Water-Supply and Irrigation Paper No. 129 Series P, Hydrographic Progress Reports, 34

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

R. E. HORTON, E. JOHNSON, Jr., and JOHN C. HOYT

PART VI.—Great Lakes and St. Lawrence River Drainage

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

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# LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
*Washington, D. C., May 13, 1905.*

SIR: I transmit herewith the manuscript of Part VI 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 Mississippi River. Parts VII to XII are devoted to the data collected in the territory west of Mississippi River.

The original data for this paper were collected under the direction of District Hydrographers R. E. Horton and E. Johnson, jr. Mr. Horton had charge of the work in New York and southern Michigan, and was assisted by C. C. Covert. Mr. Johnson had charge of the work in the other States, and was assisted by F. W. Hanna. The assembling of the data and the 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 R. M. Packard.

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 VI.

By R. E. HORTON, 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 | 20,000 |
| 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.

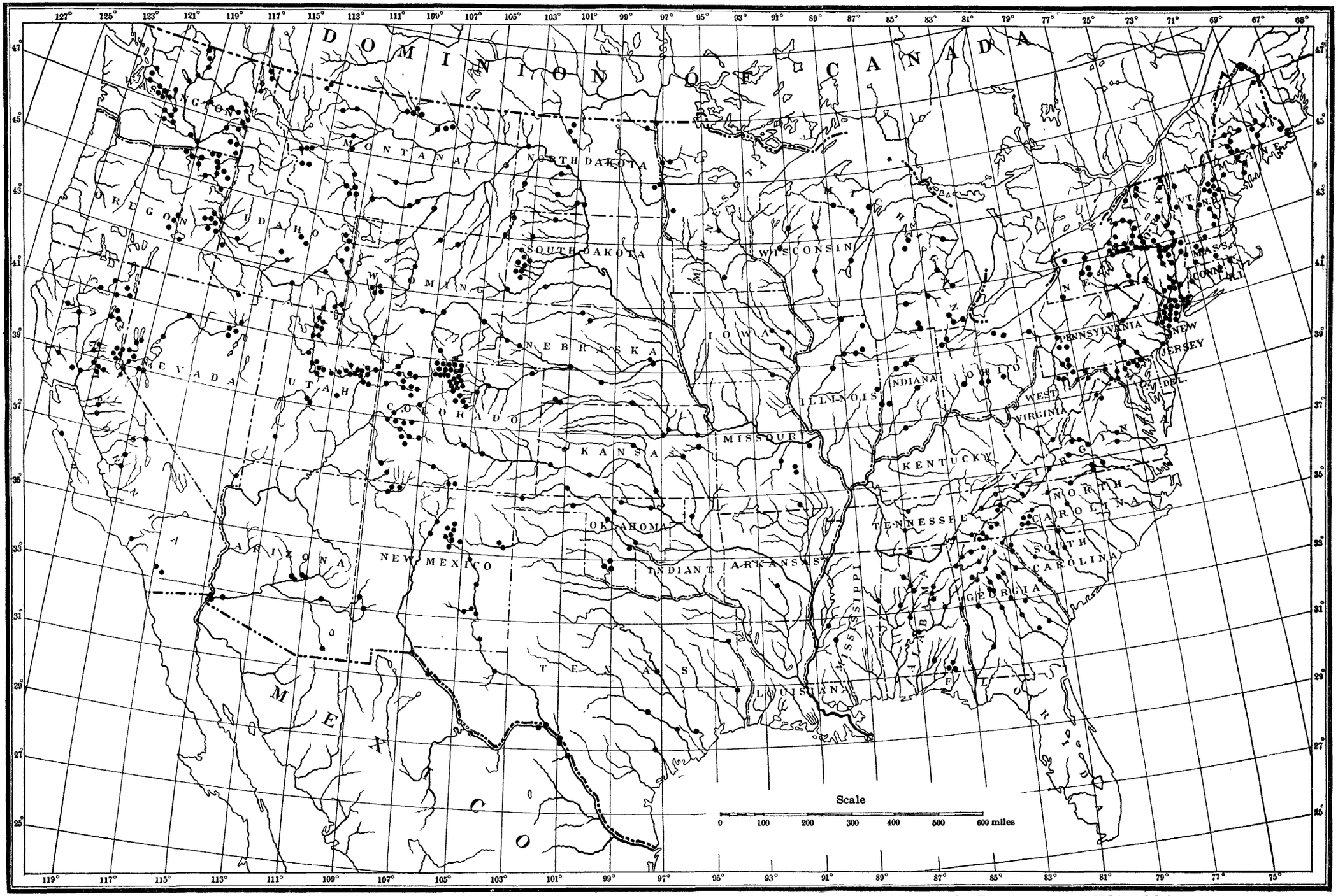
As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time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

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 swift some




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

appliance—generally a secondary cable—is necessary to hold the meter in position 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. Great care is taken in the selection and equipment of gaging stations, in order that the data may have the required degree of accuracy.

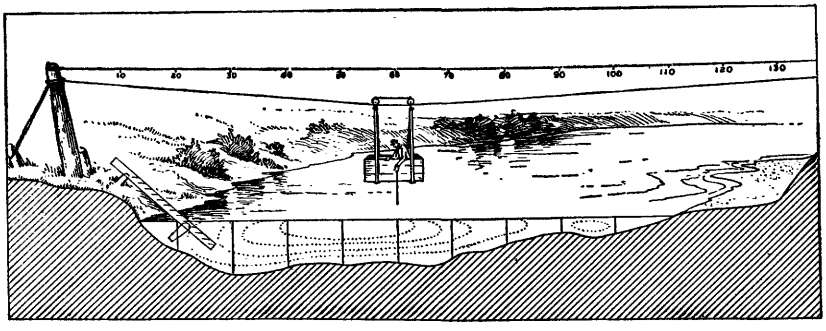


FIG. 1.—Cable station, showing section of river, car, gage, etc.

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.

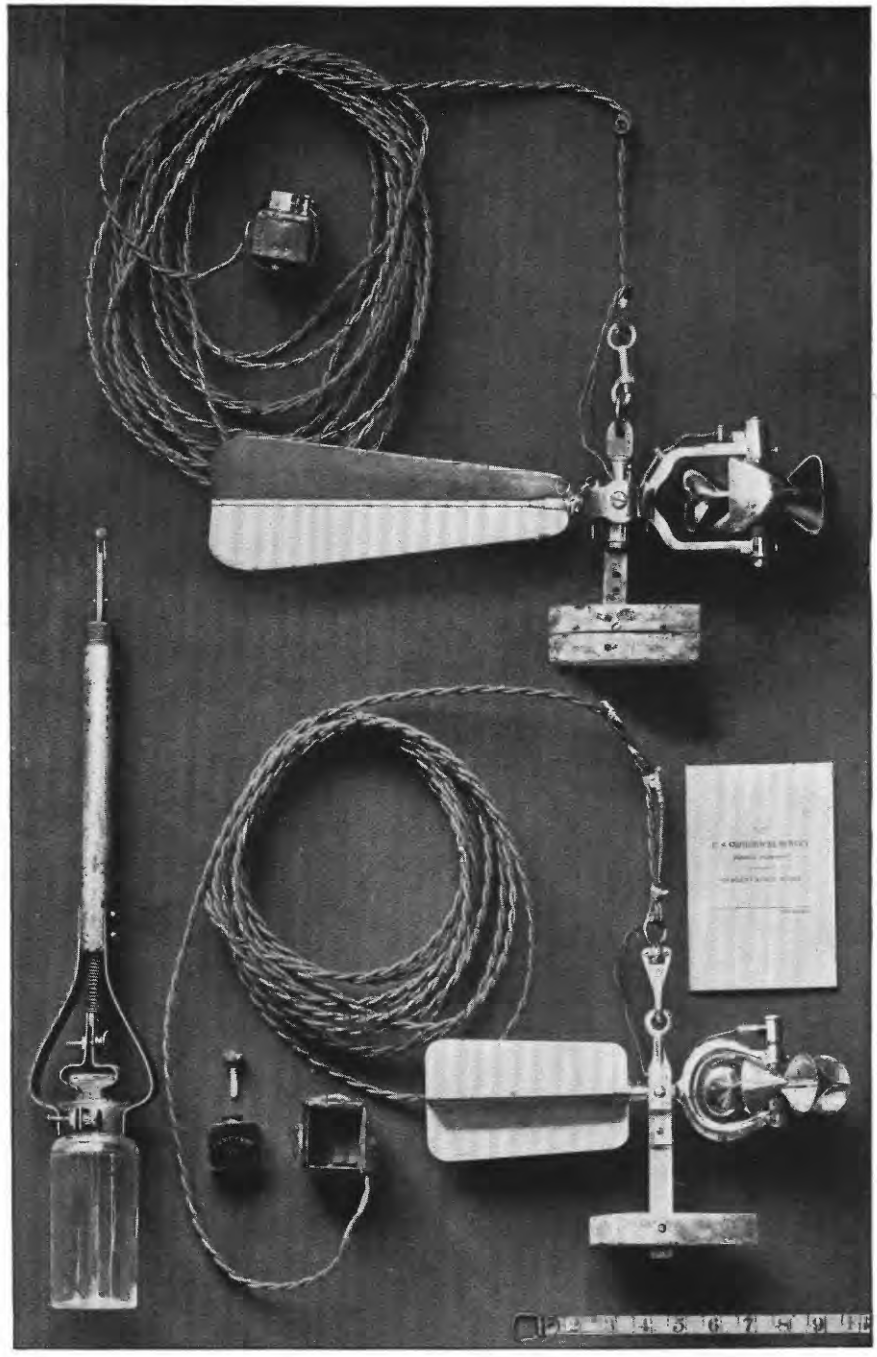
In making the measurement an arbitrary number of points are laid off perpendicular to the thread of the stream (see fig. 1). These points are usually at regular intervals, varying from 2 to 20 feet, depending

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 0.94 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 0.85 to 0.95, 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 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.



PRICE CURRENT METERS, WITH BUZZERS.

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, at 0.5 foot below the surface and at 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 computations of high-water measurements, as accurate soundings are hard to obtain at high stages.

In computing the discharge measurements from the observed velocities and depths at 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 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 platted on cross-section paper, with gage heights as ordinates and discharges as abscissas. Through these points a smooth curve is drawn, which shows the discharge for any gage height, and from which a rating table is prepared. The mean velocity and area determined for each discharge measurement are also platted. 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 vari-

ous stages as determined by these curves. These curves of mean velocity and area are of special value in determining 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 occur.

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 taken either by integration in verticals or by vertical velocity-curves, 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 VI, 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, Wapsipincon, Iowa, Des Moines, and Missouri River drainages.

Part 8. Platte, Kansas, Meramec, Arkansas, and Red River drainages.

Part 9. Western Gulf of Mexico drainage.

Part 10. Colorado River and the 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 readings 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 (from 1888–1903) 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 prices 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:

*Michigan* (*Southern Peninsula*).—District hydrographer, R. E. Horton.[a] Records have been furnished by the following individuals and corporations: Kalamazoo Valley Electric Company, Kalamazoo, Mich.; Charles A. Chapin Electric Company,

[a] Office of district hydrographer for Michigan (Southern Peninsula) and New York, 75 Arcade, Utica, N. Y.

Buchanan, Mich.; Newaygo Portland Cement Company, Newaygo, Mich.; Fletcher Paper Company, Alpena, Mich.; George S. Pierson, Kalamazoo, Mich.; L. W. Anderson, city engineer, Grand Rapids, Mich.; Traverse City, Mich.; citizens of Sherman, Mich. Transportation has been furnished by the Au Sable and Northwestern Railroad Company. In the maintenance of gaging stations on Huron River a large part of the expense has been borne by the Washtenau Electric Company, Ann Arbor, Mich. Acknowledgment is also due to Lyman E. Cooley, Chicago, Ill., and R. W. Hemphill, in connection with gagings on Huron River.

*Michigan (Northern Peninsula).*—District hydrographer, E. Johnson, jr.[a] Acknowledgment is due W. J. Phillips for voluntary observations furnished at Iron River.

*New York.*—District hydrographer, R. E. Horton,[b] assisted by C. C. Covert. Records have been furnished by the following: E. A. Fisher, city engineer, and John F. Skinner, special assistant engineer, Rochester, N. Y.; T. P. Yates, Waverly, N. Y.; William S. Bacot, Utica, N. Y.; International Paper Company, Fort Edward, N. Y.; Schroon River Pulp and Paper Company, Warrensburg, N. Y.; Duncan Company, R. P. Bloss, Mechanicsville, N. Y.; George Beebe, deputy city engineer, Syracuse, N. Y. Special acknowledgment is made of the interest and assistance of William Pierson Judson, deputy State engineer.

*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.

*Vermont.*—District hydrographer, N. C. Grover until July 1; after that time H. K. Barrows,[c] assisted by S. K. Clapp and T. W. Norcross. Acknowledgment should be made to Professors A. D. Butterfield and G. M. Brett, of the University of Vermont, for assistance rendered; to the Boston and Maine Railroad for passes issued to N. C. Grover (later to H. K. Barrows) and S. K. Clapp; to the Rutland Railroad for pass issued to H. K. Barrows, and to the St. Johnsbury and Lake Champlain Railroad for pass issued to H. K. Barrows.

## LAKE MICHIGAN DRAINAGE BASIN.

The Lake Michigan drainage basin comprises a comparatively narrow strip of flat or gently rolling land in eastern Wisconsin, on the west shore of the lake, and a much wider strip of nearly the same character in Michigan on the east shore of the lake. The principal streams entering the lake from the west are the Fox and Menominee rivers; from the east, the St. Joseph, Kalamazoo, Grand, Muskegon, and Manistee rivers.

The following pages give the results of data collected during 1904 in the Lake Michigan drainage basin.

### ESCANABA RIVER NEAR ESCANABA, MICH.

Escanaba River rises near Champion, southwest of Lake Superior, in Upper Peninsula, Michigan, and flows southeasterly a distance of 70 miles, entering Lake Michigan through Little Bay de Noquette.

[a] Office of district hydrographer for Michigan (Northern Peninsula) and Ohio, 876 Federal Building, Chicago, Ill.

[b] Office of district hydrographer for Michigan (Southern Peninsula) and New York, 75 Arcade, Utica, N. Y.

[c] Office of district hydrographer for Vermont, 6 Beacon street, Boston, Mass., rooms 808–809.

The gaging station is located 4 miles above the mouth of the river at a single-span highway bridge, where a chain gage was established in June, 1903. Bench mark No. 1 is the top surface of the steel abutment at the right end of the bridge on the downstream side. Its elevation above gage datum is 15.15 feet. Bench mark No. 2 is a nail in the root of a 5-inch birch tree about 200 feet east of the east abutment and about 50 feet downstream. Its elevation above gage datum is 18.81 feet. Gage readings are made once each day by Felix Beauchamp. The bed of the stream is covered with small bowlders and is rough but permanent. The current is swift. During the winter the channel is filled with ice, and it is impossible to make discharge measurements. The channel is nearly straight and is 194 feet wide between bridge abutments without piers.

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

*Discharge measurements of Escanaba River near Escanaba, Mich., in 1904.*

| Date. | Hydrographer. | Width. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|
| | | *Feet.* | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| May 17[a] | E. Johnson, jr | 194 | 799 | 3.18 | 4.25 | 2,546 |
| June 2 | do | 194 | 719 | 2.95 | 3.82 | 2,120 |
| August 9 | do | 194 | 396 | 0.83 | 2.04 | 329 |
| September 4 | do | 194 | 527 | 1.69 | 2.91 | 891 |
| October 11 | F. W. Hanna | 194 | 804 | 3.43 | 4.20 | 2,760 |

[a] Float measurement.

*Mean daily gage height, in feet, of Escanaba River near Escanaba, Mich., for 1904.*

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 4.1 | 2.9 | 2.2 | 2.7 | 2.5 | 2.7 | 2.7 |
| 2 | ..... | 3.9 | 2.7 | 2.3 | 2.8 | 2.4 | 2.7 | 2.7 |
| 3 | ..... | 3.7 | 2.6 | 2.4 | 2.8 | 2.4 | 2.8 | 2.6 |
| 4 | ..... | 3.7 | 2.7 | 2.4 | 2.9 | 2.3 | 2.7 | 2.7 |
| 5 | ..... | 3.6 | 2.9 | 2.5 | 2.8 | 2.4 | 2.7 | 2.7 |
| 6 | ..... | 3.9 | 2.9 | 2.4 | 2.6 | 2.5 | 2.6 | 2.7 |
| 7 | ..... | 3.9 | 2.8 | 2.2 | 2.5 | 2.3 | 2.7 | 2.6 |
| 8 | ..... | 3.9 | 2.6 | 2.1 | 2.5 | 2.4 | 2.6 | 2.7 |
| 9 | ..... | 4.0 | 2.9 | 2.0 | 2.5 | 2.7 | 2.6 | 2.7 |
| 10 | ..... | 3.5 | 2.5 | 2.2 | 2.4 | 3.8 | 2.5 | 2.7 |
| 11 | ..... | 3.4 | 2.6 | 2.2 | 2.4 | 3.6 | 2.5 | ..... |
| 12 | ..... | 3.2 | 2.6 | 2.3 | 2.3 | 4.2 | 2.5 | ..... |
| 13 | ..... | 3.1 | 2.5 | 2.4 | 2.0 | 4.2 | 2.4 | ..... |
| 14 | ..... | 2.9 | 2.5 | 2.5 | 2.4 | 3.4 | 2.4 | ..... |
| 15 | ..... | 2.9 | 2.4 | 2.3 | 2.4 | 3.5 | 2.4 | ..... |
| 16 | ..... | 2.8 | 2.6 | 2.4 | 2.6 | 3.2 | 2.5 | ..... |
| 17 | ..... | 2.8 | 2.5 | 2.3 | 2.5 | 3.1 | 2.5 | ..... |

*Mean daily gage height, in feet, of Escanaba River near Escanaba, Mich., etc.*—Cont'd.

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 18 | 4.0 | 2.9 | 2.5 | 2.2 | 3.5 | 3.0 | 2.5 | ..... |
| 19 | 4.0 | 3.4 | 2.4 | 2.1 | 3.4 | 3.1 | 2.6 | ..... |
| 20 | 3.7 | 3.3 | 2.2 | 2.1 | 3.0 | 3.1 | 2.5 | ..... |
| 21 | 3.8 | 3.3 | 2.1 | 2.2 | 3.1 | 2.9 | 2.5 | ..... |
| 22 | 3.7 | 3.3 | 2.2 | 2.2 | 2.3 | 3.1 | 2.6 | ..... |
| 23 | 9.0 | 3.1 | 2.5 | 2.3 | 2.2 | 2.9 | 2.6 | ..... |
| 24 | 3.7 | 2.9 | 2.5 | 2.3 | 2.3 | 3.0 | 2.6 | ..... |
| 25 | 3.9 | 2.8 | 2.5 | 2.3 | 2.5 | 3.1 | 2.5 | ..... |
| 26 | 4.9 | 3.2 | 2.7 | 2.2 | 2.7 | 3.1 | 2.5 | ..... |
| 27 | 5.4 | 3.1 | 2.5 | 2.2 | 2.5 | 3.1 | 2.1 | ..... |
| 28 | 5.0 | 3.2 | 2.5 | 2.1 | 2.5 | 2.3 | 2.1 | ..... |
| 29 | 4.7 | 3.3 | 2.4 | 2.1 | 2.5 | 3.0 | 2.5 | ..... |
| 30 | 4.4 | 2.9 | 2.3 | 1.9 | 2.5 | 3.0 | 2.6 | ..... |
| 31 | 4.5 | ..... | 2.3 | 2.0 | ..... | 2.9 | ..... | ..... |

*Rating table for Escanaba River near Escanaba, Mich., from April 10, 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.* |
| 1.80 | 163 | 2.90 | 960 | 4.00 | 2,435 | 5.00 | 4,070 |
| 1.90 | 229 | 3.00 | 1,080 | 4.10 | 2,590 | 5.20 | 4,410 |
| 2.00 | 295 | 3.10 | 1,205 | 4.20 | 2,745 | 5.40 | 4,750 |
| 2.10 | 362 | 3.20 | 1,330 | 4.30 | 2,905 | 5.60 | 5,090 |
| 2.20 | 429 | 3.30 | 1,455 | 4.40 | 3,065 | 5.80 | 5,430 |
| 2.30 | 497 | 3.40 | 1,580 | 4.50 | 3,225 | 6.00 | 5,770 |
| 2.40 | 565 | 3.50 | 1,710 | 4.60 | 3,390 | 6.20 | 6,110 |
| 2.50 | 633 | 3.60 | 1,845 | 4.70 | 3,560 | 6.40 | 6,450 |
| 2.60 | 701 | 3.70 | 1,985 | 4.80 | 3,730 | 6.60 | 6,790 |
| 2.70 | 771 | 3.80 | 2,130 | 4.90 | 3,900 | 6.80 | 7,130 |
| 2.80 | 857 | 3.90 | 2,280 | | | | |

The above table is applicable only for open-channel conditions. It is based upon 12 discharge measurements made during 1903 and 1904. It is well defined between gage heights 2 feet and 4.6 feet. The table has been extended beyond these limits. Above gage height 4.6 feet the rating curve is a tangent, the difference being 170 per tenth.

*Estimated monthly discharge of Escanaba River near Escanaba, Mich., for 1903 and 1904.*

[Drainage area, 800 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| 1903. | | | | | |
| August 25–31 | 1,845 | 633 | 1,376 | 1.72 | 0.448 |
| September | 2,905 | 857 | 1,647 | 2.06 | 2.30 |
| October | 3,225 | 771 | 1,625 | 2.03 | 2.34 |
| November 1–21 | 1,205 | 857 | 985 | 1.23 | .960 |
| 1904. | | | | | |
| May 18–31 | 10,870 | 1,985 | 3,477 | 4.35 | 2.26 |
| June | 2,590 | 857 | 1,521 | 1.90 | 2.12 |
| July | 960 | 362 | 669 | .836 | .964 |
| August | 633 | 229 | 454 | .568 | .655 |
| September | 1,710 | 295 | 741 | .926 | 1.03 |
| October | 2,745 | 497 | 1,145 | 1.43 | 1.65 |
| November | 857 | 362 | 657 | .821 | .916 |
| December 1–10 | 771 | 701 | 757 | .946 | .352 |

## MENOMINEE RIVER NEAR IRON MOUNTAIN, MICH.

Menominee River forms part of the boundary between Wisconsin and the upper peninsula of Michigan. It is formed by the junction of Brule and Michigamme rivers in T. 41 N., R. 31 W., and flows in a general southeasterly direction, entering Lake Michigan through Green Bay. The station was established September 4, 1902. It is located at the homestead highway bridge, 2½ miles south of Iron Mountain, Mich. The gage is a vertical board fastened to the right abutment; it is read twice each day by Theodore Moll. On November 18, 1904, a chain gage was established with the same datum as that of the board gage, and having a length of 28.19 feet from end of weight to the outside of the ring which is used as the marker. Discharge measurements are made from the single-span bridge to which the gage is attached. The channel is straight and has a width of 220 feet between bridge abutments. The current is moderate. The bed of the stream is composed of gravel and small bowlders. The bench mark is the top of the 12-inch timber bridge seat on the right abutment over the gage. Its elevation is 22.68 feet above the zero of the gage. During the winter the stream freezes beneath the bridge and it is difficult to obtain measurements in the frozen section. The drainage area at this station is 2,415 square miles.

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

*Discharge measurements of Menominee River near Iron Mountain, Mich., in 1904.*

| Date. | Hydrographer. | Width. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|
| | | *Feet.* | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Sec.-feet.* |
| May 18 | E. Johnson, jr | 210 | 2,312 | 2.68 | 7.95 | 6,193 |
| June 1 | do | 210 | 2,522 | 3.01 | 8.97 | 7,591 |
| August 10 | do | 205 | 1,101 | 1.42 | 2.06 | 1,558 |
| September 5 | do | 210 | 1,571 | 2.02 | 4.34 | 3,176 |
| October 11 | F. W. Hanna | 225 | 2,408 | 3.20 | 8.25 | 7,714 |
| November 18 | E. Johnson, jr | 210 | 1,511 | 1.94 | 4.02 | 2,925 |

*Mean daily gage height, in feet, of Menominee River near Iron Mountain Mich., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 4.30 | 4.75 | 4.65 | 7.90 | 8.45 | 4.60 | 2.35 | 1.80 | 3.05 | 3.10 | 2.42 |
| 2 | ..... | 4.25 | 4.70 | 4.55 | 7.95 | 6.95 | 2.35 | 3.30 | 3.15 | 2.75 | 3.65 | 2.20 |
| 3 | 3.20 | 4.30 | 4.55 | 4.35 | 8.70 | 5.65 | 2.20 | 2.90 | 3.70 | 2.65 | 4.10 | 2.22 |
| 4 | 2.90 | 4.50 | 4.10 | 4.60 | 9.70 | 6.30 | 2.90 | 3.00 | 4.95 | 2.45 | 3.75 | 2.25 |
| 5 | 2.70 | 4.30 | 3.90 | 5.10 | 8.15 | 9.60 | 2.80 | 1.30 | 4.30 | 2.75 | 3.25 | 2.55 |
| 6 | 2.75 | 4.25 | 4.50 | 4.85 | 9.70 | 7.30 | 3.70 | 2.70 | 4.00 | 2.85 | 3.50 | 2.50 |
| 7 | 2.75 | 4.20 | 4.90 | 4.70 | 8.50 | 8.80 | 3.60 | 1.30 | 4.10 | 2.55 | 3.80 | 2.30 |
| 8 | 3.20 | 4.20 | 4.80 | 4.65 | 10.40 | 7.50 | 3.60 | 1.20 | 4.10 | 2.90 | 4.85 | 2.92 |
| 9 | 3.60 | 4.25 | 4.70 | 6.05 | 11.95 | 8.55 | 4.20 | 1.45 | 3.70 | 3.80 | 4.10 | 2.95 |
| 10 | 3.50 | 4.00 | 3.95 | 6.20 | (a) | 8.50 | 3.30 | 3.20 | 3.15 | 6.70 | 3.10 | 2.97 |
| 11 | 3.45 | 3.90 | 3.50 | 4.10 | 11.80 | 7.50 | 4.10 | 3.80 | 2.90 | 7.60 | 3.20 | 2.75 |
| 12 | 3.20 | 3.95 | 3.00 | 3.80 | 11.10 | 6.70 | 4.20 | 4.40 | 3.10 | 8.25 | 3.20 | 2.50 |
| 13 | 3.10 | 3.90 | 3.15 | 3.65 | 10.70 | 6.70 | 1.80 | 4.00 | 2.55 | 7.80 | 3.25 | 2.32 |
| 14 | 3.40 | 3.85 | 3.30 | 3.70 | 10.55 | 5.90 | 4.30 | 1.90 | 2.85 | 7.35 | 3.05 | 2.27 |
| 15 | 4.25 | 3.95 | 3.25 | 3.75 | 9.65 | 5.40 | 3.75 | 2.05 | 3.50 | 6.40 | 2.95 | 2.32 |
| 16 | 4.30 | 3.80 | 3.00 | 4.10 | 9.05 | 4.95 | 4.30 | 3.70 | 3.40 | 5.90 | 3.05 | 2.32 |
| 17 | 4.30 | 3.75 | 3.05 | 3.95 | 8.10 | 4.60 | 1.65 | 3.60 | 2.80 | 5.55 | 2.80 | 2.47 |
| 18 | 4.35 | 3.75 | 3.35 | 4.25 | 8.15 | 4.50 | 3.25 | 4.00 | 3.15 | 5.30 | 3.85 | 2.50 |
| 19 | 4.35 | 3.70 | 3.45 | 4.40 | 8.15 | 3.70 | 3.05 | 3.10 | 2.60 | 5.20 | 3.15 | 2.47 |
| 20 | 4.40 | 3.90 | 3.15 | 4.30 | 6.25 | 3.50 | 2.50 | 3.15 | 2.70 | 5.00 | 2.92 | 2.27 |
| 21 | 4.15 | 3.75 | 3.15 | 4.35 | 4.90 | 3.50 | 4.30 | 2.40 | 2.95 | 5.00 | 2.90 | 2.22 |
| 22 | 4.10 | 3.60 | 3.40 | 4.40 | 6.15 | 4.40 | 2.70 | 3.65 | 2.30 | 5.05 | 2.67 | 2.42 |
| 23 | 4.25 | 3.60 | 3.45 | 5.45 | 6.10 | 3.70 | 2.30 | 3.45 | 2.55 | 5.05 | 2.77 | 2.37 |
| 24 | 4.25 | 3.55 | 3.75 | 6.05 | 7.05 | 3.70 | 1.30 | 3.90 | 3.80 | 5.15 | 2.85 | 2.40 |
| 25 | 4.20 | 3.65 | 4.55 | 7.35 | 8.25 | 5.45 | 2.75 | 3.90 | 3.90 | 5.05 | 2.75 | ..... |
| 26 | 4.20 | 3.55 | 4.60 | 7.25 | 9.60 | 7.20 | 1.40 | 3.40 | 3.95 | 5.15 | 2.42 | 2.47 |
| 27 | 4.25 | 3.75 | 4.35 | 7.45 | (a) | 6.75 | 2.70 | 2.70 | 4.15 | 5.05 | 1.92 | 2.32 |
| 28 | 4.20 | 4.55 | 4.40 | 8.35 | 10.90 | 5.60 | 1.50 | 2.30 | 4.00 | 4.85 | 1.75 | b 2.20 |
| 29 | 4.50 | 4.90 | 4.30 | 7.75 | 10.00 | 6.70 | 3.10 | 1.90 | 3.50 | 4.35 | 2.00 | (b) |
| 30 | 4.45 | ..... | 4.55 | 9.40 | 8.70 | 6.70 | 1.45 | 2.05 | 3.37 | 4.30 | 2.07 | (b) |
| 31 | 4.35 | ..... | 4.60 | ..... | 8.00 | ..... | 1.30 | 1.95 | ..... | 3.90 | ..... | 2.60 |

a Gage under water. b River frozen.

NOTE.—Probable ice conditions January, February, and March.

*Rating table for Menominee River near Iron Mountain, Mich., from September 4, 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.* |
| 1.20 | 1,032 | 2.80 | 2,080 | 4.40 | 3,242 | 6.80 | 5,230 |
| 1.30 | 1,094 | 2.90 | 2,150 | 4.50 | 3,319 | 7.00 | 5,420 |
| 1.40 | 1,156 | 3.00 | 2,220 | 4.60 | 3,396 | 7.20 | 5,615 |
| 1.50 | 1,219 | 3.10 | 2,290 | 4.70 | 3,474 | 7.40 | 5,815 |
| 1.60 | 1,282 | 3.20 | 2,361 | 4.80 | 3,552 | 7.60 | 6,025 |
| 1.70 | 1,346 | 3.30 | 2,432 | 4.90 | 3,630 | 7.80 | 6,235 |
| 1.80 | 1,410 | 3.40 | 2,503 | 5.00 | 3,708 | 8.00 | 6,450 |
| 1.90 | 1,475 | 3.50 | 2,575 | 5.20 | 3,865 | 8.50 | 7,020 |
| 2.00 | 1,540 | 3.60 | 2,647 | 5.40 | 4,023 | 9.00 | 7,630 |
| 2.10 | 1,606 | 3.70 | 2,719 | 5.60 | 4,183 | 9.50 | 8,280 |
| 2.20 | 1,672 | 3.80 | 2,792 | 5.80 | 4,345 | 10.00 | 8,970 |
| 2.30 | 1,739 | 3.90 | 2,866 | 6.00 | 4,510 | 10.50 | 9,670 |
| 2.40 | 1,806 | 4.00 | 2,940 | 6.20 | 4,680 | 11.00 | 10,370 |
| 2.50 | 1,874 | 4.10 | 3,015 | 6.40 | 4,860 | 11.50 | 11,070 |
| 2.60 | 1,942 | 4.20 | 3,090 | 6.60 | 5,040 | 12.00 | 11,770 |
| 2.70 | 2,011 | 4.30 | 3,166 | | | | |

The above table is applicable only for open-channel conditions. It is based upon 14 discharge measurements made during 1902 to 1904, inclusive. It is not well defined. Above gage height 9.60 feet the rating curve is a tangent, the difference being 140 per tenth.

*Estimated monthly discharge of Menominee River near Iron Mountain, Mich., 1902–1904.*

[Drainage area, 2,415 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| 1902. | | | | | |
| September 4–30 | 1,772 | 1,032 | 1,295 | 0.536 | 0.538 |
| October | 2,625 | 1,094 | 1,596 | .661 | .762 |
| November | 5,306 | 1,806 | 2,829 | 1.17 | 1.30 |
| December [a] | 2,647 | 1,282 | 1,909 | .790 | .911 |
| 1903. | | | | | |
| January [b] | | | | | |
| February [b] | | | | | |
| March [b] | | | | | |
| April | 6,780 | 1,705 | 5,175 | 2.14 | 2.39 |
| May | 11,560 | 4,698 | 7,496 | 3.10 | 3.57 |
| June | 8,020 | 1,540 | 3,417 | 1.41 | 1.57 |
| July | 6,670 | 1,806 | 3,553 | 1.47 | 1.70 |
| August | 7,630 | 2,467 | 4,049 | 1.68 | 1.94 |
| September | 10,650 | 2,575 | 5,091 | 2.11 | 2.35 |
| October | 6,130 | 2,719 | 4,057 | 1.68 | 1.94 |
| November | 3,669 | 1,874 | 2,505 | 1.04 | 1.16 |
| December [a] | 2,719 | 1,705 | 2,150 | .890 | 1.03 |
| 1904. | | | | | |
| January [b] | | | | | |
| February [b] | | | | | |
| March [b] | | | | | |
| April | 8,150 | 2,683 | 3,995 | 1.65 | 1.84 |
| May [c] | 11,770 | 3,630 | 7,879 | 3.26 | 3.76 |
| June | 8,410 | 2,575 | 4,791 | 1.98 | 3.21 |
| July | 3,396 | 1,094 | 2,196 | .909 | 1.05 |
| August | 3,242 | 1,032 | 2,125 | .880 | 1.01 |
| September | 3,669 | 1,410 | 2,488 | 1.03 | 1.15 |
| October | 6,725 | 1,840 | 3,650 | 1.51 | 1.74 |
| November | 3,591 | 1,378 | 2,293 | .949 | 1.06 |
| December [a] | 2,199 | 1,672 | 1,838 | .761 | .877 |

[a] Conditions for December uncertain; rating table applied for open channel.
[b] Probable ice conditions; no estimate made.
[c] Discharge estimated for two days that gage was under water.

### IRON RIVER NEAR IRON RIVER, MICH.

This station was established by the engineers of the Oliver Iron Mining Company. It is located at the mine bridge 1 mile below a dam used for ponding logs, which at times causes fluctuations. The gage is a vertical board attached to a braced cedar post at the left end and upstream side of the mine bridge. The gage-height record is kept by the engineers of the mining company. Discharge measurements are made from the mine bridge, which has a span of 30 feet between abutments. The bed of the stream is composed of gravel and small bowlders, and the current is swift. The stream rarely freezes over at the gaging station. The pumpage from the mine enters the stream a short distance above the gage; on September 5, 1902, it amounted to 1.7 second-feet. All gage heights have been expressed in terms of their elevation above the mine datum. The drainage area at this station is 63 square miles.

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

*Mean daily gage height, in feet, of Iron River near Iron River, Mich., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 86.40 | 86.65 | 86.10 | 86.30 | 86.75 | 86.80 | 86.40 | 86.20 | 86.30 | 86.35 | 86.50 | 86.30 |
| 2 | 86.40 | 86.65 | 86.10 | 86.30 | 86.70 | 86.75 | 86.20 | 86.20 | 87.05 | 86.35 | 86.50 | 86.30 |
| 3 | 86.25 | 86.55 | 86.80 | 86.30 | 86.70 | 86.70 | 86.40 | 86.20 | 86.80 | 86.35 | 86.45 | 86.30 |
| 4 | 86.25 | 86.55 | 86.60 | 86.30 | 87.25 | 86.90 | 86.40 | 86.20 | 86.60 | 86.35 | 86.45 | 86.30 |
| 5 | 86.25 | 86.50 | 86.40 | 86.40 | 86.90 | 86.90 | 86.40 | 86.20 | 86.50 | 86.40 | 86.45 | 86.30 |
| 6 | 86.25 | 86.50 | 86.40 | 86.50 | 86.50 | 86.80 | 86.40 | 86.20 | 86.65 | 86.35 | 86.40 | 86.30 |
| 7 | 86.25 | 86.50 | 86.25 | 86.50 | 86.50 | 86.90 | 86.65 | 86.20 | 86.80 | 86.35 | 86.40 | 86.30 |
| 8 | 86.25 | 86.50 | 86.25 | 86.50 | 87.00 | 86.80 | 86.40 | 86.20 | 86.70 | 86.50 | 86.40 | 86.30 |
| 9 | 86.25 | 86.50 | 86.15 | 86.40 | 88.42 | 86.70 | 86.70 | 86.35 | 86.55 | 86.60 | 86.40 | 86.30 |
| 10 | 86.20 | 86.45 | 86.15 | 86.40 | 88.40 | 86.70 | 86.70 | 86.55 | 86.45 | 87.45 | 86.40 | 86.30 |
| 11 | 86.20 | 86.45 | 86.10 | 86.40 | 87.17 | 86.60 | 86.40 | 86.40 | 86.40 | 87.20 | 86.40 | 86.20 |
| 12 | 86.20 | 86.45 | 86.10 | 86.40 | 87.80 | 86.55 | 86.40 | 86.50 | 86.40 | 86.95 | 86.40 | 86.20 |
| 13 | 86.20 | 86.45 | 86.10 | 86.73 | 87.65 | 86.55 | 86.40 | 86.50 | 86.40 | 86.80 | 86.35 | 86.20 |
| 14 | 86.20 | 86.40 | 86.10 | 86.40 | 87.58 | 86.50 | 86.40 | 86.40 | 86.55 | 86.65 | 86.35 | 86.20 |
| 15 | 86.20 | 86.40 | 86.10 | 86.20 | 87.60 | 86.50 | 86.40 | 86.40 | 86.50 | 86.60 | 86.30 | 86.20 |
| 16 | 86.20 | 86.40 | 86.10 | 86.20 | 87.35 | 86.50 | 86.40 | 86.30 | 86.40 | 86.55 | 86.30 | 86.20 |
| 17 | 86.35 | 86.30 | 86.10 | 86.20 | 86.80 | 86.50 | 86.30 | 86.30 | 86.40 | 86.55 | 86.30 | 86.20 |
| 18 | 86.35 | 86.30 | 86.10 | 86.20 | 87.20 | 86.70 | 86.30 | 86.30 | 86.35 | 86.50 | 86.30 | 86.20 |
| 19 | 86.35 | 86.30 | 86.10 | 86.20 | 87.00 | 86.50 | 86.30 | 86.30 | 86.35 | 86.50 | 86.30 | 86.20 |
| 20 | 86.35 | 86.30 | 86.10 | 86.20 | 86.90 | 86.40 | 86.30 | 86.25 | 86.35 | 86.70 | 86.30 | 86.20 |
| 21 | 86.35 | 86.30 | 86.20 | 86.20 | 86.80 | 86.40 | 86.30 | 87.05 | 86.35 | 86.75 | 86.30 | 86.20 |
| 22 | 86.35 | 86.30 | 86.25 | 86.30 | 86.80 | 86.40 | 86.30 | 87.12 | 86.35 | 86.70 | 86.30 | 86.20 |
| 23 | 86.35 | 86.30 | 86.25 | 86.90 | 86.65 | 86.40 | 86.30 | 86.70 | 86.45 | 86.70 | 86.30 | 86.20 |
| 24 | 86.35 | 86.20 | 86.25 | 87.30 | 86.62 | 87.00 | 86.30 | 86.40 | 86.60 | 86.70 | 86.30 | 86.20 |
| 25 | 86.35 | 86.20 | 86.25 | 86.95 | 86.78 | 86.70 | 86.20 | 86.40 | 86.50 | 86.70 | 86.30 | 86.20 |
| 26 | 86.80 | 86.20 | 86.30 | 86.95 | 88.45 | 86.50 | 86.20 | 86.35 | 86.45 | 86.70 | 86.30 | 86.20 |
| 27 | 86.80 | 86.10 | 86.30 | 86.95 | 87.80 | 86.40 | 86.20 | 86.30 | 86.40 | 86.60 | 86.30 | 86.20 |
| 28 | 86.80 | 86.10 | 86.40 | 87.68 | 87.50 | 86.40 | 86.20 | 86.30 | 86.40 | 86.60 | 86.30 | 86.20 |
| 29 | 86.80 | 86.10 | 86.10 | 87.40 | 87.15 | 86.40 | 86.20 | 86.30 | 86.35 | 86.55 | 86.30 | 86.20 |
| 30 | 86.80 | ..... | 86.20 | 87.30 | 87.15 | 86.40 | 86.30 | 86.30 | 86.35 | 86.50 | 86.30 | 86.20 |
| 31 | 86.80 | ..... | 86.25 | ..... | 86.80 | ..... | 86.20 | 86.30 | ..... | 86.50 | ..... | 86.20 |

Ice conditions during portions of Janua. , February, and March.

## FOX RIVER AT WRIGHTSTOWN, WIS.

This station was established November 19, 1902, by L. R. Stockman. It is located at the highway bridge, about 2,000 feet from the Chicago and Northwestern Railway station. A small tributary enters just above the bridge on the right side. There are no dams nearer than Kaukauna, which is 6 miles up the river. There is a small island just above the bridge, near the right bank. The gage is a vertical board fastened to a pile in the protection to the central pier; it is read twice each day by Peter Van Lieshout. Discharge measurements are made from the upper side of the six-span highway bridge, to which the gage is attached. The initial point for soundings is a nail in the railing at the left end of the bridge. The channel is straight for 2,500 feet above and below the station. At the bridge the channel is 460 feet wide, broken by five piers. The right bank is low; the left bank is high, both being covered with grass to the water's edge. The entire flow passes beneath the bridge at all stages. The bed of the stream is of clay and loam, is without vegetation, and is permanent. The current velocity is moderate and well distributed. Bench mark No. 1 is a projecting stone in the northwest corner of the foundation of the American House at a point two-tenths of a foot above the sidewalk and 2 feet from the corner of the foundation. This building is located on the street that crosses the bridge. The elevation of the bench mark is 20.21 feet above the zero of the gage. Bench mark No. 2 is a cross in a limestone rock in the east end of the south bridge abutment. Its elevation above the zero of the gage is 12.46 feet. On the vertical face of this abutment is an arrow pointing upward to the bench mark. The drainage area at this station is 6,213 square miles.

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

*Mean daily gage height, in feet, of Fox River at Wrightstown, Wis., for 1904.*

| Day. | Jan. | Feb. | Mar. | Day. | Jan. | Feb. | Mar. | Day. | Jan. | Feb. | Mar. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.3 | 5.6 | 6.6 | 12 | 6.6 | 6.8 | 6.9 | 23 | 6.7 | 6.6 | 7.6 |
| 2 | 5.2 | 6.8 | 6.8 | 13 | 6.7 | 6.8 | 5.6 | 24 | 5.1 | 7.2 | 7.5 |
| 3 | 5.3 | 6.8 | 6.8 | 14 | 6.6 | 5.7 | 5.8 | 25 | 5.6 | 7.2 | 10.8 |
| 4 | 5.3 | 6.8 | 6.8 | 15 | 6.6 | 5.4 | 6.6 | 26 | 6.6 | 7.2 | (a) |
| 5 | 6.6 | 6.6 | 6.8 | 16 | 6.5 | 6.7 | 7.0 | 27 | 6.7 | 7.0 | ..... |
| 6 | 6.4 | 6.7 | 5.5 | 17 | 5.4 | 6.7 | 7.1 | 28 | 6.8 | 5.4 | ..... |
| 7 | 6.8 | 5.8 | 5.4 | 18 | 5.0 | 6.6 | 7.0 | 29 | 6.7 | 5.8 | ..... |
| 8 | 6.8 | 5.4 | 6.8 | 19 | 5.9 | 6.7 | 7.1 | 30 | 6.7 | ..... | ..... |
| 9 | 6.8 | 6.7 | 7.0 | 20 | 6.4 | 6.6 | 5.8 | 31 | 5.8 | ..... | ..... |
| 10 | 5.6 | 6.7 | 7.0 | 21 | 6.4 | 5.8 | 5.8 | | | | |
| 11 | 6.0 | 6.7 | 7.0 | 22 | 6.8 | 6.4 | 7.2 | | | | |

(a) Gage destroyed.

NOTE.—Ice conditions January 1 to March 25. Gage heights to surface of water in hole cut in ice.

ST. JOSEPH RIVER AND PORTAGE CREEK AT MENDON, MICH.

This station was established October 25, 1902. It is located at the Marantette Bridge, near Mendon, Mich. The bridge has a single span of 136.5 feet between abutments, stands squarely across the direction of the current, and affords a fairly permanent cross section for gaging, the bed being of smooth clay. There is a bend in the stream a short distance above the bridge, but the channel below for some distance is straight. It is broken by an old bridge pier in the center, which causes eddying and some dead water. Little Portage River flows parallel to and about 1 mile distant from St. Joseph River at Mendon, and was at one time diverted across the divide, affording water power with a fall of 20 feet, but this has been discontinued. The drainage area above Marantette Bridge is 844 square miles. The gage is a vertical board attached to a cedar post near the water's edge in the village, about half a mile above the station. It is read twice each day by William P. McCoy. Little Portage River enters the St. Joseph between the gage and the measuring section and complicates the problem somewhat. The bench mark is the top of the head of a spike driven into the brick wall at the southeast corner of Masonic Hall building, 150 feet northwest from the gage. Its elevation is 19.95 feet above the zero of the gage. The growth of aquatic plants in the channel changes the relation of gage height to discharge during the summer.

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

*Discharge measurements of St. Joseph River at Mendon, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| June 3 | Horton and Covert | 468 | 1.73 | 1.50 | 810 |
| June 7 | R. E. Horton | 455 | 1.53 | 1.35 | 697 |
| September 9 | H. R. Beebe | 387 | .83 | 1.38 | 322 |
| September 22 | do | 389 | .79 | 1.24 | 306 |

*Discharge measurements of Portage Creek at Mendon, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| June 4 | Horton and Covert | 14.2 | 1.35 | ..... | 19.2 |
| June 7 | R. E. Horton | 14.1 | 1.23 | ..... | 16.8 |

*Mean daily gage height, in feet, of St. Joseph River at Mendon, Mich., for 1904.*

| Day. | Jan.[a] | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec.[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.60 | ..... | 1.90 | 5.80 | 1.70 | 1.50 | 1.10 | 1.65 | 1.70 | 1.90 | 1.20 | 0.80 |
| 2 | 1.60 | ..... | 2.00 | 5.70 | 1.70 | 1.50 | 1.10 | 1.70 | 1.65 | 1.75 | 1.20 | .75 |
| 3 | 1.60 | ..... | 3.00 | 5.50 | 1.55 | 1.50 | 1.10 | 1.60 | 1.60 | 1.65 | 1.20 | .75 |
| 4 | 1.60 | ..... | 3.50 | 5.15 | 1.50 | 1.50 | 1.10 | 1.55 | 1.50 | 1.60 | 1.20 | ..... |
| 5 | 1.60 | ..... | [b]4.00 | 4.90 | 1.50 | 1.50 | 1.15 | 1.45 | 1.50 | 1.50 | 1.20 | ..... |
| 6 | 1.60 | ..... | 4.50 | 4.30 | 1.50 | 1.40 | 1.20 | 1.40 | 1.50 | 1.50 | 1.10 | ..... |
| 7 | 1.60 | ..... | 5.75 | 4.20 | 1.50 | 1.35 | 1.20 | 1.40 | 1.40 | 1.40 | 1.05 | .85 |
| 8 | 1.60 | ..... | 6.20 | 3.95 | 1.45 | 1.30 | 1.20 | 1.40 | 1.35 | 1.35 | 1.00 | .90 |
| 9 | 1.60 | ..... | 6.80 | 3.90 | 1.40 | 1.25 | 1.65 | 1.40 | 1.30 | 1.30 | 1.00 | .90 |
| 10 | 1.60 | ..... | 6.90 | 3.85 | 1.40 | 1.20 | 1.80 | 1.40 | 1.30 | 1.30 | 1.00 | .95 |
| 11 | 1.60 | ..... | 6.20 | 3.70 | 1.40 | 1.20 | 1.80 | 1.35 | 1.30 | 1.20 | 1.00 | 1.00 |
| 12 | 1.60 | ..... | 6.00 | 3.65 | 1.40 | 1.20 | 1.95 | 1.30 | 1.40 | 1.20 | 1.00 | 1.00 |
| 13 | 1.60 | ..... | 5.65 | 3.55 | 1.40 | 1.15 | 2.00 | 1.30 | 1.35 | 1.20 | .95 | 1.00 |
| 14 | 1.60 | ..... | 5.00 | 3.35 | 1.40 | 1.10 | 2.00 | 1.30 | 1.30 | 1.20 | .85 | .95 |
| 15 | 1.60 | ..... | 4.95 | 3.30 | 1.40 | 1.10 | 2.00 | 1.30 | 1.25 | 1.20 | .80 | .90 |
| 16 | 1.60 | ..... | 4.00 | 3.20 | 1.40 | 1.10 | 2.00 | 1.30 | 1.20 | 1.20 | .80 | .90 |
| 17 | 1.50 | ..... | 3.90 | 3.10 | 1.40 | 1.10 | 1.95 | 1.32 | 1.20 | 1.20 | .80 | .90 |
| 18 | 1.50 | ..... | 3.50 | 2.95 | 1.40 | 1.10 | 1.80 | 1.40 | 1.20 | 1.20 | .80 | .90 |
| 19 | 1.50 | ..... | 3.50 | 2.75 | 1.50 | 1.10 | 1.70 | 1.40 | 1.20 | 1.20 | .80 | .90 |
| 20 | 1.50 | ..... | 3.40 | 2.65 | 1.50 | 1.10 | 1.60 | 1.70 | 1.20 | 1.20 | .80 | .90 |
| 21 | 1.50 | ..... | 3.40 | 2.40 | 1.50 | 1.10 | 1.50 | 1.90 | 1.20 | 1.20 | .80 | .90 |
| 22 | 1.50 | ..... | 3.60 | 2.30 | 1.50 | 1.10 | 1.50 | 1.90 | 1.20 | 1.30 | .90 | .90 |
| 23 | 1.50 | ..... | 4.70 | 2.30 | 1.40 | 1.10 | 1.50 | 1.90 | 1.20 | 1.30 | .85 | 1.00 |
| 24 | 1.60 | ..... | 5.65 | 2.30 | 1.40 | 1.10 | 1.50 | 1.90 | 1.20 | 1.25 | .80 | 1.10 |
| 25 | 1.60 | ..... | [c]6.75 | 2.25 | 1.40 | 1.10 | 1.45 | 1.90 | 1.20 | 1.20 | .80 | 1.20 |
| 26 | 1.70 | ..... | 7.60 | 2.20 | 1.40 | 1.10 | 1.40 | 1.90 | 1.65 | 1.20 | .80 | 1.40 |
| 27 | 1.80 | ..... | 8.00 | 2.05 | 1.40 | 1.10 | 1.40 | 1.85 | 1.70 | 1.20 | .80 | 1.40 |
| 28 | 1.80 | ..... | 7.80 | 1.95 | 1.40 | 1.10 | 1.50 | 1.80 | 1.95 | 1.20 | .80 | 1.40 |
| 29 | 1.80 | ..... | 6.60 | 1.90 | 1.40 | 1.10 | 1.40 | 1.70 | 2.00 | 1.20 | .80 | 1.40 |
| 30 | 1.80 | ..... | 6.25 | 1.80 | 1.50 | 1.10 | 1.50 | 1.70 | 1.95 | 1.20 | .80 | 1.40 |
| 31 | ..... | ..... | 5.90 | ..... | 1.50 | ..... | 1.55 | 1.70 | ..... | 1.20 | ..... | 1.40 |

[a] Ice conditions. Gage read to surface of water.
[b] Ice gorge.
[c] Flood caused by break in dams above.

