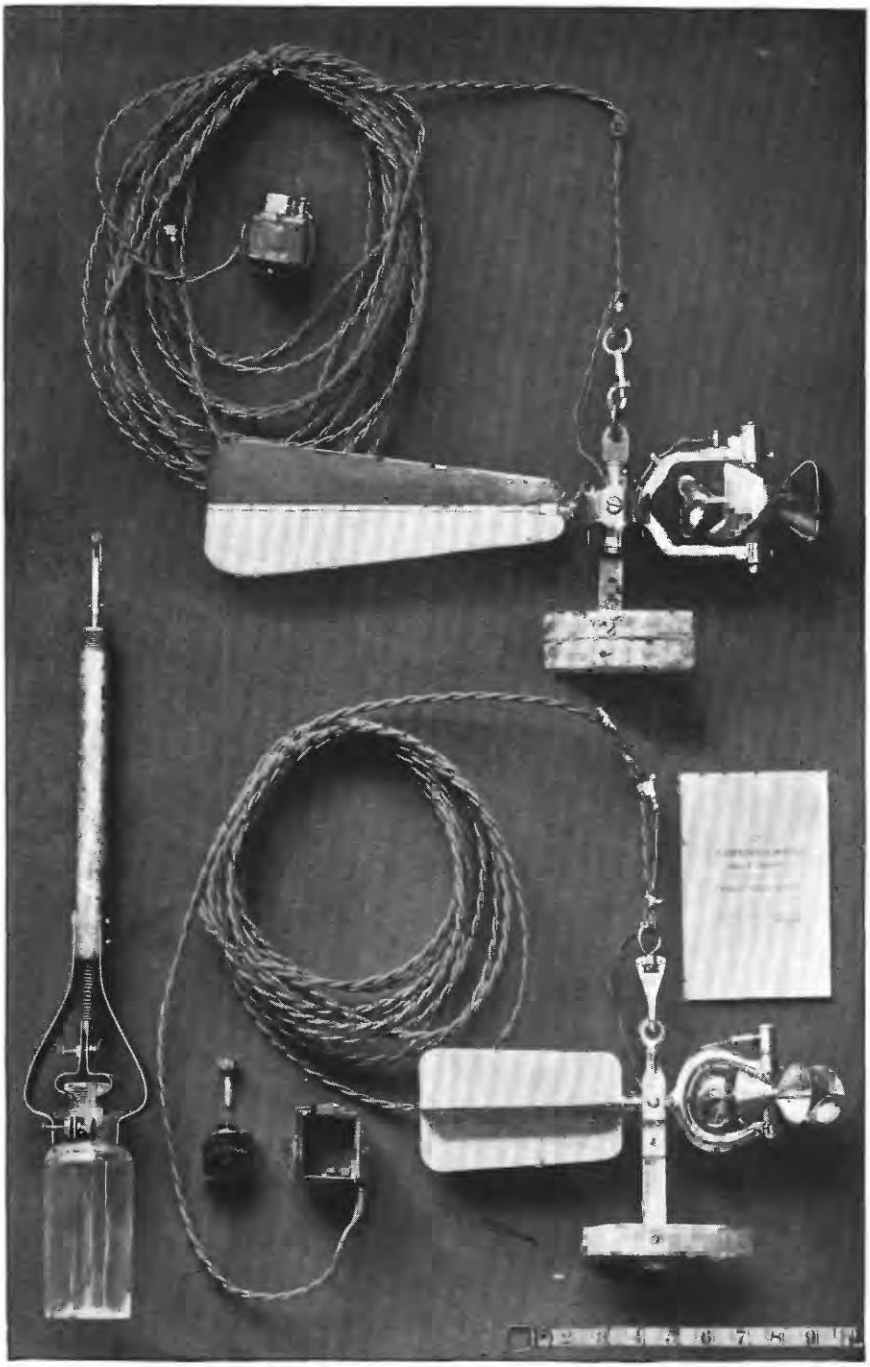
A discharge measurement is the determination of the quantity of water flowing past a certain point at a given time. This quantity is the product of two factors: (1) The mean velocity, which is the function of the cross section, surface slope, wetted perimeter, and roughness of bed; (2) the area, which depends upon the permanency of the bed and the fluctuations of the surface, which govern the depth.

In making the measurement an arbitrary number of points are laid off perpendicular to the thread of the stream (see fig. 1). These points are usually at regular intervals varying from 2 to 20 feet, depending upon the size and conditions of the stream. They are known as measuring points, and at them the observed data, the velocities and soundings, are taken. The perpendiculars dropped from the measuring points divide the gaging section into strips, and for each strip or pair of strips the mean velocity, area, and discharge are determined independently; thus conditions existing in one part of the stream are not distributed to parts where they do not apply.

The methods of obtaining velocity with the current meters which are in general use may be grouped into three classes: Single point, multiple point, and integration.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity, or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined. Extensive experiments by vertical velocity-curves show that the thread of mean velocity lies at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and it is at this depth that the meter is held in the majority of the measurements, this being known as the six-tenth depth method. It is found by a large number of vertical velocity-curve measurements, taken on various streams and under various conditions, that the coefficient for reducing the velocity obtained at six-tenths depth to mean velocity is practically unity, ranging, in a series of 910 measurements made at 39 gaging stations, between .94 and 1.04, with a mean for the 910 observations of 1.00. In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the action of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocities taken at the subsurface has been found by repeated experiments with vertical velocity-curves to be from .85 to .95, depending upon the depth of the stream and velocity and channel conditions. This method is specially adapted for flood measurements, or when the velocity is so great that the meter can not be kept at 0.6 depth.

The three principal multiple-point methods in general use are: The vertical velocity curve; top and bottom; and top, bottom, and mid depth. In the vertical velocity-curve method a series of velocity determinations are taken in the vertical at regular intervals, usually from 0.5 to 1 foot apart. By plotting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve through these points, the vertical velocity-curve is produced, which shows the change in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the depth



PRICE ELECTRIC CURRENT METERS, WITH BUZZERS.

into the area bounded by this mean velocity curve and the initial line. Owing to the length of time it takes to make these measurements they are seldom used except for determining coefficients for purposes of comparison and for measurements under ice.

In the second multiple-point method the meter is held from 0.5 to 1 foot below the surface and about 0.5 foot above the bottom, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. This method is not well adapted for general work, as the roughness of the bottom disturbs the velocity at that point. For shallow streams with comparatively smooth beds good results are obtained by this method. In the third multiple point method the meter is held at mid depth, 0.5 foot below the surface, and 0.5 foot above the bottom, and the mean velocity is determined by dividing the sum of the top velocity, twice the mid-depth velocity, and the bottom velocity by 4.

The vertical-integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface. The number of revolutions and the time taken in the operation is noted, and the mean velocity is found by dividing the number of revolutions by the number of seconds taken in the run. This method has the advantage in that the velocity at each point of the vertical is measured twice. It is well adapted for measurements under ice and as a check on the point methods.

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

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

The volume of water flowing in a stream is known as run-off. In expressing it various units are used, depending upon the kind of work for which the data are needed. Those used in this report are "second-

feet," "acre-feet," "run-off per square mile," and "run-off in depth in inches," and may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second, and is the body of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second.

The "acre-foot" is the unit of capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of 1 foot. There is a convenient relation between the second-foot and the acre-foot; 1 second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, which equals 1.9835 acre-feet, or, approximately, 2 acre-feet.

The expression "second-feet per square mile" means the average number of cubic feet of water flowing each second from every square mile of drainage area on the assumption that the run-off is uniformly distributed.

"Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet" and "depth in inches" represent the actual quantities of water which are produced during the periods in question, while "second-feet," on the contrary, is merely a rate of flow per second.

The base data for computing the daily discharge of a stream are the daily gage heights, and the various discharge measurements of which there should be sufficient number to cover the range of stage. The fundamental laws upon which these computations are based are the following:

(1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant;

(2) Neglecting the change of slope due to the rise and fall of the stream, the discharge will be the same whenever the stream is at a given stage; and

(3) The discharge is both a function of, and increases gradually with, the gage heights. (2 and 3 depend on 1).

As the beds of many streams are changeable, the problem divides itself into two classes: (1) Those of streams with permanent, or practically permanent, beds, and (2) those of streams with changeable beds. The base data and methods of obtaining them are the same for either class, and it is only in the computation of the mean daily flow that different methods are necessary.

In determining the daily discharge of streams with permanent beds the results of the discharge measurements are plotted on cross-section paper, with gage heights as ordinates and discharges as abscissas. Through these points a smooth curve is drawn, which shows the dis-

charge for any gage height, and from which a rating table is prepared. Aside from plotting the discharge, the mean velocity and area determined for each discharge measurement are plotted. Through these points the curves of mean velocity and of area are drawn, and the rating curve is largely determined by taking the product of the mean velocity and the area at various stages as determined by these curves. These curves of mean velocity and area are of special value to determine the location of the rating curve for stages at which actual discharge measurements are not available and for extending the discharge curve outside the limits of the measurements. In the preparation of the rating table the discharge for each tenth or half tenth on the gage is found from the curve. The first and second differences of these discharges are then taken and adjusted according to the law that they shall either be constant or increasing, never decreasing. The discharges in the table are then changed in accordance with these adjusted differences. In making up the station-rating curve the individual discharge measurements and the conditions under which they were taken are carefully studied, in order that proper weight shall be given to each measurement. Rating curves in general take the form of a parabola, and as a rule the high-water portion of the curve approaches a straight line. For stations of permanent character the results of the measurements from year to year should be within 5 per cent of the curve, with the exception of those taken during high water, when the probable error may be as high as 10 per cent.

The determination of the daily discharge of streams with changeable beds is difficult, and unless frequent discharge measurements are made the results obtained are only roughly approximate. For streams with continually shifting beds, such as Colorado River and the Rio Grande, discharge measurements are made every two or three days, and the discharges for the intervening days are obtained by interpolation, modified by the gage heights for these days. For stations with beds which shift slowly, or are only materially changed during floods, station-rating curves and tables can be prepared for the periods between changes, and satisfactory results can be obtained with two or three measurements a month, providing measurements are taken soon after the changes take place.

In determining the flow for periods when the streams are frozen, special rating curves and tables have to be prepared from measurements taken under these conditions. The methods of constructing these curves and tables are the same as for open sections. The discharge measurements, however, are either taken by integration in verticals or by the vertical velocity-curve method, as sufficient experiments have not been made on ice-covered streams to determine the laws which govern the position of the thread of mean velocity.

The Report of Progress of Stream Measurements for the Calendar Year 1904, of which this is Part V, is published in a series of twelve Water-Supply Papers, Nos. 124–135, inclusive, under the following subtitles:

Part 1. Atlantic coast of New England drainage.
Part 2. Hudson, Passaic, Raritan, and Delaware River drainages.
Part 3. Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages.
Part 4. Santee, Savannah, Ogeechee, Altamaha rivers, and Eastern Gulf of Mexico drainage.
Part 5. Eastern Mississippi River drainage.
Part 6. Great Lakes and St. Lawrence River drainage.
Part 7. Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.
Part 8. Platte, Kansas, Meremac, Arkansas, and Red River drainages.
Part 9. Western Gulf of Mexico drainage.
Part 10. Colorado River and Great Basin drainage.
Part 11. The Great Basin and Pacific Ocean drainage in California.
Part 12. Columbia River and Puget Sound drainage.

The territory covered by each paper is given in the subtitle, and the larger drainages are, for convenience in arrangement, subdivided into smaller ones, under which the data are arranged, as far as practicable, geographically.

These papers contain the data that have been collected at the regular gaging stations, the results of the computations based upon the observations and such other information that has been collected that has a direct bearing on these data including, as far as practicable, descriptions of the drainage areas and the streams draining them.

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

1. Description of station.
2. List of discharge measurements.
3. Gage-height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off.

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

The discharge-measurement table gives the results of the discharge measurements made during the year. This includes the date, the hydrographer's name, the gage height, and the discharge in second-feet.

The table of daily gage heights gives for each day the mean height of the surface of the river as found from the mean of the gage read-

ings taken on that day. At most of the stations the gage is read in the morning and in the evening.

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

In the table of estimated run-off the column headed "Maximum" gives the mean flow for the day when the mean gage height was the highest, and it is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge larger than given in this column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" gives the average flow for each second during the month. Upon this mean the computations for the three remaining columns which are defined on page 12 are based.

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

Fundamental rules for computation.

1. The highest degree of precision consistent with the rational use of time and money is imperative.

2. All items of computation should in general be expressed by at least two and by not more than four significant figures.

3. Any measurement in a vertical velocity, mean velocity, or discharge curve whose per cent of error is 5 times the average per cent error of all the other measurements should be rejected.

4. In reducing the number of significant figures, or the number of decimal places, by dropping the last figure, the following rules apply:

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

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

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

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

5. In constructing and applying rating tables a maximum limit of one-half per cent error should seldom be exceeded.

Special rules for computation.

1. Rating tables are to be constructed as close as the data upon which they are based will warrant. No decimals are to be used when the discharge is over 50 second-feet.

2. Daily discharges shall be applied directly to the gage heights as they are tabulated.

3. Monthly means are to be carried out to one decimal place when the quantities are below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in the monthly mean shall be a significant figure. This also applies to the yearly mean.

4. Second-feet per square mile and depth in inches for the individual months shall be carried out at least to three significant figures, except in the case of decimals, where the first significant figure is preceded by one or more naughts (0), when the quantity shall be carried out to two significant figures. Example: 1.25; .125; .012; .0012. The yearly means for these quantities are always to be expressed in three significant figures and at least two decimal places.

The results of the stream measurements made during previous years by the United States Geological Survey can be found in the following Survey publications. A detailed index of these reports is given in Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35 to 39, inclusive; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47 to 52, inclusive; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124 to 129, inclusive.
West of Mississippi River, Water Supply Papers Nos. 130 to 135, inclusive.

A limited number of these are for free distribution, and as long as the supply lasts they may be obtained by application to the Director United States Geological Survey or to members of Congress. Other copies are filed with the Superintendent of Public Documents, Washington, D. C., from whom they may be had at little above cost. Copies of Government publications are, as a rule, furnished to the public libraries in our large cities, where they may be consulted by those interested.

COOPERATION AND ACKNOWLEDGMENTS.

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

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

Alabama.—District hydrographer, M. R. Hall,[a] assisted by J. M. Giles, W. E. Hall, and B. S. Drane.

Illinois.—District hydrographer, E. Johnson, jr.,[b] assisted by E. H. Heilbron, assistant engineer, sanitary district of Chicago. Acknowledgment is due to the Sterling Manufacturing Company for the establishment of two chain gages on the Avenue G bridge, Sterling, Ill.

Indiana.—District hydrographer, E. Johnson, jr., assisted by F. W. Hanna, assistant engineer. Acknowledgment should also be made to Joseph M. Steiner and O. H. Griest, who have assisted the Survey in establishing stations and supplying voluntary readings at Cataract and Shoals, Ind.

Maryland.—Resident hydrographer, E. G. Paul, during the first half and N. C. Grover[c] during the last half of the year, assisted by H. D. Comstock. Acknowledgment is due to the State Geological Survey for cooperation in the work to the extent of paying the observers.

Minnesota.—District hydrographer, E. Johnson, jr., assisted by E. F. Chandler, assistant engineer, University, N. Dak.

Mississippi.—District hydrographer, M. R. Hall, assisted by J. M. Giles, B. S. Drane, and W. E. Hall.

New York.—District hydrographer, R. E. Horton,[d] assisted by C. C. Covert. Special acknowledgment is made of the interest and assistance of Hon. Edward A. Bond, State engineer, and William Pierson Judson, deputy State engineer.

North Carolina.—District hydrographer, M. R. Hall, assisted by J. M. Giles, B. S. Drane, and O. P. Hall. Dr. C. A. Schenck, director of the Biltmore School of Forestry, paid the gage readers at Davidsons River, Sitton, and Pinkbed.

Ohio.—District hydrographer, E. Johnson, jr., assisted by R. W. Pratt, engineer of the State board of health. Acknowledgment should also be made to the Baltimore and Ohio Railroad for passes issued to E. Johnson, jr., and R. W. Pratt.

Pennsylvania.—Resident hydrographer, E. G. Paul during the first half and N. C. Grover during the last half of the year, assisted by R. J. Taylor and H. D. Comstock.

Tennessee.—District hydrographer, M. R. Hall, assisted by J. M. Giles, B. S. Drane, and O. P. Hall. Gage heights for stations at Nashville, Chattanooga, Knoxville, Rogersville, and part of the year at Bluff City, were furnished by United States Weather Bureau officials H. C. Bate, L. M. Pindell, and Levi A. Judkins.

West Virginia.—Resident hydrographer, E. G. Paul in the first half and N. C. Grover in the last half of the year.

Wisconsin.—District hydrographer, E. Johnson, jr.

[a] The office of the district hydrographer for South Atlantic States and Eastern Gulf of Mexico, 409 Temple Court, Atlanta, Ga.

[b] The office of the district hydrographer for Mississippi Valley, 876-7 Federal Building, Chicago, Ill.

[c] The office of the resident hydrographer for North Atlantic States, United States Geological Survey, Washington, D. C.

[d] The office of the district hydrographer for New York and Michigan, 75 Arcade, Utica, N. Y.

MISSISSIPPI RIVER DRAINAGE BASIN.

MISSISSIPPI RIVER NEAR SAUK RAPIDS, MINN.

This station was established by W. R. Hoag April 23, 1903. It is located about 1½ miles south of Watab station, on the Northern Pacific Railroad, and about 5 miles north of Sauk Rapids, 7 miles north of St. Cloud. The gage is a vertical timber fastened to a post driven into the bed on the left side of the river. It is read daily by Frank McCrea. Discharge measurements are made from a boat running on a $\frac{5}{16}$-inch cable, which is securely fastened to trees on each side of the river. The point to which the soundings are referred is a nail head in the root of a tree on the left bank, to which the cable is fastened. The channel is straight for 4,000 feet above the station and for 600 feet below. Both banks are high and not subject to overflow. The bed consists of sand and gravel, and is somewhat shifting. There is but one channel at all stages. The channel has a width of about 625 feet at low water and about 700 feet at high stages.

Bench mark No. 1 is the top of a large pointed rock 150 feet upstream from the gage and 10 feet from the water's edge. Its elevation above the zero of the gage is 18.58 feet. Bench mark No. 2 is a $\frac{3}{8}$-inch iron stake, driven on the left shore between the cable and bench mark No. 1. Its elevation is 14.22 feet above the zero of the gage. Bench mark No. 3 is on the root of a small tree on the left bank just below the cable. Its elevation is 18.29 feet above the zero of the gage. A short distance above the old gage is a large rock with a vertical face at an elevation of 14.45 feet above the zero of the gage. Observations of the river height can be made by determining distances from the top of this rock to the water surface.

The drainage area at this station is 12,340 square miles.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Mississippi River near Sauk Rapids, Minn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*See.-feet.*
January 5[a]	E. Johnson, jr.	515	2,201	0.94	10.20	2,473
April 20	E. F. Chandler	585	4,171	2.94	14.26	12,250
July 1	do	577	3,790	2.12	13.31	8,019
July 25	R. Richards	557	2,678	1.77	11.38	4,745
August 22[b]	do	572	3,404	1.28	12.76	4,344
September 8[b]	do	561	2,858	1.68	11.77	4,802
October 15	E. F. Chandler	578	3,815	2.45	13.75	9,348

[a] Frozen over. [b] Log jam below station.

Mean daily gage height, in feet, of Mississippi River near Sauk Rapids, Minn., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.[b]	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[c]
1	11.60	11.20	11.32	14.00	14.50	13.35	13.30	11.00	12.85	12.20	13.00	11.70
2	11.70	11.20	11.36	14.10	14.30	13.40	13.25	11.05	12.90	12.20	12.90	11.85
3	11.80	11.28	11.44	14.60	14.40	13.60	12.90	11.35	12.90	12.00	12.80	11.85
4	11.80	11.28	11.52	15.50	14.30	14.00	12.75	11.20	11.30	12.00	12.70	11.75
5	[d]11.60	11.28	11.52	15.90	14.25	14.50	12.60	11.05	11.35	12.20	12.60	11.70
6	11.60	11.28	11.53	17.00	14.25	14.65	12.60	11.00	11.40	12.20	12.40	11.75
7	11.60	11.28	11.57	17.00	14.25	14.75	12.85	10.95	11.80	12.10	12.20	11.85
8	11.50	11.28	11.61	19.60	14.30	14.60	12.85	11.00	11.75	12.15	12.20	11.95
9	11.50	11.28	11.61	17.10	14.40	14.45	12.80	11.05	11.70	12.50	12.35	11.60
10	11.48	11.28	11.61	17.00	14.50	14.35	12.65	11.60	11.55	13.60	12.30	11.60
11	11.48	11.32	11.70	15.90	14.60	14.25	12.45	11.70	11.45	13.75	12.30	11.60
12	11.61	11.32	11.70	15.00	14.60	14.10	12.30	11.75	11.40	13.85	12.25	11.40
13	11.61	11.32	11.70	14.70	14.50	13.95	12.50	11.75	11.30	13.90	12.20	11.35
14	11.52	11.32	11.70	14.50	14.45	13.80	12.45	11.65	11.40	13.90	12.15	11.25
15	11.61	11.28	11.70	14.40	14.45	13.65	12.50	11.50	11.50	13.75	11.90	11.15
16	11.70	11.28	11.70	14.40	14.30	13.45	12.60	11.40	11.40	13.75	12.15	11.10
17	11.70	11.24	11.70	14.35	14.30	13.20	12.35	11.80	11.30	13.75	12.05	11.05
18	11.61	11.20	11.70	14.35	14.20	13.10	12.50	11.85	11.30	13.75	12.00	11.00
19	11.61	11.20	11.70	14.35	14.00	12.90	12.65	11.75	11.25	13.95	11.90	10.85
20	11.52	11.28	11.70	14.25	13.80	12.60	12.75	12.60	11.20	14.00	11.80	10.90
21	11.52	11.28	11.78	14.15	13.75	12.55	12.70	12.65	11.40	13.95	11.70	10.90
22	11.44	11.28	11.78	14.05	13.70	12.40	12.50	12.80	11.50	13.90	11.70	10.90
23	11.36	11.28	11.78	14.30	13.50	12.30	11.80	12.45	11.60	13.95	11.70	10.90
24	11.36	11.28	11.78	14.55	13.60	12.15	11.40	12.45	11.65	14.05	11.70	10.90
25	11.36	11.28	11.78	14.60	13.65	12.45	11.30	12.60	11.80	13.90	11.65	10.80
26	11.36	11.28	11.78	14.70	13.50	12.75	11.30	12.80	11.75	13.80	11.65	10.90
27	11.28	11.28	11.90	14.90	13.40	12.80	11.50	12.75	11.75	13.60	11.50	11.00
28	11.28	11.28	11.90	14.80	13.35	12.35	11.30	12.50	12.10	13.50	11.35	11.10
29	11.20	11.28	12.00	14.80	13.25	12.85	11.25	12.40	12.20	13.40	11.10	11.15
30	11.20	.....	12.20	14.70	13.15	13.20	11.20	12.45	12.20	13.30	11.00	11.20
31	11.20	.....	12.70	.....	13.25	.....	11.15	12.80	.....	13.20	.....	11.30

[a] River frozen from January 1 to March 31, 1904. Average thickness of ice about 9 inches.
[b] Ice conditions April 1 to about April 8. April 6 and 7 ice gorge.
[c] Frozen December 1 to 31.
[d] On January 5 from surface of water to under side of ice was 1.3 feet.

CHIPPEWA RIVER DRAINAGE BASIN.

Chippewa River rises in the southeastern part of Ashland County, Wis. It flows southwest, emptying into the Mississippi near Wabasha, Minn. Its principal tributary is the Flambeau, which enters from the east in Gates County. During the latter part of 1902 the United States Geological Survey began systematic measurements in this and other drainage basins of Wisconsin.

Gaging stations have been maintained in this basin on the Chippewa at Eau Claire, and on the Flambeau at Ladysmith, Wis.

CHIPPEWA RIVER NEAR EAU CLAIRE, WIS.

This station was established November 13, 1902, by L. R. Stockman. It is located 2 miles below Eau Claire, at a suburb known as Shawtown. Discharge measurements are made from a two-span highway bridge. A standard chain gage is fastened to the downstream side of highway bridge, having a length of 30.69 feet from the end of the weight to the marker. The gage is read twice each day by Joseph E. Kimpton. The channel is straight above and below the station, and the current is swift. The right bank is protected by a high masonry wall. The left bank is low, but the water is confined by an earthen embankment. The bed is composed of gravel, with a few rocks, and is permanent. There are two channels at all stages. The width is 450 feet at low water and 500 feet at flood stages.

Bench mark No. 1 is a nail in the top of a 6-inch white-oak stump which is attached to a tree still standing. It is located about 200 feet east of the road and 200 feet south of the river. Its elevation is 20.09 feet above the zero of the gage. The initial point for soundings is a point marked by two nails in the footway at the right end of the bridge, also marked 0 in white paint.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Chippewa River near Eau Claire, Wis., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Second-ft.*
January 11[a]	E. Johnson, jr	310	2,429	0.99	3.80	2,454
May 14	do	385	4,272	3.42	8.40	14,610
May 24	Johnson and Hanna	370	4,074	3.10	7.60	12,630
June 7	E. Johnson, jr	426	5,815	4.52	11.25	26,270
July 13	do	354	3,770	2.10	6.55	7,918
August 28	do	322	2,766	.82	4.20	2,274
September 19	do	329	3,122	1.47	5.25	4,581
October 12	F. W. Hanna	495	7,118	5.43	14.80	38,680
October 13	do	457	6,137	4.76	13.10	29,200
November 29	E. Johnson, jr	324	2,847	.80	4.44	2,281

[a] Frozen.

Mean daily gage height, in feet, of Chippewa River near Eau Claire, Wis., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	[c]4.90			6.25	9.00	8.45	8.10	4.42	4.58	6.31	6.79	3.93
2	[c]5.15			6.72	8.65	7.65	8.52	4.80	5.05	5.24	6.84	3.92
3				6.50	8.63	7.65	8.28	4.38	8.18	8.27	6.80	3.93
4	[c]5.00			6.52	8.28	8.85	8.02	4.78	7.52	5.65	6.61	3.45
5			[d]4.80	6.60	8.10	9.00	10.32	4.32	8.30	5.30	5.91	4.42
6		[e]4.80		7.17	8.03	10.95	10.12	4.12	7.30	5.27	6.41	4.28
7				7.60	10.13	11.30	9.63	3.45	7.52	4.82	6.08	4.26
8				9.10	8.50	10.85	8.93	4.62	7.12	9.12	5.35	4.28
9	[c]4.80			9.67	8.83	9.85	7.22	5.10	6.72	7.86	5.35	4.37
10				9.72	9.35	8.92	7.10	5.42	7.95	13.35	5.60	4.36
11				9.70	9.25	7.95	7.20	5.35	5.03	15.07	5.36	4.20
12			[e]4.95	9.32	8.85	7.80	6.72	4.38	5.28	14.93	5.02	4.34
13		[d]5.00		9.05	8.78	7.80	6.60	4.12	5.42	13.15	6.27	4.39
14				8.82	10.20	7.45	5.88	3.50	5.35	11.38	4.82	4.20
15				8.50	8.00	7.80	5.07	3.80	5.38	10.30	6.26	4.34
16	[c]5.00			7.55	8.20	8.35	5.55	4.55	5.42	9.17	5.42	4.32
17				7.25	7.55	6.25	5.35	4.82	7.10	8.10	5.30	4.15
18				7.50	7.22	5.50	5.60	4.65	4.80	8.00	5.47	4.19
19		[d]5.10	4.45	8.38	7.55	5.10	5.50	4.78	4.89	7.08	5.20	4.53
20			4.07	8.20	6.93	6.20	5.10	7.20	4.27	6.85	4.98	4.29
21			4.45	8.13	10.30	6.50	5.47	5.25	4.30	8.35	5.28	4.34
22			4.37	7.45	6.30	5.90	5.05	4.75	4.35	9.25	5.23	4.37
23	[c]5.00		4.32	8.05	6.83	5.80	4.75	4.68	5.10	9.42	5.74	4.55
24			5.62	8.50	7.33	5.50	3.93	4.60	4.24	9.00	4.77	4.38
25			5.95	9.65	9.20	8.95	4.07	5.00	5.76	8.78	4.94	3.31
26			6.45	10.63	12.00	5.55	4.90	5.40	8.18	7.81	5.10	4.19
27		[d]5.30	6.10	10.45	13.48	7.75	4.80	8.15	7.61	8.02	4.85	4.55
28			5.72	9.18	13.63	7.60	5.00	3.58	6.93	7.22	4.55	.....
29	[e]4.70		5.05	9.55	12.02	7.75	4.88	5.55	9.81	7.55	4.54	.....
30			5.10	9.03	10.67	7.50	6.45	4.92	6.65	7.30	4.46	.....
31			5.32	.....	9.20	.....	5.00	4.52	.....	6.85	.....	.....

[a] River frozen over January 1 to March 18, 1904, but open about 200 to 300 feet above and one-fourth mile below bridge.
[b] Frozen December 28 to 31.
[c] Ice 2.0 feet thick at gage; 1.0 foot in middle of channel.
[d] Ice 2.5 feet thick at gage; 2.5 feet in middle of channel.
[e] Ice 2.0 feet thick at gage; 2.0 feet in middle of channel.

Rating table for Chippewa River near Eau Claire, Wis., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.7	1,240	4.8	3,590	5.9	6,610	8.0	13,290
3.8	1,410	4.9	3,850	6.0	6,900	8.5	14,980
3.9	1,590	5.0	4,120	6.2	7,490	9.0	16,680
4.0	1,780	5.1	4,390	6.4	8,100	9.5	18,380
4.1	1,980	5.2	4,660	6.6	8,720	10.0	20,080
4.2	2,180	5.3	4,930	6.8	9,350	10.5	21,780
4.3	2,390	5.4	5,200	7.0	9,990	11.0	23,480
4.4	2,610	5.5	5,480	7.2	10,650	11.5	25,210
4.5	2,840	5.6	5,760	7.4	11,310	12.0	26,960
4.6	3,080	5.7	6,040	7.6	11,970	13.0	30,500
4.7	3,330	5.8	6,320	7.8	12,630	14.0	34,480

The above table is applicable only for open-channel conditions. It is based upon 23 discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 4.20 feet and 14.80 feet.

Estimated monthly discharge of Chippewa River near Eau Claire, Wis., for 1904.

[Drainage area, 6,740 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 19–31	8,255	1,920	4,622	0.686	0.332
April	22,220	7,640	14,550	2.16	2.41
May	32,900	7,790	16,960	2.52	2.90
June	24,510	4,390	12,600	1.87	2.09
July	21,170	1,647	8,525	1.26	1.45
August	13,790	650	3,778	.561	.647
September	19,430	2,264	7,801	1.16	1.29
October	40,400	3,642	15,170	2.25	2.59
November	9,478	2,748	5,576	.827	.923
December 1–27	2,960	380	2,230	.331	.332

FLAMBEAU RIVER NEAR LADYSMITH, WIS.

This station was established February 13, 1903, by L. R. Stockman. It is located three-fourths mile south of the Minneapolis, St. Paul and Sault Ste. Marie Railroad station, three-fourths mile south of Lady-

smith and one-half mile below the dam of the Menasha Pulp Company. Discharge measurements are made from a three-span highway bridge. A standard chain gage is fastened to the upstream side of the right span. The length of the chain from the end of the weight to the marker is 25.40 feet. The gage is read twice each day by Leonard McCandless. The initial point for soundings is a point marked by two nails and a straight white line at the right end of the bridge. The channel is straight for about 500 feet above and below the station. The right bank is low, but the overflow passes beneath the bridge. The left bank is high and covered with trees. The gaging section is broad and shallow, with a bed of small bowlders, gravel, and sand, and is not liable to shift. The stream is divided into three channels by the bridge piers. The channels are somewhat obstructed by log jams during the rafting season. The bench mark is a cut on a rivet head on the post to which the pulley of the chain gage is attached. When the gage reads zero this mark is 36.28 feet above the water surface. An arrow cut on the iron guard rail is exactly opposite the 10-foot mark of the scale of the chain gage.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Flambeau River near Ladysmith, Wis., for 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
February 13[a]	L. R. Stockman	325	472	1.64	16.20	773
March 19[b]	do	366	1,871	1.77	18.95	3,312
April 8	do	349	1,330	2.80	17.40	3,727
May 6	do	361	1,927	3.70	18.97	7,113
June 16	do	342	703	1.91	16.00	1,345
July 11	do	342	1,430	2.95	18.10	4,222
August 21	do	342	995	2.69	16.85	2,681
September 10	E. C. Murphy	364	1,579	3.36	18.05	5,303
October 23	L. R. Stockman	348	1,271	3.07	17.21	3,899
1904.						
May 16	E. Johnson, jr	350	1,333	3.15	17.88	4,203
June 3	do	350	1,448	2.99	17.45	4,321
August 29	do	349	733	2.07	16.06	1,517
September 20	do	343	702	2.21	16.01	1,554
October 12	F. W. Hanna	364	1,653	3.37	18.58	5,588

[a] Frozen. [b] Log jam below.

Mean daily gage height, in feet, of Flambeau River near Ladysmith, Wis., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.[b]	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[c]
1	16.75	16.75	17.00	16.90	18.70	17.50	17.58	15.15	16.25	(d)	17.25	15.65
2	16.95	16.75	17.05	17.20	18.55	17.40	17.77	15.40	16.30	(d)	17.30	15.05
3	16.75	16.10	17.00	16.80	18.60	17.42	17.70	(e)	16.38	(d)	17.20	15.95
4	16.85	16.80	17.05	16.90	18.35	17.43	19.90	(e)	17.78	(d)	16.90	14.50
5	17.00	16.90	17.15	16.85	18.45	18.00	18.82	15.60	17.65	16.05	16.70	15.15
6	16.50	16.70	16.95	16.80	18.60	18.02	18.88	15.72	17.20	16.05	16.80	15.30
7	16.50	16.80	16.90	17.10	18.60	18.25	18.75	15.13	17.28	16.10	16.30	14.87
8	16.65	16.75	17.15	17.25	18.85	18.27	18.75	15.40	17.30	16.10	16.20	15.78
9	16.65	16.75	16.90	17.05	19.20	17.90	18.05	15.75	17.03	17.05	16.17	15.57
10	16.70	16.65	17.50	17.00	19.15	17.22	17.95	15.92	16.00	18.70	16.15	15.55
11	16.60	16.70	17.40	17.10	18.90	17.10	17.70	15.85	16.40	18.65	16.05	15.25
12	16.55	16.95	17.05	17.10	18.80	17.25	17.25	16.00	16.32	18.60	15.55	15.77
13	16.50	17.00	17.30	17.15	18.35	17.15	16.40	15.90	16.45	18.50	15.60	15.55
14	16.70	16.70	17.20	17.05	18.15	17.12	16.30	15.90	16.30	18.43	15.45	15.30
15	16.70	16.90	17.20	17.25	18.01	16.60	16.12	15.85	16.15	18.30	15.82	15.35
16	16.75	16.95	17.00	17.20	17.95	16.55	16.15	16.02	16.05	17.85	15.28	15.45
17	16.60	16.55	17.15	17.10	18.01	16.35	16.03	15.90	16.05	17.20	15.55	15.35
18	16.60	17.10	17.20	17.05	18.01	16.25	16.00	15.85	16.13	16.95	15.72	15.30
19	16.65	16.95	17.15	17.00	18.03	16.32	15.60	15.95	16.15	17.15	15.70	15.50
20	16.30	16.95	17.05	16.85	17.05	15.95	15.80	15.75	16.00	17.25	15.60	15.57
21	16.75	17.55	17.05	16.85	17.03	15.88	15.95	16.00	16.00	17.60	15.45	15.70
22	16.75	16.90	17.15	16.65	17.01	16.15	15.85	16.20	15.90	17.80	15.82	15.72
23	16.75	17.00	16.85	17.20	17.04	15.95	15.80	15.35	15.95	17.75	15.27	15.68
24	16.65	16.60	17.15	17.20	17.06	16.35	15.70	16.45	15.95	17.75	15.55	15.60
25	16.70	17.00	16.95	18.00	18.40	16.55	15.85	16.65	16.40	17.85	15.72	15.65
26	16.70	16.90	16.95	18.40	19.00	16.70	16.15	16.45	16.40	17.75	15.70	15.70
27	16.45	17.00	16.95	18.45	19.40	16.95	16.76	16.45	16.40	17.65	15.55	16.10
28	16.65	16.95	17.15	18.50	19.30	17.05	16.75	16.20	16.45	17.55	15.40	15.75
29	16.60	16.95	17.05	18.50	18.80	17.05	15.70	16.10	16.40	17.65	14.95	15.80
30	16.75	.....	16.45	18.90	18.40	17.20	15.25	16.27	16.45	17.70	15.55	16.30
31	16.65	.....	17.20	.....	17.80	.....	15.55	16.15	.....	17.22	.....	16.40

[a] Frozen from January 1 to March 30, when ice begins to break. Ice varied rom 6 to 18 inches in thickness.
[b] Ice conditions March 31 to about April 10.
[c] Ice conditions during December.
[d] Weight gone.
[e] Key lost. No gage height taken on August 3 and 4.

Rating table for Flambeau River near Ladysmith, Wis., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
15.0	567	16.0	1,399	17.0	2,841	18.4	5,291
15.1	596	16.1	1,542	17.1	2,990	18.6	5,704
15.2	637	16.2	1,686	17.2	3,143	18.8	6,120
15.3	690	16.3	1,830	17.3	3,300	19.0	6,539
15.4	755	16.4	1,974	17.4	3,461	19.2	6,959
15.5	832	16.5	2,118	17.5	3,626	19.4	7,379
15.6	921	16.6	2,262	17.6	3,795	19.6	7,799
15.7	1,022	16.7	2,406	17.8	4,145	19.8	8,219
15.8	1,135	16.8	2,550	18.0	4,511	20.0	8,639
15.9	1,260	16.9	2,695	18.2	4,893		

The foregoing table is applicable only for open-channel conditions. It is based upon fourteen discharge measurements made during 1903 and 1904. It is well defined between gage heights 16 feet and 19 feet. The table has been extended beyond these limits. Above gage height 18.9 feet the rating curve is a tangent, the difference being 210 per tenth.

Estimated monthly discharge of Flambeau River near Ladysmith, Wis., for 1904.

[Drainage area, 2,120 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
April [a]	6,339	2,334	3,389	1.60	1.78
May	7,379	2,856	5,183	2.44	2.81
June	5,034	1,234	2,890	1.36	1.52
July	8,429	662	2,834	1.34	1.54
August [b]	2,334	607	1,336	.630	.726
September	4,109	1,260	2,056	.970	1.08
October [b]	5,912	1,470	3,517	1.66	1.91
November	3,300	555	1,416	.668	.745
December [a]	1,974	390	951	.449	.518

[a] Estimates April and December made as if open channel.
[b] Discharge estimated for August 3 and 4 and October 1 to 4.

WISCONSIN RIVER DRAINAGE BASIN.

Wisconsin River is the largest river in the State of Wisconsin. It rises in the northern part and flows south through the central portion of the State to Portage, where it turns at nearly a right angle and flows west, emptying into the Mississippi about 60 miles above Dubuque.

Gaging stations were operated at Necedah and Merrill, Wis., during 1904.

WISCONSIN RIVER AT MERRILL, WIS.

This station was established November 17, 1902, by L. R. Stockman. It is located on the highway bridge in the city of Merrill, Wis., three blocks from the Lincoln County court-house, one-half mile from the Chicago, Milwaukee and St. Paul Railroad station, and 1,000 feet below the dam of the electric power house. Prairie River enters about one-half mile above the station and there is an island about 600 feet below. There is a vertical gage fastened to the mill abutment, from which part of the gage readings for 1903 have been made. June 17, 1903, a chain gage was established on the bridge and made to read the same as the old gage at the mill. It is fastened to the guard timber on the downstream side, and the zero is marked by a brass screw driven into the guard timber. The fall of the water from the old to the new gage is 2.70 feet when the water is at a high

stage. The length of the chain from the end of the weight to the marker is 23.68 feet. The gage is read twice each day by A. F. Lueck. The initial point for soundings is a nail in the footboard at the left end of the bridge, opposite the center of the iron hand-rail post. This point is marked "zero." Discharge measurements are made from the two-span highway bridge, to which the chain gage is fastened. Each span of the bridge is 175 feet in length. The channel is straight from the dam above to the bridge and for about 400 feet below. The velocity is rapid and the surface rough. The station is so near the dam that at high stages the velocity is affected, and it is possible that the bed of the stream may be subject to slight change, although it is of rock and gravel and is very rough. The channel is about 300 feet wide at low stages and 400 feet wide at high water. Both banks are high and do not overflow. Bench mark No. 1 is a cross cut in the sandstone rock in the bridge seat of the abutment nearest to the city. Its elevation above the zero of the gage is 16.25 feet. This bench mark is 18.28 feet below the United States bench mark located at the corner of the engine house opposite the city hall.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Wisconsin River at Merrill, Wis., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Sec. feet.*
January 20[a]	L. R. Stockman	310	718	1.91	4.05	1,376
February 16[a]	do	310	669	1.86	3.70	1,250
March 20	do	344	2,639	3.78	8.90	9,995
May 7[b]	do	332	2,232	3.54	6.85	7,893
June 17[b]	do	308	1,269	1.78	4.72	2,258
July 13	do	305	1,424	2.10	5.70	2,993
August 22[b]	do	283	1,115	2.36	5.00	2,638
September 11	E. C. Murphy	343	1,759	3.19	6.66	5,614
October 24	L. R. Stockman	334	1,594	2.61	6.08	4,159
1904.						
May 12[b]	E. Johnson, jr	334	2,220	3.71	7.85	8,242
June 5	do	334	2,286	4.19	8.25	9,587
July 15[b]	do	334	1,366	1.98	5.30	3,107
September 21	do	312	1,210	1.91	5.01	2,312
October 14	F. W. Hanna	327	2,333	4.42	8.25	10,320
November 30[a]	E. Johnson, jr	306	1,237	1.85	4.97	2,294

[a] Partly frozen. [b] Effected by log jam.

Mean daily gage height, in feet, of Wisconsin River at Merrill, Wis., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.90	5.65	5.90	5.90	7.55	7.55	6.75	5.15	5.05	6.15	6.70	4.85
2	6.00	5.65	5.95	5.85	7.10	7.25	6.80	5.20	4.90	6.25	6.60	5.20
3	6.05	5.60	5.90	5.90	6.80	7.30	6.60	5.10	5.95	6.70	6.25	4.85
4	6.10	5.55	5.90	5.85	7.05	7.70	6.20	5.00	7.80	5.85	5.90	4.85
5	6.10	5.70	5.90	5.90	7.30	8.05	6.25	5.05	6.90	6.40	5.75	4.75
6	6.00	5.70	5.85	6.40	6.75	8.30	6.20	5.25	6.25	5.90	5.70	4.95
7	5.75	5.60	5.95	6.35	6.75	7.80	6.20	5.20	7.05	5.60	5.55	4.80
8	5.80	5.80	5.85	6.65	7.05	7.85	6.35	6.65	7.00	6.70	5.15	5.15
9	5.50	5.80	5.90	7.20	8.40	7.55	6.70	5.10	6.75	7.75	4.70	5.00
10	5.85	5.75	5.90	7.15	8.20	7.35	6.95	5.20	5.90	10.10	4.55	5.00
11	5.55	5.85	5.90	7.15	7.90	7.00	7.20	5.30	6.15	10.40	4.40	4.65
12	5.70	5.75	5.90	6.75	7.95	7.55	6.55	6.20	6.60	10.15	4.75	4.45
13	5.75	6.10	5.80	6.80	7.70	7.25	5.45	7.15	6.15	9.05	5.90	4.80
14	5.70	5.55	5.80	6.65	7.95	6.50	6.00	5.50	5.95	8.30	6.00	5.05
15	5.55	5.60	5.90	6.35	7.70	6.20	5.75	5.30	5.95	7.55	4.60	5.20
16	5.60	5.65	5.85	5.85	7.90	6.10	5.60	5.70	5.90	7.15	4.50	5.30
17	5.60	5.95	5.90	6.45	7.40	6.05	5.80	6.65	5.90	6.90	4.55	5.20
18	5.55	5.90	5.75	6.30	6.55	6.10	6.05	5.90	5.95	6.90	4.55	5.20
19	5.65	5.90	5.65	6.35	6.75	6.50	4.50	5.75	5.90	6.95	4.75	5.10
20	5.60	6.15	5.70	6.15	6.75	6.20	4.60	6.40	5.20	6.25	5.05	5.05
21	5.70	5.85	5.75	6.05	6.85	6.05	5.10	6.10	5.35	6.35	5.10	5.20
22	5.65	5.95	5.80	6.05	7.05	6.10	5.20	6.20	5.05	6.80	5.25	5.70
23	5.60	5.90	5.35	6.10	7.05	6.05	5.30	6.15	5.50	6.65	5.10	5.25
24	5.50	5.90	5.75	7.00	7.05	7.25	4.90	5.85	6.80	6.55	4.95	5.20
25	5.85	5.90	6.00	8.10	8.10	5.60	4.50	5.80	7.10	7.10	4.75	5.45
26	5.55	5.90	5.85	8.35	10.10	6.00	4.60	5.70	7.75	7.20	4.95	5.05
27	5.55	5.90	5.55	8.45	10.60	6.25	5.40	6.00	7.15	6.90	5.45	5.60
28	5.55	5.90	5.70	8.50	9.80	7.25	5.10	5.50	7.20	6.75	5.15	5.95
29	5.55	5.95	5.80	8.20	9.05	6.80	5.50	5.90	6.40	6.85	5.15	5.60
30	5.55	.....	5.70	7.75	8.60	6.30	5.70	6.35	6.10	6.65	4.85	5.50
31	5.50	.....	5.80	.....	7.95	.....	5.50	5.05	.....	6.25	.....	5.15

Rating table for Wisconsin River at Merrill, Wis., from June 17, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.5	1,485	5.5	3,225	6.5	5,485	8.0	9,565
4.6	1,645	5.6	3,425	6.6	5,725	8.2	10,225
4.7	1,805	5.7	3,635	6.7	5,975	8.4	10,885
4.8	1,970	5.8	3,855	6.8	6,225	8.6	11,545
4.9	2,140	5.9	4,075	6.9	6,475	8.8	12,205
5.0	2,310	6.0	4,305	7.0	6,725	9.0	12,865
5.1	2,485	6.1	4,535	7.2	7,245	9.5	14,515
5.2	2,665	6.2	4,765	7.4	7,785	10.0	16,165
5.3	2,845	6.3	5,005	7.6	8,345	10.5	17,815
5.4	3,035	6.4	5,245	7.8	8,935	11.0	19,465

The above table is applicable only for open-channel conditions. It is based upon 17 discharge measurements made during 1902 to 1904, inclusive. It is not well defined. Above gage height 8 feet the rating curve is a tangent, the difference being 330 per tenth.

Estimated monthly discharge of Wisconsin River at Merrill, Wis., for 1904.

[Drainage area, 2,630 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,535	3,225	3,664	1.39	1.60
February	4,655	3,330	3,749	1.43	1.54
March	4,305	2,945	3,889	1.48	1.71
April	11,220	3,970	6,242	2.37	2.64
May	18,140	5,610	8,935	3.40	3.92
June	10,560	3,425	6,472	2.46	2.74
July	7,245	1,485	3,957	1.51	1.74
August	7,110	2,310	3,766	1.43	1.65
September	8,935	2,140	5,000	1.90	2.12
October	17,480	3,425	7,343	2.79	3.22
November	5,975	1,410	2,800	1.06	1.18
December	4,195	1,490	2,566	.976	1.12
The year	18,140	1,410	4,865	1.85	25.18

WISCONSIN RIVER NEAR NECEDAH, WIS.

This station was established December 2, 1902, by L. R. Stockman. It is located on the highway toll bridge 3 miles east of Necedah, Wis., and 3 miles from the Chicago, Milwaukee and St. Paul and Chicago and Northwestern Railroad stations. Yellow River flows into the Wisconsin about 4 miles below the station. There are islands both above and below the station, but they are several hundred feet away. A regulation chain gage is fastened to the upstream side of the highway bridge. The length from the end of the weight to the marker is 26.87 feet. The gage is read daily by W. F. Bingman. Discharge measurements are made from the two-span highway bridge to which the gage is attached. The initial point for soundings is a point over the right abutment, marked by a nail in the floor of the bridge and also marked "zero" with paint. The general direction of the channel is straight for 2,000 feet above and below the station. The velocity is rapid and rather poorly distributed on account of an ice breaker above the middle pier and the variation in width of the channel just above the bridge. The width of the channel at ordinary stages is about 325 feet, broken by one pier. The right bank is high and rocky; the left bank overflows, making the width of the channel from 500 to 600 feet. During the spring floods of 1903 the water overflowed the turnpike.

The right side of the bed of the stream is rocky, but the remainder is sandy and liable to shift.

Bench mark No. 1 is a nail in the top of a red-oak stump, 2½ feet in diameter, about 60 feet south of the center of the roadbed and about 50 feet from the river at ordinary stages. Its elevation above the zero of the gage is 12.99 feet. Bench mark No. 2 is a nail in the root of a large cottonwood tree, 280 feet south of the bridge and about 80 feet from the river. Its elevation above the zero of the gage is 11.90 feet. Bench marks Nos. 1 and 2 are on the east side of the river. Bench mark No. 3 is a cross on a large sandstone rock, 70 feet south of the center of the roadway and 15 feet west of the water's edge on the west bank of the river. Its elevation above the zero of the gage is 20.36 feet.