### ST. JOSEPH RIVER NEAR BUCHANAN, MICH.

A gaging station was established on St. Joseph River at the dam of the South Bend Electric Company, 1 mile below the village of Buchanan, April 1, 1901. The dam is of frame timber of the Beardsley type, 10 feet high, and rests on earth foundation, leakage being prevented by means of triple-sheet piling at the downstream toe. The upstream face of the dam has a slope of approximately 2.4 horizontal to 1 vertical. The downstream side is also faced with a sloping apron, the two slopes meeting at the crest at an angle of 90°. The dam is level and 392.5 feet in length. The crest gage is attached to piling 45 feet upstream from the crest and is read four times each day by Charles E. Babcock. On the left-hand side of the dam are two 35-inch Leffel turbines in separate vertical-cylinder cases connected to a single governor; from them power is transmitted to adjacent mills by manila rope. The average working head on the water wheels is

11.25 feet. A small amount of leakage through the dam existed in 1901, which was repaired during 1903, an estimate of the leakage was obtained, and a new profile taken.

In June, 1904, a new power plant was put in operation at this dam. The new plant contains three units, each containing three wheels. The turbines are 68-inch Leffel-Samson. The first and second units are controlled by Lombard governors. The third unit is controlled by hand. There is also a 40-inch Leffel-Samson turbine used to drive exciters. A record is kept of the number of hours per day each turbine unit is operated, and governor readings are taken every four hours, showing the proportional part of full gate opening at which the wheels are being operated. A record of the total electrical output in kilowatt hours is also obtained.

From November, 1903, to November, 1904, the record consisted of readings of the crest gage and of the Watt meter above described. The operation of the water wheels was not recorded. In order to calculate the discharge for this period, an estimate was made of the efficiency of the plant, based in part on tests, and the water required to furnish the recorded power under the existing head and at the assumed efficiency, was calculated and taken as representing the discharge through the turbines.

During the month of December, 1904, a careful record was kept both of the turbine operation and of the electrical output. The results furnish a check on the calculations for the preceding months.

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

*Mean daily discharge, in second-feet, of St. Joseph River near Buchanan, Mich., for 1903 and 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May.[a] | June.[a] | July.[a] | Aug.[a] | Sept.[a] | Oct.[a] | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | | | | | |
| 1 | 4,052 | 6,380 | 9,560 | 4,277 | ..... | ..... | ..... | ..... | ..... | ..... | 438 | 1,990 |
| 2 | 4,209 | 6,903 | 8,878 | 4,277 | ..... | ..... | ..... | ..... | ..... | ..... | 967 | 1,908 |
| 3 | 4,353 | 7,077 | 9,068 | 4,277 | ..... | ..... | ..... | ..... | ..... | ..... | 960 | 1,825 |
| 4 | 4,574 | 7,253 | 8,783 | 4,421 | ..... | ..... | ..... | ..... | ..... | ..... | 960 | 1,997 |
| 5 | 4,899 | 7,336 | 9,360 | 5,388 | ..... | ..... | ..... | ..... | ..... | ..... | 1,025 | 1,678 |
| 6 | 4,977 | 6,989 | 10,145 | 6,605 | ..... | ..... | ..... | ..... | ..... | ..... | 982 | 1,447 |
| 7 | 4,977 | 7,042 | 10,463 | 5,933 | ..... | ..... | ..... | ..... | ..... | ..... | 1,885 | 2,048 |
| 8 | 4,977 | 6,698 | 10,670 | 5,849 | ..... | ..... | ..... | ..... | ..... | ..... | 1,802 | 2,374 |
| 9 | 4,821 | 6,618 | 11,468 | 5,597 | ..... | ..... | ..... | ..... | ..... | ..... | 1,628 | 2,381 |
| 10 | 4,743 | 6,366 | 10,958 | 5,111 | ..... | ..... | ..... | ..... | ..... | ..... | 1,880 | 2,448 |
| 11 | 4,652 | 6,282 | 10,658 | 5,681 | ..... | ..... | ..... | ..... | ..... | ..... | 1,753 | 2,099 |
| 12 | 4,587 | 6,618 | 10,248 | 6,982 | ..... | ..... | ..... | ..... | ..... | ..... | 1,566 | 1,809 |
| 13 | 4,509 | 6,956 | 9,838 | 8,675 | ..... | ..... | ..... | ..... | ..... | ..... | 1,648 | (a) |
| 14 | 4,353 | 7,214 | 9,458 | 9,730 | ..... | ..... | ..... | ..... | ..... | ..... | 1,614 | 1,736 |
| 15 | 4,353 | 6,698 | 9,078 | 10,645 | ..... | ..... | ..... | ..... | ..... | ..... | 1,486 | 2,282 |
| 16 | 4,209 | 6,366 | 8,688 | 10,745 | ..... | ..... | ..... | ..... | ..... | ..... | 1,732 | 2,540 |
| 17 | 4,065 | 5,364 | 8,223 | 10,440 | ..... | ..... | ..... | ..... | ..... | ..... | 1,804 | 2,525 |

[a] Record not available.

*Mean daily discharge, in second-feet, of St. Joseph River near Buchanan, Mich., for 1903 and 1904*—Continued.

| Day. | Jan. | Feb. | Mar. | Apr. | May.[a] | June.[a] | July.[a] | Aug.[a] | Sept.[a] | Oct.[a] | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1903—Cont'd. | | | | | | | | | | | | |
| 18 | 3,908 | 4,146 | 7,918 | 10,030 | ..... | ..... | ..... | ..... | ..... | ..... | 2,042 | 3,080 |
| 19 | 3,777 | 3,382 | 7,654 | 11,102 | ..... | ..... | ..... | ..... | ..... | ..... | 1,982 | 3,102 |
| 20 | 3,777 | 3,178 | 7,302 | 9,055 | ..... | ..... | ..... | ..... | ..... | ..... | 1,946 | 3,374 |
| 21 | 3,637 | 3,586 | 6,956 | 8,480 | ..... | ..... | ..... | ..... | ..... | ..... | 1,931 | 3,641 |
| 22 | 3,637 | 4,058 | 6,782 | 7,905 | ..... | ..... | ..... | ..... | ..... | ..... | 1,569 | 3,626 |
| 23 | 3,707 | 4,734 | 6,702 | 7,115 | ..... | ..... | ..... | ..... | ..... | ..... | 2,076 | 3,448 |
| 24 | 3,777 | 5,862 | 6,534 | 6,689 | ..... | ..... | ..... | ..... | ..... | ..... | 1,864 | 3,913 |
| 25 | 3,764 | 5,694 | 6,114 | 6,521 | ..... | ..... | ..... | ..... | ..... | ..... | 2,012 | 3,427 |
| 26 | 3,849 | 5,445 | 5,445 | 6,211 | ..... | ..... | ..... | ..... | ..... | ..... | 2,000 | 2,716 |
| 27 | 3,993 | 5,862 | 4,968 | 5,681 | ..... | ..... | ..... | ..... | ..... | ..... | 1,753 | 2,460 |
| 28 | 4,137 | 7,128 | 4,890 | 5,351 | ..... | ..... | ..... | ..... | ..... | ..... | 1,691 | 3,080 |
| 29 | 5,385 | ..... | 4,646 | 4,799 | ..... | ..... | ..... | ..... | ..... | ..... | (a) | 3,670 |
| 30 | 7,077 | ..... | 4,578 | 4,421 | ..... | ..... | ..... | ..... | ..... | ..... | 1,997 | 3,087 |
| 31 | 6,225 | ..... | 4,578 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2,817 |
| 1904. | | | | | | | | | | | | |
| 1 | 3,045 | 9,872 | 10,650 | 16,300 | 4,648 | 4,014 | (a) | ..... | 1,278 | 1,738 | 2,141 | 1,511 |
| 2 | 2,830 | 11,010 | 11,184 | 18,100 | 4,901 | 3,788 | (a) | ..... | 1,274 | 950 | 2,376 | 1,476 |
| 3 | 2,574 | 9,006 | 10,120 | 15,345 | 4,634 | 3,492 | 2,802 | ..... | 1,510 | 868 | 2,064 | 1,584 |
| 4 | 2,520 | 9,237 | 10,027 | 13,945 | 4,396 | 3,448 | 2,676 | ..... | 1,352 | 1,317 | 2,017 | 1,089 |
| 5 | 2,692 | 10,165 | 10,487 | 12,871 | 4,192 | 3,132 | 2,970 | ..... | 1,356 | 1,608 | 2,085 | 1,346 |
| 6 | 3,044 | 9,450 | 10,144 | 12,158 | 4,070 | 3,021 | 2,480 | ..... | 1,476 | 1,620 | 1,830 | 1,624 |
| 7 | 3,016 | 8,430 | 11,524 | 11,484 | 3,942 | 3,012 | 2,559 | ..... | 1,524 | 1,570 | 2,336 | 1,663 |
| 8 | 2,974 | 7,710 | 13,077 | 11,102 | 3,772 | 2,711 | 2,754 | ..... | 1,394 | 1,626 | 2,053 | 1,582 |
| 9 | 3,059 | 7,166 | 12,934 | 10,529 | 3,928 | 2,520 | 2,725 | ..... | 1,432 | 1,289 | 1,652 | 1,674 |
| 10 | 2,655 | 6,428 | 12,094 | 10,222 | 3,772 | 2,498 | 3,425 | ..... | 1,331 | 1,475 | 1,848 | 1,693 |
| 11 | 2,953 | 5,624 | 12,941 | 8,618 | 3,772 | 2,579 | 3,342 | ..... | 736 | 1,575 | 1,885 | 1,443 |
| 12 | 2,707 | 5,698 | 13,504 | 8,654 | 3,642 | 2,309 | 3,288 | ..... | 1,380 | 1,712 | 1,727 | 1,615 |
| 13 | 2,504 | 5,604 | 11,134 | 8,452 | 3,554 | 2,548 | 3,152 | ..... | 1,408 | 2,196 | 1,731 | 1,715 |
| 14 | 1,731 | 5,836 | 10,737 | 7,907 | 3,622 | 2,487 | 3,316 | ..... | 837 | 2,333 | 2,236 | 1,589 |
| 15 | 2,238 | 5,954 | 9,909 | 6,977 | 3,526 | 2,173 | 3,027 | ..... | 1,020 | 2,206 | 1,873 | 1,169 |
| 16 | 2,369 | (a) | 8,968 | 7,226 | 3,386 | 1,986 | 3,324 | ..... | 1,380 | 1,780 | 1,259 | 929 |
| 17 | 4,964 | 3,968 | 9,165 | 6,851 | 3,044 | 1,690 | 3,451 | ..... | 1,470 | 2,542 | 1,648 | 1,317 |
| 18 | 8,179 | 3,719 | 8,430 | 6,976 | 3,216 | 1,949 | 2,805 | ..... | 774 | 2,329 | 1,598 | 1,135 |
| 19 | 7,654 | 3,610 | 8,099 | 6,872 | 3,274 | 2,552 | 2,659 | ..... | 1,226 | 2,006 | 1,782 | 1,389 |
| 20 | 8,756 | 3,386 | 9,225 | 6,531 | 3,506 | 2,824 | 2,886 | ..... | 1,379 | 2,076 | 1,818 | 1,683 |
| 21 | 9,964 | 3,283 | 10,283 | 6,019 | 3,737 | 2,747 | 2,452 | ..... | 1,197 | 2,070 | 1,950 | 1,637 |
| 22 | 11,558 | 3,238 | 10,554 | 5,874 | 3,747 | 2,791 | 1,617 | ..... | 1,271 | 2,076 | 1,725 | 1,683 |
| 23 | 12,857 | 3,336 | 12,209 | 5,715 | 3,556 | 2,718 | 1,991 | ..... | 1,308 | 1,645 | 1,903 | 1,793 |
| 24 | 7,158 | 3,138 | 12,275 | 5,492 | 3,508 | 2,534 | 2,123 | ..... | 1,214 | 2,501 | 1,930 | 2,135 |
| 25 | 10,131 | 3,004 | 13,882 | 5,758 | 3,312 | 2,703 | 2,339 | ..... | 814 | 2,330 | 1,706 | 1,822 |
| 26 | 10,694 | 3,064 | 16,772 | 5,758 | 3,274 | 2,639 | 1,850 | ..... | 1,096 | 2,160 | 1,754 | 2,015 |
| 27 | 9,408 | 3,132 | 18,602 | 5,962 | 3,492 | 2,592 | 1,788 | ..... | 1,497 | 2,137 | 1,463 | 2,060 |
| 28 | 10,574 | 3,234 | 17,788 | 5,772 | 3,542 | 2,303 | 1,854 | ..... | 1,462 | 2,099 | 1,895 | 1,650 |
| 29 | 9,792 | 5,926 | 16,430 | 5,408 | 3,300 | 2,261 | 2,065 | ..... | 1,607 | 2,206 | 1,837 | 1,523 |
| 30 | 10,482 | ..... | 15,668 | 5,152 | 3,846 | 2,036 | 2,184 | 1,945 | 1,754 | 1,628 | 1,712 | 2,049 |
| 31 | 6,355 | ..... | 15,289 | ..... | 3,959 | ..... | (a) | 1,336 | ..... | 2,292 | ..... | 1,824 |

[a] Record not available.

*Estimated monthly discharge of St. Joseph River near Buchanan, Mich., for 1903 and 1904.*

[Drainage area, 3,935 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| 1903. | | | | | |
| January | 7,077 | 3,637 | 4,450 | 1.13 | 1.30 |
| February | 7,336 | 3,178 | 5,973 | 1.52 | 1.58 |
| March | 11,470 | 4,578 | 8,084 | 2.05 | 2.36 |
| April | 11,100 | 4,277 | 6,933 | 1.76 | 1.96 |
| May [a] | | | | | |
| June [a] | | | | | |
| July [a] | | | | | |
| August [a] | | | | | |
| September [a] | | | | | |
| October [a] | | | | | |
| November, 29 days [b] | 2,076 | 438 | 1,620 | .412 | .459 |
| December, 30 days [b] | 3,913 | 1,447 | 2,609 | .663 | .765 |
| 1904. | | | | | |
| January | 12,860 | 1,731 | 5,853 | 1.49 | 1.72 |
| February, 28 days [b] | 11,010 | 3,004 | 5,830 | 1.48 | 1.60 |
| March | 18,600 | 8,099 | 12,070 | 3.07 | 3.54 |
| April | 18,100 | 5,152 | 8,801 | 2.24 | 2.50 |
| May | 4,901 | 3,044 | 3,744 | .951 | 1.10 |
| June | 4,014 | 1,690 | 2,669 | .678 | .756 |
| July, 28 days [b] | 3,451 | 1,617 | 2,639 | .671 | .774 |
| August [a] | | | | | |
| September | 1,754 | 736 | 1,292 | .328 | .366 |
| October | 2,542 | 868 | 1,870 | .475 | .548 |
| November | 2,376 | 1,259 | 1,844 | .469 | .523 |
| December | 2,135 | 929 | 1,594 | .405 | .467 |

[a] Records not available. [b] Mean for number of days observed taken as mean for entire month.

## FAWN RIVER NEAR WHITE PIGEON, MICH.

Fawn River is a tributary of St. Joseph River, rising in northern Indiana near the Michigan line, flowing generally westward, crossing and recrossing from Michigan to Indiana, and entering St. Joseph River at Constantine. The drainage basin is flat with soil of sand and loam, and contains numerous lakes and undrained ponds, Klinger and Pickerel lakes being the largest and having water-surface areas of about 1 square mile each.

A gage was erected at the highway bridge below the abandoned Kidd mill dam, 4 miles from White Pigeon, July 4, 1903. The stream

stage has been observed twice daily, by William Probst, on a vertical graduated scale attached to the downstream left side of the bridge. Discharge measurements have been made from a boat at a point 500 feet downstream from the gage.

In the winter the stream freezes over at the gage and below, thereby changing the relation between the stage or discharge of the stream, as compared with open periods.

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

*Discharge measurements of Fawn River near White Pigeon, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| June 3 | Horton and Covert | 124 | 1.73 | 2.10 | 215 |
| June 7 | C. C. Covert | 116 | 1.59 | 2.00 | 182 |
| September 10 | H. R. Beebe | 93 | .99 | [a] 1.95 | 92 |

[a] Distance to water surface from top right-hand anchor stake at measuring section.

*Mean daily gage height, in feet, of Fawn River near White Pigeon, Mich., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. |
|---|---|---|---|---|---|---|---|
| 1 | 1.80 | 2.10 | 3.80 | 3.30 | 2.30 | 2.20 | 1.90 |
| 2 | 1.80 | 2.15 | 4.25 | 3.35 | 2.30 | 2.20 | 1.90 |
| 3 | 1.80 | 2.20 | 3.90 | 3.30 | 2.30 | 2.20 | 1.90 |
| 4 | 1.80 | 2.15 | 3.70 | 3.25 | 2.20 | 2.10 | 1.90 |
| 5 | 1.70 | 2.15 | 3.45 | 3.15 | 2.20 | 2.00 | 1.90 |
| 6 | 1.70 | 2.25 | 3.65 | 3.10 | 2.20 | 2.00 | ..... |
| 7 | 1.70 | 2.75 | 3.60 | 3.00 | 2.10 | 2.00 | ..... |
| 8 | 1.70 | 2.80 | 3.50 | 2.95 | 2.10 | 2.00 | ..... |
| 9 | 1.70 | 2.80 | 3.35 | 2.95 | 2.10 | 2.00 | ..... |
| 10 | 1.70 | 2.80 | 3.60 | 3.00 | 2.10 | 2.00 | ..... |
| 11 | 1.70 | 2.80 | 3.45 | 3.00 | 2.05 | 2.00 | ..... |
| 12 | 1.75 | 2.70 | 3.30 | 3.00 | 2.00 | 1.90 | ..... |
| 13 | 1.75 | 2.65 | 3.25 | 2.90 | 2.00 | 1.90 | ..... |
| 14 | 1.70 | 2.60 | 3.80 | 2.80 | 2.10 | 1.90 | ..... |
| 15 | 1.70 | 2.50 | 4.30 | 2.80 | 2.20 | 1.85 | ..... |
| 16 | 1.75 | 2.45 | 3.25 | 2.70 | 2.15 | 1.80 | ..... |
| 17 | 1.80 | 2.40 | 3.05 | 2.60 | 2.10 | 1.80 | ..... |
| 18 | 1.80 | 2.40 | 3.10 | 2.55 | 2.10 | 1.80 | ..... |
| 19 | 1.80 | 2.35 | 3.00 | 2.50 | 2.15 | 1.85 | ..... |
| 20 | 1.95 | 2.30 | 2.95 | 2.50 | 2.20 | 1.90 | ..... |
| 21 | 2.10 | 2.30 | 3.00 | 2.50 | 2.20 | 2.00 | ..... |
| 22 | 2.25 | 2.30 | 3.05 | 2.50 | 2.15 | 2.05 | ..... |
| 23 | 2.40 | 2.30 | 3.25 | 2.50 | 2.10 | 2.10 | ..... |
| 24 | 2.40 | 2.40 | 3.30 | 2.50 | 2.10 | 2.05 | ..... |
| 25 | 2.35 | 2.40 | 3.30 | 2.50 | 2.10 | 1.95 | ..... |
| 26 | 2.25 | 2.40 | 3.45 | 2.50 | 2.15 | 1.90 | ..... |
| 27 | 2.20 | 2.30 | 3.45 | 2.45 | 2.20 | 1.90 | ..... |
| 28 | 2.20 | 2.45 | 3.45 | 2.40 | 2.20 | 1.90 | ..... |
| 29 | 2.20 | 3.30 | 3.30 | 2.40 | 2.10 | 1.90 | ..... |
| 30 | 2.10 | ..... | 3.30 | 2.30 | 2.15 | 1.90 | ..... |
| 31 | 2.20 | ..... | 3.30 | ..... | 2.20 | ..... | ..... |

NOTE.—Ice conditions January 1 to March 2. Gage read to water surface.

KALAMAZOO RIVER NEAR ALLEGAN, MICH.

A gaging station was established at the dam of the Commonwealth Power Company, Trowbridge Township, 6 miles upstream by river from Allegan, April 4, 1901. The dam is of timber crib work filled with stone, resting on a pile foundation in clay hardpan. The dam is equipped with three Taintor segmental flood gates, each of 19.7 feet clear width. In the adjacent power house, forming a portion of the dam, are eight 43-inch Leffel-Samson turbines arranged in two sets on a horizontal shaft, each set controlled by a separate governor. The gaging record includes the number of hours of daily run; the average gate opening of the turbines, as indicated by the index wheels of the governors; the stage of water on the tailrace gage; and the reading of the crest gage. The crest gage is set with its zero at the elevation of the horizontal spillways of 20 feet crest width each, which are closed by the Taintor gates. The crest gage also serves to show the depth flowing over the crests of the Taintor gates or of flashboards placed thereon. A record of the opening and closing of the Taintor gates is also kept. The pond above the dam covers an area of 1,000 acres. The turbines run continuously and the flow of the stream is nearly all utilized, except in times of extreme freshet. At such times the water level is controlled by means of the flood gates described.

The crest and tailrace gages are set with a difference of elevation of 12 feet, and both are referred to the top of the masonry pier at the entrance to the flume as a bench mark. The elevation of the zero of the crest gage is 83.95 feet; that of the zero of the tailrace gage, 71.95 feet. The effective head varies from 21 to 23 feet.

The record is maintained in cooperation with the Commonwealth Power Company by R. E. Horton, district hydrographer.

*Mean daily discharge, in second-feet, of Kalamazoo River near Allegan, Mich., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 917 | 1,319 | 1,437 | 6,489 | 1,590 | 1,769 | 1,162 | 561 | 787 | 1,359 | 1,008 | 738 |
| 2 | 1,081 | 1,251 | 1,623 | 4,900 | 1,120 | 1,431 | 979 | 822 | 625 | 681 | 875 | 929 |
| 3 | 936 | 1,004 | 2,485 | 4,947 | 4,164 | 1,395 | 1,000 | 691 | 693 | 489 | 841 | 705 |
| 4 | 1,005 | 1,387 | 1,903 | 4,678 | 1,201 | 1,330 | 1,105 | 691 | 732 | 474 | 1,229 | 670 |
| 5 | 1,155 | 931 | 2,234 | 4,220 | 1,161 | 1,450 | 1,061 | 677 | 693 | 712 | 621 | 899 |
| 6 | 1,070 | 1,883 | 2,639 | 4,228 | 1,131 | 1,155 | 929 | 597 | 884 | 956 | 707 | 900 |
| 7 | 941 | 2,351 | 3,955 | 4,228 | 1,329 | 1,203 | 929 | 493 | 751 | 1,009 | 793 | 883 |
| 8 | 1,067 | 1,809 | 3,721 | 4,267 | 1,318 | 1,167 | 1,015 | 660 | 751 | 956 | 726 | 780 |
| 9 | 874 | 2,048 | 4,941 | 4,049 | 1,231 | 1,194 | 1,139 | 660 | 719 | 841 | 745 | 643 |
| 10 | 1,079 | 1,995 | 4,561 | 3,542 | 1,335 | 1,095 | 1,316 | 660 | 731 | 1,208 | 662 | 805 |
| 11 | 1,020 | 1,637 | 6,131 | 2,903 | 1,371 | 1,211 | 1,222 | 618 | 688 | 1,260 | 481 | 681 |
| 12 | 1,213 | 1,380 | 5,113 | 3,453 | 1,335 | 1,009 | 1,591 | 903 | 810 | 1,157 | 772 | 805 |
| 13 | 1,213 | 2,014 | 4,653 | 3,016 | 1,199 | 1,009 | 1,431 | 1,057 | 751 | 1,303 | 785 | 855 |
| 14 | 1,004 | 1,605 | 3,958 | 2,721 | 1,428 | 1,061 | 1,267 | 623 | 863 | 1,564 | 988 | 971 |
| 15 | 941 | 1,494 | 4,378 | 2,547 | 1,253 | 924 | 980 | 660 | 811 | 988 | 822 | 619 |
| 16 | 1,280 | 1,902 | 3,488 | 2,757 | 1,331 | 747 | 988 | 700 | 825 | 817 | 904 | 585 |
| 17 | 736 | 1,808 | 3,018 | 2,349 | 1,335 | 873 | 858 | 866 | 676 | 783 | 751 | 512 |
| 18 | 944 | 1,653 | 2,925 | 3,223 | 1,359 | 973 | 900 | 781 | 405 | 956 | 769 | 99 |

*Mean daily discharge, in second-feet, of Kalamazoo River, etc.*—Continued.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | 1,003 | 1,137 | 3,148 | 2,535 | 1,271 | 843 | 900 | 764 | 656 | 815 | 795 | 535 |
| 20 | 1,627 | 1,262 | 3,255 | 2,469 | 1,733 | 911 | 789 | 805 | 922 | 604 | 643 | 922 |
| 21 | 1,399 | 860 | 2,768 | 2,277 | 1,881 | 810 | 851 | 1,306 | 858 | 909 | 922 | 833 |
| 22 | 1,632 | 1,103 | 6,703 | 2,057 | 1,686 | 911 | 900 | 1,114 | 858 | 2,333 | 738 | 742 |
| 23 | 1,603 | 995 | 4,000 | 2,010 | 1,455 | 747 | 900 | 1,148 | 778 | 1,575 | 866 | 1,091 |
| 24 | 1,271 | 957 | 5,209 | 1,941 | 1,550 | 851 | 803 | 888 | 778 | 1,459 | 772 | 1,152 |
| 25 | 1,389 | 1,073 | 9,678 | 1,716 | 1,614 | 1,000 | 890 | 1,011 | 571 | 1,199 | 805 | 958 |
| 26 | 1,752 | 1,190 | 9,956 | 1,780 | 1,493 | 851 | 713 | 1,152 | 2,410 | 1,319 | 876 | 1,313 |
| 27 | 1,148 | 1,119 | 10,236 | 1,685 | 1,569 | 1,000 | 634 | 858 | 1,525 | 1,059 | 556 | 1,242 |
| 28 | 1,657 | 1,341 | 10,266 | 1,630 | 1,868 | 1,095 | 601 | 624 | 1,220 | 889 | 939 | 1,348 |
| 29 | 1,752 | 1,341 | 10,186 | 1,530 | 1,456 | 1,232 | 819 | 872 | 1,495 | 733 | 928 | 1,061 |
| 30 | 1,575 | ..... | 10,006 | 1,704 | 1,484 | 1,122 | 721 | 923 | 1,545 | 931 | 791 | 638 |
| 31 | 1,384 | ..... | 8,178 | ..... | 1,653 | ..... | 769 | 971 | ..... | 1,089 | ..... | 717 |

*Estimated monthly discharge of Kalamazoo River near Allegan, Mich., for 1904.*

[Drainage area, 1,471 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January | 1,752 | 736 | 1,215 | 0.826 | 0.952 |
| February | 2,351 | 860 | 1,443 | .981 | 1.06 |
| March | 10,260 | 1,437 | 5,057 | 3.44 | 3.97 |
| April | 6,489 | 1,530 | 3,062 | 2.08 | 2.32 |
| May | 4,164 | 1,120 | 1,513 | 1.03 | 1.19 |
| June | 1,769 | 747 | 1,079 | .734 | .819 |
| July | 1,591 | 601 | 973 | .661 | .762 |
| August | 1,306 | 493 | 811 | .551 | .635 |
| September | 2,410 | 405 | 894 | .608 | .678 |
| October | 2,333 | 474 | 1,046 | .711 | .820 |
| November | 1,229 | 481 | 804 | .547 | .610 |
| December | 1,348 | 99 | 827 | .562 | .648 |
| The year | 10,260 | 99 | 1,560 | 1.06 | 14.46 |

### GRAND RIVER AT NORTH LANSING, MICH.

This station was established March 2, 1901, by H. K. Vedder. It is located at the Seymour Street Bridge a short distance below the North Lansing dam. About November 8, 1901, a low, submerged dam was constructed a short distance downstream from the gaging station to supply water to the factory of the Michigan Beet Sugar Company. The diversion at this point is small compared with the flow of the stream. In order to determine the effect of the submerged dam on the gage readings, a second gage was established a short dis-

tance downstream and comparative readings were taken. The gage readings made prior to the construction of the dam have been corrected from the data thus obtained. The vertical gage is attached to the downstream end of the central pier of the bridge. It is read by Thomas Costigan. Discharge measurements are made from the two-span bridge to which the gage is attached. Each span has a length of 92 feet. During low water the bridge makes a slight angle with the normal to the direction of the current, at one side of the stream. The bed of the stream is composed of gravel and silt and is thickly overgrown with weeds above the bridge. The current becomes sluggish at low stages. The channel is nearly straight for 200 feet above and below the station.

Beginning October 19, 1904, gage readings have been taken at 6 a. m., noon, and 6 p. m. each day. The mean gage height for the day has been obtained by adding together twice the morning reading, the noon reading, and twice the afternoon reading, and dividing by 5. The different readings are thus given weight in proportion to the number of hours for which they are assumed to represent the stage of the stream.

Observations of the stage were taken at half-hour intervals during a portion of the low-water season of 1904, in order to determine the diurnal variation in stage and discharge resulting from the draft and storage at the mills and dam just above the gaging station. The half hourly observations were plotted, and the actual daily discharge was integrated from the diagrams by planimeter.

It was found that by using three daily readings in the manner above described the integral discharge could be closely approximated. The diurnal variation is a maximum in low water, decreasing in effect as the stage of the stream increases.

On March 26, 1904, a flood of unusual severity occurred, owing to the sudden melting of an unusually great accumulation of snow. The stage of the stream greatly exceeded the limit of the rating curve.

It is impossible to make meter measurements at the maximum stages, owing to the presence of ice and drift and to the high velocity. It is possible that the rating curve, as deduced, gives somewhat too large results for high stages, owing to the difficulty of holding the meter in position.

The dam just above the gaging station affords an opportunity to check the rating table for the higher stages and to extend it considerably. Arrangements have been made to procure a record at this dam during the spring freshet of 1905. When this has been done, it may be possible to calculate the discharge during the freshet of March 26, 1904.

The observed maximum stage, 18.55 on the gage, occurred at 6 a. m. March 26. The high-water mark at the North Lansing dam on the same date indicated a discharge of about 16,700 second-feet over the main spillway, which is 192 feet in length. In addition water flowed around both ends of the dam in an amount sufficient to increase the total discharge to somewhere from 20,000 to 25,000 second-feet.

During 1904 the United States Weather Bureau erected gages at various points along Grand River for use in predicting floods.

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

*Discharge measurements of Grand River at North Lansing, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| May 25 | C. C. Covert | 734 | 1.67 | 3.90 | 1,239 |
| May 28 | R. E. Horton | 631 | 1.61 | 3.45 | 1,020 |
| June 9 | C. C. Covert | 466 | 1.29 | 2.50 | 600 |
| September 2 | H. R. Beebe | 382 | 1.02 | 2.37 | 391 |
| September 7 | do | 392 | .91 | 2.27 | 357 |
| September 18 | do | 154 | .54 | 1.10 | 83 |
| September 18 | do | 164 | .55 | 1.20 | 92 |
| December 17 | C. C. Covert | 342 | .99 | 2.10 | 339 |

*Mean daily gage height, in feet, of Grand River at North Lansing, Mich., for 1904.*[a]

| Day. | Jan.[b] | Feb.[b] | Mar.[b] | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec.[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.18 | 3.45 | 3.52 | 11.75 | 3.80 | 2.95 | 1.92 | 1.52 | 1.85 | 2.15 | 1.96 | 1.62 |
| 2 | 2.15 | 3.38 | 3.75 | 11.40 | 3.74 | 2.98 | 1.85 | 1.55 | 1.85 | 2.10 | 1.90 | 1.71 |
| 3 | 2.28 | 3.28 | 5.19 | 11.10 | 3.60 | 2.85 | 1.95 | 1.55 | 1.60 | 2.10 | 1.86 | 1.74 |
| 4 | 2.35 | 3.20 | 6.59 | 10.06 | 3.45 | 2.65 | 1.80 | 1.48 | 1.50 | 1.98 | 1.88 | 1.30 |
| 5 | 2.45 | 3.10 | 7.30 | 8.95 | 3.35 | 2.55 | 1.80 | 1.60 | 1.75 | 2.15 | 1.82 | 1.66 |
| 6 | 2.59 | 3.10 | 8.08 | 8.22 | 3.28 | 2.55 | 1.85 | 1.38 | 1.29 | 2.20 | 1.76 | 1.54 |
| 7 | 2.45 | 4.30 | 10.08 | 7.70 | 3.12 | 2.40 | 1.75 | 1.55 | 1.65 | 2.25 | 1.58 | 1.64 |
| 8 | 2.25 | 5.65 | 11.72 | 7.38 | 2.95 | 2.32 | 1.72 | 1.40 | 1.75 | 2.18 | 1.88 | 1.81 |
| 9 | 1.92 | 6.00 | 12.19 | 7.55 | 2.90 | 2 35 | 1.74 | 1.35 | 1.62 | 2.25 | 1.74 | 1.64 |
| 10 | 1.65 | 6.42 | 12.50 | 7.70 | 2.85 | 2.35 | 2.12 | 1.40 | 1.63 | 2.30 | 1.65 | 1.64 |
| 11 | 2.18 | 6.40 | 12.19 | 7.58 | 2.79 | 2.29 | 2.38 | 1.72 | 1.15 | 2.35 | 1.82 | 1.73 |
| 12 | 2.36 | 6.02 | 11.22 | 7.22 | 2.74 | 2.20 | 2.35 | 1.90 | 1.82 | 2.52 | 1.92 | 1.64 |
| 13 | 2.42 | 5.68 | 10.35 | 6.78 | 2.65 | 2.08 | 2.26 | 1.72 | 1.80 | 2.45 | 1.71 | 2.06 |
| 14 | 2.50 | 5.26 | 9.18 | 6.32 | 2.76 | 2.18 | 2.18 | 1.68 | 1.69 | 2.21 | 1.64 | 2.08 |
| 15 | 2.15 | 5.06 | 7.95 | 6.05 | 2.70 | 2.05 | 1.98 | 1.65 | 1.72 | 2.20 | 1.76 | 1.82 |
| 16 | 1.95 | 4.75 | 6.95 | 5.74 | 2.72 | 1.95 | 1.84 | 1.60 | 1.68 | 2.26 | 1.80 | 1.84 |
| 17 | 2.00 | 4.38 | 6.45 | 5.82 | 2.74 | 1.90 | 1.88 | 1.38 | 1.68 | 2.20 | 1.68 | 1.72 |
| 18 | 2.15 | 4.18 | 6.06 | 6.18 | 2.65 | 1.75 | 1.70 | 1.52 | 1.16 | 2.05 | 1.66 | 1.48 |
| 19 | 2.30 | 3.84 | 5.65 | 6.28 | 2.74 | 1.55 | 1.72 | 1.68 | 1.80 | 2.02 | 1.80 | 1.74 |
| 20 | 2.60 | 3.34 | 6.25 | 5.90 | 3.75 | 1.74 | 1.68 | 1.98 | 1.63 | 2.08 | 1.82 | 1.66 |
| 21 | 3.25 | 3.49 | 6.60 | 5.52 | 4.52 | 1.68 | 1.65 | 2.20 | 1.72 | 1.89 | 1.74 | 1.86 |
| 22 | 3.40 | 3.38 | 7.80 | 5.08 | 4.32 | 1.50 | 1.59 | 1.90 | 1.48 | 1.84 | 1.72 | 1.75 |
| 23 | 3.20 | 3.28 | 11.39 | 4.75 | 4.22 | 1.65 | 1.58 | 2.45 | 1.44 | 1.95 | 1.78 | 1.71 |
| 24 | 3.20 | 3.20 | 13.78 | 4.71 | 4.10 | 1.60 | 1.55 | 2.25 | 1.35 | 1.96 | 1.78 | 1.86 |
| 25 | 3.60 | 3.28 | 16.65 | 4.69 | 3.72 | 1.98 | 1.52 | 2.20 | 1.20 | 1.92 | 1.70 | 1.84 |
| 26 | 3.60 | 3.30 | 18.02 | 4.45 | 3.58 | 2.12 | 1.60 | 2.20 | 1.55 | 2.01 | 1.82 | 1.84 |
| 27 | 3.52 | 3.22 | 16.05 | 4.32 | 3.63 | 1.98 | 1.52 | 2.00 | 1.74 | 1.94 | 1.76 | 2.04 |
| 28 | 3.45 | 3.20 | 14.05 | 4.19 | 3.46 | 2.00 | 1.68 | 1.75 | 2.20 | 1.86 | 1.75 | 3.06 |
| 29 | 3.35 | 3.28 | 12.80 | 4.00 | 3.10 | 1.92 | 1.42 | 2.00 | 2.18 | 1.79 | 1.68 | 2.94 |
| 30 | 3.15 | ..... | 10.86 | 3.84 | 3.05 | 1.95 | 1.38 | 1.75 | 2.25 | 1.96 | 1.89 | 2.51 |
| 31 | 3.05 | ..... | 11.07 | ..... | 3.00 | ..... | 1.40 | 1.85 | ..... | 1.80 | ..... | 2.00 |

[a] Weighted mean of three readings per day, beginning October 19, 1904.
[b] Ice conditions January 1 to March 28; also December 13 to 31, but not sufficient to modify flow.

*Rating table for Grand River at North Lansing, Mich., from March 3, 1901, 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.* |
| 1.00 | 80 | 2.70 | 596 | 4.30 | 1,340 | 6.80 | 3,010 |
| 1.10 | 108 | 2.80 | 634 | 4.40 | 1,400 | 7.00 | 3,170 |
| 1.20 | 136 | 2.90 | 672 | 4.50 | 1,450 | 7.20 | 3,350 |
| 1.30 | 164 | 3.00 | 710 | 4.60 | 1,510 | 7.40 | 3,540 |
| 1.40 | 192 | 3.10 | 754 | 4.70 | 1,570 | 7.60 | 3,730 |
| 1.50 | 220 | 3.20 | 798 | 4.80 | 1,630 | 7.80 | 3,930 |
| 1.60 | 248 | 3.30 | 842 | 4.90 | 1,690 | 8.00 | 4,130 |
| 1.70 | 276 | 3.40 | 886 | 5.00 | 1,750 | 8.20 | 4,360 |
| 1.80 | 304 | 3.50 | 930 | 5.20 | 1,870 | 8.40 | 4,590 |
| 1.90 | 332 | 3.60 | 980 | 5.40 | 2,000 | 8.60 | 4,840 |
| 2.00 | 360 | 3.70 | 1,030 | 5.60 | 2,130 | 8.80 | 5,110 |
| 2.10 | 392 | 3.80 | 1,080 | 5.80 | 2,260 | 9.00 | 5,380 |
| 2.20 | 424 | 3.90 | 1,130 | 6.00 | 2,390 | 9.50 | 6,120 |
| 2.30 | 456 | 4.00 | 1,180 | 6.20 | 2,540 | 10.00 | 7,010 |
| 2.40 | 488 | 4.10 | 1,230 | 6.40 | 2,690 | 10.50 | 8,000 |
| 2.50 | 520 | 4.20 | 1,290 | 6.60 | 2,840 | 11.00 | 9,000 |
| 2.60 | 558 | | | | | | |

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made from 1902 to 1904. It is fairly well defined between gage heights 1 foot and 5.5 feet. Above 5.5 the curve depends on ten scattered measurements at 10 feet approximately. Special corrections have been applied to discharge on account of temporary obstructions in the river. The table has been extended beyond these limits.

*Location of United States Weather Bureau flood stations on Grand River, Michigan, and elevations of stream bed, flood, and danger lines.*

[Compiled by C. F. Schneider, section director, United States Weather Bureau.]

| | Jackson. | Eaton Rapids. | Lansing. | Grand Ledge. | Portland. | Ionia. | Grand Rapids. | Grand Haven. |
|---|---|---|---|---|---|---|---|---|
| High water Mar. 26–27, 1904: | | | | | | | | |
| Above mean tide | (a) | 837.36 | 828.50 | 793.40 | 712.79 | 640.27 | 608.31 | (a) |
| Above gage zero | ..... | 9.20 | 19.45 | 14.01 | 14.44 | 27.55 | 20.45 | ..... |
| Danger line: | | | | | | | | |
| Above mean tide | ..... | 864.16 | 819.50 | 785.39 | 709.93 | 637.27 | 598.59 | ..... |
| Above gage zero | 5.00 | 6.50 | 10.85 | 6.50 | 11.58 | 24.55 | 10.73 | ..... |
| River bed and gage zero above mean tide | 920 | 858.16 | 809.05 | 779.39 | 698.35 | 612.72 | 587.86 | 564.36 |
| River fall (in feet) | 61.84 | 49.11 | 29.66 | 81.04 | 85.63 | 24.86 | 23.5 | ..... |
| River distance (miles) | 44.3 | 26.4 | 11.3 | 26.2 | 21.5 | 42.90 | 37.6 | ..... |

a No gage.

*Estimated monthly discharge of Grand River at North Lansing, Mich., for 1904.*

[Drainage area, 1,230 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January | 980 | 262 | 589 | 0.479 | 0.551 |
| February | 2,708 | 754 | 1,319 | 1.07 | 1.16 |
| March, 7 days | (a) | 942 | 3,747 | 3.05 | 1.92 |
| April, 26 days | (a) | 1,105 | 2,729 | 2.22 | 2.15 |
| May | 1,465 | 577 | 854 | .694 | .798 |
| June | 700 | 220 | 410 | .333 | .372 |
| July | 480 | 185 | 302 | .246 | .283 |
| August | 504 | 178 | 291 | .237 | .273 |
| September | 440 | 122 | 265 | .215 | .240 |
| October | 530 | 304 | 391 | .318 | .366 |
| November | 346 | 241 | 297 | .241 | .269 |
| December | 732 | 164 | 325 | .264 | .304 |

a Above limit of rating table.

## GRAND RIVER AT GRAND RAPIDS, MICH.

Grand River rises in northern Hillsdale County, in the vicinity of Bunday Hills. The headwaters of the Kalamazoo, St. Joseph, Raisin, and northern branches of Maumee River are in this same locality. Its principal tributaries are Flat, Maple, Lookingglass, and Cedar rivers from the north and Thornapple River from the south. Water power is extensively developed on the main stream and on certain of these tributaries. The drainage area is flat or moderately rolling, and comprises alternate areas of sand, loam, and clay. It is largely under cultivation, isolated timber areas remaining. Numerous small lakes and undrained hollows are located in the northwestern and southeastern parts of the drainage basin.

The station was established March 12, 1901, by L. W. Anderson, city engineer of Grand Rapids, Mich. The gage is attached to the upstream end of the ice breaker of the left bridge pier. The elevation of its zero is 0.55 foot below the city datum. All gage heights have been expressed as elevations above the city datum. Discharge measurements are made from the Fulton Street Bridge at which the gage is located. The channel is straight for several hundred feet above and below the bridge and is broken by three bridge piers. The gaging section is shallow and the bed is composed of cobblestones and gravel. The current is rapid and the velocity is poorly distributed at low stages.

The flood discharge of Grand River during March, 1904, exceeded all previous records, and the stage of the stream rose considerably above the limit of discharge measurements. An estimate of the discharge March 27, 1904, indicates that the flow was about 40,000 second-feet, or 8.2 feet per second per square mile from tributary drainage area of 4,900 square miles. The rating table for higher stages is subject to revision, having been estimated from a logarithmic formula based on data indicating somewhat higher discharge than would be obtained from the ordinary extension of the rating table.

The flood discharge of Flat River, tributary to Grand River, during the same flood, as estimated by Lyman E. Cooley, was 4,370 second-feet, or 7.15 second-feet per square mile from a tributary drainage basin of 610 square miles.[a]

During the year 1904 gages were erected by the United States Weather Bureau at various points along Grand River for use in predicting floods.[b]

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

*Discharge measurements of Grand River at Grand Rapids, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| May 31 | Horton and Covert | 2,095 | 2.05 | 2.05 | 4,288 |
| September 12 | H. R. Beebe | 673 | 2.28 | — .35 | 1,532 |

*Mean daily gage height, in feet, of Grand River at Grand Rapids, Mich., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 2.35 | 2.25 | 14.45 | ..... | 1.70 | 0.65 | −0.02 | −0.50 | 0.50 | 0.25 | −0.10 |
| 2 | 1.60 | 1.95 | 2.35 | 13.68 | 2.50 | 1.55 | .35 | — .08 | — .10 | ..... | .15 | — .15 |
| 3 | ..... | 2.10 | 2.80 | ..... | 2.30 | 1.40 | ..... | — .38 | — .08 | .10 | .20 | — .25 |
| 4 | 1.90 | 2.25 | 3.55 | 12.85 | 2.05 | 1.30 | ..... | — .48 | ..... | .32 | .10 | ..... |
| 5 | 1.60 | 2.15 | 4.50 | 12.08 | 1.92 | ..... | — .05 | — .50 | ..... | ..... | .10 | — .35 |
| 6 | 1.60 | 2.20 | ..... | 11.20 | 1.72 | 1.40 | .05 | — .32 | — .32 | 1.05 | ..... | — .25 |
| 7 | 1.55 | ..... | 6.25 | 10.50 | 1.55 | 1.15 | — .08 | ..... | — .35 | 1.15 | — .05 | — .20 |
| 8 | 1.25 | 2.88 | 7.40 | 9.55 | ..... | .95 | — .22 | — .40 | — .25 | 1.00 | .05 | — .20 |
| 9 | 1.40 | 3.38 | 8.25 | 9.40 | 1.45 | .80 | — .10 | — .65 | — .30 | ..... | .05 | — .15 |
| 10 | ..... | 3.98 | 9.28 | ..... | 1.55 | .65 | ..... | — .55 | — .40 | 1.00 | — .10 | — .15 |
| 11 | 1.45 | 4.35 | 10.95 | 8.70 | 1.40 | .40 | — .10 | — .48 | ..... | 1.38 | — .05 | ..... |
| 12 | 1.45 | 4.35 | 12.05 | 8.60 | 1.30 | ..... | .02 | — .65 | — .40 | 1.40 | — .10 | — .30 |
| 13 | 1.35 | 4.22 | ..... | 8.28 | 1.20 | .20 | .35 | — .65 | — .28 | 1.50 | ..... | — .20 |
| 14 | 1.40 | ..... | 12.40 | 7.85 | 1.15 | .28 | .25 | ..... | — .48 | 1.38 | — .10 | — .10 |

[a] Report of L. E. Cooley, C. E., on flood conditions of Grand River at Grand Rapids, Mich., 1904.
[b] See page 36 for list.

*Mean daily gage height, in feet, of Grand River at Grand Rapids, Mich., etc.*—Continued.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.30 | 3.80 | 12.15 | 7.32 | ..... | 0.15 | 0.30 | −0.55 | −0.45 | 1.32 | −0.08 | 0.00 |
| 16 | 1.30 | 3.70 | 11.70 | 6.82 | 1.05 | .15 | .20 | − .50 | − .50 | ..... | − .18 | − .10 |
| 17 | ..... | 3.55 | 11.30 | ..... | 1.05 | − .05 | ..... | − .50 | − .45 | .88 | − .20 | − .05 |
| 18 | 1.40 | 3.35 | 10.75 | 6.20 | .95 | − .15 | − .20 | − .55 | ..... | .95 | − .10 | ..... |
| 19 | 1.50 | 3.00 | 10.10 | 6.15 | 1.15 | ..... | − .18 | − .30 | − .52 | .70 | − .05 | − .05 |
| 20 | 1.45 | 2.80 | ..... | 6.15 | 1.55 | − .18 | − .30 | − .20 | − .25 | .55 | ..... | − .10 |
| 21 | 1.35 | ..... | 9.20 | 6.00 | 2.00 | − .35 | − .25 | ..... | − .30 | .65 | − .05 | − .05 |
| 22 | 1.45 | 2.60 | 9.30 | 5.68 | ..... | − .32 | − .30 | − .20 | − .38 | .80 | − .10 | − .10 |
| 23 | 1.60 | 2.55 | 10.68 | 5.25 | 5.00 | − .42 | − .40 | − .25 | − .25 | ..... | − .05 | − .02 |
| 24 | ..... | 2.45 | 11.45 | ..... | 5.30 | − .45 | ..... | .10 | − .15 | .52 | ..... | .10 |
| 25 | 2.30 | 2.45 | 15.10 | 4.65 | 4.55 | .00 | − .40 | .05 | ..... | .60 | − .12 | ..... |
| 26 | 2.25 | 2.45 | 18.10 | 4.38 | 3.85 | ..... | − .55 | − .10 | .65 | .45 | − .10 | ..... |
| 27 | 2.15 | 2.45 | 19.30 | 4.00 | 3.35 | .70 | − .52 | − .15 | .90 | .42 | ..... | .18 |
| 28 | 2.15 | ..... | 19.17 | 3.75 | 3.00 | .70 | − .40 | ..... | .75 | .40 | − .25 | .95 |
| 29 | 2.25 | 2.25 | 18.12 | 3.52 | ..... | .55 | − .50 | − .22 | 1.00 | .35 | − .15 | 1.25 |
| 30 | 2.25 | ..... | 16.75 | 3.15 | ..... | .65 | − .60 | − .45 | .65 | ..... | − .15 | 1.30 |
| 31 | ..... | ..... | 15.40 | ..... | 2.10 | ..... | ..... | − .55 | ..... | .10 | ..... | 1.05 |

NOTE.—River considered frozen greater portion of January, February, March, and December. Gage heights to water surface. Sunday or holiday, no record.

*Rating table for Grand River at Grand Rapids, Mich., 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.* |
| −0.90 | 730 | 1.00 | 3,205 | 2.90 | 5,885 | 6.60 | 11,770 |
| − .80 | 860 | 1.10 | 3,335 | 3.00 | 6,035 | 6.80 | 12,130 |
| − .70 | 980 | 1.20 | 3,470 | 3.20 | 6,325 | 7.00 | 12,490 |
| − .60 | 1,110 | 1.30 | 3,605 | 3.40 | 6,610 | 7.50 | 13,470 |
| − .50 | 1,245 | 1.40 | 3,745 | 3.60 | 6,910 | 8.00 | 14,390 |
| − .40 | 1,370 | 1.50 | 3,890 | 3.80 | 7,205 | 8.50 | 15,400 |
| − .30 | 1,495 | 1.60 | 4,030 | 4.00 | 7,505 | 9.00 | 16,425 |
| − .20 | 1,625 | 1.70 | 4,170 | 4.20 | 7,805 | 9.50 | 17,460 |
| − .10 | 1,755 | 1.80 | 4,310 | 4.40 | 8,105 | 10.00 | 18,495 |
| .00 | 1,885 | 1.90 | 4,450 | 4.60 | 8,410 | 10.50 | 19,530 |
| .10 | 2,015 | 2.00 | 4,590 | 4.80 | 8,720 | 11.00 | 20,565 |
| .20 | 2,140 | 2.10 | 4,730 | 5.00 | 9,025 | 11.50 | 21,600 |
| .30 | 2,265 | 2.20 | 4,870 | 5.20 | 9,335 | 12.00 | 22,635 |
| .40 | 2,405 | 2.30 | 5,010 | 5.40 | 9,670 | 12.50 | 23,670 |
| .50 | 2,545 | 2.40 | 5,155 | 5.60 | 10,015 | 13.00 | 24,705 |
| .60 | 2,675 | 2.50 | 5,305 | 5.80 | 10,350 | 13.50 | 25,740 |
| .70 | 2,810 | 2.60 | 5,450 | 6.00 | 10,685 | 14.00 | 26,775 |
| .80 | 2,945 | 2.70 | 5,595 | 6.20 | 11,015 | 15.00 | 28,895 |
| .90 | 3,075 | 2.80 | 5,740 | 6.40 | 11,380 | 16.00 | 31,090 |

*Estimated monthly discharge of Grand River at Grand Rapids, Mich., 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. |
| April, 26 days | 27,730 | 6,250 | 14,210 | 2.90 | 3.24 |
| May, 25 days | 9,490 | 3,140 | 4,907 | 1.00 | 1.15 |
| June, 26 days | 4,170 | 1,310 | 2,537 | .517 | .577 |
| July, 25 days | 2,740 | 1,110 | 1,732 | .353 | .407 |
| August, 27 days | 2,015 | 1,040 | 1,433 | .292 | .337 |
| September, 25 days | 3,205 | 1,210 | 1,748 | .356 | .397 |
| October, 25 days | 3,890 | 2,015 | 2,913 | .594 | .685 |
| November, 25 days | 2,200 | 1,560 | 1,821 | .372 | .415 |

NOTE.—Mean for number of days observed taken as mean for entire month. No estimate made for January, February, March, and December owing to ice conditions.

## RED CEDAR RIVER AT AGRICULTURAL COLLEGE, MICH.

This gaging station was established August 30, 1902. The gage is located at the highway bridge just below the Agricultural College grounds. The bridge has a single span of 75 feet between abutments. The bed is of sand and gravel, fairly smooth and permanent. The channel is straight for a distance of about 400 feet downstream from the gage. A short distance upstream is a low dam forming an ice pond, below which the stream does not ordinarily freeze over. In this stretch of the river is the railroad bridge of the college spur of the Pere Marquette Railroad, from which gagings are made at high water or when the stream is frozen across at the gaging station. Near this bridge low-water measurements are also made by wading. The gage is of the usual wire type, and is attached to the downstream guard rail of the bridge. The upstream corner of the right-hand wing wall of the bridge abutment is used as a bench mark, with an arbitrary elevation of 100 feet. The elevation of the datum plane of the gage is 85.45 feet. The gaging station is situated about 4 miles from the mouth of the stream. Sycamore Creek, an important tributary, enters in this section. The drainage area above the gaging station is 358 square miles, and from the gaging station to the mouth of the stream 114 square miles, making the total above Grand River 472 square miles. The flow is sluggish at low stage and the station is subject to backwater from Grand River. Gage readings at this station were discontinued December 31, 1903.

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

*Discharge measurements of Red Cedar River at Agricultural College, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Feet per sec.* | *Feet.* | *Second-feet.* |
| May 24 | C. C. Covert | 370 | 0.99 | 5.30 | 367 |
| September 8 | H. R. Beebe | 27 | .17 | 1.31 | 4.6 |

## MUSKEGON RIVER AT NEWAYGO, MICH.

The drainage basin of this stream lies immediately north of that of Grand River. Originally it was covered with pine timber, but now it is almost entirely cleared. Much of the soil is sand and gravel, unfit for profitable cultivation. Large stump-covered areas form a conspicuous feature of the topography. The drainage areas tributary to Muskegon River are given in the following table:

*Drainage areas of Muskegon River and tributary.*

| Stream. | Location. | Area. |
|---|---|---|
| | | *Sq. miles.* |
| Muskegon River | Above Clam River | 787 |
| Clam River | Above mouth | 307 |
| Muskegon River | Below Clam River | 1,094 |
| Muskegon River | Above Big Rapids | 1,764 |
| Muskegon River | Above Newaygo | 2,352 |
| Muskegon River | Above mouth | 2,663 |

In March, 1901, a station was established at the dam of the Newaygo Portland Cement Company. This dam crosses Muskegon River in a deep valley above the village of Newaygo. It is of timber, having framed cribs filled with stone. It is provided with a main spillway, with log ways, and with four flood ways. The flood ways are provided with Taintor segmental flood gates, which are operated by a traveling crab. A record is kept of the time and amount of opening of the flood gates and log ways, as well as the depth of water on the crests of the spillways. Ordinarily the flood gates and log ways are closed, and the entire flow passes over the main spillway or through the turbines. Water is carried from the pond to the power house by a short headrace separated from the stream channel by a crib breakwater.

The power house contained originally two turbine units. The number has recently been increased to four units. Each unit comprises four 35-inch Leffel-Samson turbine runners mounted on a horizontal shaft, and connected to the electrical generator by endless rope drives.

Each turbine unit is controlled by a Lombard governor and the gaging record includes a statement of the number of hours per day each unit is operated, together with the average gate opening. Beginning August, 1904, hourly readings of the governors have been taken. The wheels are ordinarily operated continuously twenty-four hours per day.

From the vicinity of Evart to Newaygo, Muskegon River flows between high banks and has a rapid fall. Levels which have been run for this purpose show that within a distance of 10 miles, 5 miles each way from Big Rapids, there is a total fall of 104 feet. Of this 16 feet is now utilized, leaving an available fall of 88 feet. There are favorable sites for the location of dams, so that practically the entire fall could be economically developed.

In connection with power development, good opportunities exist for the conservation of flow by artificial storage. The water-surface areas of the principal lakes of the watershed and of the tributary drainage which they control is given below:

*Drainage and surface areas of lakes in Muskegon River watershed.*

| Lake. | Drainage area. | Water surface. |
|---|---|---|
| | *Sq. miles.* | *Sq. miles.* |
| Muskrat Lake and group | 57 | 8.0 |
| Clam Lakes | 67 | 6.7 |
| Higgins Lake | 67 | 15.0 |
| Houghton Lake (not including Higgins Lake) | 185 | 31.0 |
| Higgins and Houghton lakes | 252 | 46.0 |

In the upper portion of the watershed there is a total lake area of about 110 square miles. Formerly a lumberman's dam was maintained for the purpose of flooding logs between Houghton and Higgins lakes, but this has been washed out. A lumberman's dam, built of logs and earth, which still remains about 1 mile below the foot of Houghton Lake, raises the water level in that lake 4 feet, providing a storage of, in round numbers, 3,350,000,000 cubic feet.

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

*Mean daily discharge, in second-feet, of Muskegon River at Newaygo, Mich., 1901–1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1901. | | | | | | | | | | | | |
| 1 | | | | | | 1,219 | 987 | 767 | 900 | 727 | 813 | 967 |
| 2 | | | | | | 1,141 | 1,043 | 741 | 1,115 | 971 | 793 | 967 |
| 3 | | | | | | 1,160 | 1,220 | 685 | 1,082 | 936 | 913 | 1,007 |
| 4 | | | | | | 1,196 | 1,380 | 722 | 1,002 | 837 | 957 | 1,014 |
| 5 | | | | | | 1,060 | 1,389 | 577 | 922 | 797 | 825 | 932 |
| 6 | | | | | | 1,062 | 1,243 | 693 | 991 | 877 | 882 | 932 |
| 7 | | | | | | 1,114 | 1,169 | 673 | 1,002 | 892 | 762 | 932 |
| 8 | | | | | | 1,180 | 1,153 | 680 | 1,082 | 972 | 797 | 852 |
| 9 | | | | | | 1,042 | 1,084 | 717 | 1,059 | 932 | 823 | 986 |
| 10 | | | | | | 1,072 | 1,206 | 845 | 941 | 846 | 861 | 986 |
| 11 | | | | | | 1,072 | 1,107 | 558 | 698 | 1,142 | 661 | 813 |
| 12 | | | | | | 1,305 | 989 | 507 | 584 | 966 | 794 | 799 |
| 13 | | | | | | 1,161 | 1,098 | 536 | 812 | 1,039 | 905 | 762 |
| 14 | | | | | | 1,161 | 1,041 | 568 | 786 | 1,639 | 948 | 897 |
| 15 | | | | | | 1,139 | 910 | 1,262 | 696 | 1,684 | 828 | 743 |
| 16 | | | | | | 1,029 | 895 | 1,199 | 866 | 1,674 | 1,018 | 703 |
| 17 | | | | | | 1,063 | 900 | 1,108 | 1,001 | 1,794 | 1,098 | 703 |
| 18 | | | | | | 1,047 | 1,051 | 1,108 | 806 | 1,634 | 798 | 760 |
| 19 | | | | | | 1,047 | 609 | 1,180 | 729 | 1,672 | 967 | 842 |
| 20 | | | | | | 1,053 | 695 | 1,160 | 736 | 1,679 | 1,083 | 882 |
| 21 | | | | | | 1,053 | 899 | 1,280 | 1,018 | 1,794 | 967 | 833 |
| 22 | | | | | | 994 | 972 | 1,180 | 921 | 1,538 | 955 | 845 |
| 23 | | | | | | 1,001 | 930 | 1,247 | 856 | 1,597 | 1,023 | 986 |
| 24 | | | | | | 1,016 | 1,010 | 1,304 | 926 | 1,063 | 1,043 | 972 |
| 25 | | | | | | 1,102 | 1,067 | 1,342 | 767 | 1,043 | 960 | 1,000 |
| 26 | | | | | | 933 | 1,128 | 1,069 | 798 | 916 | 873 | 957 |
| 27 | | | | | | 978 | 1,110 | 1,096 | 856 | 1,043 | 957 | 1,051 |
| 28 | | | | | | 903 | 1,088 | 1,057 | 856 | 1,098 | 902 | 1,000 |
| 29 | | | | | | 980 | 1,185 | 1,136 | 961 | 852 | 861 | 1,040 |
| 30 | | | | | | 893 | 1,255 | 1,067 | 826 | 908 | 865 | 852 |
| 31 | | | | | | | 1,170 | 1,031 | | [a]860 | | 986 |
| 1902. | | | | | | | | | | | | |
| 1 | 678 | 732 | 783 | 2,012 | 2,026 | 1,960 | 1,578 | 1,212 | 908 | 1,561 | 2,214 | 873 |
| 2 | 743 | 772 | 812 | 2,695 | 1,711 | 1,964 | 1,618 | 1,248 | 925 | 1,635 | 2,214 | 873 |
| 3 | 663 | 772 | 783 | 2,982 | 1,904 | 2,420 | 1,561 | 1,248 | 901 | 1,635 | 2,214 | 873 |
| 4 | 743 | 812 | 824 | 3,033 | 6,058 | 2,239 | 1,391 | 1,178 | 821 | 1,560 | 2,214 | 757 |
| 5 | 663 | 812 | 967 | 2,747 | 6,196 | 1,958 | 1,547 | 1,203 | 909 | 1,560 | 2,114 | 757 |
| 6 | 703 | 692 | 972 | 2,715 | 6,266 | 2,075 | 1,387 | 1,055 | 958 | 1,620 | 2,140 | 757 |
| 7 | 663 | 692 | 1,026 | 2,649 | 6,248 | 2,075 | 1,312 | 1,033 | 943 | 1,694 | 1,980 | 757 |
| 8 | 663 | 732 | 986 | 2,668 | 5,948 | 2,075 | 1,332 | 1,073 | 979 | 1,562 | 1,980 | 757 |
| 9 | 743 | 692 | 932 | 2,427 | 4,258 | 1,800 | 1,332 | 1,073 | 1,100 | 1,724 | 1,308 | 757 |
| 10 | 743 | 812 | 839 | 2,515 | 4,655 | 1,794 | 1,372 | 1,025 | 1,100 | 1,604 | 1,308 | 812 |
| 11 | 743 | 852 | 880 | 2,471 | 4,143 | 1,839 | 1,540 | 1,076 | 1,100 | 1,568 | 1,122 | 813 |
| 12 | 703 | 988 | 1,834 | 2,515 | 4,099 | 1,839 | 1,403 | 1,076 | 1,067 | 1,568 | 1,122 | 873 |
| 13 | 703 | 852 | 1,942 | 2,716 | 3,319 | 1,759 | 1,523 | 1,104 | 1,155 | 1,547 | 1,122 | 873 |
| 14 | 703 | 852 | 2,191 | 2,844 | 3,097 | 1,811 | 1,580 | 1,118 | 1,075 | 2,033 | 1,122 | 932 |
| 15 | 743 | 852 | 2,195 | 2,844 | 2,920 | 1,804 | 1,539 | 1,118 | 1,118 | 2,007 | 943 | 1,000 |
| 16 | 743 | 732 | 2,235 | 2,759 | 2,802 | 1,799 | 1,619 | 1,010 | 1,173 | 1,644 | 943 | 1,000 |
| 17 | 733 | 732 | 2,106 | 2,749 | 2,573 | 1,754 | 1,601 | 1,010 | 1,166 | 1,644 | 943 | 2,189 |
| 18 | 783 | 652 | 1,829 | 2,614 | 2,177 | 1,754 | 1,641 | 1,010 | 1,230 | 1,680 | 980 | 2,189 |
| 19 | 783 | 732 | 1,838 | 1,650 | 2,239 | 1,674 | 1,540 | 1,064 | 1,188 | 1,482 | 1,053 | 2,189 |

[a] Interpolated.

*Mean daily discharge, in second-feet, of Muskegon River at Newaygo, Mich., etc.*—Cont'd.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1902. | | | | | | | | | | | | |
| 20 | 703 | 732 | 1,306 | 1,746 | 2,135 | 1,754 | 1,452 | 965 | 1,173 | 1,751 | 1,128 | 2,281 |
| 21 | 703 | 732 | 1,312 | 1,835 | 2,035 | 1,794 | 1,462 | 1,045 | 1,084 | 1,491 | 1,216 | 2,395 |
| 22 | 703 | 812 | 1,289 | 1,804 | 2,055 | 1,638 | 1,422 | 1,045 | 1,088 | 1,431 | 1,288 | 2,509 |
| 23 | 743 | 772 | 1,338 | 1,754 | 1,987 | 1,618 | 1,462 | 1,036 | 1,065 | 1,431 | 1,068 | 2,281 |
| 24 | 823 | 772 | 1,209 | 1,666 | 2,244 | 1,557 | 1,484 | 1,072 | 1,063 | 1,431 | 1,068 | 2,130 |
| 25 | 743 | 812 | 1,172 | 1,884 | 2,069 | 1,523 | 1,484 | 996 | 1,063 | 1,470 | 1,068 | 1,260 |
| 26 | 823 | 772 | 1,192 | 2,565 | 2,219 | 1,618 | 1,444 | 1,124 | 1,083 | 1,350 | 873 | 1,288 |
| 27 | 623 | 732 | 1,205 | 2,655 | 2,018 | 1,618 | 1,477 | 1,193 | 1,372 | 1,390 | 788 | 783 |
| 28 | 663 | 732 | 1,319 | 2,475 | 2,078 | 1,701 | 1,531 | 1,145 | 1,204 | 1,390 | 873 | 783 |
| 29 | 703 | ..... | 1,186 | 2,387 | 2,018 | 1,539 | 1,531 | 1,118 | 1,135 | 1,390 | 873 | 1,323 |
| 30 | 703 | ..... | 1,695 | 2,535 | 2,086 | 1,580 | 1,596 | 1,110 | 1,195 | 1,510 | 873 | 1,323 |
| 31 | 663 | ..... | 1,577 | ..... | 2,026 | ..... | 1,676 | 1,158 | ..... | 1,380 | ..... | 1,323 |
| 1903. | | | | | | | | | | | | |
| 1 | ..... | 2,015 | 1,215 | 2,066 | 2,498 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 2 | ..... | 2,253 | 1,155 | 2,110 | 2,772 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3 | ..... | 2,020 | 1,335 | 2,344 | 2,498 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 4 | ..... | 1,889 | 1,500 | 3,344 | 2,434 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 5 | ..... | 1,695 | 1,688 | 5,006 | 2,314 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 6 | ..... | 2,135 | 1,665 | 3,969 | 2,314 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 7 | ..... | 1,960 | 2,503 | 4,255 | 2,171 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 8 | ..... | 1,852 | 3,517 | 2,946 | 2,220 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 9 | ..... | 1,829 | 4,159 | 3,005 | 2,220 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 10 | ..... | 2,300 | 4,390 | 3,071 | 2,220 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 11 | ..... | 2,343 | 4,528 | 2,886 | 2,160 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 12 | ..... | 2,343 | 4,259 | 2,886 | 2,139 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 13 | ..... | 2,214 | 4,223 | 2,886 | 2,139 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 14 | ..... | 1,970 | 4,280 | 2,945 | 2,079 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 15 | ..... | 1,932 | 4,962 | 5,055 | 2,019 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 16 | ..... | 1,851 | 4,926 | 5,116 | 1,914 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 17 | ..... | 592 | 4,500 | 4,768 | 1,914 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 18 | ..... | 847 | 4,311 | 4,798 | 2,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 19 | ..... | 847 | 4,301 | 4,570 | 2,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 20 | ..... | 860 | 4,232 | 3,049 | 2,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 21 | ..... | 933 | 4,503 | 3,108 | 1,672 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 22 | ..... | 1,082 | 4,267 | 3,139 | 1,794 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 23 | ..... | 1,147 | 4,393 | 2,640 | 2,032 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 24 | ..... | 1,128 | 4,267 | 2,780 | 1,912 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 25 | ..... | 1,060 | 4,252 | 2,780 | 1,914 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 26 | ..... | 1,027 | 4,536 | 2,351 | 2,365 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 27 | ..... | 967 | 4,267 | 2,411 | 2,245 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 28 | ..... | 1,120 | 4,418 | 2,286 | 2,365 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 29 | ..... | ..... | 4,219 | 2,318 | 2,129 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 30 | ..... | ..... | 4,159 | 2,436 | 2,189 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 31 | ..... | ..... | 4,207 | ..... | 2,093 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1904. | | | | | | | | | | | | |
| 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1,593 | 674 | 947 | 1,098 | 807 |
| 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1,286 | 662 | 1,078 | 992 | 868 |
| 3 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1,276 | 582 | 970 | 982 | 769 |
| 4 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1,204 | 582 | 983 | 944 | 849 |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1,234 | 546 | 1,090 | 954 | 1,049 |

*Mean daily discharge, in second-feet, of Muskegon River at Newaygo, Mich., etc.*—Cont'd.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | | | | | |
| 6 | | | | | | | | 1,026 | 690 | 898 | 993 | 1,013 |
| 7 | | | | | | | | 1,042 | 702 | 910 | 1,044 | 853 |
| 8 | | | | | | | | 1,078 | 630 | 946 | 1,028 | 969 |
| 9 | | | | | | | | 1,050 | 618 | 1,060 | 846 | 1,051 |
| 10 | | | | | | | | 1,024 | 678 | 1,040 | 989 | 923 |
| 11 | | | | | | | | 1,092 | 856 | 1,374 | 1,004 | 708 |
| 12 | | | | | | | | 1,077 | 820 | 1,489 | 876 | 799 |
| 13 | | | | | | | | 1,065 | 748 | 1,268 | 862 | 724 |
| 14 | | | | | | | | 1,053 | 789 | 1,088 | 1,031 | 934 |
| 15 | | | | | | | | 993 | 885 | 1,160 | 964 | 904 |
| 16 | | | | | | | | 1,017 | 850 | 943 | 1,160 | 1,006 |
| 17 | | | | | | | | 1,050 | 844 | 1,015 | 1,052 | 1,065 |
| 18 | | | | | | | | 1,051 | 796 | 955 | 1,087 | 836 |
| 19 | | | | | | | | 1,001 | 798 | 983 | 1,004 | 800 |
| 20 | | | | | | | | 1,077 | 922 | 971 | 1,030 | 908 |
| 21 | | | | | | | | 1,113 | 820 | 1,096 | 992 | 980 |
| 22 | | | | | | | | 1,126 | 937 | 1,181 | 1,063 | 1,076 |
| 23 | | | | | | | | 1,051 | 869 | 1,030 | 1,054 | 967 |
| 24 | | | | | | | | 1,086 | 892 | 1,004 | 1,054 | 898 |
| 25 | | | | | | | | 913 | 802 | 1,175 | 1,090 | 897 |
| 26 | | | | | | | | 991 | 706 | 1,067 | 1,142 | 956 |
| 27 | | | | | | | | 979 | 668 | 1,054 | 909 | 789 |
| 28 | | | | | | | | 932 | 1,122 | 957 | 887 | 968 |
| 29 | | | | | | | | 932 | 940 | 1,172 | 922 | 1,079 |
| 30 | | | | | | | | 954 | 925 | 906 | 724 | 1,134 |
| 31 | | | | | | | | 933 | | 1,090 | | 943 |

*Estimated monthly discharge of Muskegon River at Newaygo, Mich., 1901–1904.*

[Drainage area, 2,352 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| 1901. | | | | | |
| June | 1,305 | 893 | 1,073 | 0.456 | 0.509 |
| July | 1,389 | 609 | 1,064 | .452 | .521 |
| August | 1,342 | 507 | 939 | .399 | .460 |
| September | 1,115 | 584 | 886 | .377 | .421 |
| October | 1,794 | 727 | 1,175 | .500 | .576 |
| November | 1,098 | 661 | 898 | .382 | .426 |
| December | 1,051 | 703 | 904 | .384 | .443 |

*Estimated monthly discharge of Muskegon River at Newaygo, Mich., 1901–1904*—Continued.

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| 1902. | | | | | |
| January | 823 | 623 | 717 | 0.305 | 0.352 |
| February | 988 | 652 | 773 | .329 | .343 |
| March | 2,235 | 783 | 1,348 | .573 | .661 |
| April | 3,033 | 1,650 | 2,430 | 1.03 | 1.15 |
| May | 6,266 | 1,711 | 3,149 | 1.34 | 1.54 |
| June | 2,420 | 1,523 | 1,809 | .769 | .858 |
| July | 1,676 | 1,312 | 1,498 | .637 | .734 |
| August | 1,248 | 965 | 1,095 | .466 | .537 |
| September | 1,372 | 821 | 1,078 | .458 | .511 |
| October | 2,033 | 1,350 | 1,572 | .668 | .770 |
| November | 2,214 | 788 | 1,338 | .569 | .635 |
| December | 2,509 | 757 | 1,281 | .545 | .628 |
| The year | 6,266 | 623 | 1,507 | .641 | 8.72 |
| 1903. | | | | | |
| February | 2,343 | 592 | 1,579 | .671 | .699 |
| March | 4,962 | 1,155 | 3,715 | 1.58 | 1.82 |
| April | 5,116 | 2,066 | 3,244 | 1.38 | 1.54 |
| May | 2,772 | 1,672 | 2,153 | .915 | 1.05 |
| 1904. | | | | | |
| August | 1,593 | 913 | 1,075 | .457 | .527 |
| September | 1,122 | 546 | 778 | .331 | .369 |
| October | 1,489 | 898 | 1,061 | .451 | .520 |
| November | 1,160 | 724 | 993 | .422 | .471 |
| December | 1,134 | 708 | 920 | .391 | .451 |

## MANISTEE RIVER NEAR SHERMAN, MICH.

Manistee River is the most northerly of the group of large rivers draining central Michigan and flowing westerly into Lake Michigan. The fall of the stream is very gradual, and no important utilization of water power has been made, the principal use of the stream being for rafting logs. Manistee, at the mouth of the river, affording an excellent harbor, is an important lumber center. The drainage basin is sandy and the stream receives a very large portion of its supply from ground storage through springs along the river bank and along the tributaries.

A chain gage was established at North Bridge, near Sherman, July 10, 1903. The stage of the stream is observed twice each day by Lincoln Jewell. Current-meter discharge measurements are made at the bridge, which consists of a single span; the stream bed is of clay and sand and has some logs in it, as is frequently the case with rivers used for lumbering. It also becomes frozen over in the winter, so that the relation between the gage height and discharge is modified for that season.

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

*Discharge measurements of Manistee River near Sherman, Mich., in 1903 and 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1903. | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| July 4 | W. M. Gregory | 344 | 2.64 | ..... | 935 |
| July 10 | do | 368 | 2.79 | [a] 2.45 | 1,043 |
| July 24 | Horton and Gregory | 354 | 2.96 | [a] 2.49 | 1,050 |
| July 24 | W. M. Gregory | 358 | 2.97 | [a] 2.55 | 1,060 |
| August 26 | do | 347 | 2.86 | [a] 2.30 | 994 |
| 1904. | | | | | |
| June 2 | C. C. Covert | 538 | 2.82 | 3.62 | 1,514 |
| September 13 | H. R. Beebe | 335 | 2.77 | 2.05 | 921 |
| September 16 | do | 359 | 2.70 | 2.06 | 907 |
| September 16 | do | 359 | 2.72 | 2.05 | 912 |
| December 14 | C. C. Covert | 362 | 2.38 | 1.76 | 860 |

[a] Superseding gage heights as given in the 1903 report.

*Corrected mean daily gage height,[a] in feet, of Manistee River near Sherman, Mich., for 1903 and 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | | | | | |
| 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2.50 | 3.00 | 2.58 | 2.46 | 2.39 |
| 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2.35 | 2.90 | 2.68 | 2.46 | 2.24 |
| 3 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2.45 | 2.80 | 2.68 | 2.46 | 2.24 |
| 4 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3.40 | 2.80 | 2.88 | 2.46 | 2.44 |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 4.25 | 2.70 | 2.78 | 2.46 | 2.44 |
| 6 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 4.25 | 2.70 | 2.78 | 2.46 | 2.44 |
| 7 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3.90 | 2.70 | 2.78 | 2.46 | 2.44 |
| 8 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3.60 | 2.80 | 2.78 | 2.56 | 2.44 |
| 9 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3.30 | 2.85 | 2.88 | 2.76 | 2.44 |
| 10 | ..... | ..... | ..... | ..... | ..... | ..... | 2.55 | 3.05 | 3.05 | 2.78 | 2.71 | 2.54 |
| 11 | ..... | ..... | ..... | ..... | ..... | ..... | 2.45 | 3.00 | 3.10 | 2.78 | 2.56 | 2.39 |
| 12 | ..... | ..... | ..... | ..... | ..... | ..... | 2.40 | 3.00 | 3.10 | 2.78 | 2.96 | 2.24 |
| 13 | ..... | ..... | ..... | ..... | ..... | ..... | 2.35 | 3.10 | 3.00 | 2.68 | 2.96 | 3.64 |

[a] Superseding gage heights as given in the 1903 report.

*Corrected mean daily gage height, in feet, of Manistee River, etc.*—Continued.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | | | | | |
| 14 | ..... | ..... | ..... | ..... | ..... | ..... | 2.35 | 3.05 | 3.10 | 2.58 | 2.96 | 3.39 |
| 15 | ..... | ..... | ..... | ..... | ..... | ..... | 2.35 | 2.95 | 3.10 | 2.58 | 2.96 | 3.29 |
| 16 | ..... | ..... | ..... | ..... | ..... | ..... | 2.35 | 2.85 | 3.20 | 2.63 | 2.86 | 3.24 |
| 17 | ..... | ..... | ..... | ..... | ..... | ..... | 2.35 | 2.80 | 3.20 | 2.88 | 2.86 | 3.24 |
| 18 | ..... | ..... | ..... | ..... | ..... | ..... | 2.25 | 2.65 | 3.20 | 3.18 | 2.86 | 3.14 |
| 19 | ..... | ..... | ..... | ..... | ..... | ..... | 2.15 | 2.45 | 3.10 | 3.18 | 2.76 | 3.14 |
| 20 | ..... | ..... | ..... | ..... | ..... | ..... | 2.15 | 2.45 | 3.05 | 3.03 | 2.61 | 2.79 |
| 21 | ..... | ..... | ..... | ..... | ..... | ..... | 2.35 | 2.35 | 2.90 | 2.93 | 2.56 | 2.64 |
| 22 | ..... | ..... | ..... | ..... | ..... | ..... | 2.60 | 2.35 | 2.80 | 2.78 | 2.56 | 2.54 |
| 23 | ..... | ..... | ..... | ..... | ..... | ..... | 2.65 | 2.25 | 2.75 | 2.68 | 2.66 | 2.54 |
| 24 | ..... | ..... | ..... | ..... | ..... | ..... | 2.50 | 2.25 | 2.70 | 2.68 | 2.61 | 2.54 |
| 25 | ..... | ..... | ..... | ..... | ..... | ..... | 2.55 | 2.32 | 2.60 | 2.58 | 2.51 | 2.44 |
| 26 | ..... | ..... | ..... | ..... | ..... | ..... | 2.50 | 2.30 | 2.55 | 2.58 | 2.41 | 2.54 |
| 27 | ..... | ..... | ..... | ..... | ..... | ..... | 2.45 | 2.30 | 2.60 | 2.58 | 2.36 | 4.54 |
| 28 | ..... | ..... | ..... | ..... | ..... | ..... | 2.50 | 2.35 | 2.60 | 2.48 | 2.31 | 3.79 |
| 29 | ..... | ..... | ..... | ..... | ..... | ..... | 2.80 | 2.60 | 2.60 | 2.48 | 2.36 | 3.74 |
| 30 | ..... | ..... | ..... | ..... | ..... | ..... | 2.75 | 2.90 | 2.60 | 2.48 | 2.41 | 3.69 |
| 31 | ..... | ..... | ..... | ..... | ..... | ..... | 2.60 | 2.95 | ..... | 2.48 | ..... | 3.54 |
| 1904. | | | | | | | | | | | | |
| 1 | 3.52 | 2.40 | 2.58 | 4.31 | 4.84 | 3.82 | 2.50 | 2.38 | 1.97 | 2.25 | 2.35 | 2.15 |
| 2 | 3.52 | 2.40 | 2.58 | 4.41 | 4.69 | 3.72 | 2.50 | 2.38 | 2.17 | 2.25 | 2.25 | 2.05 |
| 3 | 3.07 | 2.40 | 2.58 | 4.36 | 4.54 | 3.47 | 2.50 | 2.38 | 2.22 | 2.20 | 2.25 | 1.95 |
| 4 | 2.92 | 2.40 | 2.38 | 4.21 | 4.34 | 3.42 | 2.50 | 2.28 | 2.27 | 2.25 | 2.25 | 1.95 |
| 5 | 2.92 | 2.40 | 2.53 | 4.21 | 4.19 | 3.42 | 2.50 | 2.23 | 2.17 | 2.30 | 2.15 | 1.90 |
| 6 | 2.92 | 2.50 | 2.48 | 4.41 | 3.99 | 3.42 | 2.50 | 2.33 | 2.07 | 2.25 | 2.15 | 1.95 |
| 7 | 2.92 | 2.50 | 2.43 | 4.66 | 3.89 | 3.42 | 2.50 | 2.38 | 2.07 | 2.25 | 2.15 | 2.00 |
| 8 | 2.92 | 2.40 | 2.48 | 5.11 | 3.84 | 3.42 | 2.40 | 2.33 | 2.07 | 2.40 | 2.15 | 2.05 |
| 9 | 2.82 | 2.30 | 2.53 | 5.49 | 4.09 | 3.32 | 2.40 | 2.38 | 2.07 | 2.45 | 2.15 | 2.00 |
| 10 | 2.82 | 2.25 | 2.43 | 6.19 | 4.44 | 3.17 | 2.40 | 2.43 | 2.07 | 2.55 | 2.15 | 1.95 |
| 11 | 2.67 | 2.30 | 2.38 | 6.19 | 4.44 | 3.02 | 2.40 | 2.48 | 2.07 | 2.60 | 2.15 | 2.00 |
| 12 | 2.62 | 2.30 | 2.38 | 6.13 | 4.54 | 3.02 | 2.40 | 2.38 | 1.97 | 2.65 | 2.15 | 2.05 |
| 13 | 2.62 | 2.25 | 2.38 | 5.61 | 4.44 | 2.92 | 2.40 | 2.43 | 2.02 | 2.75 | 2.35 | 1.90 |
| 14 | 2.62 | 2.30 | 2.18 | 5.21 | 4.19 | 2.92 | 2.40 | 2.48 | 2.05 | 2.65 | 2.40 | 1.78 |
| 15 | 2.62 | 2.20 | 2.23 | 4.86 | 3.99 | 2.92 | 2.80 | 2.58 | 2.00 | 2.55 | 2.25 | 1.95 |
| 16 | 2.62 | 2.15 | 2.28 | 4.46 | 3.79 | 2.92 | 2.85 | 2.63 | 1.95 | 2.55 | 2.15 | 2.30 |
| 17 | 2.42 | 2.20 | 2.28 | 4.36 | 3.69 | 2.82 | 2.80 | 2.53 | 1.95 | 2.45 | 2.15 | 2.00 |
| 18 | 2.02 | 2.25 | 2.28 | 4.31 | 3.64 | 2.72 | 2.70 | 2.48 | 2.15 | 2.35 | 2.15 | 2.05 |
| 19 | 1.97 | 2.35 | 2.28 | 4.71 | 3.54 | 2.62 | 2.60 | 2.43 | 2.25 | 2.25 | 2.15 | 2.10 |
| 20 | 2.37 | 2.35 | 2.23 | 4.36 | 3.64 | 2.62 | 2.45 | 2.38 | 2.25 | 2.25 | 2.15 | 2.20 |
| 21 | 2.47 | 2.40 | 2.28 | 4.26 | 3.64 | 2.57 | 2.35 | 2.38 | 2.15 | 2.25 | 2.05 | 2.10 |
| 22 | 2.62 | 2.30 | 2.28 | 4.11 | 3.69 | 2.52 | 2.30 | 2.38 | 2.05 | 2.25 | 2.05 | 2.10 |
| 23 | 2.62 | 2.35 | 2.38 | 4.11 | 3.74 | 2.52 | 2.30 | 2.23 | 2.05 | 2.25 | 1.95 | 2.25 |
| 24 | 2.37 | 2.40 | 2.48 | 4.41 | 3.64 | 2.57 | 2.30 | 2.33 | 2.30 | 2.35 | 1.95 | 2.35 |
| 25 | 1.87 | 2.45 | 2.73 | 4.91 | 4.24 | 2.52 | 2.30 | 2.38 | 2.45 | 2.35 | 2.00 | 2.30 |
| 26 | 2.07 | 2.35 | 3.68 | 5.46 | 4.44 | 2.52 | 2.35 | (a) | 2.35 | 2.35 | 1.95 | 2.25 |
| 27 | 2.27 | 2.40 | 3.38 | 5.61 | 4.44 | 2.52 | 2.40 | (a) | 2.55 | 2.35 | 1.95 | 2.30 |
| 28 | 2.32 | 2.50 | 3.08 | 5.56 | 4.59 | 2.47 | 2.40 | 2.08 | 2.55 | 2.35 | 1.80 | 2.20 |
| 29 | 2.47 | 2.50 | 3.08 | 5.21 | 4.49 | 2.52 | 2.40 | 2.03 | 2.45 | 2.35 | 1.90 | 1.85 |
| 30 | 2.42 | ..... | 3.18 | 4.96 | 4.29 | 2.52 | 2.40 | 1.98 | 2.35 | 2.35 | 2.15 | 2.20 |
| 31 | 2.42 | ..... | 3.78 | ..... | 4.04 | ..... | 2.40 | 1.98 | ..... | 2.30 | ..... | 2.20 |

(a) Log jam.

### BOARDMAN RIVER AT TRAVERSE CITY, MICH.

A gage was erected on Boardman River at Upper Union Street Bridge July 14, 1903, and the stream stage was observed twice daily by D. McLachlan. The record was furnished by Traverse City. Boardman River drains a generally level sand-covered area tributary to Lake Michigan through Grand Traverse Bay. The upper drainage basin is 10 miles in breadth, tributaries are few, and there are a small number of undrained lakes and ponds. Near the mouth the drainage area becomes much narrower and the fall is rapid, water power being utilized to some extent. Boardman Lake lies above Traverse City, at an elevation of about 25 feet above Lake Michigan. The outlet of the lake makes an abrupt bend and flows parallel with the water front of Traverse Bay for one-half mile above its outlet. A dam furnishes power for a flour mill, drawing its water supply from Boardman Lake. In order to avoid, as far as possible, backwater from Traverse Bay the gage was placed near the foot of the dam. The discharge measurements have been made by current meter at the Park Place Bridge near the mouth of the river.

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

*Discharge measurements of Boardman River at Traverse City, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height.[a] | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| June 2 | R. E. Horton | 282 | 1.36 | 9.65 | 382 |
| June 2 | do | 281 | 1.30 | 9.67 | 364 |
| September 14 | H. R. Beebe | 334 | 1.14 | 9.35 | 380 |
| September 14 | do | 334 | 1.03 | 9.44 | 344 |
| September 15 | do | 321 | 1.24 | [b]9.54 | 398 |

[a] Distance to water surface from reference point, Park Place Bridge.
[b] Gage height approximate.

## LAKE HURON DRAINAGE BASIN.

South of Saginaw Bay the Lake Huron slope is very narrow and is drained by brooks and runnels a few miles in length. The so-called Thumb of the Mitten is drained by three streams which flow northwest, known as the Willow, Pinnepog, and Pigeon, lying in a flat, marshy region.

The drainage surrounding Saginaw Bay is included in the Saginaw River system.

Northward from Saginaw Bay are Rifle, Au Sable, and Thunder Bay rivers, streams having considerable fall, excellent ground storage in

sand areas, and well-sustained flow. The rainfall is less than on the western or Lake Michigan slope of the State.

Cheboygan River also belongs in the Lake Huron drainage.

The following pages give the results of data collected during 1904 in Lake Huron drainage basin:

### THUNDER BAY RIVER NEAR ALPENA, MICH.

Thunder Bay River is tributary to Lake Huron at Alpena, Mich. The drainage basin is largely underlain by fissured limestone, more or less overlain with sand, and covered with dwarfed timber. The original pine forest has been largely lumbered. The drainage basin contains numerous small lakes in the region of the headwaters; it also contains Hubbard Lake, having a water surface of 13.4 square miles. The regimen of the stream is comparatively steady, but is more or less influenced by the operation of lumbermen's dams.

A gaging station was established at the dam of the Fletcher Paper Company, 4 miles above Alpena, April 4, 1901. The run-off for years preceding 1904 will be found in Water-Supply Paper No. 83, pages 289–293, and Water-Supply Paper No. 97, pages 436–438. The record includes two readings each day of the depth on the crest gage, located 75 feet upstream from the head-gates, opposite the left end of the dam. The dam is of timber, practically water-tight, and is usually surmounted by flashboards. It contains, in addition to three spillways, sections of lengths 90, 105, and 181.5, and a log slide 40 feet in width. The crest of the dam was originally level, but settlement of the middle section has made it necessary to subdivide the spillways into several short sections, each assumed level at its average elevation, for purposes of calculation. The discharge over the main dam has been computed by the weir formula, using coefficients derived from Cornell University experiment No. 13 of the United States Deep Waterways Board, for a dam of similar cross section. Discharge over flashboard sections has been calculated by means of the Francis formula. There is also a subsidiary logway and a headrace overflow, the latter 3 feet in width, the flow through which has been computed by suitable formulas. The adjoining pulp and paper mill has 14 pairs of 26-inch Trump model turbines, arranged in three groups, each containing four turbines on horizontal shafts, with one double horizontal turbine. The daily run of the turbines and the working head on the wheels, which is determined from readings of the crest and tailrace gage, is also recorded.

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

*Mean daily discharge, in second-feet, of Thunder Bay River near Alpena, Mich., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 533 | 677 | 518 | 1,985 | 3,299 | 2,494 | 474 | 462 | 380 | 481 | 399 | 522 |
| 2 | 483 | 683 | 502 | 2,251 | 3,175 | 2,254 | 534 | 391 | 393 | 206 | 415 | 312 |
| 3 | 310 | 677 | 502 | 4,953 | 2,930 | 2,137 | 460 | 299 | 421 | 631 | 449 | 458 |
| 4 | 521 | 645 | 521 | 4,591 | 1,939 | 1,724 | 54 | 342 | 206 | 478 | 429 | 292 |
| 5 | 503 | 657 | 546 | 4,822 | 1,875 | 1,757 | 549 | 358 | 243 | 505 | 439 | 470 |
| 6 | 470 | 577 | (a) | 6,421 | 1,679 | 2,084 | 544 | 404 | 397 | 461 | 216 | 489 |
| 7 | 479 | 370 | 571 | 6,934 | 1,513 | 2,387 | 542 | 206 | 533 | 503 | 524 | 518 |
| 8 | 488 | 633 | 596 | 6,927 | 745 | 2,556 | 524 | 502 | 402 | 426 | 449 | 498 |
| 9 | 467 | 655 | 571 | 7,275 | 1,530 | 2,569 | 548 | 470 | 501 | 23 | 428 | 473 |
| 10 | 359 | 646 | 579 | 6,940 | 1,471 | 2,579 | 178 | 548 | 524 | 631 | 338 | 451 |
| 11 | 511 | 643 | 589 | 6,592 | 1,524 | 2,303 | 538 | 577 | 206 | 503 | 397 | 279 |
| 12 | 516 | 602 | 639 | 6,095 | 1,548 | 2,012 | 532 | 577 | 561 | 548 | 371 | 453 |
| 13 | 480 | 549 | (a) | 6,427 | 1,470 | 1,992 | 588 | 592 | 490 | 705 | 45 | 478 |
| 14 | 504 | 402 | (a) | 4,730 | 1,428 | 1,697 | 624 | 280 | 410 | 610 | 538 | 478 |
| 15 | 482 | 605 | 677 | 4,233 | 747 | 1,321 | 634 | 609 | 475 | 572 | 479 | 443 |
| 16 | 477 | 559 | 665 | 3,502 | 1,404 | 1,377 | 504 | 545 | 461 | 373 | 702 | 417 |
| 17 | 298 | 573 | 512 | 3,077 | 1,383 | 1,233 | 23 | 548 | 404 | 721 | 529 | 400 |
| 18 | 496 | 552 | 669 | 2,909 | 1,582 | 1,313 | 638 | 551 | 132 | 594 | 478 | 282 |
| 19 | 475 | 546 | 664 | 2,993 | 2,145 | 1,089 | 563 | 543 | 518 | 524 | 422 | 451 |
| 20 | 491 | 480 | (a) | 2,930 | 2,211 | 1,042 | 524 | 541 | 509 | 520 | 290 | 440 |
| 21 | 502 | 363 | 673 | 2,772 | 2,521 | 827 | 503 | 169 | 525 | 482 | 546 | 442 |
| 22 | 522 | 633 | 705 | 3,429 | 2,932 | 740 | 436 | 582 | 433 | 558 | 515 | 468 |
| 23 | 484 | 583 | 823 | 2,802 | 3,187 | 866 | 503 | 510 | 415 | 206 | 536 | 488 |
| 24 | 323 | 588 | 739 | 2,467 | 3,206 | 706 | 54 | 532 | 496 | 415 | 556 | 284 |
| 25 | 532 | 579 | 883 | 3,121 | 2,913 | 582 | 545 | 535 | 321 | 379 | 609 | 595 |
| 26 | 534 | 526 | 971 | 3,545 | 3,255 | 269 | 460 | 552 | 572 | 446 | 484 | 290 |
| 27 | 556 | 485 | 1,284 | 4,393 | 3,234 | 662 | 433 | 581 | 520 | 501 | 473 | 496 |
| 28 | 614 | (a) | 1,600 | 4,466 | 4,219 | 661 | 404 | 22 | 511 | 343 | 450 | 491 |
| 29 | 576 | 589 | 1,477 | 4,555 | 3,267 | 504 | 420 | 587 | 493 | 629 | 325 | 515 |
| 30 | 518 | ..... | 1,524 | 3,594 | 3,125 | 491 | 427 | 471 | 487 | 253 | 493 | 491 |
| 31 | 325 | ..... | 1,615 | ..... | 2,414 | ..... | 547 | 415 | ..... | 535 | ..... | 511 |

a Record not available.