The drainage area at this station is 5,800 square miles.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Wisconsin River near Necedah, Wis., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Sec.-feet.*
January 13[a]	L. R. Stockman	280	2,617	1.18	5.65	2,840
February 5[a]	do	284	2,360	1.26	5.80	2,585
March 5[a]	do	284	2,411	1.09	5.80	2,422
March 26	Johnson and Stockman.		5,405	3.94	11.05	21,280
April 2	L. R. Stockman	220	4,206	2.42	7.55	10,190
April 28	do	309	3,860	1.84	6.50	7,123
June 12	do	281	3,282	1.79	6.00	5,888
July 7	do	316	4,708	4.43	10.50	20,860
August 19	do	302	2,832	2.46	6.20	6,962
September 4	do	276	2,463	2.05	5.30	5,047
October 12	do	314	3,871	3.23	9.43	12,500
1904.						
January 12[a]	E. Johnson, jr	286	2,031	1.33	4.60	3,000
May 11	do	317	4,685	3.65	9.60	17,110
May 23	Johnson and Hanna	314	3,717	2.67	7.05	9,921
July 16	E. Johnson, jr	294	3,525	1.66	5.80	5,845
September 21	do	294	1,823	2.08	4.92	3,800
October 14	F. W. Hanna	449	6,216	5.71	13.35	[b] 34,420

[a] Frozen. [b] Add to this discharge 3,000 second-feet overflow.

Mean daily gage height, in feet, of Wisconsin River near Necedah, Wis., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.[b]	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[c]
1	6.0	5.1	5.3	6.60	9.80	11.20	6.30	4.50	4.80	6.60	7.10	4.80
2	5.7	5.2	5.3	6.30	9.20	10.00	6.50	4.70	4.80	6.45	6.90	4.80
3	5.9	5.1	5.3	6.50	8.90	9.10	6.50	4.90	4.80	6.20	6.60	4.80
4	5.6	5.0	5.3	6.90	8.40	8.60	6.30	4.80	4.80	6.10	6.70	.....
5	6.0	5.2	5.3	6.60	8.00	8.40	6.20	4.70	4.30	7.00	6.50	.....
6	6.0	5.2	5.3	6.80	7.80	9.00	6.30	4.70	5.80	6.00	6.40	.....
7	5.9	5.2	5.3	7.00	7.40	9.90	6.00	4.30	6.30	5.90	6.10	.....
8	6.1	5.0	5.4	7.20	.....	10.50	5.90	4.40	5.90	6.30	6.10	.....
9	6.1	5.2	5.4	7.50	7.40	10.50	6.10	4.80	5.70	6.42	6.60	.....
10	6.0	4.9	5.3	7.90	7.90	9.80	6.30	4.90	5.70	6.70	6.10	5.10
11	5.9	5.1	5.3	8.80	9.50	9.00	6.40	5.30	5.30	8.40	5.90	.....
12	5.1	5.2	5.3	9.80	10.50	8.30	6.80	5.30	5.70	10.10	5.20	.....
13	5.1	5.1	5.3	9.80	10.50	7.80	7.10	5.40	5.30	12.00	5.50	.....
14	5.2	5.2	5.2	9.40	9.90	7.50	7.00	5.30	5.50	13.20	5.50	.....
15	5.2	5.1	5.3	8.70	9.40	7.20	6.50	5.30	5.60	13.00	5.60	.....
16	5.3	5.2	5.2	8.30	9.20	6.80	5.90	5.70	4.90	11.90	5.80	.....
17	5.2	5.2	5.2	7.70	9.00	6.90	5.80	5.00	5.20	10.30	5.50	5.50
18	5.1	5.1	5.2	7.30	8.50	6.70	5.50	5.10	5.30	9.40	5.30	.....
19	5.3	5.1	5.1	7.50	8.00	6.50	5.80	5.00	5.90	9.00	4.80	.....
20	5.0	5.0	5.0	7.50	7.70	6.20	5.50	5.00	5.70	8.40	5.00	.....
21	5.2	5.1	4.9	7.70	7.40	5.90	5.60	5.00	4.80	7.90	5.00	.....
22	5.2	5.1	5.0	7.70	7.20	5.80	5.30	4.70	4.90	8.00	5.30	.....
23	5.2	5.1	5.0	7.50	7.10	6.20	5.00	5.10	4.80	8.50	5.40	.....
24	5.1	5.1	4.8	7.60	7.00	5.70	4.80	4.80	4.70	8.50	5.30	6.00
25	5.0	5.2	5.0	8.00	7.50	6.00	4.50	4.90	4.85	8.30	4.90	.....
26	5.1	5.3	5.0	9.30	8.10	5.70	4.80	4.90	4.80	8.30	5.50	.....
27	5.0	5.4	5.2	10.30	9.40	6.10	4.90	5.00	6.70	7.90	5.10	.....
28	5.1	5.2	5.2	10.90	10.60	5.80	4.80	5.90	7.40	7.60	4.80	.....
29	5.2	5.1	5.2	10.70	11.90	6.10	4.70	4.60	7.40	7.50	5.00	.....
30	5.2	.....	5.5	10.50	12.60	6.00	4.80	5.00	7.00	7.40	5.00	.....
31	5.1	.....	5.8	.....	12.30	.....	4.70	4.70	.....	7.00	.....	6.00

[a] River frozen from January 1 to March 31. Ice, average thickness, 10 inches.
[b] Ice conditions April 1 to 12.
[c] Frozen December 4 to 31. Ice 0.1 foot to 2 feet thick.

Rating table for Wisconsin River near Necedah, Wis., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.0	1,800	5.1	4,150	6.4	7,600	9.5	16,900
4.1	2,000	5.2	4,390	6.6	8,200	10.0	18,400
4.2	2,200	5.3	4,630	6.8	8,800	10.5	19,900
4.3	2,400	5.4	4,880	7.0	9,400	11.0	21,400
4.4	2,600	5.5	5,130	7.2	10,000	11.5	23,610
4.5	2,810	5.6	5,380	7.4	10,600	12.0	25,860
4.6	3,020	5.7	5,640	7.6	11,200	12.5	28,230
4.7	3,240	5.8	5,900	7.8	11,800	13.0	30,750
4.8	3,460	5.9	6,170	8.0	12,400	13.5	38,450
4.9	3,690	6.0	6,440	8.5	13,900		
5.0	3,920	6.2	7,010	9.0	15,400		

The foregoing table is applicable only for open-channel conditions. It is based upon 19 discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 4.5 feet and 10.5 feet. The table has been extended beyond these limits. From gage height 6.3 feet to 11 feet the rating curve is a tangent, the difference being 300 per tenth. The bank overflows at gage height about 11 feet, which accounts for the suddenness and magnitude of the increase in difference per tenth.

Estimated monthly discharge of Wisconsin River near Necedah, Wis., for 1904.

[Drainage area, 5,800 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
April	21,100	7,300	12,830	2.21	2.47
May	28,720	9,400	15,250	2.63	3.03
June	22,280	5,640	11,350	1.96	2.19
July	9,700	2,810	5,926	1.02	1.18
August	6,170	2,400	3,845	.663	.764
September	10,600	2,400	5,227	.901	1.01
October	33,830	6,170	13,590	2.34	2.70
November	9,700	3,460	5,698	.982	1.10

ROCK RIVER DRAINAGE BASIN.

Rock River, with its tributaries, Pecatonica and Kishwaukee rivers, is one of the most important streams in Illinois. It rises in the southeastern part of Wisconsin, flows south and southwest, and enters the Mississippi just below Rock Island, Ill. This river has much power already developed along its course, and there are several points at which large water-power plants could be situated. It is also to be used as a feeder for the Hennepin canal. The United States Geological Survey has maintained a station on this river at Rockton, Ill., below the mouth of Pecatonica River during the year of 1904.

ROCK RIVER AT ROCKTON, ILL.

This station was established May 13, 1903, by E. Johnson, jr., assisted by L. R. Stockman. It is located at the village highway bridge, one-half mile from the Chicago, Milwaukee and St. Paul Railroad station, 1 mile below the dam and three-fourths of a mile below the junction of Pecatonica River with Rock River. There are small islands a short distance above and immediately below the station. The chain gage is located on the first span from the left end of the bridge, on the downstream side. The gage is read twice each day by

O. T. Bartholomew. The length from end of weight to marker is 26.45 feet. Discharge measurements are made from the upstream side of the five-span highway bridge to which the gage is attached. The initial point for soundings is the face of the abutment on the left end of the bridge. The channel is straight for 2,000 feet above and 1,000 feet below the station. Both banks are high and will not overflow. The channel is about 565 feet wide between bridge abutments and is broken by four piers. The bed of the stream is composed of small rocks and gravel.

Bench mark No. 1 is a hammered cross on the top stone of the left abutment, about 1 foot from the bridge shoe and 1 foot from the south edge. Its elevation above gage datum is 16.85 feet. Bench mark No. 2 is the top of the west end of the south rail of the railroad track, 250 feet north of the north end of the bridge, at a point where the sidewalk on the west side of the street crosses the track. Its elevation above gage datum is 16.49 feet.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Rock River at Rockton, Ill., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Sec.-feet.*
May 13	L. R. Stockman	.....	.....	.....	2.90	2,522
June 30	A. C. Lootz	296	547	2.74	2.30	1,501
August 18	L. R. Stockman	490	1,352	3.41	4.07	4,611
September 4	F. W. Hanna	.....	1,352	3.41	4.08	4,607
October 9	do	504	1,998	3.74	5.35	7,464
November 9	do	453	831	[a] 3.46	2.85	2,874
December 10[b]	do	367	743	3.21	2.60	2,384
1904.						
January 16[c]	F. W. Hanna	380	662	2.25	2.90	1,487
March 14	do	509	4,031	2.77	9.30	11,180
March 25	do	509	5,744	4.34	12.32	24,910
April 18	do	504	2,361	3.90	5.91	9,212
June 23	do	378	660	3.18	2.50	2,099
July 7	do	389	645	2.93	2.38	1,889
August 30	do	381	674	3.02	2.45	2,034
September 23	do	408	739	3.19	2.65	2,355
October 26	do	426	759	3.13	2.70	2,372
November 9	do	397	695	3.09	2.50	2,149

[a] High wind; velocity doubtful. [b] Partly frozen. [c] Ice 0.59 foot thick.

Mean daily gage height, in feet, of Rock River at Rockton, Ill., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[a]
1	2.90	2.90	3.80	10.65	4.53	3.68	2.20	2.10	2.15	3.50	2.65	2.20
2	2.90	2.90	3.95	9.61	4.50	3.68	2.20	1.90	2.15	3.25	2.60	2.15
3	2.90	3.10	6.09	8.85	4.30	3.51	2.25	1.80	2.20	3.15	2.45	2.20
4	3.00	3.20	6.72	8.37	4.18	3.00	2.20	1.80	2.12	3.00	2.50	2.20
5	2.90	3.00	6.83	8.06	4.05	3.20	2.15	1.80	2.30	2.85	2.45	2.25
6	2.80	2.80	6.60	7.85	4.01	3.10	2.15	1.90	2.60	3.20	2.45	2.20
7	2.90	4.50	7.45	7.60	4.00	3.10	2.30	1.95	2.45	3.25	2.25	2.20
8	2.90	5.50	9.92	7.60	4.18	3.11	2.40	1.90	2.35	3.10	2.45	2.20
9	2.90	5.90	10.80	7.60	4.50	3.00	2.50	1.82	2.30	2.75	.....	2.20
10	3.00	6.10	11.12	7.60	4.85	2.95	2.46	1.90	2.31	3.00	2.45	2.20
11	2.60	6.00	11.10	7.61	4.79	2.95	2.35	1.85	2.30	3.40	2.45	2.20
12	2.90	5.80	10.90	7.41	4.76	2.85	2.35	1.75	2.20	3.81	2.50	2.20
13	2.90	5.50	10.30	7.10	4.81	2.80	2.40	1.80	2.20	4.25	2.40	2.40
14	3.00	4.70	9.33	6.83	4.81	2.75	2.25	1.70	2.26	4.25	2.20	2.45
15	2.80	4.10	8.85	6.50	4.91	2.70	2.20	1.85	2.20	4.50	2.30	2.70
16	2.90	3.90	8.00	6.40	4.95	2.60	2.13	1.55	2.15	3.80	2.45	2.85
17	3.00	3.80	6.34	6.20	4.99	2.62	2.00	1.75	2.10	3.30	2.45	2.70
18	2.70	3.80	5.50	5.91	4.81	2.55	2.10	1.90	2.20	3.15	2.35	3.00
19	3.00	3.60	4.90	5.79	4.80	2.65	2.10	1.75	2.90	3.50	2.45	2.65
20	3.00	3.60	8.35	5.60	4.68	2.50	2.10	1.90	4.00	2.90	2.40	2.90
21	3.10	3.70	8.35	5.48	4.60	2.50	2.00	1.95	3.80	2.75	2.20	2.80
22	3.10	3.60	12.75	5.35	4.48	2.50	2.00	2.50	3.25	2.70	2.30	2.70
23	3.20	3.50	13.23	5.16	4.32	2.50	2.00	2.80	2.80	2.70	2.30	2.45
24	3.30	3.30	12.05	5.18	4.28	2.45	2.00	3.00	2.55	2.75	2.20	2.50
25	3.20	3.50	12.25	5.53	4.31	2.40	1.75	3.10	2.35	2.70	2.30	2.50
26	3.30	3.50	12.55	5.55	4.18	2.35	2.10	2.70	2.65	2.65	2.40	2.50
27	3.30	3.60	12.40	5.31	4.10	2.15	2.50	2.30	3.35	2.65	2.20	3.00
28	3.10	3.60	12.30	5.04	3.90	2.20	2.10	2.40	4.20	2.70	2.20	4.20
29	3.00	3.80	11.85	4.80	3.85	2.20	2.00	2.10	4.12	2.60	2.20	5.10
30	2.90	.....	11.45	4.63	3.79	2.20	2.00	2.20	3.65	2.55	2.30	5.15
31	2.90	.....	11.16	.....	3.80	.....	2.00	2.30	.....	2.75	.....	4.60

[a] River partially frozen January 1 to March 27, and December 13 to 31.

Rating table for Rock River at Rockton, Ill., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.5	810	2.8	2,470	4.2	4,940	8.0	14,020
1.6	910	2.9	2,620	4.4	5,345	8.5	15,270
1.7	1,015	3.0	2,775	4.6	5,760	9.0	16,520
1.8	1,125	3.1	2,935	4.8	6,180	9.5	17,770
1.9	1,235	3.2	3,105	5.0	6,620	10.0	19,020
2.0	1,350	3.3	3,280	5.2	7,070	10.5	20,270
2.1	1,470	3.4	3,455	5.4	7,540	11.0	21,520
2.2	1,600	3.5	3,635	5.6	8,020	11.5	22,770
2.3	1,740	3.6	3,815	5.8	8,520	12.0	24,020
2.4	1,880	3.7	3,995	6.0	9,020	13.0	26,520
2.5	2,025	3.8	4,180	6.5	10,270		
2.6	2,170	3.9	4,365	7.0	11,520		
2.7	2,320	4.0	4,555	7.5	12,770		

The preceding table is applicable only for open-channel conditions. It is based upon 17 discharge measurements made during 1903 and 1904. It is well defined between gage heights 2.4 feet and 6 feet. One flood measurement at 12.32 fixes the upper part of the curve. The table has been extended beyond these limits. Above gage height 5.6 feet the rating curve is a tangent, the difference being 250 per tenth.

Estimated monthly discharge of Rock River at Rockton, Ill., for 1904.

[Drainage area, 6,150 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January [a]	3,280	2,170	2,747	0.446	0.514
February [a]	9,270	2,470	4,762	.774	.835
March [a]	27,100	4,180	17,220	2.80	3.23
April	20,640	5,823	10,810	1.76	1.96
May	6,598	4,162	5,405	.879	1.01
June	3,959	1,535	2,432	.395	.441
July	2,025	1,070	1,570	.255	.294
August	2,935	860	1,471	.239	.276
September	4,940	1,470	2,344	.381	.425
October	5,550	2,098	3,058	.497	.573
November	2,245	1,600	1,847	.300	.335
December [a]	6,955	1,535	2,514	.409	.472
The year	27,100	860	4,682	.761	10.37

[a] Daily discharges January, February, March, and December applied as for open channel.

ILLINOIS RIVER DRAINAGE BASIN.

Illinois River is formed by the junction of Kankakee and Desplaines rivers at a point near Minooka, Grundy County, Ill. Its principal tributaries are Fox and Spoon rivers from the west and Vermilion and Sangamon rivers from the east. During 1904 gaging stations have been maintained in the Illinois River drainage basin at Peoria, Ottawa, and Minooka on the Illinois, and on the Desplaines at Channahon above the mouth of Jackson Creek.

The drainage areas at the points where stations have been maintained are as follows:

Drainage areas in Illinois basin at gaging stations.

	Square miles.
ILLINOIS RIVER.	
Peoria	13,250
Minooka	6,480
Ottawa	10,100
DESPLAINES RIVER.	
Jackson Creek	1,170

ILLINOIS RIVER NEAR MINOOKA, ILL.

This station was established November 7, 1902, by E. H. Heilbron, to determine the flow of Kankakee River. It is 6 miles south of Minooka, Ill., and 2½ miles below the mouth of Kankakee River at the Elgin, Joliet and Eastern Railroad bridge. The gage is a vertical rod fastened to the center pier of the bridge. It is read twice daily by J. A. Lyons. Discharge measurements are made from the bridge. The initial point for soundings is an oak hub about 4 feet north of the north side of the railroad pumping station. The channel is straight for 1,000 feet above the station and 2,000 feet below. The width at ordinary stages is 560 feet, with a maximum depth of 12 feet. The flow is moderately rapid, but is sluggish at low stages. The width at high water is about 1,000 feet. The right bank is low and liable to overflow; the left bank is high. The bed of the stream is of gravel and is shifting on the north side.

The bench mark is a cut in the stone on the south abutment of the Elgin, Joliet and Eastern Railroad bridge. It is marked S. D. ⊡ P. B. M. Its elevation is 85.030 feet above the Hennepin datum and 66.764 feet below the Chicago city datum. The gage is set with its zero at the same elevation as the zero of the Chicago datum, thus giving directly the elevation of the river surface below this datum.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr.; district hydrographer.

Discharge measurements of Illinois River near Minooka, Ill., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.[a]	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
March 15	E. H. Heilbron	630	9,182	2.80	86.84	25,680
April 19	do	594	6,604	2.04	91.12	13,480
May 10	do	553	4,893	1.03	94.10	7,393
July 12	do	541	4,556	1.64	93.83	7,465
August 31	do	560	3,856	1.83	93.99	7,044
September 26	Johnson and Hanna	520	4,199	1.75	94.10	7,319
October 24	do	530	4,317	1.78	94.10	7,673
November 11	F. W. Hanna	513	4,466	1.70	94.15	7,596
1904.						
March 26	E. H. Heilbron	948	14,800	4.40	78.50	64,880
March 27	do	682	12,980	3.85	79.98	50,920
April 3	do	622	11,230	3.30	82.40	37,120
April 17	do	580	6,937	2.44	89.63	16,930
April 26	do	584	7,740	2.62	88.15	20,310
May 2	do	560	6,454	2.46	90.51	15,890
May 19	do	565	5,140	1.91	93.00	9,845

[a] All gage heights are negative, being below Chicago datum.

Mean daily gage height, in feet, of Illinois River near Minooka, Ill., for 1904.[a]

Day.	Jan.[b]	Feb.[b]	Mar.[b]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	91.89	90.20	83.71	81.60	90.00	92.76	94.65	94.65	.....	93.75	95.05	94.65
2	91.83	90.79	83.21	81.50	90.53	92.88	94.59	94.70	.....	93.75	95.05	94.60
3	91.79	90.80	81.36	82.37	91.02	92.95	94.65	94.70	94.58	94.20	94.92	94.60
4	91.85	90.80	81.75	83.17	91.42	93.10	.....	94.75	94.75	94.40	94.53	94.35
5	92.00	90.98	82.52	84.02	91.68	93.11	94.44	94.70	94.75	94.55	94.55	94.32
6	91.94	90.08	83.38	84.97	91.85	93.30	94.42	94.58	94.75	94.70	95.00	94.40
7	91.79	85.36	82.68	85.80	91.98	93.42	94.48	94.70	94.80	94.80	94.57	94.27
8	91.80	85.10	82.78	86.20	92.11	93.48	94.55	94.70	94.75	94.90	94.75	94.27
9	91.75	85.95	84.90	86.12	91.78	93.90	93.98	94.75	95.00	94.80	94.55	94.28
10	91.62	86.14	85.35	86.27	91.60	94.10	93.82	94.75	95.08	95.00	94.53	95.05
11	91.48	86.68	85.72	86.47	91.74	94.24	(c)	94.80	95.05	94.75	94.45	94.50
12	91.41	87.64	86.56	86.85	91.92	94.26	.....	94.70	95.00	94.90	94.55	94.25
13	91.81	88.49	87.58	87.41	92.25	94.36	.....	94.75	95.05	94.80	94.47	94.40
14	92.50	88.92	87.85	87.98	92.45	94.88	.....	94.87	95.15	94.95	94.48	94.35
15	92.09	89.67	88.48	88.42	92.56	94.68	.....	94.80	95.20	94.40	94.37	.....
16	91.87	90.08	88.52	89.17	92.68	94.27	.....	94.77	95.40	94.35	94.47	.....
17	91.89	90.12	88.54	89.65	92.90	94.76	.....	94.75	95.20	94.35	94.43	.....
18	91.80	90.45	88.51	90.02	92.92	94.65	.....	94.70	93.25	94.85	94.45	.....
19	91.91	90.76	85.21	90.30	93.03	94.60	.....	94.80	94.15	95.00	94.47	.....
20	91.49	90.67	82.80	90.85	93.12	94.72	.....	(c)	94.90	95.00	94.48	.....
21	86.95	90.70	83.37	91.15	93.29	94.68	.....	.....	95.10	95.05	94.52	.....
22	83.35	90.90	82.01	91.35	93.39	94.55	.....	.....	95.10	94.90	94.52	.....
23	83.40	90.95	80.66	91.48	93.34	94.90	.....	.....	95.20	95.10	94.48	.....
24	84.90	90.88	81.21	90.60	93.47	95.02	.....	.....	95.05	95.10	94.53	.....
25	85.65	90.89	79.52	90.42	93.44	94.92	.....	.....	95.00	95.00	94.45	.....
26	86.14	90.81	78.50	88.82	93.46	94.85	.....	.....	94.55	95.00	94.45	.....
27	87.24	90.62	80.02	87.08	93.55	95.00	.....	.....	94.70	95.00	95.20	.....
28	88.38	90.53	81.25	87.50	93.51	94.84	.....	.....	93.95	94.05	95.30	.....
29	89.11	88.65	82.24	88.27	93.50	94.76	.....	.....	92.85	95.07	95.07	.....
30	89.45	.....	83.12	89.22	93.28	94.62	.....	.....	93.60	94.95	94.95	.....
31	89.73	.....	82.94	.....	92.96	.....	.....	.....	.....	95.05	.....	.....

[a] All gage heights here given of this river are below the Chicago datum.
[b] River frozen January 1 to about March 20. Ice varies in thickness from 0.5 to 2 feet.
[c] Observer absent.

Rating table for Illinois River near Minooka, Ill., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
95.0	6,320	93.5	8,735	91.0	13,530	86.5	24,590
94.9	6,470	93.4	8,905	90.8	13,950	86.0	26,040
94.8	6,620	93.3	9,075	90.6	14,370	85.5	27,550
94.7	6,770	93.2	9,245	90.4	14,800	85.0	29,120
94.6	6,925	93.1	9,415	90.2	15,240	84.5	30,750
94.5	7,080	93.0	9,590	90.0	15,680	84.0	32,440
94.4	7,240	92.8	9,950	89.8	16,120	83.5	34,200
94.3	7,400	92.6	10,330	89.6	16,560	83.0	36,000
94.2	7,560	92.4	10,710	89.4	17,020	82.5	37,880
94.1	7,720	92.2	11,110	89.2	17,480	82.0	39,820
94.0	7,885	92.0	11,510	89.0	17,960	81.0	44,010
93.9	8,055	91.8	11,910	88.5	19,210	80.0	49,910
93.8	8,225	91.6	12,310	88.0	20,510	79.0	59,010
93.7	8,395	91.4	12,710	87.5	21,820		
93.6	8,565	91.2	13,110	87.0	23,180		

The preceding table is applicable only for open-channel conditions. It is based upon 16 discharge measurements made during 1903 and 1904. It is well defined between gage heights −94 feet and −87 feet. All gage heights are negative, being below Chicago datum. The table has been extended beyond these limits. Above gage height −79.5 feet the rating curve is a tangent, the difference being 1,200 per tenth.

Estimated monthly discharge of Illinois River near Minooka, Ill., for 1904.

[Drainage area, 6,480 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 21–31	64,810	34,670	44,130	6.81	2.79
April	41,860	12,510	22,610	3.49	3.89
May	15,680	8,565	10,660	1.65	1.90
June	9,950	6,320	7,559	1.17	1.30
July 1–10	8,225	6,925	7,245	1.12	.417
August 1–19	6,925	6,470	6,699	1.03	.728
September 3–30	9,950	5,720	6,772	1.05	1.09
October	8,225	6,170	6,735	1.04	1.20
November	7,240	5,870	6,848	1.06	1.18
December 1–14	7,560	6,320	7,164	1.11	.578

ILLINOIS RIVER AT OTTAWA, ILL.

This station was established November 11, 1902, by E. H. Heilbron. It is located at the Chicago, Burlington and Quincy Railroad bridge, 2,500 feet below the mouth of Fox River and 200 feet below the highway bridge leading to the main street of Ottawa, Ill. A standard chain gage was established November 1, 1903, to replace the old vertical gage and was made to read the same as the original gage. The length of chain from the end of the weight to the marker is 37.42 feet. The gage was read twice each day by D. C. Woods. Discharge measurements were made from the upper side of the railroad bridge, to which the gage is attached. The initial point for soundings was the center one of the group of nails driven into the cap at the left end of the trestlework, south of the main bridge structure. The channel is straight for about 2,000 feet above and below the station and has a width between abutments of 650 feet, broken by three piers. The depth at ordinary stages is about 13 feet. The railroad embankments form part of the banks of this river. The bed of the stream is composed of gravel, which is somewhat shifting. The flow is somewhat sluggish at low stages.

Bench mark No. 1 is the top of the coping stone at the east end of the first pier from the north end of the railroad bridge. The point is

marked "U. S." Its elevation is 48.638 feet above the Hennepin datum, and 103.156 feet below the Chicago datum. Bench mark No. 2 is a cut in the batter on the coign, 3 feet above ground, at the west end of the south pier of the railroad bridge. The gage is set with its zero at the same elevation as the zero of the Chicago datum, thus giving directly the elevation of the river surface below this datum.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Illinois River at Ottawa, Ill., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.[a]	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
March 18	E. H. Heilbron	650	6,817	4.53	122.98	30,880
April 5	do	600	4,738	3.71	126.25	17,570
April 28	do	610	5,001	3.67	126.07	18,340
May 12	do	545	3,501	3.32	128.42	11,620
July 8	do	480	2,847	2.65	129.54	7,541
August 23	E. Johnson, jr	660	2,924	2.62	129.57	7,668
September 25	Johnson and Hanna	560	3,466	3.35	128.35	11,590
October 12	do	553	3,609	3.75	127.88	13,540
November 12	F. W. Hanna	525	3,090	2.88	129.01	8,898
December 12[b]	do	550	4,424	1.54	126.42	6,822
1904.						
March 30	E. H. Heilbron	745	10,220	4.56	118.30	46,560
April 2	do	750	10,990	4.96	117.30	54,470
April 17	do	626	5,164	3.62	125.40	18,720
April 26	do	652	6,136	4.20	123.90	25,920
May 2	do	608	4,775	3.90	125.80	18,610
May 19	do	541	3,583	2.89	128.1	10,340

[a] Below Chicago datum. [b] Ice jam.

Mean daily gage height,[a] in feet, Illinois River at Ottawa, Ill., for 1904.

Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.	Feb.
1	127.28	124.20	9	126.82	120.00	17	127.02	124.60	25	120.00	.....
2	127.22	124.20	10	126.80	120.30	18	126.95	124.80	26	120.50	.....
3	127.12	124.20	11	126.88	120.70	19	126.90	124.10	27	121.00	.....
4	126.90	124.20	12	126.85	121.30	20	125.30	124.10	28	122.10	.....
5	126.82	124.20	13	126.90	122.70	21	121.10	124.11	29	122.22	.....
6	126.80	123.45	14	126.98	123.10	22	118.60	.....	30	123.20	.....
7	126.80	120.60	15	127.24	123.60	23	118.80	.....	31	123.92	.....
8	126.85	118.60	16	127.32	123.80	24	119.45	.....			

[a] The gage heights here given of this river are below the Chicago datum and were recorded on the cards as minus (−).

ILLINOIS RIVER NEAR PEORIA, ILL.

This station was established March 10, 1903, by E. H. Heilbron. It is located on the Peoria and Pekin Union Railroad bridge over the Illinois River, 1½ miles southwest of Peoria, Ill., and can be reached by street cars. The gage is a plain staff graduated to feet and inches and fastened to the central pier of the bridge. It is read twice daily by the draw tender of the bridge, P. A. Blumb. The measurements are taken from the bridge, and the initial point for sounding is on the right bank. The river is straight for 3,000 feet above and 2,000 feet below the station and has a width of about 1,000 feet, broken by six piers. The section is deep and the flow sluggish. The bed of the stream is composed of gravel and silt. The right bank is high, and there is a railroad embankment along this shore. The left bank is low and liable to overflow.

The bench mark is the southwest corner of the top stone of the west abutment of the bridge; elevation, 125.722 feet below the Chicago datum. The gage at this point has for its zero a point 153.814 feet below the Chicago city datum. The gage reads up from this point, and in order to obtain the height of the river, referred to the Chicago datum, it is necessary to subtract the gage reading from 153.814 feet.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Illinois River near Peoria, Ill., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second ft.*
January 30[a]	E. H. Heilbron	943	14,870	1.58	16.30	21,120
February 4[a]	do	933	13,640	1.20	15.42	16,300
February 14	do	955	14,810	1.50	16.30	21,780
March 3	do	953	13,300	1.75	14.94	23,280
March 28	do	951	19,980	2.93	21.83	58,370
March 31	do	953	20,250	2.21	21.48	[b]44,810
April 2	do	953	19,310	2.17	21.17	[b]41,930
April 7	do	953	19,030	2.71	20.12	51,560
April 9	do	953	18,570	2.87	19.66	52,370
April 16	do	953	16,870	2.46	18.00	41,460
April 24	do	946	14,080	1.96	15.70	27,590
May 1	do	952	14,460	2.16	16.00	31,310
May 18	do	950	11,830	1.43	13.21	16,910

[a] Partly frozen. [b] Questionable.

Mean daily gage height, in feet, of Illinois River near Peoria, Ill., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	10.12	15.86	14.17	21.29	15.96	11.67	8.42	8.46	8.04	9.58	7.83	7.58
2	10.25	15.71	14.37	21.17	15.75	11.54	8.04	8.42	7.96	9.67	7.83	7.58
3	10.25	15.54	14.79	21.08	15.54	11.46	7.88	8.33	8.00	9.63	7.83	7.50
4	10.25	15.37	15.54	20.87	15.42	11.62	7.71	8.25	7.96	9.50	7.75	7.50
5	10.25	15.21	16.12	20.62	15.12	11.38	.....	8.21	7.83	9.58	7.79	7.50
6	10.17	15.33	16.67	20.46	14.87	11.29	8.04	8.12	7.78	9.46	7.75	7.50
7	10.17	15.50	16.87	20.12	14.75	11.17	7.95	8.00	7.75	9.29	7.67	7.54
8	10.17	15.62	17.04	19.79	14.54	11.17	7.92	7.92	7.63	9.17	7.75	7.66
9	10.17	15.92	17.25	19.67	14.37	11.38	8.12	7.75	7.46	9.17	7.75	7.79
10	10.17	16.29	17.67	19.46	14.29	11.46	8.12	7.83	7.38	9.08	7.75	7.83
11	10.17	16.42	17.87	19.21	14.04	11.25	8.16	7.75	7.58	9.08	7.75	7.67
12	10.21	16.42	17.92	19.08	13.87	11.04	8.42	7.71	7.42	9.04	7.71	7.67
13	10.25	16.42	17.92	18.79	13.83	10.87	8.42	7.54	7.33	9.00	7.83	7.67
14	10.25	16.29	17.79	18.50	13.79	10.71	8.58	7.67	7.33	8.88	7.71	7.67
15	10.25	16.04	17.54	18.17	13.29	10.54	8.71	7.54	7.33	8.75	7.67	7.67
16	10.17	15.79	17.29	17.96	13.46	10.38	8.67	7.50	7.29	8.66	7.75	7.67
17	10.17	15.54	17.13	17.50	13.37	10.16	8.67	7.50	7.25	8.58	7.75	7.67
18	10.08	15.33	16.87	17.21	13.21	9.88	8.67	7.42	7.33	8.50	7.83	7.75
19	10.08	15.13	16.87	16.96	13.17	9.75	8.62	7.42	7.54	8.42	7.79	7.83
20	10.46	14.85	17.25	16.58	12.88	9.46	8.54	7.84	7.75	8.33	7.88	7.83
21	12.21	14.70	17.83	16.25	12.71	9.41	8.42	7.58	7.79	8.37	7.83	7.92
22	13.04	14.54	18.83	15.87	12.42	9.29	8.29	8.12	7.75	8.42	7.83	7.92
23	13.54	14.36	19.46	15.58	12.50	9.08	8.12	8.21	7.62	8.33	7.79	7.92
24	14.46	14.20	20.04	15.58	12.38	8.83	8.04	8.29	7.66	8.25	7.83	8.08
25	15.33	14.00	20.62	15.75	12.13	8.83	7.88	8.42	7.83	8.20	7.83	8.08
26	15.91	13.80	21.12	15.92	12.08	8.71	7.79	8.42	8.94	8.20	7.83	8.21
27	16.08	13.60	21.67	15.87	11.96	8.54	7.75	8.42	9.63	8.08	7.83	8.29
28	16.29	13.58	21.83	15.87	11.79	8.38	7.75	8.33	9.44	8.00	7.58	8.71
29	16.33	14.00	21.75	15.54	11.67	8.21	7.62	8.25	9.33	8.00	7.58	8.75
30	16.25	.....	21.62	16.00	11.75	8.13	7.54	8.25	9.54	8.00	7.58	8.83
31	16.04	.....	21.46	.....	11.67	.....	8.84	8.12	.....	7.92	.....	8.75

[a] River frozen over from January 1 to March 20, 1904. Average thickness 0.1 foot to 1 foot.
[b] Ice December 13 to 31.

DESPLAINES RIVER ABOVE JACKSON CREEK, NEAR CHANNAHON, ILL.

This station was established October 23, 1902, by E. H. Heilbron. It is located just above the mouth of Jackson Creek, 2½ miles southwest of Millsdale, Ill. The gage is a vertical staff graduated to feet and tenths, and is read daily by Ruth Alexander. The measurements are taken from a cable and boat. The initial point for sounding is a red hub driven in the ground on the left bank near the end of the cable. The channel is straight for about 3,000 feet both above and below the station and has a width of 360 feet and a maximum depth of 16 feet at ordinary stages. Its flow is moderately rapid. Both banks of the stream are low and liable to overflow, but a few feet from the top of the banks on either side are high ridges, which never overflow. Measurements can be made at all stages. The bed of the stream is gravel.

The bench mark is the top of a red oak hub (the initial point for sounding) driven in the bluff between Jackson Creek and the south bank of Desplaines River. It is about 300 feet west of the west line of sec. 15, T. 37 N., R. 9 E., third principal meridian, and is on the farm owned by George Alexander. Elevation, 64.262 feet below the Chicago datum. The gage is set with its zero at the same elevation as the zero of the Chicago datum, thus giving directly the elevation of the river surface below this datum. This station was located to give the discharge of upper Desplaines River.

The excessively large discharge at this station is due to the fact that between 4,000 and 5,000 second-feet are constantly being diverted from Lake Michigan into Desplaines River a short distance above this gaging station.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Desplaines River above the mouth of Jackson Creek, near Channahon, Ill., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
January 21[a]	E. H. Heilbron	375	5,133	1.70	78.00	8,535
January 22[a]	do	440	6,468	1.09	75.20	7,062
March 24	do	440	6,240	2.62	76.06	16,330
March 24	do	437	6,324	2.57	76.10	16,230
March 24	do	430	6,057	2.56	76.32	15,530
March 25	do	465	6,654	2.61	74.80	17,340
March 25	do	477	6,813	2.63	74.60	17,940
March 25	do	485	7,112	2.82	74.10	20,080
March 27	do	450	6,386	2.48	75.64	15,820
April 3	do	384	5,071	2.09	78.80	10,610
April 14	do	360	3,936	1.40	81.80	5,548

[a] Partly frozen. Ice gorge below Kankakee River.

All gage heights are negative, being below Chicago datum.

Mean daily gage height,[a] in feet, of Des Plaines River above the mouth of Jackson Creek, near Channahon, Ill., for 1904.

Day.	Jan.[b]	Feb.[b]	Mar.[b]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[c]
1	81.01	78.47	76.65	77.78	82.59	82.92	83.29	82.98	82.98	83.53	83.85	83.10
2	80.76	78.85	76.96	78.04	82.61	82.88	83.38	83.20	83.02	83.58	83.80	82.97
3	80.60	78.80	75.17	78.91	82.65	82.91	83.22	83.10	83.05	83.60	83.75	83.03
4	80.62	78.97	76.65	79.68	82.77	82.95	83.15	83.11	83.10	83.64	83.01	82.90
5	80.84	78.56	77.96	80.18	82.74	82.90	83.26	83.05	83.03	83.60	83.05	82.84
6	80.79	78.15	78.13	80.45	82.59	82.95	83.30	83.03	83.16	83.62	83.20	82.90
7	80.98	75.55	76.91	80.90	82.65	82.80	83.20	83.02	82.96	83.68	83.01	82.81
8	81.58	75.02	77.96	80.70	82.68	83.00	83.10	83.11	83.02	83.50	83.51	82.75
9	81.20	76.61	78.52	81.16	82.53	83.38	83.11	83.10	83.65	83.62	83.00	82.77
10	80.41	76.89	78.52	81.10	82.60	83.42	83.36	83.05	83.65	83.58	82.98	84.00
11	80.51	77.44	78.46	81.22	82.70	83.48	83.10	83.12	83.62	84.15	83.01	82.97
12	80.60	78.08	78.78	81.32	82.78	83.50	83.10	83.08	83.72	83.55	83.12	82.65
13	81.04	78.53	78.78	81.70	82.86	83.50	83.19	83.04	83.62	83.64	82.82	82.95
14	82.28	78.75	78.74	81.78	82.75	84.02	83.18	83.36	83.22	83.58	83.09	82.84
15	80.63	79.38	78.84	81.85	82.69	83.85	83.15	83.24	83.67	83.00	82.99	82.83
16	80.43	79.50	79.78	82.35	82.70	83.48	83.05	83.08	83.90	83.00	83.06	82.97
17	80.68	79.68	80.70	82.38	82.65	83.80	83.05	83.18	83.70	82.97	82.97	82.96
18	80.70	79.75	80.96	82.44	82.60	83.68	83.16	83.31	82.87	83.60	83.15	83.05
19	80.82	79.78	79.42	82.35	82.69	83.70	83.22	83.04	82.95	83.60	83.05	82.94
20	80.50	79.90	78.47	82.56	82.76	83.78	83.18	83.72	83.68	83.82	82.99	82.98
21	78.16	79.85	78.55	82.58	82.87	83.75	83.11	83.92	83.71	83.88	83.16	83.02
22	75.06	79.95	76.31	82.62	82.97	83.65	83.00	83.05	83.86	83.53	83.08	83.00
23	75.30	79.95	75.27	82.68	83.25	83.82	83.07	83.10	83.80	83.87	83.17	82.85
24	75.54	79.95	76.15	81.44	83.15	84.00	83.14	82.91	83.80	83.77	83.01	82.77
25	75.52	80.20	74.37	81.38	82.95	83.90	83.02	82.88	83.70	83.89	83.00	82.85
26	75.86	80.20	74.30	81.05	82.95	83.82	83.05	82.90	83.60	83.88	83.09	83.07
27	76.74	80.17	75.95	81.40	83.00	83.89	82.95	82.95	83.68	83.87	84.40	83.00
28	77.37	80.15	76.92	81.79	82.98	83.57	83.00	83.00	83.01	83.83	84.25	83.13
29	77.74	78.46	77.85	82.13	83.00	83.53	83.00	82.92	83.02	84.50	84.10	82.38
30	77.92	.....	78.86	82.41	82.72	83.20	83.00	82.90	83.48	83.87	83.95	82.70
31	78.20	.....	78.60	.....	82.90	.....	82.98	83.00	.....	83.83	.....	82.87

[a] All gage heights of this station are negative (−), being below Chicago datum.
[b] Ice conditions January 1 to about March 15.
[c] Frozen December 11 to 31.

Rating table for Des Plaines River above the mouth of Jackson Creek, near Channahon, Ill., from March 14, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
84.0	4,480	82.8	5,580	81.2	7,580	78.5	11,620
83.9	4,545	82.7	5,700	81.0	7,840	78.0	12,470
83.8	4,615	82.6	5,820	80.8	8,100	77.5	13,320
83.7	4,690	82.5	5,940	80.6	8,370	77.0	14,170
83.6	4,770	82.4	6,060	80.4	8,650	76.5	15,070
83.5	4,855	82.3	6,180	80.2	8,930	76.0	15,970
83.4	4,945	82.2	6,300	80.0	9,210	75.5	16,870
83.3	5,040	82.1	6,420	79.8	9,510	75.0	17,770
83.2	5,140	82.0	6,545	79.6	9,830	74.0	19,570
83.1	5,245	81.8	6,800	79.4	10,150	73.0	21,370
83.0	5,355	81.6	7,060	79.2	10,470		
82.9	5,465	81.4	7,320	79.0	10,790		

The above table is applicable only for open-channel conditions. It is based upon 21 discharge measurements made during 1903 and 1904, inclusive. It is not well defined. All gage heights are negative, being below Chicago datum. Above gage height —77.0 feet the rating curve is a tangent, the difference being 180 per tenth.

Estimated monthly discharge of Des Plaines River above the mouth of Jackson Creek, near Channahon, Ill., for 1903 and 1904.

[Drainage area, 1,170 square miles.]

Month.	1903.			1904.		
	Discharge in second feet.			Discharge in second-feet.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
March 16 to 31	9,990	6,180	7,559	19,030	7,892	13,180
April	10,790	5,090	6,844	12,840	5,724	7,565
May	5,557	5,030	5,235	5,904	5,090	5,604
June	5,580	5,192	5,420	5,580	4,468	4,919
July	6,300	5,234	5,460	5,410	4,964	5,215
August	5,820	4,992	5,333	5,488	4,532	5,247
September	8,165	5,182	6,001	5,500	4,545	4,967
October	5,880	5,322	5,554	5,388	4,200	4,740
November	6,420	4,200	5,483	5,557	4,250	5,098
December	8,426	4,754	6,489	6,084	4,480	5,443

Miscellaneous discharge measurements of Illinois River at highway bridge, near Havana, Ill., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-ft.*
March 28	E. H. Heilbron	1,034	15,990	4.65	19.40	74,310
March 29	do	1,034	16,260	4.68	19.70	76,070
April 1	do	1,035	16,410	4.90	19.90	80,300
April 16	do	1,035	13,830	3.58	17.20	49,530
April 18	do	726	13,160	4.41	18.95	[a] 58,050
April 25	do	1,034	11,270	3.29	14.90	37,100
May 1	do	1,034	11,270	3.10	14.80	34,950

[a] Channel obstructed by drift.

ALLEGHENY RIVER DRAINAGE BASIN.

Allegheny River, which, with the Monongahela, forms the Ohio at Pittsburg, rises in northern Pennsylvania, flows north into the State of New York, then flows south through western Pennsylvania. The headwaters have an elevation of about 2,500 feet, and join those of Genesee River on the north and of the Susquehanna on the east. The total length from the source to the mouth at Pittsburg is about 300 miles, 47 of which are in the State of New York. The principal facts concerning this river have been given in a report by Mr. George M. Lehman, assistant engineer, contained in House Document No. 72, Fifty-fifth Congress, third session. Although this river drains a large area, much of which is of an elevated and even mountainous character, yet it is of comparatively small value for water power. The total fall in 255 miles between Olean, N. Y., and the mouth is only 725 feet, or an average of less than 3 feet per mile. This descent is accomplished without abrupt pitches and even with few rapids having a fall of much consequence. Between Olean and the mouth of Kiskiminitas River, 30 miles above Pittsburg, the greatest amount of natural fall on any ripple less than a thousand feet long is 3.9 in 850 feet at Pattersons Falls. During about half of the year the river is navigable for small steamers to Franklin, 123 miles above Pittsburg.

The drainage areas of the river and its chief tributaries are given in the following table:

River.	Locality.	Drainage area.
		Sq. miles.
Allegheny	Mouth	11,100
Do	Kittanning	8,700
Do	Above mouth of French Creek	5,950
Do	Franklin	5,670
Do	Warren	3,050
Do	Salamanca	1,560
Do	Olean, below Olean Creek	1,100
Do	Port Allegheny	220
Conewago Creek	Mouth	935
Tionesta Creek	do	458
French Creek	do	1,180
Clarion	do	1,175
Red Bank Creek	do	526
Mahoning Creek	do	397
Kiskiminitas	do	1,846
Do	Salina	1,770
Blacklick Creek	Blacklick	403

During 1904 the United States Geological Survey has maintained gaging stations in this basin at the following places: Allegheny River at Redhouse, N. Y.; Kittanning, Pa.; Chadakoin River at Jamestown, N. Y.; Kiskiminitas River at Salina, Pa.; Blacklick Creek at Blacklick, Pa.

ALLEGHENY RIVER AT REDHOUSE, N. Y.

This station was established September 4, 1903, by R. E. Horton, assisted by C. C. Covert. It is located at the Redhouse Bridge near the stations of the Erie and Pennsylvania railroads and about 5 miles below Salamanca, N. Y., and about 13 miles above the point where the river leaves New York State. The standard chain gage is fastened to the upstream side of the bridge near the middle of the left span. The length of the chain from the end of the weight to the marker is 24.16 feet. The gage is read twice each day by James H. Smith. Discharge measurements are made from the downstream side of the bridge. The initial point for soundings is the left end of the downstream side of the bridge. The channel is straight for 800 feet above and below the bridge. The current velocity is well distributed. The right bank is high and does not overflow. The left bank overflows only at flood stages. The bed of the stream is of gravel, and is regular.

The channel is 494 feet wide between abutments, broken by two piers. At extreme high water there is an additional flood channel on the left bank. The bench mark is a circle cut on the downstream side of the left abutment. Its elevation is 21.09 feet above the water surface when the gage reads zero.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Allegheny River at Redhouse, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 10	Horton and Mott	2,807	4.97	8.35	14,220
July 18	C. C. Covert	1,198	.99	3.68	1,188

Mean daily gage height, in feet, of Allegheny River at Redhouse, N. Y., for 1904.

Day.	Jan.[a]	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.[b]	Dec.[b]
1	.....	4.70	6.10	7.30	6.30	7.32	3.25	3.32	3.45	4.50	3.90	3.40
2	.....	4.50	6.85	8.35	5.90	6.55	3.55	3.28	3.38	4.18	3.85	3.40
3	.....	4.35	8.50	7.85	5.55	6.05	3.55	3.20	3.45	4.05	3.80	3.40
4	.....	4.00	8.68	7.28	5.25	5.55	3.40	3.20	3.70	4.00	3.72	3.40
5	.....	4.30	8.00	6.88	4.98	5.32	3.48	3.20	3.45	3.88	3.62	3.90
6	4.50	4.40	7.28	6.55	4.82	5.05	3.82	3.20	3.40	3.78	3.50	3.35
7	4.50	8.60	8.75	6.25	4.60	4.85	3.90	3.20	3.32	3.70	3.50	3.32
8	4.50	10.70	10.50	6.12	4.48	4.60	3.75	3.12	3.30	3.70	3.50	3.30
9	4.50	9.85	10.10	7.80	4.40	4.60	3.60	3.10	3.22	3.80	3.50	3.30
10	4.50	9.00	9.05	8.32	4.25	4.42	6.05	3.00	3.20	4.00	3.50	3.35
11	4.50	8.10	7.82	7.78	4.20	4.25	6.00	3.00	3.20	4.70	3.45	3.52
12	4.50	7.00	6.75	7.50	4.12	4.00	5.20	3.00	3.20	5.00	3.40	3.60
13	4.50	6.00	6.12	7.10	4.05	3.95	5.45	3.00	3.12	5.10	3.50	3.60
14	4.50	5.48	5.50	6.50	3.90	3.80	4.95	3.00	3.10	5.00	3.50	3.55
15	.....	4.90	5.12	6.00	4.05	3.80	4.40	3.00	3.10	4.70	3.45	3.50
16	4.50	4.55	4.85	5.50	4.22	3.75	4.15	3.00	3.10	4.45	3.45	3.50
17	.....	4.40	4.60	5.70	4.15	3.55	3.95	3.00	3.20	4.25	3.40	3.50
18	4.50	4.30	4.68	5.80	4.20	3.50	3.80	3.00	3.25	4.10	3.35	3.50
19	4.50	4.10	4.70	5.65	6.15	3.50	3.70	3.00	3.22	3.95	3.30	3.50
20	4.50	3.95	5.45	5.35	6.20	3.48	3.50	3.15	3.12	3.78	3.30	3.50
21	4.60	.....	5.88	5.20	5.72	3.52	3.48	3.60	3.05	3.68	3.30	3.52
22	7.00	.....	5.55	5.20	5.35	3.62	3.38	4.00	3.00	4.15	3.30	3.60
23	9.95	.....	8.25	5.00	5.15	3.80	3.30	4.35	3.00	5.10	3.30	3.62
24	9.40	4.58	8.85	4.82	5.80	3.65	3.58	4.40	3.05	5.10	3.30	5.25
25	8.95	4.38	8.98	5.22	5.90	3.48	3.45	4.15	4.20	4.90	3.30	5.75
26	8.10	4.00	11.10	5.35	5.65	3.40	3.32	3.90	4.75	4.60	3.25	5.45
27	6.90	3.95	10.70	5.20	6.60	3.28	3.30	3.90	4.70	4.60	3.40	6.05
28	6.45	3.85	9.50	5.80	6.45	3.20	3.30	4.00	4.45	4.50	3.30	8.05
29	6.10	4.10	8.20	6.30	5.78	3.20	3.68	3.70	4.15	4.30	3.20	6.90
30	5.40	.....	7.25	6.70	5.65	3.20	3.65	3.52	4.50	4.20	3.25	6.20
31	5.00	.....	6.88	.....	7.50	.....	3.45	3.45	.....	4.00	.....	5.45

[a] River frozen January 1 to 23. Ice about 1 foot thick.
[b] River frozen November 28 to December 26.