*Estimated monthly discharge of Thunder Bay River near Alpena, Mich., for 1904.*

[Drainage area, 1,260 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January | 614 | 298 | 478 | 0.379 | 0.437 |
| February, 28 days | 683 | 363 | 574 | .456 | .475 |
| March, 27 days | 1,615 | 502 | 800 | .635 | .638 |
| April | 7,275 | 1,985 | 4,391 | 3.48 | 3.88 |
| May | 4,219 | 745 | 2,254 | 1.79 | 2.06 |
| June | 2,579 | 269 | 1,474 | 1.17 | 1.31 |
| July | 638 | 23 | 461 | .365 | .421 |
| August | 609 | 22 | 461 | .365 | .421 |
| September | 572 | 132 | 428 | .340 | .379 |
| October | 721 | 23 | 476 | .378 | .436 |
| November | 702 | 45 | 444 | .352 | .392 |
| December | 595 | 279 | 441 | .350 | .404 |

## AU SABLE RIVER AT BAMFIELD, MICH.

Au Sable River rises in southern Otsego County, flows south to Grayling, thence east to the west line of Alcona County, from which point it follows a tortuous course in a general southeasterly direction to its outlet in Lake Huron at Oscoda. Its drainage basin embraces a region at one time noted for the abundance of white pine. The area is now almost entirely cleared of its valuable native timber and contains a large extent of sandy plains covered with shrub conifers. There are also areas of diversified soils, pink clay, loam, and gravel. The basin is underlain by Coldwater shales. Rock outcrops are very rare, the stream bed being usually clay or sand.

The basin contains numerous small lakes, wet sand areas, and undrained hollows, the topographic features being mainly the work of the retreating ice of the Glacial epoch.

At Bamfield, about 40 miles from the outlet, following the river, the elevation is about 850 feet above sea level. From this point to the mouth of the stream excellent sites for water-power development occur. These water powers are favored by a stream bed of firm clay, the river being flanked in many places with high terraced clay bluffs, rising often 60 to 100 feet above the stream. In some places the upper half or two-thirds of the bluff is sand, the lower portion being clay. At the clay horizon numerous springs appear. The tributaries are not important, nearly all the rainfall being directly absorbed by the porous sand areas. The drainage area above the junction of the two branches of Au Sable River is 1,005 square miles; above the gaging station at Bamfield, 1,425 square miles; and above its mouth at Oscoda, 1,932 square miles.

A gaging station was established at the highway bridge at Bamfield August 27, 1902, and gage readings have been taken twice each day since that date. The observer is William H. Bamfield. The gage is a vertical scale graduated to feet and tenths, attached to the left side of the left pier supporting the main bridge span on the downstream side. The bridge has three spans, one a main Pratt truss span of 92 feet, with flood channels at ends. One truss is supported on trestle work that is clogged with drift. Only a small part of the flow, however, passes through this channel at high water. The channel is straight for 800 feet below the station, and in this distance slight rifts occur. It is straight for 500 feet above the gage. The channel has a width at ordinary stage of 140 feet. The bed of the stream is composed of sand and gravel, and is somewhat rough, with sunken logs and short piles, but is permanent. The velocity is moderate to rapid. The banks are low and are skirted on the right by a flood plain, which is, however, seldom overflowed. Beyond the flood plain on the right, and close to the river on the left, are high gravel banks.

The stream seldom freezes over in winter so that the relation of gage height to discharge differs little from that in summer. Anchor ice backs the water up at times, however. Wire spikes, driven into the upstream end of the left pier, serve as a temporary bench mark. Its elevation is 8.00 feet above the zero of the gage.

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

*Discharge measurements of Au Sable River at Bamfield, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| May 28 | C. C. Covert | 823 | 3.19 | 3.30 | 2,569 |
| June 10 | do | 653 | 2.79 | 2.20 | 1,823 |
| September 5 | H. R. Beebe | 466 | 2.29 | 1.00 | 1,066 |

*Mean daily gage height, in feet, of Au Sable River at Bamfield, Mich., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.70 | 4.40 | 4.00 | 2.25 | 3.35 | 2.00 | 1.75 | 1.20 | 1.00 | 1.05 | 0.95 | 1.05 |
| 2 | 2.70 | 4.40 | 4.00 | 2.30 | 3.10 | 2.00 | 1.75 | 1.25 | 1.00 | 1.15 | 1.00 | 1.10 |
| 3 | 2.70 | 4.40 | 4.00 | 2.50 | 2.75 | 2.05 | 1.70 | 1.25 | .95 | 1.20 | 1.00 | 1.10 |
| 4 | 3.00 | 4.40 | 4.00 | 2.50 | 2.70 | 2.05 | 1.60 | 1.30 | 1.00 | 1.20 | 1.00 | 1.10 |
| 5 | 3.40 | 4.40 | 4.00 | 2.70 | 2.60 | 2.05 | 1.45 | 1.30 | .95 | 1.15 | .95 | 1.20 |
| 6 | 3.20 | 4.40 | 3.60 | 2.90 | 2.50 | 2.25 | 1.40 | 1.30 | 1.00 | 1.00 | .90 | 1.20 |
| 7 | 3.00 | 4.40 | 3.60 | 3.10 | 2.40 | 2.30 | 1.40 | 1.35 | .95 | 1.05 | 1.00 | 1.20 |
| 8 | 3.00 | 4.40 | 3.50 | 3.30 | 2.45 | 2.25 | 1.40 | 1.35 | 1.00 | 1.10 | 1.00 | 1.15 |
| 9 | 3.00 | 4.45 | 3.50 | 3.50 | 2.60 | 2.20 | 1.35 | 1.40 | 1.00 | 1.15 | .95 | 1.10 |
| 10 | 3.00 | 4.40 | 3.50 | 3.75 | 2.70 | 2.15 | 1.40 | 1.25 | 1.00 | 1.25 | .90 | 1.20 |
| 11 | 3.00 | 4.40 | 3.50 | 4.05 | 2.85 | 2.10 | 1.50 | 1.30 | 1.00 | 1.60 | .95 | 1.05 |
| 12 | 2.80 | 4.40 | 3.50 | 4.40 | 3.00 | 2.10 | 1.40 | 1.25 | 1.00 | 1.75 | 1.00 | 1.00 |
| 13 | 2.70 | 4.40 | 3.50 | 4.50 | 3.05 | 2.05 | 1.30 | 1.25 | 1.00 | 1.65 | .95 | 1.10 |
| 14 | 2.70 | 4.40 | 3.50 | 4.27 | 3.05 | 2.00 | 1.45 | 1.30 | 1.00 | 1.50 | .90 | 1.20 |
| 15 | 2.70 | 4.40 | 3.50 | 4.03 | 3.00 | 1.95 | 1.40 | 1.40 | 1.00 | 1.35 | 1.00 | 1.20 |
| 16 | 2.70 | 4.40 | 3.50 | 3.93 | 2.90 | 1.80 | 1.30 | 1.35 | 1.00 | 1.25 | 1.00 | 2.40 |
| 17 | 3.40 | 4.40 | 3.40 | 3.53 | 2.80 | 1.75 | 1.25 | 1.35 | 1.00 | 1.10 | 1.00 | 2.65 |
| 18 | 4.00 | 4.40 | 3.40 | 3.40 | 2.75 | 1.75 | 1.30 | 1.25 | 1.00 | 1.10 | 1.00 | 2.95 |
| 19 | 4.10 | 4.40 | 3.30 | 3.13 | 2.65 | 1.65 | 1.20 | 1.20 | 1.00 | 1.05 | .90 | 3.55 |
| 20 | 4.30 | 4.20 | 3.30 | 2.97 | 2.75 | 1.45 | 1.30 | 1.20 | 1.10 | 1.00 | .95 | 4.00 |
| 21 | 4.35 | 4.20 | 3.30 | 2.80 | 2.80 | 1.30 | 1.25 | 1.20 | 1.15 | 1.00 | 1.00 | 4.00 |
| 22 | 4.35 | 4.20 | 3.20 | 2.87 | 2.85 | 1.20 | 1.25 | 1.35 | 1.00 | 1.00 | 1.00 | 4.25 |
| 23 | 4.30 | 4.10 | 3.00 | 2.80 | 2.90 | 1.30 | 1.25 | 1.30 | 1.00 | 1.05 | 1.05 | 4.00 |
| 24 | 4.30 | 4.00 | 2.90 | 3.30 | 3.00 | 1.25 | 1.25 | 1.30 | 1.00 | 1.05 | 1.00 | 3.45 |
| 25 | 4.30 | 4.00 | 2.85 | 4.10 | 3.35 | 1.30 | 1.20 | 1.20 | 1.00 | 1.00 | 1.00 | 3.45 |
| 26 | 4.30 | 4.00 | 2.70 | 4.53 | 2.75 | 1.20 | 1.25 | 1.20 | 1.05 | 1.00 | 1.00 | 3.50 |
| 27 | 4.30 | 4.00 | 2.60 | 4.40 | 2.30 | 1.25 | 1.40 | 1.10 | 1.20 | 1.00 | 1.05 | 3.50 |
| 28 | 4.30 | 4.00 | 2.50 | 4.10 | 2.30 | 1.25 | 1.55 | 1.00 | 1.15 | 1.00 | 1.15 | 3.40 |
| 29 | 4.30 | 4.00 | 2.20 | 3.77 | 2.25 | 1.35 | 1.35 | .90 | 1.00 | 1.00 | 1.10 | 3.50 |
| 30 | 4.30 | ..... | 2.00 | 3.63 | 2.15 | 1.65 | 1.30 | .95 | 1.00 | 1.05 | 1.10 | 3.40 |
| 31 | 4.30 | ..... | 2.00 | ..... | 2.10 | ..... | 1.30 | .95 | ..... | 1.00 | ..... | 3.40 |

NOTE.—Ice conditions January 16 to March 22, and December 14 to 31.

*Rating table for Au Sable River at Bamfield, Mich., from August 27, 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.* |
| 0.50 | 875 | 1.70 | 1,460 | 2.90 | 2,260 | 4.00 | 3,130 |
| .60 | 919 | 1.80 | 1,520 | 3.00 | 2,340 | 4.10 | 3,210 |
| .70 | 963 | 1.90 | 1,570 | 3.10 | 2,410 | 4.20 | 3,300 |
| .80 | 1,000 | 2.00 | 1,630 | 3.20 | 2,490 | 4.30 | 3,390 |
| .90 | 1,050 | 2.10 | 1,700 | 3.30 | 2,570 | 4.40 | 3,480 |
| 1.00 | 1,100 | 2.20 | 1,760 | 3.40 | 2,650 | 4.50 | 3,560 |
| 1.10 | 1,140 | 2.30 | 1,830 | 3.50 | 2,730 | 4.60 | 3,650 |
| 1.20 | 1,200 | 2.40 | 1,900 | 3.60 | 2,810 | 4.70 | 3,740 |
| 1.30 | 1,240 | 2.50 | 1,960 | 3.70 | 2,890 | 4.80 | 3,840 |
| 1.40 | 1,300 | 2.60 | 2,040 | 3.80 | 2,970 | 4.90 | 3,930 |
| 1.50 | 1,340 | 2.70 | 2,110 | 3.90 | 3,050 | 5.00 | 4,020 |
| 1.60 | 1,400 | 2.80 | 2,190 | | | | |

The above table is applicable only for open-channel conditions. It is based upon 11 discharge measurements made during 1902 to 1904, inclusive. It is fairly well defined between gage heights 0.70 foot and 3.50 feet. The table has been extended beyond these limits. Above gage height 3.50 feet the rating curve is based upon logarithmic extension.

*Estimated monthly discharge of Au Sable River at Bamfield, Mich., 1902–1904.*

[Drainage area, 1,425 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| 1902. | | | | | |
| August 27–31 | 1,030 | 1,000 | 1,006 | 0.706 | 0.131 |
| September | 1,120 | 1,000 | 1,008 | .707 | .789 |
| October | 1,460 | 1,000 | 1,067 | .749 | .864 |
| November | 1,700 | 1,050 | 1,352 | .949 | 1.06 |
| December | 1,460 | 1,200 | 1,299 | .912 | 1.05 |
| 1903. | | | | | |
| January [a] | | | | | |
| February [b] | | | | | |
| March 4–31 [c] | 2,530 | 1,100 | 2,030 | 1.42 | 1.64 |
| April | 2,410 | 1,570 | 1,938 | 1.36 | 1.52 |
| May | 1,600 | 1,240 | 1,380 | .968 | 1.12 |
| June | 1,200 | 1,070 | 1,117 | .784 | .875 |

[a] Ice conditions January 7 to 29.

[b] Ice conditions February 18 to March 3.

[c] Mean for 28 days taken as mean for entire month.

*Estimated monthly discharge of Au Sable River at Bamfield, Mich., 1902–1904*—Cont'd.

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| 1903. | | | | | |
| July | 1,300 | 1,050 | 1,124 | .789 | .910 |
| August | 2,080 | 1,000 | 1,465 | 1.03 | 1.19 |
| September | 1,630 | 1,140 | 1,436 | 1.01 | 1.13 |
| October | 1,320 | 1,140 | 1,228 | .862 | .994 |
| November | 1,140 | 1,100 | 1,107 | .777 | .867 |
| December 1–14 [a] | 1,300 | 1,100 | 1,184 | .831 | .433 |
| 1904. | | | | | |
| January [b] | | | | | |
| February [b] | | | | | |
| March 23–31 [b] | 2,340 | 1,630 | 1,994 | 1.40 | .469 |
| April | 3,580 | 1,800 | 2,698 | 1.89 | 2.11 |
| May | 2,610 | 1,700 | 2,142 | 1.50 | 1.73 |
| June | 1,830 | 1,200 | 1,506 | 1.06 | 1.18 |
| July | 1,490 | 1,200 | 1,290 | .905 | 1.04 |
| August | 1,300 | 1,050 | 1,212 | .851 | .981 |
| September | 1,170 | 1,070 | 1,108 | .778 | .868 |
| October | 1,490 | 1,100 | 1,175 | .825 | .951 |
| November | 1,170 | 1,050 | 1,094 | .768 | .857 |
| December 1–13 [c] | 1,200 | 1,100 | 1,155 | .811 | .392 |

[a] Probably ice conditions December 15 to 31. [b] Ice conditions January 16 to March 22. [c] Ice conditions December 14 to 31.

NOTE.—During frozen period gage heights are to water surface in hole cut in ice.

## RIFLE RIVER AT OMER, MICH.

Rifle River rises in the vicinity of Rose City, northern Ogemaw County, flows southward to the northwest corner of T. 19 N., R. 4 W., turns easterly, and then gradually to the southeast, and finally enters Saginaw Bay. The basin is heavily overlain with glacial deposits, sand, overwash gravel, and till. There are two old lumber dams in the basin and a water-power dam at Omer. There are numerous small glacial lakes, but no controlled storage, and a very small percentage of natural water surface in the drainage basin. The basin is narrow and elongated, having a width of about 3 miles at the mouth. Ramifying tributaries in the headwaters give the stream a relatively large volume at the entrance of West Branch, in T. 21 N., R. 3 E. At Omer the stream falls from an elevation of 608 to 595 feet over a dam, affording power for a grist and saw mill. The drainage area at Omer is 364 square miles, and at the mouth of the stream is 385 square miles.

The gaging station was established September 1, 1902. It is located at the Detroit and Mackinaw Railroad bridge, one-half mile below the dam in Omer village. The gage is a wire gage with a boxed scale, graduated to feet and tenths, and is attached to the downstream guard rail of the bridge. The regular gage readings were discontinued December 31, 1903. The bridge has a single span of 109 feet. The bed is of sand and fine drift. The channel is curved and does not pass beneath the bridge at right angles. The bed is stony on the concave and sandy on the convex side, with some piles and sunken logs in between. The bench mark is on the right corner of the left bridge abutment on the downstream side. Its elevation is 15.75 feet above gage datum.

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

*Discharge measurements of Rifle River at Omer, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| May 27 | C. C. Covert | 363 | 2.37 | 7.35 | 855 |
| September 4 | H. R. Beebe | 142 | 1.26 | 4.68 | 179 |
| September 6 | do | 175 | 1.61 | 4.96 | 279 |
| September 6 | do | 160 | 1.20 | 4.66 | 157 |

## TITTABAWASSEE RIVER AT FREELAND, MICH.

Tittabawassee River forms the most northerly of the three tributaries which join to form Saginaw River at Saginaw. Their combined catchment areas receive the drainage from a crescent-shaped region of about 6,000 square miles surrounding Saginaw Bay. Tittabawassee River drains an area relatively flat, with clay soil predominating, and with occasional sand patches; the glacial sands and clay overlying the rock of the Coal Measures to a depth of several hundred feet. The area is largely cleared and under cultivation. From railroad profiles, the fall of the stream from Highwood to its mouth, a distance of about 50 miles along the river, is estimated at 140 feet.

The gaging station was established August 22, 1903, by W. M. Gregory. It is located at Freeland highway bridge, 10 miles northwest of Saginaw, in sec. 21, T. 13 N., R. 3 E., one-half mile from Freeland, Mich. The bridge consists of two main spans 320 feet between abutments, an auxiliary trestle span of 150 feet, and two overflow channels under the highway, some distance from the right end of the bridge. The gage is a standard chain gage, bolted to the upstream side of the iron guard rail, 180 feet from the left end. The length of

the chain from the end of the weight to the marker is 31.33 feet. The gage is read twice each day by W. E. Dennison. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The downstream hand rail is painted and numbered at 5-foot intervals. The initial point for soundings is the left end of the hand rail, on the downstream side of the bridge. The channel is straight above and below the station. The current is uniform and has a medium velocity. It may be affected at times by strong winds, which have a free sweep through the valley. The right bank has a flood plain which is inundated only at extreme flood stages. The left bank is high and smooth and is not subject to overflow. The bed of the stream is composed of clay and cobblestones and is fairly permanent, but tends to cut near the left bank. Bench mark No. 1 is the top of a nail head 1 foot below the top of the cedar corner post of the road fence in front of the blacksmith shop on the left bank. Its elevation is 32.96 feet above gage datum. Bench mark No. 2 is a circle inclosing the letters "B. M." painted on the top of the downstream end of the left pier. Its elevation is 22.88 feet above gage datum. The elevation of the top of the gage pulley is 31.33 feet, and that of the reference point, the top of the hand rail over the pulley, is 31.50 feet above gage datum.

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

*Discharge measurements of Tittabawassee River at Freeland, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Feet per sec.* | *Feet.* | *Sec.-feet.* |
| May 26 | C. C. Covert | 2,394 | 2.54 | 6.62 | 6,499 |
| June 10 | R. E. Horton | 1,239 | 1.65 | 3.35 | 2,047 |
| September 3 | H. R. Beebe | 748 | .81 | 1.35 | 597 |
| September 6 | do | 727 | .62 | 1.13 | 454 |
| September 20 | do | 769 | .70 | 1.30 | 536 |
| September 20 | do | 787 | .67 | 1.28 | 526 |
| December 13 | C. C. Covert | | | 2.00 | [a]576 |
| December 15 | do | | | 2.10 | [a]611 |

[a] Measurement made through ice.

*Mean daily gage height, in feet, of Tittabawassee River at Freeland, Mich., for 1904.*

| Year. | Jan.[a] | Feb.[a] | Mar.[a] | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov.[a] | Dec.[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.70 | 3.15 | 4.15 | 14.50 | 5.17 | 3.22 | 1.88 | 1.75 | 1.22 | 1.50 | 1.82 | 1.36 |
| 2 | 2.62 | 3.20 | 4.20 | 14.80 | 4.37 | 2.95 | 1.95 | 1.95 | 1.28 | 1.62 | 1.85 | 1.52 |
| 3 | 2.55 | 3.20 | 4.20 | 13.90 | 4.02 | 3.00 | 2.00 | 1.98 | 1.38 | 1.70 | 1.80 | 1.65 |
| 4 | 2.50 | 3.25 | 4.30 | 12.80 | 3.99 | 3.18 | 2.00 | 2.10 | 1.28 | 1.78 | 1.75 | 1.80 |
| 5 | 2.60 | 3.30 | 4.40 | 11.60 | 3.87 | 3.22 | 1.92 | 1.82 | 1.18 | 1.85 | 1.68 | 1.82 |
| 6 | 2.68 | 3.30 | 4.45 | 10.75 | 3.57 | 4.15 | 1.82 | 1.75 | 1.12 | 2.00 | 1.65 | 1.88 |
| 7 | 2.70 | 3.25 | 4.55 | 9.20 | 3.07 | 4.48 | 1.80 | 1.62 | 1.35 | 1.85 | 1.72 | 1.95 |
| 8 | 2.80 | 3.30 | 4.85 | 9.50 | 3.07 | 4.40 | 1.85 | 1.70 | 1.52 | 1.72 | 1.62 | 2.02 |
| 9 | 2.88 | 3.35 | 5.10 | 10.15 | 3.07 | 4.18 | 1.90 | 1.62 | 1.52 | 1.75 | 1.62 | 2.10 |
| 10 | 2.90 | 3.35 | 5.60 | 10.75 | 3.27 | 3.55 | 1.92 | 1.52 | 1.42 | 1.95 | 1.70 | 2.15 |
| 11 | 3.00 | 3.40 | 6.20 | 10.60 | 3.62 | 3.15 | 1.95 | 1.45 | 1.32 | 2.25 | 1.68 | 2.12 |
| 12 | 3.02 | 3.40 | 6.75 | 10.20 | 3.62 | 2.85 | 2.05 | 1.42 | 1.25 | 2.60 | 1.68 | 2.10 |
| 13 | 3.10 | 3.40 | 7.00 | 9.68 | 3.47 | 2.65 | 2.30 | 1.40 | 1.05 | 2.90 | 1.72 | 2.10 |
| 14 | 3.05 | 3.45 | 7.00 | 9.32 | 3.49 | 2.45 | 2.15 | 1.32 | 1.15 | 2.75 | 1.70 | 2.00 |
| 15 | 3.00 | 3.45 | 7.15 | 7.60 | 3.39 | 2.25 | 1.95 | 1.22 | 1.38 | 2.38 | 1.72 | 2.00 |
| 16 | 2.95 | 3.50 | 7.22 | 7.15 | 3.32 | 2.08 | 1.82 | 1.20 | 1.40 | 2.18 | 1.68 | 2.00 |
| 17 | 2.90 | 3.50 | 7.30 | 7.05 | 3.12 | 1.95 | 1.68 | 1.28 | 1.35 | 2.05 | 1.75 | 2.00 |
| 18 | 2.85 | 3.45 | 7.30 | 8.55 | 3.12 | 1.82 | 1.60 | 1.30 | 1.30 | 1.78 | 1.68 | 2.00 |
| 19 | 2.90 | 3.50 | 7.15 | 9.95 | 3.29 | 1.72 | 1.52 | 1.38 | 1.32 | 1.82 | 1.70 | 2.05 |
| 20 | 3.00 | 3.52 | 6.95 | 10.07 | 3.52 | 1.70 | 1.45 | 1.42 | 1.48 | 1.85 | 1.72 | 2.10 |
| 21 | 3.10 | 3.55 | 7.10 | 9.02 | 4.12 | 1.70 | 1.40 | 1.48 | 1.58 | 1.75 | 1.70 | 2.15 |
| 22 | 3.10 | 3.60 | 7.75 | 7.92 | 4.19 | 1.62 | 1.45 | 1.35 | 1.50 | 1.80 | 1.70 | 2.18 |
| 23 | 3.02 | 3.60 | 8.25 | 7.07 | 5.72 | 1.58 | 1.50 | 1.30 | 1.60 | 1.82 | 1.78 | 2.25 |
| 24 | 2.95 | 3.60 | 9.50 | 6.69 | 8.27 | 1.60 | 1.48 | 1.38 | 1.70 | 1.82 | 1.70 | 2.32 |
| 25 | 2.90 | 3.65 | 12.70 | 7.22 | 8.22 | 1.70 | 1.40 | 1.50 | 1.80 | 1.90 | 1.65 | 2.40 |
| 26 | 2.88 | 3.70 | 17.30 | 7.79 | 7.62 | 1.62 | 1.35 | 1.45 | 1.72 | 1.92 | a1.62 | 2.42 |
| 27 | 2.90 | 3.70 | 18.25 | 7.22 | 6.88 | 1.58 | 1.30 | 1.42 | 1.82 | 1.85 | 1.48 | 2.48 |
| 28 | 2.80 | 3.85 | 16.50 | 6.62 | 5.92 | 1.50 | 1.48 | 1.28 | 1.90 | 1.78 | 1.32 | 2.48 |
| 29 | 2.95 | 4.05 | 14.90 | 5.92 | 5.12 | 1.58 | 1.42 | 1.18 | 1.75 | 1.72 | 1.25 | 2.42 |
| 30 | 3.10 | ..... | 13.85 | 5.52 | 4.38 | 1.75 | 1.42 | 1.08 | 1.58 | 1.75 | 1.28 | 2.41 |
| 31 | 3.10 | ..... | 13.80 | ..... | 3.60 | ..... | 1.55 | 1.22 | ..... | 1.82 | ..... | 2.44 |

[a] Frozen January 1 to March 28 and November 26 to December 31.

## FLINT RIVER AT FLINT, MICH.

This station was established September 9, 1903, by W. M. Gregory. It is located at the Grand Trunk Railway bridge at Flint, Mich. A plain board gage graduated to feet and tenths is attached to piles on the inside of a row of piling 34 feet from the right abutment. It is read twice each day by F. J. Lowlery. Discharge measurements are made from the Smith Street Bridge above or the South Street Bridge below the railway bridge, the first having a single span of 129.5 feet and the latter a single span of 105 feet. The initial point for soundings at the Smith Street Bridge is the face of the left abutment on the downstream side. At the South Street Bridge it is the left end of the iron guard rail on the downstream side. The channel is straight for a short distance above and below the station. The current is moderate. Both banks are composed of earth, clean, and seldom, if ever, overflow.

The bench mark is a point marked on the top of the downstream guard rail of the railway bridge to which the gage is attached, 34 feet from the right end. Its elevation is 18.47 feet above the zero of the gage.

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

*Discharge measurements of Flint River at Flint, Mich., in 1903.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Feet. per sec.* | *Feet.* | *Second-feet.* |
| September 9[a] | W. M. Gregory | 350 | 2.06 | [b]15.75 | 721 |
| September 9 | do | 330 | 1.91 | 1.10 | 632 |

[a] Durrant and Dort Bridge above gage.
[b] Distance to water surface from top of iron guard rail, downstream side, 13 feet from left end.

*Mean daily gage height, in feet, of Flint River at Flint, Mich., for 1903 and 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | | | | | |
| 1 | | | | | | | | | | 0.70 | 0.25 | −0.20 |
| 2 | | | | | | | | | | 1.00 | − .30 | − .30 |
| 3 | | | | | | | | | | 1.10 | − .45 | − .30 |
| 4 | | | | | | | | | | 1.25 | − .15 | − .30 |
| 5 | | | | | | | | | | 1.35 | − .10 | − .30 |
| 6 | | | | | | | | | | 1.05 | − .10 | − .30 |
| 7 | | | | | | | | | | .95 | − .10 | − .35 |
| 8 | | | | | | | | | | 1.85 | − .10 | − .40 |
| 9 | | | | | | | | | 1.10 | 1.65 | − .10 | − .40 |
| 10 | | | | | | | | | .95 | 1.40 | − .10 | − .40 |
| 11 | | | | | | | | | .80 | 1.25 | − .15 | − .40 |
| 12 | | | | | | | | | .70 | 1.15 | .05 | − .50 |
| 13 | | | | | | | | | .70 | 1.05 | .25 | − .40 |
| 14 | | | | | | | | | .70 | .95 | .35 | − .20 |
| 15 | | | | | | | | | 1.45 | .75 | .20 | − .30 |
| 16 | | | | | | | | | 2.65 | .70 | .45 | − .20 |
| 17 | | | | | | | | | 4.40 | .50 | .55 | − .20 |
| 18 | | | | | | | | | 4.05 | .60 | .60 | − .30 |
| 19 | | | | | | | | | 3.60 | .55 | .75 | − .30 |
| 20 | | | | | | | | | 3.35 | .50 | .00 | − .20 |
| 21 | | | | | | | | | 3.10 | .50 | .10 | − .20 |
| 22 | | | | | | | | | 2.90 | .40 | .10 | − .20 |
| 23 | | | | | | | | | 2.65 | .40 | .10 | − .20 |
| 24 | | | | | | | | | 2.30 | .40 | .15 | − .20 |
| 25 | | | | | | | | | 1.90 | .30 | .10 | − .10 |
| 26 | | | | | | | | | 1.35 | .20 | − .05 | − .10 |
| 27 | | | | | | | | | 1.05 | .10 | − .30 | .00 |
| 28 | | | | | | | | | .85 | .10 | − .40 | − .20 |
| 29 | | | | | | | | | .70 | .05 | − .25 | − .10 |
| 30 | | | | | | | | | .60 | .00 | − .10 | − .10 |
| 31 | | | | | | | | | | .00 | | − .10 |

*Mean daily gage height, in feet, of Flint River at Flint, Mich., etc.*—Continued.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | | | | | |
| 1 | −0.10 | −0.20 | 0.20 | | | | | | | | | |
| 2 | − .10 | − .20 | .45 | | | | | | | | | |
| 3 | .00 | − .20 | 1.85 | | | | | | | | | |
| 4 | .10 | − .20 | 1.95 | | | | | | | | | |
| 5 | .00 | − .10 | 2.15 | | | | | | | | | |
| 6 | .00 | .25 | | | | | | | | | | |
| 7 | − .10 | .85 | | | | | | | | | | |
| 8 | − .10 | 1.05 | | | | | | | | | | |
| 9 | − .10 | 1.70 | | | | | | | | | | |
| 10 | − .10 | 1.90 | | | | | | | | | | |
| 11 | − .10 | 2.05 | | | | | | | | | | |
| 12 | .00 | 2.00 | | | | | | | | | | |
| 13 | .00 | 1.95 | | | | | | | | | | |
| 14 | − .05 | 1.95 | | | | | | | | | | |
| 15 | − .10 | 1.85 | | | | | | | | | | |
| 16 | − .10 | 1.75 | | | | | | | | | | |
| 17 | − .10 | 1.55 | | | | | | | | | | |
| 18 | − .20 | 1.40 | | | | | | | | | | |
| 19 | − .20 | 1.25 | | | | | | | | | | |
| 20 | − .20 | 1.05 | | | | | | | | | | |
| 21 | − .20 | .95 | | | | | | | | | | |
| 22 | − .20 | .85 | | | | | | | | | | |
| 23 | − .20 | .70 | | | | | | | | | | |
| 24 | − .20 | .65 | | | | | | | | | | |
| 25 | − .20 | .55 | | | | | | | | | | |
| 26 | − .20 | .45 | | | | | | | | | | |
| 27 | − .20 | .37 | | | | | | | | | | |
| 28 | − .20 | .30 | | | | | | | | | | |
| 29 | − .20 | .25 | | | | | | | | | | |
| 30 | − .20 | | | | | | | | | | | |
| 31 | − .20 | | | | | | | | | | | |

## LAKE ERIE DRAINAGE BASIN.

The Lake Erie drainage basin is conspicuous by the lack of any large streams which flow through it, this being due to the comparatively short distance from the lake to the divide between it and its adjacent drainage areas. The largest stream is the Maumee, which is formed in the northeast part of Indiana by the junction of St. Joseph and St. Mary rivers, and flows northeast, entering Lake Erie at the northwest corner of Ohio.

Huron River is tributary to the west end of Lake Erie, near the mouth of Detroit River. The Huron receives drainage from an irregular-shaped basin having its greatest length parallel to, and lying at a distance of 25 to 30 miles from, Detroit River. This basin is connected with Lake Erie by a long, narrow valley averaging 5 miles in width, and extending from a point near Ypsilanti southeasterly to Lake Erie, a distance of 28 miles. In this portion of its course, a large part of

the total fall of the river occurs. The conditions are thus nearly ideal for the development of water power, in that nearly the entire catchment area, all the large tributaries, and an extensive area affording lake and ground storage, lie above the head of the narrow valley referred to.

The drainage basin below Ypsilanti is flat, the soil comparatively heavy and impervious, mostly under cultivation, the ground water level being controlled by means of numerous drain trenches.

In the vicinity of Ann Arbor the topography is very rolling. The stream flows through a broad, flat valley bordered by abrupt hills 100 to 200 feet in height. The channel is tortuous and changeable. Numerous abandoned sections remain as bayous. Large streams issue from the morainal hills.

On the right-hand or southwesterly side, the main catchment basin above Ann Arbor is moderately rolling and comprises a very large percentage of marsh area. There are a few small lakes and a considerable number of undrained depressions. The numerous branching tributaries have been cleaned to facilitate drainage, and main drainage channels have been excavated through the marsh.

The northerly portion of the main catchment basin is rolling and its topography complex. The stream flows through a series of lakes, and the entire basin is largely comprised of lakes and surrounding marshes north of Dover.

An investigation of the water power of Huron River was made by Lyman E. Cooley, C. E., in 1904, and the following results of miscellaneous measurements of Huron River have been collected and furnished by Mr. Cooley:

Discharge May 7, 1898, deduced from surface-velocity measurements in Osborne mill, by A. A. Weber and M. A. Wood, 261.6 second-feet.

Discharge at Argo mill, deduced by M. H. Freeman and F. M. Rademacher, from average gage reading at Swift's dam, Ann Arbor, April 21 to May 4, inclusive, 1903, was 807.4 second-feet; the maximum discharge observed during the summer period was 1,775 second-feet.

Discharge at Flat Rock measured by W. T. Sherman, September 11, 1903, 688.6 second-feet. Water level above normal.

Discharge at Geddes dam, Ann Arbor, Mich., June 15, 1903, estimated by L. E. Cooley from depth on spillway and run of turbine was 424 second-feet. Flood discharge of July 7, 1902, at Geddes dam, Ann Arbor, estimated by L. E. Cooley, was 5,510 second-feet.

In addition to the above, the following miscellaneous measurements have been made by W. M. Gregory:

August 4, 1904, at lower highway bridge, Ann Arbor, discharge 134 second-feet. Water surface 16.35 feet below top of iron handrail, 75 feet from zero mark on bridge, downstream side.

August 4, 1904, discharge at Dover, Mich., 116 second-feet.

During the winter of 1903–1904 a survey of Huron River was made, under the direction of L. E. Cooley, by H. B. Alexander. Data were

obtained at various dams along the stream, from which the following data of discharge have been computed:

*Discharge of Huron River in winter of 1903–1904.*

| Name of dam and locality. | Date. | Discharge. | Drainage area. | Estimated discharge at Geddes. | Remarks. |
|---|---|---|---|---|---|
| | | *Sec.-feet.* | *Sq. miles.* | *Sec.-feet.* | |
| Hudson | Jan. 27 | 369 | 520 | 337 | |
| Scio | Feb. 5 | 367 | 683 | 407 | Thaw on Feb. 6. |
| Hudson | Feb. 17 | 347 | 520 | 505 | |
| Ann Arbor | Feb. 22 | 540 | 724 | 564 | Thawing Feb. 28, 29. |
| Geddes | Feb. 26 | 505 | 757 | 505 | Do. |
| Do | Mar. 2 | 730 | 757 | 730 | River rising. |
| Peninsular and Dubel. | Mar. 3 | 1,300 | 795 | 1,238 | Some uncertainty. |
| Waterworks | Mar. 4 | 1,800 | 801 | 1,626 | Freeze-up. |
| Below waterworks | Mar. 8 | 3,100 | 801 | 3,200 | Relative stage. |
| Do | Mar. 9 | 3,100 | 801 | 3,200 | Unchanging. |
| Do | Mar. 10 | 3,100 | 801 | 3,200 | Freezing Mar. 12–17. |

A portion of the drainage basin is shown on the Ann Arbor sheet of the United States Geological Survey Typographic Atlas. The drainage areas have been deduced from this and other recent maps. The area above Ann Arbor has formerly been given as 841 square miles.

The discharge at Rawsonville, Mich., was measured by surface floats by Edgar Williams, C. E., October 10, 1904, and was 310 second-feet. The maximum discharge in the flood of March, 1904, deduced from a profile of the Geddes dam by L. E. Cooley was 4,700 second-feet.

### HURON RIVER AT DOVER, MICH.

A gage was erected at the highway bridge at Dover, August 7, 1904. The conditions are not suitable for the use of current meter at the highway bridge. The stream above this point is unregulated, and the fluctuations in gage heights show its natural variation. The gage is read and the record furnished by F. Burkett. A current-meter measurement by W. M. Gregory, made by wading near the gage August 4, 1904, showed a discharge of 116 second-feet.

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

*Mean daily gage height, in feet, of Huron River at Dover, Mich., for 1904.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec.[b] | Day | Aug. | Sept. | Oct. | Nov. | Dec.[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 1.20 | 2.25 | 1.90 | 1.70 | 17 | .25 | 1.20 | 2.20 | 1.80 | 1.50 |
| 2 | ..... | 1.10 | 2.25 | 1.90 | 1.70 | 18 | .25 | 1.20 | 2.15 | 1.80 | 1.45 |
| 3 | ..... | 1.05 | 2.20 | 1.85 | 1.70 | 19 | .28 | 1.20 | 2.15 | 1.80 | 1.45 |
| 4 | ..... | 1.00 | 2.20 | 1.85 | 1.70 | 20 | .52 | 1.20 | 2.15 | 1.80 | 1.45 |
| 5 | ..... | .90 | 2.15 | 1.80 | 1.65 | 21 | .75 | 1.20 | 2.10 | 1.80 | 1.50 |
| 6 | ..... | .70 | 2.12 | 1.80 | 1.65 | 22 | .92 | 1.25 | 2.10 | 1.80 | 1.50 |
| 7 | 0.25 | .60 | 2.10 | 1.80 | 1.65 | 23 | 1.05 | 1.28 | 2.05 | 1.75 | 1.60 |
| 8 | .22 | .60 | 2.15 | 1.80 | 1.65 | 24 | 1.20 | 1.30 | 2.00 | 1.75 | 1.65 |
| 9 | .20 | .90 | (a) | 1.80 | 1.65 | 25 | 1.25 | 1.70 | 2.00 | 1.75 | 1.70 |
| 10 | .20 | 1.20 | ..... | 1.80 | 1.60 | 26 | 1.25 | 1.95 | 2.00 | 1.75 | 1.70 |
| 11 | .20 | 1.20 | ..... | 1.80 | 1.60 | 27 | 1.20 | 2.00 | 2.00 | 1.70 | 1.80 |
| 12 | .25 | 1.20 | ..... | 1.80 | 1.60 | 28 | 1.18 | 2.10 | 1.95 | 1.70 | 1.90 |
| 13 | .25 | 1.20 | ..... | 1.80 | 1.55 | 29 | 1.20 | 2.12 | 1.95 | 1.70 | 1.90 |
| 14 | .25 | 1.15 | ..... | 1.80 | 1.55 | 30 | 1.20 | 2.20 | 1.95 | 1.70 | 2.00 |
| 15 | .25 | 1.15 | ..... | 1.80 | 1.55 | 31 | 1.25 | ..... | 1.95 | ..... | 2.10 |
| 16 | .25 | 1.20 | 2.20 | 1.80 | 1.55 | | | | | | |

[a] No record. [b] Probable ice conditions during December.

## HURON RIVER AT DEXTER, MICH.

A vertical gage scale, divided decimally, was erected for use during low water just above the highway bridge in the village of Dexter, September 1, 1904. The record has been maintained by the Washtenaw Electric Company, and has been furnished by R. W. Hemphill, manager. A boat and cable section was selected a short distance below the highway bridge, and current-meter measurements have been made, as indicated in the accompanying table. The gage is located just above a rapid, where it will be less affected by freezing than elsewhere.

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

*Discharge measurements of Huron River at Dexter, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| August 30 | Horton and Beebe | 282 | 0.67 | 1.10 | 189 |
| September 21 | H. R. Beebe | 274 | .76 | 1.14 | 208 |
| October 6 | Edgar Williams | ..... | ..... | 1.37 | [a] 278 |
| December 19 | C. C. Covert | 279 | .86 | 1.10 | 241 |

[a] Velocity determined by floats.

*Mean daily gage height, in feet, of Huron River at Dexter, Mich., for 1904.*

| Day. | Sept. | Oct. | Nov. | Dec. | Day. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.30 | 1.38 | 1.18 | 1.05 | 17 | 1.05 | 1.35 | 1.15 | 1.35 |
| 2 | 1.40 | 1.35 | 1.15 | 1.05 | 18 | 1.10 | 1.35 | 1.15 | 1.30 |
| 3 | 1.25 | 1.28 | 1.15 | 1.05 | 19 | 1.10 | 1.35 | 1.15 | 1.25 |
| 4 | 1.10 | 1.30 | 1.15 | 1.10 | 20 | 1.10 | 1.30 | 1.15 | 1.25 |
| 5 | 1.25 | 1.30 | 1.15 | 1.15 | 21 | 1.05 | 1.30 | 1.15 | 1.25 |
| 6 | 1.15 | 1.35 | 1.15 | 1.15 | 22 | 1.02 | 1.28 | 1.15 | 1.25 |
| 7 | 1.10 | 1.30 | 1.15 | 1.15 | 23 | 1.05 | 1.25 | 1.15 | 1.10 |
| 8 | 1.10 | 1.30 | 1.15 | 1.10 | 24 | 1.02 | 1.25 | 1.15 | 1.10 |
| 9 | 1.10 | 1.30 | 1.15 | 1.10 | 25 | 1.12 | 1.25 | 1.15 | 1.25 |
| 10 | 1.15 | 1.30 | 1.15 | 1.10 | 26 | 1.30 | 1.25 | 1.15 | 1.35 |
| 11 | 1.08 | 1.40 | 1.15 | 1.10 | 27 | 1.60 | 1.20 | 1.10 | 1.30 |
| 12 | 1.10 | 1.40 | 1.15 | 1.10 | 28 | 1.68 | 1.20 | 1.10 | 1.35 |
| 13 | 1.08 | 1.42 | 1.15 | 1.25 | 29 | 1.55 | 1.20 | 1.10 | 1.40 |
| 14 | 1.02 | 1.40 | 1.15 | 1.30 | 30 | 1.40 | 1.20 | 1.10 | 1.35 |
| 15 | 1.02 | 1.35 | 1.15 | 1.40 | 31 | ..... | 1.20 | ..... | 1.30 |
| 16 | 1.05 | 1.35 | 1.15 | 1.30 | | | | | |

## HURON RIVER AT GEDDES, MICH.

A record of the depth of overflow at the dam and of the run of the water wheels in the adjacent electric plant was maintained at Geddes by the Washtenaw Electric Company, beginning February 1, 1904. This record has been compiled and the discharge computed by L. E. Cooley, and a copy of the results furnished. A survey of the dam was made by R. E. Horton for the United States Geological Survey in September, 1904. New gages were erected and the record has been maintained and furnished to the Survey from that date. The crest of the dam was changed in September, 1904, and the additional data necessary for computation of the discharge to the end of the year have not been obtained. This gaging station affords opportunity to determine the discharge during low water both in summer and winter. At times, when water flows over the dam, the discharge is less certain.

*Mean daily discharge, in second-feet, of Huron River at Geddes, Mich., for 1904.*

| Day. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | a 465 | a 600 | 3,602 | 791 | 617 | 219 | 117 | 288 | 307 | 248 |
| 2 | a 450 | 730 | 3,066 | 923 | 559 | 210 | 111 | 325 | 307 | 238 |
| 3 | a 435 | 1,238 | 3,254 | 754 | 589 | 396 | 117 | 271 | 288 | 238 |
| 4 | a 420 | 1,636 | 3,000 | 739 | 652 | 337 | 118 | 222 | 288 | 238 |
| 5 | 407 | a 2,000 | 2,761 | 819 | 543 | 184 | 135 | 271 | 288 | 238 |
| 6 | a 410 | a 2,600 | 2,412 | 804 | 521 | 176 | 136 | 238 | 307 | 238 |
| 7 | a 590 | a 3,000 | 2,226 | 763 | 514 | 193 | 97 | 238 | 288 | 238 |
| 8 | a 700 | 3,200 | 2,221 | 684 | 413 | 197 | 125 | 222 | 288 | 238 |
| 9 | 676 | 3,200 | 2,211 | 466 | 343 | 199 | 128 | 222 | 288 | 238 |
| 10 | a 600 | 3,200 | 2,285 | 505 | 300 | 278 | 119 | 238 | 288 | 238 |
| 11 | a 560 | a 3,160 | 2,081 | 589 | 315 | 218 | 101 | 216 | 325 | 238 |
| 12 | a 540 | a 2,960 | 1,977 | 601 | 438 | 196 | 153 | 222 | 325 | 238 |
| 13 | a 530 | a 2,500 | 1,610 | 541 | 357 | 189 | 147 | 216 | 332 | 238 |
| 14 | a 520 | a 2,100 | 1,309 | 438 | 241 | 186 | 155 | 197 | 325 | 238 |
| 15 | a 515 | a 1,700 | 1,134 | 450 | 227 | 154 | 132 | 197 | 307 | 238 |
| 16 | a 510 | a 1,300 | 1,245 | 440 | 217 | 136 | 130 | 191 | 307 | 238 |
| 17 | 505 | a 1,000 | 1,278 | 448 | 171 | 113 | 126 | 191 | 307 | 238 |
| 18 | a 503 | 1,089 | 1,228 | 494 | 198 | 146 | 127 | 222 | 307 | 238 |
| 19 | a 501 | 1,312 | 1,257 | 410 | 167 | 153 | 164 | 222 | 307 | 238 |
| 20 | a 500 | 1,602 | 1,198 | 617 | 156 | 119 | 335 | 222 | 288 | ..... |
| 21 | a 530 | 1,502 | 1,166 | 952 | 148 | 122 | 304 | 206 | 288 | ..... |
| 22 | 564 | 2,642 | 1,123 | 1,006 | 157 | 98 | 292 | 197 | 296 | ..... |
| 23 | a 600 | 2,965 | 1,131 | 745 | 157 | 107 | 245 | 206 | 271 | ..... |
| 24 | a 560 | 2,673 | 877 | 811 | 138 | 92 | 260 | 197 | 271 | ..... |
| 25 | a 520 | 3,535 | 815 | 713 | 162 | 105 | 258 | 228 | 271 | ..... |
| 26 | 505 | 3,519 | 981 | 633 | 347 | 134 | 233 | 288 | 271 | ..... |
| 27 | a 500 | 3,090 | 819 | 616 | 518 | 132 | 235 | 403 | 254 | ..... |
| 28 | a 536 | 3,720 | 782 | 707 | 396 | 124 | 269 | 436 | 254 | ..... |
| 29 | a 570 | 3,734 | 749 | 749 | 212 | 118 | 254 | 383 | 254 | ..... |
| 30 | ..... | 3,409 | 722 | 487 | 233 | 102 | 213 | 325 | 254 | ..... |
| 31 | ..... | 3,096 | ..... | 649 | ..... | 106 | a 254 | ..... | 254 | ..... |

a Interpolated.

*Estimated monthly discharge of Huron River at Geddes, Mich., for 1904.*

| Month. | Discharge in second-feet. | | |
|---|---|---|---|
| | Maximum. | Minimum. | Mean. |
| February | 700 | 407 | 525 |
| March | 3,734 | 600 | 2,387 |
| April | 3,602 | 722 | 1,684 |
| May | 1,006 | 410 | 656 |
| June | 652 | 138 | 334 |
| July | 396 | 92 | 169 |
| August | 335 | 97 | 180 |
| September | 436 | 191 | 250 |
| October | 332 | 254 | 290 |
| November 1–19 | 248 | 238 | 239 |

## HURON RIVER AT FRENCH LANDING, MICH.

A temporary gage was erected at the Wabash Railroad bridge at Frenchville, and maintained for a few weeks during the low-water season of 1903. A new gage was erected August 5, 1904, at the highway bridge at French Landing. This gage consists of a vertical scale divided decimally attached to the downstream side of the right-hand bridge abutment. The gage is read twice each day by F. L. Robbe. The record is furnished by the Washtenaw Electric Company, of Ann Arbor, Mich. The stream freezes over in winter, and when frozen the conditions are unfavorable for the determination of the discharge. The right-hand bank is never overflowed. The highway may be overflowed for a short distance from the bridge during extreme freshets.

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

*Discharge measurements of Huron River at French Landing, Mich., in 1903 and 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1903. | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| September 16 | W. M. Gregory | 455 | 1.50 | [a] 1.70 | 685 |
| September 18 | do | 500 | 1.64 | [a] 2.20 | 824 |
| 1904. | | | | | |
| May 24 | R. E. Horton | 516 | 1.51 | [a] 2.00 | 781 |
| August 2 | W. M. Gregory | 322 | .61 | [b] .88 | 197 |
| August 31 | Horton and Beebe | 305 | .88 | [b] 1.49 | 269 |
| September 23 | H. R. Beebe | 352 | .96 | [b] 1.80 | 337 |
| September 23 | do | 371 | 1.04 | [b] 1.98 | 387 |

[a] Board gage at Wabash Railroad bridge.
[b] Permanent gage at highway bridge from which measurements are made.

*Mean daily gage height, in feet, of Huron River at French Landing, Mich., for 1904.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec.[a] | Day. | Aug. | Sept. | Oct. | Nov. | Dec.[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 1.28 | 2.60 | 1.75 | 1.18 | 17 | 1.10 | 1.20 | 1.85 | 1.22 | 1.08 |
| 2 | ..... | 1.58 | 1.95 | 1.75 | 1.20 | 18 | 1.12 | .88 | 2.15 | 1.25 | 1.22 |
| 3 | ..... | 1.78 | 1.85 | 1.50 | 1.52 | 19 | 1.22 | 1.38 | 1.65 | 1.22 | 1.48 |
| 4 | ..... | 1.58 | 2.10 | 1.32 | 1.28 | 20 | 1.37 | 1.22 | 1.78 | 1.12 | 2.10 |
| 5 | 1.27 | 1.42 | 1.78 | 1.30 | 1.00 | 21 | .87 | 1.28 | 1.85 | 1.28 | 1.48 |
| 6 | 1.10 | 1.45 | 1.75 | 1.28 | 1.85 | 22 | 1.54 | 1.68 | 1.85 | 1.68 | 1.48 |
| 7 | .80 | 1.88 | 1.75 | 1.10 | 1.38 | 23 | 1.72 | 1.80 | 1.58 | 1.32 | 1.48 |
| 8 | .42 | 1.42 | 1.72 | 1.58 | 1.08 | 24 | 1.50 | 1.72 | 1.52 | 1.28 | 1.68 |
| 9 | .60 | 1.20 | 1.90 | 1.42 | 1.05 | 25 | 1.47 | 1.60 | 1.92 | 1.28 | 1.58 |
| 10 | 1.27 | .55 | 1.65 | 1.15 | 1.22 | 26 | 1.44 | 2.32 | 1.70 | 1.25 | 1.50 |
| 11 | 1.24 | —.70 | 2.05 | 1.22 | 1.15 | 27 | 1.27 | 3.00 | 1.58 | 1.18 | 2.55 |
| 12 | 1.10 | .30 | 2.10 | 1.28 | 1.10 | 28 | 1.10 | 3.12 | 1.68 | 1.35 | 2.55 |
| 13 | .97 | 1.90 | 1.55 | 1.15 | 1.55 | 29 | 1.30 | 2.85 | 1.65 | 1.82 | 1.55 |
| 14 | .67 | 1.38 | 1.88 | 1.00 | 1.45 | 30 | 1.44 | 2.68 | 1.60 | 1.28 | 1.80 |
| 15 | .22 | 1.15 | 2.05 | 1.70 | 1.42 | 31 | 1.49 | ..... | 1.22 | ..... | 2.40 |
| 16 | 1.22 | 1.18 | 1.62 | 1.35 | 1.35 | | | | | | |

[a] Ice conditions during December.

## HURON RIVER AT FLATROCK, MICH.

A gage was erected on August 6, 1904, at the highway bridge below Metler's dam at Flatrock. The gage is a vertical scale, divided decimally, attached to the downstream side of the left-hand bridge abutment. The stream bed is of horizontal rock overlaid with sand and gravel. The current, aside from slight eddies and swirls carried by the water from the dam and mill above, is comparatively smooth and uniform. The gage is read twice each day by C. L. Metler.

The stream freezes over but little in winter, owing to the close proximity to the dam above, and the banks are smooth and are only overflowed in highest freshets, occurring at rare intervals, such as, for example, the flood of March 26, 1904, which overflowed the banks on the right-hand side of the bridge. Flatrock is located about 8 miles above the mouth of the stream.

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

*Discharge measurements of Huron River at Flatrock, Mich., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| August 1 | W. M. Gregory | 79 | 1.21 | 0.30 | 95 |
| August 6 | do | 144 | 1.43 | .98 | 208 |
| September 1 | Horton and Beebe | 168 | 1.63 | 1.29 | 274 |
| September 23 | H. R. Beebe | 177 | 1.68 | 1.35 | 298 |
| December 20 | C. C. Covert | 159 | 1.30 | 1.20 | 209 |

*Mean daily gage height, in feet, of Huron River at Flatrock, Mich., for 1904.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 1.30 | 2.10 | 1.40 | 1.30 | 17 | 1.05 | 1.10 | 1.40 | 1.35 | 1.25 |
| 2 | ..... | 1.35 | 1.70 | 1.60 | 1.30 | 18 | .95 | 1.10 | 1.85 | 1.35 | 1.45 |
| 3 | ..... | 1.80 | 1.80 | 1.30 | 1.15 | 19 | .95 | 1.10 | 1.75 | 1.35 | 1.40 |
| 4 | ..... | 1.60 | 1.85 | 1.40 | 1.40 | 20 | 1.19 | 1.10 | 1.75 | 1.30 | 1.30 |
| 5 | ..... | 1.40 | 1.65 | 1.30 | 1.35 | 21 | 1.01 | 1.20 | 1.75 | 1.40 | 1.60 |
| 6 | 0.95 | 1.30 | 1.60 | 1.40 | 1.60 | 22 | 1.12 | 1.12 | 1.75 | 1.60 | 1.35 |
| 7 | .85 | 1.50 | 1.65 | 1.25 | 1.55 | 23 | 1.60 | 1.55 | 1.60 | 1.40 | 1.55 |
| 8 | .45 | 1.65 | 1.70 | 1.65 | 1.30 | 24 | 1.40 | 1.40 | 1.35 | 1.30 | 1.60 |
| 9 | .34 | 1.30 | 1.75 | 1.45 | 1.35 | 25 | 1.15 | 1.55 | 1.65 | 1.30 | 1.35 |
| 10 | .59 | 1.20 | 1.70 | 1.35 | 1.40 | 26 | 1.20 | 1.90 | 1.55 | 1.40 | 1.15 |
| 11 | .88 | 1.28 | 1.80 | 1.40 | 1.30 | 27 | 1.25 | 2.65 | 1.45 | 1.40 | 1.85 |
| 12 | .82 | 1.10 | 1.90 | 1.45 | 1.25 | 28 | 1.10 | 2.65 | 1.45 | 1.35 | 2.50 |
| 13 | .90 | 1.22 | 1.80 | 1.40 | 1.15 | 29 | .95 | 2.62 | 1.45 | 1.50 | 2.10 |
| 14 | .82 | ..... | 1.45 | 1.30 | 1.75 | 30 | 1.40 | 2.55 | 1.45 | 1.35 | 2.00 |
| 15 | .46 | 1.25 | 1.95 | 1.40 | 1.25 | 31 | 1.35 | ..... | 1.35 | ..... | 1.85 |
| 16 | .26 | 1.25 | 1.80 | 1.40 | 1.40 | | | | | | |

MAUMEE RIVER NEAR SHERWOOD, OHIO.

This station was established May 19, 1903, by R. Winthrop Pratt. It is located at the highway bridge 2½ miles south of Sherwood, Ohio, and 200 feet upstream from the Cincinnati and Northern Railroad bridge. The inclined gage which was established on the bank under the north end of the bridge was destroyed. A regulation chain gage was installed in June, 1903. This is bolted to the hand rail of the bridge on the upstream side, 200 feet from the south abutment. The length of the chain from the end of the weight to the marker is 28.88 feet. The channel is straight for 1,000 feet above and 500 feet below the bridge. Both banks are high and clean, and both may overflow at extreme high water. A high-water gage is painted on the bridge abutment at the north end of the bridge. The observer is George J. Coffin. Discharge measurements are made from the two-span highway bridge, which has a total length of 300 feet between abutments. The initial point for soundings is the face of the south abutment.

The following bench marks have been established: (1) A copper bolt in the stepping stone of the west wing wall of the north abutment (stone is in tier just below the top tier). It is 22.30 feet above the zero of the gage. (2) A cut in the iron hand rail directly over the pulley of the gage. Its elevation is 29.69 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.

*Discharge measurements of Maumee River near Sherwood, Ohio, in 1904.*

| Date. | Hydrographer. | Width. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|
| | | *Feet.* | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Sec.-feet.* |
| February 12[a] | R. W. Pratt | 284 | 5,112 | 2.45 | 18.30 | 12,520 |
| March 31 | do | 282 | 4,973 | 3.42 | 18.50 | 17,000 |
| May 11 | do | 245 | 787 | 1.06 | 3.34 | 832 |
| May 31 | do | 250 | 1,022 | 1.54 | 4.34 | 1,572 |
| August 18[b] | do | 139 | 212 | .61 | 1.98 | 130 |
| September 27 | do | 244 | 506 | .39 | 2.20 | 199 |
| October 13 | do | 244 | 527 | .49 | 2.28 | 258 |
| December 3[b] | do | 156 | 170 | .64 | 1.83 | 109 |

[a] Partially frozen. Velocity partially estimated. Backwater due to ice gorge below.
[b] Wading at different section.

*Mean daily gage height, in feet, of Maumee River near Sherwood, Ohio, for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.50 | 16.00 | 20.60 | 18.80 | 6.70 | 4.70 | 2.80 | 2.30 | 2.40 | 2.40 | 2.00 | 1.85 |
| 2 | 3.40 | 13.00 | 21.30 | 18.50 | 5.80 | 5.20 | 2.80 | 2.30 | 2.40 | 2.45 | 2.00 | 1.85 |
| 3 | 3.20 | 11.00 | 21.80 | 18.00 | 5.00 | 4.90 | 2.70 | 2.30 | 2.30 | 2.40 | 2.00 | 1.85 |
| 4 | 3.00 | 10.50 | 21.60 | 18.00 | 4.70 | 4.70 | 2.60 | 2.40 | 2.30 | 2.30 | 2.00 | 1.85 |
| 5 | 2.70 | 10.20 | 21.00 | 18.10 | 4.20 | 4.30 | 2.60 | 2.40 | 2.20 | 2.30 | 2.00 | 1.85 |
| 6 | 2.70 | 10.70 | 21.00 | 17.50 | 3.90 | 4.00 | 2.70 | 2.40 | 2.20 | 2.20 | 2.00 | 1.80 |
| 7 | 2.70 | 12.50 | 20.40 | 14.80 | 3.60 | 3.80 | 2.90 | 2.30 | 2.20 | 2.20 | 2.00 | 1.80 |
| 8 | 2.70 | 17.50 | 20.90 | 9.60 | 3.30 | 3.60 | 5.10 | 2.30 | 2.20 | 2.15 | 1.95 | 1.80 |
| 9 | 2.70 | 18.50 | 20.30 | 8.60 | 3.40 | 3.40 | 7.60 | 2.20 | 2.20 | 2.30 | 1.95 | 1.80 |
| 10 | 2.70 | 19.30 | 19.30 | 8.50 | 3.40 | 3.20 | 7.70 | 2.20 | 2.20 | 2.40 | 1.95 | 1.80 |
| 11 | 2.70 | 19.50 | 16.40 | 8.40 | 3.40 | 3.00 | 7.90 | 2.20 | 2.20 | 2.30 | 1.95 | 1.85 |
| 12 | 2.70 | 18.30 | 12.20 | 8.00 | 3.20 | 2.90 | 8.10 | 2.20 | 2.10 | 2.30 | 1.95 | 1.90 |
| 13 | 2.70 | 17.40 | 10.30 | 7.50 | 3.10 | 2.80 | 7.50 | 2.20 | 2.10 | 2.25 | 1.90 | 1.90 |
| 14 | 2.70 | 16.30 | 9.60 | 7.00 | 3.10 | 2.70 | 6.60 | 2.10 | 2.10 | 2.20 | 1.90 | 1.90 |
| 15 | 2.70 | 14.70 | 8.50 | 6.40 | 3.10 | 2.60 | 5.90 | 2.10 | 2.05 | 2.20 | 1.85 | 2.00 |
| 16 | 2.70 | 12.30 | 7.20 | 5.80 | 3.00 | 2.60 | 4.60 | 2.10 | 2.05 | 2.20 | 1.85 | 2.00 |
| 17 | 2.70 | 11.50 | 7.20 | 5.30 | 3.00 | 2.50 | 3.60 | 2.10 | 2.05 | 2.20 | 1.85 | 2.00 |
| 18 | 2.70 | 10.50 | 6.50 | 4.90 | 3.00 | 2.50 | 3.20 | 2.00 | 2.05 | 2.20 | 1.85 | 2.00 |
| 19 | 2.70 | 9.80 | 8.60 | 4.60 | 3.00 | 2.50 | 2.90 | 2.00 | 2.10 | 2.20 | 1.85 | 2.00 |
| 20 | 2.70 | 9.30 | 11.70 | 4.30 | 3.00 | 2.50 | 2.70 | 2.20 | 2.30 | 2.20 | 1.85 | 2.00 |
| 21 | 6.60 | 8.70 | 11.70 | 4.00 | 3.20 | 2.50 | 2.60 | 2.30 | 2.20 | 2.15 | 1.85 | 2.00 |
| 22 | [a]19.00 | 8.30 | 12.80 | 3.90 | 3.40 | 2.50 | 2.60 | 2.40 | 2.20 | 2.15 | 1.85 | 2.00 |
| 23 | 22.50 | 8.40 | 14.20 | 3.70 | 3.50 | 2.70 | 2.50 | 3.40 | 2.20 | 2.15 | 1.85 | 2.00 |
| 24 | 22.75 | 8.70 | 14.00 | 4.20 | 3.50 | 3.00 | 2.50 | 3.30 | 2.20 | 2.10 | 1.85 | 2.00 |
| 25 | 20.25 | 11.00 | 14.30 | 4.40 | 3.40 | 3.10 | 2.50 | 2.90 | 2.20 | 2.00 | 1.85 | 2.00 |
| 26 | 19.25 | 11.50 | 18.50 | 10.20 | 3.40 | 3.20 | 2.40 | 2.80 | 2.20 | 2.00 | 1.85 | 2.00 |
| 27 | 18.50 | 11.30 | 19.85 | 12.90 | 3.50 | 3.20 | 2.30 | 2.60 | 2.20 | 2.00 | 1.85 | 2.35 |
| 28 | 18.00 | 10.10 | 19.65 | 11.90 | 3.40 | 3.10 | 2.30 | 2.60 | 2.20 | 2.00 | 1.85 | 2.50 |
| 29 | 17.50 | 11.30 | 19.15 | 9.80 | 3.40 | 3.00 | 2.30 | 2.50 | 2.30 | 2.00 | 1.85 | 3.65 |
| 30 | 17.00 | ..... | 18.30 | 7.90 | 3.80 | 2.80 | 2.30 | 2.40 | 2.40 | 2.00 | 1.85 | 4.00 |
| 31 | 16.50 | ..... | 18.60 | ..... | 4.20 | ..... | 2.30 | 2.40 | ..... | 2.00 | ..... | 4.00 |

[a] Backwater caused by ice gorge.

NOTE.—Ice conditions January 1 to March 11, and during December.

*Rating table for Maumee River near Sherwood, Ohio, from May 19, 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.* |
| 1.80 | 80 | 3.50 | 995 | 5.40 | 2,390 | 10.00 | 6,370 |
| 1.90 | 110 | 3.60 | 1,065 | 5.60 | 2,550 | 10.50 | 6,870 |
| 2.00 | 145 | 3.70 | 1,135 | 5.80 | 2,710 | 11.00 | 7,370 |
| 2.10 | 185 | 3.80 | 1,205 | 6.00 | 2,870 | 11.50 | 7,920 |
| 2.20 | 230 | 3.90 | 1,275 | 6.20 | 3,030 | 12.00 | 8,470 |
| 2.30 | 280 | 4.00 | 1,345 | 6.40 | 3,190 | 12.50 | 9,020 |
| 2.40 | 330 | 4.10 | 1,415 | 6.60 | 3,350 | 13.00 | 9,580 |
| 2.50 | 380 | 4.20 | 1,485 | 6.80 | 3,510 | 13.50 | 10,180 |
| 2.60 | 440 | 4.30 | 1,555 | 7.00 | 3,670 | 14.00 | 10,780 |
| 2.70 | 500 | 4.40 | 1,625 | 7.20 | 3,830 | 14.50 | 11,430 |
| 2.80 | 560 | 4.50 | 1,695 | 7.40 | 3,990 | 15.00 | 12,080 |
| 2.90 | 620 | 4.60 | 1,765 | 7.60 | 4,170 | 15.50 | 12,730 |
| 3.00 | 680 | 4.70 | 1,835 | 7.80 | 4,350 | 16.00 | 13,380 |
| 3.10 | 740 | 4.80 | 1,910 | 8.00 | 4,530 | 16.50 | 14,080 |
| 3.20 | 800 | 4.90 | 1,990 | 8.50 | 4,980 | 17.00 | 14,780 |
| 3.30 | 860 | 5.00 | 2,070 | 9.00 | 5,430 | 18.00 | 16,280 |
| 3.40 | 925 | 5.20 | 2,230 | 9.50 | 5,880 | 19.00 | 17,780 |

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 1.80 feet and 6.20 feet. Above 6.20 feet the rating curve is determined by one high-water measurement. Above gage height 17.00 feet the rating curve is a tangent, the difference being 150 per tenth.

*Estimated monthly discharge of Maumee River near Sherwood, Ohio, for 1903 and 1904.*

[Drainage area, 2,190 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | | | Rainfall in inches. |
|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. | Per cent of rainfall. | |
| 1903. | | | | | | | |
| January | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | 1.65 |
| February | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | 3.91 |
| March | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | 1.91 |
| April | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | 5.02 |
| May 20–31 | 1,205 | 230 | 756 | 0.345 | 0.154 | ---------- | 3.15 |
| June | 4,980 | 230 | 1,313 | .600 | .669 | 19 | 3.56 |
| July [a] | 620 | 110 | 287 | .131 | .151 | 3 | 4.56 |
| August [a] | 380 | 185 | 255 | .116 | .134 | 3 | 4.45 |
| September | 1,695 | 280 | 689 | .315 | .351 | 18 | 1.99 |
| October | 440 | 185 | 287 | .131 | .151 | 6 | 2.56 |
| November | 380 | 185 | 261 | .119 | .133 | 8 | 1.70 |
| December 1–10 [b] | 230 | 230 | 230 | .105 | .039 | ---------- | 2.42 |

[a] Discharge July 21 to August 4 interpolated. [b] River frozen December 11 to 31.

*Estimated monthly discharge of Maumee River near Sherwood, Ohio, etc.*—Continued.

| Month. | Discharge in second-feet. | | | Run-off. | | | Rainfall in inches. |
|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. | Per cent of rainfall. | |
| 1904. | | | | | | | |
| January | | | | | | | 4.55 |
| February | | | | | | | 3.33 |
| March 12–31 | 19,130 | 3,270 | 10,400 | 4.75 | 3.53 | | 6.39 |
| April | 17,480 | 1,135 | 6,648 | 3.04 | 3.39 | 95 | 3.58 |
| May | 3,430 | 680 | 1,130 | .516 | .595 | 18 | 3.28 |
| June | 2,230 | 380 | 860 | .393 | .438 | 20 | 2.18 |
| July | 4,620 | 280 | 1,354 | .618 | .712 | 19 | 3.74 |
| August | 860 | 145 | 313 | .143 | .165 | 5 | 3.42 |
| September | 330 | 165 | 232 | .106 | .118 | 4 | 3.14 |
| October | 355 | 145 | 229 | .105 | .121 | 6 | 1.87 |
| November | 145 | 95 | 113 | .052 | .058 | 40 | .14 |
| December | | | | | | | |

NOTE.—River frozen during omitted periods 1904.

### TIFFIN RIVER NEAR DEFIANCE, OHIO.

This station was established May 19, 1903, by R. Winthrop Pratt. It is located at the highway bridge on the new road to Evansport, one-half mile above the settlement of Brunnesburg, and 3 miles by river above the center of the city of Defiance, Ohio. A standard chain gage is located on the upstream handrail of the bridge, about 100 feet from the initial point for soundings. The length of the chain from the end of the weight to the marker is 28.00 feet. The gage is read once each day by F. A. Goddard. Discharge measurements are made from the single-span highway bridge 140 feet long between abutments. The initial point for soundings is the face of the south abutment. The channel is somewhat curved, but the section is at right angles to the direction of the current. The velocity is sluggish at low stages at the regular section, but can be measured by wading a short distance below the bridge. The bed of the stream is composed of gravel and rock, with deposits of silt at the sides of the channel. Both banks are high; the right bank is not liable to overflow, but the left will overflow at extreme high stages on account of a low place in the road. The bench mark is a cut on the upstream corner of the north abutment. Its elevation is 23.82 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 Tiffin River near Defiance, Ohio, in 1904.*

| Date. | Hydrographer. | Width. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|
| | | *Feet.* | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Sec.-feet.* |
| February 12 [a] | R. W. Pratt | 128 | 1,341 | 2.01 | 11.80 | 2,700 |
| March 31 | do | 130 | 1,639 | 2.67 | 14.00 | 4,378 |
| May 11 | do | 99 | 335 | .71 | 3.44 | 238 |
| August 18 [b] | do | 45 | 74 | .49 | 2.40 | 36 |
| September 27 | do | 90 | 234 | .21 | 2.52 | 50 |
| October 13 | do | 91 | 242 | .25 | 2.60 | 61 |
| December 3 [b] | do | 42 | 36 | .78 | 2.32 | 28 |

[a] Ice. [b] Wading at different section.

*Mean daily gage height, in feet, of Tiffin River near Defiance, Ohio, for 1904.*

| Day. | Jan.[a] | Feb.[a] | Mar.[a] | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.50 | 6.30 | 20.50 | 16.20 | 5.40 | 5.50 | 2.50 | 3.00 | 2.50 | 2.90 | 2.50 | 2.40 |
| 2 | 3.40 | 6.20 | 20.80 | 17.20 | 4.50 | 5.00 | 2.50 | 2.70 | 2.50 | ..... | 2.50 | 2.35 |
| 3 | ..... | 6.70 | 17.40 | 17.50 | 4.10 | 4.70 | ..... | 2.70 | 2.50 | 3.15 | 2.45 | 2.30 |
| 4 | 3.30 | 6.30 | 15.40 | 15.30 | 3.90 | 4.30 | 2.50 | 2.50 | ..... | 3.10 | 2.50 | ..... |
| 5 | 3.20 | 6.00 | 14.05 | 13.50 | 3.60 | ..... | 2.50 | 2.50 | 2.50 | 2.70 | 2.50 | ..... |
| 6 | 3.10 | 6.60 | ..... | 10.20 | 3.50 | 3.90 | 2.50 | 2.40 | 2.40 | 2.55 | ..... | ..... |
| 7 | 3.10 | ..... | 13.30 | 9.20 | 3.40 | 3.70 | 3.00 | ..... | 2.40 | 2.50 | 2.40 | ..... |
| 8 | 3.10 | 12.80 | 13.90 | 7.20 | ..... | 3.50 | 4.50 | 2.40 | 2.40 | 2.50 | 2.40 | ..... |
| 9 | 3.10 | 14.00 | 12.80 | 7.00 | 3.20 | 3.20 | 6.40 | 2.40 | 2.40 | ..... | 2.40 | ..... |
| 10 | ..... | 13.80 | 12.00 | 8.00 | 3.20 | 3.10 | ..... | 2.30 | 2.40 | 2.50 | 2.50 | ..... |
| 11 | 3.10 | 12.60 | 11.60 | 7.50 | 3.30 | 2.90 | 6.30 | 2.30 | ..... | 2.55 | 2.50 | ..... |
| 12 | 3.10 | 11.80 | 11.20 | 7.20 | 3.30 | ..... | 5.60 | 2.40 | 2.40 | 2.60 | 2.50 | [b]2.50 |
| 13 | 3.10 | 11.05 | ..... | 6.90 | 3.40 | 2.80 | 4.70 | 2.40 | 2.40 | 2.60 | ..... | ..... |
| 14 | 3.10 | ..... | 9.00 | 6.30 | 3.30 | 2.70 | 4.00 | ..... | 2.40 | 2.60 | 2.40 | ..... |
| 15 | 3.10 | 8.80 | 7.70 | 5.70 | ..... | 2.60 | 3.60 | 2.60 | 2.40 | 2.60 | 2.40 | ..... |
| 16 | 3.10 | 7.60 | 6.70 | 5.40 | 3.20 | 2.60 | 3.00 | 2.40 | 2.40 | ..... | 2.40 | ..... |
| 17 | 3.10 | 6.50 | 6.10 | ..... | 3.10 | 2.50 | ..... | 2.60 | 2.40 | 2.65 | 2.40 | 2.35 |
| 18 | 3.10 | 5.70 | 5.70 | 4.60 | 3.10 | 2.50 | 2.60 | 2.40 | ..... | 2.60 | 2.40 | ..... |
| 19 | 3.10 | 5.50 | 6.30 | 4.60 | 3.10 | ..... | 2.50 | 2.40 | 2.40 | 2.50 | 2.40 | ..... |
| 20 | 4.60 | 5.00 | 9.00 | 4.40 | 3.50 | 2.50 | 2.70 | 2.55 | 2.40 | 2.50 | ..... | ..... |
| 21 | 12.00 | ..... | 11.20 | 4.20 | 3.80 | 2.60 | 2.70 | ..... | 2.40 | 2.40 | 2.40 | ..... |
| 22 | 17.10 | 4.90 | 12.50 | 4.10 | ..... | 2.60 | 2.90 | 4.20 | 2.40 | 2.50 | 2.40 | ..... |
| 23 | 17.80 | 4.90 | 13.50 | 4.00 | 3.90 | 2.60 | 2.70 | 3.70 | 2.40 | ..... | 2.40 | ..... |
| 24 | ..... | 5.60 | 13.10 | ..... | 3.80 | 2.60 | ..... | 3.50 | 2.40 | 2.45 | 2.40 | 2.50 |
| 25 | 14.70 | 5.70 | 13.00 | 4.50 | 3.60 | 2.60 | 2.50 | 3.10 | ..... | 2.45 | 2.40 | ..... |
| 26 | 13.70 | 6.00 | 17.60 | 6.50 | 3.20 | ..... | 2.50 | 3.00 | 2.50 | 2.45 | 2.40 | 2.70 |
| 27 | 12.50 | 5.60 | 19.50 | 8.50 | 3.10 | 2.50 | 2.40 | 2.85 | 2.50 | 2.50 | ..... | 2.90 |
| 28 | 10.90 | ..... | 18.00 | 7.00 | 3.00 | 2.60 | 2.40 | ..... | 2.70 | 2.50 | 2.40 | 4.80 |
| 29 | 9.20 | 13.30 | 15.00 | 6.40 | 3.00 | 2.50 | 2.50 | 2.80 | 3.10 | 2.50 | 2.40 | 4.55 |
| 30 | 8.40 | ..... | 12.70 | 5.70 | 3.10 | 2.50 | 2.50 | 2.70 | 3.20 | ..... | 2.40 | 4.60 |
| 31 | ..... | ..... | 14.00 | ..... | 5.30 | ..... | ..... | 2.60 | ..... | 2.50 | ..... | 4.15 |

[a] Ice conditions January 1 to March 10. [b] River frozen December 12 to 31.

NOTE.—During frozen period gage read to water surface

*Rating table for Tiffin River near Defiance, 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.* |
| 2.30 | 24 | 4.10 | 484 | 5.80 | 1,034 | 9.00 | 2,200 |
| 2.40 | 33 | 4.20 | 515 | 5.90 | 1,068 | 9.50 | 2,400 |
| 2.50 | 46 | 4.30 | 546 | 6.00 | 1,102 | 10.00 | 2,600 |
| 2.60 | 64 | 4.40 | 578 | 6.20 | 1,172 | 10.50 | 2,811 |
| 2.70 | 88 | 4.50 | 610 | 6.40 | 1,242 | 11.00 | 3,035 |
| 2.80 | 114 | 4.60 | 642 | 6.60 | 1,312 | 11.50 | 3,260 |
| 2.90 | 140 | 4.70 | 674 | 6.80 | 1,382 | 12.00 | 3,485 |
| 3.00 | 167 | 4.80 | 706 | 7.00 | 1,454 | 12.50 | 3,710 |
| 3.10 | 194 | 4.90 | 738 | 7.20 | 1,526 | 13.00 | 3,935 |
| 3.20 | 221 | 5.00 | 770 | 7.40 | 1,598 | 13.50 | 4,160 |
| 3.30 | 249 | 5.10 | 803 | 7.60 | 1,670 | 14.00 | 4,385 |
| 3.40 | 277 | 5.20 | 836 | 7.80 | 1,742 | 15.00 | 4,835 |
| 3.50 | 306 | 5.30 | 869 | 8.00 | 1,814 | 16.00 | 5,285 |
| 3.60 | 335 | 5.40 | 902 | 8.20 | 1,890 | 17.00 | 5,735 |
| 3.70 | 364 | 5.50 | 935 | 8.40 | 1,966 | 18.00 | 6,185 |
| 3.80 | 393 | 5.60 | 968 | 8.60 | 2,044 | 19.00 | 6,635 |
| 3.90 | 423 | 5.70 | 1,001 | 8.80 | 2,122 | 20.00 | 7,085 |
| 4.00 | 453 | | | | | | |

The above table is applicable only for open-channel conditions. It is based upon 12 discharge measurements made during 1903 and 1904. It is fairly well defined between gage heights 2.3 feet and 3.1 feet, and poorly defined above. A single high-water measurement at gage height 14.0 feet determines the upper part of the curve. Above gage height 10.6 feet the rating curve is a tangent, the difference being 45 per tenth.

*Estimated monthly discharge of Tiffin River near Defiance, Ohio, for 1904.*

[Drainage area, 748 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| March 11–31 | 6,860 | 1,001 | 3,730 | 4.99 | 3.90 |
| April | 5,960 | 453 | 1,865 | 2.49 | 2.78 |
| May | 902 | 167 | 328 | .439 | .506 |
| June | 935 | 46 | 209 | .279 | .311 |
| July | 1,242 | 33 | 270 | .361 | .416 |
| August | 515 | 24 | 109 | .146 | .168 |
| September | 221 | 33 | 49.7 | .066 | .074 |
| October | 208 | 33 | 68.6 | .092 | .105 |
| November | 46 | 33 | 36.7 | .049 | .055 |

NOTE.—Discharge interpolated for missing days. River frozen January 1 to March 10, also during December.

BLACK RIVER NEAR ELYRIA, OHIO.

This station was established May 23, 1903, by R. Winthrop Pratt, the object being to furnish data for the water supply of near-by towns. The station is located at the Niel Avenue Bridge, about 5 miles from the center of the city of Elyria, Ohio. The original gage consisted of an inclined 1 by 6 inch board set on edge in the bank and secured to long stakes, and a vertical section nailed to stakes driven in the ground. The inclined section reads from zero to 5 feet and the vertical section from 5 to 12 feet. A regulation chain gage has been installed to replace the rod gage first established. The length from the end of the weight to the marker is 24.67 feet. The gage is read once each day by N. L. Durfee. Discharge measurements are made from the single-span highway bridge. The initial point for soundings is the face of the west abutment. The bed of the stream is a rock ledge, and there is but one channel. The current is sluggish at low stages at the regular section, but may be measured by wading 500 feet below. The channel is straight for 300 feet above and 200 feet below the bridge. The right bank is fairly high, and overflows only in extreme floods. When this occurs a large adjacent field is generally flooded. The left bank is a high, rocky bluff, from 75 to 100 feet in height, which can not overflow.

The following bench marks have been established: (1) A wire nail in the root of a double tree which is in line with the center of and 38 feet west from the west end of the bridge. Its elevation is 28.74 feet above gage datum. (2) The top of the flange of the fifth floor beam from the west abutment on the downstream end (almost under the pulley of the gage). Its elevation is 22.56 feet above gage datum. The elevation of the center of the pulley is 24.67 feet above gage datum. The drainage area at this station is 417 square miles.

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

*Discharge measurements of Black River near Elyria, Ohio, in 1904.*

| Date. | Hydrographer. | Width. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|
| | | *Feet.* | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| March 9 | R. W. Pratt | 79 | 188 | 3.68 | 3.55 | 691 |
| May 17 | do | 63 | 66 | 1.03 | 1.70 | [a] 68 |
| June 22 | do | 35 | 20 | .59 | 1.15 | 12 |
| June 22 | do | 35 | 19 | .58 | 1.15 | 11.4 |
| July 6 | do | 80 | 246 | 3.63 | 4.11 | 894 |
| July 28 | do | 41 | 24 | 1.04 | 1.28 | 25 |
| August 11 | do | 34 | 14 | .59 | 1.05 | 8.2 |
| October 4 | do | 35 | 17 | .60 | 1.14 | 10.5 |
| November 4 | do | 33 | 13 | .22 | .96 | 2.8 |

[a] Channel changed.

*Mean daily gage height, in feet, of Black River near Elyria, Ohio, for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.00 | 2.80 | 13.60 | 12.20 | 4.50 | 8.70 | 1.00 | 1.00 | 1.30 | 1.10 | 1.00 | 1.40 |
| 2 | 1.90 | 2.70 | 6.50 | 13.40 | 3.70 | 8.10 | 1.00 | 1.10 | 1.30 | 1.20 | 1.00 | 1.30 |
| 3 | 1.90 | 2.60 | 8.90 | 7.80 | 2.60 | 5.10 | 1.40 | 1.10 | 1.20 | 1.15 | 1.05 | 1.20 |
| 4 | 1.80 | 2.90 | 9.40 | 3.70 | 2.10 | 3.20 | 1.40 | 1.00 | 1.10 | 1.10 | 1.05 | 1.20 |
| 5 | 1.80 | 4.20 | 5.90 | 2.50 | 1.60 | 2.70 | 1.90 | 1.00 | 1.10 | 1.10 | 1.00 | 1.20 |
| 6 | 1.80 | 2.70 | 4.70 | 2.40 | 1.20 | 2.60 | 4.20 | 1.00 | 1.10 | 1.05 | .90 | 1.10 |
| 7 | 1.70 | 12.20 | 4.40 | 2.20 | 1.10 | 2.60 | 8.70 | .90 | 1.00 | 1.00 | .90 | 1.00 |
| 8 | 1.70 | 10.60 | 4.10 | 2.10 | 1.00 | 2.40 | 5.90 | .90 | 1.00 | 1.00 | .90 | 1.10 |
| 9 | 1.60 | 8.20 | 3.50 | 2.10 | 1.00 | 1.90 | 3.40 | 1.00 | 1.00 | .90 | 1.00 | 1.60 |
| 10 | 1.60 | 5.10 | 2.90 | 2.50 | 1.50 | 1.70 | 2.30 | 1.00 | 1.00 | .90 | 1.00 | 1.60 |
| 11 | 1.50 | 4.90 | 2.40 | 2.40 | 1.50 | 1.50 | 2.40 | 1.20 | .90 | 1.01 | 1.00 | 1.50 |
| 12 | 1.50 | 3.90 | 2.40 | 3.10 | 1.40 | 1.50 | 2.40 | 1.70 | 1.10 | 1.02 | 1.60 | 1.50 |
| 13 | 1.40 | 3.90 | 2.30 | 2.50 | 1.40 | 1.40 | 1.90 | 1.80 | 1.10 | 1.15 | 1.50 | 1.60 |
| 14 | 1.40 | 3.80 | 2.20 | 2.80 | 1.40 | 1.40 | 1.60 | 1.70 | 1.20 | 1.15 | 1.50 | 1.50 |
| 15 | 1.30 | 2.60 | 2.00 | 2.20 | 1.60 | 1.30 | 1.40 | 1.70 | 1.25 | 1.01 | 1.40 | 1.40 |
| 16 | 1.30 | 2.50 | 1.90 | 2.10 | 1.60 | 1.30 | 1.30 | 1.60 | 1.20 | 1.01 | 1.40 | 1.40 |
| 17 | 1.50 | 2.30 | 1.50 | 2.00 | 1.50 | 1.40 | 1.30 | 1.60 | 1.20 | 1.02 | 1.60 | 1.50 |
| 18 | 1.30 | 2.20 | 4.10 | 1.90 | 1.90 | 1.30 | 1.20 | 1.60 | 1.15 | 1.02 | 1.70 | 1.40 |
| 19 | 1.50 | 2.20 | 5.20 | 1.90 | 2.10 | 1.20 | 1.20 | 1.80 | 1.15 | 1.15 | 1.80 | a1.40 |
| 20 | 2.90 | 2.10 | 3.90 | 1.80 | 2.10 | 1.20 | 1.10 | 1.90 | 1.15 | 1.15 | 1.80 | 1.50 |
| 21 | 11.50 | 2.20 | 3.90 | 1.50 | 1.80 | 1.30 | 1.70 | 1.90 | 1.10 | 1.05 | 1.70 | 1.50 |
| 22 | 18.50 | 3.20 | 3.50 | 1.30 | 1.60 | 1.20 | 1.80 | 1.80 | 1.05 | 1.00 | 1.60 | 1.40 |
| 23 | 15.60 | 3.90 | 3.40 | 1.20 | 1.40 | 1.20 | 1.70 | 1.80 | .90 | 1.00 | 1.60 | 1.40 |
| 24 | 10.50 | 3.50 | 4.50 | 1.20 | 1.90 | 1.20 | 1.60 | 1.70 | .90 | 1.03 | 1.70 | 1.40 |
| 25 | 6.10 | 3.30 | 4.00 | 2.20 | 1.70 | 1.10 | 1.50 | 1.70 | .95 | 1.03 | 1.80 | 1.45 |
| 26 | 4.50 | 3.10 | 11.90 | 3.10 | 2.00 | 1.10 | 1.40 | 1.50 | 1.20 | 1.02 | 1.90 | 1.60 |
| 27 | 2.80 | 2.60 | 12.20 | 4.50 | 2.10 | 1.00 | 1.30 | 1.40 | 1.05 | 1.02 | 1.90 | 2.50 |
| 28 | 3.40 | 2.40 | 7.50 | 4.10 | 2.00 | 1.10 | 1.20 | 1.40 | .90 | 1.01 | 1.85 | 2.60 |
| 29 | 3.20 | 7.60 | 4.60 | 4.50 | 2.00 | 1.10 | 1.10 | 1.30 | .90 | 1.01 | 1.80 | 2.50 |
| 30 | 3.00 | ..... | 2.40 | 4.40 | 2.70 | 1.10 | 1.10 | 1.20 | .90 | 1.05 | 1.70 | 2.30 |
| 31 | 2.80 | ..... | 4.80 | ..... | 5.80 | ..... | 1.00 | 1.20 | ..... | 1.05 | ..... | 2.40 |

a Ice conditions January, February, and March, and also December 19 to 31.

## CUYAHOGA RIVER AT INDEPENDENCE, OHIO.

This station is located on a single-span highway bridge at the town of Independence, 10 miles south of Cleveland, Ohio, and 4 miles south of the gaging station formerly located on the highway bridge between Brooklyn and Newburg. It was established at this point September 21, 1903. The observer is W. H. Rupp. The initial point for soundings is the face of the eastern abutment. The gage is a regulation chain gage bolted to the hand rail of the bridge on the downstream side, 100 feet west of the initial point. The length from the end of the weight to the back of the ring is 26.84 feet. The conditions at this point are generally favorable, though the current at low water is sluggish, and in the center there is the remains of an old pier used in the support of a former two-span bridge.

The following bench marks have been established: (1) A cross cut on the northeast corner of the top stone of the northerly wing wall of the west abutment; elevation, 23.65 feet above gage datum. (2) A cross

cut on the southwest corner of the top stone of the southerly wing wall; elevation, 22.58 feet above gage datum. (3) The top of the inside eyebeam of the lower chord, downstream side, at a point 100 feet west of the initial point; elevation, 23.95 feet above gage datum. Elevation of the center of the pulley is 26.18 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 Cuyahoga River at Independence, Ohio, in 1904.*

| Date. | Hydrographer. | Width. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|
| | | *Feet.* | *Sq. feet.* | *Feet per. sec.* | *Feet.* | *Second-feet.* |
| March 7 | R. W. Pratt | 102 | 1,183 | 4.41 | 14.65 | 5,230 |
| April 15 | do | 78 | 397 | 2.40 | 7.05 | [a]952 |
| May 18 | do | 70 | 286 | 1.15 | 5.63 | [b]330 |
| June 25 | do | 68 | 293 | 1.33 | 5.52 | 390 |
| July 27 | do | 71 | 268 | 1.27 | 5.45 | 341 |
| August 11 | do | 76 | 276 | 1.52 | 5.61 | 420 |
| September 16 | do | 62 | 229 | .42 | 4.98 | 95 |
| October 5 | do | 62 | 239 | .52 | 5.10 | [c]125 |
| November 5 | do | 62 | 244 | .39 | 5.00 | [d]91 |
| December 7 | do | 64 | 262 | .57 | 5.15 | 150 |

[a] No flow in canal. [b] Canal, 32 second-feet. [c] Canal, 78 second-feet. [d] Canal, 67 second-feet.

*Mean daily gage height, in feet, of Cuyahoga River at Independence, Ohio, for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.70 | 11.70 | 17.00 | 16.30 | 8.70 | 11.20 | 5.30 | 5.50 | 5.10 | 4.95 | 5.10 | 5.05 |
| 2 | 5.70 | 10.70 | 17.00 | 15.10 | 8.40 | 14.80 | 6.60 | 6.70 | 5.10 | 4.90 | 5.05 | 5.10 |
| 3 | 5.60 | 10.70 | 17.00 | 13.40 | 8.00 | 13.80 | ..... | 5.60 | 5.10 | 4.90 | 5.00 | 4.75 |
| 4 | 5.50 | 10.00 | 17.00 | 11.50 | 7.40 | 12.00 | ..... | 5.30 | 5.10 | 5.10 | 5.15 | 4.70 |
| 5 | 6.50 | 9.70 | 17.00 | 10.10 | 7.00 | 10.40 | ..... | 5.20 | 5.10 | 5.10 | 5.00 | 4.75 |
| 6 | 5.40 | 9.70 | 14.00 | 9.10 | 6.50 | 8.90 | ..... | 5.10 | 5.05 | 5.05 | 5.05 | 5.00 |
| 7 | 5.40 | 12.00 | 14.00 | 8.20 | 6.20 | 7.90 | ..... | 5.10 | 5.20 | 5.00 | 4.90 | 5.15 |
| 8 | 5.50 | 12.00 | 10.40 | 8.70 | 6.10 | 7.00 | ..... | 4.90 | 5.00 | 5.10 | 5.10 | [a]5.00 |
| 9 | 5.50 | 12.00 | 9.90 | 8.30 | 6.00 | 6.50 | ..... | 5.10 | 5.00 | 5.10 | 5.05 | 5.10 |
| 10 | 5.40 | 12.00 | 9.50 | 7.90 | 6.00 | 6.50 | ..... | 5.10 | 5.00 | 5.00 | 5.05 | 5.00 |
| 11 | 5.40 | 12.00 | 8.60 | 7.90 | 5.90 | 5.90 | ..... | 5.60 | 4.90 | 4.95 | 5.10 | 5.00 |
| 12 | 5.40 | 12.00 | 7.80 | 7.80 | 5.90 | 5.90 | ..... | 5.20 | 4.90 | 5.10 | 5.10 | 4.90 |
| 13 | 5.60 | 12.00 | 7.30 | 7.80 | 5.80 | 5.80 | ..... | 5.10 | 5.10 | 5.10 | 5.15 | 5.05 |
| 14 | 5.50 | 12.00 | 6.90 | 7.30 | 5.60 | 7.10 | ..... | 5.60 | 5.10 | 5.15 | 5.00 | 5.00 |
| 15 | 5.60 | 12.00 | 6.80 | 7.00 | 5.70 | 5.70 | ..... | 5.20 | 5.05 | 5.10 | 5.20 | 5.00 |
| 16 | 5.60 | 12.00 | 6.30 | 6.80 | 5.70 | 5.60 | ..... | 5.20 | 5.00 | 5.05 | 5.10 | 5.00 |
| 17 | 5.60 | 12.00 | 9.30 | 6.60 | 5.60 | 5.55 | 6.00 | 5.20 | 4.95 | 4.95 | 5.10 | 5.00 |
| 18 | 5.60 | 12.00 | 9.40 | 6.50 | 5.60 | 5.30 | 5.80 | 5.10 | 4.90 | 4.95 | 5.15 | 5.00 |
| 19 | 5.50 | 12.00 | 9.20 | 6.40 | 6.50 | 5.70 | 5.80 | 4.90 | 4.90 | 4.90 | 5.05 | 5.00 |
| 20 | 5.60 | 12.00 | 8.70 | 6.20 | 6.50 | 5.30 | 5.80 | 5.30 | 4.80 | 4.95 | 5.10 | 5.00 |
| 21 | 11.00 | 11.00 | 8.60 | 6.10 | 6.10 | 5.70 | 5.30 | 5.30 | 4.90 | 4.95 | 4.95 | 5.00 |
| 22 | 11.00 | 11.00 | 10.80 | 6.00 | 6.50 | 5.10 | 5.30 | 5.20 | 4.90 | 5.00 | 5.00 | 5.00 |

*Mean daily gage height, in feet, of Cuyahoga River at Independence, Ohio, etc.*—Cont'd.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 12.00 | 11.00 | 9.60 | 6.20 | 6.50 | 5.70 | 6.30 | 5.80 | 4.85 | 5.10 | 5.05 | 5.10 |
| 24 | 12.00 | 11.00 | 9.00 | 6.20 | 7.50 | 5.70 | 5.80 | 5.50 | 4.85 | 5.00 | 5.10 | 5.15 |
| 25 | 12.00 | 11.00 | 16.30 | 7.30 | 7.30 | 5.60 | 5.50 | 5.20 | 4.90 | 5.20 | 4.80 | 5.40 |
| 26 | 12.00 | 11.00 | 15.20 | 7.00 | 7.00 | 5.30 | 5.50 | 5.50 | 4.85 | 5.20 | 4.90 | 5.55 |
| 27 | 12.00 | 10.80 | 12.10 | 7.40 | 10.40 | 5.20 | 5.50 | 5.30 | 5.10 | 5.10 | 4.85 | 8.75 |
| 28 | 12.00 | 11.00 | 11.60 | 7.80 | 8.80 | 5.50 | 5.90 | 5.20 | 5.10 | 5.05 | 4.90 | 7.65 |
| 29 | 12.00 | 16.00 | 10.60 | 8.80 | 8.20 | 5.40 | 5.50 | 5.20 | 5.00 | 5.05 | 5.05 | 6.55 |
| 30 | 12.00 | ..... | 11.10 | 8.90 | 7.90 | 5.30 | 5.50 | 5.15 | 4.85 | 5.00 | 5.15 | 5.35 |
| 31 | 11.80 | ..... | 11.00 | ..... | 11.00 | ..... | 5.50 | 5.05 | ..... | 4.80 | ..... | 5.35 |

[a] River frozen December 8 to 26.

NOTE.—High water January 21 to March 5 caused by ice gorge below station.

*Rating table for Cuyahoga River at Independence, Ohio, from September 21, 1903, to August 23, 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.* |
| 4.40 | 56 | 6.00 | 550 | 7.60 | 1,178 | 10.20 | 2,408 |
| 4.50 | 82 | 6.10 | 586 | 7.70 | 1,220 | 10.40 | 2,516 |
| 4.60 | 109 | 6.20 | 623 | 7.80 | 1,263 | 10.60 | 2,624 |
| 4.70 | 137 | 6.30 | 660 | 7.90 | 1,306 | 10.80 | 2,734 |
| 4.80 | 166 | 6.40 | 698 | 8.00 | 1,350 | 11.00 | 2,845 |
| 4.90 | 195 | 6.50 | 736 | 8.20 | 1,439 | 11.50 | 3,137 |
| 5.00 | 225 | 6.60 | 774 | 8.40 | 1,530 | 12.00 | 3,445 |
| 5.10 | 255 | 6.70 | 812 | 8.60 | 1,622 | 12.50 | 3,765 |
| 5.20 | 286 | 6.80 | 852 | 8.80 | 1,715 | 13.00 | 4,090 |
| 5.30 | 317 | 6.90 | 892 | 9.00 | 1,809 | 13.50 | 4,424 |
| 5.40 | 349 | 7.00 | 932 | 9.20 | 1,903 | 14.00 | 4,770 |
| 5.50 | 381 | 7.10 | 972 | 9.40 | 1,999 | 14.50 | 5,120 |
| 5.60 | 414 | 7.20 | 1,012 | 9.60 | 2,096 | 15.00 | 5,470 |
| 5.70 | 447 | 7.30 | 1,053 | 9.80 | 2,196 | 16.00 | 6,170 |
| 5.80 | 481 | 7.40 | 1,094 | 10.00 | 2,300 | 17.00 | 6,870 |
| 5.90 | 515 | 7.50 | 1,136 | | | | |

The above table is applicable only for open-channel conditions. It is based upon 10 discharge measurements made during 1903 and 1904. It is well defined between gage heights 4.70 feet and 7.05 feet. The table has been extended beyond these limits. One flood measurement at gage height 14.65 determines the upper part of the curve. Above gage height 13.7 feet the rating curve is a tangent, the difference being 70 per tenth. Some change seems to have occurred in the channel between August 11, 1904, and September 16, 1904. The above table has been applied to the medial date of August 24, 1904. The table following has been made for the remaining portion of the year.

*Rating table for Cuyahoga River at Independence, Ohio, from August 24 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.* |
| 4.80 | 37 | 5.20 | 157 | 5.50 | 252 | 5.80 | 352 |
| 4.90 | 66 | 5.30 | 188 | 5.60 | 285 | 5.90 | 386 |
| 5.00 | 96 | 5.40 | 220 | 5.70 | 318 | 6.00 | 421 |
| 5.10 | 126 | | | | | | |

The above table is applicable only for open-channel conditions. It is based upon 3 discharge measurements made during 1904, and parallels the curve for the first part of the year. This table is but a rough approximation.