ALLEGHENY RIVER AT KITTANNING, PA.

This station, which is located at Market Street Bridge, was established August 18, 1904, by R. J. Taylor. A standard chain gage is bolted to the outside of the upstream hand rail in the first span from the left bank. The length of the chain from the end of the weight to the marker is 38.67 feet. Discharge measurements are made from the downstream foot walk of the five-span steel highway bridge to which the gage is attached. The initial point for soundings is the left end of the hand rail on the downstream side of the bridge. The channel, which is broken by four piers at the station, is straight for about 500 feet above and for 1,000 feet below. The current is swift. Both banks are high, clean, and do not overflow. The bed of the stream is composed of clean gravel, and is permanent. The water is approximately 3 to 4 feet deep in the first three channels and 6 to 8 feet deep in the last two at low stages. The gage is read twice daily by S. B. Cochrane.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Allegheny River at Kittanning, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
August 18	R. J. Taylor	620	2,615	0.82	2.40	2,140
September 19	E. C. Murphy	603	2,602	.79	2.26	2,046
September 29	N. C. Grover	720	4,010	1.77	4.42	7,087

Mean daily gage height, in feet, of Allegheny River at Kittanning, Pa., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.[b]	Day.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	.....	2.90	3.80	3.80	2.30	17	.....	2.20	4.00	(a)	2.90
2	.....	2.80	4.00	3.60	2.60	18	.....	2.40	3.70	(a)	3.00
3	.....	2.80	4.00	3.40	2.70	19	.....	2.20	3.50	(a)	3.30
4	.....	2.70	3.80	3.30	2.80	20	.....	2.20	3.30	2.50	3.20
5	.....	2.80	3.80	3.10	2.70	21	.....	2.10	3.20	2.40	3.00
6	.....	3.50	3.40	3.10	2.50	22	.....	2.00	3.30	2.40	2.90
7	.....	3.30	3.40	3.20	2.50	23	.....	2.00	3.30	2.40	2.90
8	.....	3.00	3.10	3.00	2.60	24	.....	2.00	4.30	2.30	3.40
9	.....	2.70	3.00	2.80	2.50	25	4.50	2.00	5.70	2.40	8.30
10	.....	2.70	2.80	2.80	2.30	26	3.90	2.00	6.00	2.40	7.30
11	.....	2.80	2.60	2.80	2.70	27	3.90	3.40	5.70	2.40	8.00
12	.....	2.70	3.40	2.80	2.80	28	4.10	4.60	5.10	2.30	11.90
13	.....	2.60	3.60	2.80	2.80	29	3.70	4.50	4.70	2.30	12.40
14	.....	2.40	4.30	2.70	2.90	30	3.40	4.10	4.40	2.30	10.60
15	.....	2.30	4.40	(a)	2.90	31	3.10	.....	4.10	.....	8.80
16	.....	2.20	4.10	(a)	2.90						

[a] Gage out of order. River stationary from November 15 to 19, inclusive.
[b] Reading taken to top of ice, December 12 to 31.

CHADAKOIN RIVER AT JAMESTOWN, N. Y.

Chadakoin River drains Lake Chautauqua, entering Allegheny River in Pennsylvania, through Conewango Creek. Lake Chautauqua extends in a northwest and southeasterly direction, having its head at a distance of 8 miles from Lake Erie, its water surface being at elevation 1,308 feet above sea level or 735 feet above Lake Erie. The drainage area above the foot of the lake is 190.6 square miles, of which 20.8 square miles comprises the lake surface, which represents 10.9 per cent of the drainage area. The land tributary to the lake is very rolling and the soil is impervious. Chadakoin River furnishes water power at numerous dams.

A gaging station was established on Chadakoin River April 3, 1904, by R. E. Horton. It is located at the outlet of Lake Chautauqua, near Jamestown, N. Y. The gage is read once each day by R. L. Carlson.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Chadakoin River at Jamestown, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 11	Horton and Mott	385	2.88	2.38	1,110
July 19	C. C. Covert	290	1.70	1.90	494

Daily gage height, in feet, of Chadakoin River at Jamestown, N. Y., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.20	2.40	1.90	1.90	1.50	1.20	2.00	1.70
2	.....	2.30	2.50	2.00	1.80	1.40	1.50	2.00	1.70
3	3.00	2.30	2.80	1.90	1.70	1.50	.80	2.00	1.80
4	2.95	2.20	2.40	2.00	1.60	1.50	.70	2.00	1.70
5	3.00	2.30	2.60	1.90	2.20	1.50	.80	1.80	1.70
6	2.95	2.20	2.60	2.00	2.00	1.40	.80	2.00	1.90
7	2.85	2.10	2.40	2.00	2.00	1.10	.80	1.60	1.60
8	2.85	2.10	2.40	2.00	2.10	1.10	.80	1.80	1.60
9	2.80	2.00	2.30	1.80	1.80	1.10	1.30	2.00	1.60
10	2.80	2.10	2.20	2.20	1.80	1.20	1.40	1.80	1.50
11	2.80	2.10	2.30	2.40	1.80	1.10	1.40	1.80	1.80
12	2.70	2.00	2.10	2.30	1.70	1.10	1.50	1.80	1.80
13	2.80	1.90	2.00	2.30	1.80	.90	1.50	1.90	1.50
14	2.65	1.90	2.10	2.30	2.10	1.10	1.60	1.90	1.50
15	2.60	1.80	1.90	2.20	1.70	1.20	1.40	1.80	1.40
16	2.70	2.10	2.10	2.20	1.70	1.50	1.20	1.80	1.40
17	2.60	1.90	2.00	2.10	1.90	1.30	1.20	1.80	1.50
18	2.50	2.00	2.10	2.20	1.70	1.20	1.20	1.70	1.50
19	2.70	2.10	2.10	1.90	1.40	1.20	1.20	1.70	1.50
20	2.50	2.20	2.00	1.80	1.90	1.10	1.20	1.80	1.50
21	2.40	2.20	2.20	2.20	1.80	.90	.....	1.90	1.50
22	2.40	2.08	2.30	1.80	1.90	.80	.....	1.90	1.40
23	2.30	2.10	2.20	2.20	1.80	.80	.....	2.00	1.50
24	2.20	2.30	2.00	1.80	1.80	.80	.....	2.00	1.50
25	2.30	2.20	2.10	2.00	1.80	1.50	.....	2.00	1.60
26	2.30	2.30	2.00	2.00	1.70	1.40	1.90	2.00	2.00
27	2.30	2.50	2.10	2.10	1.50	1.30	1.90	2.00	1.80
28	2.30	2.40	1.80	2.10	1.90	1.40	1.90	1.80	1.90
29	2.40	2.20	2.00	2.10	1.70	1.30	1.60	1.80	1.90
30	2.30	2.10	1.80	1.80	1.60	1.40	2.00	1.70	2.10
31	.....	2.20	.....	2.00	1.50	.....	2.00	.....	2.00

KISKIMINITAS RIVER AT SALINA, PA.

This station was established August 17, 1904, by R. J. Taylor. It is located at the highway bridge between the village at Salina, Pa., and the Pennsylvania Railroad station, and about 200 feet from the latter. A standard chain gage is bolted to the outside of the hand rail on the downstream side of the bridge. The length of the chain from the end of the weight to the marker is 36.76 feet. Bench mark No. 1 is a chisel draft on a shelf on the downstream corner of the right abutment. Its elevation is 5.77 feet above the datum of the gage. Bench mark No. 2 is a chisel draft on the top of the downstream corner of the right abutment. Its elevation is 30.39 feet above the datum of the gage. Discharge measurements are made from the downstream side of the two-span steel bridge to which the gage is attached. The initial point for soundings is the right end of the guard rail on the downstream side of the bridge. The channel is

straight for about 300 feet above and for 500 feet below the station. The current is swift. Both banks are high, rocky, clean, and are not subject to overflow. The bed of the stream is composed of rock and is clean and permanent. At low stages all the water passes beneath the right span of the bridge. Water will begin to flow beneath the left span when the gage reads about 1.50 to 1.70 feet. At such times the water in the left channel is too shallow to measure, but the velocity may be estimated very closely. The gage is read once each day by J. F. Whitesell.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Kiskiminitas River at Salina, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
August 17	R. J. Taylor	153	222	2.48	1.50	550
September 20	E. C. Murphy	144	161	1.74	1.22	281
September 30	N. C. Grover	140	132	1.32	1.07	174

Mean daily gage height, in feet, of Kiskiminitas River at Salina, Pa., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.15	1.00	1.10	0.90	17	.....	1.40	1.40	1.10	1.00
2	.....	1.15	.90	1.10	.90	18	1.70	1.40	1.22	1.12	1.00
3	.....	1.35	.90	1.05	.90	19	1.65	1.40	1.20	1.10	1.00
4	.....	1.30	.85	1.05	.88	20	1.80	1.30	1.15	1.10	1.00
5	.....	1.20	.80	1.05	.85	21	1.70	1.15	1.10	1.10	1.00
6	.....	1.25	1.00	1.02	1.00	22	1.80	1.15	1.10	1.10	1.00
7	.....	1.15	1.20	1.02	1.10	23	1.78	1.10	1.20	1.05	1.00
8	.....	1.20	1.20	1.00	1.10	24	1.70	1.00	1.55	1.05	[b]1.70
9	.....	1.25	1.20	1.10	1.10	25	1.62	1.02	1.45	1.02	[c]5.00
10	.....	1.60	1.20	1.10	1.12	26	1.60	1.02	1.45	1.02	4.40
11	.....	1.60	1.50	1.10	[a]1.00	27	1.52	1.00	1.30	1.02	5.20
12	.....	1.65	1.52	1.12	1.00	28	1.50	1.00	1.20	1.02	6.70
13	.....	1.50	1.60	1.15	1.00	29	1.38	1.00	1.20	1.00	5.25
14	.....	1.30	1.60	1.20	1.00	30	1.25	1.00	1.15	1.00	[d]8.35
15	.....	1.35	1.50	1.15	1.00	31	1.20	.....	1.15	.....	[d]8.30
16	.....	1.40	1.45	1.10	1.00						

[a] River frozen from December 11 to 24, inclusive.
[b] December 24 water running over ice.
[c] Ice gone.
[d] Ice gorge.

BLACKLICK CREEK AT BLACKLICK, PA.

This station was established August 16, 1904, by R. J. Taylor. It is located at the covered wooden highway bridge one-fourth mile from the railway station at Blacklick. A standard chain gage is spiked to the floor on the upstream side of the first span near the left bank.

The length of the chain from the end of the weight to the marker is 17.32 feet. The bench mark is a chisel draft on top of upstream corner of left-hand abutment; elevation 15.63 feet above the datum of the gage. During low water discharge measurements are made by wading just below the bridge. At high water discharge measurements are made from a coal-mine tipple crossing the stream one-fourth mile above the bridge to which the gage is attached. The channel is divided at this point by piers into three channels at both low and high water. The gage is read once each day by Mark Maynard.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Blacklick Creek at Blacklick, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
August 12	R. J. Taylor	205	242	0.26	2.02	63
September 20	E. C. Murphy	130	61	.74	1.94	45
September 30	N. C. Grover	100	37	.62	1.84	23

Mean daily gage height, in feet, of Blacklick Creek at Blacklick, Pa., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.88	1.95	2.00	2.05	17	2.18	2.15	2.22	2.15	(a)
2	.....	1.90	1.92	2.00	2.30	18	2.15	2.00	2.20	2.15	(a)
3	.....	1.92	1.85	1.98	2.25	19	2.12	2.00	2.10	2.12	(a)
4	.....	1.90	1.85	1.95	2.25	20	2.02	1.95	2.00	2.00	(a)
5	.....	1.90	1.90	1.90	2.30	21	2.20	1.90	2.25	2.00	(a)
6	.....	1.90	2.10	1.90	2.30	22	2.32	1.90	2.65	1.98	(a)
7	.....	1.90	2.15	2.00	(a)	23	2.42	1.95	2.55	1.95	(a)
8	.....	1.90	2.10	2.10	(a)	24	2.35	1.95	2.45	1.90	(b)
9	.....	2.00	2.00	2.15	(a)	25	2.25	2.00	2.30	2.00	4.20
10	.....	2.10	2.00	2.20	(a)	26	2.50	2.02	2.20	2.00	3.90
11	.....	2.25	2.35	2.25	(a)	27	2.25	2.05	2.20	2.00	6.90
12	.....	2.10	2.62	2.30	(a)	28	2.08	2.02	2.15	2.00	5.30
13	.....	2.02	2.50	2.25	(a)	29	1.98	2.00	2.10	2.00	4.30
14	.....	2.00	2.45	2.20	(a)	30	1.95	2.00	2.10	2.05	3.80
15	.....	2.20	2.30	2.20	(a)	31	1.90	.....	2.00	.....	3.70
16	.....	2.25	2.30	2.15	(a)						

a Ice. b Ice went out.

MONONGAHELA RIVER DRAINAGE BASIN.

Monongahela River is formed near Fairmont in Marion County, in the northern part of West Virginia, by the union of its West Fork with Tygarts Valley River. The headwaters of the latter stream lie on the slopes and in the valleys of the Appalachian Mountains near

the eastern boundary of West Virginia; thence they flow northward, draining a hilly and mountainous country. The West Fork has its headwaters west of those of Tygarts Valley River in the central part of West Virginia; thence they flow northerly, draining a hilly country.

The principal tributaries of Monongahela River below Fairmont are Cheat and Youghiogheny rivers, both entering from the east. Cheat River drains a rugged, mountainous district in northern West Virginia, and flows into Monongahela River near Point Marion, Pa. Youghiogheny River drains a mountainous district of Maryland and Pennsylvania, and enters the Monongahela about 15 miles above Pittsburg. The basins of all of these tributary rivers have steep slopes and collect and discharge their waters quickly, with the result that the Monongahela is liable to the excessive freshets for which it is noted. The whole basin was once heavily timbered, but has been quite thoroughly cleared except about the upper waters of the principal streams. Little water power is used in the basin. Navigation extends to Fairmont.

CHEAT RIVER NEAR MORGANTOWN, W. VA.

A cable station was established July 8, 1899, by E. G. Paul, at Uneva, about 7 miles from Morgantown, W. Va. On July 26, 1901, the cable was moved about 1 mile downstream, in order to secure a more satisfactory cross section and better facilities for observing gage heights. An inclined timber gage was established at the present station August 21, 1902. It is located 275 feet below the cable and is inclined up to 6.5 feet, above which point readings are taken on a vertical timber spiked to an ash tree. On September 28, 1904, a standard chain gage was installed by N. C. Grover on the new steel bridge, known as Ice's ferry bridge, and near the site of the first cable, and both gages have been read during the remainder of the year. They were set to read the same, and their records have checked very closely. The published record is that for the inclined gage. The channel is straight for about 800 feet above and 1,200 feet below the station. The right bank is low and liable to overflow; the left bank is high. The bed of the stream is of rocks and gravel and the current is sluggish. The bench mark is a mark on the face of a sandstone rock at the edge of the road, 20 feet downstream and 30 feet back from the gage. Its elevation above gage datum is 21.13 feet.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Cheat River near Morgantown, W. Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Sec.-feet.*
July 6	J. C. Hoyt and W. E. Hall.	300	1,226	0.63	2.60	773
September 16	R. J. Taylor	275	887	.15	2.00	136

Mean daily gage height, in feet, of Cheat River near Morgantown, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.30	3.60	6.40	6.40	6.25	3.40	3.60	2.15	1.80	1.60	2.00	2.00
2	3.25	3.00	6.80	6.50	5.85	3.45	4.00	2.25	1.85	1.85	2.00	2.05
3	[a]8.50	3.25	7.20	5.95	4.95	3.50	3.65	2.15	1.85	1.90	1.90	2.20
4	11.00	3.15	8.30	5.10	5.00	3.90	3.35	2.35	1.85	1.90	1.90	2.10
5	11.00	3.00	6.40	4.55	4.55	3.85	3.00	2.55	1.85	1.90	1.90	2.10
6	11.00	3.00	5.50	4.30	4.20	4.80	3.00	2.35	1.80	1.85	1.90	2.60
7	11.00	4.90	6.10	4.15	3.95	4.30	3.65	2.25	1.75	1.85	1.82	2.50
8	11.00	8.60	7.40	4.05	3.75	4.10	3.50	2.30	1.75	1.90	1.80	2.50
9	11.00	6.30	6.60	4.05	3.55	3.85	3.40	2.15	1.75	1.80	1.80	2.50
10	11.00	5.35	5.70	4.15	3.75	3.70	3.30	2.05	1.75	1.90	1.80	2.40
11	11.00	4.65	5.15	4.00	3.75	3.50	3.55	2.05	1.75	1.95	1.80	2.35
12	11.00	4.00	5.05	3.85	3.45	3.30	3.50	2.00	1.75	2.00	1.80	2.20
13	11.00	3.60	4.90	3.80	3.30	3.10	3.35	2.05	1.75	2.05	1.80	2.15
14	11.00	3.65	4.55	3.85	3.25	2.90	3.05	2.05	1.85	2.75	1.80	2.05
15	11.00	3.80	5.15	3.70	3.40	2.85	2.80	2.05	1.85	2.30	1.90	2.15
16	11.00	3.40	4.95	3.95	3.70	2.85	2.70	1.95	2.10	2.20	1.95	2.15
17	11.00	2.95	4.40	5.05	3.65	2.75	2.55	1.95	1.95	2.15	1.88	2.10
18	11.00	3.15	4.35	4.65	3.70	2.90	2.55	1.95	2.00	2.05	1.90	2.20
19	11.00	3.00	4.45	4.25	7.20	2.95	2.35	2.00	1.90	2.00	1.90	2.20
20	11.00	3.15	4.45	4.00	6.50	2.70	2.30	1.95	1.85	2.00	1.90	2.20
21	11.00	3.65	5.10	3.80	6.70	3.25	2.75	2.35	2.20	1.90	2.05	2.15
22	[a]21.00	5.70	5.65	3.60	6.30	4.30	3.00	2.10	2.10	2.00	2.10	2.10
23	[b]10.80	5.45	8.20	3.45	6.20	4.75	3.25	2.40	1.90	2.00	2.35	2.00
24	7.50	6.05	7.80	3.35	4.90	3.45	2.80	2.55	1.85	2.10	2.45	2.60
25	5.95	5.40	6.30	3.55	4.45	3.30	2.60	2.55	1.80	2.10	2.40	8.20
26	5.05	4.65	5.85	4.70	4.10	2.95	2.45	2.40	1.75	2.00	2.40	7.20
27	4.40	4.20	6.00	6.60	4.05	2.85	2.55	2.20	1.75	2.00	2.35	7.20
28	3.80	3.95	5.30	7.40	4.15	2.85	2.45	2.05	1.70	2.10	2.05	6.80
29	3.75	5.15	4.65	6.30	3.90	3.05	2.50	1.95	1.60	2.00	2.10	5.40
30	3.65	.....	4.30	6.05	3.70	3.80	2.35	1.85	1.60	2.00	2.00	4.20
31	3.60	.....	4.35	.....	3.55	.....	2.20	1.85	.....	2.00	.....	3.85

[a] Ice gorge January 3 to 22.

[b] Ice passed out January 23.

YOUGHIOGHENY RIVER AT FRIENDSVILLE, MD.

Youghiogheny River rises in Garrett County, Md., flows in a northwesterly direction into Pennsylvania, and is tributary to Monongahela River 15 miles above Pittsburg. Its source is on the western slope of the Allegheny Mountains, at an elevation of about 2,900 feet. The average fall of the stream for 19 miles above its mouth is about 2 feet per mile, but above this point it soon increases to an average fall of nearly 5 feet per mile. The river is liable to excessive freshets and the height of floods above low water ranges between 15 and 30 feet. The following heights of the high water of February, 1897, above low-water stage, at various points in Pennsylvania, were furnished by George M. Lehman: Whikett, 13 feet; Jacobs Creek, 10 feet; Smithton, 14 feet; Port Royal, 17 feet; Snyder, 16 feet; West Newton, 20 feet; Suterville, 22 feet; Buena Vista, 26.5 feet; Coulterville, 28.5 feet; Boston, 29 feet; McKeesport, 28.5 feet.

A measurement of the flow of Youghiogheny River was made October 13, 1892, with surface floats, at Ohiopyle, Pa., by Kenneth Allen, in connection with an investigation of a water supply for the works of the H. C. Frick Coke Company. It was during a period of extreme drought, and the discharge was found to be 106 second-feet.

The station at Friendsville, Md., was established by E. G. Paul on August 17, 1898. The standard chain gage is located on the upstream side of the right span of the bridge and is nailed to the guard rail. The length of the chain from the end of the weight to the marker is 20 feet. A United States Geological Survey bench mark consisting of an aluminum tablet disk marked "1501," is set in the foundation corner stone of the southeast corner of Friend's store; elevation 33.17 feet above the datum of the gage. The initial point for soundings is a point 15 feet back from the face of the right abutment on the upstream side of the bridge. Measurements are made from the iron highway bridge connecting the east and the west portions of the village. The channel is straight for several hundred feet above and below the bridge. The bed is rocky and the banks are high and not subject to overflow. The gage is read twice daily by J. H. Cuppet. This station was discontinued December 31, 1904.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurement of Youghioghney River at Friendsville, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
July 7.....	J. C. Hoyt and W. E. Hall.	145	344	0.46	4.30	157

Mean daily gage height, in feet, of Youghiogheny River at Friendsville, Md., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[a]
1	4.30	5.40	8.00	5.70	5.40	4.90	4.60	4.00	3.80	3.80	3.80	3.90
2	4.30	5.10	7.60	5.60	5.30	4.90	4.50	4.00	3.80	3.80	3.80	3.90
3	4.30	5.00	6.80	5.50	5.30	4.90	4.50	4.00	3.80	3.80	3.80	3.90
4	4.30	4.80	6.40	5.50	5.30	4.90	4.40	4.00	3.80	3.80	3.80	3.90
5	4.30	4.60	6.10	5.30	5.20	4.80	4.50	4.10	3.80	3.80	3.80	3.90
6	4.30	4.50	6.00	5.10	5.10	4.80	4.40	4.00	3.80	3.80	3.80	3.90
7	4.30	6.30	5.90	5.10	4.90	4.70	4.30	3.90	3.80	3.90	3.80	3.90
8	4.30	6.00	6.30	5.20	4.80	4.90	4.40	3.90	3.80	3.90	3.80	3.90
9	4.30	6.50	6.60	5.10	4.80	4.80	4.50	3.90	3.80	3.90	3.80	3.90
10	4.30	6.30	6.40	5.00	4.70	4.70	4.50	3.90	3.80	3.90	3.80	3.90
11	4.30	6.20	6.20	5.00	4.60	4.60	4.60	3.80	3.80	3.90	3.80	3.90
12	4.30	5.90	5.90	4.90	4.60	4.50	4.50	3.80	3.80	3.90	3.80	3.90
13	4.30	5.90	5.70	4.80	4.60	4.40	4.50	3.80	3.80	3.90	3.80	3.90
14	4.30	5.90	5.40	4.80	4.50	4.40	4.40	3.80	3.80	3.90	3.80	3.90
15	4.30	5.90	5.20	4.70	4.50	4.30	4.30	3.70	3.80	3.90	3.80	3.90
16	4.30	5.90	5.00	4.80	4.40	4.30	4.20	3.70	3.80	3.90	3.80	3.90
17	5.40	5.90	4.90	4.80	4.50	4.30	4.10	3.70	3.80	3.90	3.80	3.90
18	5.90	5.90	4.80	4.80	5.30	4.30	4.20	3.70	3.80	3.90	3.80	3.90
19	6.30	5.90	5.00	4.80	6.70	4.30	4.00	3.70	3.80	3.90	3.80	3.90
20	7.50	5.90	5.20	4.70	6.80	4.40	4.00	3.70	3.80	3.90	3.80	3.90
21	8.20	5.90	5.30	4.70	6.70	4.50	4.00	3.80	3.80	3.90	3.80	4.60
22	8.60	6.40	5.60	4.70	6.50	4.50	4.00	3.80	3.80	3.90	3.90	4.80
23	9.40	6.20	5.80	4.80	6.10	4.70	4.10	3.80	3.80	3.90	3.90	5.90
24	6.70	6.00	5.60	4.80	5.80	4.80	4.10	3.90	3.80	3.90	3.90	7.80
25	6.00	6.30	5.70	4.80	5.50	4.70	4.20	3.90	3.80	3.90	3.90	8.60
26	5.70	6.80	5.90	5.20	5.20	4.60	4.10	3.90	3.80	3.90	3.80	8.30
27	5.50	7.40	6.00	5.60	5.20	4.50	4.10	3.80	3.80	3.90	3.80	7.50
28	5.60	7.60	6.30	5.80	5.00	4.50	4.00	3.80	3.80	3.90	3.90	6.70
29	5.80	8.20	6.20	5.60	5.00	4.60	4.00	3.80	3.80	3.90	3.90	5.90
30	5.70	.....	6.10	5.40	5.00	4.70	4.00	3.80	3.80	3.90	3.90	5.40
31	5.50	.....	5.90	.....	5.00	.....	4.10	3.80	.....	3.90	.....	5.10

[a] Frozen during portions of January, February, and December.

Rating table for Youghiogheny River at Friendsville, Md., from January 1, 1902, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.6	12	4.4	230	5.6	1,150	6.8	2,512
3.65	18	4.5	280	5.7	1,260	6.9	2,626
3.7	25	4.6	340	5.8	1,372	7.0	2,740
3.75	35	4.7	400	5.9	1,486	7.2	2,968
3.8	45	4.8	464	6.0	1,600	7.4	3,196
3.85	55	4.9	530	6.1	1,714	7.6	3,424
3.9	65	5.0	600	6.2	1,828	7.8	3,652
3.95	77	5.1	685	6.3	1,942	8.0	3,880
4.0	90	5.2	770	6.4	2,056	8.5	4,450
4.1	120	5.3	862	6.5	2,170	9.0	5,020
4.2	150	5.4	955	6.6	2,284	9.5	5,590
4.3	185	5.5	1,050	6.7	2,398		

The above table is applicable only for open-channel conditions. Curve not well defined.

Estimated monthly discharge of Youghiogheny River at Friendsville, Md., for 1904.

[Drainage area, 295 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January [a]	5,476	185	1,159	3.93	4.53
February [a]	4,108	280	1,667	5.64	6.09
March	3,880	464	1,551	5.26	6.06
April	1,372	400	703	2.38	2.66
May	2,512	230	883	2.99	3.45
June	530	185	351	1.19	1.33
July	340	90	185	.627	.723
August	120	25	55.3	.187	.216
September	45	45	45	.153	.171
October	65	45	61.1	.207	.239
November	65	45	49.7	.168	.187
December [a]	4,564	65	802	2.72	3.14
The year	5,476	25	626	2.12	28.80

[a] January, February, and December approximate on account of ice during portions of the months.

YOUGHIOGHENY RIVER NEAR CONFLUENCE, PA.

This station was established September 15, 1904, by E. C. Murphy. It is located at the highway bridge about one-half mile from the railway station at Confluence, Pa. A standard chain gage is fastened to the downstream hand rail of the bridge. The length of the chain from the end of the weight to the marker is 23.23 feet. Bench mark No. 1 is a cross on the head of a rivet in the bedplate at the right abutment on the downstream side. Its elevation is 20.53 feet above the datum of the gage. Bench mark No. 2 is a cross on the lower chord of the bridge under the gage box. Its elevation is 20.28 feet above gage datum. Discharge measurements are made from the upstream side of the two-span steel bridge to which the gage is attached. The initial point for soundings is the center of the bridge pin over the right abutment on the upstream side of the bridge. The channel is straight for about 200 feet above and for 500 feet below the station. The current is swift. The right bank is high and does not overflow. The left bank is low, clean, and overflows during high water. The bed of the stream is rocky. There are two channels at all stages. There is a small cobble-stone dam about 4 to 6 inches high under the bridge. The gage is read once daily by L. L. Mountain.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Youghiogheny River near Confluence, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Sec.-feet.*
July 7[a]	Hoyt and Hall	235	379	1.40	.....	530
September 12	E. C. Murphy	78	64	.55	1.30	35
September 27	N. C. Grover	190	80	.54	1.37	43

[a] Measured at railroad bridge below junction of Casselman River.

Mean daily gage height, in feet, of Youghiogheny River near Confluence, Pa., for 1904.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	1.30	1.35	1.40	17	1.35	1.60	1.40	[b] 1.60
2	.....	1.30	1.35	1.40	18	1.35	1.60	1.40	(a)
3	.....	1.30	1.35	1.40	19	1.35	1.50	1.40	(a)
4	.....	1.25	1.35	1.40	20	1.35	1.45	1.40	(a)
5	.....	1.25	1.30	1.40	21	1.40	1.40	1.40	(a)
6	.....	1.25	1.30	1.40	22	1.40	1 40	1.40	(a)
7	.....	1.25	1.30	1.40	23	1.55	1.40	1.40	(a)
8	.....	1.30	1.30	1.40	24	1.55	1.40	1.40	[b] 1.90
9	.....	1.35	1.30	1.40	25	1.50	1.40	1.40	[c] 4.80
10	.....	1.35	1.35	1.40	26	1.40	1.40	1.40	4.25
11	.....	1.40	1.35	(a)	27	1.40	1.40	1.40	4.50
12	.....	1.40	1.35	(a)	28	1.35	1.35	1.40	4.90
13	.....	1.40	1.35	(a)	29	1.35	1.35	1.40	3.80
14	.....	1.70	1.35	(a)	30	1.35	1.35	1.40	3.00
15	.....	1.70	1.35	(a)	31	.....	1.35	.....	2.70
16	1.35	1.65	1.35	(a)					

[a] Frozen. [b] Hole cut in ice and gage read to surface of water. [c] Ice gone out.

CASSELMAN RIVER AT CONFLUENCE, PA.

This station was established September 15, 1904, by E. C. Murphy. It is located at the highway bridge in Confluence, Pa., about 500 yards from the railroad station. A standard chain gage is fastened to the upstream hand rail of the bridge. The length of the chain from the end of the weight to the marker is 21.41 feet. Bench mark No. 1 is a chisel draft marked with paint on the right abutment on the downstream side. Its elevation is 17.88 feet above the datum of the gage. Bench mark No. 2 is a cross on the top of the lower chord of the bridge near the gage. Its elevation is 18.61 feet above the datum of the gage. Discharge measurements are made from the upper side of the two-span steel bridge to which the gage is attached. The initial point for soundings is the center of the bridge pin over the right abutment on the upstream side. The channel is straight for 200 feet above and for 500 feet below the station. The current is swift. The right bank is high, and is not subject to overflow. The left bank

is low and overflows during extreme high water. The bed of the stream is covered with bowlders and there is some vegetation. There are two channels at all stages. The gage is read once each day by L. L. Mountain.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Casselman River at Confluence, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
July 8	Hoyt and Hall	230	279	0.80	1.65	224
September 12	E. C. Murphy	194	123	.36	1.50	44
September 27	N. C. Grover	220	107	.27	1.49	29

Mean daily gage height, in feet, of Casselman River at Confluence, Pa., for 1904.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	1.40	1.45	1.55	17	1.55	1.50	1.45	[b]1.60
2	.....	1.40	1.45	1.55	18	1.50	1.50	1.45	(a)
3	.....	1.40	1.45	1.55	19	1.45	1.45	1.45	(a)
4	.....	1.35	1.45	1.55	20	1.45	1.40	1.50	(a)
5	.....	1.35	1.40	1.55	21	1.55	1.50	1.50	(a)
6	.....	1.35	1.40	1.55	22	1.50	1.50	1.50	(a)
7	.....	1.35	1.40	1.55	23	1.45	1.50	1.50	(a)
8	.....	1.40	1.40	1.55	24	1.45	1.50	1.55	[b]1.95
9	.....	1.45	1.40	1.55	25	1.45	1.50	1.55	[c]3.35
10	.....	1.45	1.40	1.55	26	1.50	1.50	1.55	2.70
11	.....	1.50	1.40	(a)	27	1.50	1.45	1.55	2.95
12	.....	1.50	1.40	(a)	28	1.45	1.45	1.55	4.10
13	.....	1.50	1.40	(a)	29	1.45	1.45	1.55	3.00
14	.....	1.60	1.40	(a)	30	1.45	1.45	1.55	2.05
15	.....	1.60	1.40	(a)	31	.....	1.45	.....	2.15
16	1.55	1.55	1.40	(a)					

[a] Ice. [b] Hole cut in ice and gage read to surface of water. [c] Ice gone out

LAUREL HILL CREEK AT CONFLUENCE, PA.

This station was established September 15, 1904, by E. C. Murphy. It is located at the highway bridge near the tannery, about one-fourth of a mile from the railroad station at Confluence, Pa. A standard chain gage is fastened to the downstream hand rail of the bridge. The length of the chain from the end of the weight to the marker is 17.55 feet. Bench mark No. 1 is a cross on the top of a bolt in the bed plate of the bridge at the right abutment. Its elevation is 14.16 feet above the datum of the gage. Bench mark No. 2 is a cross on the lower chord of the bridge under the gage box. Its elevation is 14.74 feet above the gage datum. Discharge measurements are made from the lower side of the single-span steel bridge to which the gage is

attached. The initial point for soundings is the center of the bridge pin over the left abutment on the left side of the bridge. The channel is straight for about 25 feet above and for 300 feet below the station. The current is swift. The right bank is low, clean, and subject to overflow during high water. The left bank is high and not subject to overflow. The bed of the stream is composed of rough cobblestones and is permanent. There is one channel at all except freshet stages. The gage is read daily by L. L. Mountain.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Laurel Hill Creek at Confluence, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
July 8	Hoyt and Hall	83	156	0.80	2.14	125
September 12	E. C. Murphy	80	91	.30	1.78	27
September 27	N. C. Grover	84	84	.19	1..75	16

Mean daily gage height, in feet, of Laurel Hill Creek at Confluence, Pa., for 1904.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	1.65	1.60	1.70	17	1.80	1.70	1.70	1.80
2	.....	1.65	1.60	1.70	18	1.70	1.65	1.70	1.85
3	.....	1.60	1.60	1.70	19	1.65	1.60	1.70	1.85
4	.....	1.60	1.60	1.70	20	1.65	1.60	1.70	1.85
5	.....	1.60	1.60	1.70	21	1.70	1.60	1.70	1.85
6	.....	1.60	1.60	1.70	22	1.70	1.60	1.70	1.85
7	.....	1.60	1.65	1.70	23	1.65	1.60	1.70	1.90
8	.....	1.65	1.65	1.70	24	1.65	1.60	1.70	[b]3.00
9	.....	1.65	1.65	1.70	25	1.65	1.70	1.70	3.35
10	.....	1.65	1.65	1.70	26	1.65	1.70	1.70	2.70
11	.....	1.80	1.65	[a]1.70	27	1.75	1.65	1.70	3.40
12	.....	1.80	1.65	1.75	28	1.75	1.65	1.70	3.60
13	.....	1.80	1.65	1.75	29	1.70	1.65	1.70	3.00
14	.....	1.75	1.65	1.75	30	1.65	1.60	1.70	2.50
15	.....	1.70	1.65	1.80	31	.....	1.60	.....	2.40
16	1.80	1.70	1.65	1.80					

[a] River frozen from December 11 to 23. [b] Ice gone out.

MAHONING RIVER DRAINAGE BASIN.

Mahoning River rises in the northwestern part of Columbiana County, Ohio, flows north, then turns southeast, entering Ohio River at Beaver, in Beaver County, Pa. This river flows through a hilly and important territory. There are numerous water-power developments on it, and it forms an important adjunct in the water supply and sewage disposal of numerous towns along its course. Among

them is Youngstown, Ohio, where the United States Geological Survey station is maintained. Its drainage area at Youngstown is 958 square miles.

MAHONING RIVER AT YOUNGSTOWN, OHIO.

This station was established May 23, 1903, by R. Winthrop Pratt, and is located about 2 miles below the center of the city of Youngstown, at the highway bridge near the plant of the Hazelton Steel Company. The vertical gage, consisting of a 1-inch by 6-inch board nailed to stakes driven in the river bed 15 feet from the east abutment, was used up to September 23, 1903, at which time a standard chain gage was installed, having a length of 25.36 feet from the end of the weight to the marker. The gage is read once each day by John McVean. Discharge measurements are made from the single-span highway bridge, to which the gage is attached. The initial point for soundings is the face of the parapet wall of the east abutment on the upstream side. The channel is straight for about 800 feet above and 200 feet below the bridge and is 200 feet wide between abutments. Both banks are high and are subject to overflow only at high water. The section is fairly regular and the bed of the stream is composed of gravel and small bowlders, probably not subject to change.

Bench mark No. 1 is the top of the copper plate on the face of the east abutment near the upstream corner. It is 9.37 feet above gage datum. Bench mark No. 2 is the northwest corner of the bridge seat of the west abutment. It is 17.12 feet above gage datum. Bench mark No. 3 is a cut in the end stone of the second tier from the top of the north wing wall of the west abutment. It is 21.34 feet above gage datum. Bench mark No. 4 is a cut in the top hand rail at a point 35 feet from the east abutment on the upstream side. It is 25.88 feet above gage datum. The elevation of the center of the pulley on which the chain of the gage runs is 23.61 feet above gage datum.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Mahoning River at Youngstown, Ohio, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
January 27	R. W. Pratt	162	654	2.16	2.50	1,413
March 8	do	192	1,624	4.50	7.80	7,322
April 16	do	152	503	1.38	1.86	694
May 18	do	144	393	.56	1.07	219
July 26	do	150	361	.45	.80	164
August 24	do	155	437	1.04	1.35	455
September 15	do	135	335	.21	.65	66
November 3	do	153	360	.30	.74	108

Mean daily gage height, in feet, of Mahoning River at Youngstown, Ohio, for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.30	10.00	13.00	5.40	9.00	0.60	0.96	0.88	0.53	0.71	0.67
2	1.05	1.20	10.00	12.60	4.10	11.40	.80	.77	.65	.43	.70	.66
3	.90	1.00	9.80	7.00	3.00	10.10	.80	.81	.62	.35	.72	.64
4	.85	1.10	9.10	3.10	2.50	4.70	.80	.71	.60	.35	.71	.68
5	.70	1.20	8.80	2.50	1.90	2.90	1.10	.78	.58	.61	.68	.68
6	.70	1.30	5.20	2.20	1.60	2.20	1.30	.70	.82	.65	.59	.70
7	.70	7.20	5.70	2.20	1.40	1.80	2.40	.76	.75	.61	.59	.78
8	.85	10.10	7.90	2.10	1.30	1.50	2.60	.72	.65	.45	.67	.65
9	.80	10.00	5.70	2.70	1.30	1.40	2.20	.68	.80	.34	.67	.50
10	.70	5.50	4.00	3.40	1.20	1.40	1.90	.67	.68	.52	.70	.60
11	.70	3.50	2.80	2.70	1.10	1.30	1.40	.78	.60	.55	.75	.60
12	.80	2.20	2.50	2.40	1.10	1.20	1.40	.76	.72	.66	.70	.52
13	.80	1.90	2.00	2.20	1.00	1.10	1.30	.75	.80	.62	.55	.58
14	.90	1.50	1.90	2.10	1.00	1.00	1.20	.78	.82	.59	.80	.72
15	.80	1.30	1.70	1.90	1.10	1.00	1.20	.77	.66	.55	.71	.70
16	.70	1.30	1.60	1.80	1.00	.90	1.20	.75	.61	.55	.70	.71
17	.90	1.00	1.50	1.70	1.10	.90	1.10	.71	.62	.65	.70	.60
18	.80	.90	2.70	1.70	1.20	.70	1.00	.69	.44	.61	.75	.40
19	.90	.90	4.40	1.60	3.10	.70	.80	.70	.65	.70	.50	.48
20	1.20	.80	4.70	1.50	4.50	.90	.80	.98	.68	.50	.71	.50
21	4.30	1.00	4.40	1.40	3.30	1.10	.80	.94	.62	.58	.73	.45
22	14.15	1.60	3.40	1.30	2.20	1.40	.70	1.00	.52	.80	.71	.50
23	17.45	1.80	5.40	1.20	1.90	1.40	.70	1.40	.50	.51	.55	.63
24	15.00	2.40	4.90	1.20	4.50	1.30	.60	1.25	.53	.55	.64	.70
25	9.70	1.90	3.50	1.50	4.70	1.10	.60	1.17	.46	.55	.62	1.00
26	4.50	1.50	9.20	2.50	5.50	.80	.70	2.05	.72	.57	.50	1.40
27	3.60	1.90	10.20	3.70	10.10	.80	.85	2.25	.50	.56	.50	2.48
28	2.50	.90	8.30	3.90	8.70	.70	.87	1.52	.58	.72	.62	3.20
29	2.30	1.00	5.40	4.80	4.40	.70	.90	1.15	.45	.81	.64	1.81
30	2.00	.....	3.50	7.10	2.80	.60	.69	1.02	.41	.60	.65	1.80
31	1.50	.....	3.50	.....	3.30	.....	.61	.93	.....	.64	.....	1.82

[a] Ice conditions January and February.

Rating table for Mahoning River at Youngstown, Ohio, from May 23, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.5	8	1.9	750	3.6	2,010	8.5	9,100
.6	52	2.0	810	3.8	2,190	9.0	10,120
.7	98	2.1	880	4.0	2,390	9.5	11,170
.8	146	2.2	950	4.2	2,610	10.0	12,240
.9	195	2.3	1,020	4.4	2,830	10.5	13,400
1.0	245	2.4	1,090	4.6	3,070	11.0	14,600
1.1	295	2.5	1,160	4.8	3,310	11.5	15,800
1.2	345	2.6	1,230	5.0	3,550	12.0	17,000
1.3	395	2.7	1,300	5.5	4,200	13.0	19,400
1.4	450	2.8	1,370	6.0	4,870	14.0	21,800
1.5	510	2.9	1,450	6.5	5,620	15.0	24,200
1.6	570	3.0	1,530	7.0	6,420		
1.7	630	3.2	1,690	7.5	7,270		
1.8	690	3.4	1,850	8.0	8,140		

The foregoing table is applicable only for open-channel conditions. It is based upon 15 discharge measurements made during 1903 and 1904. It is well defined between gage heights 0.9 foot and 2 feet. The table has been extended beyond these limits. The curve is very unsatisfactory below 0.9 foot gage height. This is probably due to the dam below this station; at low stages the water may even fall below the crest of the dam. Above gage height 10.4 feet the rating curve is a tangent, the difference being 240 per tenth.

Estimated monthly discharge of Mahoning River at Youngstown, Ohio, for 1904.

[Drainage area, 958 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March	12,700	510	4,726	4.93	5.68
April	19,400	345	2,615	2.73	3.05
May	12,470	245	1,959	2.04	2.35
June	15,560	52	1,686	1.76	1.96
July	1,230	52	310	.324	.374
August	985	84	236	.246	.284
September	185	1	70.2	.073	.081
October	151	0	47.3	.049	.056
November	146	8	79.6	.083	.093
December	1,690	0	228	.238	.274

MUSKINGUM RIVER DRAINAGE BASIN.

Muskingum River is formed by the junction of Walhonding and Tuscarawas rivers in the east-central part of Ohio, flows south, and enters Ohio River at Marietta, Ohio. In this drainage basin the United States Geological Survey operates a station on Licking River at Pleasant Valley, Ohio.

LICKING RIVER AT PLEASANT VALLEY, OHIO.

This station was established November 14, 1902, by Benjamin H. Flynn. It is located at the highway bridge, 300 feet north of the railroad station at Pleasant Valley, Ohio. A standard chain gage is attached to the bridge. The length of the chain from the end of the weight to the marker is 20.93 feet. The gage is read once each day by A. B. Lebold. Low-water measurements are made by wading, and high-water measurements from the bridge to which the gage is attached. The channel is straight for 200 feet above and 500 feet below the station. The banks are high and not liable to overflow, except in extreme floods. The bed of the stream is composed of gravel and clay. Bench mark No. 1 is three copper nails driven into a willow tree about 400 feet to the right of the right end of the bridge, arranged in a vertical position, and having elevations respectively 14.92, 15.92, and 16.92 feet above the datum of the gage. Bench mark No. 2 is a nail driven into the outside guard timber near the gage box and has an elevation of 21.52 feet above the datum of the gage.

The drainage area at Pleasant Valley is 696 square miles. Licking River flows into the Muskingum at Zanesville, Ohio.

Discharge measurements of Licking River at Pleasant Valley, Ohio, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 7	R. W. Pratt	66	249	1.65	2.61	412
May 23	do	61	204	1.59	2.32	324
June 27 [a]	do	74	53	3.31	1.74	176
July 2 [a]	do	95	77	2.17	1.75	167
July 16	do	177	176	2.40	2.90	422
August 27	do	65	61	2.68	1.87	163
September 24 [a]	do	53	36	2.00	1.54	72
October 29 [a]	do	71	61	2.75	2.00	168
November 26 [a]	do	53	35	2.23	1.56	78

[a] Wading.

Mean daily gage height, in feet, of Licking River at Pleasant Valley, Ohio., for 1994.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	2.80	3.40	4.90	10.80	4.10	9.00	1.80	2.00	1.80	1.55	2.05	1.50
2	2.70	3.20	4.10	13.50	3.80	5.80	1.80	2.20	1.90	1.55	2.05	1.50
3	2.40	3.00	5.30	7.00	3.50	4.40	1.70	2.10	1.80	1.50	2.10	1.50
4	2.20	2.90	7.70	5.20	3.30	3.50	1.70	2.00	1.80	1.50	2.10	1.50
5	2.30	2.90	4.10	4.30	3.10	3.00	1.70	1.90	1.80	1.50	2.10	1.50
6	2.30	3.00	3.30	4.20	2.90	2.70	1.70	1.90	1.70	1.75	2.10	1.55
7	2.40	4.70	7.10	3.90	2.80	2.50	9.20	1.80	1.70	1.65	1.90	1.55
8	2.40	8.90	6.50	3.70	2.60	2.40	14.80	1.80	1.70	1.60	1.80	1.55
9	2.50	5.40	4.90	3.80	2.50	2.30	6.80	1.80	1.70	1.60	1.60	1.55
10	2.50	4.00	3.80	3.70	2.40	2.20	5.30	1.80	1.60	1.70	1.60	1.60
11	2.50	3.20	3.50	3.50	2.30	2.20	4.30	1.80	1.60	2.55	1.60	.....
12	2.40	2.90	3.30	3.50	2.30	2.10	3.90	1.70	1.60	2.05	1.60	.....
13	2.40	2.80	3.30	3.40	2.20	2.00	4.60	1.70	1.60	1.90	1.60	.....
14	2.30	2.70	3.10	3.30	2.20	2.00	4.00	1.70	1.60	1.80	1.60	.....
15	2.30	2.60	3.70	3.20	2.20	1.90	3.30	1.70	1.60	1.75	1.55	.....
16	2.30	2.60	3.30	3.10	2.20	1.90	3.00	1.70	1.60	1.70	1.55	1.70
17	2.30	2.60	3.40	2.90	2.20	2.00	2.80	1.90	1.60	1.65	1.55	.....
18	2.40	2.50	3.50	2.80	2.20	1.90	2.60	1.80	1.60	1.60	1.55	.....
19	2.40	2.40	4.90	2.60	2.30	1.90	2.50	1.80	1.60	1.60	1.55	.....
20	2.50	2.40	4.00	2.50	2.30	2.00	2.40	1.80	1.60	1.60	1.55	.....
21	2.60	2.30	3.60	2.50	2.30	2.00	2.30	1.80	1.60	1.60	1.55	.....
22	14.25	8.70	3.80	2.50	2.20	2.60	2.30	1.80	1.60	1.60	1.55	.....
23	13.20	6.90	5.30	2.40	2.20	2.30	2.20	1.80	1.60	1.60	1.55	1.75
24	7.80	8.70	5.00	2.40	2.40	2.00	2.20	1.80	1.60	1.60	1.55	2.40
25	4.80	5.40	3.90	2.40	2.30	1.90	2.10	1.70	1.60	1.55	1.55	2.75
26	4.60	3.80	7.50	5.20	2.70	1.80	2.00	2.70	1.60	1.55	1.55	2.60
27	4.50	3.60	12.20	6.10	2.50	1.80	2.00	2.00	1.60	1.60	1.50	5.80
28	4.50	3.60	6.40	5.30	2.30	1.70	2.00	1.80	1.60	1.80	1.50	5.40
29	4.40	3.50	4.80	5.40	2.10	1.90	3.70	1.80	1.55	2.00	1.50	3.30
30	4.00	.....	4.20	4.70	2.20	1.90	2.30	1.80	1.55	2.00	1.50	3.00
31	3.70	.....	6.60	.....	2.60	.....	2.10	1.70	.....	2.00	.....	2.80

[a] Ice conditions January and February. [b] River frozen December 10 to 25.

Rating table for Licking River at Pleasant Valley, Ohio, from November 14, 1902, to July 9, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.2	72	2.5	375	3.8	935	6.5	2,610
1.3	77	2.6	412	3.9	985	7.0	2,960
1.4	86	2.7	450	4.0	1,035	7.5	3,310
1.5	99	2.8	490	4.2	1,140	8.0	3,660
1.6	116	2.9	530	4.4	1,250	9.0	4,360
1.7	136	3.0	570	4.6	1,360	10.0	5,060
1.8	159	3.1	610	4.8	1,480	11.0	5,760
1.9	184	3.2	655	5.0	1,600	12.0	6,460
2.0	211	3.3	700	5.2	1,725	13.0	7,160
2.1	240	3.4	745	5.4	1,855	14.0	7,860
2.2	271	3.5	790	5.6	1,985		
2.3	304	3.6	835	5.8	2,120		
2.4	339	3.7	885	6.0	2,260		

The above table is applicable only for open-channel conditions. It is based upon 9 discharge measurements made during 1902 to 1904, inclusive.

The channel changed during flood July 7 to 9, 1904. After this date use the following table.

Rating table for Licking River at Pleasant Valley, Ohio, from July 10 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.4	54	2.2	230	3.0	510	3.8	860
1.5	66	2.3	260	3.1	550	3.9	910
1.6	81	2.4	290	3.2	590	4.0	960
1.7	99	2.5	320	3.3	630	4.2	1,080
1.8	120	2.6	350	3.4	670	4.4	1,200
1.9	143	2.7	390	3.5	710	4.6	1,320
2.0	170	2.8	430	3.6	760	4.8	1,440
2.1	200	2.9	470	3.7	810	5.0	1,560

The above table is applicable only for open-channel conditions. It is based upon 5 discharge measurements made during 1904. It is well defined between gage heights 1.25 feet and 3 feet. The table has been extended beyond these limits. Above gage height 5 feet the rating curve is a tangent, the difference being 70 per tenth.

Estimated monthly discharge of Licking River at Pleasant Valley, Ohio, for 1904.

[Drainage area, 696 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March	6,600	610	1,618	2.32	2.68
April	7,510	339	1,361	1.96	2.19
May	1,085	240	408	.586	.676
June	4,360	136	502	.721	.804
July	8,440	136	913	1.31	1.51
August	390	99	137	.197	.227
September	143	74	90.2	.130	.145
October	335	66	107	.154	.178
November	194	66	102	.147	.164
December[a]	2,120	66	277	.398	.459

[a] December estimates assumed same as open channel.

KANAWHA RIVER DRAINAGE BASIN.

Kanawha River, which rises in Watauga, Ashe, and Alleghany counties, N. C., flows northwesterly through Virginia and West Virginia, and joins Ohio River at Point Pleasant, W. Va. In its upper course it is known as New River. The headwaters lie in the Appalachian Mountains, among the high ridges which form the divides between

the drainage basin of this river and Yadkin River on the east, and of Holston River on the west. The upper tributaries drain narrow valleys of the mountainous region of North Carolina and their slopes are generally steep and their beds are rough. The main river cuts the Alleghany fronts just below Pearisburg, Va.; thence the river's course is through a narrow valley of West Virginia, over a rough bed with many falls and rapids. The basin is as beautiful and picturesque as any in the eastern part of the United States. The country on its lower courses, through which the Cheasapeake and Ohio Railway passes, is noted for its scenic beauty. Below the junction with the Gauley the river is known as the Kanawha.

The principal tributaries of New River are Little River, which empties near Radford, Va., and the Greenbrier, which rises in the eastern part of West Virginia and joins the New at Hinton, W. Va. The following is a list of the stations maintained during 1904 in this drainage basin by the United States Geological Survey: New River at Fayette, W. Va.; Greenbrier River at Alderson, W. Va.; New River at Radford, Va.

NEW RIVER AT RADFORD, VA.

This station is located at the highway bridge near the Norfolk and Western Railway station, and was established by D. C. Humphreys August 1, 1898. The gage used at first was erected by the United States Weather Bureau. It consists of a vertical board graduated to feet and tenths, and is attached to the iron framework connecting the pair of iron concrete cylinders, which form the first pier from the right bank. On account of the inaccessibility of the Weather Bureau gage, a wire gage was put in February 23, 1900, the datum being the same as that of the old gage. On December 1, 1903, the old wire gage was replaced by a standard chain gage, which was installed by W. C. Sawyer. At this time the gage datum was lowered 3.41 feet. The length of the chain from the end of the weight to the marker is 87 feet. The observer is T. M. Brady, saddler and harness dealer, who reads the gage twice daily. The channel is straight for several hundred feet above and below the station and has a width of 580 feet at ordinary stages, broken by five piers. At high water its width is about 1,200 feet. The bottom is of solid rock and gravel and is smooth and regular. On the left bank there is a steep, rocky bluff. The right bank is low and subject to overflow for about 100 yards, but all the water must pass under the bridge, which is about 85 feet above low water. The discharge measurements are made from the upstream side of the bridge. The initial point for soundings is on the right bank of the river, 50 feet from the first pier.

The bench marks described below are all referred to the datum of the chain gage. Bench mark No. 1 is the bottom of the lowest horizontal brace connecting the two cylinders; elevation, 7.28 feet. Bench

mark No. 2 is the top of the lowest horizontal brace on the west side of the bridge, 2.5 feet south of the northwest post of the bent nearest the river on the right bank; elevation, 22.66 feet. Bench mark No. 3 is the northwest corner of the top of the stone under the seventh post from the right bank; elevation, 18.58 feet.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of New River at Radford, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
June 18	F. H. Brundage	530	1,833	1.87	4.07	3,436
September 16	R. H. Bolster	520	1,411	1.10	3.40	1,553
September 29	do	520	1,330	.88	3.24	1,177
October 18	do	518	1,280	.75	3.14	954

Mean daily gage height, in feet, of New River at Radford, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.50	3.40	4.20	4.10	4.00	4.80	4.70	3.70	3.30	3.20	3.10	3.20
2	3.70	3.60	4.30	4.00	3.80	6.50	4.30	4.00	3.70	3.10	3.10	3.20
3	3.60	3.50	4.20	4.00	3.70	5.70	4.10	4.30	3.80	3.10	3.20	3.20
4	3.40	3.60	4.20	4.00	3.70	2.90	3.90	4.40	3.80	3.10	3.20	3.40
5	3.40	3.70	4.20	3.90	4.50	2.90	4.00	4.30	3.60	3.10	3.20	3.40
6	3.30	3.70	4.10	3.90	4.40	3.30	4.10	4.60	3.50	3.10	3.30	3.70
7	3.30	4.00	4.00	3.90	4.10	4.10	4.10	4.00	3.30	3.10	3.60	4.10
8	3.40	4.80	7.40	3.80	4.00	4.20	3.90	3.90	3.30	3.10	3.40	3.70
9	3.40	4.80	5.50	3.80	4.00	4.30	3.80	4.10	3.40	3.10	3.30	3.60
10	3.40	4.50	5.00	4.20	5.50	4.00	4.00	4.20	3.30	3.10	3.20	3.50
11	3.40	4.20	4.60	4.10	4.80	3.80	4.30	4.70	3.30	3.10	3.10	3.50
12	3.50	3.50	4.40	4.00	4.40	4.00	4.00	4.60	3.30	3.10	3.10	3.50
13	3.50	3.50	4.40	4.00	4.10	4.20	3.80	4.20	3.30	3.00	3.50	3.40
14	3.50	3.20	4.30	3.90	3.90	4.00	3.60	4.00	3.30	3.00	3.70	3.40
15	3.50	3.50	4.20	4.00	3.90	3.80	3.60	3.90	3.30	3.00	3.60	3.30
16	3.50	3.60	4.00	3.80	4.10	4.30	3.60	3.90	3.30	3.00	3.50	3.20
17	3.40	3.80	3.80	3.70	4.10	4.00	3.50	3.90	3.30	3.00	3.50	3.20
18	3.40	3.80	3.80	3.70	4.20	4.00	3.50	3.80	3.30	3.00	3.40	3.40
19	3.40	3.70	3.30	3.60	6.30	4.00	3.40	3.70	3.30	3.00	3.40	3.20
20	3.50	3.30	3.70	3.60	5.20	4.50	3.40	3.60	3.30	3.00	3.40	3.10
21	3.50	3.50	3.70	3.50	4.90	4.10	3.30	3.60	3.20	3.00	3.30	3.10
22	3.80	4.50	3.70	3.50	4.70	3.90	3.30	3.60	3.20	3.00	3.30	3.10
23	5.40	5.30	3.60	3.50	4.50	3.80	3.50	3.70	3.20	3.00	3.20	3.10
24	4.80	4.90	3.90	3.50	4.30	3.70	3.60	3.60	3.20	3.00	3.20	3.30
25	4.30	4.40	4.90	3.50	3.90	3.60	3.70	3.50	3.20	3.00	3.20	3.50
26	3.80	3.90	4.70	3.50	4.00	3.70	3.80	3.50	3.20	3.10	3.20	3.60
27	3.60	3.90	4.70	3.70	4.00	3.90	3.80	3.50	3.20	3.10	3.20	3.50
28	3.40	3.80	4.60	3.90	3.90	3.70	3.90	3.50	3.20	3.10	3.20	3.60
29	3.20	4.10	4.40	4.00	3.80	5.90	4.00	3.40	3.20	3.10	3.20	3.50
30	2.90	.....	4.20	3.90	3.60	5.40	4.50	3.40	3.20	3.10	3.20	3.40
31	3.10	.....	4.00	.....	3.60	.....	4.10	3.30	.....	3.10	.....	3.30

Rating table for New River at Radford, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.0	690	4.0	3,220	5.0	6,830	6.0	11,500
3.1	895	4.1	3,540	5.1	7,245	6.2	12,550
3.2	1,105	4.2	3,870	5.2	7,670	6.4	13,610
3.3	1,325	4.3	4,205	5.3	8,110	6.6	14,690
3.4	1,555	4.4	4,550	5.4	8,560	6.8	15,790
3.5	1,800	4.5	4,905	5.5	9,020	7.0	16,910
3.6	2,055	4.6	5,270	5.6	9,490	7.2	18,050
3.7	2,325	4.7	5,645	5.7	9,975	7.4	19,200
3.8	2,610	4.8	6,030	5.8	10,470		
3.9	2,910	4.9	6,425	5.9	10,980		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1898 to 1904, inclusive, special weight being given to 1904 measurements. It is well defined between gage heights 3 feet and 4.1 feet.

Estimated monthly discharge of New River at Radford, Va., for 1904.

[Drainage area, 2,725 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	8,560	485	2,114	0.776	0.895
February	8,110	1,105	3,150	1.16	1.25
March	19,200	1,325	4,525	1.66	1.91
April	3,870	1,800	2,689	.987	1.10
May	13,080	2,055	4,217	1.55	1.79
June	14,150	485	4,071	1.49	1.66
July	5,645	1,325	2,802	1.03	1.19
August	5,645	1,325	2,941	1.08	1.24
September	2,610	1,105	1,418	.520	.580
October	1,105	690	816	.299	.345
November	2,325	895	1,340	.492	.549
December	3,540	895	1,570	.576	.664
The year	19,200	485	2,638	.968	13.17

NEW RIVER AT FAYETTE, W. VA.

This station, established by C. C. Babb and D. C. Humphreys July 29, 1895, is located just below the mouth of Wolf Creek, on the highway bridge of one span at Fayette, W. Va. The wire gage was located on the guard rail on the upper side of the bridge, about the middle of the span, the scale being graduated to feet and tenths. The gage is referred to four bench marks: First, the top of the bottom plate of the lower plate girder at the end of the first panel from the right bank, downstream side, 55.13 feet above the zero of the gage; second, the

top of the lower end of the coping on the main pier, right bank, downstream side, 52.08 feet above the zero of the gage; third, the bridge seat on the right bank, downstream side, 54.54 feet above the zero of the gage; fourth, the west corner of the abutment stone by the Chesapeake and Ohio Railway station, 58.56 feet above the zero of the gage. A temporary bench mark, established when the chain gage was installed, is the top of the bottom plate of the plate girder 0.5 foot south of the gage box. Its elevation is 52.57 feet above gage datum. The channel is straight above and below the station. The current is swift and without obstructions, except for immense bowlders in the bottom. The banks are high, rocky, and not subject to overflow. The bed is constant in section. The observer is J. R. Durrett, a clerk in the store at Fayette, W. Va. The station was discontinued May 22, 1901. On August 11, 1902, it was reestablished. On November 20, 1903, a standard chain gage was installed by W. C. Sawyer. It occupies the same position as the old wire gage, which it replaced, and it has the same datum. The length of the chain from the end of the weight to the marker is 59 feet. The station was discontinued December 31, 1904.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Mean daily gage height, in feet, of New River at Fayette, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.60	1.20	8.00	4.20	7.20	3.80	8.33	2.59	0.55	−0.08	−0.31	0.05
2	1.90	1.10	9.50	4.80	6.10	5.00	7.17	1.81	.75	− .12	− .25	.05
3	1.90	1.60	8.20	5.30	5.20	9.30	4.65	1.60	.75	− .19	− .23	.10
4	1.90	1.50	7.50	4.80	4.70	9.50	4.04	3.12	1.60	− .27	− .04	.15
5	1.80	2.00	7.00	4.20	5.00	7.40	3.42	2.70	2.25	− .35	− .04	.25
6	1.90	2.40	6.10	3.70	4.50	5.90	3.01	3.40	1.75	(a)	− .06	1.00
7	1.90	2.60	5.90	3.60	5.10	4.90	3.65	2.55	1.50	− .41	.05	1.88
8	1.60	4.40	10.00	3.40	4.50	4.30	3.10	3.41	1.10	− .50	.68	2.70
9	1.40	8.00	12.20	3.40	4.00	4.00	3.30	2.30	.55	− .54	.86	2.69
10	1.00	7.00	9.20	3.40	4.00	4.10	2.86	2.20	.65	− .41	.59	2.03
11	1.30	5.00	7.30	4.10	4.80	4.20	3.66	2.30	.65	− .45	.31	1.85
12	1.30	3.70	6.40	3.80	5.20	4.00	3.97	2.40	.40	− .45	.11	1.66
13	1.40	2.80	(a)	3.70	4.30	3.70	3.33	3.56	.52	− .37	.09	1.36
14	1.20	2.10	5.70	3.50	3.80	4.40	2.55	3.16	.40	− .27	.24	.77
15	1.10	2.30	5.30	3.50	3.40	3.40	2.15	2.55	.32	− .37	.32	.73
16	.90	1.70	5.20	3.60	3.30	(a)	1.60	2.10	.38	− .29	.60	.70
17	.80	1.60	4.90	3.50	3.40	3.07	1.50	1.95	.40	− .37	1.23	.00
18	.70	1.60	4.40	3.40	3.80	3.11	1.45	1.56	.35	− .42	.99	1.11
19	.70	1.70	4.00	3.30	8.30	3.05	1.27	2.35	.35	− .42	.75	.55
20	1.00	1.70	4.00	3.10	13.30	3.10	1.02	2.00	.25	− .46	.57	.91
21	1.70	2.30	3.80	3.00	10.10	3.68	.86	2.00	.17	− .14	.44	.95
22	2.00	5.10	3.70	2.70	(a)	3.50	.81	1.75	.04	− .37	.46	.85
23	5.30	10.50	5.00	2.50	6.60	3.10	.60	1.55	.00	− .42	.50	.73
24	9.90	9.20	7.30	2.50	6.10	2.82	1.27	1.55	.00	− .21	.39	.80
25	7.40	7.80	7.30	2.50	6.80	2.50	1.01	1.45	−.04	− .37	.35	1.12
26	5.50	6.40	7.60	2.80	6.20	2.05	1.45	1.20	−.05	− .37	.40	1.15
27	4.00	5.10	6.90	5.30	5.80	1.99	1.72	1.05	−.06	− .37	.25	(a)
28	2.80	4.80	6.30	10.30	5.40	3.56	1.90	.85	−.15	− .17	.30	3.22
29	2.20	6.00	5.80	10.30	4.50	6.10	2.17	.75	−.08	− .33	.25	2.98
30	1.70	.....	5.10	8.60	4.00	6.15	2.30	.65	−.06	− .20	.08	2.72
31	1.40	.....	4.60	.....	3.90	.....	3.36	.50	.....	− .29	.....	2.37

a Observer absent.

Estimated monthly discharge of New River at Fayette, W. Va., for 1904.

[Drainage area, 6,200 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	22,800	1,755	4,519	0.729	0.840
February	24,600	2,190	7,790	1.26	1.36
March	29,700	6,806	13,340	2.15	2.48
April	24,000	4,479	8,229	1.33	1.48
May	33,000	6,021	11,070	1.79	2.06
June	21,600	3,566	8,321	1.34	1.50
July	18,090	1,665	5,133	.828	.955
August	6,530	1,580	3,746	.604	.696
September	4,022	1,155	1,698	.274	.306
October	1,192	984	1,070	.173	.200
November	2,362	1,075	1,484	.239	.267
December	5,866	1,240	2,646	.427	.492
The year	33,000	984	5,754	.929	12.64

NOTE.—The above estimate can only be considered as approximate. It is based upon the 1902 rating table with some modification below 2 feet gage height.

GREENBRIER RIVER AT ALDERSON, W. VA.

Greenbrier River rises on the western slope of the Allegheny Mountains, in Pocahontas County, W. Va., and flows in a southwesterly direction, emptying into New River near Hinton, Summers County, W. Va. It receives many short tributaries from the Allegheny Range, and flows for the most part through a broken, hilly, and mountainous country well covered with forests. This station, which is 21 miles above Hinton, was established by C. C. Babb and D. C. Humphreys August 1, 1895. It is located one-half mile above the mouth of Muddy Creek, at the highway bridge in the village of Alderson. The wire gage which was originally installed was located in the third panel of the second span, downstream side of the bridge. This gage was referred to three bench marks: The first, on the upper end of the coping of the first pier from the left bank, 21.74 feet above gage datum; the second, on the upper end of the bridge seat of the left-bank abutment, 21.61 feet above gage datum; the third, on the stone foundation of the water tank of the Chesapeake and Ohio Railway, 23.48 feet above gage datum. A temporary bench mark has been established on the lower end of the third floor beam, in the second span from the left bank. Its elevation is 22.72 feet above gage datum. On November

20, 1903, a standard chain gage was installed by W. C. Sawyer. It occupies the same position as the wire gage which it replaced, and its datum is the same. The length of the chain from the end of the weight to the marker is 27.81 feet. A new bench mark, to which this gage is referred, is the top of the water table at the northwest corner of the Merchants' Grocery Company building. Its elevation is 21.71 feet above gage datum. The channel, which is straight for 500 feet above and below the station, is broken at the bridge by three piers. At low stages the water flows in two channels, between which is an island 600 feet long and 75 feet wide. The initial point for soundings is the center of the pin on the downstream side of the bridge, on the left bank. The banks are high and not subject to overflow. The bed is of rock and gravel and fairly constant. The observer is W. J. Hancock, merchant at Alderson, W. Va., who reads the gage once daily.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Greenbrier River at Alderson, W. Va., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per. sec.*	*Feet.*	*Second-ft.*
June 15	F. H. Brundage	390	1.26	2.20	490
August 9	N. C. Grover	256	.57	1.72	146
September 20	R. H. Bolster	251	.45	1.63	114
October 1	do	196	.26	1.44	51
October 20	do	217	.35	1.51	76

Mean daily gage height, in feet, of Greenbrier River at Alderson, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.88	2.35	4.65	3.30	3.90	3.00	2.70	1.75	1.55	1.40	1.60	1.60
2	1.90	2.42	5.60	4.20	3.60	3.60	2.50	1.70	1.60	1.40	1.55	1.60
3	2.27	2.20	4.70	4.10	3.40	4.40	2.35	1.60	1.55	1.40	1.45	1.60
4	2.67	1.98	4.40	3.70	3.60	5.25	2.25	1.60	1.55	1.40	1.50	1.60
5	2.93	2.10	3.45	3.35	3.80	3.75	2.25	1.70	1.55	1.40	1.55	1.65
6	2.60	1.90	3.65	3.10	3.10	3.15	2.25	1.75	1.55	1.40	1.50	1.70
7	2.32	2.20	3.40	3.00	3.00	3.00	2.20	1.80	1.55	1.45	1.40	1.90
8	2.20	5.25	6.10	2.95	2.90	2.85	2.20	1.80	1.55	1.50	1.50	1.95
9	2.22	4.50	5.30	2.95	2.80	2.75	2.20	1.70	1.55	1.60	1.45	1.85
10	2.20	3.60	4.35	3.00	2.75	2.65	2.15	1.70	1.55	1.55	1.40	1.75
11	2.10	3.20	3.70	3.00	2.65	2.60	2.10	1.70	1.55	1.60	1.40	1.70
12	2.03	2.80	3.50	3.00	2.65	2.50	2.20	1.75	1.55	1.50	1.50	1.65
13	2.00	2.65	3.50	2.95	2.55	2.45	2.00	1.65	1.60	1.50	1.50	1.65
14	1.97	2.45	3.30	2.95	2.45	2.35	2.00	1.75	1.60	1.50	1.50	1.70
15	1.90	2.32	3.25	2.90	2.45	2.25	1.95	1.70	1.55	1.45	1.60	1.75
16	2.15	2.50	3.40	2.80	2.50	2.20	1.90	1.65	1.50	1.45	1.60	1.75
17	2.12	2.90	3.10	2.80	2.55	2.25	1.85	1.65	1.50	1.40	1.60	1.60
18	2.08	2.10	3.00	2.75	2.65	2.20	1.80	1.70	1.55	1.50	1.60	1.60
19	1.92	2.00	2.90	2.65	7.80	2.15	1.80	1.70	1.50	1.50	1.60	1.60
20	1.85	2.40	2.90	2.65	5.85	2.15	1.80	1.70	1.65	1.50	1.50	1.70
21	1.90	2.45	2.85	2.60	4.75	2.10	1.80	1.75	1.80	1.50	1.55	1.65
22	2.20	5.10	2.85	2.55	4.45	2.10	1.70	1.80	1.50	1.50	1.60	1.65
23	7.70	5.90	3.75	2.45	3.65	2.25	1.70	1.70	1.50	1.45	1.60	1.50
24	5.40	4.60	5.30	2.40	3.45	2.15	1.75	1.80	1.55	1.40	1.60	1.60
25	4.00	4.45	4.40	2.35	3.45	2.20	1.70	1.80	1.50	1.50	1.60	1.75
26	3.25	3.75	3.85	2.45	3.35	2.10	1.80	1.70	1.50	1.45	1.60	2.40
27	3.03	3.25	3.55	3.45	3.20	2.20	1.80	1.65	1.50	1.40	1.60	3.30
28	3.10	2.95	3.45	5.70	3.05	2.40	1.85	1.60	1.60	1.40	1.60	3.20
29	3.15	3.55	3.20	5.00	2.85	2.50	1.80	1.60	1.50	1.40	1.60	3.10
30	2.90	.....	2.95	4.45	2.75	2.85	1.75	1.55	1.40	1.40	1.55	2.85
31	2.63	.....	2.85	.....	2.80	.....	1.75	1.55	.....	1.40	.....	2.50

Rating table for Greenbrier River at Alderson, W. Va., from January 1, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.4	46	2.6	1,000	3.8	3,440	6.0	9,300
1.5	70	2.7	1,160	3.9	3,680	6.5	10,830
1.6	101	2.8	1,330	4.0	3,920	7.0	12,400
1.7	140	2.9	1,510	4.2	4,400	7.5	14,000
1.8	188	3.0	1,700	4.4	4,890	8.0	15,600
1.9	246	3.1	1,900	4.6	5,390	8.5	17,270
2.0	315	3.2	2,110	4.8	5,900	9.0	19,000
2.1	396	3.3	2,320	5.0	6,420	9.5	20,700
2.2	490	3.4	2,540	5.2	6,960	10.0	22,500
2.3	598	3.5	2,760	5.4	7,530	10.5	24,400
2.4	720	3.6	2,980	5.6	8,110	11.0	26,500
2.5	855	3.7	3,210	5.8	8,700		

The preceding table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1897 to 1904, inclusive. It is well defined between gage heights 1.4 feet and 2.4 feet, being determined between these limits by 1903 and 1904 measurements. Above 2.4 feet the table is fairly accurate to 6 feet, being determined above 6 feet by three measurements made in 1897. Above 9 feet the table is the same as the 1902 table.

Estimated monthly discharge of Greenbrier River at Alderson, W. Va., for 1903 and 1904.

[Drainage area, 1,344 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
January	22,290	577	3,711	2.76	3.18
February	23,620	1,700	6,567	4.89	5.10
March	30,700	1,160	6,063	4.51	5.20
April	9,600	1,900	3,298	2.45	2.73
May	2,540	315	864	.643	.741
June	8,400	396	1,702	1.27	1.42
July	2,386	128	754	.561	.647
August	788	58	239	.178	.205
September	301	79	161	.120	.134
October	246	101	149	.111	.128
November	246	70	150	.112	.125
December	490	101	183	.136	.157
The year	30,700	58	1,987	1.48	19.77
1904.					
January	14,640	217	1,529	1.14	1.31
February	9,000	246	2,247	1.67	1.80
March	9,600	1,420	3,515	2.62	3.02
April	8,400	659	2,219	1.65	1.84
May	14,960	788	2,715	2.02	2.33
June	7,100	396	1,328	.988	1.10
July	1,160	140	352	.262	.302
August	188	86	141	.105	.121
September	188	46	86.4	.064	.071
October	101	46	60.5	.045	.052
November	101	46	83.4	.062	.069
December	2,320	70	412	.307	.354
The year	14,960	46	1,224	.911	12.37

SCIOTO RIVER DRAINAGE BASIN.

Scioto River rises in the eastern part of Auglaize County, Ohio, flows east for about 40 miles and then almost due south, entering the Ohio at Portsmouth. Below Columbus, where it is joined by the Olentangy, it is one of the largest and most important streams in the State. The United States Geological Survey maintained stations on both Scioto and Olentangy rivers at Columbus for the purpose of studying the water supply and sewage disposal of that city. The river has considerable fall and flows through a hilly basin, forming numerous good locations for water-power developments. Its drainage area at Columbus is 1,051 square miles.

SCIOTO RIVER NEAR COLUMBUS, OHIO.

This station was originally established for the Ohio State board of health by B. F. Flynn, on the Grand View Avenue Bridge, 3 miles northwest of Columbus post-office, and was reestablished on the same bridge by R. W. Pratt, on November 21, 1903. This bridge is a two-span iron highway bridge, 250 feet between abutments. The initial point for soundings is the face of the easterly abutment on the downstream side, and the bridge is marked every 10 feet with double nails. The main channel is straight for about 100 feet above and 200 feet below, and there is a small island 150 feet above, which causes a side channel to enter the main channel at this point. The banks are high and only overflow in extreme floods. At low water the river is sluggish, but can be waded at several points below the bridge, where good measurements can be obtained. The following bench marks have been established:

Bench mark No. 1 is the upper side of the upper angle iron forming the lowest part of the hand rail above a point 1 foot east of the pulley. This point is 34.02 feet above the zero of the gage. Bench mark No. 2 is the extreme northeast corner of the north stone of the parapet wall of the east abutment, the elevation of which is 34.32 feet above the zero of the gage. Bench mark No. 3 is a nail in a telegraph pole 10 feet east of the east abutment at the north side, having an elevation of 34.95 feet above the zero of the gage. The gage established by Mr. Pratt has its zero at the same elevation as the gage which was established by Mr. Flynn. It consists of a regulation chain and weight, with a length of 30.40 feet from the end of the weight to the end of the last copper link, which is used as the marker.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Scioto River near Columbus, Ohio, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
January 18[a]	R. W. Pratt	36	39	1.31	[b] 9.70	51
January 22[c]	do	225	3,344	5.43	23.40	18,120
February 29[c]	do	246	2,187	2.66	17.60	5,827
March 4	do	228	3,373	3.98	20.40	13,400
March 26	do	233	3,426	5.66	23.40	19,400
April 4	do	235	2,247	4.31	18.00	9,691
May 14	do	123	278	.76	9.81	210
June 3	do	180	571	1.62	11.14	927
July 21	do	132	317	.76	9.87	241
August 6	do	100	207	.24	9.12	50
August 6[d]	do	84	68	.81	9.12	55
September 3[d]	do	91	78	.46	9.04	36
October 22[d]	do	77	75	.47	9.10	35
November 19[d]	do	15	10.5	1.36	8.89	14.3
December 16	do	16	13.5	1.33	9.08	18

[a] Wading 600 feet above bridge.
[b] Ice caused gage to read about 0.50 too high.
[c] Ice and débris.
[d] Wading 800 feet above bridge.

Mean daily gage height, in feet, of Scioto River near Columbus, Ohio, for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.80	14.10	16.00	21.30	12.05	10.00	9.77	9.55	9.03	9.08	9.15	9.13
2	9.80	13.30	16.00	24.30	11.70	10.42	9.95	9.55	9.02	9.01	9.00	9.12
3	9.85	11.90	19.00	20.80	11.45	10.75	10.10	9.19	8.97	9.00	8.97	9.13
4	9.80	11.95	20.65	17.95	11.25	10.55	10.00	9.16	8.97	9.28	8.97	9.12
5	9.70	11.95	17.80	16.10	10.78	10.50	10.05	9.12	9.05	9.48	9.17	9.15
6	9.75	12.75	16.15	14.45	10.55	10.37	16.02	9.33	9.00	9.27	9.15	9.20
7	9.70	17.95	14.35	13.10	10.40	10.10	16.45	9.10	9.06	9.16	9.32	9.06
8	9.75	16.15	13.55	12.65	10.25	9.95	15.05	9.03	9.03	9.27	9.15	9.28
9	9.80	14.85	13.10	12.55	10.20	9.80	17.60	9.00	9.08	9.12	9.25	9.13
10	9.70	14.35	12.55	12.50	10.10	9.70	15.48	9.10	9.03	9.10	9.13	9.15
11	9.70	13.60	12.35	12.30	10.00	9.60	13.85	9.15	9.12	9.10	9.31	9.10
12	9.70	12.50	12.15	12.15	9.90	9.52	13.02	9.12	9.04	9.10	9.18	9.14
13	9.70	12.40	12.45	12.00	9.80	9.50	12.25	9.08	9.00	9.11	9.17	9.22
14	9.65	14.15	12.55	11.80	9.82	9.45	11.70	9.10	8.97	9.08	9.08	9.11
15	9.70	14.35	12.20	11.55	9.80	9.45	11.32	9.12	8.96	9.15	8.90	9.20
16	9.70	13.30	11.35	11.15	9.78	9.45	11.20	9.15	9.02	9.03	9.05	9.10
17	9.70	13.15	11.50	10.83	9.72	9.50	10.45	9.01	9.04	9.05	9.09	9.05
18	9.70	12.70	11.70	10.65	9.80	9.47	10.67	8.87	8.98	8.98	9.08	9.00
19	9.70	12.40	12.80	10.50	9.80	9.50	10.07	9.01	9.04	9.27	9.10	.....
20	9.75	12.50	12.70	10.30	9.85	9.95	9.82	9.15	9.10	9.07	9.10	.....
21	15.40	12.35	12.65	10.15	9.87	9.80	9.72	9.10	8.97	9.05	9.16	9.20
22	23.35	15.50	12.50	10.10	9.90	9.82	9.61	9.22	8.96	9.00	9.32	9.22
23	21.60	15.15	13.70	10.10	9.95	10.25	9.55	8.86	9.00	9.00	9.28	9.30
24	17.15	15.40	13.90	9.95	10.00	10.52	9.50	8.87	8.94	9.05	9.02	9.30
25	14.80	14.55	23.45	10.05	9.85	10.42	9.47	8.90	8.94	9.00	9.10	9.35
26	13.75	13.85	23.45	12.60	9.70	10.15	9.40	9.32	8.92	9.00	8.95	9.45
27	13.60	13.65	20.00	12.85	9.80	9.87	9.38	9.20	8.92	9.05	9.00	11.10
28	15.35	13.55	17.25	12.60	9.80	9.75	9.31	9.05	8.96	9.00	8.95	10.05
29	15.05	15.80	15.10	12.35	9.72	10.00	9.35	9.09	8.94	8.87	9.05	9.85
30	14.55	.....	13.60	12.25	9.75	9.82	9.29	9.02	9.07	8.81	9.15	10.65
31	14.10	.....	15.35	.....	9.83	.....	9.39	8.97	.....	9.00	.....	10.45

[a] Ice conditions during January and February.

Rating table for Scioto River near Columbus, Ohio, from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
8.8	6	10.1	285	11.8	1,000	16.5	7,000
8.9	16	10.2	310	12.0	1,160	17.0	7,890
9.0	29	10.3	335	12.2	1,340	17.5	8,790
9.1	45	10.4	360	12.4	1,540	18.0	9,690
9.2	64	10.5	385	12.6	1,740	18.5	10,590
9.3	86	10.6	410	12.8	1,940	19.0	11,490
9.4	110	10.7	440	13.0	2,140	20.0	13,290
9.5	135	10.8	470	13.5	2,680	21.0	15,090
9.6	160	10.9	500	14.0	3,230	22.0	16,890
9.7	185	11.0	530	14.5	3,860	23.0	18,690
9.8	210	11.2	620	15.0	4,560	24.0	20,490
9.9	235	11.4	730	15.5	5,330		
10.0	260	11.6	860	16.0	6,150		

The above table is applicable only for open-channel conditions. It is based upon 15 discharge measurements made during 1903 and 1904. It is well defined between gage heights 9 feet and 15 feet. The table has been extended beyond these limits. Above gage height 16.6 feet the rating curve is a tangent, the difference being 180 per tenth. The curve includes measurements made during 1899, 1900, and 1903, but the changes due to measurements of 1904 make it applicable only to the above limits.

Estimated monthly discharge of Scioto River near Columbus, Ohio, for 1904.

[Drainage area, 1,051 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March	19,500	700	5,180	4.93	5.68
April	21,030	248	3,205	3.05	3.40
May	1,205	185	331	.315	.363
June	455	122	243	.231	.258
July	8,970	84	1,445	1.38	1.59
August	148	12	50.9	.048	.055
September	49	19	30.3	.029	.032
October	130	7	44.5	.042	.048
November	91	16	48.7	.046	.051
December	570	29	110	.105	.121

OLENTANGY RIVER NEAR COLUMBUS, OHIO.

This station was established October 7, 1903, by R. Winthrop Pratt, in connection with the water supply and sewage disposal investigations of the city of Columbus. It is located 4 miles north of the Columbus, Ohio, post-office and one-fourth mile west of North High street at the Doddridge Street Bridge. The boxed chain gage is bolted to the hand rail of the bridge on the upstream side. The observer is A. D. Winegardner. Discharge measurements are made from the two-span highway bridge and by wading below the bridge. The initial point for soundings is the east face of the west parapet wall. The channel is straight for 300 feet above and 500 feet below the station. The banks overflow only at high stages. The bed of the stream is of sand and clay. The drainage area at the station is 520 square miles.

Bench mark No. 1 is the northwest corner of the top stone of the north wing of the west abutment. Its elevation is 34.99 feet above gage datum. Bench mark No. 2 is a cut in the top of the hand rail over the gage 31 feet from the initial point for soundings. Its elevation is 39.89 feet above the zero of the gage. Bench mark No. 3 is the center pin of the west end of the north truss, the elevation of which is 38.60 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction af E. Johnson, jr., district hydrographer.

Discharge measurements at regular stations on Olentangy River near Columbus, Ohio, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
January 16[a]	R. W. Pratt	70	36	1.00	6.40	36
January 22	do	186	2,445	5.73	19.40	14,000
February 5[a b]	do	78	60	1.55	6.90	93
February 22[c]	do	120	510	3.09	9.40	1,575
February 25[c]	do	118	530	2.89	9.35	1,529
March 5	do	151	1,104	3.15	11.50	3,469
March 19	do	144	856	1.81	9.20	1,569
April 23[a]	do	43	53	2.66	7.10	140
May 28[a]	do	84	86	2.64	7.22	226
June 4	do	137	570	0.44	7.35	249
July 23[a]	do	50	50	1.24	6.80	62
August 20[a]	do	31	12	1.16	6.56	14
September 30[a]	do	20.5	7.2	0.97	6.52	7
October 28[a]	do	24	10.9	1.87	6.70	20.4
November 12[a]	do	19.5	9.2	1.16	6.59	10.7
December 23[a]	do	28	13.6	1.29	6.66	17.5

[a] Wading at different sections. [b] Ice. [c] At Lane avenue, three-fourths mile below station.

Mean daily gage height, in feet, of Olentangy River near Columbus, Ohio, for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	6.50	6.60	13.40	16.30	8.20	8.20	7.20	6.70	6.50	6.50	6.60	6.60
2	6.50	6.60	11.60	19.60	8.20	7.70	7.10	6.60	6.60	6.50	6.60	6.60
3	6.40	6.50	14.80	12.30	7.80	7.60	7.00	6.60	6.75	6.50	6.55	6.60
4	6.40	6.50	15.80	9.80	7.60	7.40	7.00	6.60	6.70	6.50	6.60	6.60
5	6.40	6.60	12.30	8.70	7.50	7.20	7.00	6.60	6.70	6.55	6.60	6.60
6	6.50	9.00	9.20	8.40	7.30	7.20	7.00	6.60	6.65	6.60	6.60	6.60
7	6.50	11.20	9.30	8.10	7.20	7.00	13.05	6.60	6.60	6.55	6.60	6.60
8	6.50	13.10	9.90	7.90	7.20	6.90	11.70	6.60	6.95	6.50	6.60	6.65
9	6.50	10.40	9.00	7.90	7.10	6.90	12.50	6.60	6.90	6.55	6.60	6.60
10	6.40	9.00	8.30	8.10	7.10	6.90	10.00	6.60	6.80	6.65	6.55	6.60
11	6.40	7.40	8.00	8.00	7.00	6.80	8.50	6.60	6.70	6.70	6.55	6.60
12	6.40	7.50	7.90	7.70	7.00	6.80	8.00	6.60	6.60	6.80	6.60	6.60
13	6.40	7.60	7.70	7.80	7.00	6.80	7.60	6.60	6.60	6.80	6.60	6.60
14	6.40	7.20	7.50	7.70	7.00	6.80	7.50	6.60	6.70	6.60	6.60	6.60
15	6.40	7.40	7.70	7.70	7.00	6.80	7.20	6.60	6.60	6.60	6.60	6.60
16	6.40	7.40	7.50	7.50	7.00	7.00	7.20	6.60	6.60	6.60	6.60	6.60
17	6.40	7.00	7.50	7.30	7.00	7.00	7.10	6.60	6.60	6.70	6.60	6.60
18	6.40	6.90	8.00	7.30	7.20	6.90	7.00	6.60	6.60	6.65	6.60	6.60
19	6.40	6.60	9.40	7.20	7.00	6.80	6.90	6.60	6.60	6.65	6.65	6.60
20	6.40	6.70	8.90	7.20	7.10	8.00	6.90	6.60	6.60	6.70	6.60	6.60
21	9.20	6.70	8.00	7.10	7.10	7.10	6.90	6.55	6.60	6.60	6.60	.....
22	20.40	8.80	8.40	7.10	7.20	7.00	6.80	6.50	6.60	6.65	6.60	.....
23	18.90	9.70	10.20	7.10	7.30	7.00	6.80	6.55	6.60	6.60	6.60	6.65
24	16.20	10.00	10.20	7.10	7.20	7.00	6.70	6.50	6.60	6.60	6.60	6.70
25	14.40	9.20	9.70	7.10	7.10	7.20	6.60	6.50	6.60	6.60	6.60	6.85
26	9.40	8.20	16.80	9.50	7.50	7.20	6.60	6.85	6.50	6.65	6.60	6.80
27	7.40	7.90	15.40	9.80	7.30	7.10	6.70	6.80	6.50	6.60	6.60	8.20
28	7.20	7.90	11.80	9.40	7.30	7.00	6.70	6.55	6.50	6.60	6.60	8.30
29	7.50	10.20	9.20	8.80	7.20	7.50	6.70	6.60	6.50	6.65	6.60	7.80
30	7.00	.....	8.50	8.50	7.20	7.50	6.80	6.60	6.50	6.60	6.60	7.60
31	6.60	.....	11.00	.....	7.60	.....	6.70	6.60	.....	6.60	.....	7.20

[a] Ice conditions January and February.

[b] Frozen December 7 to 31.

Rating table for Olentangy River near Columbus, Ohio, from October 7, 1903, to January 22, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
6.2	13	6.6	55	7.0	133	7.3	234
6.3	21	6.7	69	7.1	163	7.4	275
6.4	31	6.8	85	7.2	197	7.5	320
6.5	43	6.9	107				

During the flood of January 22, 1904, the channel shifted, changing the curve below gage height 7.5 feet, as shown in succeeding table. Above gage height 7.5 the two tables are alike.

Rating table for Olentangy River near Columbus, Ohio, from January 23 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
6.5	5	8.0	600	9.5	1,630	12.0	3,950
6.6	20	8.1	660	9.6	1,710	12.5	4,500
6.7	39	8.2	720	9.7	1,790	13.0	5,100
6.8	62	8.3	780	9.8	1,870	13.5	5,700
6.9	89	8.4	840	9.9	1,950	14.0	6,300
7.0	118	8.5	910	10.0	2,030	14.5	6,950
7.1	150	8.6	980	10.2	2,210	15.0	7,600
7.2	185	8.7	1,050	10.4	2,390	15.5	8,300
7.3	225	8.8	1,120	10.6	2,570	16.0	9,000
7.4	270	8.9	1,190	10.8	2,750	16.5	9,700
7.5	320	9.0	1,260	11.0	2,940	17.0	10,400
7.6	370	9.1	1,330	11.2	3,140	18.0	11,900
7.7	425	9.2	1,400	11.4	3,340	19.0	13,400
7.8	480	9.3	1,470	11.6	3,540		
7.9	540	9.4	1,550	11.8	3,740		

The above table is applicable only for open-channel conditions. It is based upon 14 discharge measurements made during 1904. It is well defined between gage heights 6.2 feet and 11.5 feet. The table has been extended beyond these limits. Above gage height 17 feet the rating curve is a tangent, the difference being 150 per tenth.

Estimated monthly discharge of Olentangy River near Columbus, Ohio, for 1904.

[Drainage area, 520 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March	10,120	320	2,501.	4.81	5.54
April	14,300	150	1,516.	2.92	3.26
May	720	118	232.	.446	.514
June	720	62	187.	.360	.402
July	5,160	20	634.	1.22	1.41
August	76	5	21.5	.041	.047
September	104	5	27.4	.053	.059
October	62	5	23.3	.045	.052
November	30	12	19.5	.038	.042

LITTLE MIAMI RIVER DRAINAGE BASIN.

Little Miami River rises in the southeastern part of Clark County, flows southwest through Greene and Warren counties, and enters Ohio River just above Cincinnati. The greater part of the drainage area lies to the east, as there is only a narrow piece of country between this and Miami River. The Little Miami is the best power river in the State of Ohio. The United States Geological Survey maintained a station on the Little Miami at Morrow in 1903, where its drainage area is 951 square miles. In 1904 a gaging station was operated on Mad River near Springfield.

MAD RIVER NEAR SPRINGFIELD, OHIO.

This station was established December 31, 1903, by R. Winthrop Pratt. It is located at a highway bridge 4 miles west of Springfield, Ohio, and about 500 feet below old Red Mill dam. A standard chain gage is spiked to the bridge. The length of the chain from the end of the weight to the marker is 16.05 feet. The gage is read once each day by Charles W. Smith. Discharge measurements are made from the downstream side of the single-span bridge to which the gage is fastened. The bridge has a length between abutments of 128 feet. The channel is practically straight for 1,000 feet above and below the station, there being a slight curve just above. The right bank is high, clean, and seldom overflows. The left bank is rather low and is subject to overflow. The bed of the stream is composed of a mixture of clay and gravel and is fairly permanent. Bench mark No. 1 is on the extreme west corner of the second stepstone on the upstream side of the north side of the bridge. Its elevation is 15.88 feet above the datum of the gage. Bench mark No. 2 is on the top of the bottom of the gage box. Its elevation is 19.67 feet above the datum of the gage. Bench mark No. 3 is a nail in top of lower chord, 87 feet from initial point. Its elevation is 18.69 feet above gage datum.

The drainage area at this station is 290 square miles.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Mad River near Springfield, Ohio, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
January 30	R. W. Pratt	55	224	1.50	6.40	334
February 27	do	60	292	1.80	6.60	547
March 25	do	99	701	3.65	10.20	2,559
April 9	do	63	337	2.43	6.90	820
June 25	do	65	239	1.10	5.82	262
July 30[a]	do	82	80	2.17	5.65	174
August 30[a]	do	97	92	1.50	5.56	138
September 23[a]	do	96	95	1.34	5.50	127
October 18[a]	do	95	99	1.47	5.59	145
November 17[a]	do	96	117	1.28	5.64	150
December 28[a]	do	130	939	.43	6.50	407

[a] Wading 500 feet above bridge.

Mean daily gage height, in feet, of Mad River near Springfield, Ohio, for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.10	6.30	7.90	13.50	6.30	6.00	6.80	5.80	5.60	5.55	5.60	5.65
2	6.10	6.40	6.90	11.90	6.30	6.00	6.10	5.70	5.55	5.55	5.60	5.68
3	6.30	6.30	9.60	8.80	6.20	5.90	5.80	5.60	5.55	5.55	5.60	5.67
4	6.40	6.30	9.20	7.40	6.20	5.90	5.80	5.60	5.60	5.60	5.60	5.62
5	6.40	6.30	9.30	7.10	6.10	5.80	5.80	5.60	5.50	5.50	5.60	5.63
6	6.30	6.70	7.00	7.00	6.00	5.80	6.50	5.50	5.52	5.55	5.65	5.60
7	6.30	10.90	7.00	6.90	6.00	5.80	6.90	5.50	5.50	5.55	5.60	5.60
8	6.30	8.90	6.90	6.80	6.00	5.80	6.90	5.50	5.50	5.55	5.60	5.60
9	6.30	8.00	6.60	6.90	6.10	5.80	7.30	5.50	5.56	5.60	5.60	5.60
10	6.30	6.50	6.50	6.70	6.00	5.80	6.40	5.50	5.50	5.55	5.60	5.65
11	6.30	6.70	6.90	6.60	5.90	5.80	6.20	5.50	5.50	5.85	5.70	5.60
12	6.20	6.50	6.70	6.60	5.90	5.70	6.10	5.50	5.45	5.70	5.65	5.62
13	6.10	6.40	6.50	6.50	5.90	5.70	6.00	5.50	5.50	5.70	5.60	5.60
14	5.90	6.30	6.60	6.50	5.90	5.70	5.80	5.50	5.60	5.65	5.60	5.60
15	6.10	6.10	6.50	6.50	6.10	5.70	5.80	5.50	5.15	5.60	5.60	5.60
16	6.00	6.30	6.50	6.40	6.00	5.80	5.80	5.50	5.50	5.60	5.60	5.63
17	5.90	6.20	6.50	6.30	5.90	5.90	5.80	5.50	5.50	5.60	5.60	5.63
18	6.00	6.20	7.50	6.30	6.00	5.90	5.90	5.40	5.50	5.56	5.60	5.62
19	6.00	6.10	7.00	6.30	6.00	5.80	5.80	5.50	5.50	5.60	5.65	5.70
20	6.10	6.10	6.80	6.20	5.90	7.00	5.80	5.70	5.32	5.60	5.60	5.60
21	12.00	6.20	6.70	6.10	6.30	6.30	5.70	5.70	5.50	5.60	5.60	5.60
22	14.10	8.70	6.60	6.10	6.10	6.10	5.70	5.60	5.55	5.65	5.60	5.60
23	11.80	8.00	7.70	6.10	6.10	5.90	5.70	5.60	5.50	5.65	5.60	5.70
24	8.40	9.50	7.20	6.10	6.00	5.80	5.60	5.50	5.45	5.60	5.65	6.10
25	7.30	7.30	9.30	6.10	6.00	5.80	5.70	5.50	5.70	5.60	5.63	6.20
26	6.70	6.70	15.40	7.00	5.90	5.80	5.70	5.80	5.60	5.60	5.67	6.20
27	6.60	6.50	12.00	6.70	6.10	5.80	5.60	5.70	5.60	5.60	5.65	7.90
28	6.60	8.20	8.30	6.60	6.00	5.80	5.50	5.50	5.60	5.60	5.65	6.35
29	6.60	8.50	7.50	6.60	5.90	6.10	5.60	5.50	5.60	5.60	5.65	6.15
30	6.50	.....	8.90	6.50	5.90	5.90	5.50	5.50	5.50	5.65	5.65	6.15
31	6.40	.....	11.45	.....	5.90	.....	5.50	5.53	.....	5.60	.....	5.95

[a] Ice conditions January and February.

WABASH RIVER DRAINAGE BASIN.

The drainage basin of the Wabash embraces an area of about 33,000 square miles, distributed as follows: In Ohio, 400 square miles; in Indiana, 24,350 square miles; in Illinois, 8,250 square miles. It drains, therefore, slightly more than two-thirds of Indiana, the area of the State being 35,910 square miles. Of the portion of Indiana, about one-half is embraced in the drainage areas of East and West White rivers. By including these drainage areas with the Wabash, the entire basin has a nearly symmetrical, broadly ovate form. Not including the White River system, the Wabash basin is an unsymmetrical, elongated tract, curving around White River.

The length of the valley occupied by the Wabash is about 450 miles, but the length of the stream is fully 500 miles, for the river in its lower course makes several oxbow curves within the valley. The source of the river is about 1,000 feet above tide, while its mouth at low water is but 311 feet. The average fall, if we estimate the stream to have a length of 500 miles, is therefore about 16.5 inches per mile. The rate of descent is far from uniform, being much more rapid in the upper portion than in the lower. There are also many rapids, separated by pools or sluggish portions of the stream. The elevation of the stream is accurately determined at many points, but in the absence of a careful measurement of the length of the stream the rate of fall is only approximately known. The section above the point where the river enters the old lake outlet, estimated to have a length of 100 miles, has a fall of about 300 feet, or 3 feet per mile. Railway levels and canal surveys at the point where the river joins the old lake outlet show its elevation to be nearly 700 feet above sea level, the altitudes reported varying between 696 and 699 feet.