*Estimated monthly discharge of Cuyahoga River at Independence, Ohio, for 1903 and 1904.*

[Drainage area, 698 square miles.]

| Month. | Discharge in second-feet. | | |
|---|---|---|---|
| | Maximum. | Minimum. | Mean. |
| 1903. | | | |
| September 21–30 | 195 | 109 | 160 |
| October | 3,077 | 56 | 472 |
| November [a] | 2,248 | 56 | 337 |
| 1904. | | | |
| March 11–31 | 6,380 | 660 | 2,342 |
| April | 6,380 | 550 | 1,641 |
| May | 2,845 | 414 | 959 |
| June | 5,330 | 255 | 1,094 |
| July [b] | 774 | 317 | 546 |
| August | 812 | 111 | 288 |
| September | 157 | 37 | 92.7 |
| October | 157 | 37 | 104 |
| November | 157 | 37 | 109 |
| December 1–7 | 142 | 10 | 76.1 |

[a] Discharge interpolated November 4 to 6, 1903.
[b] Discharge interpolated July 3 to 16, 1904.

NOTE.—The above estimates do not include the canal, which parallels the river.

## LAKE ONTARIO DRAINAGE BASIN.

Lake Ontario drainage basin comprises an area of about one-fourth of the State of New York. The principal streams that drain this area are the Oswego River, formed by the Seneca and Oneida rivers, which drain the chain of lakes in central New York; the Genesee, Salmon, and Black rivers. The upper part of the drainage basin is mostly hilly pasture land, the lower part gently rolling, cultivated land.

### OAK ORCHARD CREEK NEAR MEDINA, N. Y.

Oak Orchard Creek drains a swampy plateau having an elevation of 600 to 650 feet, lying in an easterly and westerly direction, south of Medina and Albion, N. Y.

At the western border of this swamp the stream turns northerly, crosses Erie Canal at Medina, and enters Lake Ontario at Point Breeze. The creek and its watershed are shown on the Albion, Medina, Ridgeway, and Oak Orchard sheets of the United States Geological Survey Topographic Atlas. The original Tonawanda Swamp had two outlets, the eastern end draining into Sandy Creek near Holly, N. Y., and the western end being tributary to Tonawanda Creek.

In 1824 a channel was cut across the western end of the Tonawanda Swamp entering Oak Orchard Creek, the object being to divert a portion of the flow of Tonawanda Creek to feed the long level of Erie Canal extending from Lockport to Rochester. This feeder channel intercepts the drainage from a portion of Tonawanda Creek watershed, including Whitney Creek, a small tributary. The flow from the diverting dam on Tonawanda Creek into the feeder channel is controlled by gates and is cut off, except during the season of canal navigation.

Water brought from lower Tonawanda Creek and from Lake Erie through the Erie Canal is passed over the waste weir at Medina, entering Oak Orchard Creek. The amount thus inverted to the watershed at times greatly exceeds that taken from Oak Orchard feeder for the supply of the canal; hence the importance of the stream for water-power purposes is chiefly confined to its lower course, about 18 miles, from Medina to its mouth. In this distance occurs a fall of 250 feet. The stream flows throughout much of the distance through a gulf cut in the drift overlying the Medina sandstone and affording a narrow flood plain.

A temporary gaging station was established on Oak Orchard Creek at Coon's bridge, which is located 6 miles from Medina along stream, and is just below the junction of Tonawanda feeder and the so-called Acker ditch, an artificial channel 2 miles in length leading Oak Orchard

Creek into the lower end of the feeder channel. The bridge has a single span of 60.8 feet between vertical masonry abutments. The low-water flow is confined in a central channel about 25 feet in width with hard gravel bed and smooth, uniform current, this channel having been excavated by the State of New York in 1894. A low-water gage, reading from zero to 4.5 feet, is attached vertically to a brace post underneath the downstream side of the bridge and at the right-hand side of the low-water channel.

The stream bends about 100 feet above the bridge, but is straight below, and the current passes underneath normal to the bridge. The remaining channel, unoccupied by the low-water course, is covered with silt and sand, with numerous willow bushes.

A secondary flood channel, having a width of 26 feet between abutments, is situated 283 feet to the right of the main bridge. Water also flows over a highway between the two bridges in extreme freshets.

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

*Drainage areas of Oak Orchard Creek.*[a]

| Location. | Place to place. | Total area. |
|---|---|---|
| | *Sq. miles.* | *Sq. miles.* |
| Above Coon's bridge | 142.6 | 142.6 |
| Above Medina feeder dam | 8.1 | 150.7 |
| Above Ridgeway | 7.5 | 158.2 |
| Above mouth | 23.7 | 281.9 |
| Swamp area | ..... | 32.0 |
| Tonawanda Creek above diverting dam | ..... | [b]236.3 |

[a] From United States Geological Survey Topographic Atlas.
[b] From Bien's Atlas of New York.

*Discharge measurements of Oak Orchard Creek near Medina, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| April 13 | Horton and Mott | 194 | 1.58 | 5.91 | 306 |
| July 21 | C. C. Covert | 20 | 1.19 | 1.20 | 24 |

*Mean daily gage height, in feet, of Oak Orchard Creek near Medina, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.90 | ..... | ..... | 9.38 | 5.68 | 2.40 | 1.10 | 0.92 |
| 2 | 1.95 | ..... | ..... | 9.25 | 5.42 | 2.25 | 1.32 | .92 |
| 3 | ..... | ..... | ..... | 8.90 | 5.28 | 2.08 | 1.30 | .88 |
| 4 | ..... | ..... | ..... | 8.80 | 5.00 | 2.00 | 1.30 | .78 |
| 5 | ..... | ..... | 6.60 | 8.42 | 4.75 | 2.00 | 1.50 | .78 |
| 6 | ..... | ..... | 7.20 | 8.08 | 4.40 | 1.92 | 1.50 | .80 |
| 7 | ..... | 6.80 | 8.58 | 7.60 | 4.10 | 1.82 | 1.55 | .70 |
| 8 | ..... | ..... | 9.58 | 7.10 | 3.82 | 1.90 | 1.40 | .70 |
| 9 | ..... | ..... | 9.70 | 6.82 | 3.50 | 1.98 | 1.35 | .70 |
| 10 | ..... | 7.50 | 10.60 | 6.50 | 3.25 | 1.90 | 1.45 | ..... |
| 11 | ..... | 7.60 | 10.60 | 6.25 | 3.05 | 1.82 | 1.35 | ..... |
| 12 | ..... | 7.40 | 10.20 | 6.05 | 2.85 | 1.72 | 1.55 | ..... |
| 13 | ..... | 7.05 | 9.60 | 5.88 | 2.65 | 1.68 | 1.60 | ..... |
| 14 | ..... | ..... | 8.85 | 5.68 | 2.50 | 1.55 | 1.55 | ..... |
| 15 | ..... | ..... | 8.02 | 5.45 | 2.60 | 1.48 | 1.80 | ..... |
| 16 | ..... | ..... | 7.48 | 4.98 | 2.45 | 1.40 | 1.78 | ..... |
| 17 | ..... | ..... | 6.80 | 5.15 | 2.30 | 1.32 | 1.70 | ..... |
| 18 | ..... | ..... | 6.45 | 5.50 | 2.35 | 1.22 | 1.50 | ..... |
| 19 | ..... | ..... | 6.22 | 5.85 | 2.38 | 1.20 | 1.38 | ..... |
| 20 | ..... | ..... | 6.15 | 5.78 | 2.70 | 1.12 | 1.25 | ..... |
| 21 | ..... | 1.30 | 6.10 | 6.15 | 2.60 | 1.22 | 1.08 | ..... |
| 22 | ..... | ..... | 6.88 | 6.45 | 2.35 | 1.18 | 1.22 | ..... |
| 23 | ..... | ..... | 8.38 | 6.55 | 2.30 | 1.10 | 1.15 | ..... |
| 24 | 2.50 | ..... | 9.25 | 6.50 | 2.22 | 1.08 | 1.10 | ..... |
| 25 | ..... | ..... | 10.00 | 6.98 | 2.15 | 1.08 | 1.10 | ..... |
| 26 | ..... | ..... | 10.62 | 7.05 | 2.10 | 1.02 | 1.05 | ..... |
| 27 | ..... | ..... | 10.38 | 6.85 | 2.00 | 1.00 | 1.00 | ..... |
| 28 | ..... | ..... | 10.40 | 6.65 | 1.88 | .98 | 1.05 | ..... |
| 29 | ..... | ..... | 10.15 | 6.40 | 1.78 | 1.00 | 1.08 | ..... |
| 30 | ..... | ..... | 9.58 | 6.25 | 1.75 | 1.05 | .95 | ..... |
| 31 | 2.30 | ..... | 9.35 | ..... | 1.90 | ..... | .98 | ..... |

NOTE.—Creek frozen January 1 to March 4.

## GENESEE RIVER NEAR MOUNT MORRIS, N. Y.

A current-meter gaging station was established at this point May 22, 1903. Observations of the stream stage are taken twice each day by J. T. Trewer, observer. The discharge measurements are made from a footbridge erected on the outriggers of the downstream side of the highway bridge, which consists of two spans of 174.3 and 31.7 feet, respectively. A weight and chain gage 15.50 feet in length is secured to the truss uprights near the center of the main bridge span on the upstream side. The bench mark is corner of wing wall left-hand abutment upstream side. Assumed elevation, 100.00 feet. Elevation datum plane of gage, 69.64 feet.

The river channel is of clay and straight for several hundred feet below the gage. About 300 feet above the bridge is an abrupt bend. The location of the gaging station and the course of the river from Jones Bridge to its outlet into Lake Ontario near Rochester is shown on the

Caledonia, Honeoye, and Rochester sheets of the United States Geological Survey Topographic Atlas. The gaging station is located a short distance below the inflow of Canaseraga Creek. The course of Genesee River below Mount Morris is very winding, traversing from side to side a flood plain 1½ miles average width. Owing to overflow on this flood plain, the high-water discharge is not determined at that point.

Cuba reservoir on the Genesee-Allegheny divide receives the drainage from a tributary area of 26.6 square miles. The storage volume is 454,000,000 cubic feet.[a] The overflow from this reservoir enters Allegheny River. The storage water may be turned into the summit level of the abandoned Genesee Valley canal, and thence into Genesee River.

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

*Discharge measurements of Genesee River near Mount Morris, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| March 10[b] | C. C. Covert | 3,870 | 2.45 | 25.30 | 9,413 |
| April 12 | Horton and Mott | 1,071 | 4.35 | 11.86 | 4,658 |
| July 16 | C. C. Covert | 250 | 2.57 | 5.25 | 644 |
| November 10 | Horton and Covert | 180 | 2.14 | 4.60 | 387 |

*Mean daily gage height, in feet, of Genesee River near Mount Morris, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.42 | 11.92 | 12.02 | 14.30 | 12.15 | 14.40 | 4.55 | 4.85 | 4.12 | 5.06 | 4.94 | 4.35 |
| 2 | 6.32 | 10.92 | 15.37 | 18.85 | 10.40 | 10.65 | 4.65 | 5.00 | 4.07 | 4.81 | 4.94 | 4.30 |
| 3 | 6.22 | 9.92 | 20.87 | 14.05 | 9.10 | 8.90 | 4.70 | 5.45 | 4.17 | 4.61 | 4.74 | 4.05 |
| 4 | 6.32 | 9.42 | 26.47 | 10.90 | 8.20 | 7.90 | 4.60 | 5.10 | 4.47 | 4.61 | 4.64 | 4.25 |
| 5 | 6.37 | 9.52 | 24.42 | 10.20 | 7.60 | 8.45 | 4.80 | 4.70 | 4.52 | 4.46 | 4.64 | 4.30 |
| 6 | 6.32 | 9.72 | 21.02 | 10.00 | 7.20 | 7.85 | 5.50 | 4.55 | 4.32 | 4.36 | 4.64 | 4.30 |
| 7 | 6.47 | 18.82 | 21.97 | 9.60 | 6.90 | 6.90 | 5.60 | 4.40 | 4.27 | 4.36 | 4.59 | 4.30 |
| 8 | 6.52 | 28.42 | 27.07 | 9.70 | 6.55 | 6.55 | 5.15 | 4.45 | 4.27 | 4.35 | 4.64 | 4.20 |
| 9 | 6.47 | 27.12 | 26.62 | 12.25 | 6.30 | 6.85 | 4.90 | 4.18 | 4.37 | 4.30 | 4.54 | 4.40 |
| 10 | 6.42 | 25.87 | 25.31 | 19.63 | 6.20 | 7.45 | 7.00 | 4.28 | 4.32 | 4.35 | 4.30 | 5.35 |
| 11 | 6.47 | 23.77 | 22.70 | 14.45 | 6.10 | 6.45 | 7.85 | 4.48 | 4.17 | 6.75 | 4.50 | 5.20 |
| 12 | 6.32 | 21.02 | 18.48 | 11.75 | 5.95 | 5.85 | 6.90 | 4.13 | 4.12 | 7.00 | 4.55 | 5.25 |
| 13 | 6.37 | 18.47 | 15.45 | 10.90 | 5.75 | 5.60 | 7.50 | 4.18 | 4.17 | 7.90 | 4.40 | 5.10 |
| 14 | 6.22 | 16.77 | 13.90 | 9.35 | 5.70 | 5.40 | 6.40 | 4.28 | 4.22 | 7.20 | 4.40 | 5.05 |
| 15 | 6.32 | 15.32 | 13.10 | 8.85 | 6.80 | 5.30 | 5.60 | 4.28 | 4.22 | 6.20 | 4.50 | 4.80 |
| 16 | 6.27 | 14.17 | 12.70 | 8.20 | 7.80 | 5.20 | 5.15 | 4.18 | 4.12 | 5.65 | 4.50 | 4.70 |
| 17 | 6.17 | 12.67 | 12.05 | 8.40 | 7.50 | 5.10 | 4.95 | 4.13 | 4.02 | 5.40 | 4.45 | 4.60 |
| 18 | 6.27 | 11.92 | 11.65 | 10.35 | 6.80 | 5.00 | 4.75 | 4.23 | 4.01 | 5.20 | 4.45 | 4.60 |
| 19 | 6.02 | 12.02 | 12.05 | 13.25 | 8.75 | 4.85 | 4.70 | 4.03 | 4.11 | 5.05 | 4.30 | 4.70 |

[a] Including Rockville reservoir.

[b] Backwater caused by ice jam.

*Mean daily gage height, in feet, of Genesee River near Mount Morris, N. Y., for 1904—Continued.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 6.22 | 11.77 | 14.05 | 10.15 | 10.15 | 4.85 | 4.55 | 4.33 | 4.11 | 4.95 | 4.45 | 4.70 |
| 21 | 6.22 | 11.77 | 16.95 | 9.55 | 8.75 | 5.05 | 4.50 | 4.88 | 4.11 | 5.00 | 4.40 | 4.80 |
| 22 | 6.42 | 12.27 | 16.80 | 10.35 | 8.00 | 5.20 | 4.45 | 4.78 | 4.06 | 5.80 | 4.45 | 4.70 |
| 23 | 17.68 | 12.47 | 23.70 | 10.70 | 7.15 | 5.40 | 4.70 | 4.78 | 4.01 | 6.00 | 4.45 | 4.80 |
| 24 | 24.02 | 12.42 | 27.15 | 9.95 | 7.20 | 5.15 | 5.00 | 4.93 | 3.96 | 6.35 | 4.35 | 7.10 |
| 25 | 19.57 | 12.37 | 26.15 | 10.30 | 7.95 | 4.90 | 6.30 | 4.88 | 4.21 | 5.85 | 4.30 | 10.50 |
| 26 | 16.07 | 11.32 | 26.60 | 10.20 | 6.90 | 4.75 | 6.20 | 4.58 | 4.91 | 5.50 | 4.40 | 9.35 |
| 27 | 15.27 | 10.67 | 24.80 | 9.10 | 8.10 | 4.65 | 5.80 | 4.38 | 5.36 | 5.45 | 4.35 | 9.75 |
| 28 | 14.07 | 11.07 | 19.65 | 13.35 | 9.10 | 4.55 | 5.35 | 4.38 | 4.86 | 5.45 | 4.00 | 19.80 |
| 29 | 12.82 | 12.02 | 13.05 | 14.00 | 7.25 | 4.60 | 6.75 | 4.32 | 4.71 | 5.24 | 4.15 | 10.90 |
| 30 | 12.42 | ..... | 11.20 | 13.25 | 6.70 | 4.55 | 5.60 | 4.22 | 5.01 | 5.19 | 4.45 | 7.80 |
| 31 | 12.27 | ..... | 11.75 | ..... | 12.90 | ..... | 5.15 | 4.02 | ..... | 5.04 | ..... | 7.80 |

NOTE.—Owing to the swiftness of the current the river seldom freezes over at the gaging station.

*Discharge measurements of Canaseraga Creek at Mount Morris, N. Y., in 1904.*

| Date. | Hydrographer. | Gage height.[a] | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Second-feet.* |
| April 12 | Horton and Mott | 17.42 | 1,048 |
| July 16 | C. C. Covert | 21.2 | 242 |

[a] Distance to water surface below top of horizontal tie bar, 20 feet from left-hand end downstream side of bridge.

*Discharge measurements of tailrace of Mount Morris power canal near Mount Morris, N. Y., in 1904.*

| Date. | Hydrographer. | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Second-feet.* |
| July 16 | C. C. Covert | 2.05 | 107 |
| November 10 | Horton and Covert | 2.08 | 116 |

## GENESEE RIVER AT ROCHESTER, N. Y.

During the low-water seasons of 1903 and 1904 a series of current-meter measurements were made in the Carroll and Fitzhugh and Johnson and Seymour raceways, which receive their water supply from the Johnson and Seymour dam on Genesee River in Rochester. The stage of the water was below the crest of the dam at all times during the period while measurements were being taken, in 1904, with the exceptions noted on the tables. Measurements were taken both in daytime and at night to determine the relative day and night use of water for power purposes, the water being drawn down to the mini-

mum stage, and they therefore represent, as nearly as could be obtained, the natural low-water flow of the stream at this point. The Johnson and Seymour dam is of masonry, practically water-tight. It is located below the point of diversion from Genesee River to Erie Canal feeder, and the pond above the dam receives only the water supply available to the extensive power development at the three falls on the river, which occur within the city limits.

A record of the daily stage of Genesee River in the pond, measured at a point 15 feet upstream from Johnson and Seymour dam, has been kept, beginning March, 1893; a survey and profile of the dam have also been made. From these data the high-water discharge has been calculated.

In addition to the canal feeder mentioned, water is diverted from Allen Creek at Scottsville and brought down the abandoned Genesee Valley canal for the supply of Erie Canal at Rochester. The water supply of the city of Rochester is also drawn from Hemlock Lake, the outlet of which is tributary to Genesee River.

A standard cypress gage staff 16 feet in length, graduated decimally with galvanized-iron division marks, was secured to the downstream face of the first pier from the right-hand abutment of the Elmwood Avenue Bridge in Rochester, and readings of the stage have been taken under the direction of E. A. Fisher, city engineer. This gage is located above the State diverting dam, which causes, however, but little fluctuation in the level.

The bridge consists of three spans of about 125 feet each. The stream bed is of gravel, clean, and fairly permanent, and conditions are favorable for the use of a current meter.

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

*Discharge measurements of Genesee River at Rochester, N. Y., in 1904.*

| Date. | Hydrographer. | Area. | Mean velocity. | Gage height.[a] | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Feet per sec.* | *Feet.* | *Second-feet.* |
| July 20 | C. C. Covert | 1,008 | 0.59 | 246.89 | 592 |
| August 9 | E. H. Fisher | 976 | .63 | 246.77 | 614 |
| August 10 | do | 957 | .62 | 246.69 | 589 |
| August 11 | do | 944 | .63 | 246.74 | 594 |
| August 12 | do | 963 | .69 | 246.79 | 667 |
| August 15 | do | 973 | .60 | 246.69 | 587 |
| August 27 | do | 972 | .72 | 246.82 | 703 |
| August 30 | do | 916 | .64 | 246.66 | 554 |
| September 17 | do | 923 | .56 | 246.64 | 511 |
| November 11 | C. C. Covert | 994 | .54 | 246.79 | 534 |

[a] City topographic datum.

*Mean daily elevation of water surface above city datum of Genesee River at Rochester, N. Y., for 1904.*

| Day. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | ..... | 250.49 | 250.29 | 250.59 | 246.99 | 247.29 | 246.59 | 246.99 | 246.99 | 246.69 |
| 2 | ..... | 248.49 | 251.89 | 249.99 | 250.59 | 246.99 | 247.09 | 246.69 | 247.09 | 246.99 | 246.79 |
| 3 | ..... | 252.19 | 251.79 | 248.59 | 249.39 | 247.09 | 246.99 | 246.69 | 246.99 | 246.99 | 246.79 |
| 4 | ..... | 252.89 | 250.69 | 248.39 | 248.59 | 247.09 | 247.19 | 246.79 | 246.89 | 246.89 | 246.79 |
| 5 | ..... | 252.89 | 249.79 | 248.29 | 248.39 | 246.99 | 247.19 | 246.79 | 246.79 | 246.89 | 246.79 |
| 6 | ..... | 252.49 | 249.49 | 248.19 | 248.49 | 247.09 | 246.99 | 246.79 | 246.69 | 246.89 | 246.79 |
| 7 | ..... | 252.29 | 249.39 | 248.09 | 248.29 | 247.19 | 246.99 | 246.69 | 246.69 | 246.89 | 246.79 |
| 8 | ..... | 253.69 | 249.19 | 247.99 | 247.99 | 247.39 | 246.89 | 246.69 | 246.69 | 246.89 | 246.79 |
| 9 | 256.74 | 254.19 | 249.19 | 247.89 | 247.89 | 247.19 | 246.79 | 246.69 | 246.69 | 246.89 | 246.79 |
| 10 | 257.29 | 254.69 | 250.99 | 247.79 | 248.19 | 247.49 | 246.69 | 246.69 | 246.69 | 246.79 | 246.79 |
| 11 | 254.19 | 254.09 | 252.19 | 247.69 | 248.19 | 247.79 | 246.69 | 246.69 | 246.69 | 246.79 | 246.79 |
| 12 | 252.59 | 253.19 | ..... | 247.64 | 247.99 | 247.99 | 246.69 | 246.69 | 247.59 | 246.79 | 246.79 |
| 13 | (a) | 251.29 | ..... | 247.59 | 247.69 | 248.19 | 246.79 | 246.69 | 247.69 | 246.69 | 246.79 |
| 14 | ..... | 249.79 | ..... | 247.49 | 247.49 | 248.39 | 246.79 | 246.69 | 248.09 | 246.69 | 246.79 |
| 15 | ..... | 248.79 | 249.09 | 247.79 | 247.49 | 247.79 | 246.69 | 246.69 | 247.89 | 246.69 | 246.79 |
| 16 | ..... | 248.89 | 248.89 | 248.59 | 247.49 | 247.49 | 246.69 | 246.69 | 247.49 | 246.69 | 246.79 |
| 17 | ..... | 248.49 | 248.89 | 248.69 | 247.39 | 247.39 | 246.69 | 246.69 | 247.29 | 246.69 | 246.79 |
| 18 | ..... | 248.19 | 248.89 | 248.29 | 247.19 | 247.09 | 246.69 | 246.69 | 247.19 | 246.69 | 246.79 |
| 19 | ..... | 248.09 | 250.99 | 248.39 | 247.09 | 246.99 | 246.69 | 246.59 | 247.09 | 246.69 | 246.79 |
| 20 | ..... | ..... | 250.59 | 249.39 | 247.04 | 246.89 | 246.69 | 246.59 | 246.99 | 246.69 | 246.79 |
| 21 | ..... | 249.59 | 249.49 | 249.29 | 247.04 | 246.89 | 246.79 | 246.69 | 246.99 | 246.69 | 246.79 |
| 22 | ..... | ..... | 249.99 | 248.89 | 247.29 | 246.89 | 246.89 | 246.69 | 246.89 | 246.69 | 246.79 |
| 23 | ..... | 251.69 | 250.09 | 248.59 | 247.39 | 246.89 | 246.99 | 246.69 | 247.09 | 246.69 | 246.79 |
| 24 | ..... | 253.29 | 249.89 | 248.39 | 247.39 | 246.99 | 246.89 | 246.59 | 247.39 | 246.69 | 246.79 |
| 25 | ..... | 253.49 | 249.89 | 248.19 | 247.19 | 247.29 | 246.89 | 246.59 | 247.49 | 246.69 | 246.89 |
| 26 | ..... | 255.09 | 249.79 | 248.09 | 247.09 | 247.79 | 246.89 | 246.79 | 247.29 | 246.69 | 246.99 |
| 27 | ..... | 255.99 | 249.49 | 247.89 | 246.99 | 247.69 | 246.79 | 246.89 | 247.19 | 246.69 | 248.09 |
| 28 | ..... | 256.09 | 249.29 | 248.19 | 247.09 | 247.49 | 246.79 | 247.09 | 247.19 | 246.69 | 249.99 |
| 29 | ..... | 254.69 | 251.39 | 248.39 | 246.99 | 247.39 | 246.69 | 246.99 | 247.19 | 246.69 | 252.19 |
| 30 | ..... | 251.89 | 251.29 | 248.09 | 246.89 | 247.89 | 246.69 | 246.99 | 247.09 | 246.69 | 249.89 |
| 31 | ..... | 250.29 | ..... | 248.79 | ..... | 247.49 | 246.59 | ..... | 246.99 | ..... | 248.89 |

(a) River frozen February 13–March 1, inclusive; no record.

*Discharge measurements of Fitzhugh and Carroll race at Rochester, N. Y., in 1904.*

| Date. | Hydrographer. | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Second-feet.* |
| June 30 | E. H. Fisher | 2.05 | 578 |
| July 5 | do | 2.10 | 442 |
| July 7 | do | 3.50 | 229 |
| July 8 | do | 3.42 | 309 |
| July 14 | do | 3.90 | 441 |
| July 18 | do | 3.05 | 408 |
| July 25 | do | 3.00 | 454 |

NOTE.—Discharge in raceway at given stage varies with running of turbines.

*Discharge measurements of Johnson and Seymour race at Rochester, N. Y., in 1904.*

| Date. | Hydrographer. | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Second-feet.* |
| June 30 | E. H. Fisher | 2.90 | 508 |
| July 1 | do | 2.80 | 462 |
| July 1 | do | 1.78 | 360 |
| July 5 | do | 3.35 | 477 |
| July 7 | do | 4.40 | 501 |
| July 8 | do | 4.20 | 545 |
| July 14 | do | 4.50 | 662 |
| July 25 | do | 4.00 | 454 |

NOTE.—Discharge in raceway at given stage varies with running of turbines.

## CANADICE LAKE OUTLET NEAR HEMLOCK, N. Y.

Canadice Lake is tributary to Genesee River through Hemlock Lake outlet and Honeoye Creek. The drainage basin is shown on the Honeoye and Wayland sheets of the United States Geological Survey Topographic Atlas.

Canadice Lake drains an area forming an irregular rectangle, the lake lying somewhat to the left of the longitudinal axis, with the greater portion of the drainage on the easterly slope. The westerly slope is narrow and precipitous; Bald Hill rising from altitude 1,090 feet at the lake to altitude 1,800 feet at the summit, the axis of the hill being parallel with the lake and an average of three-fourths mile distant therefrom.

The lake has a water surface area of 0.7 square mile and drains a total area of 12.6 square miles, 5.6 per cent of which is lake surface. A weir was constructed on the outlet at the foot of the lake by the city engineers department of Rochester, N. Y., in February, 1903. The entire yield of the drainage basin passes this weir. It consists of a standard thin-edged weir with a 5-foot crest and two end contractions, so arranged with needle timbers at the ends that the length may be increased to 14.96 feet with no end contractions during high water.

The weir crest stands 3 feet above the stream channel, and is never submerged by backwater. There are two additional rectangular gates, each 1 foot square, with three complete contractions, and a fourth partial contraction at the bottom. The outflow from the lake above the weir is controlled by gates. A reading of the depth on the weir is taken each morning, and also for each change of the gates; the depth being read to hundredths, and corrections being made for velocity of approach for the larger discharges.

The discharge is calculated by the Francis formula. The record has been furnished by E. A. Fisher, city engineer, and John F. Skinner, special assistant city engineer, of Rochester, N. Y.

*Estimated monthly discharge of Canadice Lake outlet near Hemlock, N. Y., for 1903.*

[Drainage area, 12.6 square miles.]

| Month. | Mean discharge in second-feet. | Mean elevation of lake above low water. | Run-off. | |
|---|---|---|---|---|
| | | | Second-feet per square mile. | Depth in inches. |
| February | ..... | 1.08 | ..... | ..... |
| March | ..... | 2.48 | ..... | ..... |
| April 26–30 | [a] 7.85 | 3.04 | 0.623 | 0.695 |
| May | 8.33 | 2.42 | .661 | .760 |
| June | 8.50 | 1.87 | .675 | .756 |
| July | 8.03 | 2.09 | .638 | .734 |
| August | 6.44 | 1.57 | .511 | .588 |
| September | 4.50 | 1.45 | .357 | .400 |
| October | 4.04 | 1.40 | .321 | .369 |
| November | 5.08 | 1.42 | .403 | .451 |
| December | 5.90 | 1.27 | .468 | .538 |

[a] Mean for days observed taken as mean for entire month.

## HONEOYE CREEK AT EAST RUSH, N. Y.

A gaging station was established February 13, 1903, on Honeoye Creek at the gristmill in the village of East Rush. The record includes the flow over the dam, which is of timber, having a crest varying somewhat in level 150.15 feet in length; also the discharge through two Leffel standard turbines, one 48 inches, the other 35 inches diameter. A record is kept of the head on the turbines and the number of hours each runs per day and the average gate opening. The latter is obtained by noting the number of gear teeth out of the total possible number through which the wheel gates stems may be turned to open the gates, allowance being made for lost motion. The bench mark on the window sill of the mill near flume is assumed at elevation 100.00, the gages being set with their zero marks as below:

| | |
|---|---|
| Crest gage elevation | 94.855 |
| Tailrace gage | 87.380 |
| Difference | 7.475 |

Honeoye Creek is the outlet of Honeoye Lake, which forms one of a group of narrow parallel lakes similar to the Finger Lakes of the Seneca River basin and located to the west of the latter. Honeoye Creek is joined 4 miles below its source by the combined outlet of Hemlock and Canadice lakes, which enters Genesee River near Rochester Junction. This group of lakes has areas and elevations as indicated below: [a]

[a] The drainage basin of Honeoye Creek is shown on the Honeoye, Canandaigua, Naples, and Wayland sheets of the U. S. Geological Survey topographic atlas, from which the areas have been taken, with the exception of those for Hemlock and Canadice lakes, which are from surveys of Rochester waterworks.

| Location. | Elevation. | Water-surface area. | Drainage area. | Per cent water surface. |
|---|---|---|---|---|
| | *Feet.* | *Sq. miles.* | *Sq. miles.* | |
| Hemlock Lake | 896 | 2.8 | 46.8 | 6.12 |
| Canadice Lake | 1,092 | 0.7 | 12.6 | 5.57 |
| Honeoye Lake | 800 | 2.5 | 39.6 | 6.41 |

Honeoye Creek enters Genesee River at Genesee Valley Junction. The entire drainage area is approximately rectangular, having a length of 30 miles; average width, 9.5 miles. The fall of 280 feet in the course of the stream has been largely utilized by the construction of dams.

The lakes, which serve as natural reservoirs, have inlets draining considerable areas at their uppermost ends. The slopes adjacent to the lakes themselves are narrow and steep and are drained by gulleys and torrential brooks. The area below the lakes is rolling, the soil rich and extensively cultivated. The stream tributaries are not numerous, but ramify in such manner as to give good drainage of all portions of the area.

The diversion from Hemlock Lake by the city of Rochester is to be added to the measured run-off at East Rush to obtain the total yield of the drainage basin. The average diversion rate is about 22 second-feet.

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

*Drainage areas of Honeoye Creek.*

| Location. | Place to place. | Total. |
|---|---|---|
| | *Sq. miles.* | *Sq. miles.* |
| Hemlock Lake, above outlet | 46.8 | ..... |
| Hemlock Lake outlet to Canadice Lake outlet | .1 | 46.9 |
| Canadice Lake, above outlet | 12.6 | ..... |
| Canadice Lake outlet to Hemlock Lake outlet | 18.9 | 31.5 |
| Junction of Hemlock and Canadice Lake outlets | ..... | 78.4 |
| Hemlock Lake outlet, from junction to Honeoye Creek | 15.6 | 94.0 |
| Honeoye Lake, above outlet | 39.6 | ..... |
| Honeoye Creek, from lake outlet to junction of Hemlock Lake outlet | 31.7 | 71.3 |
| Honeoye and Hemlock Lake outlets at junction | ..... | 165 |
| Honeoye Creek junction to Honeoye Falls | 44.0 | 209 |
| Honeoye Falls to East Rush | 50.0 | 260 |
| Honeoye Creek, East Rush to mouth | 28.0 | 288 |

*Mean daily discharge, in second-feet, of Honeoye Creek at East Rush, N. Y., for 1903 and 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | | | | | |
| 1 | (a) | ..... | (b) | 490 | 108 | 55 | 108 | 65 | 225 | 33 | 34 | 31 |
| 2 | ..... | ..... | 293 | 381 | 108 | 55 | 108 | (b) | 129 | 33 | 33 | 32 |
| 3 | ..... | ..... | 293 | 417 | (b) | 55 | 76 | 44 | 85 | 33 | (b) | 36 |
| 4 | ..... | ..... | 263 | 2,710 | 86 | 55 | (b) | 44 | 85 | (b) | 34 | 32 |
| 5 | ..... | ..... | 323 | (b) | 86 | 76 | (b) | 225 | 65 | 33 | 52 | 32 |
| 6 | ..... | ..... | 420 | 608 | 108 | 35 | 76 | 173 | (b) | 33 | 69 | (b) |
| 7 | ..... | ..... | 353 | 690 | 86 | (b) | 76 | 129 | 44 | 33 | 74 | 36 |
| 8 | ..... | ..... | (b) | 526 | 86 | 35 | 76 | 85 | 44 | 37 | (b) | 31 |
| 9 | ..... | ..... | 1,295 | 526 | 86 | 35 | 76 | (b) | 33 | 129 | 61 | 33 |
| 10 | ..... | ..... | 652 | 381 | (b) | 35 | 76 | 129 | 33 | 75 | 43 | 32 |
| 11 | ..... | ..... | 1,014 | 245 | 66 | 55 | 55 | 85 | 65 | (b) | 43 | 45 |
| 12 | ..... | ..... | 614 | (b) | 76 | 55 | (b) | 85 | 65 | 65 | 43 | 59 |
| 13 | ..... | 265 | 526 | 305 | 76 | 76 | 55 | 65 | (b) | 55 | 32 | (b) |
| 14 | ..... | 145 | 526 | 305 | 66 | (b) | 55 | 65 | 44 | 44 | 39 | 38 |
| 15 | ..... | (b) | (b) | 526 | 76 | 76 | 76 | 44 | 55 | 44 | (b) | 29 |
| 16 | ..... | 219 | 381 | 690 | 66 | 76 | 76 | (b) | 55 | 44 | 43 | 29 |
| 17 | ..... | 85 | 417 | 526 | (b) | 76 | 76 | 44 | 44 | 33 | 104 | 39 |
| 18 | ..... | 294 | 417 | 363 | 55 | 76 | 76 | 44 | 85 | (b) | 150 | 25 |
| 19 | ..... | 234 | 381 | (b) | 66 | 76 | (b) | 44 | 65 | 65 | 82 | 23 |
| 20 | ..... | 212 | 345 | 256 | 66 | 76 | 76 | 44 | (b) | 65 | 53 | (b) |
| 21 | ..... | 294 | 369 | 286 | 66 | (b) | 76 | 44 | 33 | 55 | 57 | 34 |
| 22 | ..... | (b) | (b) | 256 | 55 | 76 | 55 | 85 | 33 | 44 | (b) | 52 |
| 23 | ..... | 146 | 972 | 226 | 55 | 108 | 196 | (b) | 33 | 43 | 52 | 55 |
| 24 | ..... | 146 | 1,427 | 174 | (b) | 76 | 152 | 65 | 32 | 38 | 71 | 46 |
| 25 | ..... | 135 | 875 | 174 | 66 | 174 | 86 | 65 | 32 | (b) | 136 | (b) |
| 26 | ..... | 168 | 608 | (b) | 66 | 196 | (b) | 129 | 32 | 33 | (b) | 60 |
| 27 | ..... | 155 | 608 | 152 | 55 | 108 | 66 | 173 | (b) | 33 | 59 | (b) |
| 28 | ..... | 617 | 527 | 152 | 76 | (b) | 66 | 173 | 32 | 37 | 53 | 43 |
| 29 | ..... | ..... | (b) | 152 | 66 | 108 | 66 | 173 | 32 | 38 | (b) | 33 |
| 30 | ..... | ..... | 315 | 130 | (b) | 2,263 | 66 | (b) | 32 | 39 | 32 | 33 |
| 31 | ..... | ..... | 444 | ..... | (b) | ..... | 66 | 173 | ..... | 34 | ..... | 33 |
| 1904. | | | | | | | | | | | | |
| 1 | (b) | ..... | 520 | 366 | (b) | 407 | 25 | 80 | c 15 | 68 | 32 | 15 |
| 2 | 26 | ..... | 445 | 472 | 193 | 254 | 24 | 32 | c 14 | 67 | 53 | 35 |
| 3 | (b) | ..... | 1,014 | (b) | 193 | 150 | (b) | c 10 | 24 | 67 | 26 | 39 |
| 4 | 26 | ..... | 1,309 | 301 | 172 | 105 | (b) | c 11 | (b) | 43 | 53 | c 7 |
| 5 | 17 | ..... | 682 | 253 | 150 | (b) | 25 | 22 | 31 | 49 | 39 | 23 |
| 6 | 22 | ..... | (b) | 323 | 126 | 126 | 18 | 31 | 28 | 67 | (b) | 50 |
| 7 | 31 | ..... | 1,528 | 193 | 106 | 95 | 16 | (b) | 26 | 34 | 27 | 40 |
| 8 | 37 | ..... | 2,188 | 171 | (b) | 73 | 22 | 31 | 26 | 38 | 50 | 49 |
| 9 | 31 | ..... | 718 | 175 | 106 | 82 | (b) | 31 | 19 | (b) | 50 | 27 |
| 10 | (b) | ..... | 553 | (b) | 106 | 82 | (b) | 31 | 31 | 43 | 44 | 26 |
| 11 | 31 | ..... | 367 | 253 | 106 | 68 | 191 | 24 | (b) | 47 | 44 | c 7 |
| 12 | 31 | ..... | 302 | 193 | 106 | (b) | 69 | 49 | 42 | 68 | 37 | 26 |
| 13 | 31 | ..... | (b) | 149 | 106 | 87 | 131 | 50 | 18 | 68 | c 7 | 26 |
| 14 | 20 | ..... | 305 | 171 | 69 | 82 | 60 | (b) | 52 | 67 | 27 | 24 |
| 15 | 19 | ..... | 275 | 127 | (b) | 82 | 34 | 29 | 28 | 52 | 52 | 34 |
| 16 | 13 | ..... | 186 | 68 | 415 | 60 | 34 | 36 | 36 | (b) | 56 | 32 |
| 17 | (b) | ..... | 560 | (b) | 312 | 56 | (b) | 36 | 57 | 67 | 50 | 32 |
| 18 | 36 | ..... | 410 | 223 | 253 | 23 | 30 | 36 | (b) | 31 | 22 | c 7 |
| 19 | 19 | ..... | 483 | 518 | 379 | (b) | 14 | 36 | 46 | 23 | 29 | 27 |
| 20 | 31 | ..... | (b) | 343 | 476 | 30 | c 15 | 35 | 55 | 30 | c 7 | 26 |

a Stream frozen from January 1 to February 12, 1903.
b Sunday or holiday; no record. No estimate made owing to pondage.
c Flow held back by pondage.

*Mean daily discharge, in second-feet, of Honeoye Creek at East Rush, N. Y., etc.*—Cont'd.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | | | | | |
| 21 | 21 | ..... | 445 | 172 | 304 | 23 | a 10 | (b) | 54 | 27 | 46 | 34 |
| 22 | 31 | ..... | 445 | 451 | (b) | 33 | a 5 | 49 | 46 | 41 | 46 | 32 |
| 23 | 91 | ..... | 1,357 | 563 | 193 | 36 | a 10 | 36 | 32 | (b) | 61 | 32 |
| 24 | (c) | ..... | 816 | (b) | 223 | 27 | (b) | 36 | 23 | 37 | a 7 | 36 |
| 25 | ..... | 190 | 964 | 343 | 149 | 32 | 126 | a 12 | (b) | 38 | 41 | a 8 |
| 26 | ..... | 70 | 1,065 | 223 | 132 | (b) | 123 | a 13 | 68 | 38 | 40 | 35 |
| 27 | ..... | 102 | (b) | 193 | 123 | 32 | 112 | a 13 | 66 | 38 | a 7 | 153 |
| 28 | ..... | (b) | 522 | 223 | 129 | 32 | 40 | (b) | 66 | 38 | 61 | 418 |
| 29 | ..... | 563 | 377 | 450 | (b) | 24 | 132 | 21 | 283 | 38 | 63 | 56 |
| 30 | ..... | ..... | 341 | 342 | 145 | 24 | 69 | 31 | 65 | 38 | 66 | 45 |
| 31 | ..... | ..... | 310 | ..... | 122 | ..... | (b) | 17 | ..... | 31 | ..... | 35 |

a Flow held back by pondage.
b No record.
c Stream frozen January 24 to February 24, inclusive; record not available.

*Estimated monthly discharge of Honeoye Creek at East Rush, N. Y., for 1903 and 1904.*

[Drainage area, 238 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum.b | Mean. | Second-feet per square mile. | Depth in inches. |
| 1903. | | | | | |
| January a | ..... | ..... | ..... | ..... | ..... |
| February, 16 days | 617 | ..... | 222 | 0.933 | 0.486 |
| March, 26 days | 1,427 | ..... | 564 | 2.37 | 2.29 |
| April, 26 days | 2,710 | ..... | 448 | 1.88 | 1.82 |
| May, 25 days | 108 | ..... | 74.9 | .315 | 2.92 |
| June, 26 days | 2,263 | ..... | 161 | .677 | .655 |
| July, 26 days | 196 | ..... | 81.2 | .341 | .304 |
| August, 26 days | 225 | ..... | 95.9 | .403 | .330 |
| September, 26 days | 225 | ..... | 54.3 | .228 | .220 |
| October, 27 days | 129 | ..... | 45.8 | .193 | .194 |
| November, 24 days | 136 | ..... | 60.4 | .254 | .227 |
| December, 26 days | 60 | ..... | 37.3 | .157 | .152 |
| 1904. | | | | | |
| January, 19 days a | ..... | ..... | 29.7 | .125 | .884 |
| February a | ..... | ..... | ..... | ..... | ..... |
| March, 27 days | 2,188 | ..... | 685 | 2.88 | 2.89 |
| April, 26 days | 563 | ..... | 279 | 1.17 | 1.13 |
| May, 26 days | 476 | ..... | 188 | .790 | .764 |
| June, 26 days | 407 | ..... | 81.7 | .343 | .332 |
| July, 24 days | 191 | ..... | 55.6 | .234 | .209 |
| August, 27 days | 80 | ..... | 31.0 | .130 | .130 |
| September, 26 days | 283 | ..... | 48.1 | .202 | .195 |
| October, 28 days | 68 | ..... | 46.2 | .194 | .202 |
| November, 29 days | 66 | ..... | 39.4 | .166 | .179 |
| December | 418 | ..... | 46.3 | .195 | .225 |

a Stream frozen January 1 to February 12, 1903; also January 24 to February 24, 1904.
b Regimen of stream disturbed by pondage.

NOTE.—This discharge does not include the diversion from Hemlock Lake for water supply for Rochester.

### SKANEATELES LAKE OUTLET AT WILLOWGLEN, N. Y.[a]

The daily discharge over a thin-edged weir, located in the village of Willowglen, 1½ miles below the foot of Skaneateles Lake, has been observed, beginning March 10, 1895. The weir has a crest length of 27 feet, with two end contractions. The discharge is calculated from the observed depth on a stake set with its top at crest level 5.2 feet upstream from the weir, by means of the Francis formula, including corrections for end contractions and velocity of approach.

Beginning July 1, 1894, the water supply of the city of Syracuse has been drawn from Skaneateles Lake and the amount of its diversion should be added to the discharge over Willowglen weir to obtain the total run-off from the drainage basin. The calculated diversion, as determined from the record of gate openings and head at the inlet gates, using the formula for orifices with a constant coefficient stated as 0.62, have been furnished by the city of Syracuse. The observations were taken at the weir and gates by Edward Conron.

*Drainage areas of Skaneateles Lake.*[a]

| Location. | Area. |
|---|---|
| | *Sq. miles.* |
| Land surface above State dam at Skaneateles | 60.25 |
| Water surface of lake at Skaneateles | 12.75 |
| Total drainage area above foot of lake | 73.00 |
| (Water surface above foot of lake is 17.46 per cent.) | |
| Total area above Willowglen weir | 74.25 |
| Area above Erie Canal at Jordan | 93.00 |

[a] Areas here given have been taken from proceedings in condemnation of water powers on Skaneateles outlet. The lake and its tributary area are shown on the Skaneateles, Tully, Cortland, and Moravia sheets of the U. S. Geological Survey topographic atlas.

The lake surface is at an elevation about 865 feet above tide.

The average width of the land surface on the two sides of the lake is 2½ miles. In this distance occurs a rise of 400 to 800 feet, the greater portion being within 1 mile of the lake on either side. The surface inflow takes place through numerous short lateral feeders flowing down these slopes.

Skaneateles Lake outlet enters Seneca River above Cross Lake, crossing Erie Canal at Jordan. The fall from the foot of the lake to this point is 465 feet.

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

[a] For complete description of gagings which have been made of this stream, see Report on Stream Gagings, contained in Supplement, Report of State Engineer and Surveyor of New York for 1902 pp. 61 to 76.

*Mean daily discharge,[a] in second-feet, of Skaneateles Lake outlet at Willowglen, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 91.2 | 74.7 | 80.0 | 116.2 | 146.0 | 129.2 | 91.2 | 91.2 | 122.7 | 103.4 | 103.4 | 85.5 |
| 2 | 91.2 | 69.6 | 82.8 | 122.7 | 146.0 | 129.2 | 91.2 | 91.2 | 122.7 | 103.4 | 103.4 | 85.5 |
| 3 | 91.2 | 69.6 | 88.3 | 116.2 | 146.0 | 129.2 | 91.2 | 91.2 | 135.8 | 103.4 | 103.4 | 85.5 |
| 4 | 91.2 | 74.7 | 85.5 | 109.8 | 142.5 | 129.2 | 91.2 | 91.2 | 135.8 | 103.4 | 103.4 | 85.5 |
| 5 | 91.2 | 80.0 | 85.5 | 109.8 | 142.5 | 129.2 | 91.2 | 91.2 | 135.8 | 106.6 | 103.4 | 85.5 |
| 6 | 91.2 | 97.2 | 85.5 | 109.8 | 142.5 | 129.2 | 91.2 | 91.2 | 135.8 | 106.6 | 103.4 | 85.5 |
| 7 | 91.2 | 109.8 | 122.7 | 109.8 | 142.5 | 129.2 | 91.2 | 97.2 | 135.8 | 103.4 | 100.3 | 85.5 |
| 8 | 91.2 | 116.2 | 116.2 | 109.8 | 142.5 | 129.2 | 91.2 | 119.4 | 119.4 | 103.4 | 100.3 | 85.5 |
| 9 | 91.2 | 100.3 | 85.5 | 109.8 | 142.5 | 129.2 | 91.2 | 119.4 | 119.4 | 103.4 | 100.3 | 82.8 |
| 10 | 91.2 | 94.2 | 74.7 | 106.6 | 142.5 | 129.2 | 91.2 | 119.4 | 119.4 | 103.4 | 100.3 | 82.8 |
| 11 | 91.2 | 91.2 | 69.6 | 106.6 | 142.5 | 129.2 | 91.2 | 119.4 | 103.4 | 106.6 | 97.2 | 80.0 |
| 12 | 91.2 | 85.5 | 91.2 | 103.4 | 116.2 | 129.2 | 91.2 | 119.4 | 103.4 | 106.6 | 97.2 | 72.2 |
| 13 | 91.2 | 80.0 | 72.2 | 103.4 | 109.8 | 125.9 | 91.2 | 119.4 | 103.4 | 103.4 | 97.2 | 72.2 |
| 14 | 91.2 | 80.0 | 72.2 | 103.4 | 109.8 | 125.9 | 91.2 | 119.4 | 103.4 | 103.4 | 97.2 | 74.7 |
| 15 | 91.2 | 80.0 | 85.5 | 103.4 | 116.2 | 125.9 | 91.2 | 119.4 | 103.4 | 103.4 | 91.2 | 74.7 |
| 16 | 91.2 | 80.0 | 97.2 | 103.4 | 109.8 | 125.9 | 91.2 | 119.4 | 103.4 | 103.4 | 88.3 | 74.7 |
| 17 | 91.2 | 74.7 | 97.2 | 103.4 | 109.8 | 125.9 | 91.2 | 119.4 | 103.4 | 103.4 | 85.5 | 74.7 |
| 18 | 91.2 | 74.7 | 97.2 | 103.4 | 109.8 | 125.9 | 91.2 | 119.4 | 103.4 | 103.4 | 85.5 | 74.7 |
| 19 | 91.2 | 72.2 | 97.2 | 103.4 | 109.8 | 125.9 | 91.2 | 119.4 | 103.4 | 103.4 | 85.5 | 74.7 |
| 20 | 91.2 | 80.0 | 97.2 | 122.7 | 109.8 | 97.2 | 91.2 | 119.4 | 109.8 | 103.4 | 85.5 | 74.7 |
| 21 | 94.2 | 85.5 | 97.2 | 129.2 | 109.8 | 94.2 | 91.2 | 122.7 | 103.4 | 109.8 | 85.5 | 74.7 |
| 22 | 103.4 | 82.8 | 100.3 | 129.2 | 109.8 | 91.2 | 91.2 | 122.7 | 103.4 | 116.2 | 85.5 | 69.6 |
| 23 | 109.8 | 82.8 | 106.6 | 129.2 | 109.8 | 91.2 | 91.2 | 122.7 | 103.4 | 106.6 | 85.5 | 69.6 |
| 24 | 113.0 | 82.8 | 113.0 | 129.2 | 129.2 | 91.2 | 91.2 | 122.7 | 103.4 | 103.4 | 85.5 | 72.2 |
| 25 | 100.3 | 85.5 | 135.8 | 129.2 | 129.2 | 91.2 | 91.2 | 122.7 | 109.8 | 103.4 | 85.5 | 72.2 |
| 26 | 97.2 | 82.8 | 119.4 | 129.2 | 129.2 | 91.2 | 91.2 | 122.7 | 109.8 | 103.4 | 85.5 | 72.2 |
| 27 | 94.2 | 85.5 | 116.2 | 142.5 | 129.2 | 91.2 | 135.8 | 122.7 | 103.4 | 103.4 | 85.5 | 80.0 |
| 28 | 91.2 | 88.3 | 103.4 | 149.5 | 129.2 | 91.2 | 135.8 | 122.7 | 103.4 | 103.4 | 85.5 | 88.3 |
| 29 | 91.2 | 82.8 | 103.4 | 142.5 | 129.2 | 91.2 | 135.8 | 122.7 | 106.6 | 103.4 | 85.5 | 85.5 |
| 30 | 91.2 | ..... | 103.4 | 142.5 | 129.2 | 91.2 | 135.8 | 122.7 | 103.4 | 103.4 | 85.5 | 82.8 |
| 31 | 91.2 | ..... | 109.8 | ..... | 129.2 | ..... | 91.2 | 122.7 | ..... | 103.4 | ..... | 82.8 |

[a] Actual flow in outlet, not including diversion.