The following table gives the elevation and fall at various points in this basin:

Table of altitudes and distances along Wabash River.

Location.	Estimated distance.	Altitude.	Fall per mile.
	Miles.	*Feet.*	*Feet.*
Source	0.0	1,000.0	0.00
Huntington	100.0	699.0	36.00
Mouth of Salamonie River	15.0	667.0	25.56
Mouth of Mississinewa River	20.0	633.0	20.40
Logansport	20.0	583.0	30.00
Lafayette	50.0	506.0	18.48
Attica	25.0	487.0	9.12
Covington	20.0	470.0	10.20
Terre Haute	55.0	447.7	4.80
State line	14.6	440.6	5.80
Hutsonville, Ill	29.0	424.6	6.60
Vincennes	46.4	398.8	6.60
Mouth of White River	32.5	376.5	8.30
Grayville, Ill	28.0	365.0	5.00
Mouth of Little Wabash	46.0	323.0	11.00
Mouth of Wabash River	16.0	311.0	9.00

During 1904 the United States Geological Survey maintained stations in this basin at Logansport, Delphi, Indianapolis, Cataract, and Shoals. The following are the drainage areas of the several streams at these points.

Drainage areas in Wabash River basin.

	Sq. miles.
Wabash River at Logansport	3,163
Tippecanoe River near Delphi	1,890
Lower Eel River at Cataract	255
White River (East Branch) at Shoals	4,900
White River (West Branch) at Indianapolis	1,520

WABASH RIVER AT LOGANSPORT, IND.

This station was established April 27, 1903, by George E. Waesche. It is located at the Cicott Street Bridge, about 1 mile from the center of the city of Logansport, 1¾ miles from the Wabash Railroad station, 1½ miles from the Pennsylvania station, four blocks from the street car line, and 1,000 feet below the mouth of Eel River. A standard chain gage is placed on the second span of the bridge, at the third panel from the second pier, and is supported by the bridge pins, and is between the lower chord bars. It is reached through a trap door in the floor planks of the bridge. The distance from the end of the weight to the marker is 20.78 feet. The gage is read once each day by W. R. Allison. Discharge measurements are made from the

upstream side of the bridge to which the gage is attached. The initial point for soundings is the inner face of the left abutment. The channel is nearly straight for 1,000 feet above and for 1,500 feet below the station. The distance between abutments is 550 feet, and the channel is broken by three bridge piers. The right bank is high, and is not subject to overflow at the bridge. The left bank is submerged only at extreme high water. The bed of the stream consists of solid rock covered with small bowlders and is rough and permanent. The stream is shallow and the current is never sluggish.

Bench mark No. 1 is the top of the north abutment, under the fourth board of the downstream sidewalk. Its elevation above gage datum is 18.814 feet. From Pennsylvania Railroal levels its elevation above sea level has been found to be 591 feet. Bench mark No. 2 is the top of the third course of masonry from the top of the north abutment. Its elevation above the zero of the gage is 15.31 feet.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Wabash River at Logansport, Ind., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 27	G. E. Waesche		978	2.42	2.50	2,367
June 8	do		2,060	3.49	4.55	7,180
June 16	do					1,444
July 8	do		829	1.64	2.30	1,358
July 16	E. C. Murphy		669	1.08	1.54	719
August 15	E. Johnson, jr		576	.72	1.35	418
September 30	L. R. Stockman		491	.71	1.30	349
November 10	do		610	.74	1.38	452
December 28[a]	E. Johnson, jr		1,024	1.25	2.75	1,285
1904.						
January 22[b]	F. W. Hanna	528	6,721	6.95	13.11	46,660
March 2[c]	do	536	4,210	5.62	8.20	23,660
March 29[c]	do	536	5,335	6.09	10.50	32,480
May 3	F. W. Hanna and Johnson.		1,536	2.44	2.98	3,744
June 17	F. W. Hanna	483	810	1.08	1.66	878
July 21	do	477	814	1.13	1.76	920
August 23	do	478	753	.96	1.50	723
September 14	do	446	637	.85	1.48	542
October 21	do	426	574	.70	1.30	401
November 4	do	420	558	.68	1.27	379

[a] Partly frozen. [b] Float measurement. [c] Some floating ice.

Mean daily gage height, in feet, of Wabash River at Logansport, Ind., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[a]
1	2.53	3.10	9.90	12.22	3.75	2.90	1.80	1.30	1.30	1.35	.....	1.30
2	2.50	3.00	7.88	13.00	3.25	3.00	1.73	1.30	1.33	1.35	1.22	1.35
3	2.33	2.30	7.65	13.02	2.95	3.00	1.75	1.35	1.27	1.30	1.25	1.45
4	2.23	2.50	7.88	11.06	2.75	2.90	1.68	1.33	1.21	1.29	1.27	1.22
5	2.23	2.50	7.30	7.65	2.58	2.70	1.76	1.30	1.25	1.26	1.23	1.28
6	2.20	3.00	6.50	5.73	2.50	2.40	1.90	1.35	1.30	1.25	1.25	1.22
7	2.20	10.20	8.19	4.88	2.40	2.30	3.10	1.29	1.24	1.28	1.27	1.22
8	2.15	9.65	7.35	4.45	2.30	2.20	5.12	1.29	1.20	1.35	1.27	1.28
9	2.15	7.90	5.83	4.70	2.30	2.00	4.95	1.32	1.25	1.45	1.22	1.25
10	2.15	6.35	5.00	4.95	2.35	1.90	4.71	1.25	1.25	1.46	1.30	1.18
11	2.15	5.60	5.00	4.70	2.25	1.90	4.43	1.25	1.25	1.46	1.30	1.31
12	2.10	5.10	5.15	4.68	2.13	1.82	4.14	1.24	1.25	1.45	1.30	1.20
13	2.10	4.20	.....	4.30	2.10	1.78	3.53	1.20	1.26	1.45	1.30	1.40
14	2.20	3.60	4.20	3.90	.....	1.73	2.99	1.25	1.48	1.40	1.31	.....
15	2.20	2.70	3.70	3.60	.....	1.70	2.69	1.21	1.41	1.37	1.31	.....
16	2.15	2.50	3.42	3.33	2.00	1.70	2.50	1.25	1.25	1.35	1.25	.....
17	2.15	2.30	3.45	3.15	1.95	1.65	2.00	1.25	1.30	1.35	1.31	.....
18	2.20	2.34	5.40	2.90	2.00	1.73	1.99	1.25	1.41	1.29	1.30	.....
19	2.25	2.38	6.75	2.90	2.15	1.75	1.85	1.25	1.49	1.28	1.30	.....
20	2.60	2.10	7.00	2.63	2.40	1.90	1.81	1.50	1.49	1.25	1.33	.....
21	10.85	2.25	6.20	2.52	2.40	2.56	1.78	1.61	1.51	1.30	1.35	.....
22	13.19	2.21	8.30	2.48	2.35	3.30	1.65	1.76	1.39	1.30	1.35	.....
23	12.55	2.35	8.10	2.85	2.43	3.15	1.65	1.50	1.37	1.30	1.30	1.31
24	10.00	3.50	6.68	2.15	2.40	2.97	1.61	1.45	1.37	1.30	1.28	1.35
25	7.45	4.80	6.85	2.60	2.40	2.49	1.55	1.40	1.40	1.30	1.31	1.41
26	6.00	4.50	13.45	7.05	2.75	2.20	1.53	1.29	1.56	1.30	1.30	1.50
27	4.75	3.70	14.84	7.12	2.70	2.00	1.53	1.30	1.50	1.30	1.30	1.73
28	4.38	3.88	13.05	5.90	2.53	1.93	1.50	1.27	1.56	1.24	1.34	.....
29	4.00	9.22	10.32	5.25	2.40	1.87	1.50	1.30	1.46	1.22	1.30	4.12
30	3.70	.....	7.50	4.50	2.43	1.80	1.41	1.33	1.40	1.22	1.28	3.95
31	3.50	.....	9.10	.....	2.55	.....	1.39	1.34	.....	.....	.....	3.41

[a] Ice conditions January 1 to March 3 and December 14 to 31.

Rating table for Wabash River at Logansport, Ind., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.2	260	2.5	2,540	4.2	7,380	8.0	22,770
1.3	360	2.6	2,770	4.4	8,050	8.5	25,060
1.4	480	2.7	3,010	4.6	8,730	9.0	27,410
1.5	620	2.8	3,260	4.8	9,430	9.5	29,790
1.6	770	2.9	3,510	5.0	10,140	10.0	32,200
1.7	930	3.0	3,770	5.2	10,880	10.5	34,650
1.8	1,100	3.1	4,030	5.4	11,640	11.0	37,130
1.9	1,280	3.2	4,300	5.6	12,420	12.0	42,130
2.0	1,470	3.3	4,580	5.8	13,220	13.0	47,130
2.1	1,670	3.4	4,870	6.0	14,040	14.0	52,130
2.2	1,880	3.6	5,460	6.5	16,170	15.0	57,130
2.3	2,090	3.8	6,080	7.0	18,320		
2.4	2,310	4.0	6,720	7.5	20,520		

The preceding table is applicable only for open-channel conditions. It is based upon 19 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.3 feet and 8.2 feet. The table has been extended beyond these limits. Above gage height 10.7 feet the rating curve is a tangent, the difference being 500 per tenth.

Estimated monthly discharge of Wabash River at Logansport, Ind., for 1904.

[Drainage area, 3,163 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimun.	Mean.	Second-feet per square mile.	Depth in inches.
March 4–31	56,140	4,928	19,900	6.29	6.55
April	47,130	1,775	12,860	4.06	4.53
May	5,925	1,375	2,440	.771	.889
June	4,580	850	6,146	1.94	2.16
July	10,580	468	2,673	.845	.974
August	1,032	260	409	.128	.148
September	710	260	439	.139	.155
October	566	280	392	.124	.143
November	420	280	349	.110	.123

TIPPECANOE RIVER NEAR DELPHI, IND.

This station was established March 14, 1903, by George E. Waesche. The station is located at the highway bridge at Springboro, Ind. The nearest railroad station is Delphi, 5 miles east of Springboro. A standard chain gage is located on the second span from the east bank, one panel length beyond the center of the span. The length of the chain from the end of the weight to the marker is 25.66 feet. The gage is read once each day by Lois Imler. Discharge measurements are made from the downstream side of the bridge, to which the gage is attached. The initial point for soundings is the face of the east abutment. The channel is straight for about 1,600 feet above and about 2,000 feet below the station. Its width at ordinary stages is 350 feet, broken by two piers, and at high water is 510 feet, broken by three piers. Both banks are high and can not overflow to any considerable extent. The bed of the stream is rocky and rough; the current is swift. The bench mark is the head of an anchor bolt in the east abutment; it is the outside anchor of the downstream truss. Its elevation above the zero of the gage is 22.25 feet.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Tippecanoe River near Delphi, Ind., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
January 23	F. W. Hanna	448	2,404	4.10	8.48	9,863
March 2[a]	do	466	3,920	2.55	13.00	10,010
March 28	do	449	2,560	4.78	8.80	12,240
May 2	Hanna and Johnson	343	917	4.04	4.95	3,708
June 18	F. W. Hanna	253	328	2.12	2.98	694
July 23	Hanna and Johnson	238	292	1.83	2.92	534
August 22	F. W. Hanna	255	370	2.38	3.20	882
September 13	do	241	278	1.62	2.85	451
October 22	do	249	273	1.77	2.90	484
November 5	do	240	266	1.49	2.86	396

[a] Ice jam.

Mean daily gage height, in feet, of Tippecanoe River near Delphi, Ind., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[a]
1	.....	.....	14.60	9.55	6.59	4.25	3.49	2.85	2.93	3.10	2.83	2.83
2	.....	.....	13.44	9.43	5.07	4.21	3.37	2.82	2.90	3.07	2.82	2.82
3	.....	.....	13.21	8.49	4.80	3.87	3.21	2.80	2.87	3.05	2.84	2.80
4	.....	.....	12.90	8.34	5.60	3.74	3.09	2.81	2.86	3.00	2.84	2.80
5	.....	.....	12.37	8.21	5.12	3.65	3.17	2.81	2.84	2.95	2.85	2.91
6	4.10	8.25	12.25	8.03	4.96	3.61	3.22	2.77	2.85	2.91	2.85	2.96
7	.....	.....	12.80	7.95	4.72	3.49	3.75	2.75	2.83	2.90	2.84	2.97
8	3.80	.....	13.20	8.20	4.57	3.45	4.03	2.73	2.83	2.93	2.80	2.98
9	.....	.....	12.47	8.75	4.35	3.49	4.40	2.73	2.84	3.00	2.85	3.00
10	.....	.....	7.05	8.15	4.05	3.52	4.37	2.72	2.85	3.07	2.87	3.02
11	.....	.....	7.00	7.75	4.00	3.43	4.26	2.71	2.85	3.05	2.86	3.00
12	.....	.....	6.95	7.08	3.93	3.18	4.20	2.69	2.84	3.00	2.85	2.99
13	.....	7.85	6.90	5.53	3.84	3.17	4.17	2.74	2.81	3.00	2.86	2.98
14	.....	.....	7.00	4.98	3.89	3.13	3.98	2.73	3.00	2.98	2.84	.....
15	.....	.....	6.87	5.02	3.91	3.13	3.96	2.72	2.98	2.97	2.87	.....
16	3.85	.....	6.77	5.17	3.89	3.12	3.71	2.71	3.01	3.03	2.89	.....
17	.....	.....	7.00	5.17	3.85	3.54	3.55	2.78	3.05	3.00	2.88	3.04
18	.....	.....	7.20	5.14	4.01	3.27	3.47	2.80	3.21	2.97	2.86	.....
19	.....	.....	7.23	5.12	3.99	3.20	3.38	2.81	3.10	2.95	2.86	.....
20	4.75	8.20	7.10	5.09	3.95	3.16	3.30	2.90	3.05	2.92	2.85	.....
21	11.05	.....	7.15	4.98	3.90	3.10	3.21	3.05	3.00	2.90	2.83	.....
22	11.25	.....	7.77	4.91	3.81	3.09	3.00	3.35	2.98	2.98	2.80	.....
23	10.95	.....	8.10	4.67	3.70	3.07	2.95	3.42	2.97	2.95	2.85	3.05
24	.....	.....	8.54	4.47	3.64	3.06	2.91	3.40	2.95	2.94	.....	3.09
25	.....	.....	8.92	4.01	3.73	3.00	2.90	3.35	2.93	2.97	.....	3.12
26	.....	.....	11.20	5.80	3.72	2.96	2.90	3.28	3.10	2.95	.....	.....
27	15.00	8.20	9.41	7.03	3.71	3.00	2.99	3.18	3.15	2.92	.....	.....
28	.....	.....	7.94	6.70	3.70	3.83	2.98	2.98	3.23	2.81	.....	.....
29	.....	15.20	7.02	6.35	3.60	3.71	2.93	3.00	3.20	2.85	2.84	.....
30	7.25	.....	6.76	6.10	3.74	3.79	2.91	2.93	3.16	2.85	2.83	3.05
31	.....	.....	8.90	.....	4.20	.....	2.89	2.90	.....	2.84	.....	.....

[a] Frozen January 1 to March 9 and December 14 to 31.

Rating table for Tippecanoe River near Delphi, Ind., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.7	280	3.8	1,770	4.9	3,640	7.0	8,110
2.8	390	3.9	1,930	5.0	3,830	7.5	9,220
2.9	510	4.0	2,090	5.2	4,230	8.0	10,370
3.0	630	4.1	2,250	5.4	4,650	8.5	11,520
3.1	760	4.2	2,410	5.6	5,070	9.0	12,670
3.2	890	4.3	2,580	5.8	5,490	9.5	13,820
3.3	1,030	4.4	2,750	6.0	5,910	10.0	14,970
3.4	1,170	4.5	2,920	6.2	6,350	10.5	16,120
3.5	1,320	4.6	3,090	6.4	6,790	11.0	17,270
3.6	1,470	4.7	3,270	6.6	7,230	12.0	19,570
3.7	1,620	4.8	3,450	6.8	7,670	13.0	21,870

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is well defined between gage heights 2.8 feet and 8.8 feet. The table has been extended beyond these limits. Above gage height 7.4 feet the rating curve is a tangent, the difference being 230 per tenth.

Estimated monthly discharge of Tippecanoe River near Delphi, Ind., for 1904.

[Drainage area, 1,890 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 10 to 31	17,730	7,560	9,633	5.10	4.17
April	13,940	2,090	7,210	3.81	4.25
May	7,230	1,470	2,492	1.32	1.52
June	2,495	582	1,199	.634	.707
July	2,750	498	1,247	.660	.761
August	1,200	269	534	.282	.325
September	932	402	601	.318	.355
October	760	402	585	.310	.357
November	498	390	446	.236	.264
December 1 to 13	656	390	543	.287	.139

WHITE RIVER (WEST BRANCH) AT INDIANAPOLIS, IND.

This station was established May 6, 1904, by E. Johnson, jr., assisted by F. W. Hanna. It is located in the central portion of the city on the bridge of the Cleveland, Cincinnati, Chicago, and St. Louis Railway. A standard chain gage is attached to the downstream side of the bridge, the scale being graduated to feet and tenths on the downstream side of the binding tie. The length of the chain from the end of the weight to the marker, which is the outside of the ring, is 37.10 feet. The gage is read twice each day by J. D. Burk. The chain and weight are kept at the water softening plant of the Kingan Packing Company, located 100 feet downstream from the right abutment of the bridge. Discharge measurements are made from the downstream side of the through Pratt truss bridge of three spans, to which the gage is attached. The initial point for soundings is the downstream inner face of the right abutment. The channel is straight for about 500 feet above and for 1,000 feet below the station. The current is direct, but sluggish in low stages. The right bank is moderately high and seldom overflows. The left bank is high, covered by buildings, and never overflows. All the water passes between the abutments of the bridge. The bed of the stream is composed of gravel and sand, and is fairly permanent. There are three channels at all stages. At low water the current is too sluggish to permit of very accurate measurement. Bench mark No. 1 is the south capstone of the ballast wall of the right abutment. Its elevation is 36.51 feet above the datum of the gage. Bench mark No. 2 is the downstream top edge of the fifth cross girder from the right abutment of the bridge. Its elevation is 36.54 feet above the datum of the gage.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of White River (West Branch) at Indianapolis, Ind., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 6	Johnson and Hanna	265	1,423	0.81	8.80	1,147
June 17	F. W. Hanna	256	1,324	.65	8.45	866
July 29	do	222	1,129	.34	7.53	380
August 23	do	233	1,210	.41	7.85	495
September 14	do	223	1,042	.23	7.20	240
October 21 [a]	do	68	150	1.43	7.30	216
November 4 [a]	do	68	131	1.49	7.20	195

[a] Measurement made from boat and cable 1 mile below station.

Mean daily gage height, in feet, of White River (West Branch) at Indianapolis, Ind., in 1904.

Day.	Mar.[a]	Apr.[a]	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	18.85	.....	8.90	8.30	7.50	7.30	7.40	7.20	7.10
2	.....	21.66	.....	9.50	8.45	7.45	7.30	7.10	7.20	7.10
3	.....	20.90	.....	9.20	8.35	7.40	7.30	7.30	7.20	7.10
4	.....	14.71	.....	9.10	8.25	7.40	7.20	7.30	7.20	7.10
5	.....	.....	.....	9.10	8.20	7.40	7.20	7.30	7.20	7.10
6	.....	.....	8.80	8.75	8.20	7.35	7.25	7.25	7.20	7.10
7	.....	.....	8.75	8.60	9.10	7.35	7.30	7.25	7.20	7.10
8	.....	.....	8.70	8.40	9.50	7.35	7.30	7.20	7.20	6.75
9	.....	.....	8.70	8.30	9.45	7.30	7.25	7.20	7.30	6.70
10	.....	.....	8.70	8.30	9.20	7.30	7.20	7.20	7.25	7.10
11	.....	.....	8.60	8.20	8.90	7.40	7.20	7.50	7.20	7.10
12	.....	.....	8.50	8.20	8.70	7.30	7.20	7.50	7.20	7.10
13	.....	.....	8.50	8.10	8.50	7.25	7.20	7.40	7.20	7.10
14	.....	.....	8.40	8.10	8.40	7.20	7.25	7.40	7.10	6.90
15	.....	.....	8.40	8.00	8.20	7.15	7.20	7.30	7.20	6.95
16	.....	.....	8.40	8.10	8.10	7.20	7.20	7.30	7.20	7.00
17	.....	.....	8.40	8.50	8.00	7.20	7.20	7.30	7.20	7.15
18	.....	.....	8.50	8.50	8.00	7.10	7.25	7.30	7.20	7.15
19	.....	.....	8.70	8.70	7.90	7.20	7.30	7.30	7.20	7.10
20	.....	.....	8.90	9.10	7.90	7.50	7.55	7.30	7.20	7.10
21	.....	.....	9.10	9.60	7.85	7.80	7.35	7.30	7.20	7.10
22	.....	.....	9.10	9.60	8.00	8.20	7.30	7.30	7.20	7.10
23	.....	.....	8.80	9.00	8.00	8.00	7.30	7.30	7.20	7.20
24	.....	.....	8.70	8.90	7.85	7.65	7.30	7.30	7.20	7.50
25	.....	.....	8.70	8.55	7.80	7.60	7.40	7.25	7.20	7.60
26	21.42	.....	8.60	8.45	7.70	7.40	7.70	7.25	7.20	7.70
27	24.74	.....	8.70	8.40	7.65	7.35	7.60	7.25	7.20	9.20
28	21.21	.....	8.70	8.30	7.60	7.30	7.60	7.20	7.10	9.70
29	13.79	.....	8.80	8.30	7.55	7.30	7.60	7.10	7.10	8.75
30	12.15	.....	8.80	8.30	7.50	7.25	7.60	7.15	7.10	8.45
31	13.26	.....	8.90	.....	7.50	7.30	.....	7.15	.....	8.50

[a] Readings March 26 to April 4 reduced from readings of Kingan gage.

Rating table for White River (West Branch) at Indianapolis, Ind., from May 6 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
7.0	184	7.6	380	8.2	700	8.8	1,150
7.1	211	7.7	425	8.3	770	8.9	1,240
7.2	240	7.8	475	8.4	840	9.0	1,330
7.3	271	7.9	525	8.5	910		
7.4	304	8.0	580	8.6	990		
7.5	340	8.1	640	8.7	1,070		

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1904. It is well defined between gage heights 7.2 feet and 8.8 feet. The table has been extended beyond these limits.

Estimated monthly discharge of White River (West Branch) at Indianapolis, Ind., for 1904.

[Drainage area, 1,520 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
May 6–31	1,420	840	1,064	0.700	0.677
June	1,870	580	1,045	.688	.768
July	1,780	340	759	.499	.575
August	700	211	314	.207	.239
September	425	240	284	.187	.209
October	340	211	265	.174	.201
November	271	211	238	.157	.175
December	1,960	115	391	.257	.296

LOWER EEL RIVER NEAR CATARACT, IND.

This station was established August 6, 1903, by E. Johnson, jr., assisted by L. R. Stockman. It is located 6 miles from Cloverdale, Ind., and one-half mile northeast of Cataract, Ind. It is 300 feet above a dam below which there is a fall of 35 feet. The gage is a 3 by 6 inch oak timber, securely fastened to the west abutment on the downstream face. It is marked by brass-headed nails and reads from zero to 10 feet. The gage is read once each day by Joe Steiner. Discharge measurements are made from the upstream side of the single-span, covered highway bridge, which has a length between abutments of 128 feet. The initial point for soundings is the face of the left or west abutment at the top of the coping on the upstream side. Distances are marked by wire nails and painted figures on the guard rail on the upstream side of the bridge. The channel is straight for about 500 feet above and 300 feet below the bridge. The current varies from swift to rather sluggish. Both banks are high and rocky and will not overflow. The bed of the stream is a smooth rock ledge, nearly level between the bridge abutments.

Bench mark No. 1 is a wire nail in the root of a small elm tree in a stone wall on the north side of the road approaching the bridge on the west side of the river about 50 feet from the bridge. Its elevation above the zero of the gage is 12.60 feet. Bench mark No. 2 is a wire nail in the root of a large oak tree in the pasture on the west side of the river 300 feet from the bridge and 20 feet from the fence which bounds the south side of the road approaching the bridge. The elevation of this bench mark is 27.20 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

One measurement was made on May 4, 1904; gage height, 1.28 feet; discharge, 104 second-feet.

Mean daily gage height, in feet, of Eel (lower) River near Cataract, Ind., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.60	2.40	3.50	4.80	2.00	1.40	1.40	0.90	1.10	1.40	0.80	(b)
2	1.60	2.40	3.60	4.90	2.10	1.30	1.30	.90	1.20	1.40	.80	(b)
3	1.50	2.40	3.70	4.80	2.10	1.30	1.30	.90	1.20	1.30	.70	(b)
4	1.50	2.40	3.70	4.80	2.20	1.30	1.30	.90	1.10	1.30	.70	(b)
5	1.50	2.40	3.60	4.60	2.20	1.20	1.20	.90	1.10	1.20	.70	(b)
6	1.50	2.60	2.70	3.60	2.20	1.20	1.20	.90	1.00	1.10	.80	(b)
7	1.50	4.00	2.90	3.00	2.20	1.30	1.20	.80	1.00	1.10	.90	(b)
8	1.50	4.00	2.90	2.50	2.10	1.40	1.20	.80	.90	1.10	1.00	(b)
9	1.50	4.00	2.60	2.20	2.10	1.40	1.20	.80	.80	1.20	1.00	(b)
10	1.50	4.00	2.60	2.10	2.10	1.40	1.10	.80	.60	1.20	1.00	(b)
11	1.50	3.90	2.70	2.10	2.20	1.30	1.10	.80	.70	1.30	1.00	(b)
12	1.50	3.70	2.60	2.10	2.30	1.30	1.10	.80	.70	1.20	1.00	(b)
13	1.50	3.40	2.30	2.00	2.30	1.40	1.10	.80	.70	1.10	1.10	(b)
14	1.50	3.20	2.25	2.00	2.20	1.40	1.10	.90	.80	1.00	1.10	(b)
15	1.50	3.20	2.30	2.00	2.20	1.40	1.10	.90	.90	1.00	1.10	(b)
16	1.50	3.10	2.40	2.00	2.20	1.40	1.10	.90	1.00	1.00	1.00	(b)
17	1.60	3.00	2.50	2.10	2.10	1.40	1.05	.90	1.00	1.00	1.00	(b)
18	1.70	2.90	2.60	2.10	2.10	1.40	1.05	.90	1.00	1.10	1.10	(b)
19	1.90	2.90	2.70	2.00	2.10	1.40	1.05	.90	1.10	1.10	1.00	(b)
20	2.50	2.90	2.80	2.00	2.00	1.50	1.10	1.00	1.10	1.10	1.00	(b)
21	2.70	2.90	2.90	2.00	2.00	1.50	1.00	1.00	1.20	1.10	1.00	(b)
22	4.10	2.90	3.00	2.00	2.00	1.50	1.00	1.00	1.10	1.00	1.00	0.50
23	4.10	3.00	3.40	2.00	2.00	1.50	1.00	1.00	1.00	1.00	1.00	.80
24	4.00	3.00	3.50	2.20	2.00	1.50	1.00	1.10	1.00	1.00	1.00	1.30
25	3.90	3.00	4.70	2.20	1.80	1.60	1.00	1.20	1.20	1.10	1.00	1.40
26	3.60	3.00	6.60	2.10	1.80	1.60	.90	1.20	1.40	1.00	1.00	1.70
27	3.40	3.00	6.60	2.10	1.70	1.50	.90	1.20	1.45	1.00	.80	2.00
28	3.00	3.20	6.30	2.10	1.60	1.50	.90	1.10	1.55	1.00	.70	2.30
29	2.70	3.40	5.20	2.10	1.50	1.40	.90	1.10	1.50	.90	.50	2.70
30	2.60	.....	4.00	2.00	1.50	1.40	.90	1.10	1.40	.90	.40	3.00
31	2.40	.....	3.90	.....	1.40	.....	.90	1.00	.....	.90	.....	3.30

[a] Ice conditions January and February. [b] Below gage.

NOTE.—The zero of the gage is 0.96 feet below the crest of the dam; therefore when the gage is below 0.96 all the water flows through a small flume.

WHITE RIVER (EAST BRANCH) AT SHOALS, IND.

This station was established June 25, 1903, by A. C. Lootz. It is located at the highway bridge, in the village of Shoals, Ind., 400 feet above the Baltimore and Ohio Southwestern Railroad bridge. There are rapids just below this station and also about 5½ miles below. The gage is read once each day by O. H. Greist. A standard chain gage is fastened to the railing and metal posts of the downstream side of the first span on the left end of the highway bridge. The length of the chain from the end of the weight to the marker is 46.41 feet. Discharge measurements are made from the 3-span highway bridge to which the gage is attached. The initial point for soundings is the face of the left abutment. The channel is straight above and below the station and the current is swift. The right bank is a high rocky road embankment and never overflows; the left bank is a steep rocky bluff and does not overflow. The bed of the stream is rocky, and the channel is divided into three parts by the bridge piers. Bench mark No. 1 is the stone cap on the downstream end of the first pier from the left bank. Its elevation is 100 feet above gage datum.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of White River (East Branch) at Shoals, Ind., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Ft. per. sec.*	*Feet.*	*Second-ft.*
June 22 [a]	A. C. Lootz					2,000
August 4	L. R. Stockman	344	1,083	3.13	65.07	3,392
September 24	do	286	408	1.25	63.40	511
1904.						
January 24	F. W. Hanna		4,105	4.61	73.47	19,010
March 5	do	375	2,321	4.99	68.64	11,590
March 30	do	427	13,410	6.00	95.20	79,820
May 5	F. W. Hanna and Johnson.	356	1,124	3.72	65.43	4,180
June 16	F. W. Hanna	349	789	2.30	64.53	1,812
July 28	do	307	515	1.60	63.88	823
August 24	do	295	379	1.28	63.32	484
September 15	do	295	373	1.06	63.24	397
October 20	do	295	371	1.07	63.23	396
November 3	do	288	324	.99	63.17	320

[a] Float measurement.

Mean daily gage height, in feet, of White River (East Branch) at Shoals, Ind., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	64.60	66.20	67.60	91.00	67.00	64.80	65.30	63.80	63.30	63.50	63.20	63.20
2	64.50	65.50	68.10	88.80	66.50	65.60	65.10	63.70	63.30	63.50	63.20	63.20
3	64.30	65.20	68.20	87.20	65.90	66.00	65.00	63.70	63.30	63.50	63.20	63.20
4	64.20	64.90	68.70	85.60	65.60	66.00	64.80	63.70	63.30	63.40	63.20	63.20
5	64.10	64.80	68.60	84.40	65.40	65.60	64.70	63.70	63.30	63.40	63.20	63.20
6	64.10	68.50	69.10	83.40	65.30	65.40	64.50	63.70	63.20	63.30	63.20	63.20
7	64.10	71.50	72.30	80.20	65.10	65.00	64.40	63.70	63.20	63.30	63.20	63.20
8	64.00	72.80	72.90	78.20	65.00	64.90	64.30	63.70	63.20	63.30	63.20	63.20
9	64.00	74.30	71.50	68.40	64.90	64.70	64.30	63.70	63.20	63.30	63.20	63.20
10	64.00	76.10	70.30	67.70	64.80	64.60	64.30	63.60	63.30	63.30	63.20	63.20
11	64.00	77.00	70.50	67.50	64.70	64.50	64.40	63.60	63.30	63.30	63.20	63.20
12	64.00	76.00	69.80	67.30	64.70	64.40	64.50	63.60	63.30	63.30	63.20	63.20
13	64.00	72.50	69.10	67.00	64.70	64.40	64.50	63.50	63.30	63.30	63.20	63.20
14	64.00	68.50	68.90	66.80	64.60	64.30	64.50	63.50	63.30	63.30	63.20	63.20
15	64.00	66.50	68.70	66.50	64.60	64.40	64.40	63.50	63.30	63.30	63.20	63.00
16	64.00	66.00	68.00	66.20	64.50	64.30	64.50	63.50	63.20	63.30	63.20	63.00
17	64.00	65.90	67.60	66.00	64.50	64.50	64.30	63.50	63.20	63.30	63.20	63.10
18	64.00	65.60	67.50	65.80	66.50	64.60	64.20	63.50	63.40	63.30	63.20	63.10
19	64.10	65.40	67.60	65.60	66.50	64.70	64.20	63.50	63.70	63.30	63.20	63.20
20	64.10	65.20	67.70	65.40	64.50	64.90	64.20	63.50	63.60	63.30	63.20	63.20
21	64.60	65.10	67.70	65.30	64.50	64.90	64.20	63.60	63.50	63.30	63.20	63.20
22	69.40	67.30	68.00	65.20	64.50	64.90	64.20	63.60	63.50	63.20	63.20	63.20
23	78.30	68.30	74.40	65.10	64.60	64.80	64.20	63.60	63.40	63.20	63.20	63.20
24	73.50	69.60	75.20	65.10	64.70	64.80	64.10	63.50	63.40	63.20	63.20	63.30
25	74.20	70.90	78.40	65.20	64.60	64.80	64.10	63.40	63.40	63.20	63.20	63.40
26	74.50	70.60	87.10	66.50	64.60	64.80	64.00	63.40	63.70	63.20	63.20	63.90
27	74.80	69.40	87.70	67.50	64.80	64.80	64.00	63.30	63.80	63.20	63.20	64.50
28	75.00	68.00	92.80	68.60	64.60	65.20	63.90	63.30	63.80	63.20	63.20	65.20
29	72.20	67.30	95.00	68.40	64.60	64.80	63.90	63.30	63.70	63.20	63.20	66.00
30	67.80	.....	94.90	67.80	64.60	65.40	63.80	63.30	63.50	63.20	63.20	66.30
31	66.50	.....	93.40	.....	64.70	.....	63.80	63.30	.....	63.20	.....	66.00

[a] Ice conditions January, February, and March; uncertain. [b] Frozen December 15 to 31.

Rating table for White River (East Branch) at Shoals, Ind., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
63.0	215	64.7	2,000	67.4	8,110	76.0	30,030
63.1	286	64.8	2,150	67.6	8,610	77.0	32,630
63.2	360	64.9	2,310	67.8	9,110	80.0	40,430
63.3	440	65.0	2,470	68.0	9,610	83.0	48,230
63.4	520	65.1	2,640	68.5	10,860	84.0	50,830
63.5	605	65.2	2,820	69.0	12,110	85.0	53,430
63.6	695	65.3	3,010	69.5	13,360	87.0	58,630
63.7	790	65.4	3,210	70.0	14,610	88.0	61,230
63.8	890	65.6	3,640	70.5	15,860	90.0	66,430
63.9	990	65.8	4,110	71.0	17,110	91.0	69,030
64.0	1,100	66.0	4,610	71.5	18,360	92.0	71,630
64.1	1,210	66.2	5,110	72.0	19,630	93.0	74,230
64.2	1,330	66.4	5,610	72.5	20,930	94.0	76,830
64.3	1,450	66.6	6,110	73.0	22,230	95.0	79,430
64.4	1,580	66.8	6,610	73.5	23,530		
64.5	1,710	67.0	7,110	74.0	24,830		
64.6	1,850	67.2	7,610	75.0	27,430		

The above table is applicable only for open-channel conditions. It is based upon 13 discharge measurements made during 1903 and 1904. It is well defined between gage heights 63.2 feet and 65.4 feet. Above gage height 72 feet the rating curve is a tangent the difference being 260 per tenth. Two flood measurements above 65.4 feet gage height define the tangent. The table has been extended beyond these limits.

Estimated monthly discharge of White River (East Branch) at Shoals, Ind., for 1904.

[Drainage area, 4,900 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January [a]	27,430	1,100	7,320	1.49	1.72
February [a]	32,630	2,150	11,710	2.39	2.58
March [a]	79,430	8,360	25,310	5.17	5.96
April	69,330	2,640	1,822	.372	.415
May	7,110	1,710	2,709	.553	.638
June	4,610	1,450	2,375	.485	.541
July	3,010	890	1,539	.314	.362
August	890	440	647	.132	.152
September	890	360	525	.107	.119
October	605	360	435	.089	.103
November	360	360	360	.073	.081
December [a]	5,360	215	932	.190	.219
The year	79,430	215	4,640	.947	12.89

[a] January, February, March, and December estimates computed as if open channel.

CUMBERLAND RIVER DRAINAGE BASIN.

Cumberland River rises in the eastern part of Kentucky and flows west till it meets the South Fork, which rises in northern Tennessee and flows northward. After this junction the Cumberland turns toward the southwest into Tennessee, and, after flowing through the north-central part, again enters Kentucky in Trigg County, flows across the State, and enters Ohio River at Smithland, about 15 miles above the mouth of Tennessee River. The gaging station on this river is located at Nashville, Tenn.

CUMBERLAND RIVER AT NASHVILLE, TENN.

The gage, which belongs to the United States Engineer Corps, is at the foot of Broad street. It is in three sections, two of which are upright and one inclined. The lowest section, extending from −0.2 foot to +46 feet, is on the slope of the bank and consists of timbers embedded in the ground, bearing an iron strap, into which the markings are cut. The section extending from gage height 46 to 53 feet is fastened to a small building at the top of the bank, and consists of a timber painted white with black markings. The top section of the gage, extending from 52 feet to 55.3 feet, is on the corner of Temperance Hall, painted on the stones in white with black markings. In addition there is a vertical section reading from −1.2 feet to +2 feet. Discharge measurements are made from the upstream side of Woodlawn Street Bridge, which has four spans having a total length of 656 feet. The floor of the bridge is on a slope, the lower or right bank end being about 100 feet above low water. The initial point for soundings is the end of the iron hand rail on the upstream side of the bridge at the left bank. The channel is nearly straight for 2,000 feet above and for 1,500 feet below the station. The right bank is high, but overflows at high stages. It is occupied by lumber yards and sawmills. The left bank is high, rocky, and is not subject to overflow. The bed of the stream is composed of rock and is permanent. There is one channel broken by one pier at ordinary and by three piers at high water.

During October, 1904, a lock and dam were completed about 2½ miles below the gage, which at low water raises the water surface at the gage about 5½ feet and causes the low-water velocity to become rather slow for good measurements. The datum of the gage corresponds to elevation 110.3 feet of the city levels. A cross, cut on the upper face of the corner stone in the southeast corner of Temperance Hall, on Broad street, near Front street, is 52 feet above the zero of the gage, and 366.6 feet above mean sea level. The highest observed water was 55.3 feet on January 22, 1882. The lowest occurred on October 15 and 16, 1878, at a gage height of −0.4 foot. The danger line is at 40 feet.

Records have been kept for a number of years by the United States Weather Bureau, from which readings previous to those here published may be obtained.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Cumberland River at Nashville, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 18	J. M. Giles	344	4,789	2.87	8.25	13,730
May 19	do	344	5,034	2.79	8.35	14,030
May 20	do	344	5,031	2.59	8.13	13,030
August 19	do	313	2,991	.88	2.26	2,630
August 19	do	313	3,000	.88	2.30	2,648
August 20	do	313	2,924	.83	2.22	2,428
October 22	do	328	4,239	.36	[a] 6.60	1,534

[a] Rise in gage height caused by new dam 2½ miles below station=5.6.

Mean daily gage height, in feet, of Cumberland River at Nashville, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.50	8.60	10.10	31.90	9.50	6.90	6.20	2.70	2.30	1.00	6.60	6.80
2	9.40	7.60	9.80	24.10	9.80	8.40	5.40	2.70	2.10	1.10	6.60	6.90
3	9.40	6.90	9.70	19.20	9.80	11.70	4.80	3.00	1.90	1.20	6.70	6.90
4	9.70	6.30	9.40	15.40	10.50	14.00	4.80	2.90	3.20	1.10	6.70	6.90
5	9.40	5.80	9.10	13.20	11.40	15.20	4.90	2.70	2.10	1.00	6.80	7.00
6	10.50	5.40	8.70	11.70	12.40	14.40	4.70	2.70	1.80	1.00	6.70	7.00
7	11.00	5.00	9.80	10.40	11.90	13.10	4.60	2.70	1.70	1.00	6.80	7.40
8	10.40	4.90	14.30	9.60	10.90	14.80	4.00	2.60	1.60	1.00	6.80	7.40
9	9.00	4.90	15.70	8.80	10.70	14.70	4.20	2.50	1.70	1.20	6.90	7.50
10	7.60	4.90	17.80	8.50	10.20	14.00	4.50	2.50	1.60	1.00	6.90	8.30
11	6.70	5.70	21.20	8.40	10.00	11.80	4.80	2.40	1.50	[a] 1.50	6.90	8.10
12	6.10	7.20	22.50	8.60	10.20	10.00	4.60	2.50	1.40	2.80	6.90	8.90
13	6.00	8.00	20.70	8.30	10.00	8.70	4.70	2.60	1.40	3.70	6.90	9.00
14	6.00	7.60	18.30	7.80	10.30	7.50	4.10	2.50	1.40	4.60	6.80	8.70
15	7.20	7.20	16.00	7.40	10.00	6.40	3.90	2.50	1.50	5.30	6.80	8.50
16	7.00	7.00	14.40	7.10	9.10	5.50	3.70	2.40	1.40	6.00	6.80	8.30
17	7.10	6.00	14.60	6.80	8.40	4.90	3.60	2.30	1.30	6.50	6.80	8.30
18	9.00	5.60	14.30	6.80	8.30	4.40	3.30	2.30	1.20	6.60	6.90	8.30
19	9.70	5.30	13.60	6.40	8.30	4.30	3.80	2.20	1.20	6.60	6.90	8.30
20	10.00	5.10	13.00	6.20	8.10	3.60	3.70	2.20	1.70	6.60	6.90	8.10
21	11.40	5.00	12.40	6.10	7.50	4.10	3.50	2.20	1.20	6.60	6.90	8.00
22	14.30	5.10	18.10	6.00	6.90	3.70	3.50	2.20	1.30	6.60	6.90	7.80
23	16.80	5.30	21.40	6.00	6.30	3.40	3.70	2.30	1.20	6.60	6.90	7.70
24	16.60	5.30	26.10	6.00	6.00	3.50	3.30	2.30	1.10	6.60	6.90	7.80
25	18.00	5.60	27.90	6.40	5.70	3.40	3.00	2.80	1.00	6.60	6.90	8.30
26	20.00	6.40	31.30	6.70	5.40	3.30	3.00	4.40	1.00	6.60	6.90	8.90
27	20.50	7.90	37.30	6.90	5.00	3.20	3.00	3.90	1.10	6.60	6.90	11.40
28	18.70	9.60	37.20	7.30	4.60	4.20	3.00	3.30	1.10	6.60	6.80	18.40
29	15.60	10.10	36.90	8.00	4.20	5.50	2.80	2.90	1.10	6.60	6.80	16.70
30	12.60	.....	36.20	8.70	4.20	5.40	2.80	2.60	1.00	6.60	6.80	18.50
31	10.00	.....	33.90	.....	5.00	.....	2.70	2.50	.....	6.50	.....	18.80

[a] Dam at lock 2½ miles below put into operation, raising water level at gage about 5.6 feet above low-water stage.

TENNESSEE RIVER DRAINAGE BASIN.

Tennessee River is formed by the junction of the French Broad and the Holston about 4 miles above Knoxville, Tenn. It flows southwest, crossing into Alabama about 40 miles below Chattanooga, Tenn., and, after crossing the northern part of Alabama, again enters Tennessee in Harding County. It then flows north, crossing Tennessee and Kentucky, and enters Ohio River at Paducah, about 40 miles above Cairo. Its principal tributary on the north is Clinch River, which enters it near Kingston, Roan County, Tenn. The principal tributaries on the south are Hiwassee and Little Tennessee rivers. Hiwassee rises in the northern part of Georgia and flows into the Tennessee about 30 miles above Chattanooga. Its principal tributaries are the Okoee and the Nottely. Little Tennessee River rises in the northeastern corner of Georgia, flows across the southwestern part of North Carolina, and enters the Tennessee near Loudon, Tenn. Its principal tributary is the Tuckasegee. French Broad River rises in the western part of North Carolina. Its principal tributaries are the Pigeon and the Nolichucky. Holston River rises in the western part of Virginia. Its principal tributary is Watauga River, into which stream Roan Creek enters.

FRENCH BROAD RIVER AT HORSESHOE, N. C.

This station was established October 4, 1904, by B. S. Drane. It is located at the steel highway bridge at Horseshoe, N. C. A plain staff gage, graduated to feet and tenths, is attached vertically to a 1½ by 4 inch oak timber which is driven into the bed of the stream to a firm foundation and nailed to an overhanging birch on the right bank, 25 feet below the bridge. The gage is read once each day by Charles Duncan. Discharge measurements are made from the downstream side of the single-span, five-panel truss bridge mounted on stone abutments. The approach on each side is over an earth embankment. On the left bank a flood channel 81 feet wide is opened through the embankment 140 feet from the end of the bridge. The initial point for soundings is on the downstream hand rail over the inner edge of the capstone of the left abutment. The channel is straight for about 2,000 feet above and 1,500 feet below the station. The current is of fair velocity at all stages except at the lowest when it inclines to be sluggish along the right bank. The right bank is of earth, wooded, and about 15 feet high. The left bank is similar but is cleared. The earth embankments on either side to the higher ground are of such a height that all the water passes beneath the bridge and the overflow channel at all stages. There is but one channel at low and ordinary stages. The bed of the stream is composed of sand and a few rocks. It is smooth and permanent. Bench mark No. 1 is the upper surface

of the downstream end of the first floor beam from the left bank, 15 feet from the initial point for soundings. Its elevation is 20.48 feet above the zero of the gage. Bench mark No. 2 is the center of the head of a wire nail driven into the downstream face of a large birch tree on the right bank, about 20 feet above the bridge. Its elevation is 12.40 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of French Broad River at Horseshoe, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
July 18	B. S. Drane	82	241	1.64	0.86	396
August 18	do	82	285	1.86	1.51	529
October 3	do	81	192	1.50	.51	290
December 7	do	81	318	1.84	1.91	584

Mean daily gage height, in feet, of French Broad River at Horseshoe, N. C., for 1904.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	0.50	0.35	0.60	12	0.40	0.50	1.00	23	0.30	0.65	0.75
2	.50	.35	.55	13	.40	1.50	.90	24	.30	.65	.75
3	.50	.45	.65	14	.35	2.00	.80	25	.30	.55	.90
4	.50	2.45	.75	15	.35	1.10	.80	26	.35	.55	1.00
5	.50	2.10	.75	16	.35	.90	.85	27	.35	.55	1.55
6	.50	1.75	4.60	17	.30	.80	.85	28	.35	.55	6.00
7	.50	1.00	2.20	18	.30	.75	.95	29	.35	.50	3.30
8	.55	.75	1.50	19	.30	.70	.85	30	.35	.50	2.15
9	.45	.60	1.30	20	.30	.65	.80	31	.35	.....	1.80
10	.45	.60	1.10	21	.30	.60	.80				
11	.40	.55	1.10	22	.30	.60	.75				

FRENCH BROAD RIVER AT BINGHAM SCHOOL BRIDGE, NEAR ASHEVILLE, N. C.

This station was established in September, 1895, by C. C. Babb. It is located at Bingham School Bridge crossing French Broad River at Riverside Park, about 3 miles west of Asheville, N. C. It was maintained as a regular station from 1895 to the close of 1901. It is now maintained as a bench-mark station. Discharge measurements are made from the upstream side of the three-span bridge. The initial point for soundings is the right end of the iron bridge on the upstream side. The channel is straight for about 700 feet above and below the station. The current is swift. Both banks are high, wooded, and not liable to overflow. The bed of the stream is composed of bowlders, very rough,

and permanent. There is but one channel at all stages, broken by two piers at ordinary stages and four piers at high stages. Since the regular station was discontinued a large waterpower development has been installed about six miles below, and it is possible that the rating of the station has been changed and the flow affected. Bench mark No. 1 is the upper edge of the steel plate riveted to the bridge post, over the second floor beam, from the right bank, on the upstream side of the bridge. Its elevation is 20 feet above gage datum. Bench mark No. 2 is the center of the head of a small nail driven into the limb on the downstream side of a large sycamore tree on the right bank, just above the bridge, along which a platform runs out over the water. Its elevation is 11.71 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of French Broad River at Bingham School Bridge, near Asheville, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 21	B. S. Drane	279	564	2.08	2.72	1,172
May 23	do	279	565	2.01	2.64	1,138
July 20	do	268	414	1.52	2.16	629

FRENCH BROAD RIVER AT SMITH BRIDGE, NEAR ASHEVILLE, N. C.

This station was established May 21, 1904, as a bench-mark station. It is located about 1 mile below the Southern Railway depot at Asheville, N. C., and just down the hill from the terminal of the Patton avenue line of the Asheville Street Railway Company. The Southern Railway bridge is about 1,500 feet below and the Bingham School bridge about a mile below the station. A plain staff gage, graduated to feet and tenths, the property of the United States Weather Bureau, is bolted vertically to the southwest corner of the second stone pier from the left bank. A short section, reading from 0.00 downward, is set just downstream from the main section. Discharge measurements are made from the downstream side of the four-span bridge to which the gage is attached. The initial point for soundings is the left end of the downstream hand rail. The channel is straight for about 1,500 feet above and 800 feet below the station. The current has a good velocity. Both banks are clean, and will not overflow beyond the bridge and its approaches. The bed of the stream is composed of sand and silt, with a few scattered bowlders. There is but one channel at all stages, broken by three piers at ordinary stages and five piers at high-water stages. The operations of a waterpower development about 7 miles below will probably affect the flow at this point.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of French Broad River at Smith Bridge, near Asheville, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 21	B. S. Drane	345	843	1.31	—0.24	1,107
July 20	do	339	668	1.06	— .68	707
August 13	do	350	898	1.92	.09	1,725
October 1	do	328	487	1.04	— .91	506
December 10	do	330	656	1.08	— .68	707

FRENCH BROAD RIVER AT OLDTOWN, NEAR NEWPORT, TENN.

This was originally one of the temporary stations established in connection with the general hydrographic study of the southern Appalachian region.

The original gage put in at this station was carried away with the old bridge by flood early in the spring of 1902.

A wire gage was established on the new bridge October 27, 1902, by B. S. Drane. The wire gage was replaced April 29, 1903, by a standard chain gage, with inclosed scale, with its zero 133 feet from initial point for soundings. This gage was made to read the same as the one which it replaced. The length of the chain from the end of the weight to the marker is 28 feet. Discharge measurements are made from the downstream side of the steel highway bridge, in four spans, to which the gage is attached. The initial point for soundings is the end of the guard rail at the left end of the bridge, on the downstream side. The channel is straight for about 600 feet above and below the station. The velocity is moderately swift, well distributed, and can be measured at all stages. Both banks are high and wooded, and all water passes beneath the bridge at all stages. The section is smooth and regular, and the bed is of gravel and sand, not subject to much change.

Bench mark No. 1 is a point marked in white paint on the sharp, rectangular corner of the angle iron connection between the floor beam and the first post on the downstream side in the second span from the left end of the bridge. This point is toward the right bank and is 25.84 feet above gage datum. Bench mark No. 2 is the top of the copper bolt set in a bowlder projecting from the hillside on the left bank 175 feet downstream from the center line of the bridge, 8 feet from the center of the road, and about 4 feet above ground. This rock is the first smooth-faced ledge of limestone outcropping close to the road. The face next the road is nearly vertical for a length of 4 feet. The elevation of the bench mark is 29.52 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer:

Discharge measurements of French Broad River at Oldtown, near Newport, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 23	B. S. Drane	453	2,155	2.59	2.92	5,568
February 23	do	453	2,136	2.51	2.87	5,358
March 29	do	450	1,928	1.97	2.34	3,804
April 27	M. R. Hall	448	1,925	1.57	2.12	3,025
July 8	J. M. Giles	334	1,371	.76	1.30	1,045
August 20	B. S. Drane	463	1,492	.92	1.50	1,380
October 15	do	442	1,267	.40	.98	508

Mean daily gage height, in feet, of French Broad River at Oldtown, near Newport, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.30	1.50	1.90	2.00	2.00	2.30	1.95	1.40	1.45	1.10	0.95	1.25
2	1.30	1.50	2.00	1.90	1.80	2.40	1.70	1.70	1.40	1.10	1.00	1.20
3	1.30	1.40	1.90	1.80	2.00	2.00	1.60	1.60	1.80	1.05	1.05	1.30
4	1.30	1.50	1.90	1.80	1.85	1.80	1.50	1.50	1.90	1.00	1.10	1.35
5	1.20	1.50	1.90	1.75	1.90	1.70	1.40	1.65	1.80	1.00	1.50	1.45
6	1.20	1.40	2.00	1.70	1.80	1.60	1.45	1.60	1.70	1.00	1.70	1.95
7	1.20	1.60	2.90	1.75	1.85	1.70	1.40	1.70	1.45	1.00	1.40	2.10
8	1.30	2.10	4.50	1.90	2.00	1.90	1.30	1.80	1.40	1.00	1.30	1.70
9	1.40	2.10	3.70	2.00	3.35	1.85	1.70	1.80	1.35	1.00	1.20	1.50
10	1.30	1.80	2.70	2.00	2.80	1.65	1.60	1.85	1.40	1.00	1.10	1.50
11	1.30	1.70	2.55	2.00	2.40	1.70	1.50	1.90	1.35	.95	1.00	1.50
12	1.40	1.60	2.30	1.90	2.20	1.65	1.40	2.00	1.40	1.00	1.10	1.45
13	1.70	1.50	2.15	1.90	2.00	1.60	1.30	1.90	1.40	1.00	1.20	1.40
14	1.60	1.40	2.10	1.80	1.95	1.50	1.30	1.70	1.35	.95	1.45	1.35
15	1.60	1.60	2.20	1.80	1.90	1.45	1.20	1.60	1.30	1.00	1.45	1.35
16	1.50	1.50	2.00	1.80	1.80	1.45	1.15	1.70	1.25	.95	1.40	1.30
17	2.00	1.50	1.90	1.80	1.75	1.40	1.15	1.55	1.20	.95	1.35	1.30
18	2.10	1.50	1.90	1.80	1.70	1.40	1.15	1.55	1.20	.90	1.30	1.35
19	2.10	1.40	1.95	1.70	1.70	1.85	1.20	1.50	1.15	.95	1.30	1.30
20	1.90	1.50	1.90	1.70	1.70	1.75	1.20	1.50	1.20	.95	1.25	1.25
21	1.90	1.60	2.00	1.75	1.65	1.70	1.40	1.50	1.15	1.00	1.25	1.30
22	2.00	1.80	2.20	1.80	1.60	1.75	1.30	1.50	1.20	.95	1.25	1.20
23	2.10	2.90	4.20	1.70	1.55	1.65	1.40	1.55	1.15	1.05	1.40	1.25
24	2.50	2.30	3.70	1.75	1.60	1.55	1.55	1.95	1.15	.95	1.30	1.30
25	1.90	2.00	3.10	1.70	1.65	1.45	1.85	1.70	1.15	1.00	1.25	1.35
26	1.80	1.90	2.80	1.75	1.60	1.50	1.50	1.75	1.10	1.00	1.25	1.35
27	1.60	2.20	2.75	2.15	1.60	1.60	1.50	.70	1.20	1.00	1.10	1.40
28	1.60	2.20	2.60	2.30	1.55	1.70	1.45	2.00	1.10	.95	1.00	1.60
29	1.50	2.00	2.30	2.20	1.50	1.90	1.40	1.95	1.15	1.00	1.10	2.25
30	1.40	.....	2.20	2.10	1.50	1.90	1.30	1.60	1.15	1.00	1.20	1.80
31	1.70	.....	2.10	.....	1.80	.....	1.30	1.50	.....	1.00	.....	1.60

Rating table for French Broad River at Oldtown, near Newport, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.9	400	1.9	2,410	2.8	5,140	3.7	8,805
1.0	535	2.0	2,680	2.9	5,500	3.8	9,245
1.1	685	2.1	2,955	3.0	5,875	3.9	9,690
1.2	850	2.2	3,235	3.1	6,260	4.0	10,140
1.3	1,030	2.3	3,525	3.2	6,660	4.1	10,590
1.4	1,225	2.4	3,825	3.3	7,075	4.2	11,050
1.5	1,435	2.5	4,135	3.4	7,500	4.3	11,510
1.6	1,660	2.6	4,455	3.5	7,930	4.4	11,980
1.7	1,900	2.7	4,790	3.6	8,365	4.5	12,450
1.8	2,150						

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1904, and one measurement made during 1903 to determine the upper part of the curve. It is well defined between gage heights 1 foot and 3 feet.

Estimated monthly discharge of French Broad River at Oldtown, near Newport, Tenn., for 1904.

[Drainage area, 1,737 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,135	850	1,758	1.01	1.16
February	5,500	1,225	2,063	1.19	1.28
March	12,450	2,410	4,271	2.46	2.84
April	3,525	1,900	2,333	1.34	1.50
May	7,288	1,435	2,407	1.39	1.60
June	3,825	1,225	1,957	1.13	1.26
July	2,545	768	1,299	.748	.862
August	2,680	1,225	1,877	1.08	1.24
September	2,410	685	1,125	.648	.723
October	685	400	526	.303	.349
November	1,900	468	943	.543	.606
December	3,380	850	1,375	.792	.913
The year	12,450	400	1,828	1.05	14.33

SWANNANOA RIVER AT BILTMORE, N. C.

This station was established as a bench-mark station May 21, 1904, by B. S. Drane. It is located at the Biltmore, N. C., terminal of the Asheville-Biltmore electric railway line, about three-fourths mile above the mouth of Swannanoa River. Discharge measurements are made from the upstream side of a single-span highway bridge. The initial point for soundings is the right end of the upstream hand rail of the bridge. The channel is straight for about 1,000 feet above and curved for 300 feet below the station. The current is sluggish above and somewhat swifter below the bridge. Both banks are high and not subject to overflow. The bed of the stream is composed of sand. There is but one channel at all stages. Bench mark No. 1 is the center of the center-pin bearing at the upstream end of the second floor beam from the right bank. Its elevation is 16 feet above the datum of the gage. Bench mark No. 2 is the center of the head of a small wire nail driven into a triangular-shaped blaze in the downstream side of a birch tree on the right bank, about 25 feet above the bridge. Its elevation is 5.74 feet above the datum of the gage.

Discharge measurements of Swannanoa River at Biltmore, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
May 21	B. S. Drane	73	165	0.86	1.12	143
July 20	do	72	107	.35	.71	38
August 16	do	74	134	.75	.97	100

TENNESSEE RIVER NEAR KNOXVILLE, TENN.

This station was originally established by the United States Weather Bureau at the old county highway bridge, which has been torn down and replaced by a new bridge. Instead of placing the gage at the new bridge, it was decided to move it down the river in order to get below some shoals and wing dams which have been put in for boating. A temporary gage was put in at the Knoxville and Augusta Railroad bridge, a half mile below the highway bridge, and was used during the greater part of the year 1899. In the latter part of that year a new permanent gage was established, and readings from it began on November 1, 1899. The new gage is on the right bank of the river, just below the mouth of West Knoxville Bayou, and about 1,000 feet below the temporary gage at the Knoxville and Augusta Railroad bridge. The gage, which is graduated to feet and tenths, is in two sections—the first, a sloping section, made of a 2 by 4 inch pine tim-

ber spiked on top of an 8 by 8 inch oak sill well bolted to piles and embedded in crushed stone, reading from −2 to +12 feet; the second, a vertical section, attached to one of the bents of the railroad trestle across West Knoxville Bayou, about 50 feet from the bank of the river and from the sloping gage, reading from 12 to 36.5 feet. The gage is fastened to the upstream post of the bent, facing away from the river. The zero of the gage is 804.3 feet above sea level. The gage was located for the United States Weather Bureau by the United States Engineer Corps. Daily records are kept by the United States Weather Bureau and are furnished to the Geological Survey. Until recently discharge measurements have been made from the Cherokee Bridge, about 2½ miles downstream from the Gay street or county bridge, at which measurements are now made, and which is one-half mile above the Knoxville and Augusta Railroad bridge. The Gay Street Bridge has seven spans, with a total length of 1,570 feet. The floor of the bridge is about 100 feet above low water. The initial point for soundings is the end of the bridge on the right bank, downstream side. The channel is straight for one-half mile above and for 1,000 feet below the station. The right bank will overflow for about 400 feet and the left bank for 200 feet, beyond which points a steep high bluff begins on both sides of the river. The bed is of rocks and gravel, and is rough and probably permanent. The current is swift and somewhat broken by the rough bed and by the remains of old piers. The bench mark is a cross in the stone on the east corner of the base of the right-bank pier of the Knoxville and Augusta Railroad bridge. Its elevation is 2.4 feet above the zero of the gage and 806.7 feet above sea level.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Tennessee River near Knoxville, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 27	O. P. Hall	890	6,958	3.32	5.70	23,100
July 7	J. M. Giles	644	3,588	1.88	1.42	6,728
August 6	B. S. Drane	668	3,501	1.73	1.26	6,031
October 21	do	629	2,110	.86	−.36	1,813

Mean daily gage height, in feet, of Tennessee River near Knoxville, Tenn, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.80	0.80	3.80	3.20	4.50	1.10	3.10	0.70	0.60	−0.10	−0.30	0.40
2	.70	.80	3.50	3.40	3.70	2.70	2.70	.80	.50	− .10	− .30	.40
3	.50	.70	3.30	3.10	3.10	3.10	2.70	1.50	.50	− .20	− .30	.40
4	.50	.60	3.60	2.80	2.90	2.80	1.90	1.20	1.00	− .20	− .20	.40
5	.50	.60	3.20	2.60	2.70	2.10	1.50	1.40	1.00	− .20	− .20	.80
6	.20	.60	2.90	2.30	3.90	1.70	1.20	1.20	1.00	− .20	− .20	2.30
7	.10	.70	3.40	2.20	3.30	1.40	1.40	1.30	1.20	− .30	.40	3.20
8	.10	2.10	6.60	2.20	2.80	1.50	1.30	1.30	.80	− .30	.40	3.40
9	.20	2.60	8.30	2.50	3.00	1.60	1.20	1.50	.60	− .30	.30	2.20
10	.40	2.90	6.70	2.60	5.00	1.60	1.60	1.40	.50	− .30	.20	1.60
11	.40	2.50	5.40	2.70	4.80	1.30	1.50	1.50	.40	− .30	− .10	1.30
12	.40	2.00	4.90	2.40	3.80	1.20	2.00	1.50	.30	− .30	− .20	1.00
13	.60	1.70	4.20	2.20	3.30	1.40	1.60	1.70	.20	− .30	− .10	1.00
14	.90	1.30	3.90	2.00	2.90	1.20	1.10	1.80	.30	− .20	.00	.90
15	1.00	1.20	3.70	2.00	2.70	1.00	.90	1.60	.20	− .30	.20	.90
16	1.10	1.10	3.50	2.00	2.40	.90	.80	2.10	.20	− .30	.50	.80
17	1.00	1.10	3.10	3.00	2.30	.80	.80	1.40	.10	− .30	.60	.60
18	1.10	1.10	2.90	2.90	2.00	.70	.60	1.30	.00	− .30	.50	.60
19	1.30	1.00	2.70	2.10	1.90	.70	.70	1.20	.00	− .30	.30	.50
20	1.40	1.60	2.60	1.90	1.80	.90	.50	1.00	.00	− .30	.20	.50
21	1.10	1.90	2.80	1.90	1.80	1.30	.50	1.20	.00	− .30	.20	.40
22	1.00	2.50	4.50	1.90	1.70	1.00	.50	1.30	.00	− .30	.20	.30
23	1.80	3.70	7.30	2.00	1.50	1.00	.70	2.10	.00	− .30	.20	.20
24	2.60	4.80	12.00	1.90	1.40	1.00	.90	1.60	− .10	− .30	.30	.20
25	3.70	4.20	12.60	1.60	1.30	1.00	.90	1.60	− .10	− .40	.40	.50
26	2.80	3.20	10.10	1.70	1.20	.80	.80	1.50	− .20	− .40	.30	.70
27	2.00	5.20	8.30	1.80	1.10	1.10	.80	1.10	− .20	− .40	.30	.90
28	1.50	5.30	7.10	2.50	1.10	1.10	1.70	1.00	− .10	− .30	.20	3.50
29	1.20	4.70	6.10	4.30	1.00	1.40	1.30	1.10	− .10	− .30	.00	3.40
30	1.10	.....	5.00	5.40	1.00	2.30	.90	1.00	− .10	− .30	.10	3.60
31	.90	.....	4.20	.....	1.00	.....	.80	.80	.....	− .30	.....	2.50

Rating table for Tennessee River near Knoxville, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.4	1,750	1.1	5,500	3.2	12,950	8.0	33,440
− .3	1,930	1.2	5,820	3.4	13,710	8.5	35,840
− .2	2,120	1.3	6,150	3.6	14,480	9.0	38,290
− .1	2,320	1.4	6,480	3.8	15,260	10.0	43,340
.0	2,530	1.5	6,820	4.0	16,040	11.0	48,590
.1	2,750	1.6	7,160	4.2	16,840	12.0	54,040
.2	2,980	1.7	7,500	4.4	17,640	13.0	59,690
.3	3,220	1.8	7,850	4.6	18,450	14.0	65,490
.4	3,470	1.9	8,200	4.8	19,270	15.0	71,290
.5	3,730	2.0	8,550	5.0	20,090	16.0	77,090
.6	4,000	2.2	9,260	5.5	22,190	18.0	88,690
.7	4,280	2.4	9,980	6.0	24,340	20.0	100,290
.8	4,570	2.6	10,710	6.5	26,540	22.0	111,890
.9	4,870	2.8	11,450	7.0	28,790	25.0	129,290
1.0	5,180	3.0	12,190	7.5	31,090		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1900 to 1904, inclusive. It is well defined. Above gage height 0.4 feet the curve is the same as that for 1903.

Estimated monthly discharge of Tennessee River near Knoxville, Tenn., for 1904.

[Drainage area, 8,990 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	14,870	2,750	5,545	0.617	0.711
February	21,350	4,000	9,377	1.04	1.12
March	57,410	10,710	21,770	2.42	2.79
April	21,770	7,160	10,420	1.16	1.29
May	20,090	5,180	10,430	1.16	1.34
June	12,570	4,280	6,516	.725	.809
July	12,570	3,730	6,095	.678	.782
August	8,900	4,280	6,323	.703	.810
September	5,820	2,120	3,258	.362	.404
October	2,320	1,750	1,968	.219	.252
November	4,000	1,930	2,852	.317	.354
December	14,480	2,980	6,309	.702	.809
The year	57,410	1,750	7,572	.842	11.47

TENNESSEE RIVER AT CHATTANOOGA, TENN.

This station was established in 1879, at the foot of Lookout street, just below Chattanooga Island, by the Signal Corps of the United States Army; but since July 1, 1891, it has been in charge of the Weather Bureau. The gage consists of a sloping section made of railroad rails bolted to solid rock, and a vertical section of heavy timber bolted to the vertical face of rock cliff. During the year 1900 a new gage was established. It is a vertical metal scale bolted to the south side of the third stone pier from the south end of the Hamilton County highway bridge. The original sloping gage, however, is still considered standard as the later gage is not properly adjusted at its lower end on account of the projecting base of the pier. During the present year the self-registering gage invented by Professor Fulton, of Tennessee University, has been in use at this station. The gage is connected by wire with the Weather Bureau office, and a continuous electrical record of river height is made in the same manner as the record of wind, sunshine, etc. Gage heights are furnished to the Geological Survey through L. M. Pindell.

Discharge measurements are made from the steel highway bridge in six spans and an approach about 1,000 feet long on the right bank. The floor of the bridge is about 125 feet above low water. The initial point for soundings is the outside corner of the iron post of the downstream hand rail on the left bank. The channel is curved for 3,000

feet above and 2,000 feet below the station. The right bank is high and overflows at flood stages, but all water passes under the bridge or its approach. The left bank is a high, rocky bluff, and will not overflow. The bed is composed of loose rock, sand, and gravel, and is fairly constant. The bench mark is the top of the water table on the southeast corner of the post-office on Eleventh street. Its elevation is 74.4 feet above the zero of the gage, and 705 feet above sea level.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Tennessee River at Chattanooga, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 3	J. M. Giles	975	7,395	2.23	2.77	16,480
February 10	do	1,054	10,610	3.36	5.85	35,640
April 19	do	993	8,493	2.94	4.30	24,980
July 6	do	956	6,920	2.54	3.18	17,590
August 5	B. S. Drane	1,114	7,014	2.10	2,73	14,710
October 13	do	1,014	4,375	1.23	.21	5,368
October 14	do	1,016	4,433	1.25	.22	5,558
October 22	do	1,012	4,234	1.15	.06	4,863

Mean daily gage height, in feet, of Tennessee River at Chattanooga, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.10	3.40	8.10	9.00	6.00	4.30	3.60	2.20	2.20	0.70	0.10	1.10
2	2.60	3.10	7.40	8.10	7.60	4.10	3.70	2.20	2.00	.70	.10	1.40
3	2.30	2.80	7.00	7.20	6.70	4.30	4.30	2.60	1.80	.60	.20	1.70
4	2.20	2.70	6.60	6.60	5.80	4.40	4.00	2.40	1.80	.50	.40	2.20
5	2.00	2.50	6.10	6.00	5.40	4.90	3.90	2.60	1.70	.40	.50	2.10
6	2.00	2.40	6.20	5.60	5.20	4.90	3.40	2.90	1.70	.50	.50	3.50
7	1.70	2.30	6.10	5.40	4.90	4.50	3.10	3.70	2.20	.40	.60	4.40
8	1.60	3.60	8.00	5.40	5.40	3.80	2.90	3.70	2.40	.30	.60	5.80
9	1.50	4.80	11.00	5.80	5.60	3.70	2.70	3.30	2.20	.20	.60	5.70
10	1.60	5.90	11.30	5.90	6.40	3.70	2.90	3.30	2.00	.30	.90	5.40
11	1.70	5.40	11.10	6.00	7.00	3.40	2.90	3.30	1.80	.30	.90	4.20
12	1.70	5.50	10.10	5.60	7.20	3.20	3.10	3.30	1.60	.30	.90	3.50
13	1.90	4.90	9.00	5.30	6.60	2.80	3.10	4.10	1.40	.30	.80	3.00
14	2.10	4.40	8.50	4.90	5.70	2.60	3.60	3.70	1.30	.20	.60	2.70
15	2.30	3.90	9.10	4.70	5.40	2.50	3.40	3.30	1.20	.20	.60	2.50
16	2.50	3.60	8.90	4.40	5.20	2.50	3.00	3.30	1.10	.20	.70	2.40
17	2.60	3.50	8.10	4.30	4.90	2.40	2.60	4.10	1.00	.20	.80	2.30
18	2.90	3.30	7.10	4.30	4.50	2.20	2.40	3.90	1.00	.20	.90	2.10
19	3.90	3.10	6.60	4.30	4.30	2.10	2.20	3.10	.90	.20	1.00	2.00
20	3.80	3.20	6.10	4.20	4.10	2.00	2.10	2.70	.90	.20	1.10	1.80
21	3.60	3.70	5.80	4.10	3.80	2.00	1.80	2.40	.90	.10	1.00	1.70
22	3.60	5.20	7.40	4.00	3.60	2.10	1.70	2.40	.80	.10	1.00	1.60
23	6.00	6.30	12.90	4.00	3.50	2.60	1.90	2.20	.80	.10	.90	1.50
24	10.60	7.90	18.20	4.00	3.40	2.70	2.20	2.20	.80	.10	1.00	1.40
25	9.20	8.10	21.80	4.00	3.10	2.30	2.10	2.90	.80	.10	1.00	1.40
26	7.50	7.90	20.90	3.80	2.90	2.30	2.00	3.00	.70	.10	1.00	2.00
27	7.10	7.10	19.10	3.70	2.80	2.20	2.20	2.80	.60	.10	1.10	3.00
28	5.80	7.30	16.90	4.10	2.70	2.20	2.40	2.60	.60	.10	1.00	7.30
29	4.80	9.00	14.00	4.60	2.70	2.70	2.10	2.60	.60	.10	1.00	10.20
30	4.20	.....	11.80	4.70	2.60	3.40	2.60	2.50	.60	.10	1.00	9.60
31	3.80	.....	10.30	.....	3.00	.....	2.90	2.30	.....	.10	.....	7.60

DAVIDSONS RIVER NEAR DAVIDSONS RIVER, N. C.

This station was established May 19, 1904, by M. R. Hall. It is located at English Bridge, about 2 miles from Davidsons River, N. C., and about 500 feet above the mouth of Avery Creek. The gage is a 1-inch by 4-inch pine timber fastened to a 2½-inch by 4-inch oak scantling, which is spiked to the downstream side of a maple tree on the left bank, 40 feet below the bridge. It is graduated to feet and tenths and is 10 feet long. The gage is read once each day by J. J. Perry. Discharge measurements are made from the single-span wooden highway bridge, with log abutments. The floor of the bridge is about 12 feet above low water. The initial point for soundings is the edge of the wooden crib abutment on the upstream side at the left bank. The channel is straight for about 500 feet above and below the station. The current is moderately swift. The right bank is high, rocky, wooded, and is not subject to overflow. The left bank is low, but is not subject to overflow. The bed of the stream is composed of rock, mostly loose bowlders and shingle, and is clean and permanent. There is but one channel at all stages. Bench mark No. 1 is two wire nails driven into the downstream side of the tree to which the gage is attached. Its elevation is 4 feet above the zero of the gage. Bench mark No. 2 is a cross cut on the top of solid rock at edge of water, 8 feet below the bridge at right bank. Its elevation is 1.48 feet above the zero of the gage. Bench mark No. 3 is the center of a nail head in third log from bottom of crib at the right bank on the upstream side. Its elevation is 7 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Davidsons River near Davidsons River, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 20	M. R. Hall	65	105	0.79	1.00	83
May 19	B. S. Drane	66	108	.77	1.05	84
July 19	do	64	88	.46	.78	41
July 19	do	64	86	.47	.78	41
August 17	do	68	99	.72	.99	71
October 4	do	63	86	.47	.79	40
December 8	do	63	88	.57	.85	51
December 8	do	63	88	.62	.85	55

Mean daily gage height, in feet, of Davidsons River near Davidsons River, N. C., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.05	0.85	1.05	1.10	0.80	0.75	0.75
2	1.10	.85	1.00	1.10	.80	.75	.75
3	1.05	.80	.90	1.05	.80	.90	.80
4	1.00	.80	1.00	1.05	.80	1.20	.80
5	.95	.80	.90	1.05	.80	1.00	1.15
6	.95	.80	.90	1.00	.80	.80	1.05
7	1.15	.85	.90	1.00	.80	.80	.90
8	1.05	.90	1.10	.95	.80	.80	.85
9	1.00	.85	1.00	1.00	.80	.75	.85
10	.95	.85	1.45	.95	.75	.75	.85
11	1.10	.90	1.50	1.00	.75	.75	.80
12	1.00	.90	1.40	1.00	.75	.75	.80
13	1.00	.90	1.25	1.00	.75	1.10	.80
14	.95	.90	1.10	.95	.75	.85	.80
15	.90	.80	1.05	.95	.75	.80	.80
16	.90	.75	1.05	.90	.75	.80	.80
17	1.00	.85	1.00	.90	.75	.80	.80
18	.95	.80	.95	.90	.75	.80	.80
19	.95	.80	.90	.90	.75	.75	.80
20	.95	1.00	.90	.85	.75	.75	.80
21	.90	1.05	.95	.85	.75	.75	.80
22	.95	.90	1.05	.85	.75	.75	.80
23	.90	.90	1.15	.85	.75	.75	.80
24	.90	.85	1.25	.85	.75	.75	.80
25	.90	.90	1.65	.85	.75	.75	.85
26	.90	.85	1.60	.85	.75	.75	.80
27	.85	.85	1.55	.85	.75	.75	1.30
28	.85	.80	1.40	.85	.75	.75	1.30
29	.95	1.00	1.25	.80	.75	.75	1.10
30	.90	.90	1.20	.80	.75	.80	1.05
31	.....	.95	1.10	.....	.75	.....	1.00

AVERY CREEK AT DAVIDSONS RIVER, N. C.

This station was established as a bench-mark station May 19, 1904, by M. R. Hall. It is located about one-fourth mile above the junction of Avery Creek with Davidsons River and a less distance from the regular gaging station on the latter stream. Discharge measurements are made from the foot log just above the wagon bridge, the section being smoother than that under bridge. The initial point for soundings is the edge of the large rock which forms the left bank. The channel is curved for about 100 feet above the station and straight for 50 feet below, when it curves to the right. The current is swift. The right bank is high, wooded, and not liable to overflow. The left bank is low, wooded, and overflows at high stages. The bed of the stream is rocky along the right bank and sandy for the remainder. It is not liable to change. There is but one channel at all stages. The bench mark is a small shelf chipped in the upper edge of the upstream face of the large rock on the right bank upon which the end of the foot log rests. Its elevation is 5 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Avery Creek at Davidsons River, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 19	B. S. Drane	18	16	0.91	1.79	14.0
July 19	do	18	13	.64	1.63	8.0
August 17	do	18	14.5	1.00	1.77	14.5
October 4	do	18	12.5	.55	1.62	6.8
December 8	do	18	12	.52	1.66	6.3

LITTLE RIVER AT CALHOUN, N. C.

This station was established as a bench-mark station July 19, 1904, by B. S. Drane. It is located at the highway bridge about one-fourth mile from Calhoun post-office, N. C., and about 1 mile above the mouth of Little River. Discharge measurements are made from the upstream side of the two-span wooden bridge. The initial point for soundings is the right end of the upstream guard rail. The channel is curved for about 75 feet above and 100 feet below the station. The current is swift. The right bank is a high rock cliff; the left bank is composed of earth, steep and wooded. Neither bank is liable to overflow. The bed of the stream is composed of rock along the right bank, and of sand for the greater part of the distance. There is one channel at all stages. Possibly a freshet in French Broad River would make a sluggish back water at this station, but this is not liable to occur. Bench mark No. 1 is the upstream end of the horizontal strap binding the upstream guard rail to the girder, 31 feet from the initial point for soundings. Its elevation is 16 feet above datum. Bench mark No. 2 is the upper edge of a small ledge of rock overhanging the water just under a point on the upstream side of the bridge, 6 feet from the initial point for soundings. It is marked by a nick in the rock on either side. Its elevation is 3 feet above datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Little River at Calhoun, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
July 19	B. S. Drane	36	43	1.16	0.59	50
August 17	do	37	73	1.27	1.00	93
December 8	do	33	67	1.28	1.09	86

MILLS RIVER (NORTH FORK) AT PINKBED, N. C.

This station was established May 18, 1904, by M. R. Hall. It is located at wagon bridge in the village of Pinkbed, N. C., about three-fourths mile below the post-office of that name. The gage is a vertical 1-inch by 4-inch pine timber fastened to a 2-inch by 4-inch oak scantling which is spiked to the log crib on right bank, at upper side of bridge. The gage is 10 feet long, and is graduated to feet and tenths. It is read once each day by C. D. Davenport. Discharge measurements are made from the single, 39-foot span, wagon bridge to which the gage is attached. The bridge rests upon log crib abutments, and the floor is about 10 feet above low water. The initial point for soundings is the edge of crib abutment at the left bank, on the downstream side of the bridge. The channel is straight for about 200 feet above and below the station. The current is swift. Both banks are about 10 feet above low water, and are not liable to overflow. There is a wide, level stretch of land from the left bank to foot of hill. The bed of the stream is composed of loose rock and is probably permanent. There is but one channel at all stages. Bench mark No. 1 is a nail driven in bottom log of crib on right bank at downstream corner of crib. Its elevation is 1.70 feet above the zero of the gage. Bench mark No. 2 is the center of a nail driven in a notch on a small poplar tree on left bank about 40 feet above bridge. Its elevation is 5.70 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Mills River (North Fork) at Pinkbed, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 21	M. R. Hall	36	27	1.45	0.70	39.4
May 18	B. S. Drane	37	31	1.61	.82	50.6
July 18	do	34	22	1.23	.56	27.0
August 18	do	34	23	1.40	.64	33.0
October 3	do	29	17	1.11	.47	18.0
October 3	do	29	17	1.01	.47	17.0
December 9	do	33	19	1.17	.52	22.0
December 9	do	33	19	1.08	.52	20.0

Mean daily gage height, in feet, of Mills River (North Fork) at Pinkbed, N. C., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.80	0.60	0.85	0.60	0.45	0.45	0.45
2	.85	.55	.65	.65	.45	.45	.45
3	.80	.55	.60	.55	.45	.55	.50
4	.70	.50	.65	.55	.45	.90	.50
5	.70	.50	.65	.90	.45	.80	.60
6	.65	.50	.70	.70	.45	.50	.70
7	.90	.50	.75	.65	.45	.50	.60
8	.75	.50	.95	.60	.45	.50	.50
9	.70	.90	.80	.60	.45	.45	.50
10	.70	.70	.85	.55	.45	.45	.55
11	.70	.70	1.35	.60	.45	.45	.50
12	.65	.65	1.15	.60	.45	.45	.50
13	.60	.60	.90	.60	.45	1.00	.50
14	.60	.55	.80	.55	.45	.50	.50
15	.60	.55	.75	.55	.45	.50	.50
16	.60	.55	.70	.55	.45	.50	.50
17	.70	.70	.70	.55	.45	.50	.50
18	.70	.65	.65	.50	.45	.50	.50
19	.70	.55	.60	.50	.45	.50	.45
20	.85	.50	.65	.50	.45	.50	.60
21	.70	.55	.60	.50	.45	.50	.60
22	.75	.55	.60	.50	.45	.50	.60
23	.65	.60	.60	.50	.45	.50	.45
24	.60	.55	.65	.50	.45	.45	.50
25	.60	.55	.65	.50	.45	.45	.50
26	.55	.60	.60	.50	.45	.45	.50
27	.60	.55	.80	.50	.45	.45	.70
28	.65	.55	.75	.50	.45	.45	1.00
29	.65	.55	.65	.45	.45	.45	.70
30	.65	.55	.55	.45	.45	.45	.70
31	.....	.55	.60	.....	.45	.....	.55

Rating table for Mills River (North Fork) at Pinkbed, N. C., from June 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.45	16	0.70	39	0.95	65	1.20	95
.50	20	.75	44	1.00	71	1.25	101
.55	24	.80	49	1.05	77	1.30	107
.60	29	.85	54	1.10	83	1.35	113
.65	34	.90	59	1.15	89		

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1904. It is well defined between gage heights 0.45 feet and 0.85 feet. The table has been extended above gage height 0.85 feet.

Estimated monthly discharge of Mills River (North Fork) at Pinkbed, N. C., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
June	59	24	37.8
July	59	20	27.1
August	113	24	42.9
September	59	16	25.3
October	16	16	16.0
November	71	16	22.4
December	71	16	25.3

MILLS RIVER (SOUTH FORK) NEAR SITTON, N. C.

This station was established May 18, 1904, by M. R. Hall. It is located at Sycamore Church, about 1 mile below Sitton's mill, Sitton, N. C. The gage is a vertical 1 by 4 inch pine timber, 10 feet long, graduated to feet and tenths, fastened to a 2 by 4 inch chestnut scantling, which is spiked to a whiteoak tree on the right bank of the river about 40 feet above foot log. The gage faces upstream and can be easily read from the bank. It is read once each day by W. E. Field. Discharge measurements are made from a foot log about 150 feet above ford. The channel above curves about 90 degrees in 500 feet above and is straight for 200 feet below the station. The current is moderately swift, but may be rather sluggish above the station at low stages. Both banks are high and clean and are subject to overflow at extreme high water. The bed of the stream is composed of rock, and is clean and constant. There is but one channel at all stages. Owing to the overflowing of the banks discharge measurements can not be made at high water. Bench mark No. 1 is the center of two nail heads driven into the tree to which the gage is attached, on the side next the river. Its elevation is 5 feet above the zero of the gage. Bench mark No. 2 is the center of nails in root of whiteoak tree on the right bank, 15 feet below the foot log. Its elevation is 5 feet above the zero of the gage. Bench mark No. 3 is nails driven into a beech tree on the right bank about 50 feet below the foot log. Its elevation is 8 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Mills River (South Fork) near Sitton, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 21	M. R. Hall	47	79	1.04	1.00	82
May 18	B. S. Drane	41	79	1.21	1.09	96
July 18	do	40	68	.72	.81	49
August 18	do	41	74	.93	.98	69
October 3	do	41	65	.56	.76	36
October 3	do	41	65	.54	.76	35
December 9	do	40	66	.72	.82	47
December 9	do	40	66	.74	.82	49

Mean daily gage height, in feet, of Mills River (South Fork) near Sitton, N. C., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.20	1.05	1.10	1.15	0.75	0.70	0.80
2	1.20	.95	.90	1.05	.75	.75	.80
3	1.05	.90	.85	1.00	.75	.85	.80
4	1.00	.90	.90	1.90	.75	1.25	.80
5	.95	.90	.90	1.15	.75	1.00	1.15
6	.90	.85	.90	1.00	.75	.90	1.15
7	1.65	.85	1.00	.95	.75	.80	.90
8	1.10	.85	1.10	.90	.75	.80	.85
9	1.00	1.30	1.05	.90	.75	.80	.80
10	.95	1.00	1.10	.95	.75	.75	.80
11	1.15	.95	1.80	1.10	.75	.75	.80
12	1.00	.90	1.65	.95	.75	.75	.80
13	.95	.90	1.30	1.00	.75	1.10	.80
14	.90	.85	1.10	.90	.70	.90	.70
15	1.00	.80	1.05	.90	.70	.80	.80
16	.95	.80	1.25	.90	.70	.80	.80
17	1.05	.90	1.00	.85	.70	.80	.80
18	.95	.80	1.00	.85	.70	.80	.80
19	.95	.80	.95	.85	.70	.80	.80
20	1.10	1.45	1.00	.80	.70	.80	1.00
21	.95	.85	.90	.80	.70	.80	1.00
22	1.00	.90	1.10	.80	.70	.80	1.00
23	.90	.95	1.00	.80	.70	.80	.80
24	.90	.90	.95	.80	.70	.80	.80
25	1.10	.90	1.45	.80	.70	.75	.80
26	1.10	1.00	1.20	.80	.70	.75	.80
27	.90	.90	1.50	.80	.75	.75	1.10
28	1.10	.85	1.30	.80	.70	.75	1.40
29	1.35	.80	1.10	.80	.70	.75	1.10
30	1.20	.85	1.05	.80	.70	.80	1.00
31	.....	.85	1.00	.....	.70	.....	1.00

Provisional rating table for Mills River (South Fork) near Sitton, N. C., from June 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*
0.7	22	1.0	82
.8	42	1.1	102
.9	62		

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1904. It is well defined between gage heights 0.75 feet and 1.10 feet, and can only be considered roughly approximate above 1.1 feet. The rating curve is a tangent, the difference being 20 per tenth.

Estimated monthly discharge of Mills River (South Fork) near Sitton, N. C., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
June	212	62	92.0
July	172	42	65.5
August	242	52	104
September	262	42	69.0
October	32	22	26.5
November	132	22	46.3
December	162	22	61.0

PIGEON RIVER AT NEWPORT, TENN.

The station was established September 4, 1900, by E. W. Myers. It is located at the highway bridge in the eastern part of Newport, Tenn., 1 mile from the railroad station and 1 mile above the dam of the Newport Flouring Mill, out of reach of backwater. On April 30, 1903, the old wire gage was replaced by a standard chain gage with inclosed scale fastened to the lower chord of the bridge on the downstream side, approximately at the same location as the old gage. The new gage was made to read the same as the one which it replaced. The gage is read once each day by S. R. McSween. Since it was first established the gage has been damaged several times, and the records are continuous only from December 14, 1902. Discharge measurements are made from the lower side of the single-span steel highway bridge to which the gage is attached. The initial point for soundings is the end of the hand rail over the left bank on the downstream side of the bridge. The channel is straight for about 300 feet above and

200 feet below the station. The section is deep, rough, and irregular in shape; the velocity is poorly distributed and about 50 feet of the total width at low stages is stillwater or has a negative velocity. The section is better for measuring at the Southern Railway bridge, about 300 feet below, at which point some of the measurements have been made. The right bank is low and overflows to some extent, but all water passes beneath the bridge and its approach. The left bank is a high vertical rock cliff. The bed of the stream is rocky near the left bank and sandy near the right bank.

Bench mark No. 1 is the top surface of the outer left corner of the plate at the bottom of the floor-beam hanger to the left of the zero of the gage. When the gage reads zero the water surface is 26.87 feet below this bench mark. Bench mark No. 2 is the top of a copper plug set in cement on the top of a limestone outcrop about 5 feet upstream and 3 feet to the left of the end of the upstream hand rail on the left bank. When the gage reads zero the water surface is 32.61 feet below the top of the bolt.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Pigeon River at Newport, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 22	B. S. Drane	159	1,203	1.72	2.68	2,070
March 29	do	150	1,132	1.57	2.45	1,775
April 26	do	143	992	.87	1.68	861
July 8	J. M. Giles	110	835	.77	1.27	642
August 20	B. S. Drane	134	854	.50	1.10	425
August 20[a]	do	228	585	.84	1.10	490
October 15	do	125	783	.21	.62	169
October 15[a]	do	221	443	.49	.62	216

[a] At railroad bridge.

Mean daily gage height, in feet, of Pigeon River at Newport, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.15	1.90	2.00	1.85	1.80	1.60	1.10	1.15	0.70	0.60	1.10
2	1.05	1.10	1.85	1.90	1.80	1.70	1.45	1.50	1.25	.65	.60	1.00
3	1.10	1.10	1.80	1.85	1.75	1.65	1.20	1.10	1.20	.65	.65	.90
4	1.00	1.05	1.70	1.80	1.80	1.50	1.20	1.20	1.25	.65	.80	1.00
5	.70	1.10	1.65	1.75	1.75	1.30	1.20	1.40	1.25	.65	1.05	1.20
6	.50	1.15	1.60	1.70	1.70	1.50	1.30	1.55	1.30	.70	.95	2.40
7	1.15	1.50	6.30	1.75	1.60	1.70	1.45	1.50	1.15	.65	.85	1.60
8	1.00	2.40	3.10	1.90	2.00	1.85	1.30	1.30	1.00	.65	.80	1.25
9	.95	2.00	2.50	2.50	2.70	1.50	2.25	1.40	1.00	.65	.70	1.10
10	1.00	1.75	2.35	2.00	2.25	1.35	1.75	1.50	1.00	.65	.65	1.05
11	1.10	1.55	2.30	1.80	2.00	1.30	1.45	1.55	.95	.60	.65	1.00
12	1.25	1.50	2.30	1.75	1.95	1.35	1.75	1.60	.95	.60	.60	1.00
13	1.20	1.40	2.10	1.70	1.90	1.35	1.50	1.70	.95	.60	.70	1.00
14	1.10	1.40	2.05	1.60	1.85	1.25	1.25	1.40	.90	.60	.80	.95
15	1.10	1.35	2.00	1.65	1.80	1.20	1.25	1.35	.85	.60	.90	.90
16	1.15	1.30	2.00	1.70	1.70	1.20	1.15	1.40	.80	.55	.85	.90
17	1.15	1.30	1.90	1.70	1.60	1.15	1.30	1.15	.80	.55	.80	.90
18	1.15	1.30	1.90	1.65	1.60	1.20	1.20	1.05	.80	.55	.80	.85
19	1.15	1.30	1.90	1.60	1.55	1.20	1.10	1.05	.80	.55	.75	.85
20	1.20	1.40	1.80	1.50	1.50	1.30	1.00	1.10	.80	.60	.75	.70
21	1.25	1.40	2.00	1.75	1.45	1.50	1.00	1.10	.75	.60	.80	.65
22	2.65	2.65	2.50	1.85	1.35	1.40	1.40	1.15	.75	.55	.80	.65
23	3.15	2.25	5.10	1.75	1.35	1.40	1.50	1.50	.75	.55	.90	.60
24	2.00	1.85	2.30	1.60	1.35	1.20	1.45	1.40	.70	.55	1.00	.90
25	1.75	1.20	2.20	1.60	1.40	1.25	1.40	1.30	.70	.60	.90	.95
26	1.60	1.65	2.80	1.60	1.40	1.25	1.30	1.40	.70	.60	.80	1.00
27	1.50	2.70	2.95	1.95	1.35	1.35	1.20	1.30	.75	.60	.75	1.05
28	1.40	2.20	2.75	2.00	1.30	1.45	1.05	1.25	.75	.60	.75	3.05
29	1.30	2.00	2.45	2.00	1.25	1.50	1.00	1.20	.75	.60	.75	1.90
30	1.25	.....	2.30	2.00	1.20	1.70	1.00	1.15	.70	.60	1.20	1.50
31	1.20	.....	2.15	.....	2.20	.....	1.05	1.10	.....	.60	.....	1.40

Rating table for Pigeon River at Newport, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.6	180	1.5	710	2.4	1,660	3.3	3,300
.7	225	1.6	790	2.5	1,810	3.4	3,500
.8	275	1.7	875	2.6	1,970	3.5	3,700
.9	325	1.8	965	2.7	2,140	3.6	3,900
1.0	380	1.9	1,060	2.8	2,320	3.7	4,100
1.1	440	2.0	1,160	2.9	2,510	3.8	4,300
1.2	500	2.1	1,270	3.0	2,700	3.9	4,500
1.3	565	2.2	1,390	3.1	2,900	4.0	4,700
1.4	635	2.3	1,520	3.2	3,100	5.0	6,700

The above table is based upon measurements made 1900 to 1904, and is well defined. Above gage height 3 feet the rating curve is a tangent, the difference being 200 per tenth.

Estimated monthly discharge of Pigeon River at Newport, Tenn., for 1904.

[Drainage area, 655 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	3,000	140	635	0.969	1.12
February	2,140	410	846	1.29	1.39
March	9,300	790	1,859	2.84	3.27
April	1,810	710	974	1.49	1.66
May	2,140	500	895	1.37	1.58
June	1,012	470	653	.997	1.11
July	1,455	380	598	.913	1.05
August	875	410	583	.890	1.03
September	565	225	340	.519	.579
October	225	160	184	.281	.324
November	500	180	275	.420	.469
December	2,800	180	529	.808	.932
The year	9,300	140	698	1.07	14.51

NOLICHUCKY RIVER NEAR GREENEVILLE, TENN.

This station was established May 7, 1903, by E. W. Myers, assisted by B. S. Drane. It is located at Jones's bridge, 5 miles southeast of Greeneville, Tenn., which is the nearest railroad station. The standard chain gage, with inclosed scale, is nailed to wooden blocks bolted to the lower chord of the bridge on the upstream side midway between the second and third intermediate post from the right bank. The length of the chain from the end of the weight to the marker is 33.63 feet. The gage is read once each day by B. H. Jones. Discharge measurements are made from the downstream side of the two-span steel highway bridge to which the gage is attached. The initial point for soundings is the left end of the top bar of the downstream hand rail. The channel is straight for about 700 feet above and below the station. The right bank is high, but at flood stages part of the water will pass around the end of the bridge. The left bank is high and can never overflow. The section is regular, and the bed is composed of pebbles and small stones and is not subject to change. The velocity is uniform and well distributed except at extreme low water (below gage height 0.50 foot), when the middle pier and a small bar of gravel and small stones throw the current toward both banks.

Bench mark No. 1 is a standard iron bench-mark post of the United States Geological Survey set on the left bank just below the bridge. It is 5.5 feet downstream from the left end of the bridge, and is said

to be above high-water mark. Its elevation above gage datum is 26.80 feet. Bench mark No. 2 is the upper outer edge of the outer eyebar of the lower chord of the bridge, 3.6 feet to the right of the center of the third intermediate post from the right bank. The point is marked by a spot of white paint and the letters "B. M." Its elevation above gage datum is 32.03 feet.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Nolichucky River near Greeneville, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 24	B. S. Drane	275	1,015	1.57	1.11	1,592
February 27	do	274	1,157	2.21	1.69	2,529
March 23	do	275	1,558	3.45	3.26	5,383
March 23	do	275	1,732	3.84	3.66	6,657
March 24	do	311	2,008	3.99	4.67	8,018
May 3	do	133	987	1.56	1.11	1,542
July 9	J. M. Giles	264	806	1.07	.48	859
August 9	B. S. Drane	275	911	1.24	.81	1,129
August 9	do	275	914	1.34	.82	1,222
October 17	do	275	649	.52	— .12	340
October 17	do	275	646	.55	— .10	355

Mean daily gage height, in feet, of Nolichucky River near Greeneville, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.11	0.20	1.40	1.40	1.40	1.75	1.30	0.30	0.25	0.00	—0.10	0.20
2	.12	.20	1.40	1.40	1.25	1.95	.90	1.45	.50	— .05	— .05	.25
3	.30	.18	1.30	1.25	1.15	1.55	.65	.95	.65	— .10	— .05	.30
4	.18	.30	1.20	1.05	1.20	1.15	.50	.65	.60	— .05	.00	.30
5	.06	.20	1.20	1.00	1.40	.95	.70	.50	.50	— .10	.25	.60
6	.10	.15	1.00	.95	1.20	.85	.50	.65	.40	— .10	.55	1.05
7	.04	.30	3.10	1.00	1.05	.90	.50	.60	.30	— .10	.30	1.20
8	.12	1.80	3.70	1.00	.90	.80	.45	.70	.25	.00	.10	.75
9	.11	1.40	2.40	.95	3.70	.75	.50	.80	.20	— .05	.05	.50
10	.09	.90	1.80	1.15	2.30	.60	1.00	.65	.15	— .05	.00	.45
11	.12	.70	1.65	.95	1.70	.85	.65	.75	.15	— .05	.00	.50
12	.20	.60	1.60	.90	1.45	.75	.85	1.05	.15	— .05	.00	.55
13	.30	.40	1.40	.90	1.35	.70	.65	.80	.15	— .10	.10	.50
14	.30	.40	1.25	.80	1.15	.55	.50	.65	.20	— .10	.55	.35
15	.19	.40	1.25	.75	1.05	.50	.35	.50	.10	— .10	.55	.20
16	.10	.60	1.10	.80	1.00	.40	.30	.65	.10	— .10	.30	.30
17	.30	.40	.95	1.20	.90	.45	.35	.60	.05	— .10	.25	.35
18	.70	.30	.95	1.00	.85	.55	.35	.55	.05	— .10	.30	.30
19	.50	.40	1.05	.85	.95	.65	.25	.40	.05	— .10	.20	.30
20	.30	.50	1.00	.80	.85	.75	.20	.55	.05	— .10	.15	.20
21	.30	.60	.95	.80	.80	.75	.20	.75	.05	— .10	.20	.10
22	.30	.60	2.10	.80	.75	.70	.70	.90	.05	— .10	.20	.20
23	1.00	1.70	2.10	.75	.65	.55	.45	.65	.00	— .15	.25	.15
24	1.00	1.20	5.00	.75	.60	.45	.30	.75	.00	— .10	.40	.15
25	.90	.90	3.30	.80	.60	.40	.25	1.00	.00	— .10	.30	.50
26	.50	.90	2.50	.75	.60	.50	.90	.55	.00	— .10	.20	.50
27	.40	1.50	2.40	1.50	.70	.85	.70	.45	.00	— .10	.15	.50
28	.30	2.20	2.30	2.25	.65	.60	.40	.45	.00	— .05	.10	.70
29	.30	1.60	1.90	1.90	.55	1.95	.45	.35	.00	— .05	.05	1.35
30	.30	.....	1.70	1.65	.55	1.55	.50	.30	.00	— .05	.20	.80
31	.20	.....	1.50	.....	.60	.....	.45	.25	.00	— .10	.....	.55

Rating table for Nolichucky River near Greeneville, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.15	320	0.8	1,195	1.9	2,780	3.0	4,860
− .1	355	.9	1,305	2.0	2,955	3.2	5,270
− .05	390	1.0	1,420	2.1	3,135	3.4	5,680
.0	430	1.1	1,545	2.2	3,315	3.6	6,100
.1	510	1.2	1,675	2.3	3,500	3.8	6,530
.2	595	1.3	1,815	2.4	3,685	4.0	6,960
.3	685	1.4	1,965	2.5	3,875	4.2	7,390
.4	780	1.5	2,120	2.6	4,070	4.4	7,820
.5	880	1.6	2,280	2.7	4,265	4.6	8,250
.6	980	1.7	2,445	2.8	4,460	4.8	8,690
.7	1,085	1.8	2,610	2.9	4,660	5.0	9,130

The above table is applicable only for open-channel conditions. It is based upon 18 discharge measurements made during 1903 and 1904. It is well defined between gage heights −0.15 feet and 1.10 feet. Above 1.10 feet the curve is somewhat uncertain owing to the fluctuation of the water surface during the high-water measurements.