*Estimated monthly discharge of Skaneateles Lake outlet[a] at Willowglen, N. Y., for 1904.*

[Drainage area, 74.2 square miles.]

| Month | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January | 113.0 | 91.2 | 93.6 | 1.26 | 1.45 |
| February | 116.2 | 69.6 | 84.3 | 1.14 | 1.23 |
| March | 135.8 | 69.6 | 96.5 | 1.30 | 1.50 |
| April | 149.5 | 103.4 | 117.6 | 1.59 | 1.77 |
| May | 146.0 | 109.8 | 127.2 | 1.71 | 1.97 |
| June | 129.2 | 91.2 | 114.8 | 1.55 | 1.73 |
| July | 135.8 | 91.2 | 97.1 | 1.31 | 1.51 |
| August | 122.7 | 91.2 | 114.4 | 1.54 | 1.78 |
| September | 135.8 | 103.4 | 112.4 | 1.52 | 1.68 |
| October | 116.2 | 103.4 | 104.5 | 1.41 | 1.63 |
| November | 103.4 | 85.5 | 92.9 | 1.25 | 1.40 |
| December | 88.3 | 69.6 | 78.9 | 1.06 | 1.22 |
| The year | 149.5 | 69.6 | 102.8 | 1,39 | 18.87 |

[a] Actual flow in outlet, not including diversion.

*Estimated monthly discharge of Skaneateles Lake outlet[a] near Willowglen, N. Y., for 1903 and 1904.*

[Drainage area, 74.2 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | In outlet. | Through conduit. | Total. | Second-feet per square mile. | Depth in inches. |
| 1903. | | | | | |
| November | 113.0 | 19.1 | 132.1 | 1.78 | 1.99 |
| December | 91.4 | 17.5 | 108.9 | 1.47 | 1.70 |
| 1904. | | | | | |
| January | 93.6 | 18.4 | 112.0 | 1.51 | 1.74 |
| February | 84.3 | 18.4 | 102.7 | 1.38 | 1.49 |
| March | 96.5 | 18.2 | 114.7 | 1.55 | 1.79 |
| April | 117.6 | 19.6 | 137.2 | 1.85 | 2.06 |
| May | 127.2 | 18.9 | 146.1 | 1.97 | 2.27 |
| June | 114.8 | 19.0 | 133.8 | 1.80 | 2.02 |
| July | 97.1 | 20.0 | 117.1 | 1.58 | 1.82 |
| August | 114.4 | 19.5 | 133.9 | 1.80 | 2.08 |
| September | 112.4 | 18.7 | 131.1 | 1.77 | 1.98 |
| October | 104.5 | 19.6 | 124.1 | 1.67 | 1.92 |
| November | 92.9 | 17.2 | 110.1 | 1.48 | 1.65 |
| December | 78.9 | 17.5 | 96.4 | 1.30 | 1.50 |
| The year | ..... | ..... | 121.6 | 1.64 | 22.30 |

[a] Including diversion for municipal water supply of Syracuse, N. Y.

## OSWEGO RIVER AT BATTLE ISLAND, N. Y.

Oswego River is formed by the confluence of Oneida and Seneca rivers at Three River Point. The stream is shown throughout its course of 24 miles on the Oswego Special and Baldwinsville sheets of the United States Geological Survey Topographic Atlas. The drainage tributary to the river below the junction of Oneida and Seneca rivers is of small extent. The tributaries of Oswego River proper are neither large nor numerous, receiving the drainage from a number of small lakes and marshes in a moderately rolling basin. Oneida and Seneca rivers are both notable for the large extent of lake and marsh area contained within their basins, Oneida Lake in the former and the Finger Lakes tributary to the latter streams affording extensive natural storage regulation of flow to Oswego River.

A fall of 100 feet in the course of Oswego River is mainly utilized by seven dams, which also partially canalize the stream. The intervening stretches are covered by the Oswego canal, which draws its

water supply from the river. The accompanying tables of discharge show the actual flow past the gaging station, not including the flow in Oswego canal.[a]

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

*Discharge measurement of Oswego River at Battle Island, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| June 24 | C. C. Covert | 2,051 | 3.36 | 87.15 | 6,891 |
| November 18 | Covert and Weeks | 1,640 | 2.44 | 86.15 | 4,002 |

*Mean daily elevation of water surface of Oswego River at Battle Island, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 87.85 | 90.10 | 91.25 | 94.15 | 92.10 | 89.15 | 86.78 | 85.75 | 85.10 | 85.35 | 86.65 | 85.75 |
| 2 | 88.20 | 89.85 | 91.38 | 94.25 | 92.15 | 89.03 | 86.55 | 85.50 | 85.05 | 84.95 | 86.60 | 85.75 |
| 3 | 88.80 | 89.75 | 91.25 | 94.25 | 92.02 | 88.90 | 86.15 | 85.40 | 85.12 | 85.85 | 86.65 | 85.65 |
| 4 | 88.95 | 89.78 | 91.32 | 94.22 | 91.90 | 88.70 | 86.35 | 85.30 | 84.62 | 85.85 | 86.57 | 85.85 |
| 5 | 89.00 | 89.75 | 91.25 | 94.05 | 91.90 | 87.83 | 86.50 | 85.22 | 85.10 | 85.95 | 86.40 | 86.15 |
| 6 | 89.05 | 89.65 | 91.18 | 93.95 | 91.82 | 87.75 | 86.42 | 85.20 | 85.05 | 85.95 | 85.75 | 85.95 |
| 7 | 89.10 | 89.70 | 91.75 | 93.78 | 91.50 | 87.80 | 86.18 | 85.10 | 85.10 | 86.00 | 87.05 | 85.90 |
| 8 | 89.05 | 90.53 | 92.80 | 93.50 | 91.45 | 87.85 | 86.35 | 85.50 | 85.08 | 86.02 | 86.55 | 85.95 |
| 9 | 89.02 | 91.23 | 93.45 | 93.40 | 91.38 | 87.87 | 86.25 | 85.28 | 85.05 | 85.35 | 86.35 | 85.95 |
| 10 | 89.05 | 91.50 | 93.50 | 93.48 | 91.05 | 87.90 | 86.00 | 85.12 | 84.98 | 86.35 | 86.40 | 85.63 |
| 11 | 89.05 | 91.45 | 93.38 | 93.60 | 90.82 | 88.05 | 86.32 | 85.05 | 84.48 | 86.33 | 86.35 | 85.20 |
| 12 | 89.05 | 91.35 | 93.15 | 93.52 | 90.62 | 88.00 | 86.15 | 84.90 | 84.90 | 86.40 | 86.25 | 85.60 |
| 13 | 89.10 | 91.32 | 93.00 | 93.40 | 90.30 | 88.12 | 86.22 | 84.78 | 85.20 | 86.55 | 85.40 | 85.50 |
| 14 | 89.07 | 91.60 | 92.98 | 93.38 | 90.08 | 88.10 | 86.25 | 85.20 | 85.10 | 86.50 | 86.70 | 85.50 |
| 15 | 89.13 | 91.25 | 92.85 | 93.20 | 90.05 | 87.95 | 86.38 | 85.15 | 85.22 | 86.40 | 86.37 | 85.45 |
| 16 | 89.33 | 90.90 | 92.65 | 93.05 | 90.05 | 87.85 | 86.45 | 84.90 | 85.25 | 85.90 | 86.15 | 85.35 |
| 17 | 89.15 | 90.70 | 92.55 | 92.95 | 89.95 | 87.72 | 85.50 | 84.98 | 85.05 | 86.80 | 86.05 | 85.35 |
| 18 | 88.85 | 90.65 | 92.45 | 92.88 | 89.98 | 87.75 | 86.25 | 84.80 | 84.25 | 86.65 | 86.13 | 85.25 |
| 19 | 89.02 | 90.65 | 92.35 | 92.88 | 89.92 | 87.55 | 86.18 | 84.90 | 85.22 | 86.45 | 86.00 | 85.50 |
| 20 | 89.25 | 90.50 | 92.08 | 92.85 | 89.88 | 87.52 | 86.02 | 85.10 | 85.08 | 86.33 | 85.35 | 85.65 |
| 21 | 89.28 | 90.60 | 92.15 | 92.68 | 89.85 | 87.45 | 85.75 | 84.75 | 85.15 | 86.37 | 86.30 | 85.50 |
| 22 | 89.50 | 90.58 | 92.25 | 92.48 | 89.70 | 87.35 | 85.60 | 84.98 | 85.10 | 86.47 | 86.00 | 85.45 |
| 23 | 89.00 | 90.40 | 92.70 | 92.50 | 90.00 | 87.30 | 85.65 | 85.40 | 85.05 | 86.10 | 86.10 | 85.25 |
| 24 | 88.95 | 90.30 | 92.82 | 92.38 | 89.90 | 87.15 | 85.15 | 85.58 | 85.18 | 87.10 | 86.13 | 85.10 |
| 25 | 89.25 | 90.20 | 93.70 | 92.25 | 89.68 | 87.07 | 85.80 | 85.40 | 84.48 | 86.70 | 86.00 | 84.95 |
| 26 | 89.65 | 90.35 | 94.05 | 92.22 | 89.68 | 86.75 | 85.55 | 85.20 | 85.92 | 86.70 | 85.60 | 85.40 |
| 27 | 89.85 | 90.18 | 94.05 | 92.15 | 90.12 | 87.00 | 85.50 | 85.10 | 85.40 | 86.65 | 85.60 | 85.25 |
| 28 | 90.00 | 91.15 | 94.05 | 92.15 | 90.35 | 86.95 | 85.02 | 84.60 | 85.38 | 86.85 | 86.05 | 87.80 |
| 29 | 90.12 | 91.48 | 93.82 | 92.20 | 89.40 | 86.85 | 85.32 | 85.50 | 85.70 | 86.67 | 85.85 | 88.10 |
| 30 | 90.10 | ..... | 94.05 | 92.28 | 89.35 | 86.85 | 85.32 | 85.15 | 85.60 | 86.20 | 85.80 | 88.45 |
| 31 | 89.72 | ..... | 94.18 | ..... | 89.25 | ..... | 85.00 | 85.12 | ..... | 87.00 | ..... | 88.45 |

[a] For additional data of gagings of Oswego River see Report on Stream Gagings, contained in Supplement, Report of State Engineer and Surveyor of New York for 1902, pp. 84–96; also 1903, pp. 41–42.

*Rating table for Oswego River at Battle Island, N. Y., 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.* |
| 83.00 | 1,280 | 84.60 | 2,630 | 86.40 | 5,050 | 89.60 | 11,280 |
| 83.10 | 1,350 | 84.70 | 2,740 | 86.60 | 5,380 | 89.80 | 11,710 |
| 83.20 | 1,420 | 84.80 | 2,860 | 86.80 | 5,730 | 90.00 | 12,150 |
| 83.30 | 1,480 | 84.90 | 2,970 | 87.00 | 6,080 | 90.20 | 12,590 |
| 83.40 | 1,550 | 85.00 | 3,080 | 87.20 | 6,450 | 90.40 | 13,020 |
| 83.50 | 1,620 | 85.10 | 3,210 | 87.40 | 6,820 | 90.60 | 13,460 |
| 83.60 | 1,700 | 85.20 | 3,340 | 87.60 | 7,200 | 90.80 | 13,910 |
| 83.70 | 1,790 | 85.30 | 3,460 | 87.80 | 7,590 | 91.00 | 14,360 |
| 83.80 | 1,870 | 85.40 | 3,590 | 88.00 | 7,990 | 91.50 | 15,490 |
| 83.90 | 1,950 | 85.50 | 3,720 | 88.20 | 8,390 | 92.00 | 16,630 |
| 84.00 | 2,040 | 85.60 | 3,860 | 88.40 | 8,790 | 92.50 | 17,830 |
| 84.10 | 2,140 | 85.70 | 4,000 | 88.60 | 9,200 | 93.00 | 19,000 |
| 84.20 | 2,230 | 85.80 | 4,150 | 88.80 | 9,610 | 93.50 | 20,190 |
| 84.30 | 2,330 | 85.90 | 4,290 | 89.00 | 10,020 | 94.00 | 21,400 |
| 84.40 | 2,420 | 86.00 | 4,430 | 89.20 | 10,440 | 94.50 | 22,610 |
| 84.50 | 2,520 | 86.20 | 4,740 | 89.40 | 10,850 | | |

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1901–1904. It is well defined between gage heighths 85 feet and 93 feet. Below 85 the curve is based on 1 measurement at 83.6. The table has been extended beyond these limits.

*Estimated monthly discharge of Oswego River at Battle Island, N. Y., for 1904.*

[Drainage area, 4,990 square miles.]

| Month. | Drainage in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January[a] | | | | | |
| February[a] | | | | | |
| March[a] | | | | | |
| April | 22,000 | 16,990 | 19,330 | 3.87 | 4.32 |
| May | 16,990 | 10,540 | 13,320 | 2.67 | 3.08 |
| June | 10,330 | 5,640 | 7,497 | 1.50 | 1.67 |
| July | 5,680 | 3,080 | 4,416 | .885 | 1.02 |
| August | 4,070 | 2,630 | 3,291 | .660 | .761 |
| September | 4,320 | 2,280 | 3,223 | .646 | .721 |
| October | 6,260 | 3,020 | 4,904 | .983 | 1.13 |
| November | 6,170 | 3,530 | 4,719 | .946 | 1.06 |
| December[a] | | | | | |

[a] Probable ice conditions January 1 to March 31; December 1–31.

SENECA RIVER AT BALDWINSVILLE, N. Y.

This station was established November 12, 1898.[a] The gaging station is located at the State dam in Baldwinsville, 12 miles along the river from the junction of Seneca River with Oneida River. These two streams unite at Three River Point to form Oswego River.

Seneca River receives the drainage from the central group of lakes lying southward from Lake Ontario. The drainage basin is rolling, though not precipitous, excepting for the deep, narrow valleys crossing it, in which the lakes are situated, and certain additional valleys not at the present time occupied by lakes.

The location of the gaging station is shown on the Baldwinsville sheet of the United States Geological Survey Topographic Atlas. The topographic sheets also show the entire drainage basin. Current-meter measurements, to determine the leakage of the several mills, have been made during 1904, as in preceding years, and the allowance for this leakage has been made. The record has also been checked by current-meter measurements made during 1901, 1903, and 1904 at Belgium. The discharge at New Bridge, Belgium, April 15, 1904, was 10,615 second-feet.

The gaging record at Baldwinsville includes the discharge over the main dam, which is calculated by the formula for a broad, flat-crested weir when flashboards are removed. Discharge over flashboards is calculated by the Francis formula. Gage readings in the river channel below the dam are utilized to determine the average working head on turbines. Discharge through the three main canals is determined from records of the run of water wheels kept in each mill, and from the recorded lockage and opening of paddles at the Oswego Canal lock at the foot of the canal.[b]

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

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[a] By George W. Rafter for U. S. Board of Engineers on Deep Waterways.

[b] See Report State Engineer and Surveyor of New York, Supplement, 1902, pp. 77–81, 1903, pp. 39–40.

*Mean daily discharge, in second-feet, of Seneca River at Baldwinsville, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,270 | 4,270 | 4,130 | 10,220 | 6,770 | 5,850 | 3,530 | 2,700 | 1,630 | 1,850 | 2,940 | 2,690 |
| 2 | 2,480 | 3,970 | 4,100 | 10,230 | 7,910 | 5,800 | 3,540 | 2,460 | 1,630 | 1,220 | 2,940 | 2,690 |
| 3 | 1,360 | 3,760 | 4,230 | 9,850 | 7,610 | 5,610 | 2,750 | 2,540 | 1,630 | 2,160 | 2,980 | 2,500 |
| 4 | 2,080 | 3,800 | 4,450 | 10,010 | 7,610 | 5,610 | 3,800 | 2,460 | 840 | 2,260 | 2,940 | 1,740 |
| 5 | 2,180 | 3,670 | 4,830 | 9,810 | 7,490 | 4,730 | 3,040 | 2,390 | 2,170 | 2,170 | 2,770 | 2,560 |
| 6 | 2,260 | 3,460 | 4,410 | 9,600 | 7,190 | 5,550 | 3,500 | 2,380 | 1,850 | 1,960 | 2,250 | 2,510 |
| 7 | 2,240 | 3,620 | 5,180 | 9,460 | 7,050 | 5,360 | 3,500 | 1,600 | 1,670 | 1,860 | 3,010 | 2,530 |
| 8 | 2,210 | 4,400 | 6,280 | 9,230 | 6,280 | 5,240 | 3,450 | 2,300 | 1,830 | 1,820 | 2,890 | 2,550 |
| 9 | 2,340 | 4,880 | 6,540 | 9,080 | 6,760 | 5,300 | 3,400 | 2,440 | 1,830 | 1,150 | 2,970 | 2,410 |
| 10 | 1,870 | 5,260 | 6,810 | 8,740 | 6,590 | 5,180 | 2,440 | 2,400 | 1,830 | 2,150 | 2,930 | 2,440 |
| 11 | 2,370 | 5,300 | 6,940 | 8,950 | 6,400 | 5,240 | 3,190 | 1,820 | 1,200 | 2,140 | 2,970 | 1,330 |
| 12 | 2,280 | 5,150 | 6,940 | 8,900 | 6,200 | 4,220 | 3,140 | 2,060 | 1,850 | 2,160 | 2,830 | 2,100 |
| 13 | 2,240 | 5,270 | 6,620 | 8,680 | 6,120 | 5,120 | 3,060 | 2,170 | 1,700 | 2,170 | 2,110 | 1,970 |
| 14 | 2,320 | 4,950 | 7,130 | 8,450 | 6,060 | 4,930 | 3,110 | 1,610 | 1,700 | 2,020 | 2,820 | 1,950 |
| 15 | 2,280 | 5,300 | 7,080 | 8,370 | 5,340 | 4,810 | 3,060 | 2,240 | 1,730 | 1,920 | 2,790 | 2,150 |
| 16 | 2,320 | 5,330 | 7,080 | 8,150 | 5,990 | 4,810 | 3,110 | 2,100 | 1,700 | 1,770 | 2,850 | 2,160 |
| 17 | 1,840 | 5,050 | 6,870 | 7,630 | 6,060 | 4,520 | 2,340 | 2,100 | 1,700 | 2,480 | 2,780 | 2,260 |
| 18 | 2,170 | 4,850 | 6,580 | 8,270 | 5,800 | 4,630 | 2,890 | 2,040 | 1,230 | 2,400 | 2,700 | 1,380 |
| 19 | 1,840 | 4,720 | 6,500 | 8,110 | 6,060 | 3,740 | 2,700 | 1,970 | 1,970 | 2,420 | 2,660 | 2,380 |
| 20 | 2,060 | 4,410 | 6,040 | 8,180 | 6,060 | 4,460 | 2,570 | 2,340 | 1,840 | 2,360 | 1,610 | 2,340 |
| 21 | 1,960 | 4,070 | 6,620 | 8,030 | 6,210 | 4,160 | 2,390 | 1,610 | 1,860 | 2,520 | 2,770 | 2,320 |
| 22 | 2,120 | 5,010 | 6,720 | 7,730 | 5,620 | 4,290 | 2,430 | 2,210 | 1,870 | 2,700 | 2,630 | 2,320 |
| 23 | 2,380 | 4,480 | 7,640 | 8,240 | 6,390 | 4,170 | 2,480 | 2,170 | 1,860 | 2,240 | 2,560 | 2,240 |
| 24 | 2,620 | 4,370 | 7,990 | 7,860 | 6,260 | 4,170 | 1,720 | 1,760 | 1,920 | 3,080 | 2,660 | 2,170 |
| 25 | 3,530 | 4,290 | 8,580 | 8,050 | 6,350 | 4,170 | 2,390 | 1,710 | 800 | 2,850 | 2,470 | 1,480 |
| 26 | 3,730 | 4,460 | 9,600 | 8,050 | 6,350 | 3,280 | 2,380 | 1,890 | 1,910 | 2,780 | 2,430 | 2,270 |
| 27 | 3,900 | 4,150 | 9,550 | 7,970 | 6,350 | 4,120 | 2,280 | 1,910 | 2,040 | 2,770 | 1,820 | 2,570 |
| 28 | 4,220 | 3,850 | 10,310 | 7,970 | 6,210 | 3,920 | 2,420 | 1,320 | 1,970 | 2,790 | 2,500 | 3,250 |
| 29 | 4,680 | 4,105 | 10,230 | 8,120 | 5,500 | 3,640 | 2,430 | 2,000 | 1,800 | 2,810 | 2,430 | 3,800 |
| 30 | 4,300 | ..... | 10,260 | 7,940 | 6,400 | 3,550 | 2,510 | 1,650 | 1,750 | 2,410 | 2,410 | 3,850 |
| 31 | 3,950 | ..... | 10,250 | ..... | 6,060 | ..... | 1,830 | 1,660 | ..... | 2,870 | ..... | 3,840 |

NOTE.—Ice formed on portion of crest of dam during January and February. Discharge may be excessive.

*Estimated monthly discharge of Seneca River at Baldwinsville, N. Y., for 1904.*

[Drainage area, 3,103 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January | 4,680 | 1,360 | 2,594 | 0.836 | 0.964 |
| February | 5,330 | 3,460 | 4,490 | 1.45 | 1.56 |
| March | 10,310 | 4,100 | 6,986 | 2.25 | 2.59 |
| April | 10,230 | 7,630 | 8,663 | 2.79 | 3.11 |
| May | 7,910 | 5,340 | 6,421 | 2.07 | 2.39 |
| June | 5,850 | 3,280 | 4,673 | 1.51 | 1.68 |
| July | 3,800 | 1,720 | 2,818 | .908 | 1.05 |
| August | 2,700 | 1,320 | 2,065 | .665 | .767 |
| September | 2,170 | 800 | 1,711 | .551 | .615 |
| October | 3,080 | 1,150 | 2,266 | .730 | .842 |
| November | 3,010 | 1,610 | 2,647 | .853 | .952 |
| December | 3,850 | 1,330 | 2,411 | .777 | .896 |
| The year | 10,310 | 800 | 3,979 | 1.28 | 17.42 |

ONONDAGA LAKE OUTLET AT LONG BRANCH, N. Y.

Readings have been taken showing the stage of this stream on a vertical staff gage graduated decimally and having its zero mark at elevation 360.81, located 800 feet upstream from Long Branch highway bridge. Current-meter measurements have also been made to determine the outflow from Onondaga Lake. The discharge is not a continuous function of the stage of the stream, however, owing to the variation in the water level of Seneca River, which forms the outlet of the lake, and to the growth of grass and aquatic plants in the stream channel.

Onondaga Lake receives the drainage from an irregular pear-shaped area; the broad end, 17 miles in width, extends east and west just west of Syracuse, the lake lying near the northern boundary. The length of the drainage basin is 25 miles, the apex lying in the Tully Lake region. The altitude of Onondaga Lake is 364 feet. The general elevation of the flats surrounding the lake and extending eastward to the boundary of the drainage area is 400 feet. The surface rises rapidly to elevation 800 feet on a line crossing the basin immediately south of Syracuse. South of this line the topography is bold, broad hills 2 to 4 miles in diameter rising to altitudes of from 1,200 to 1,800 feet.

Otisco Lake here occupies the western portion of the main drainage basin, and comprises approximately one-third the total area. The

lake is at an elevation of 784 feet, and its drainage basin is at an average altitude about 200 feet greater than that of Onondaga Creek. Otisco Lake lies parallel to and at a distance of 2¾ miles from Skaneateles Lake. The latter is at elevation 867 feet; the difference of level between the two lakes being 83 feet. They are separated by a ridge rising to elevation 1,700 feet.

The Tully Lakes are located in a flat-bottomed valley from 1 to 2 miles wide. Two of these lakes have a southerly outlet to Tioughnioga River; the remaining lakes have no surface outlets. Just north of these lakes the valley drops rapidly from elevation 1,200 to elevation 900, within a distance of one-half mile, and on this slope, within a short distance of Tully Lakes, spring-fed streams rise forming the headwaters of Onondaga Creek.

The drainage area is largely rich agricultural land. There are no extensive marshes. Stream tributaries are rather sparse and the steep hillside slopes are usually smooth in the Onondaga Creek basin, but serrated and with numerous short lateral streams in the Otisco basin. The combined water surface of Onondaga and Otisco Lakes is 8 square miles, or 2.8 per cent of the total drainage area.

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

*Drainage areas of Onondaga Creek.*[a]

| Location. | Areas. | |
|---|---|---|
| | Place to place. | Total. |
| Otisco Lake: | *Sq. miles.* | *Sq. miles.* |
| Above foot of lake[b] | 44.7 | 44.7 |
| Otisco Lake water surface | ..... | 3.3 |
| Nine Mile Creek, foot of lake to mouth | 74.0 | 118.7 |
| Onondaga Creek: | | |
| Above junction West Branch | 40.6 | 40.6 |
| Junction West Branch to mouth | 65.3 | 105.9 |
| Onondaga Lake: | | |
| Total area above outlet[b] | ..... | 288.4 |
| Water surface | ..... | 4.7 |
| Onondaga Lake outlet: | | |
| Long Branch to mouth | 3.0 | 291.4 |

[a] From Syracuse, Baldwinsville, Skaneateles, and Tully sheets of the United States Geological Survey Topographic Atlas.
[b] Including water surface.

*Discharge measurements of Onondaga Lake outlet at Long Branch, N. Y., in 1904.*

| Date | Hydrographer. | Gage height.[a] | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Second-feet.* |
| April 15 | Covert and Swancott | 7.60 | [b] 563 |
| April 25 | C. C. Covert | 6.80 | 774 |
| May 5 | do | 6.40 | 805 |
| May 18 | do | 4.80 | 796 |
| May 27 | C. A. Swancott | 4.70 | 605 |
| July 30 | do | 2.45 | [c] 276 |
| September 2 | do | 2.10 | 338 |
| November 19 | Covert and Weeks | 1.80 | 331 |

[a] Barge canal gage about 700 feet above bridge.
[b] Backwater from Seneca River.
[c] Stream badly choked by eel grass.

*Mean daily gage height, in feet, of Onondaga Lake outlet at Long Branch, N. Y., for 1904.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 6.80 | 4.40 | 2.85 | ..... | ..... | ..... | ..... |
| 2 | ..... | 6.60 | 4.35 | ..... | ..... | 2.15 | ..... | ..... |
| 3 | ..... | 6.60 | 4.25 | ..... | ..... | ..... | ..... | 2.40 |
| 4 | ..... | 6.50 | 4.15 | ..... | 2.60 | ..... | 2.10 | ..... |
| 5 | ..... | 6.50 | ..... | 2.80 | ..... | ..... | ..... | ..... |
| 6 | ..... | 6.30 | 4.00 | ..... | ..... | 2.10 | ..... | ..... |
| 7 | ..... | 6.10 | 3.90 | ..... | ..... | ..... | ..... | 2.20 |
| 8 | ..... | ..... | 3.80 | ..... | 2.52 | ..... | ..... | ..... |
| 9 | ..... | 5.90 | 3.95 | 2.65 | ..... | ..... | ..... | ..... |
| 10 | ..... | 5.70 | 3.90 | ..... | ..... | 2.08 | 2.05 | ..... |
| 11 | ..... | 5.60 | 3.80 | ..... | ..... | ..... | ..... | ..... |
| 12 | ..... | 5.40 | ..... | 2.55 | 2.38 | ..... | ..... | 2.20 |
| 13 | ..... | 5.20 | 3.70 | ..... | ..... | 2.07 | ..... | ..... |
| 14 | ..... | 5.00 | 3.60 | 2.50 | ..... | ..... | 2.00 | ..... |
| 15 | ..... | ..... | 3.55 | ..... | 2.33 | ..... | ..... | ..... |
| 16 | 7.50 | 5.00 | 3.55 | 2.72 | ..... | 2.06 | ..... | ..... |
| 17 | 7.40 | 4.95 | 3.50 | ..... | ..... | ..... | ..... | 1.80 |
| 18 | 7.30 | 4.85 | 3.40 | ..... | 2.30 | ..... | ..... | ..... |
| 19 | 7.40 | 4.80 | ..... | 2.65 | ..... | ..... | 1.90 | ..... |
| 20 | 7.30 | 4.85 | 3.30 | ..... | ..... | 2.04 | ..... | ..... |
| 21 | 7.10 | 4.90 | ..... | 2.50 | ..... | ..... | ..... | ..... |
| 22 | 7.00 | ..... | 3.30 | ..... | ..... | ..... | ..... | 1.80 |
| 23 | 7.00 | 4.80 | ..... | 2.40 | 2.40 | 1.98 | ..... | ..... |
| 24 | 6.90 | 4.80 | 3.15 | ..... | ..... | ..... | 2.20 | ..... |
| 25 | 6.80 | 4.80 | ..... | ..... | ..... | ..... | ..... | ..... |
| 26 | 6.80 | 4.80 | ..... | ..... | 2.28 | ..... | ..... | ..... |
| 27 | 6.70 | 4.75 | 2.95 | ..... | ..... | 2.00 | ..... | ..... |
| 28 | 6.70 | 4.70 | ..... | ..... | ..... | ..... | 2.10 | 1.80 |
| 29 | 6.80 | ..... | 2.90 | ..... | ..... | ..... | ..... | ..... |
| 30 | 6.80 | 4.50 | ..... | ..... | 2.20 | 2.05 | ..... | ..... |
| 31 | ..... | 4.50 | ..... | ..... | ..... | ..... | 2.50 | ..... |

## ONEIDA LAKE, NEW YORK.

Oneida Lake affords a large evaporation surface in summer. In winter, however, the evaporation rate is greatly reduced by freezing of the lake surface. At the same time the precipitation on the drainage basin to the north and east is chiefly held back as surface storage in the form of snow, this portion of the area lying in the region of maximum snowfall of the State, the depth of accumulated snow aggregating sometimes several feet in the woodlands and having a water equivalent of from 2 to 3 inches per foot of densely compacted snow.

The following table shows the date of opening and closing of Oneida Lake by ice at Constantia, N. Y., the data up to 1896 having been collected for the United States Deep Waterways Commission by William Pierson Judson, C. E.:

*Table showing dates of opening and closing of Oneida Lake oy ice.*

| Year. | Opened. | Closed. | Year. | Opened. | Closed. |
|---|---|---|---|---|---|
| 1845 | ..... | Dec. 15 | 1875 | Apr. 2 | Dec. 24 |
| 1846 | Apr. 3 | Dec. 8 | 1876 | Mar. 27 | Dec. 15 |
| 1847 | Apr. 10 | Dec. 28 | 1877 | Apr. 3 | Dec. 19 |
| 1848 | Apr. 1 | Dec. 25 | 1878 | Apr. 1 | Dec. 3 |
| 1849 | Apr. 12 | Dec. 14 | 1879 | Apr. 7 | Dec. 25 |
| 1850 | Apr. 9 | Dec. 22 | 1880 | Apr. 1 | Dec. 16 |
| 1851 | Apr. 15 | ..... | 1881 | Apr. 25 | Dec. 3 |
| 1852 | ..... | Feb. 10 | 1882 | Apr. 2 | Dec. 15 |
| 1852 | Apr. 3 | Dec. 13 | 1883 | Apr. 6 | Dec. 24 |
| 1853 | Mar. 28 | Dec. 24 | 1884 | Apr. 2 | Dec. 6 |
| 1854 | Apr. 4 | Dec. 3 | 1885 | Apr. 3 | Dec. 7 |
| 1855 | Apr. 15 | Dec. 17 | 1886 | Apr. 2 | Dec. 13 |
| 1856 | Apr. 5 | Dec. 25 | 1887 | Apr. 1 | Dec. 25 |
| 1857 | Apr. 2 | Dec. 16 | 1888 | Apr. 5 | Dec. 13 |
| 1858 | Apr. 8 | Dec. 3 | 1889 | Apr. 3 | Dec. 25 |
| 1859 | Apr. 6 | Dec. 17 | 1890 | Apr. 6 | Dec. 22 |
| 1860 | Apr. 1 | Dec. 20 | 1891 | Apr. 25 | Dec. 16 |
| 1861 | Apr. 7 | Dec. 15 | 1892 | Apr. 4 | Dec. 11 |
| 1862 | Apr. 3 | Dec. 4 | 1893 | Apr. 2 | Dec. 24 |
| 1863 | Apr. 9 | Dec. 20 | 1894 | Apr. 6 | Dec. 17 |
| 1864 | Apr. 2 | Dec. 13 | 1895 | Apr. 19 | Dec. 28 |
| 1865 | Mar. 26 | Dec. 5 | 1896 | Apr. 19 | ..... |
| 1866 | Mar. 30 | Dec. 11 | 1897 | Mar. 30 | Dec. 18 |
| 1867 | Mar. 24 | Dec. 25 | 1898 | Mar. 17 | Dec. 12 |
| 1868 | Apr. 2 | Dec. 10 | 1899 | Apr. 20 | Dec. 28 |
| 1869 | Apr. 5 | Dec. 25 | 1900 | Apr. 18 | Dec. 25 |
| 1870 | Apr. 1 | Dec. 16 | 1901 | Apr. 14 | Dec. 30 |
| 1871 | Apr. 3 | Dec. 2 | 1902 | Mar. 28 | Dec. 24 |
| 1872 | Apr. 12 | Dec. 24 | 1903 | Mar. 21 | Dec. 22 |
| 1873 | Apr. 1 | Dec. 3 | 1904 | Mar. 15 | ..... |
| 1874 | Apr. 6 | Dec. 13 | | | |

ONEIDA RIVER NEAR EUCLID, N. Y.

Oneida Lake has a water-surface area of 80 square miles and lies at elevation 370 feet above tide. The drainage basin within a radius of 10 miles to the south and west is relatively flat, with numerous marshy tracts. The lake receives, through Chittenango and Oneida creeks, drainage from an extensive area of the central New York plateau, and through Wood and Fish creeks on the east, drainage from a portion of the west slope of the plateau bordering the Adirondack Mountains. On the north the drainage area is less extensive and the inflowing streams are small.

The outflow from the lake through Oneida River, 16 miles in length, joins Seneca River at Three River Point, forming Oswego River, which is tributary to Lake Ontario. Observations of the stream stage have been taken by measuring down to water surface each morning and evening from a reference point on the bulkhead coping of the lock at the Oak Orchard State dam 0.4 mile above Schroeppel's bridge. Flashboards placed on the dam during the low-water season of 1904 have modified the stage during the period when they are in use.

A calibration curve for the cross section of the stream at Schroeppel's bridge has been obtained by current-meter measurements. The gage readings have been taken above the dam, as stated, to avoid backwater from ice or other causes as far as possible.

The gaging station is 7 miles upstream from Three River Point. The observations are taken by Arthur McArthur. The drainage area above the gaging station has been taken provisionally at 1,400 square miles.[a]

Above a certain stage the dam becomes submerged and the discharge modified. A special rating table deduced from measurements made during the period of submergence has been used to calculate the discharge in the high-water season of 1904. Allowance is made for opening of lock paddles in winter.

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

[a] From Bien's Atlas of New York. A portion of the drainage area is shown on the Syracuse, Chittenango, Oneida, Oriskany, Morrisville, Cazenovia, and Tully sheets of the United States Geological Survey Topographic Atlas. For additional data concerning Oneida River see report on stream gagings, contained in Supplement, Report of State Engineer and Surveyor for New York, 1902, pp. 82–84.

*Discharge measurements of Oneida River near Euclid, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Sec.-feet.* |
| April 26 | C. C. Covert | 2,070 | 4.06 | 0.87 | 8,408 |
| May 5 | do | 1,920 | 4.13 | 1.10 | 7,959 |
| May 12 | do | 1,711 | 3.90 | 1.92 | 6,683 |
| May 18 | do | 1,575 | 3.67 | 2.40 | 5,792 |
| May 28 | C. A. Swancott | 578 | 6.70 | 3.00 | 3,880 |
| June 25 | C. C. Covert | 1,003 | 2.19 | 4.20 | 2,199 |
| July 29 | C. A. Swancott | 839 | 1.43 | 4.15 | 1,200 |
| September 1 | do | 829 | 1.38 | 4.22 | 1,143 |
| November 19 | Covert and Weeks | 852 | 1.53 | 4.60 | 1,307 |

*Mean daily discharge, in second-feet, of Oneida River near Euclid, N. Y., for 1904.*

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

[a] January 1 to February 22 stream partly frozen above dam, but not sufficient to modify the flow.

*Estimated monthly discharge of Oneida River near Euclid, N. Y., for 1904.*

[Drainage area, 1,313 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January | 2,710 | 1,660 | 2,162 | 1.64 | 1.89 |
| February | 4,330 | 2,230 | 3,403 | 2.59 | 2.80 |
| March | 9,860 | 2,960 | 5,934 | 4.52 | 5.20 |
| April | 10,200 | 8,320 | 9,474 | 7.22 | 8.06 |
| May | 8,380 | 3,870 | 5,944 | 4.53 | 5.22 |
| June | 3,970 | 1,780 | 2,592 | 1.97 | 2.20 |
| July | 1,780 | 1,300 | 1,439 | 1.10 | 1.27 |
| August | 1,450 | 1,040 | 1,204 | .917 | 1.06 |
| September | 1,300 | 1,040 | 1,152 | .877 | .978 |
| October | 1,920 | 940 | 1,517 | 1.16 | 1.34 |
| November | 1,920 | 1,300 | 1,535 | 1.17 | 1.30 |
| December | 1,900 | 1,150 | 1,344 | 1.02 | 1.18 |
| The year | 10,200 | 940 | 3,142 | 2.39 | 32.50 |

## CHITTENANGO CREEK AT CHITTENANGO, N. Y.

A current-meter gaging station was established at Main Street Bridge in Chittenango village May 22, 1901. The stream at this point is entrained between parallel walls, affording a channel 50 feet wide, over which the bridge passes at a single span. The bridge stands at an angle to the thread of the stream, and has a span between abutments of 57 feet. The gage board is secured in a vertical position to the right abutment on the upstream side, and reads decimally from zero to 8 feet. The stage of the stream is observed twice daily by Bessie M. Kellogg. The bench mark is on the upstream corner of the coping of the right-hand bridge abutment.

Elevation bench mark ..... 100.00
Elevation gage zero ..... 91.77

The gaging station is one-half mile above the State dam diverting water for the supply of the summit level of Erie Canal. The flow of Chittenango Creek above Chittenango is regulated by storage in Cazenovia Lake and Erieville reservoir.[a]

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

*Erieville reservoir.*

| | | |
|---|---|---|
| Tributary watershed | square miles | 5.4 |
| Storage capacity | cubic feet | 318,424,000 |
| Water surface | acres | 340 |

[a] Data below from New York Barge Canal Report, 1900.

*Drainage areas of Chittenango Creek.*[a]

| Location. | Area. |
|---|---|
| | *Sq. miles.* |
| Above Chittenango Falls | 63.0 |
| Above gaging station | 78.9 |
| Above mouth | 326.3 |

[a] From Morrisville, Oneida, Cazenovia, Chittenango, Tully, and Syracuse sheets of the United States Geological Survey Topographic Atlas.

*Discharge measurements of Chittenango Creek at Chittenango, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Sec.-feet.* |
| June 30 | C. A. Swancott | 97 | 0.70 | 1.38 | 55 |
| July 28 | do | 104 | .82 | 1.50 | 70 |
| August 31 | do | 95 | .73 | 1.48 | 70 |
| October 1 | A. M. Evans | 96 | .58 | 1.34 | 56 |

*Mean daily gage height, in feet, of Chittenango Creek at Chittenango, N. Y., for 1904.*

| Day. | Jan. | Feb.[a] | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | [b]1.80 | 1.90 | 1.70 | 3.20 | 2.20 | 1.50 | 1.48 | 1.45 | 1.45 | 1.40 | 1.40 | 1.55 |
| 2 | 1.80 | 1.90 | 1.70 | 3.10 | 2.20 | 1.45 | 1.55 | 1.50 | 1.35 | 1.40 | 1.40 | 1.30 |
| 3 | 1.80 | 1.90 | 2.20 | 2.60 | 2.00 | 1.45 | 1.25 | 1.75 | 1.38 | 1.40 | 1.40 | 1.35 |
| 4 | 1.80 | 2.00 | 2.25 | 2.40 | 2.00 | 1.45 | 1.20 | 1.50 | 1.45 | 1.40 | 1.35 | 1.35 |
| 5 | 1.80 | 1.90 | 1.95 | 2.45 | 1.90 | 1.50 | 1.32 | 1.55 | 1.40 | 1.45 | 1.35 | 1.30 |
| 6 | 1.80 | 1.95 | 1.92 | 2.55 | 1.85 | 1.45 | 1.48 | 1.52 | 1.45 | 1.45 | 1.40 | 1.30 |
| 7 | [c]1.80 | 3.03 | 2.90 | 2.60 | 1.80 | 1.40 | 1.40 | 1.50 | 1.40 | 1.30 | 1.40 | 1.20 |
| 8 | 1.80 | 3.15 | 3.45 | 2.65 | 1.80 | 1.40 | 1.40 | 1.48 | 1.40 | 1.30 | 1.35 | 1.10 |
| 9 | 1.80 | 2.65 | 2.75 | 2.85 | 1.80 | 1.95 | 1.30 | 1.40 | 1.40 | 1.30 | 1.40 | 1.25 |
| 10 | 1.80 | 2.40 | 2.45 | 3.30 | 1.80 | 1.70 | 1.30 | 1.40 | 1.40 | 1.30 | 1.30 | 1.40 |
| 11 | 1.70 | 2.35 | 2.30 | 2.80 | 1.70 | 1.50 | 1.30 | 1.48 | 1.40 | 1.40 | 1.30 | 1.20 |
| 12 | 1.70 | 2.30 | 2.15 | 2.80 | 1.65 | 1.50 | 1.32 | 1.42 | 1.32 | 1.40 | 1.35 | 1.20 |
| 13 | 1.70 | 2.20 | 2.00 | 2.70 | 1.60 | 1.50 | 1.48 | 1.35 | 1.30 | 1.40 | 1.25 | 1.00 |
| 14 | [d]1.70 | 2.20 | 1.95 | 2.60 | 1.52 | 1.50 | 1.45 | 1.52 | 1.38 | 1.30 | 1.35 | 1.00 |
| 15 | 1.70 | 2.00 | 1.90 | 2.55 | 2.00 | 1.50 | 1.35 | 1.45 | 1.48 | 1.30 | 1.25 | .90 |
| 16 | 1.70 | 2.00 | 1.90 | 2.30 | 1.95 | 1.50 | 1.45 | 1.50 | 1.50 | ..... | 1.45 | .85 |
| 17 | [c]1.70 | 2.00 | 2.00 | 2.30 | 1.85 | 1.50 | 1.50 | 1.50 | 1.45 | ..... | 1.45 | .85 |
| 18 | 1.70 | 1.90 | 2.10 | 2.20 | 1.75 | 1.50 | 1.42 | 1.62 | 1.40 | ..... | 1.45 | .80 |
| 19 | 1.70 | 1.85 | 2.15 | 2.20 | 1.70 | 1.40 | 1.32 | 1.65 | 1.40 | ..... | 1.40 | .90 |
| 20 | 1.70 | 1.80 | 2.10 | 2.20 | 1.75 | 1.40 | 1.48 | 1.90 | 1.40 | ..... | 1.45 | .95 |
| 21 | 1.70 | 1.75 | 2.10 | 2.30 | 1.70 | 1.40 | 1.35 | 1.75 | 1.50 | ..... | 1.50 | .95 |
| 22 | 1.90 | 2.00 | 2.70 | 2.32 | 1.60 | 1.40 | 1.35 | 1.80 | 1.40 | ..... | 1.50 | .90 |
| 23 | [d]2.90 | 1.85 | 3.60 | 2.45 | 1.60 | 1.40 | 1.38 | 2.15 | 1.40 | 1.40 | 1.50 | 1.35 |
| 24 | 2.45 | 1.75 | 3.40 | 2.45 | 1.50 | 1.40 | 1.55 | 1.75 | 1.40 | 1.50 | 1.45 | 1.75 |
| 25 | 2.20 | 1.80 | 3.80 | 2.08 | 1.50 | 1.30 | 1.58 | 1.55 | 1.40 | 1.40 | 1.65 | 1.55 |
| 26 | 2.20 | 1.80 | 4.80 | 2.30 | 1.50 | 1.30 | 1.50 | 1.48 | 1.45 | 1.40 | 1.65 | 1.00 |
| 27 | 2.20 | 1.82 | 3.40 | 2.45 | 1.95 | 1.40 | 1.55 | 1.40 | 1.45 | 1.30 | 1.55 | 1.45 |
| 28 | 2.10 | 1.80 | 2.85 | 2.65 | 1.75 | 1.42 | 1.55 | 1.45 | 1.40 | 1.25 | 1.55 | 2.65 |
| 29 | 2.00 | 1.80 | 2.80 | 2.55 | 1.55 | 1.48 | 1.65 | 1.42 | 1.70 | 1.30 | 1.55 | 3.00 |
| 30 | 2.00 | ..... | 2.80 | 2.20 | 1.55 | 1.52 | 1.52 | 1.45 | 1.65 | 1.50 | 1.50 | 2.00 |
| 31 | 1.95 | ..... | 2.60 | ..... | 1.60 | ..... | 1.50 | 1.45 | ..... | 1.40 | ..... | 1.80 |

[a] During the most of February the creek was frozen part way across.
[b] Anchor ice.
[c] Stream completely frozen over.
[d] Stream open.

NOTE.—During the frozen season the gage was read to the water surface in hole cut in ice.