Estimated monthly discharge of Nolichucky River near Greeneville, Tenn., for 1904.

[Drainage area, 1,099 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,420	462	711	0.647	0.746
February	3,315	553	1,210	1.10	1.19
March	9,130	1,363	2,778	2.53	2.92
April	3,408	1,140	1,549	1.41	1.57
May	6,315	930	1,631	1.48	1.71
June	2,868	780	1,313	1.19	1.33
July	1,815	595	931	.847	.976
August	2,043	640	1,045	.951	1.10
September	1,033	430	573	.521	.581
October	430	320	369	.336	.387
November	930	355	588	.535	.597
December	1,890	510	869	.791	.912
The year	9,130	320	1,131	1.03	14.01

HOLSTON RIVER (SOUTH FORK) AT BLUFF CITY, TENN.

This station was originally established by the United States Weather Bureau at the highway bridge at Bluff City, Tenn. Readings were begun July 17, 1900, by the United States Geological Survey in connection with the general hydrographic investigation of the Southern Appalachian region. The gage, which is the property of the United States Weather Bureau, is a 4 by 8 inch timber bolted to the downstream side of the first channel pier from the right bank. The gage readings are furnished by the United States Weather Bureau. Discharge measurements are made from the lower side of the four-span highway bridge to which the gage is attached. This bridge is a short distance below the Virginia and Southwestern Railroad bridge. The initial point for soundings is the end of the guard rail on the downstream side of the bridge over the left abutment. The channel is straight above the bridge for a distance of 300 feet, to the bridge of the Virginia and Southwestern Railroad. The channel is straight for about 1,000 feet below the bridge. The bed is rocky and permanent. The bottom is very rough, and rocky ledges just above and below the bridge cause back currents, eddies, and sudden variations in the velocity. Both banks are high and do not overflow. The gage is referred to a United States Geological Survey bronze bench-mark tablet set in the upstream side of the capstone of the left abutment. When the gage reads zero, this bench mark is 20.44 feet above the water surface. Its elevation above sea level is 1,389 feet.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Holston River (South Fork) at Bluff City, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 26	B. S. Drane	265	590	1.89	1.62	1,114
March 28	do	268	763	1.98	2.38	1,509
April 29	Drane and M. R. Hall	275	955	3.04	3.27	2,900
July 12	J. M. Giles	97	273	1.68	.60	459
July 12[a]	do	123	490	.97	.60	475
August 10	B. S. Drane	204	252	1.52	.60	384
October 18	do	196	181	.89	— .05	162
October 18	do	108	73	2.35	— .05	171
October 18[a]	do	112	349	.48	— .09	168

[a] Measurement made at Virginia and Southwestern Railroad bridge.

Mean daily gage height, in feet, of Holston River (South Fork) at Bluff City, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.30	0.70	1.60	1.65	2.40	0.90	1.80	0.40	0.00	0.10	−0.10	0.30
2	.40	.20	1.80	1.60	2.10	.90	1.30	2.00	.20	.10	.00	.30
3	.60	.50	2.00	1.45	2.00	1.00	1.00	1.60	.40	.10	.00	.40
4	.30	.40	2.00	1.20	3.00	.90	.90	1.20	.60	.10	.10	.60
5	.10	.10	1.90	1.20	2.85	.70	.80	.90	.70	.10	.30	.70
6	.40	.40	1.70	1.10	2.30	.70	.70	1.00	.60	.10	.30	2.80
7	.40	.50	1.70	1.10	1.95	.60	.70	.90	.40	.10	.20	1.80
8	.40	1.90	3.20	1.25	1.75	.70	.60	.70	.20	.10	.20	1.30
9	.40	2.00	3.00	1.10	1.90	.60	.60	.60	.20	.00	.10	.90
10	.20	1.50	2.40	1.00	2.00	.60	.80	.60	.10	.00	.10	.80
11	.10	1.40	2.10	1.00	2.00	.60	.80	.70	.20	.00	.10	.80
12	.90	1.10	2.20	1.00	1.80	.60	.60	1.60	.20	.00	.00	.90
13	.90	.80	1.90	1.10	1.60	.60	.50	1.20	.10	.00	.20	.80
14	.90	.90	1.90	1.55	1.40	.50	.70	1.00	.10	.00	.50	.80
15	.70	1.00	1.80	1.50	1.50	.50	.40	.80	.10	.00	.50	.50
16	.60	1.00	1.75	1.50	1.45	.50	.30	.70	.10	−.10	.40	.60
17	1.00	.80	1.50	1.40	1.20	.50	.90	.60	.10	−.10	.30	.60
18	1.00	.50	1.65	1.10	1.10	.50	.50	.50	.10	−.10	.30	.60
19	.90	.80	1.60	1.20	1.20	.50	.40	.50	.10	−.10	.30	.50
20	.90	1.10	1.60	1.00	1.20	.40	.40	.80	.10	.00	.20	.50
21	.80	1.10	1.55	1.00	1.20	.40	.30	.70	.10	−.10	.20	.40
22	.80	1.60	1.80	1.00	1.10	.40	.30	.70	.10	−.10	.20	.40
23	1.70	3.10	3.10	1.00	1.00	.40	.30	.70	.10	−.10	.40	.30
24	1.80	2.40	5.70	.90	.90	.40	.40	.50	.10	−.10	.40	.30
25	1.40	1.90	3.90	.90	.90	.30	.70	.40	.10	−.10	.40	.70
26	1.30	1.60	3.00	.90	.80	.30	.60	.40	.00	.00	.30	.90
27	1.10	1.60	2.75	2.00	.80	.40	.50	.40	.00	−.10	.20	.90
28	.80	1.50	2.60	4.20	.70	.80	.60	.30	.10	.00	.10	2.00
29	.70	1.50	2.10	3.60	.80	1.70	.50	.20	.10	−.10	.10	1.50
30	.40	.....	2.00	2.90	.80	2.50	.50	.20	.10	−.10	.20	1.00
31	.40	.....	1.70	.....	.80	.....	.40	.00	.....	−.10	.....	.90

Rating table for Holston River (South Fork) at Bluff City, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.1	150	1.2	840	2.5	1,970	3.8	3,800
.0	190	1.3	910	2.6	2,080	3.9	3,980
.1	235	1.4	980	2.7	2,190	4.0	4,160
.2	280	1.5	1,060	2.8	2,310	4.2	4,530
.3	330	1.6	1,140	2.9	2,430	4.4	4,910
.4	380	1.7	1,220	3.0	2,550	4.6	5,310
.5	430	1.8	1,300	3.1	2,680	4.8	5,730
.6	485	1.9	1,390	3.2	2,820	5.0	6,180
.7	540	2.0	1,480	3.3	2,970	5.2	6,650
.8	595	2.1	1,570	3.4	3,120	5.4	7,130
.9	650	2.2	1,670	3.5	3,280	5.6	7,630
1.0	710	2.3	1,770	3.6	3,450	5.8	8,130
1.1	770	2.4	1,870	3.7	3,620	6.0	8,630

The above table is applicable only for open-channel conditions. It is based upon 41 discharge measurements made during 1900 to 1904, inclusive. It is well defined between gage heights −0.1 feet and 3.5 feet. The table has been extended beyond these limits. Above gage height 5.4 feet the rating curve is a tangent, the difference being 250 per tenth.

Estimated monthly discharge of Holston River (South Fork) at Bluff City, Tenn., for 1904.

[Drainage area, 828 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,300	235	573	0.692	0.798
February	2,680	235	885	1.07	1.15
March	7,880	1,060	1,860	2.25	2.59
April	4,530	650	1,086	1.31	1.46
May	2,550	540	1,115	1.35	1.56
June	1,970	330	550	.664	.741
July	1,300	330	515	.622	.717
August	1,480	190	579	.699	.806
September	540	190	274	.331	.369
October	235	150	185	.223	.257
November	430	150	291	.351	.392
December	2,310	330	651	.786	.906
The year	7,880	150	714	.862	11.75

HOLSTON RIVER AT AUSTINS MILLS, NEAR ROGERSVILLE, TENN.

This station is maintained in cooperation with the United States Weather Bureau, by whom the gage readings are furnished. It is located at the Southern Railway bridge at Austins Mills, Tennessee. The gage is graduated by feet and tenths to 49 feet, and is attached vertically to the downstream end of the pier nearest the right bank. It is read once each day by Fred Beal. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. This is a deck bridge, 800 feet long, resting on stone piers. Six spans are wooden truss, and piers have been built for two more spans at each end, but the track is carried on trestle work. The initial point for soundings is the end of the bridge truss over the center of the pier on the right bank, downstream side. The channel is straight for about 2,000 feet above and for 1,000 feet below the bridge. The current is swift, there being a shoal about 500 feet below the bridge. The right bank will overflow gradually at gage heights from 10 to 20 feet, and the left bank at gage heights 8 to 20 feet. There is a fringe of trees along both banks. The bed of the stream is composed of rock and gravel and is permanent. All the water passes beneath the bridge and trestles, there being one channel broken by three piers at ordinary stages.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Holston River at Austins Mills, near Rogersville, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
July 14	J. M. Giles	376	1,526	1.17	1.75	1,783
August 12	B. S. Drane	420	1,591	1.47	2.00	2,332
October 21	do	413	1,229	.53	1.10	647

Mean daily gage height, in feet, of Holston River at Austins Mills, near Rogersville, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	1.70	2.90	3.00	3.70	2.00	3.10	1.60	1.40	1.20	1.00	1.30
2	1.50	1.60	3.10	2.90	3.30	2.70	2.80	1.60	1.40	1.20	1.00	1.30
3	1.60	1.60	3.70	2.60	3.10	2.80	2.20	2.40	1.40	1.20	1.00	1.50
4	1.60	1.50	3.10	2.40	3.00	2.40	2.10	2.30	1.80	1.20	1.10	1.60
5	1.60	1.50	3.10	2.30	4.30	2.20	2.10	2.00	1.90	1.20	1.20	1.70
6	1.70	1.50	2.90	2.30	3.60	2.20	2.10	2.00	1.60	1.20	1.30	3.10
7	1.60	1.60	2.90	2.30	3.20	2.10	2.20	2.00	1.60	1.20	1.40	3.40
8	1.60	2.00	5.00	2.30	2.60	2.10	2.10	1.90	1.50	1.10	1.30	2.60
9	1.80	3.10	4.50	2.40	3.00	2.10	2.10	1.80	1.50	1.10	1.30	2.20
10	1.60	2.80	3.90	2.40	3.40	2.00	2.00	1.80	1.40	1.10	1.20	2.00
11	1.60	2.50	3.50	2.30	3.30	2.50	2.20	1.70	1.40	1.10	1.20	1.80
12	1.70	2.20	3.40	2.20	3.10	2.20	2.00	1.70	1.40	1.10	1.20	1.80
13	1.80	2.00	3.10	2.20	3.00	2.10	1.90	2.20	1.40	1.10	1.30	1.90
14	2.00	1.80	3.10	2.40	2.70	1.90	1.80	2.00	1.40	1.10	1.30	1.80
15	2.00	1.80	3.10	2.40	2.60	1.90	1.70	2.00	1.30	1.10	1.50	1.70
16	1.80	1.80	3.10	2.40	2.50	1.80	1.70	2.10	1.30	1.10	1.50	1.70
17	2.00	1.80	2.80	2.30	2.40	1.80	1.60	1.80	1.30	1.10	1.40	1.70
18	2.20	1.70	2.60	2.40	2.30	1.80	1.50	2.00	1.30	1.10	1.30	1.60
19	2.20	1.70	2.50	2.30	2.30	1.80	1.50	1.80	1.20	1.10	1.30	1.50
20	2.00	2.10	2.50	2.20	2.20	1.80	1.50	1.90	1.20	1.10	1.30	1.50
21	1.80	2.20	2.50	2.10	2.20	1.70	1.50	2.70	1.20	1.10	1.30	1.50
22	1.80	2.20	3.20	2.00	2.20	1.70	1.50	2.60	1.20	1.10	1.30	1.50
23	2.30	3.80	3.70	2.00	2.20	1.70	1.50	2.20	1.20	1.00	1.40	1.50
24	3.40	3.80	7.00	2.00	2.20	1.70	1.50	1.80	1.20	1.00	1.40	1.40
25	3.00	3.20	6.50	2.00	2.10	1.70	1.50	1.70	1.20	1.00	1.30	1.70
26	2.50	3.00	5.00	2.00	2.10	1.70	1.70	1.60	1.20	1.00	1.50	1.80
27	2.30	3.10	4.40	2.20	2.10	1.60	1.70	1.50	1.20	1.00	1.40	2.00
28	2.20	3.30	4.10	3.70	2.00	1.80	1.70	1.50	1.20	1.00	1.30	2.80
29	1.80	3.00	3.70	5.00	1.80	2.40	1.70	1.50	1.20	1.00	1.30	3.20
30	1.70	.....	3.50	4.30	1.80	2.90	1.70	1.40	1.20	1.00	1.30	2.60
31	1.70	.....	3.10	.....	1.80	.....	1.60	1.40	.....	1.00	.....	2.40

Rating table for Holston River at Austins Mills, near Rogersville, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.1	645	1.7	1,695	2.3	3,035	2.9	4,675
1.2	805	1.8	1,900	2.4	3,285	3	4,980
1.3	970	1.9	2,110	2.5	3,545	3.1	5,290
1.4	1,140	2	2,330	2.6	3,815	3.2	5,610
1.5	1,315	2.1	2,555	2.7	4,095	3.3	5,940
1.6	1,500	2.2	2,790	2.8	4,380	3.4	6,270

The above table is applicable only for open-channel conditions. It is based upon 3 discharge measurements made during 1904 and one made in 1905. It is well defined between gage heights 1.1 feet and 2 feet. The table has been extended above these limits.

Estimated monthly discharge of Holston River at Austins Mills, near Rogersville, Tenn., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
January	6,270	1,315	2,273
February	7,590	1,315	3,169
March	18,150	3,545	7,007
April	11,550	2,330	3,704
May	9,240	1,900	4,096
June	4,675	1,500	2,460
July	5,290	1,315	2,093
August	4,095	1,140	2,125
September	2,110	805	1,077
October	805	490	636
November	1,315	490	952
December	6,270	970	2,325
The year	18,150	490	2,660

WATAUGA RIVER NEAR ELIZABETHTON, TENN.

This station was established May 11, 1903, by E. W. Myers, assisted by B. S. Drane. The station is located on the Virginia and Southwestern Railroad bridge at Siam, about 4 miles from Elizabethton, Tenn. The standard inclosed chain gage is located on the downstream side of the middle span on the inside of the guard rail. The zero of the scale is opposite a point 142 feet from the initial point for soundings. The length of the chain from the end of the weight to the marker is 22.66 feet. It is read once each day by J. B. Nave. Discharge measurements are made on the lower side of the bridge to which the gage is attached. This bridge crosses the river at an angle of about 14° with the normal to the direction of the current. The initial point for soundings is the top of the first bolt on the downstream guard rail over the middle of the left abutment. The channel is straight for 1,000 feet above and below the station. The right bank is high and will overflow only at flood stages. All water will, however, pass under the bridge and the trestle approach. The left bank is a perpendicular masonry abutment and will not overflow. The section underneath the bridge is smooth and consists of sand, silt, and some small rocks, and does not appear to be shifting. At ordinary stages the channel is divided into three parts by the bridge piers. At flood stages there is an additional flood channel on the right bank. A shallow stretch 1,000 feet below the bridge makes the current under

the bridge sluggish at low stages. Bench mark No. 1 is a standard copper bolt set in the cap of the abutment on the left bank, upstream side of the bridge. When the gage reads zero its elevation is 21.11 feet above the water surface. Bench mark No. 2 is the upper edge of the plate connecting the lower bracing system with the lower chord and floor beam opposite the middle of the gage box on the downstream side of the bridge. This floor beam is the fourth from the left end of the middle span. When the gage reads zero its elevation is 19.60 feet above the water surface. During the summer and fall of 1902 a line of levels was run from Carter's station, Tennessee, near the mouth of the river, to a point near Shulls Mills, in North Carolina, near the head of the river, locating the water powers of this stream. These powers are numerous and of considerable magnitude, but at present are comparatively inaccessible and hence not commercially available.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Watauga River near Elizabethton, Tenn., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 10	E. W. Myers	233	1,002	1.09	2.80	1,095
May 11	do	229	762	.87	2.00	665
July 13	B. S. Drane	228	662	.35	1.61	234
August 15	do	229	653	.31	1.38	205
August 15	M. R. Hall	205	620	.53	1.38	328
September 5	B. S. Drane	228	633	.36	1.25	226
September 5 [a]	do	108	369	.67	1.25	247
October 17	do	228	625	.33	1.20	204
November 23	do	228	633	.34	1.26	214
1904.						
February 25	B. S. Drane	229	788	.68	2.03	537
February 25	do	229	784	.65	2.01	507
March 25	do	234	1,183	2.12	3.70	2,507
April 30	do	230	751	.96	2.15	720
July 11	J. M. Giles	189	594	.68	1.60	403
August 11	B. S. Drane	231	760	.99	2.13	754
October 19 [b]	do	109	311	.51	1.06	158
October 19	do	228	517	.30	1.06	156

[a] Boat three-fourths mile above station. [b] Boat one-half mile above station.

Mean daily gage height, in feet, of Watauga River near Elizabethton, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.30	1.50	2.35	2.05	2.10	2.50	2.00	2.20	1.40	1.15	1.05	1.25
2	1.30	1.70	2.60	2.00	2.00	3.00	1.80	2.20	1.70	1.15	1.05	1.30
3	1.25	1.60	2.30	2.00	2.70	2.30	1.70	2.10	1.60	1.15	1.10	1.35
4	1.25	1.50	2.30	1.90	3.70	2.20	1.60	2.00	1.50	1.15	1.20	1.35
5	1.20	1.40	2.15	1.80	2.70	2.10	2.70	1.60	1.60	1.15	1.50	1.60
6	1.15	1.60	2.00	1.75	2.40	2.00	1.90	1.75	1.50	1.10	1.50	2.30
7	1.20	1.50	4.45	1.80	2.20	2.20	1.70	1.75	1.45	1.10	1.30	1.80
8	1.20	2.70	3.90	1.70	2.90	1.95	1.60	1.70	1.40	1.10	1.20	1.50
9	1.20	2.20	3.10	2.20	3.50	1.80	1.50	1.65	1.30	1.10	1.15	1.40
10	1.20	1.90	2.60	1.90	3.00	1.80	1.70	1.50	1.30	1.10	1.10	1.50
11	1.30	1.80	2.80	1.85	2.80	1.80	1.60	2.15	1.25	1.10	1.10	1.60
12	1.50	1.65	2.30	1.90	2.50	1.80	1.60	1.90	1.25	1.10	1.10	1.60
13	1.50	1.65	2.30	1.80	2.40	1.70	1.55	1.70	1.30	1.10	1.40	1.50
14	1.40	1.65	2.20	1.70	2.20	1.70	1.50	1.65	1.30	1.10	1.45	1.50
15	1.20	1.70	2.15	1.70	2.25	1.60	1.45	1.70	1.35	1.10	1.50	1.40
16	1.35	1.70	2.10	1.80	2.10	1.50	1.40	2.60	1.30	1.10	1.50	1.40
17	1.80	1.60	2.00	1.85	2.00	1.60	1.40	2.00	1.25	1.10	1.45	1.40
18	1.70	1.60	1.95	1.75	2.60	1.60	1.40	1.70	1.20	1.10	1.45	1.35
19	1.70	1.60	2.00	1.70	2.40	1.50	1.40	1.60	1.20	1.10	1.40	1.35
20	1.40	1.70	2.00	1.70	2.10	1.50	1.30	1.60	1.20	1.05	1.35	1.30
21	1.50	1.70	2.00	1.65	2.00	1.60	1.30	2.00	1.20	1.05	1.35	1.30
22	1.70	2.15	2.35	1.65	1.90	1.70	1.40	1.80	1.15	1.05	1.40	1.30
23	3.00	2.40	4.00	1.60	1.80	1.60	1.50	1.60	1.15	1.05	1.40	1.30
24	2.10	2.20	5.20	1.60	1.75	1.50	1.55	1.50	1.15	1.05	1.40	1.30
25	1.90	2.05	4.00	1.55	1.90	1.45	1.85	1.50	1.15	1.05	1.35	1.50
26	1.90	2.00	3.10	1.65	1.35	1.45	1.80	1.45	1.15	1.05	1.35	1.60
27	1.50	2.60	2.85	1.90	1.30	1.50	1.50	1.45	1.15	1.05	1.30	1.65
28	1.50	2.75	2.60	2.30	1.20	1.70	1.60	1.45	1.15	1.05	1.30	1.70
29	1.55	2.40	2.40	2.30	1.20	2.80	1.50	1.40	1.15	1.05	1.30	1.65
30	1.40	.....	2.20	2.20	1.20	2.20	1.50	1.40	1.15	1.05	1.30	1.60
31	1.40	.....	2.10	.....	2.30	.....	1.60	1.40	.....	1.05	.....	1.60

Rating table for Watauga River near Elizabethton, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.0	135	2.0	650	3.0	1,530	4.0	3,025
1.1	170	2.1	720	3.1	1,645	4.2	3,390
1.2	210	2.2	790	3.2	1,765	4.4	3,770
1.3	250	2.3	865	3.3	1,895	4.6	4,160
1.4	295	2.4	945	3.4	2,035	4.8	4,560
1.5	345	2.5	1,030	3.5	2,180	5.0	4,960
1.6	400	2.6	1,120	3.6	2,335	5.2	5,360
1.7	460	2.7	1,215	3.7	2,500		
1.8	520	2.8	1,315	3.8	2,670		
1.9	585	2.9	1,420	3.9	2,845		

The above table is applicable only for open-channel conditions. It is based upon 12 discharge measurements made during 1903 and 1904. It is not well defined. The table has been extended above gage height 3.7 feet. This table is very uncertain above gage height 3.0 feet.

Estimated monthly discharge of Watauga River near Elizabethton, Tenn., for 1904.

[Drainage area, 408 square miles].

Month.	Discharge in second-feet.			Run-off.	
	Maxtmum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,530	190	372	0.912	1.05
February	1,265	295	601	1.47	1.59
March	5,360	618	1,357	3.33	3.84
April	865	372	552	1.35	1.51
May	2,500	210	873	2.14	2.47
June	1,530	320	579	1.42	1.58
July	1,215	250	417	1.02	1.18
August	1,120	295	496	1.22	1.41
September	460	190	254	.623	.695
October	190	152	166	.407	.469
November	345	152	258	.632	.705
December	865	230	349	.855	.986
The year	5,360	152	523	1.28	17.48

DOE RIVER AT ELIZABETHTON, TENN.

This station was established as a bench-mark station May 22, 1904, by B. S. Drane. It is located at the covered wagon bridge in the town of Elizabethton, Tenn. Discharge measurements are made from the downstream side of the bridge by lowering the meter between the sill and the edge of the floor. The initial point for soundings is the left bank end of the downstream hand rail. The channel is straight for 500 feet above and below the station. The current is extremely sluggish at low water. Both banks are high and do not overflow. All the water passes between the stone abutments of the bridge. The bed of the stream is composed of sand, and is very shifting. There is but one channel at all stages. A low dam about 300 feet below the bridge will affect the flow considerably at low stages. The bench mark is the top of the lower downstream hand rail opposite the tension rods at the middle of the bridge, 65 feet from the initial point for soundings. Its elevation is 16 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Doe River at Elizabethton, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 22	B. S. Drane	128	253	1.21	1.55	307
July 11	J. M. Giles	129	166	.60	.79	99
October 20	B. S. Drane	134	131	.37	.64	48

LITTLE TENNESSEE RIVER AT JUDSON, N. C.

This river rises in the extreme northeast Georgia, with tributaries from the mountains between North Carolina and Georgia, and flows in a northwesterly direction, emptying into Tennessee River at Lenoir, Tenn. Measurements of flow are made at Judson, N. C., below the mouth of Sawyer Branch. The area drained is mountainous and covered with forest growth. The station was established by E. W. Myers in June, 1896. It is located on the Southern Railway bridge, about one-fourth of a mile from Judson, N. C. The standard chain gage with inclosed scale is located on the downstream side of the first span from the left end of the bridge. The length of the chain from the end of the weight to the marker is 26.29 feet. The observer is J. L. Enloe, who reads the gage once daily. The river is straight for several hundred yards above and below the station; the bottom rocky and very rough on the west side and sandy on the east side. The current is swift and considerably obstructed by two wide timber piers. The section is constant, but not a good one for measurements.

Bench mark No. 1 is the top of the angle block on the lower chord at the middle of the first span from the left end of the bridge, on the downstream side. Its elevation is 23.36 feet above gage datum. Bench mark No. 2 is a standard copper bolt set in the rock near the end of the tunnel, on the right bank, 130 feet from the end of the bridge and 8 feet from the center of the track. Its elevation is 28.14 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Little Tennessee River at Judson, N. C., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 21	B. S. Drane	434	3.58	3.49	1,554
May 25	do	303	3.27	2.95	993
August 15	do	311	3.07	2.98	955
September 30	do	216	2.02	2.32	436
December 13	do	249	2.33	2.53	580

Mean daily gage height, in feet, of Little Tennessee River at Judson, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.65	3.14	3.50	3.25	3.30	2.80	2.75	3.00	2.20	2.10	2.90
2	2.52	2.61	3.08	3.50	3.15	3.20	2.75	2.80	3.10	2.20	2.30	2.80
3	2.48	2.63	2.98	3.55	3.15	3.05	2.55	2.85	2.80	2.20	2.50	2.60
4	2.42	2.48	3.09	3.40	3.20	2.95	2.50	2.75	3.00	2.20	2.60	2.60
5	2.39	2.34	3.13	3.40	3.20	2.85	2.80	2.70	3.20	2.30	2.50	4.10
6	2.43	3.18	4.20	3.35	3.25	2.80	2.60	2.95	2.80	2.20	2.30	3.80
7	2.55	3.30	6.25	3.85	(a)	3.25	2.50	2.75	2.70	2.20	2.20	3.80
8	2.52	3.32	5.15	4.00	(a)	3.30	2.50	3.10	2.70	2.20	2.20	3.70
9	2.48	3.34	4.40	3.90	(a)	3.00	3.25	3.30	2.60	2.20	2.20	3.70
10	2.45	3.28	4.19	3.65	(a)	2.90	2.75	3.20	2.60	2.20	2.20	2.70
11	2.65	3.20	4.65	3.60	(a)	2.90	2.65	4.45	2.60	2.20	2.20	2.60
12	2.58	2.81	4.25	3.60	(a)	2.90	2.65	3.70	2.50	2.20	2.60	2.60
13	2.59	2.81	4.10	3.55	(a)	2.80	2.85	3.45	2.50	2.10	2.60	2.50
14	2.52	3.48	3.90	3.55	3.30	2.75	2.60	3.10	2.50	2.10	2.60	2.50
15	2.45	3.51	3.95	3.50	3.25	2.80	2.50	2.90	2.50	2.10	2.30	2.50
16	3.28	3.22	3.85	3.45	3.20	2.65	2.45	2.85	2.50	2.10	2.30	2.50
17	3.35	3.30	3.85	3.40	3.10	2.65	2.70	2.75	2.40	2.10	2.30	2.55
18	3.22	3.28	3.80	3.35	3.15	2.75	2.80	2.70	2.40	2.10	2.20	2.45
19	3.18	3.30	3.70	3.45	3.15	2.70	2.50	2.65	2.40	2.10	2.20	2.35
20	2.84	3.80	3.65	3.40	3.10	2.90	2.45	2.60	2.40	2.10	2.20	2.10
21	2.58	4.24	3.60	3.35	3.10	2.90	2.50	2.70	2.30	2.10	2.40	2.35
22	5.30	5.38	4.72	3.30	3.05	3.00	3.00	2.65	2.40	2.10	2.60	2.35
23	4.28	4.47	5.66	3.30	2.95	2.80	2.80	2.55	2.40	2.10	2.50	2.50
24	3.22	4.13	5.12	3.25	2.90	2.70	2.70	2.90	2.30	2.10	2.30	2.50
25	3.18	3.91	4.40	3.25	2.90	2.70	2.60	2.80	2.30	2.10	2.30	2.95
26	2.59	3.63	4.10	3.20	2.95	2.80	2.50	3.00	2.30	2.10	2.20	2.80
27	2.50	3.31	3.45	3.20	2.95	2.90	2.65	3.70	2.30	2.10	2.20	2.70
28	2.42	3.14	3.45	3.15	2.90	2.70	2.60	3.50	2.40	2.10	2.60	4.70
29	2.45	3.10	3.40	3.15	2.85	3.20	2.55	2.90	2.40	2.10	2.80	3.70
30	2.81	.....	3.45	3.20	2.90	2.85	2.50	2.65	2.30	2.10	2.50	3.30
31	2.71	.....	3.40	.....	3.50	.....	2.45	2.70	.....	2.10	.....	3.10

a Chain stolen.

Rating table for Little Tennessee River at Judson, N. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.2	335	3.4	1,580	4.6	3,580	6.6	8,050
2.3	405	3.5	1,720	4.7	3,780	6.8	8,540
2.4	485	3.6	1,860	4.8	3,980	7.0	9,050
2.5	575	3.7	2,000	4.9	4,180	7.5	10,460
2.6	675	3.8	2,140	5.0	4,380	8.0	12,200
2.7	775	3.9	2,300	5.2	4,820	8.5	14,200
2.8	875	4.0	2,460	5.4	5,260	9.0	16,200
2.9	985	4.1	2,620	5.6	5,700	9.5	18,450
3.0	1,100	4.2	2,800	5.8	6,140	10.0	20,700
3.1	1,220	4.3	2,980	6.0	6,580	11.0	25,500
3.2	1,340	4.4	3,180	6.2	7,070		
3.3	1,460	4.5	3,380	6.4	7,560		

The above table is applicable only for open-channel conditions. It is based upon 37 discharge measurements made during 1896 to 1904. It is well defined between gage heights 2.2 and 5 feet. The table has been extended beyond these limits. Above gage height 10 feet the rating curve is a tangent, the difference being 480 per tenth.

Estimated monthly discharge of Little Tennessee River at Judson, N. C., for 1904.

[Drainage area, 675 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	5,040	477	984	1.46	1.68
February	5,216	437	1,620	2.40	2.59
March	7,192	1,077	2,617	3.88	4.47
April	2,460	1,280	1,655	2.45	2.73
May	1,720	930	1,268	1.88	2.17
June	1,460	725	992	1.47	1.64
July	1,400	530	724	1.07	1.23
August	3,280	625	1,112	1.65	1.90
September	1,340	405	642	.951	1.06
October	405	275	300	.444	.512
November	875	275	472	.699	.780
December	3,780	275	964	1.43	1.65
The year	7,192	275	1,112	1.65	22.41

TUCKASEGEE RIVER AT BRYSON, N. C.

Tuckasegee River rises in the southwestern part of North Carolina, at the base of Tennessee Ridge, which separates Jackson and Transylvania counties. It flows in a northwesterly direction, emptying into Little Tennessee River at Bushnell, N. C. Measurements of discharge are made at Bryson, 2 miles below the mouth of Newton Mill Creek. The drainage area is largely rough and mountainous and covered with forest growth.

This station was originally established by E. W. Myers, June, 1896, at the Southern Railroad bridge, about 3 miles above Bryson, N. C., just below Governor Island post-office. This station was abandoned March 25, 1897, on account of the poor section. The present station was established November 7, 1897, by A. P. Davis, at the highway bridge in the town of Bryson, N. C., 2 miles below the mouth of Newton Mill Creek. The gage is a vertical rod bolted to the north pier on the right bank at the downstream side of the bridge. It is read once daily by J. M. Welch. Discharge measurements are made from the sidewalk on the downstream side of the single-span steel highway bridge. The initial point for soundings is the end of the hand rail at the left bank on the downstream side of the bridge. The channel is straight for about 600 feet above and below the station. The water is moderately swift, but the current is obstructed by the remnants of two old bridge piers. The right bank is low at the bridge and overflows to a slight extent, but all water passes beneath the bridge and its approach. The right bank is high and rocky and does not overflow. The bed is of gravel and sand and is fairly constant. Bench mark No. 1 is a copper bolt set in the stone sill beneath the large window in the northwest corner of D. K. Collins's brick store, about 80 feet east of the northeast corner of the county court-house. The window is on the side of the store nearest the court-house. The elevation of the bench mark is 22.32 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Tuckasegee River at Bryson, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 18	B. S. Drane	189	865	0.92	1.31	759
February 20	do	189	937	1.32	1.82	1,239
February 23	M. R. Hall	189	988	1.82	2.04	1,800
March 19	B. S. Drane	188	949	1.35	1.74	1,281
March 22	do	190	1,079	1.92	2.29	2,068
May 26	do	290	882	1.07	1.41	944
August 15	do	187	821	1.14	1.41	940
August 16	do	188	869	1.47	1.65	1,274
September 30	do	182	701	.65	1.00	456
October 1	do	182	701	.60	.98	422
October 12	do	182	730	.75	1.11	550
December 14	do	182	721	.70	1.05	502

Mean daily gage height, in feet, of Tuckasegee River at Bryson, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.10	1.20	1.85	1.90	1.60	1.70	1.45	1.40	1.30	1.00	0.85	1.10
2	1.20	1.10	1.70	1.80	1.60	1.70	1.35	1.40	1.50	1.00	.85	1.05
3	1.10	1.25	1.70	1.75	1.60	1.60	1.25	1.30	1.30	.95	1.00	1.30
4	1.00	1.10	1.65	1.70	1.55	1.50	1.40	1.30	1.40	.95	1.10	1.10
5	.90	1.15	1.50	1.70	1.50	1.40	1.30	1.40	1.50	.95	1.15	2.80
6	1.10	1.20	1.50	1.80	1.50	1.40	1.25	1.40	1.30	.95	1.05	1.70
7	1.10	1.90	4.80	2.60	1.50	2.00	1.20	1.80	1.20	.95	.90	1.40
8	1.05	2.00	2.65	2.40	3.90	1.70	1.20	1.40	1.20	.95	.90	1.30
9	1.00	1.60	2.30	2.10	2.60	1.60	1.60	1.40	1.20	.90	.90	1.15
10	1.10	1.50	2.05	1.95	2.10	1.45	1.35	2.00	1.20	.90	.90	1.25
11	1.25	1.50	2.10	1.85	1.90	1.50	1.35	2.00	1.25	.90	.90	1.20
12	1.10	1.40	1.90	1.80	1.80	1.40	1.30	1.70	1.15	.90	.90	1.15
13	1.25	1.30	1.80	1.75	1.80	1.35	1.20	1.50	1.15	.90	1.25	1.10
14	1.10	1.40	1.40	1.70	1.80	1.30	1.25	1.40	1.10	.90	1.10	1.05
15	1.10	1.40	2.00	1.70	1.70	1.30	1.15	1.40	1.10	.90	1.00	1.10
16	1.50	1.30	1.85	1.70	1.60	1.30	1.30	1.50	1.05	.90	.95	1.05
17	1.60	1.25	1.80	1.70	1.60	1.30	1.25	1.30	1.05	.90	.95	1.10
18	1.30	1.30	1.85	1.60	1.55	1.30	1.20	1.30	1.00	.90	.90	1.10
19	1.20	1.70	1.70	1.60	1.55	1.30	1.10	1.25	1.00	.90	.90	1.00
20	1.20	1.60	1.70	1.70	1.50	1.55	1.20	1.30	1.00	.85	.90	.95
21	1.20	2.00	2.10	1.70	1.50	1.30	1.30	1.20	1.00	.90	.90	1.00
22	5.40	2.80	2.10	1.60	1.45	1.50	1.40	1.20	1.00	.85	1.10	.95
23	1.90	2.00	3.70	1.55	1.40	1.30	1.40	1.30	1.00	.85	1.15	1.00
24	1.60	1.80	3.10	1.50	1.40	1.25	1.40	1.70	1.00	.85	1.00	1.20
25	1.60	1.70	2.70	1.50	1.40	1.25	1.40	1.50	1.00	.90	1.00	1.40
26	1.50	1.60	2.70	2.30	1.35	1.40	1.30	1.50	.95	.90	.90	1.30
27	1.35	2.00	2.60	1.80	1.35	1.30	1.20	1.60	.95	.90	.90	2.20
28	1.40	1.70	2.30	1.70	1.30	1.40	1.30	1.40	1.00	.85	.90	2.20
29	1.40	1.70	2.15	1.70	1.40	1.95	1.20	1.30	1.00	.85	.90	1.45
30	1.20	.....	2.10	1.70	1.60	1.50	1.20	1.25	1.00	.85	1.50	1.40
31	1.20	.....	2.00	.....	2.00	.....	1.20	1.25	.....	.85	.....	1.30

Rating table for Tuckasegee River at Bryson, N. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.9	380	1.9	1,510	2.9	3,250	3.9	5,540
1.0	460	2.0	1,660	3.0	3,460	4.0	5,800
1.1	550	2.1	1,810	3.1	3,670	4.2	6,350
1.2	650	2.2	1,970	3.2	3,890	4.4	6,920
1.3	750	2.3	2,130	3.3	4,110	4.6	7,530
1.4	860	2.4	2,300	3.4	4,330	4.8	8,160
1.5	980	2.5	2,480	3.5	4,560	5.0	8,800
1.6	1,100	2.6	2,660	3.6	4,800	5.2	9,475
1.7	1,230	2.7	2,850	3.7	5,040	5.4	10,250
1.8	1,370	2.8	3,050	3.8	5,290		

The above table is applicable only for open-channel conditions. It is based principally upon discharge measurements made during 1904. It is well defined.

Estimated monthly discharge of Tuckasegee River at Bryson, N. C., for 1904.

[Drainage area, 662 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	10,250	380	1,026	1.55	1.79
February	3,050	550	1,103	1.67	1.80
March	8,160	860	2,061	3.11	3.58
April	2,660	980	1,378	2.08	2.32
May	5,540	750	1,286	1.94	2.24
June	1,660	700	942	1.42	1.58
July	1,100	550	743	1.12	1.29
August	1,660	650	921	1.39	1.60
September	980	420	586	.885	.986
October	460	340	383	.579	.668
November	980	340	457	.690	.770
December	3,050	420	805	1.22	1.41
The year	10,250	340	974	1.47	20.03

HIWASSEE RIVER AT MURPHY, N. C.

The station was established July 26, 1896, by E. W. Myers. It is located at the highway bridge, about 80 feet above the Atlanta, Knoxville and Northern Railroad bridge and one-half mile above the mouth

of Valley River. The standard chain gage, with 24-inch box, is clamped to the top of the downstream end of the first iron floorbeam from the right bank in the space between the bridge floor and the lower chords. The length of the chain from the bottom of the weight to the index is 27.05 feet. The gage is read once each day by William Mingus. Discharge measurements are made from the sidewalk on the upstream side of the single-span highway bridge. The bridge is 195 feet long, supported by stone abutments. The initial point for soundings is the end of the iron hand rail on the right bank, upstream side of the bridge. The channel is straight for about 500 feet above and below the station. The right bank is high and rocky and will not overflow. The left bank will overflow for a short distance around the abutment. The bed of the stream is rocky and rough and makes soundings uncertain. The bed is permanent and the flow is rapid.

Bench mark No. 1 is the downstream side of the top of the stone pier at the right bank, 22.55 feet above gage datum. Bench mark No. 2 is the top of the downstream end of the first iron floorbeam from the right end of the bridge; its elevation is 25.05 feet above gage datum. Bench mark No. 3 is a cut with large nail on a large white-oak tree in the grounds of the Atlanta, Knoxville and Northern Railroad station, on the left side of the street leading from the highway bridge to the town and 325 feet from the end of the bridge. Its elevation is 31.57 feet above gage datum. Bench mark No. 4 is a copper plug set in the solid rock on the right side of the river, 100 feet from the water's edge, 10 feet uphill from the foot of the hill and 500 feet up the river from the bridge. Its elevation is 21.31 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Hiwassee River at Murphy, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 22	M. R. Hall	172	562	3.55	6.63	1,996
February 24	do	168	441	2.58	6.00	1,138
March 1	O. P. Hall	168	392	1.69	5.54	661
March 2	do	168	386	1.67	5.54	644
May 12	do	168	403	1.87	5.66	754
June 29	do	167	366	1.75	5.53	639
August 29	do	164	318	1.08	5.10	344
October 6	do	156	259	.71	4.80	183
December 15	M. R. Hall	162	266	1.08	5.02	287

Mean daily gage height, in feet, of Hiwassee River at Murphy, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.90	5.15	5.50	5.75	5.45	5.50	5.25	5.50	5.20	4.80	4.75	5.15
2	4.90	5.10	5.50	5.70	5.40	5.35	5.10	5.20	5.10	4.80	4.75	5.00
3	5.05	5.25	5.55	5.60	5.45	5.30	5.10	5.05	5.05	4.80	4.80	5.55
4	4.95	5.10	5.55	5.55	5.45	5.25	5.05	5.05	5.30	4.80	5.00	5.15
5	4.90	5.10	5.45	5.55	5.50	5.20	5.45	5.05	5.55	4.80	4.95	5.15
6	4.85	5.10	5.40	5.50	5.45	5.15	5.10	5.65	5.15	4.80	4.90	5.95
7	5.00	5.15	7.80	5.95	5.40	6.85	5.10	5.15	5.10	4.80	4.80	5.40
8	4.85	6.00	6.60	6.50	5.55	5.65	5.05	5.85	5.05	4.80	4.80	5.15
9	4.90	5.50	6.15	5.95	5.55	5.35	6.15	5.45	5.00	4.75	4.80	5.10
10	4.90	5.45	5.90	6.05	6.05	5.25	5.25	5.25	5.00	4.75	4.80	5.15
11	4.95	5.40	6.00	5.95	5.80	5.25	5.10	5.65	5.00	4.75	4.80	5.15
12	5.05	5.35	5.75	5.80	5.70	5.35	5.10	5.45	4.95	4.75	4.80	5.00
13	5.05	5.25	5.70	5.70	5.60	5.20	5.25	5.50	4.95	4.75	5.00	5.05
14	5.10	5.20	6.25	5.65	5.55	5.15	5.10	5.25	4.95	4.75	5.00	5.05
15	5.00	5.60	6.00	5.60	5.55	5.15	5.00	7.25	4.95	4.75	5.00	5.00
16	5.00	5.40	5.75	5.65	5.45	5.10	5.00	5.45	4.90	4.75	4.90	5.00
17	5.70	5.30	5.70	5.55	5.45	5.10	5.35	5.25	4.90	4.75	4.80	5.05
18	5.35	5.25	5.65	5.55	5.45	5.10	5.35	5.15	4.90	4.75	4.80	5.05
19	5.20	5.25	5.60	5.50	5.40	5.10	5.00	5.10	4.85	4.75	4.85	5.05
20	5.15	6.05	5.50	5.45	5.35	5.65	4.95	5.45	4.85	4.75	4.85	5.00
21	5.10	5.70	5.50	5.60	5.35	5.30	4.95	5.20	4.95	4.75	4.80	4.95
22	5.20	6.55	6.50	5.45	5.30	5.20	5.20	5.10	4.90	4.75	4.90	4.95
23	6.30	6.40	7.40	5.40	5.30	5.15	5.05	5.10	4.90	4.70	4.90	4.95
24	5.70	6.00	7.35	5.40	5.30	5.10	5.05	5.50	4.85	4.75	4.95	5.00
25	5.45	5.75	6.50	5.40	5.25	5.05	5.15	5.35	4.85	4.75	4.85	5.25
26	5.35	5.60	6.35	5.40	5.25	5.25	5.00	5.10	4.85	4.75	4.85	5.15
27	5.25	5.60	6.35	5.75	5.25	5.60	4.95	5.60	4.85	4.75	4.85	5.10
28	5.20	5.50	6.10	5.60	5.20	5.10	4.95	5.30	4.85	4.80	4.80	6.45
29	5.20	5.45	6.00	5.55	5.20	5.85	5.05	5.15	4.85	4.80	4.80	5.65
30	5.05	.....	5.90	5.50	5.20	5.30	5.20	5.10	4.85	4.80	5.25	5.40
31	5.20	.....	5.80	.....	6.10	.....	4.95	5.10	.....	4.75	.....	5.30

Rating table for Hiwassee River at Murphy, N. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.8	190	5.6	710	6.4	1,690	7.2	3,130
4.9	235	5.7	800	6.5	1,850	7.3	3,330
5.0	285	5.8	900	6.6	2,020	7.4	3,540
5.1	340	5.9	1,010	6.7	2,190	7.5	3,750
5.2	400	6.0	1,130	6.8	2,370	7.6	3,960
5.3	470	6.1	1,260	6.9	2,550	7.7	4,180
5.4	540	6.2	1,400	7.0	2,740	7.8	4,400
5.5	620	6.3	1,540	7.1	2,930		

The above table is applicable only for open-channel conditions. It is based upon 59 discharge measurements made during 1900 to 1904, inclusive. It is well defined between gage heights 4.8 feet and 6.8 feet. The table has been extended above gage height 6.8 feet. Above gage height 7.6 feet the rating curve is a tangent, the difference being 220 per tenth.

Estimated monthly discharge of Hiwassee River at Murphy, N. C., for 1904.

[Drainage area, 410 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,540	212	401	0.978	1.13
February	1,935	340	671	1.64	1.77
March	4,400	540	1,303	3.17	3.66
April	1,850	540	777	1.90	2.12
May	1,260	400	605	1.48	1.71
June	2,460	312	532	1.30	1.45
July	1,330	260	380	.927	1.07
August	3,230	312	573	1.40	1.61
September	665	212	282	.688	.768
October	190	150	176	.429	.495
November	435	170	224	.546	.609
December	1,770	260	438	1.07	1.23
The year	4,400	150	530	1.29	17.62

HIWASSEE RIVER AT RELIANCE, TENN.

This station was established August 17, 1900, by O. P. Hall. It is located at the Atlanta, Knoxville and Northern Railroad bridge, near the ferry landing. The gage consists of a vertical rod, reading from zero to 10 feet, fastened to an oak tree on the right bank, 150 feet above the railroad bridge and 40 feet below the ferry landing, and a 5-foot section, reading from 10 to 15 feet, attached to a sycamore tree on the downstream side of the road leading to the ferry, about 400 feet from the river. The gage is read once each day by C. V. Higdon. Discharge measurements are made from the railroad bridge and from the wooden trestles on both banks. The railroad track is about 34 feet above low water. The initial point for soundings is the center of the heavy bolt or bridge pin, about 1 foot from the end of the bridge on the right bank, downstream side. This point is also at the center of the pier on the right bank. Above the station the channel makes a sharp bend to the east for a distance of 800 feet. Below the station the channel makes a sharp bend to the west for about 1,000 feet. At ordinary stages the river is about 350 feet wide at this point, and the section is a fairly good one. The water is held back by a ledge of rock below and is rather sluggish at low stages. Discharge measurements at low stages can be made at a ferry near Wetmore, 6 miles below. Both banks overflow, but all water passes beneath the bridge and its approaches.

Bench mark No. 1 is a cut in a hickory tree on the right bank of the river, about 75 feet upstream from the bridge. Its elevation is 5.82 feet above the zero of the gage. Bench mark No. 2 is the top of the downstream iron girder under the cross-ties at a point about 40 feet from the end of the bridge on the right bank. Its elevation is 23.90 feet above the zero of the gage. Bench mark No. 3 is the top of the capstone of the right-bank pier on the upstream side of the bridge. Its elevation is 19.26 feet above the zero of the gage. Bench mark No. 4 is a copper plug set in a stone post flush with the surface of the ground at the south end of C. V. Higdon's house, under the south window. This house stands on the right bank, about 50 feet up from the foot of the hill, 600 feet north of the right-bank end of the bridge and opposite a point on the river about 300 feet above the bridge. Its elevation is 27.16 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Hiwassee River at Reliance, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 24	O. P. Hall	332	2,197	1.45	2.32	3,177
February 25	do	331	2,145	1.23	2.10	2,632
February 25	M. R. Hall	304	2,017	1.36	2.10	2,735
May 16	O. P. Hall	308	1,968	.82	1.64	1,607
August 25	do	302	1,855	.55	1.30	1,012
August 26	do	302	1,864	.53	1.28	994
October 10	do	299	1,656	.25	.75	418

Mean daily gage height, in feet, of Hiwassee River at Reliance, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.30	1.80	2.40	1.65	1.90	1.50	1.10	1.10	0.80	0.75	1.20
2	1.00	1.40	1.80	2.00	1.60	1.60	1.25	1.50	1.20	.75	.75	1.30
3	1.10	1.40	1.70	1.90	1.60	1.45	1.15	1.25	1.05	.80	.75	1.60
4	1.30	1.30	1.70	1.85	1.30	1.45	1.10	1.50	1.00	.80	.85	1.50
5	1.40	1.30	1.70	1.80	1.20	1.40	1.10	1.15	1.45	.80	1.00	1.30
6	1.30	1.20	1.60	1.80	1.60	1.25	1.55	2.50	1.40	.78	1.00	2.50
7	1.40	1.20	2.20	2.00	1.55	1.30	1.20	1.60	1.15	.75	.90	1.70
8	1.10	2.10	3.20	2.10	1.30	1.85	1.15	1.65	1.05	.72	.85	1.40
9	1.10	2.00	2.50	2.80	3.20	1.55	1.10	1.45	1.00	.75	.85	1.30
10	1.00	1.70	2.10	2.30	2.30	1.40	1.40	1.50	.90	.75	.80	1.20
11	1.10	1.60	2.10	2.30	2.05	1.25	1.20	1.60	1.00	.75	.80	1.25
12	1.20	1.60	2.10	2.00	1.90	1.30	1.40	1.60	.95	.75	.80	1.20
13	1.30	1.50	1.90	2.00	1.80	1.35	1.50	1.45	.95	.75	.95	1.15
14	1.30	1.40	2.20	1.85	1.75	1.20	1.30	1.45	.92	.72	1.00	1.10
15	1.30	1.50	2.50	1.80	1.75	1.20	1.10	1.40	.90	.72	1.05	1.10
16	1.20	1.60	2.20	1.85	1.65	1.15	.90	2.10	.90	.72	.90	1.10
17	1.60	1.50	2.00	1.75	1.60	1.15	1.10	1.50	.85	.72	.85	1.10
18	1.80	1.50	1.90	1.75	1.60	1.15	1.12	1.35	.85	.72	.85	1.15
19	1.50	1.60	1.85	1.70	1.55	1.15	1.20	1.35	.80	.70	.85	1.15
20	1.40	2.30	1.80	1.65	1.50	1.15	.90	1.35	.80	.70	.85	1.15
21	1.30	2.00	1.80	1.70	1.50	1.50	.94	1.40	.90	.70	.85	1.05
22	1.70	2.70	3.10	1.70	1.45	1.40	1.40	1.25	.95	.70	.95	1.00
23	3.60	3.10	4.30	1.60	1.40	1.40	1.50	1.25	.85	.70	1.00	1.00
24	2.30	2.50	4.30	1.60	1.40	1.20	1.20	1.10	.90	.70	1.20	1.05
25	1.90	2.10	3.30	1.60	1.40	1.15	1.18	1.35	.80	.70	1.00	1.30
26	1.60	1.90	2.80	1.70	1.35	1.20	1.22	1.30	.80	.70	.90	1.35
27	1.50	1.80	2.80	2.20	1.35	1.30	1.15	1.10	.80	.75	.90	1.40
28	1.40	1.80	2.60	1.85	1.30	1.50	1.10	1.50	.80	.75	.85	2.50
29	1.40	1.80	2.40	1.80	1.30	1.60	1.40	1.30	.85	.75	.85	2.60
30	1.40	.....	2.20	1.75	1.30	1.70	1.15	1.20	.85	.75	1.20	1.70
31	1.30	.....	2.40	.....	1.60	.....	1.15	1.10	.....	.80	.....	1.50

Rating table for Hiwassee River at Reliance, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.7	380	1.7	1,725	2.7	4,410	3.7	8,080
.8	460	1.8	1,940	2.8	4,745	3.8	8,475
.9	550	1.9	2,165	2.9	5,090	3.9	8,875
1.0	655	2.0	2,400	3.0	5,445	4.0	9,280
1.1	770	2.1	2,650	3.1	5,805	4.1	9,685
1.2	895	2.2	2,915	3.2	6,170	4.2	10,090
1.3	1,030	2.3	3,190	3.3	6,540	4.3	10,500
1.4	1,180	2.4	3,480	3.4	6,915		
1.5	1,345	2.5	3,780	3.5	7,300		
1.6	1,525	2.6	4,090	3.6	7,690		

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1904 and 1 measurement made in 1901. It is well defined between gage heights 0.7 foot and 2.3 feet.

Estimated monthly discharge of Hiwassee River at Reliance, Tenn., for 1904.

[Drainage area, 1,180 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	7,690	655	1,402	1.19	1.37
February	5,805	895	1,962	1.66	1.79
March	10,500	1,525	3,563	3.02	3.48
April	4,745	1,525	2,217	1.88	2.10
May	6,170	895	1,635	1.39	1.60
June	2,165	833	1,169	.991	1.11
July	1,435	550	930	.788	.908
August	3,780	770	1,280	1.08	1.24
September	1,263	460	625	.530	.591
October	460	380	412	.349	.402
November	895	420	562	.476	.531
December	4,090	655	1,281	1.09	1.26
The year	10,500	380	1,420	1.20	16.38

VALLEY RIVER AT TOMOTLA, N. C.

This station was established June 29, 1904, by M. R. Hall. It is located at a footbridge about 250 feet below a public road ford and 200 yards from Tomotla, N. C., and 5 miles above Murphy, N. C. The gage is a vertical timber 10 feet long, graduated to feet and tenths, fastened to a pine timber which is spiked to the upstream side of a maple tree on the right bank about 50 feet below the ford. It is read once each day by J. T. Hayes. Discharge measurements are made from the single-span footbridge, the floor of which is 10 to 15 feet above low water. The initial point for soundings is the upstream edge of abutment next to the water on the right bank. The channel is straight for about 500 feet above and for 1,000 feet below the station. The current is moderately swift. Both banks are high and rocky, and are not liable to overflow. The bed of the stream is composed of rock, but there is a fairly smooth and permanent section. There is but one channel at all stages. Bench mark No. 1 is a cross on the head of a large spike driven into the downstream side of an elm tree about 10 feet upstream from gage. Its elevation is 8.50 feet above the zero of the gage. Bench mark No. 2 is a cross on a point of rock at a spring on right bank about 50 feet above the foot bridge. Its elevation is 3 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Valley River at Tomotla, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 13	O. P. Hall	58	145	1.42	1.76	206
June 29	do	57	117	.71	1.17	83
August 29	do	55	106	.70	1.12	74
October 6	do	55	88	.36	.80	32

Mean daily gage height, in feet, of Valley River at Tomotla, N. C., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.10	1.30	1.10	0.90	0.70	1.70	17	1.00	1.40	0.95	0.80	0.90	1.30
2	1.00	1.10	1.10	.90	.70	1.70	18	1.00	1.30	.95	.80	.90	1.20
3	.95	1.10	1.10	.90	.90	2.40	19	.95	1.20	.95	.75	.90	1.20
4	1.00	1.10	1.10	.90	.90	1.60	20	.95	1.20	.95	.75	1.00	1.20
5	1.20	1.10	1.10	.90	1.00	2.10	21	1.00	1.20	.95	.75	1.00	1.20
6	1.00	1.40	1.10	.90	1.00	2.00	22	1.40	1.20	.90	.75	1.00	1.20
7	1.00	1.10	1.10	.90	.90	1.80	23	1.10	2.00	.90	.75	1.00	1.20
8	1.00	1.40	1.10	.85	.90	1.60	24	1.10	1.40	.90	.75	1.00	1.90
9	1.30	1.20	1.00	.85	.90	1.60	25	1.10	1.30	.90	.75	1.00	1.60
10	1.10	1.20	1.00	.85	.90	1.60	26	1.10	1.30	.90	.75	1.00	1.50
11	1.00	1.20	1.00	.85	.90	1.60	27	1.00	1.30	.90	.75	1.00	2.20
12	1.20	1.10	1.00	.85	1.00	1.50	28	1.20	1.30	.90	.70	1.00	2.60
13	1.00	1.10	1.00	.80	1.00	1.50	29	1.00	1.20	.90	.70	1.00	2.00
14	1.00	1.10	.95	.80	1.00	1.40	30	1.00	1.20	.90	.70	2.30	1.60
15	.95	4.00	.95	.80	.90	1.30	31	1.00	1.10	.....	.70	.....	1.60
16	.95	2.00	.95	.80	.90	1.20							

Rating table for Valley River at Tomotla, N. C., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.7	22	1.2	88	1.7	192	2.2	327
.8	32	1.3	106	1.8	217	2.3	357
.9	44	1.4	126	1.9	243	2.4	388
1.0	57	1.5	147	2.0	270	2.5	420
1.1	72	1.6	169	2.1	298	2.6	452

The above table is applicable only for open-channel conditions. It is based upon four discharge measurements made during 1904. It is fairly well defined between gage heights 0.70 feet and 1.75 feet. The table has been extended above gage height 1.75 feet to 2.60 feet.

Estimated monthly discharge of Valley River at Tomotla, N. C., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
July	126	50	65.6
August	1,000	72	13.3
September	72	44	55.2
October	44	22	32.9
November	357	22	59.5
December	452	88	18.1

NOTTELY RIVER NEAR RANGER, N. C.

This station was established February 16, 1901, by O. P. Hall. It is located at the wooden wagon bridge one-half mile from the railroad station at Ranger, N. C., and one-fourth mile below the Atlanta, Knoxville and Northern Railroad bridge. The vertical gage is a 1-inch by 3-inch pine board in two sections, each 8 feet long, fastened to the left-hand side of the first wooden pier from the right bank. The gage is read once each day by A. D. Kilpatrick. Discharge measurements are made from the wagon bridge, a wooden structure of three spans supported by two wooden piers and two stone abutments; the center span is 55 feet long and the end spans are each 36 feet long. The floor of the bridge is about 20 feet above low water. The initial point for soundings is the inside face of the stone abutment on the right bank. The bridge is at a flat bend in the river, the channel curving slightly above and below the station for 600 feet. The right bank is high, rocky, and is somewhat wooded, and will overflow around the end of the bridge for about 50 feet only. The left bank is low and will overflow for a distance of 700 feet at a gage height of from 15 to 18 feet. The bed of the stream is of gravel and sand and probably shifts considerably. The current is somewhat broken and irregular, caused mostly by the piers. There is a moderate velocity and a depth of from 2 to 5 feet at low stages.

Bench mark No. 1 consists of the heads of large wire nails driven in the top of the downstream end of the wooden cap on the left bent of the wooden pier nearest the right bank of the river. Its elevation is 20.05 feet above the zero of the gage. Bench mark No. 2 is a cut on a maple tree 18 inches in diameter, 25 feet from the upstream side of the bridge on the right bank, 25 feet from the edge of the water. Its elevation is 15 feet above the zero of the gage. Bench mark No. 3 is a cut on red oak tree about 15 inches in diameter on the left bank

of the river, 35 feet from the end of the bridge near the downstream side of the road. Its elevation is 17.27 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Nottely River near Ranger, N. C., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-ft.*
March 1	O. P. Hall	236	1.58	3.40	373
May 14	do	240	1.47	3.35	353
August 30	do	198	1.12	2.75	222
October 7	do	176	.69	2.30	121
December 16	M. R. Hall	190	.97	2.58	184

Mean daily gage height, in feet, of Nottely River near Ranger, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	3.00	3.40	3.80	3.30	3.30	2.90	3.40	2.70	2.30	2.20	2.80
2	2.80	2.90	3.40	3.70	3.30	3.30	2.70	3.00	2.60	2.30	2.20	2.40
3	2.80	2.90	3.30	3.60	3.30	3.00	2.50	2.80	2.60	2.30	2.20	2.40
4	2.70	3.40	3.30	3.50	3.30	2.90	2.40	2.80	2.70	2.20	2.40	2.80
5	2.70	3.20	3.30	3.40	3.30	2.90	2.40	3.60	4.10	2.20	2.30	4.10
6	2.60	3.00	3.20	3.30	3.20	2.80	2.90	3.00	3.00	2.20	2.30	3.60
7	2.80	3.00	8.30	4.20	3.20	7.30	2.70	2.80	2.80	2.20	2.30	3.10
8	2.70	4.50	5.10	5.60	3.30	4.70	2.70	5.00	2.70	2.20	2.30	3.00
9	2.70	3.60	4.50	5.00	4.60	3.70	3.00	3.50	2.60	2.20	2.30	2.90
10	2.60	3.20	4.00	4.50	3.90	3.00	2.80	3.10	2.50	2.20	2.30	2.80
11	2.60	3.30	4.00	4.00	3.70	2.90	2.60	4.00	2.60	2.20	2.30	2.80
12	2.60	3.30	3.80	3.80	3.40	3.00	3.10	3.80	2.60	2.20	2.30	2.80
13	2.50	3.10	3.30	3.70	3.40	2.90	2.20	3.40	2.50	2.20	2.40	2.70
14	2.50	3.00	4.40	3.60	3.30	2,70	2.70	2.90	2.50	2.20	2.40	2.60
15	2.70	3.30	4.00	3.60	3.30	2.70	2.60	3.90	2.40	2.20	2.40	3.00
16	2.80	3.10	3.70	3.50	3.10	2.70	2.40	3.10	2.30	2.20	2.40	2.90
17	4.00	3.00	3.70	3.40	3.10	2.70	2.60	2.90	2.30	2.20	2.40	2.80
18	3.20	3.00	3.70	3.50	3.10	2.70	2.60	2.70	2.30	2.20	2.30	2.70
19	3.80	3.00	3.60	3.50	3.10	2.60	2.50	2.70	2.30	2.20	2.30	2.70
20	3.00	4.80	3.40	3.50	3.10	2.70	2.40	2.70	2.30	2.20	2.30	2.70
21	3.00	3.80	3.30	3.40	3.00	2.90	2.40	2.70	2.20	2.20	2.30	2.70
22	3.00	5.60	5.40	2.40	3.00	3.00	4.20	2.70	2.20	2.20	2.30	2.60
23	5.00	5.00	6.70	3.40	3.00	2.80	2.80	2.60	2.20	2.20	2.30	2.50
24	4.00	4.30	6.40	3.30	2.90	2.70	2.60	3.50	3.00	2.20	2.20	2.70
25	3.80	3.80	5.20	3.30	3.00	2.70	3.10	2.90	2.60	2.20	2.20	2.80
26	3.40	3.70	5.10	3.80	2.90	2.70	2.80	2.80	2.30	2.20	2.20	2.80
27	3.20	3.60	5.00	3.70	2.90	2.80	2.60	2.70	2.30	2.20	2.20	2.80
28	3.00	3.50	4.50	3.70	2.90	3.20	2.80	3.20	2.30	2.20	2.20	4.70
29	3.00	3.30	4.10	3.40	2.90	4.60	2.60	2.70	2.30	2.20	2.20	3.40
30	3.00	.....	4.00	3.40	5.40	3.20	2.60	2.70	2.30	2.20	3.00	3.10
31	2.80	.....	3.90	.....	3.80	.....	2.60	2.70	.....	2.20	.....	3.00

Rating table for Nottely River near Ranger, N. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.2	101	3.1	295	4.0	560	4.9	848
2.3	120	3.2	320	4.1	592	5.0	880
2.4	141	3.3	346	4.2	624	5.2	944
2.5	162	3.4	373	4.3	656	5.4	1,008
2.6	184	3.5	402	4.4	688	5.6	1,072
2.7	206	3.6	432	4.5	720	5.8	1,136
2.8	228	3.7	464	4.6	752	6.0	1,200
2.9	250	3.8	496	4.7	784	7.0	1,520
3.0	272	3.9	528	4.8	816		

The above table is applicable only for open-channel conditions. It is based upon 18 discharge measurements made during 1901 to 1904, inclusive. It is well defined between gage heights 2.25 feet and 3.50 feet. The table has been extended beyond these limits. Above gage height 3.60 feet the rating curve is a tangent, the difference being 32 per tenth.

Estimated monthly discharge of Nottely River near Ranger, N. C., for 1904.

[Drainage area, 272 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	880	162	293	1.08	1.24
February	1,072	250	423	1.56	1.68
March	1,936	320	656	2.41	2.78
April	1,072	346	472	1.74	1.94
May	1,008	250	362	1.33	1.53
June	1,616	184	334	1.23	1.37
July	624	101	210	.772	.890
August	880	184	310	1.14	1.31
September	592	101	174	.640	.714
October	120	101	103	.379	.437
November	272	101	124	.456	.509
December	784	141	264	.971	1.12
The year	1,936	101	310	1.14	15.52

OCOEE RIVER AT M'CAYS, TENN.

This station was established March 21, 1903, by O. P. Hall, and was permanently equipped by M. R. Hall on May 13, 1903. It is located at a suspension footbridge just below McCays's ferry at McCays, Tenn., near the Georgia-Tennessee boundary and one-half mile below the railroad bridge of the Atlanta, Knoxville and Northern Railroad. The gage is in two sections, the inclined section reading from −0.3 to 8.5 feet, and consists of double 2 by 6 inch timbers, spiked and bolted together, set in a trench and held in place by 2 by 6 inch posts driven into the ground and bolted or spiked to the gage. The vertical section, reading from 8 to 18 feet, is attached to the bridge posts on the right bank. Discharge measurements are made from the suspension footbridge, consisting of four wire cables and a plank footway. Its span is about 230 feet and it is 23 feet above the water surface at the end supports and 17 feet above the water surface at the middle. The initial point for soundings is the center of the high bent supporting the bridge on the left bank. The channel is practically straight for about 800 feet above and below the station. The right bank will overflow at about 14 feet gage height for about 500 feet; the left bank will overflow at gage height 12 to 20 feet for about 400 feet. The water is confined to one channel and the bed is probably constant. The current is good and the section is excellent.

Bench mark No. 1 is a cut on a walnut tree on the downstream side of the road, about 50 feet from the left-bank landing of McCays's ferry; its elevation is 12.59 feet above the zero of the gage. Bench mark No. 2 is the head of a large nail in the center of a post at the right-bank end of the footbridge, on the downstream side; its elevation is 16.10 feet above the zero of the gage. This post is an anchor post for the cable of the suspension bridge and may be pulled out of place. Bench mark No. 3 is a copper plug set in solid rock at the outer edge of the side ditch of the railroad bed, about 800 feet west of the railroad station at McCays. It is 11 feet north of the center of the track and is slightly higher than the railroad. Its elevation is 20.98 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Ocoee River at McCays, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per. sec.*	*Feet.*	*Second-ft.*
February 22	Hoyt and M. R. Hall	155	722	2.30	2.80	1,664
February 25	O. P. Hall	150	504	1.39	1.40	701
February 26	do	150	489	1.37	1.30	669
May 11	do	148	488	1.29	1.33	629
June 30	do	140	400	.96	.82	386
August 26	do	134	369	.96	.65	354
October 10	do	128	303	.71	.30	214

Mean daily gage height, in feet, of Ocoee River at McCays, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.60	0.90	1.10	1.50	1.20	1.45	0.75	1.60	0.60	0.30	0.30	0.60
2	.60	.80	1.20	1.50	1.25	1.20	.70	.95	.55	.30	.30	.85
3	.70	.90	1.20	1.40	1.25	1.00	.70	.75	.55	.35	.40	1.05
4	.60	.90	1.20	1.35	1.30	1.00	.65	.75	.55	.35	.50	.60
5	.60	.80	1.00	1.30	1.20	.90	.90	1.00	.70	.30	.50	1.85
6	.60	.80	1.00	1.35	1.10	.90	.80	.95	.60	.30	.40	1.40
7	.70	.80	3.00	1.90	1.10	2.10	.70	1.10	.50	.30	.35	.75
8	.60	1.80	2.00	2.30	1.95	1.20	.75	1.70	.50	.30	.30	.60
9	.60	.90	1.60	2.10	1.80	.90	.90	1.25	.50	.30	.30	.50
10	.60	1.00	1.50	1.70	1.45	.90	.75	1.05	.50	.30	.30	.60
11	.80	1.20	1.60	1.65	1.30	.85	.70	1.45	.45	.30	.30	.55
12	.70	1.00	1.45	1.55	1.25	.90	1.20	1.10	.45	.30	.35	.50
13	.70	.90	1.30	1.50	1.20	.85	1.00	1.20	.45	.30	.55	.50
14	.70	.90	2.35	1.40	1.20	.80	.75	.95	.45	.30	.55	.40
15	.70	1.00	1.35	1.40	1.20	.80	.65	1.00	.40	.25	.50	.45
16	.70	.90	1.40	1.40	1.15	.75	.75	.85	.40	.25	.45	.40
17	1.30	.90	1.30	1.35	1.10	.75	.80	.75	.40	.25	.35	.55
18	1.00	.80	1.30	1.35	1.10	.70	.60	.70	.40	.25	.30	.50
19	.80	.90	1.30	1.30	1.10	.70	.60	.75	.40	.25	.30	.45
20	.70	2.00	1.30	1.25	1.15	.80	.55	.80	.35	.25	.30	.40
21	.70	2.00	2.25	1.30	1.00	.75	.60	.70	.40	.25	.35	.40
22	1.00	2.90	2.25	1.35	1.00	1.20	1.10	.60	.45	.25	.40	.40
23	1.70	2.20	3.60	1.25	1.00	.80	.75	.60	.40	.25	.65	.40
24	1.40	1.70	2.80	1.20	.90	.70	.70	.75	.35	.25	.40	.45
25	1.20	1.40	2.20	1.20	1.00	.65	.90	.70	.35	.25	.40	.75
26	1.10	1.30	1.95	1.35	.95	.70	.85	.70	.35	.30	.30	.60
27	.90	1.30	2.20	1.50	.90	.70	.65	.95	.35	.30	.30	1.50
28	1.00	1.20	1.85	1.35	.90	.70	1.00	.75	.40	.30	.30	2.25
29	.90	1.10	1.70	1.30	.90	1.20	.75	.65	.35	.30	.30	1.05
30	.90	.....	1.60	1.20	.90	.85	.70	.60	.30	.30	.75	.80
31	.80	.....	1.55	.....	2.35	.....	.75	.60	.....	.30	.....	.70

Rating table for Ocoee River at McCays, Tenn., from March 20, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.2	200	1.1	551	2.0	1,080	2.9	1,690
.3	230	1.2	602	2.1	1,145	3.0	1,760
.4	262	1.3	655	2.2	1,210	3.1	1,830
.5	296	1.4	710	2.3	1,275	3.2	1,900
.6	332	1.5	767	2.4	1,340	3.3	1,975
.7	370	1.6	826	2.5	1,410	3.4	2,050
.8	411	1.7	887	2.6	1,480	3.5	2,125
.9	455	1.8	950	2.7	1,550	3.6	2,200
1.0	502	1.9	1,015	2.8	1,620		

The above table is applicable only for open-channel conditions. It is based upon 15 discharge measurements made during 1903 and 1904. It is well defined between gage heights 0.25 feet and 3.4 feet. Above gage height 0.50 feet the rating table is the same as for 1903.

Estimated monthly discharge of Ocoee River at McCays, Tenn., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
January	887	332	435
February	1,690	411	630
March	2,200	502	922
April	1,275	602	745
May	1,308	455	610
June	1,145	351	475
July	602	314	403
August	887	332	470
September	370	230	279
October	246	215	226
November	370	230	261
December	1,242	262	407
The year	2,200	215	488

FIGHTINGTOWN CREEK AT M'CAYS, TENN.

This station was established as a bench-mark station August 27, 1904, by O. P. Hall. It is located about one-half mile above the mouth of the creek, which flows into Ocoee River about one-half mile below the station on Ocoee River, at McCays, Tenn. Discharge measurements are made by means of a boat or by wading. Both banks are open,

cultivated lands, which will probably overflow. The bed is sandy and will no doubt change much. The bench mark is two small nails driven into the largest of a cluster of small maple sprouts on the right bank, 40 feet above the mouth of a small branch. Its elevation is 5 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Fightingtown Creek at McCays, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 12	O. P. Hall	40	119	1.03	[a] 1.25	122
August 27	do	40	107	.74	1.72	79
October 11	do	40	91	.44	1.12	40

[a] Gage height given is for the Ocoee River at McCays.

PAINT ROCK RIVER NEAR PAINTROCK, ALA.

This station was established as a bench-mark station February 4, 1904, by J. M. Giles. It is located at the highway bridge 2¾ miles south of Paintrock, Ala., and about 400 feet above the Southern Railway bridge. Discharge measurements are made from the upstream side of the single-span bridge, which is supported by tubular iron piers and has an approach of 12 feet at the right and 23 feet at the left bank. The initial point for soundings is the center of the upstream pier at the left bank. The channel is straight for about 200 feet above and 600 feet below the station. The current is sluggish. The right bank is low, wooded, and overflows during high water from one-fourth to one-half mile. The left bank is rocky, wooded, and overflows only under the approach. The bed of the stream is rocky, free from vegetation, and permanent. An old crib divides the stream into two channels at low stages. At high stages it is broken by the tubular steel piers. The bench mark is a point on the upstream end of the crossbeam 17 feet from the initial point for soundings. Its elevation is 20 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Paint Rock River near Paintrock, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 4	J. M. Giles	62	283	0.56	1.55	159
April 20	do	64	300	.92	2.00	275

FLINT RIVER AT BROWNSBORO, ALA.

This station was established as a bench-mark station February 5, 1904, by J. M. Giles. It is located at the highway bridge about one-fourth mile west of Brownsboro, Ala., and 100 feet below a 6-foot mill-dam. Discharge measurements are made from the downstream side of the single-span bridge, which is supported by tubular iron piers and has a trestle approach of 64 feet at each bank. The initial point for soundings is the center of the downstream pier at the left bank. The channel is straight for about 100 feet above and slightly curved for 500 feet below the station. The current is sluggish above and swift below the section. Both banks are high and clean. The left bank overflows during flood stages, forming a second channel about 500 feet east of the bridge. The bed of the stream is composed of clean sand and gravel, and is permanent. There is one channel at low and two at high stages. The channel at low and intermediate stages is broken by the piers and trestlework of the bridge. The bench mark is the top of the upstream pier at the left bank. Its elevation is 17 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Flint River at Brownsboro, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 5	J. M. Giles	120	395	0.53	1.70	209
April 29	do	127	411	.72	1.95	294

ELK RIVER NEAR ELKMONT, ALA.

This station was established June 24, 1904, by M. R. Hall. It is located at the wagon bridge near Wilson's store, about 5 miles east of Elkmont, Ala., and 3 miles below the bridge of the Louisville and Nashville Railway. A standard chain gage of the 24-inch boxed pattern is used. The box and scale are attached to the upstream lattice iron fencing of the bridge, about 125 feet from the right end. The length of the chain from the end of the weight to the marker is 36.45 feet. The gage is read once each day by J. S. Wilson. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. This bridge is of iron, with stone abutments and cylindrical iron piers, having a span of 82 feet at the right bank, a main span of 181 feet, and two spans of 82 and 20 feet, respectively, at the left bank. The initial point for soundings is the end of

the bridge downstream side at the right bank. Distances from the initial point are marked on the rail with white paint. The channel is nearly straight for about 1,500 feet above and straight for about 2,500 feet below the station. The current is swift. Both banks are high, cultivated, and liable to overflow. The bed of the stream is composed of rock, and is permanent. There is one channel broken by two piers at ordinary stage. Bench mark No. 1 is a point marked with white paint on the top of the downstream pier at the right bank. Its elevation is 31 feet above the datum of the gage. Bench mark No. 2 is a chisel mark on the intermediate post at the end of the gage box. Its elevation is 35 feet above gage datum. Bench mark No. 3 is a copper plug set in the upstream corner of the right abutment.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Elk River near Elkmont, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 21	J. M. Giles	213	605	2.23	2.62	1,352
May 17	do	205	482	1.65	2.15	794
June 24	do	170	498	1.39	2.02	690
August 17	do	221	518	1.53	2.10	795
October 20	do	188	335	.60	1.28	202
October 20	do	188	331	.59	1.27	194

Mean daily gage height, in feet, of Elk River near Elkmont, Ala., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.30	1.60	1.40	1.30	1.30	1.70	17	1.70	2.10	1.30	1.30	1.30	1.90
2	2.00	2.10	1.30	1.40	1.20	1.70	18	2.00	2.10	1.30	1.20	1.30	1.90
3	1.90	1.90	1.40	1.40	1.30	1.70	19	1.70	1.90	1.20	1.30	1.30	1.90
4	1.80	1.60	2.00	1.40	1.30	2.00	20	2.10	2.30	1.40	1.30	1.30	1.90
5	1.80	2.00	1.40	1.30	1.50	2.40	21	2.40	1.90	1.50	1.30	1.40	1.80
6	2.10	1.70	1.60	2.20	1.60	2.80	22	2.70	1.70	1.40	1.30	1.40	1.80
7	2.30	1.60	1.50	2.00	1.50	3.10	23	2.70	2.50	1.40	1.30	1.40	1.70
8	2.30	1.60	1.30	1.70	1.50	2.90	24	2.20	2.80	1.40	1.20	1.40	1.90
9	2.40	1.60	1.40	1.50	1.40	2.60	25	1.80	2.00	1.40	1.30	1.50	4.80
10	2.10	1.70	1.40	1.40	1.40	2.40	26	1.80	1.80	1.50	1.30	1.40	3.40
11	1.90	6.00	1.40	1.40	1.40	2.40	27	1.70	1.70	1.50	1.20	1.40	6.80
12	2.10	4.10	1.30	1.40	1.30	2.30	28	1.70	1.60	1.50	1.20	1.40	11.70
13	2.00	2.70	1.40	1.30	1.40	2.10	29	1.70	1.50	1.40	1.30	1.40	6.80
14	1.90	2.30	1.30	1.30	1.40	2.10	30	1.80	1.50	1.40	1.20	1.60	5.45
15	1.80	2.70	1.30	1.30	1.30	2.00	31	1.70	1.50	.....	1.20	.....	4.40
16	1.70	2.20	1.30	1.30	1.30	1.90							

Rating table for Elk River near Elkmont, Ala., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.2	165	1.7	468	2.2	870	2.7	1,475
1.3	220	1.8	538	2.3	975	2.8	1,620
1.4	278	1.9	612	2.4	1,090	2.9	1,775
1.5	338	2.0	690	2.5	1,210	3.0	1,940
1.6	401	2.1	775	2.6	1,340		

The above table is applicable only for open-channel conditions. It is based upon six discharge measurements made during 1904. It is well defined between gage heights 1.2 feet and 2.6 feet. The table has been extended above gage height 2.6 feet.

Estimated monthly discharge of Elk River near Elkmont, Ala.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
July	1,475	468	724
August	11,000	338	1,144
September	690	165	287
October	870	165	268
November	401	165	271
December, 1–24	2,115	468	860

BIG SPRING AT TUSCUMBIA, ALA.

This station was established as a bench mark-station July 20, 1903, by M. R. Hall. It is located at the ford just below the spring at Tuscumbia, Ala. Discharge measurements are made by wading, or from a buggy, at the lower side of the ford. There is no fixed initial point for soundings. The channel is nearly straight for about 1,000 feet below the station. The current is swift. Both banks are low and clean. The bed of the stream is composed of sand and gravel, with some moss on the bottom. The bench mark is the top of the fourth stone step from the top, left side, of the steps leading down to the spring. Its elevation is 8 feet above the datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Big Spring at Tuscumbia, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 22	J. M. Giles	46	70	1.43	2.15	100
August 15	do	45	48	.90	1.55	43
October 19	do	18	13.2	1.50	.70	20
October 19	do	16	12.4	1.50	.70	19

DUCK RIVER AT COLUMBIA, TENN.

This is an old Weather Bureau station which has not been maintained continuously. Two discharge measurements were made in 1901 by M. R. Hall. During 1904 discharge measurements have been made, and the gage heights have been regularly recorded since October 21, 1904.

It is located at the highway bridge two blocks north of the public square at Columbia, Tenn., three-fourths mile below a mill dam. Gage readings are made from the United States Weather Bureau gage, which is a vertical oak timber bolted to the downstream pier at the right bank. The gage reads by feet and tenths from 1 foot to 38 feet. A supplementary gage, graduated from −0.5 to 5 feet is spiked to a small willow tree on the left bank about 150 feet above the bridge. The gage is read twice each day by W. O. Cherry. Discharge measurements are made from the downstream side of the two-span bridge to which the gage is attached. The bridge consists of two spans, 199 feet and 97 feet long. Low-water measurements are made from a boat about one-fourth mile above the bridge. The initial point for soundings is the end of the bridge on the left bank, downstream side. The channel is curved for about 1,000 feet above and nearly straight for 2,000 feet below the station. The current is sluggish above and swift below the measuring section. Both banks are high and fringed with trees. The right bank overflows under the short span of the bridge during floods. The bed of the stream is composed of rock and gravel, free from vegetation and constant. There is one channel; all water passing under the left span at ordinary and under both spans at high stages.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Duck River at Columbia, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 21	J. M. Giles	85	610	0.49	0.70	299
August 18	do	115	755	.38	.70	287
August 18	do	115	725	.39	.70	284
October 21	do	79	139	.94	.44	130
October 21	do	79	144	1.10	.40	158

Mean daily gage height, in feet, of Duck River at Columbia, Tenn., in 1904.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	.....	0.40	0.40	12	.....	0.45	0.75	23	0.45	0.40	0.45
2	.....	.35	.35	13	.....	.45	.60	24	.50	.35	1.50
3	.....	.30	.45	14	.....	.45	.55	25	.45	.45	4.00
4	.....	.40	.50	15	.....	.50	.65	26	.40	.45	4.80
5	.....	.55	.70	16	.....	.35	.70	27	.40	.40	16.45
6	.....	.50	1.35	17	.....	.35	.55	28	.40	.45	15.25
7	.....	.70	2.40	18	.....	.35	.55	29	.40	.40	8.35
8	.....	.60	1.60	19	.....	.35	.55	30	.30	.40	4.45
9	.....	.50	1.00	20	.....	.30	.50	31	.40	.....	3.15
10	.....	.45	.95	21	0.45	.40	.50				
11	.....	.45	.85	22	.50	.40	.50				

MISCELLANEOUS DISCHARGE MEASUREMENTS IN THE TENNESSEE RIVER DRAINAGE BASIN.

The following is a list of miscellaneous discharge measurements made in the Tennessee River drainage basin during 1904:

Roane Creek at Butler, Tenn.—This stream is an important tributary of Watauga River. A measurement was made March 26 at the county bridge crossing the creek about 600 feet above its mouth. The bench mark is the top of the downstream end of the second floor beam from the left bank, 25 feet above the datum of the gage.

Width, 82 feet; area, 188 square feet; mean velocity, 2.57 feet per second; gage height, 1.75 feet; discharge, 483 second-feet.

Watauga River at Watauga, Tenn.—A measurement was made July 13 from a bridge. The bench mark is the top of cross brace at the foot of the third post from the left end of the bridge, upstream side, 35 feet above the datum of the gage.

Width, 170 feet; area, 871 square feet; mean velocity, 0.68 foot per second; gage height, 2.70 feet; discharge, 594 second-feet.

Holston River (South Fork) near Bluff City, Tenn.—A measurement was made April 29 at the upper bridge, 9 miles above Bluff City, Tenn. The water surface was 23.10 feet below the bench mark.

Width, 182 feet; area, 632 square feet; mean velocity, 4.92 feet per second; discharge, 3,110 second-feet.

French Broad River at Alexander, N. C.—A measurement was made May 20.from the wagon bridge. The bench mark is the upper edge of the third band from the top on the upstream, left bank tubular pier, 5 feet above the datum of the gage.

Width, 223 feet; area, 992 square feet; mean velocity, 1.34 feet per second; gage height, 1.60 feet; discharge, 1,329 second-feet.

Pigeon River near Newport, Tenn.—Measurements were made at Deep Ford Bridge, 2 miles below Newport, Tenn., and 3 miles below the regular gaging station on Pigeon River, and 1½ miles above the mouth of the river.

March 29: Width, 198 feet; area, 913 square feet; mean velocity, 1.85 feet per second; gage height, 2.35 feet; discharge, 1,694 second-feet.

April 26: Width, 198 feet; area, 854 square feet; mean velocity, 1.07 feet per second; gage height, 1.68 feet; discharge, 915 second-feet.

July 8: Width, 179 feet; area, 768 square feet; mean velocity, 0.74 foot per second; gage height, 1.27 feet; discharge, 574 second-feet.

Clinch River at Clinton, Tenn.—A measurement was made August 8 from the ferryboat, 1,000 feet below the Southern Railway crossing at Clinton, Tenn. The gage height is from the gage of the United States Weather Bureau.

Width, 240 feet; area, 1,813 square feet; mean velocity, 0.61 foot per second; gage height, 3.90 feet; discharge, 1,109 second-feet.

Little Tennessee River at Franklin, N. C.—A measurement was made May 24 from the iron wagon bridge one-half mile east of Franklin, N. C., and 1 mile below the mouth of Cullasagee River. The bench mark is the upper edge of tie plate on the streamward side of the bottom of the first post from the right bank, 20 feet above the datum of the gage.

Gage height, 1.67 feet; discharge, 562 second-feet.

Little Tennessee River near Franklin, N. C.—A measurement was made May 24 from Iotla Bridge, 4 miles north of Franklin, N. C. The bench mark is the top of small plate tying the bottom of first post from the right bank to its floor beam, 22 feet above the datum of the gage.

Width, 131 feet; area, 271 square feet; mean velocity, 2.04 feet per second; gage height, 1.96 feet; discharge, 553 second-feet.

Nantahala River near Nantahala, N. C.—This stream is an important tributary of Little Tennessee River. A measurement was made October 8 from Matthew Cole's foot bridge, about 1 mile above Nantahala, N. C. The bench mark is the top of the left bent on the upstream side, 12 feet above the datum of the gage.

Width, 50 feet; area, 120 square feet; mean velocity, 0.96 foot per second; gage height, 0.82 foot; discharge, 115 second-feet.

Brasstown Creek at Brasstown, N. C.—This stream enters Hiwassee River about 5 miles above Murphy, N. C. A measurement was made May 13, at which time the gage on Hiwassee River at Murphy read 5.60 feet.

Width, 35 feet; area, 61 square feet; mean velocity, 1.34 feet per second; discharge, 82 second-feet.

Hanging Dog Creek near Murphy, N. C.—This creek enters Hiwassee River about 2 miles below Murphy. A measurement was made May 14, at which time the gage on Hiwassee River at Murphy read 5.60 feet.

Width, 33 feet; area, 54 square feet; mean velocity, 1.26 feet per second; discharge, 68 second-feet.

Sequatchie River near Jasper, Tenn.—This stream enters Tennessee River 5 miles south of Jasper, Tenn. A measurement was made February 9 from the highway bridge 2 miles northeast of Jasper, Tenn. The bench mark is the top of the downstream end of crossbeam 37 feet from the center of the right bank pier, 28 feet above the datum of the gage.

Width, 134 feet; area, 790 square feet; mean velocity, 2.32 feet per second; gage height, 8.30 feet; discharge, 1,829 second-feet.

Sequatchie River near Jasper, Tenn.—A measurement was made February 9 from the wagon bridge at Pregor's mill, 2 miles east of Jasper, Tenn. The bench mark is the top of the downstream end of crossbeam 37 feet from the left bank abutment, 28 feet above the datum of the gage.

Width, 170 feet; area, 1,036 square feet; mean velocity, 1.85 feet per second; gage height, 9.95 feet; discharge, 1,916 second-feet.

Battle Creek near South Pittsburg, Tenn.—This stream enters Tennessee River 1 mile east of Jasper, 1½ miles north of the Tennessee-Alabama State line. A measurement was made February 9 from the highway bridge on the road from South Pittsburg to Jasper. The bench mark is the top of the upstream end of crossbeam 56 feet from the right abutment, 25 feet above the datum of the gage.

Width, 67 feet; area, 276 square feet; mean velocity, 1.75 feet per second; gage height, 5.67 feet; discharge, 482 second-feet.

Toccoa River near Blueridge, Ga.—This stream is a tributary of Hiwassee River, its name becoming Ocoee River in the State of Tennessee. A measurement was made October 3 from a small boat, at Bench Leg Ford, 1 mile below the Morganton road bridge, and one-fourth mile below the mouth of Weaver Creek.

Width, 110 feet; area, 264 square feet; mean velocity, 0.65 foot per second; discharge, 172 second-feet.

Fightingtown Creek near Blueridge, Ga.—This stream is a tributary of Toccoa River. A measurement was made October 4 at the Galloway bridge, above the Horseshoe Bend.

Width, 33 feet; area, 25 square feet; mean velocity, 1 foot per second; discharge, 25 second-feet.

Flint River near New Decatur, Ala.—This stream enters Tennessee River from the south, near Decatur, Ala. A measurement was made May 16 from the bridge near New Decatur. The bench mark is the top of the downstream end of the crossbeam 67 feet from the left end of the bridge, 22 feet above the datum of the gage.

Width, 63 feet; area, 138 square feet; mean velocity, 0.45 foot per second; gage height, 2.45 feet; discharge, 62 second-feet.

Elk River near Prospect, Tenn.—This stream is an important tributary of Tennessee River, entering from the northeast, about 20 miles below Decatur, Ala. A measurement was made February 8 from the Louisville and Nashville Railroad bridge, three-fourths of a mile south of Prospect, Tenn. The bench mark is the base of rail, 150 feet from the right end of the bridge, 40 feet above the datum of the gage.

Width, 310 feet; area, 1,772 square feet; mean velocity, 2.99 feet per second; gage height, 2.70 feet; discharge, 5,296 second-feet.

Spring Creek at Tuscumbia, Ala.—This stream enters Tennessee River from the south near Tuscumbia, Ala. A measurement was made February 6 at the wagon bridge one-half mile northwest of the depot at Tuscumbia. The bench mark is the top of the upstream end of the crossbeam 18 feet from the right end of iron bridge, 20 feet above the datum of the gage.

Width, 70 feet; area, 201 square feet; mean velocity, 0.21 foot per second; gage height, 1.47 feet; discharge, 43 second-feet.

Big Bear Creek near Iuka, Miss.—This stream enters Tennessee River from the south, near the Alabama-Mississippi State line, about 5 miles northeast of Iuka. A measurement was made April 22 at the highway bridge, 5 miles east of Iuka. The bench mark is the top of the downstream right bank pier, 30 feet above the datum of the gage.

Width, 160 feet; area, 1,383 square feet; mean velocity, 0.48 foot per second; gage height, 7.10 feet; discharge, 670 second-feet.

YAZOO RIVER DRAINAGE BASIN.

Yazoo River rises in the northwestern part of Mississippi. It flows south just west of the central portion of the State and enters Mississippi River just above Vicksburg. The United States Geological Survey is maintaining a station on this river at Yazoo City, under the direction of M. R. Hall.

YAZOO RIVER AT YAZOO CITY, MISS.

A gage has been maintained at this point by the Engineer Corps of the Army. It was replaced in 1901 by a new gage rod in three sections, marked with brass figures and brass tacks, the sections being placed as follows: The lowest, marked from −3 to +4.5 feet, is attached to the protecting work of the bridge; the middle section, marked from 4.5 to 18.5 feet, is attached to the piling that protects the bridge pier; the uppermost section, continuing the graduation up to 32.3 feet, is on a post under the approach to the bridge. The highest known water occurred in 1882, reaching a gage height of 36.5 feet; the lowest occurred on October 15 to 17 and 20 to 22, 1896, with a gage height of −2.8 feet. The danger line is at 25 feet.

Discharge measurements are made from the highway bridge, consisting of one span of 85 feet, a turn-span of 190 feet, an approach on the right bank of about 100 feet, and on the left bank of about 1,200 feet. This is the bridge to which the gage is attached, and is located one-half mile northwest from the Illinois Central Railroad station in Yazoo City. The initial point for soundings is the end of the iron bridge on the left bank, downstream side. The channel is straight for about 3,000 feet above the station and is curved for about 2,000 feet below. The current is moderately rapid. As this stream is connected with the Mississippi River both above and below the station, it is influenced by the stage of that stream to the extent that high-water measurements are of no value. The bed is of sand and mud, and is subject to some change. The right bank is high, but overflows for a long distance at extreme floods; the left bank is high and overflows to the foot of the hill, about one-half mile from the river. There are trees along both banks.

A bench mark was established on the top of the upstream cylinder of the second pier from the left bank, at a distance of 85 feet from the initial point for soundings, which is on the downstream end of iron bridge on the left bank. The elevation of the mark is 35.85 feet above the zero of the gage. Other important bench marks in Yazoo City are the following: P. B. M. 12, Yazoo City, is a copper bolt in stone under ground, surmounted by an iron pipe and cap, in the north corner of the county court-house yard. It is 44.1 feet above the zero of the gage and 116.2 feet above mean sea level. P. B. M. 13, Yazoo City, is a copper bolt in stone under ground, surmounted by an iron pipe and cap, in the north corner of the public school yard, near Washington and Main streets. It is 29.2 feet above the zero of the gage and 101.3 feet above mean sea level. The observer is P. C. Battaille. Daily gage heights are furnished by the Weather Bureau.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Yazoo River at Yazoo City, Miss., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Second-ft.*
January 14	J. M. Giles	191	2,043	1.11	—0.55	2,261
August 11	do	223	2,929	1.73	3.00	5,054
October 27	do	183	1,656	.68	—3.15	1,122
October 27	do	183	1,639	.68	—3.15	1,120

Mean daily gage height, in feet, of Yazoo River at Yazoo City, Miss., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	3.50	0.00	15.40	22.30	5.50	10.70	6.00	−1.90	−2.80	−2.80	−2.50
2	2.50	3.70	.00	15.80	22.00	4.20	10.00	5.40	−1.90	−2.70	−2.80	−2.30
3	2.50	3.90	.00	16.20	21.80	3.00	9.50	4.00	−1.50	−2.60	−2.80	−2.00
4	2.50	4.00	.00	16.50	21.40	2.00	8.80	3.00	−1.30	−2.60	−2.80	−2.20
5	1.50	4.00	.00	16.80	21.00	1.40	8.30	2.50	−1.50	−2.60	−2.80	−2.20
6	1.00	4.00	.80	17.20	20.50	1.00	7.50	2.00	−1.70	−2.60	−2.80	−2.30
7	.90	4.00	1.40	17.60	20.00	1.00	7.00	1.90	−1.70	−2.60	−2.80	−2.40
8	.70	3.60	1.70	18.70	19.60	1.00	6.50	1.90	−1.90	−2.50	−2.80	−2.40
9	.50	3.40	2.00	18.70	19.00	2.00	6.40	2.00	−2.00	−2.60	−2.80	−2.40
10	.30	3.20	2.30	18.90	18.70	4.00	6.30	2.80	−2.00	−2.70	−2.80	−2.30
11	.00	3.00	2.60	19 10	18.30	5.50	6.00	3.00	−2.00	−2.70	−2.80	−2.20
12	− .30	2.50	2.90	19.40	18.00	6.80	6.30	3.40	−2.00	−2.70	−2.80	−2.00
13	− .50	1.50	3.20	19.80	17.80	7.90	5.80	3.70	−2.00	−2.80	−2.80	−1.90
14	− .60	1.00	3.30	20.00	17.70	8.80	5.50	4.10	−2.00	−2.80	−2.80	−1.80
15	− .60	.70	3.50	20.30	17.50	9.50	5.30	4.30	−2.10	−2.80	−2.80	−1.80
16	− .70	.50	3.80	20.60	17.40	10.30	5.40	4.20	−2.20	−2.80	−3.00	−1.80
17	− .80	.20	4.20	20.80	17.40	10.80	5.50	3.80	−2.20	−2.80	−3.00	−1.80
18	− .90	.00	5.30	21.10	17.30	11.30	6.20	3.50	−2.20	−2.80	−3.00	−1.80
19	−1.00	− .10	6.20	21.40	17.20	11.70	6.80	2.50	−2.20	−2.80	−3.00	−1.90
20	−1.10	− .10	7.00	21.60	17.00	12.00	7.50	2.00	−2.20	−2.80	−3.00	−1.80
21	−1.10	− .10	8.40	21.90	17.00	12.10	8.00	1.60	−2.30	−2.80	−3.00	−2.00
22	−1.10	− .10	9.10	22.00	16.50	12.30	8.30	1.00	−2.40	−2.80	−2.80	−2.10
23	− .10	− .10	9.90	22.20	16.10	12.50	8.50	.50	−2.40	−2.80	−2.80	−2.20
24	.00	− .10	10.80	22.40	15.60	12.40	8.70	− .10	−2.50	−2.80	2.80	−2.20
25	.20	− .10	11.60	22.50	14.90	12.30	8.80	− .30	−2.60	−2.80	−2.80	−2.20
26	1.00	− .10	12.30	22.60	14.00	12.20	8.80	− .50	−2.70	−2.80	−3.00	−2.40
27	1.80	.00	14.00	22.60	12.90	12.00	8.80	− .80	−2.80	−2.80	−3.00	3.80
28	2.50	.00	14.10	22.60	11.50	12.00	8.80	−1.20	−2.80	−2.80	−3.00	4.20
29	3.00	.00	14.30	22.60	10.00	11.50	8.00	−1.40	−2.80	−2.80	−3.00	5.40
30	3.40	.....	14.70	22.50	8.50	11.30	7.50	−1.50	−2.80	−2.80	−3.00	7.50
31	3.50	.....	15.00	.....	7.00	.....	6.60	−1.80	.....	−2.80	.....	9.00

Rating table for Yazoo River at Yazoo City, Miss., from August 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−3.0	1,190	−2.2	1,534	−1.4	1,884	−0.6	2,239
−2.9	1,233	−2.1	1,577	−1.3	1,928	−0.5	2,284
−2.8	1,276	−2.0	1,620	−1.2	1,972	−0.4	2,329
−2.7	1,319	−1.9	1,664	−1.1	2,016	−0.3	2,374
−2.6	1,362	−1.8	1,708	−1.0	2,060	−0.2	2,419
−2.5	1,405	−1.7	1,752	−0.9	2,104	−0.1	2,464
−2.4	1,448	−1.6	1,796	−0.8	2,149	0.0	2,510
−2.3	1,491	−1.5	1,840	−0.7	2,194		

The above table is based upon 13 discharge measurements made during 1901 to 1904, and is well defined.

Estimated monthly discharge of Yazoo River at Yazoo City, Miss., for 1904.

[Drainage area, 8,580 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,245	2,016	2,856	0.333	0.384
February	4,520	2,464	3,294	.384	.414
August	5,800	1,708	3,516	.410	.473
September	1,928	1,276	1,555	.181	.202
October	1,405	1,276	1,302	.152	.175
November	1,276	1,190	1,244	.145	.162
December	8,220	1,405	2,273	.265	.306

Estimates March to July omitted, on account of probable back-water influence of Mississippi River on this station during portions of those months.

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[Water-Supply Paper No. 128.]

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1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
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