*Rating table for Chittenango Creek at Chittenango, N. Y., from December 16, 1901, 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.* |
| 1.00 | 16 | 2.20 | 180 | 3.40 | 728 | 4.50 | 1,500 |
| 1.10 | 22 | 2.30 | 210 | 3.50 | 786 | 4.60 | 1,590 |
| 1.20 | 29 | 2.40 | 242 | 3.60 | 846 | 4.70 | 1,680 |
| 1.30 | 36 | 2.50 | 276 | 3.70 | 906 | 4.80 | 1,780 |
| 1.40 | 45 | 2.60 | 318 | 3.80 | 968 | 4.90 | 1,870 |
| 1.50 | 54 | 2.70 | 359 | 3.90 | 1,030 | 5.00 | 1,970 |
| 1.60 | 66 | 2.80 | 405 | 4.00 | 1,100 | 5.20 | 2,190 |
| 1.70 | 78 | 2.90 | 454 | 4.10 | 1,170 | 5.40 | 2,410 |
| 1.80 | 93 | 3.00 | 504 | 4.20 | 1,240 | 5.60 | 2.640 |
| 1.90 | 111 | 3.10 | 558 | 4.30 | 1,320 | 5.80 | 2,900 |
| 2.00 | 130 | 3.20 | 613 | 4.40 | 1,410 | 6.00 | 3,160 |
| 2.10 | 155 | 3.30 | 669 | | | | |

The above table is applicable only for open-channel conditions. It is based upon 29 discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 1.4 feet and 3 feet. Above gage height 3 feet the rating curve is based on 1 measurement at 3.8 feet. The table has been extended beyond these limits by means of logarithmic section paper.

*Estimated monthly discharge of Chittenango Creek at Chittenango, N. Y., for 1904.*

[Drainage area, 79 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January | | | | | |
| February | | | | | |
| March | 1,780 | 78 | 361 | 4.57 | 5.27 |
| April | 669 | 150 | 305 | 3.86 | 4.31 |
| May | 180 | 54 | 91.5 | 1.16 | 1.34 |
| June | 120 | 36 | 52.4 | .663 | .740 |
| July | 63 | 28 | 48.0 | .608 | .701 |
| August | 168 | 45 | 62.7 | .794 | .915 |
| September | 78 | 36 | 48.0 | .608 | .678 |
| October [a] | 54 | 32 | 42.6 | .539 | .621 |
| November | 72 | 32 | 48.0 | .608 | .678 |
| December | 504 | 9 | 51.8 | .656 | .756 |

[a] No record October 16-22. Mean for actual number of days observed used as mean for entire month.

NOTE.—For ice conditions, see footnote to daily gage heights.

*Cazenovia Lake.*

| | | |
|---|---|---|
| Tributary watershed | square miles | 8.7 |
| Storage capacity | cubic feet | 206,997,000 |
| Water surface | square miles | 1.7 |

The drainage basin is deeply rolling, mostly cleared, and has a heavy impervious soil with extensive sodded meadow areas. The soil is underlaid by shale rock, often outcropping and affording numerous springs. The stream tributaries are somewhat sparse, marsh and swamp areas are very limited, with the exception of the Nelson Swamp, about 2 square miles in area.

Cazenovia Lake is located at an elevation of 1,190 feet. From its outlet to the foot of the plateau at Erie Canal crossing, the stream descends 770 feet; the distance, following the general trend of the valley, is 11 miles. The freshet of December 15, 1901, changed the cross section of the stream at the gaging station. Separate rating curves have been prepared for the periods preceding and following that date.[a]

### SALMON RIVER NEAR PULASKI, N. Y.

A current-meter gaging station was established at Fox Bridge September 5, 1900. The original gage was a vertical board scale attached to the upstream end of the center pier, having its zero mark at elevation 88.41 feet, the top of the capstone of the central pier, upstream end, being used as a bench mark, with arbitrary elevation 100.00.

This gage was carried away by ice in the winter of 1901–2, and was replaced July 23, 1902, by a standard chain and weight gage, having its datum at elevation 87.21 feet.

The gage readings have been taken twice each day by S. J. Fox, and have been continued throughout winter and summer, the winter readings being obtained by observing the height to which the water rose in a hole in the ice underneath the gage. Owing to the obstruction of the river channel by ice the discharge for the winter period has not been deduced.

The gaging bridge consists of two spans 183.5 feet between abutments. The stream bed is of gravel and cobble, relatively flat and shallow. There are also two small overflow channels and a flood plain at an average elevation at the highway of 95 feet; the discharge through these is included in the high-water measurements.

The drainage basin above the gaging station is rolling and very sandy, rock lying near the surface in the upper regions of the watershed, in which locality there are also extensive areas of original forest.

The drainage area at the gaging station is provisionally taken at 264 square miles.

The drainage basin is located in a region of heavy snowfall; several feet of snow sometimes accumulating in the forest areas, and, by

[a] For results of gagings of Chittenango Creek at Bridgeport, just above the inflow to Oneida Lake, see Report on Stream Gagings, contained in Supplement, Report of State Engineer and Surveyor of New York, pp. 52-57.

gradually melting, feeding the stream during March and April. The current-meter measurements are made at 5-foot intervals across the stream from the downstream side of Fox Bridge, which is located about 2 miles upstream from Pulaski. The location of the gaging station is shown on the Pulaski sheet of the United States Geological Survey Topographic Atlas.

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

*Discharge measurements of Salmon River near Pulaski, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Feet per sec.* | *Feet.* | *Second-feet.* |
| April 11 | Covert and Swancott | 1,055 | 5.73 | 6.45 | 6,053 |
| September 23 | A. M. Evans | 259 | .83 | 2.71 | [a] 215 |
| November 15 | E. F. Weeks | 248 | 1.23 | 2.82 | 305 |

[a] Discharge probably affected by brush in stream a few feet below gaging section.

*Mean daily gage height, in feet, of Salmon River near Pulaski, N. Y., for 1904.*

| Day. | Jan.[a] | Feb.[a] | Mar.[a] | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | ..... | ..... | 4.70 | 5.80 | 3.28 | 3.72 | 2.70 | 2.60 | 4.38 | 3.28 | 2.85 |
| 2 | [b] 4.10 | ..... | ..... | 5.15 | 6.35 | 3.18 | 3.90 | 2.70 | 2.60 | 3.75 | 3.20 | 2.82 |
| 3 | ..... | ..... | ..... | 5.00 | 6.15 | 3.08 | 4.08 | 2.70 | 2.58 | 3.48 | 3.20 | 2.88 |
| 4 | ..... | ..... | ..... | 4.55 | 6.05 | 3.05 | 3.40 | 2.70 | 3.90 | 3.30 | 3.10 | 2.82 |
| 5 | ..... | ..... | [d] 5.60 | 4.50 | 6.00 | 3.05 | 3.32 | 2.60 | 3.38 | 3.15 | 3.05 | 2.92 |
| 6 | ..... | 5.70 | ..... | 4.60 | 5.75 | 3.10 | 3.50 | 2.70 | 3.10 | 3.28 | 3.05 | 2.95 |
| 7 | ..... | ..... | ..... | 4.82 | 5.45 | 3.05 | 3.25 | 2.65 | 2.95 | 3.30 | 3.00 | 3.05 |
| 8 | ..... | ..... | ..... | 5.10 | 5.45 | 3.00 | 3.05 | 2.60 | 2.80 | 3.18 | 3.00 | 2.98 |
| 9 | ..... | ..... | ..... | 6.24 | 5.22 | 3.62 | 2.85 | 2.50 | 2.78 | 3.10 | 2.92 | 3.08 |
| 10 | 4.30 | ..... | ..... | 7.08 | 4.85 | 3.70 | 2.75 | 2.50 | 2.75 | 3.65 | 2.92 | 3.05 |
| 11 | ..... | ..... | ..... | 6.12 | 4.32 | 3.28 | 2.80 | 2.48 | 2.70 | 4.95 | 2.88 | [a] |
| 12 | ..... | ..... | 5.80 | 5.48 | 3.95 | 3.05 | 2.88 | 2.45 | 2.68 | 4.65 | 2.88 | ..... |
| 13 | ..... | [d] 5.00 | ..... | 4.98 | 3.70 | 2.95 | 3.60 | 2.45 | 2.55 | 3.98 | 2.88 | ..... |
| 14 | ..... | ..... | ..... | 4.60 | 3.60 | 2.88 | 3.40 | 2.45 | 2.90 | 3.62 | 2.85 | ..... |
| 15 | ..... | ..... | ..... | 4.28 | 3.98 | 2.92 | 3.00 | 2.45 | 3.08 | 3.42 | 2.82 | ..... |
| 16 | [e] 4.35 | ..... | ..... | 4.08 | 4.90 | 3.10 | 2.85 | 2.42 | 2.98 | 3.30 | 2.82 | ..... |
| 17 | ..... | ..... | ..... | 3.92 | 4.25 | 2.92 | 2.75 | 2.40 | 2.75 | 3.18 | 2.80 | 3.30 |
| 18 | ..... | ..... | ..... | 3.95 | 3.75 | 2.82 | 3.20 | 2.40 | 2.78 | 3.10 | 2.80 | ..... |
| 19 | ..... | ..... | [e] 4.80 | 4.05 | 3.62 | 2.75 | 3.20 | 2.40 | 2.70 | 3.10 | 2.78 | ..... |
| 20 | ..... | 5.00 | ..... | 3.82 | 4.08 | 2.75 | 2.92 | 2.85 | 2.70 | 3.02 | 2.80 | ..... |
| 21 | ..... | ..... | ..... | 3.80 | 4.15 | 2.82 | 2.72 | 5.75 | 2.72 | 3.42 | 2.82 | ..... |
| 22 | ..... | ..... | ..... | 3.82 | 3.90 | 3.42 | 2.70 | 4.20 | 2.70 | 4.60 | 2.95 | ..... |
| 23 | 5.00 | ..... | ..... | 4.20 | 3.62 | 3.42 | 2.72 | 4.10 | 2.70 | 4.05 | 2.80 | ..... |
| 24 | ..... | ..... | ..... | 4.70 | 3.78 | 3.12 | 3.00 | 3.48 | 2.78 | 3.82 | 2.80 | 3.85 |
| 25 | ..... | ..... | ..... | 6.78 | 3.68 | 3.00 | 2.92 | 3.15 | 5.00 | 3.58 | 2.85 | ..... |
| 26 | ..... | ..... | [f] 7.40 | 6.27 | 3.80 | 3.00 | 2.80 | 3.15 | 4.55 | 3.68 | 2.85 | ..... |
| 27 | ..... | [g] 4.85 | ..... | 5.68 | 3.98 | 2.95 | 2.75 | 3.05 | 3.90 | 4.00 | 2.75 | ..... |
| 28 | ..... | ..... | ..... | 5.95 | 4.00 | 2.80 | 2.72 | 2.88 | 3.48 | 3.75 | 2.80 | 4.70 |
| 29 | ..... | ..... | 7.20 | 6.35 | 3.60 | 2.78 | 2.95 | 2.80 | 3.55 | 3.58 | 2.80 | 4.30 |
| 30 | [h] 4.80 | ..... | 5.10 | 6.05 | 3.38 | 2.98 | 3.00 | 2.68 | 5.25 | 3.50 | 2.80 | 3.95 |
| 31 | ..... | ..... | 4.45 | ..... | 3.35 | ..... | 2.78 | 2.70 | ..... | 3.38 | ..... | 3.90 |

[a] Stream frozen over January 16 to March 28 and December 4 to 31, inclusive. Readings taken weekly to water surface.
[b] Ice 18 inches thick at gage.
[c] Ice 22 inches thick at gage.
[d] Ice 28 inches thick at gage.
[e] Ice 20 inches thick at gage.
[f] River open; ice jam below the station.
[g] Ice 30 inches thick at gage.
[h] Ice 26 inches thick at gage.

*Rating table for Salmon River near Pulaski, N. Y., 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.* |
| 2.40 | 110 | 3.60 | 781 | 4.70 | 2,140 | 5.80 | 4,490 |
| 2.50 | 144 | 3.70 | 865 | 4.80 | 2,300 | 5.90 | 4,780 |
| 2.60 | 181 | 3.80 | 965 | 4.90 | 2,470 | 6.00 | 5,100 |
| 2.70 | 218 | 3.90 | 1,060 | 5.00 | 2,640 | 6.20 | 5,770 |
| 2.80 | 265 | 4.00 | 1,170 | 5.10 | 2,840 | 6.40 | 6,530 |
| 2.90 | 312 | 4.10 | 1,300 | 5.20 | 3,020 | 6.60 | 7,340 |
| 3.00 | 364 | 4.20 | 1,420 | 5.30 | 3,240 | 6.80 | 8,190 |
| 3.10 | 422 | 4.30 | 1,450 | 5.40 | 3,460 | 7.00 | 9,070 |
| 3.20 | 480 | 4.40 | 1,680 | 5.50 | 3,700 | 7.20 | 10,000 |
| 3.30 | 550 | 4.50 | 1,830 | 5.60 | 3,950 | 7.40 | 11,000 |
| 3.40 | 620 | 4.60 | 1,980 | 5.70 | 4,200 | 7.60 | 12,060 |
| 3.50 | 697 | | | | | | |

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 2.45 feet and 3.25 feet. Above this point the curve is based on three measurements at gage height 6.3 feet. The table has been extended beyond these limits.

*Estimated monthly discharge of Salmon River near Pulaski, N. Y., for 1904.*

[Drainage area, 264 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January [a] | | | | | |
| February [a] | | | | | |
| March [a] | | | | | |
| April | 9,420 | 965 | 3,175 | 12.03 | 13.42 |
| May | 6,340 | 585 | 2,143 | 8.13 | 9.37 |
| June | 865 | 241 | 411 | 1.56 | 1.74 |
| July | 4,260 | 218 | 443 | 1.68 | 1.94 |
| August | 4,350 | 110 | 430 | 1.63 | 1.88 |
| September | 3,130 | 162 | 581 | 2.20 | 2.46 |
| October | 2,550 | 378 | 874 | 3.31 | 3.82 |
| November | 532 | 241 | 317 | 1.20 | 1.34 |
| December [a] | | | | | |

[a] Stream frozen. Record not available.

BLACK RIVER NEAR FELTS MILLS, N. Y.

The gaging station is located at the dam of the Black River Traction Company, near the village of Felts Mills. The dam is situated 9 miles upstream from Watertown and 7 miles upstream from the old Huntingtonville gaging station on the same stream. The drainage area is estimated at 1,851 square miles, or 37.5 square miles less than that at Huntingtonville. The intervening area is mainly comprised in two small streams, Townsend and Rutland Hollow creeks.

The dam is of squared timber and has a slope on the upstream face of 2.88 horizontal to 1 vertical. The crest is protected by boiler plate, and the downstream face is vertical, giving a free overfall. The main crest is 380.6 feet in length. There are two additional sections on the right-hand side, one 14.1 feet long and the other 17.9 feet in length. A similarly constructed dam, 117 feet long at the left bank, serves as an auxiliary spillway and as a headrace wall.

The gage is attached vertically to a crib at the juncture of the main and auxiliary spillways, 12 feet upstream from the crest, and a correction is made to the gage readings for velocity of approach during high water. The discharge over the spillways has been calculated by means of the weir formula using coefficients derived from experiments of the United States Geological Survey for a dam of similar cross section. The dam was constructed in 1900, rests on limestone foundation, and is very nearly water-tight. The headrace is closed by a bulkhead, no water wheels having been installed.

Owing to continued discharge over dam to a considerable depth during the years 1903 and 1904, it has not been possible to obtain a new profile of the crest. The discharge has been calculated from the known elevations of the ends of the crest, and the results given are subject to revision. Settlement of the crest, if any has taken place, would have the effect of making the discharge at a given gage height greater than that given in the accompanying tables. The gage readings are taken twice daily, at 7 a. m. and 6 p. m., by George W. Kidder.

The regimen of Black River is controlled by storage on its larger tributaries, including Beaver River at Beaver, a series of reservoirs at the headwaters of Moose River, and additional reservoirs at Forestport and on the headwaters of Black River.

Water is diverted from Black River through Forestport feeder to supply the Black River canal at Boonville. A portion of this diversion flows northward from Boonville and enters Black River again at Lyons Falls; the remainder flows southward through Black River canal and enters Erie canal at Rome. The amount of this diversion which takes place during the season of canal navigation is not continuously recorded.

Measurements made by the New York Barge Canal Survey in 1900

showed the following amounts of flow in the Black River canal south of the Forestport feeder:

| Date. | Discharge. |
|---|---|
| | *Second-feet.* |
| August 31, 1900 | 197.4 |
| September 24, 1900 | 242.2 |
| November 7, 1900 | 254.2 |
| December 1, 1900 | 181.2 |

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

*Mean daily discharge, in second-feet, of Black River near Felts Mills, N. Y., 1902–1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1902. | | | | | | | | | | | | |
| 1 | | | | | | | | | 975 | 1,520 | 3,900 | 2,600 |
| 2 | | | | | | | | | 1,070 | 1,470 | 3,130 | 2,210 |
| 3 | | | | | | | | | 1,320 | 1,580 | 2,860 | 2,080 |
| 4 | | | | | | | | | 1,270 | 1,270 | 2,210 | 4,990 |
| 5 | | | | | | | | | 1,120 | 804 | 1,750 | 4,430 |
| 6 | | | | | | | | | 975 | 1,370 | 1,690 | 2,860 |
| 7 | | | | | | | | | 590 | 1,970 | 1,690 | 3,000 |
| 8 | | | | | | | | | 1,320 | 1,970 | 1,750 | 2,660 |
| 9 | | | | | | | | | 1,470 | 2,150 | 1,690 | 2,470 |
| 10 | | | | | | | | | 1,470 | 1,860 | 1,580 | 2,280 |
| 11 | | | | | | | | | 2,340 | 1,220 | 1,520 | 1,860 |
| 12 | | | | | | | | | 1,970 | 1,320 | 1,580 | 1,370 |
| 13 | | | | | | | | | 1,580 | 1,470 | 4,590 | 1,420 |
| 14 | | | | | | | | | 1,120 | 2,080 | 5,070 | 1,470 |
| 15 | | | | | | | | | 1,420 | 2,410 | 5,240 | 1,320 |
| 16 | | | | | | | | | 1,320 | 2,080 | 3,970 | 1,580 |
| 17 | | | | | | | | | 1,270 | 1,690 | 3,130 | 590 |
| 18 | | | | | | | | | 1,220 | 1,640 | 2,730 | 2,340 |
| 19 | | | | | | | | | 1,170 | 1,420 | 2,660 | 3,400 |
| 20 | | | | | | | | | 932 | 1,800 | 2,860 | 3,200 |
| 21 | | | | | | | | | 676 | 1,970 | 2,340 | 3,620 |
| 22 | | | | | | | | | 1,170 | 2,210 | 1,920 | 4,200 |
| 23 | | | | | | | | | 1,020 | 1,750 | 1,750 | 5,820 |
| 24 | | | | | | | | | 761 | 2,080 | 2,800 | 6,500 |
| 25 | | | | | | | | | 847 | 1,640 | 2,280 | 5,640 |
| 26 | | | | | | | | | 1,020 | 1,690 | 1,920 | 5,240 |
| 27 | | | | | | | | | 804 | 1,970 | 2,080 | 4,270 |
| 28 | | | | | | | | | 1,020 | 2,340 | 2,730 | 3,620 |
| 29 | | | | | | | | 1,220 | 1,320 | 3,970 | 3,130 | 3,200 |
| 30 | | | | | | | | 1,120 | 1,580 | 4,750 | 2,280 | 3,000 |
| 31 | | | | | | | | 932 | | 4,830 | | 2,800 |
| 1903. | | | | | | | | | | | | |
| 1 | 2,470 | 5,640 | 8,590 | 5,920 | 2,210 | 522 | 1,970 | 5,560 | 2,210 | 1,020 | 2,340 | 1,320 |
| 2 | 2,150 | 6,590 | 9,160 | 5,720 | 1,970 | 453 | 1,920 | 3,970 | 1,750 | 1,320 | 2,080 | 1,420 |
| 3 | 2,340 | 6,690 | 9,640 | 5,240 | 1,640 | 453 | 1,970 | 3,690 | 1,750 | 1,120 | 1,970 | 1,520 |
| 4 | 3,270 | 7,400 | 9,870 | 6,300 | 1,690 | 453 | 2,080 | 3,400 | 1,420 | 1,320 | 1,750 | 1,640 |
| 5 | 3,970 | 8,360 | 8,930 | 7,300 | 1,860 | 351 | 1,860 | 3,540 | 1,220 | 1,220 | 2,210 | 1,750 |
| 6 | 3,620 | 7,600 | 8,480 | (a) | 1,640 | 282 | 2,340 | 3,830 | 1,120 | 1,320 | 2,860 | 1,860 |
| 7 | 3,400 | 6,690 | 7,300 | (a) | 1,580 | 282 | 3,270 | 4,120 | 932 | 1,320 | 2,470 | 1,970 |
| 8 | 2,800 | 6,010 | 7,500 | (a) | 1,640 | 761 | 3,130 | 4,430 | 761 | 1,750 | 1,970 | 2,210 |
| 9 | 2,470 | 5,320 | 10,200 | (a) | 1,520 | 718 | 2,730 | 2,730 | 676 | 3,270 | 1,750 | 1,860 |

(a) Record not available.

*Mean daily discharge, in second-feet, of Black River near Felts Mills, N. Y., etc.*—Cont'd.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | | | | | |
| 10 | 2,280 | 4,270 | 11,400 | (a) | 1,320 | 890 | 2,340 | 3,400 | 676 | 11,500 | 1,520 | 1,320 |
| 11 | 1,920 | 3,900 | 14,100 | (a) | 1,020 | 487 | 1,750 | 3,130 | 847 | 17,600 | 1,320 | 1,750 |
| 12 | 1,860 | 4,430 | 17,600 | (a) | 1,520 | 1,750 | 1,520 | 3,400 | 676 | 18,200 | 1,520 | 1,750 |
| 13 | 1,750 | 5,560 | 16,700 | (a) | 1,320 | 5,320 | 1,640 | 3,830 | 1,020 | 10,500 | 1,320 | 1,520 |
| 14 | 1,640 | 5,640 | 15,500 | (a) | 975 | 4,910 | 1,320 | 3,540 | 590 | 8,590 | 1,520 | 1,750 |
| 15 | 1,520 | 5,560 | 14,100 | (a) | 676 | 3,830 | 1,120 | 2,470 | 590 | 7,500 | 1,750 | 2,340 |
| 16 | 1,750 | 5,240 | 11,700 | (a) | 590 | 2,660 | 1,020 | 1,860 | 590 | 6,500 | 1,970 | 1,860 |
| 17 | 1,970 | 4,670 | 11,500 | (a) | 932 | 2,340 | 847 | 1,640 | 847 | 5,920 | 2,210 | 1,420 |
| 18 | 1,470 | 4,040 | 11,200 | (a) | 718 | 1,750 | 761 | 1,120 | 932 | 7,500 | 1,970 | 1,750 |
| 19 | 1,320 | 3,900 | 12,800 | (a) | 890 | 1,320 | 590 | 1,120 | 1,420 | 9,040 | 1,750 | 1,750 |
| 20 | 1,690 | 3,620 | 14,700 | (a) | 1,020 | 1,470 | 453 | 1,120 | 1,120 | 10,200 | 1,420 | 1,640 |
| 21 | 2,800 | 2,930 | 16,800 | (a) | 590 | 1,020 | 1,020 | 1,580 | 1,750 | 10,200 | 1,320 | 2,080 |
| 22 | 2,800 | 2,730 | 18,800 | (a) | 419 | 2,730 | 1,420 | 1,690 | 1,120 | 8,810 | 1,750 | 2,860 |
| 23 | 2,080 | 2,660 | 22,100 | (a) | 590 | 3,470 | 2,210 | 1,750 | 932 | 6,500 | 2,080 | 3,400 |
| 24 | 2,210 | 2,470 | (b) | (a) | 159 | 3,400 | 3,000 | 1,520 | 2,120 | 4,750 | 2,600 | 3,970 |
| 25 | 2,660 | 2,470 | (b) | (a) | 522 | 3,470 | 3,400 | 1,860 | 847 | 4,430 | 2,080 | 4,270 |
| 26 | 2,800 | 2,410 | (b) | 1,580 | 676 | 3,970 | 3,000 | 2,210 | 590 | 4,270 | 1,970 | 3,400 |
| 27 | 2,800 | 2,540 | 21,400 | 2,030 | 590 | 3,760 | 2,600 | 2,600 | 676 | 3,690 | 1,750 | 3,000 |
| 28 | 2,800 | 3,470 | 17,300 | 2,540 | 453 | 3,000 | 2,210 | 2,470 | 676 | 3,400 | 1,420 | 3,270 |
| 29 | 3,690 | ..... | 13,300 | 2,150 | 453 | 2,340 | 2,470 | 2,340 | 1,320 | 3,000 | 1,220 | 3,270 |
| 30 | 4,590 | ..... | 8,360 | 1,580 | 385 | 1,970 | 5,070 | 2,210 | 1,220 | 2,730 | 1,520 | 2,860 |
| 31 | 6,010 | ..... | 6,690 | ..... | 385 | ..... | 6,500 | 2,340 | ..... | 2,470 | ..... | 2,600 |
| 1904. | | | | | | | | | | | | |
| 1 | 2,470 | 932 | 1,640 | 9,990 | (c) | 3,310 | 1,620 | 1,620 | 736 | 7,760 | 2,530 | 1,280 |
| 2 | 2,210 | 1,220 | 1,860 | 9,520 | (c) | 2,900 | 1,410 | 1,510 | 513 | 7,760 | 2,470 | 1,380 |
| 3 | 1,970 | 1,640 | 2,470 | 9,040 | (c) | 2,190 | 2,010 | 1,160 | 907 | 7,250 | 2,210 | 1,480 |
| 4 | 2,210 | 1,860 | 3,400 | 9,750 | (c) | 2,120 | 2,120 | 1,110 | 1,280 | 6,360 | 2,470 | 616 |
| 5 | 1,860 | 2,470 | 4,270 | 10,200 | (c) | 1,960 | 1,960 | 1,310 | 2,340 | 5,130 | 2,400 | 907 |
| 6 | 1,750 | 4,590 | 4,750 | 9,750 | (c) | 2,010 | 2,010 | 1,160 | 2,140 | 4,030 | 2,340 | 1,080 |
| 7 | 1,420 | 6,890 | 5,070 | 9,040 | (c) | 2,640 | 2,190 | 527 | 1,380 | 3,460 | 2,140 | 1,280 |
| 8 | 1,320 | 6,300 | 4,270 | 8,360 | (c) | 2,840 | 1,900 | 1,160 | 1,040 | 2,990 | 2,090 | 992 |
| 9 | 1,120 | 5,720 | 3,690 | 8,590 | (c) | 3,800 | 1,620 | 1,360 | 1,180 | 2,530 | 1,750 | 1,040 |
| 10 | 1,320 | 5,400 | 3,270 | 14,700 | (c) | 4,550 | 887 | 1,160 | 907 | 2,400 | 1,580 | 1,040 |
| 11 | 1,640 | 5,070 | 3,690 | 18,200 | (c) | 5,280 | 1,110 | 1,210 | 907 | 3,890 | 1,580 | 1,280 |
| 12 | 1,970 | 4,750 | 3,270 | 19,200 | (c) | 5,030 | 1,160 | 887 | 736 | 5,300 | 1,580 | 1,530 |
| 13 | 1,520 | 4,430 | 3,540 | 15,300 | (c) | 4,160 | 1,260 | 596 | 693 | 5,780 | 1,380 | 1,380 |
| 14 | 847 | 4,120 | 3,000 | 13,100 | (c) | 3,040 | 1,510 | 493 | 1,750 | 5,300 | 1,640 | 1,480 |
| 15 | 676 | 3,830 | 2,470 | 11,000 | 3,800 | 2,320 | 1,460 | 801 | 693 | 4,810 | 1,580 | 1,580 |
| 16 | 590 | 3,270 | 2,730 | 9,040 | 5,110 | 1,680 | 1,260 | 1,310 | 1,180 | 3,190 | 1,700 | 1,480 |
| 17 | 590 | 3,000 | 2,600 | 7,500 | 5,360 | 1,730 | 1,160 | 1,020 | 1,430 | 2,790 | 1,580 | 1,700 |
| 18 | 590 | 2,860 | 2,210 | 7,090 | 5,080 | 1,460 | 1,460 | 887 | 821 | 2,140 | 1,330 | 1,700 |
| 19 | 761 | 2,210 | 1,640 | 6,300 | 4,240 | 1,110 | 3,730 | 673 | 693 | 1,810 | 1,640 | 1,530 |
| 20 | 761 | 1,320 | 2,080 | 5,720 | 4,310 | 1,260 | 2,840 | 930 | 992 | 1,810 | 1,040 | 1,580 |
| 21 | 847 | 1,220 | 3,000 | 5,240 | 5,110 | 1,110 | 1,560 | 3,730 | 1,860 | 2,030 | 1,480 | 1,480 |
| 22 | 1,320 | 1,520 | 3,970 | 5,070 | 5,190 | 1,020 | 887 | 5,280 | 2,660 | 5,130 | 1,810 | 1,580 |
| 23 | 2,470 | 1,860 | 5,720 | 5,400 | 4,790 | 2,010 | 844 | 5,520 | 2,400 | 5,460 | 1,700 | 1,430 |
| 24 | 2,730 | 2,340 | 7,090 | 5,720 | 3,730 | 2,580 | 844 | 5,030 | 1,700 | 5,620 | 1,580 | 1,430 |
| 25 | 1,970 | 2,470 | 7,920 | 7,920 | 3,510 | 2,120 | 1,410 | 3,870 | 3,130 | 5,980 | 1,700 | 1,480 |
| 26 | 1,750 | 1,860 | 12,000 | 9,520 | 3,730 | 1,680 | 1,680 | 2,840 | 5,620 | 5,620 | 1,580 | 1,640 |
| 27 | 1,520 | 1,520 | 13,300 | 11,500 | 3,730 | 1,210 | 1,360 | 2,120 | 6,360 | 5,130 | 821 | 1,580 |
| 28 | 1,220 | 1,320 | 13,300 | 13,100 | 4,240 | 758 | 1,060 | 2,120 | 6,360 | 4,490 | 1,130 | 1,750 |
| 29 | 1,120 | 1,220 | 12,800 | 14,400 | 4,080 | 562 | 1,790 | 1,460 | 5,880 | 4,030 | 1,580 | 1,980 |
| 30 | 1,120 | ..... | 11,500 | 15,500 | 3,870 | 1,360 | 1,900 | 1,210 | 6,950 | 2,920 | 1,280 | 3,530 |
| 31 | 932 | ..... | 10,200 | ..... | 3,660 | ..... | 1,160 | 1,060 | ..... | 2,660 | ..... | 1,480 |

a Record not available. b Above rating table. c No record.

*Estimated monthly discharge of Black River near Felts Mills, N. Y., 1902–1904.*

[Drainage area, 1,851 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| 1902. | | | | | |
| September | 2,340 | 590 | 1,205 | 0.651 | 0.726 |
| October | 4,830 | 804 | 2,009 | 1.09 | 1.26 |
| November | 5,240 | 1,520 | 2,628 | 1.42 | 1.58 |
| December | 6,500 | 590 | 3,098 | 1.67 | 1.92 |
| 1903. | | | | | |
| January | 6,010 | 1,320 | 2,610 | 1.41 | 1.63 |
| February | 8,360 | 2,410 | 4,743 | 2.56 | 2.66 |
| March, 28 days | (a) | 6,690 | 12,700 | 6.86 | 7.14 |
| April, 10 days | (b) | ..... | 4,036 | 2.18 | .811 |
| May | 2,210 | 159 | 1,031 | .557 | .642 |
| June | 5,320 | 282 | 2,002 | 1.08 | 1.20 |
| July | 6,500 | 453 | 2,178 | 1.18 | 1.36 |
| August | 5,560 | 1,120 | 2,725 | 1.47 | 1.70 |
| September | 2,210 | 590 | 1,047 | .566 | .632 |
| October | 18,200 | 1,020 | 5,837 | 3.15 | 3.63 |
| November | 2,860 | 1,220 | 1,846 | .997 | 1.11 |
| December | 4,270 | 1,320 | 2,238 | 1.21 | 1.40 |
| 1904. | | | | | |
| January | 2,730 | 590 | 1,438 | .777 | .896 |
| February | 6,890 | 932 | 3,007 | 1.62 | 1.75 |
| March | 13,300 | 1,640 | 5,249 | 2.84 | 3.27 |
| April | 19,200 | 5,070 | 10,160 | 5.49 | 6.12 |
| May 15–31 | 5,360 | 3,510 | 4,323 | 2.34 | 1.48 |
| June | 5,280 | 562 | 2,327 | 1.26 | 1.41 |
| July | 3,730 | 844 | 1,586 | .857 | .988 |
| August | 5,520 | 493 | 1,779 | .961 | 1.11 |
| September | 6,950 | 513 | 2,174 | 1.17 | 1.30 |
| October | 7,760 | 1,810 | 4,373 | 2.36 | 2.71 |
| November | 2,530 | 821 | 1,723 | .931 | 1.04 |
| December | 3,530 | 616 | 1,474 | .796 | .918 |

a Above rating table.
b Record not available April 6–25, inclusive.

## MOOSE RIVER AT MOOSE RIVER, N. Y.

Moose River drainage basin lies mainly in Herkimer and Hamilton counties, N. Y. The stream is tributary to Black River at Lyons Falls. The gaging station was established June 5, 1900. Two readings of the stream stage are taken daily on a graduated board scale attached to posts on the left bank of the stream at Moose River village, the gage comprising a high-water and a low-water section. The observer is Chris Hannan.

A cableway was erected at the gaging station in June, 1903, having a clear span of 269 feet, from which the current meter measurements listed below have been made in 1904. The bed of the stream is of cobble with occasional bowlders, the current smooth, depth fairly uniform. A short distance below occurs a fall. The stream is smooth above the gaging station to the foot of McKeever Dam, 2 miles upstream, but is divided by an island a short distance above the gage, which creates an ice jam during spring freshets. The gage was carried out by such an ice freshet February 28, 1903, and was replaced at a slightly different elevation. The bench mark is on top of a bowlder on the left stream bank 300 feet upstream from cableway.

| | |
|---|---|
| Elevation bench mark, assumed | 100.00 |
| Elevation gage zero prior to February 28, 1903 | 84.64 |
| Elevation gage zero after February 28, 1903 | 84.47 |

The flow for the spring months is controlled by lumbermen's dams, large volumes of water being turned into the stream when required for log driving.

The stream freezes over in winter, alternate layers of ice and snow or slush often forming in such manner as to prevent discharge measurements being made. During the ice season the gage is read once each week.

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

*Drainage areas of Moose River.*[a]

| Stream. | Location. | Area. |
|---|---|---|
| | | *Sq. miles.* |
| South Branch Moose River | Above Indian River | 67.2 |
| Indian River | Above mouth | 50.2 |
| Total | | 117.4 |
| Middle Branch Moose River | Above Old Forge | 52.3 |
| Moose River | Above Moose River gaging station | 374.1 |
| Do | Above mouth | 439.6 |

[a] From U. S. Geol. Maps, East of 75th Meridian, remainder from Bien's Atlas of New York.

*Discharge measurements of Moose River at Moose River, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| June 29 | C. C. Covert | 474 | 0.62 | 1.15 | 290 |
| September 21 | A. M. Evans | 702 | .92 | 2.21 | 648 |
| October 22 | Beebe and Swancott | 1,408 | 2.25 | 5.39 | 3,162 |
| October 23 | C. A. Swancott | 1,116 | 1.74 | 4.22 | 1,943 |
| October 24 | do | 828 | 1.30 | 3.12 | 1,074 |

*Mean daily gage height, in feet, of Moose River at Moose River, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.80 | ..... | ..... | ..... | 6.20 | 2.35 | 1.60 | 1.40 | 0.80 | 4.85 | 2.15 | 1.65 |
| 2 | 1.80 | ..... | ..... | 3.60 | 6.95 | 2.35 | 2.20 | 1.50 | 1.20 | 4.05 | 2.55 | 1.65 |
| 3 | 1.80 | ..... | ..... | ..... | 6.65 | 2.25 | 2.25 | 1.40 | 1.45 | 3.85 | 2.85 | 1.75 |
| 4 | 1.80 | ..... | ..... | ..... | 6.50 | 1.95 | 2.35 | 1.35 | 2.75 | 3.60 | 2.85 | 1.80 |
| 5 | 1.90 | ..... | 3.90 | ..... | 6.10 | 1.95 | 2.45 | 1.25 | 2.20 | 3.35 | 2.85 | 1.65 |
| 6 | 1.90 | 2.60 | ..... | ..... | 5.85 | 2.95 | 2.65 | 1.35 | 1.70 | 3.25 | 2.55 | 1.70 |
| 7 | 1.85 | ..... | ..... | ..... | 5.35 | 3.20 | 2.40 | 1.25 | 1.45 | 3.10 | 2.35 | 1.40 |
| 8 | 1.80 | ..... | ..... | ..... | 5.20 | 2.95 | 2.05 | 1.20 | 1.35 | 2.60 | 2 55 | 1.30 |
| 9 | 1.80 | ..... | ..... | 4.60 | 4.75 | 4.05 | 1.85 | 1.15 | 1.20 | 2.25 | 2.50 | 1.50 |
| 10 | 1.85 | ..... | ..... | 6.15 | 4.25 | 5.40 | 1.50 | 1.10 | 1.10 | 2.25 | 2.55 | 1.75 |
| 11 | 1.80 | ..... | ..... | 5.70 | 3.75 | 4.20 | 1.35 | 1.00 | .95 | 4.45 | 2.35 | 1.80 |
| 12 | 1.80 | ..... | 4.40 | 5.00 | 3.20 | 3.45 | 1.25 | .90 | 1.05 | 4.65 | 2.20 | 1.70 |
| 13 | 1.90 | 2.10 | ..... | 4.45 | 3.05 | 2.75 | 1.25 | .95 | .95 | 3.90 | 2.25 | 1.60 |
| 14 | 1,90 | ..... | ..... | 4.05 | 2.85 | 2.60 | 1.15 | 1.15 | 1.00 | 3.50 | 2.30 | 1.65 |
| 15 | 1.90 | ..... | ..... | 3.85 | 2.75 | 2.45 | 1.15 | 1.40 | 1.35 | 2.90 | 2.20 | 1.65 |
| 16 | 2.05 | ..... | ..... | 3.80 | 4.10 | 2.05 | 1.05 | 1.50 | 1.90 | 2.45 | 2.05 | 1.60 |
| 17 | 2.10 | ..... | ..... | 3.70 | 3.90 | 1.85 | .90 | 1.35 | 2.05 | 2.30 | 1.95 | 1.50 |
| 18 | 2.10 | ..... | ..... | 3.55 | 3.35 | 1.60 | 1.00 | 1.25 | 1.75 | 2.60 | 1.85 | 1.50 |
| 19 | 2.10 | ..... | 3.60 | 3.35 | 3.10 | 1.50 | .95 | 1.15 | 1.70 | 2.45 | 1.75 | 1.40 |
| 20 | 2.10 | ..... | ..... | 2.90 | 3.30 | 1.40 | .85 | 1.85 | 2.35 | 2.25 | 1.80 | 1.50 |
| 21 | 2.10 | ..... | ..... | 2.70 | 3.25 | 1.75 | .70 | 4.15 | 2.45 | 2.50 | 2.05 | 1.40 |
| 22 | 2.20 | ..... | ..... | 2.55 | 3.05 | 2.85 | .80 | 3.50 | 2.30 | 5.55 | 2.05 | 1.50 |
| 23 | 2.40 | ..... | ..... | 2.80 | 2.75 | 3.05 | .85 | 3.05 | 2.10 | 4.20 | 2.15 | 1.45 |
| 24 | 2.70 | ..... | ..... | 3.20 | 2.45 | 2.65 | .95 | 2.65 | 2.25 | 3.40 | 2.15 | 1.40 |
| 25 | 2.95 | ..... | ..... | 5.45 | 2.70 | 2.25 | 1.25 | 1.85 | 5.10 | 2.90 | 2.00 | 1.45 |
| 26 | 2.95 | ..... | 4.30 | 5.35 | 2.70 | 1.95 | 1.55 | 1.60 | 5.05 | 2.85 | 1.80 | 1.50 |
| 27 | 3.00 | 3.60 | ..... | 5.20 | 3.15 | 1.65 | 1.65 | 1.35 | 4.15 | 2.85 | 1.65 | 1.85 |
| 28 | 2.80 | ..... | ..... | 5.70 | 3.25 | 1.35 | 1.65 | 1.15 | 3.85 | 2.60 | 1.65 | 2.30 |
| 29 | 2.75 | ..... | ..... | 6.35 | 3.20 | 1.10 | 1.65 | 1.00 | 3.65 | 2.20 | 1.90 | 2.85 |
| 30 | 2.70 | ..... | ..... | 6.50 | 2.50 | 1.25 | 1.60 | .85 | 6.05 | 2.10 | 1.80 | 2.95 |
| 31 | (a) | ..... | ..... | ..... | 2.40 | ..... | 1.50 | .80 | ..... | 2.15 | ..... | 3.05 |

a River frozen January 31 to April 8.

## ST. LAWRENCE RIVER DRAINAGE BASIN.

St. Lawrence River receives the drainage from a number of New York streams having their headwaters in a northerly slope of the Adirondack region, where there are also numerous lakes and storage facilities.

Grass, Raquette, and St. Regis rivers lie within the United States. Salmon, Trout, Chateaugay, and English rivers cross the international boundary line and flow northerly into St. Lawrence River in Canada, as does also Richelieu River, the outlet of Lake Champlain.

*St. Lawrence River tributaries in United States.*

| Stream. | Drainage area. |
|---|---|
| | *Sq. miles.* |
| Oswegatchie River | 1,609 |
| Grass River | 637 |
| Raquette River | 1,219 |
| St. Regis River | 910 |
| Little Salmon River [a] | 103 |
| Salmon River [a] | 273 |
| Trout River [b] | 129 |
| Chateaugay River [b] | 199 |
| English River [b] | 53 |
| Lake Champlain [b] | 8,187 |

[a] Above junction near international boundary. [b] Above New York State line.

Chateaugay River has extensive surface storage in the Upper and Lower Chateaugay lakes lying on the north slope of the Adirondacks. A measurement of the ordinary spring discharge of this stream was made by the engineers of the United States Deep Waterways at Ormstown, April 19, 1899; discharge, 2,720 second-feet, or 13.6 second-feet per square mile.

English River rises near the international boundary, flows southeasterly in New York, then recrosses into Canada, draining an area above the crossing of the boundary line of 53 square miles. A measurement of the spring flow of this stream was made near the New York and Canada boundary line, April 26, 1899, by the engineers of the United States Deep Waterways, at which time the discharge was 392 second-feet.

St. Lawrence River drains, through Lake Champlain, an area of 4,560 square miles in the State of Vermont. This drainage is practically all from Missisquoi, Lamoille, and Winooski rivers and Otter Creek.

Missisquoi River has a total drainage area of 860 square miles, of which 245 square miles lie in Canada. It has its headwaters in the highlands west of Lake Memphremagog, thence flows southerly through Canada and westerly through Vermont into Lake Champlain. The slopes as a rule are quite steep. The basin is very generally made up of farm lands, but considerable areas of forest are found at the head-

waters of all its tributaries. There is no great amount of lake or artificial storage. At many points water power is in use, but the storage at such power plants is invariably small.

Lamoille River drains a total area of 725 square miles. Its headwaters lie in the Green Mountain region in the northern part of Vermont; thence it flows in a general westerly direction into Lake Champlain. The basin includes considerable farm land, but extensive areas of forest occur at the headwaters, especially in the mountainous regions. As the slopes are steep, there is no great amount of natural or artificial storage. Water power is used at many points along the river.

Winooski River drains a total area of 995 square miles, all in Vermont. It has its headwaters in the Green Mountain district in the east-central part of the State; thence it flows generally northwesterly into Lake Champlain near Burlington. The basin is generally in farm lands, with considerable areas of forest in the headwaters. The storage, either natural or artificial, is insignificant.

Raquette River drains a long, narrow watershed extending from Hamilton County to St. Lawrence River. Above Piercefield the drainage basin broadens out, including a region interspersed with lakes and ponds and affording ample opportunities for storage development,[a] as shown by the following list of lakes:

| Lake. | Elevation of water surface. | Surface area. | Drainage area. |
|---|---|---|---|
| | *Feet.* | *Sq. miles.* | *Sq. miles.* |
| Blue Mountain Lake[b] | 1,788 | 3.9 | 39.3 |
| Raquette Lake | 1,762 | 8.3 | 93.9 |
| Forked Lake | 1,741 | 2.5 | 39.8 |
| Long Lake | 1,629 | 4.7 | 152.2 |
| Big Tupper Lake | 1,554 | 8.0 | 59.3 |

The headquarters of Raquette River are on an elevated plateau dotted with mountains and interspersed with lakes. The region is timbered, and underlaid with granitic gneiss of the Adirondack formation, the soil in the valleys being often sandy. Numerous marsh and swamp areas exist; many of these are on the watershed divide and feed streams flowing in opposite directions.[c]

[a] Described in report on a survey of upper Hudson and Raquette rivers, Farrand N. Benedict; 1872.

[b] Including Eagle and Utowana lakes.

[c] The upper drainage basin is shown on the Blue Mountain, Raquette Lake, Big Moose, and Canada Lake sheets of the United States Geological Survey Topographic Atlas. Drainage areas south of the 75th meridian have been taken from this map. Those on the north are from Bien's atlas of New York.

*Drainage areas of Raquette River.*

| Location. | Area. | |
|---|---|---|
| | Point to point. | Total. |
| | *Sq. miles.* | *Sq. miles.* |
| Blue Mountain and Utowana lakes | ..... | 18.4 |
| South inlet, above mouth | ..... | 32.7 |
| Above Raquette Lake outlet | 67.0 | 118.1 |
| Above Forked Lake dam | 55.2 | 173.3 |
| Above outlet Long Lake | 100.5 | 273.8 |
| Above Raquette Pond dam | 421.1 | 694.9 |
| Above Hannawa Falls | 257.9 | 952.7 |
| Above Massena Springs | 216.0 | 1,168.7 |
| Above mouth | 50.0 | 1,218.7 |

Otter Creek drains a total area of 925 square miles, all in Vermont. Its headwaters are in the southern part of the State, generally at a lower elevation than those of either of the three rivers mentioned above. It flows generally northerly through some of the best farm districts in Vermont. The slope of the river between Rutland and Middlebury is very small, while between Middlebury and the mouth it is greater. The slopes of the tributary streams are generally steep. Storage in the basin is insignificant. Considerable areas on the headwaters of the river are in forest.

The following pages give the results of data collected during 1904 in the St. Lawrence River drainage basin:

### OSWEGATCHIE RIVER NEAR OGDENSBURG, N. Y.

A gaging station was established at Eel Weir Bridge May 16, 1903. Observations of the stream stage are taken twice daily by Joseph H. La Rue. This stream has its source in a region of lakes and timbered swamps in the southern part of St. Lawrence County. The largest of the lakes is Cranberry Lake, which affords valuable storage to water power users on its outlet, East Branch of Oswegatchie River. The East and West branches flow in a general direction northwesterly. The two branches join near Talcville. From Gouverneur to Oxbow the river flows southwest. It then turns abruptly to the northeast. At Galilee it is joined by the outlet of Black Lake, and finally enters St. Lawrence River at Ogdensburg. The Eel Weir Bridge is located just below the junction of Oswegatchie River and Black Lake outlet. The channel is in rock and is partly artificial, rock underneath the bridge having been removed by blasting to increase the bridge opening.

A standard chain gage is attached to the iron work of the bridge on the upstream side of the right-hand span. The bench mark is a square chisel draft on the upstream side of the right-hand abutment.

Elevation assumed ..... 100.00
Elevation of datum plane of gage ..... 83.28

The bridge consists of two spans: Right-hand, 129.6; left-hand, 130.1, feet length, respectively.

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

*Drainage areas of Oswegatchie River.* [a]

| Stream. | Location. | Area. |
|---|---|---|
| | | *Sq. miles.* |
| East Branch Oswegatchie River | Above mouth | 358 |
| West Branch Oswegatchie River | do | 272 |
| Oswegatchie River | Below junction of two branches | 630 |
| Do | Above Gouverneur | 727 |
| Do | Above Galilee | 1,033 |
| Indian River | Above Philadelphia | 216 |
| Black Lake watershed | Above Galilee | 544 |
| Oswegatchie River | Below Black Lake Junction | 1,577 |
| Do | Above Ogdensburg | 1,609 |
| Black Lake water surface | | 17.2 |
| Cranberry Lake water surface | | 12.8 |

[a] From Bien's Atlas of New York State.

*Discharge measurements of Oswegatchie River near Ogdensburg, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Feet per sec.* | *Feet.* | *Second-feet.* |
| April 8 | Covert and Swancott | 1,166 | 8.11 | 8.10 | 9,464 |
| April 10 | do | 1,176 | 8.11 | 8.05 | 9,548 |
| July 4 | C. C. Covert | 306 | 3.95 | 4.80 | 1,206 |
| October 23 | A. M. Evans | 549 | 4.40 | 5.68 | 2,414 |
| October 23 | do | 536 | 4.42 | 5.64 | 2,372 |

*Mean daily gage height, in feet, of Oswegatchie River near Ogdensburg, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.10 | 5.40 | 5.20 | 9.60 | 6.70 | 5.45 | 4.60 | 5.00 | 5.00 | 6.20 | 5.80 | 4.60 |
| 2 | 5.10 | 5.40 | 5.30 | 9.45 | 6.70 | 5.50 | 4.60 | 5.00 | 4.95 | 6.40 | 5.70 | 4.60 |
| 3 | 5.00 | 5.40 | 5.30 | 9.20 | 6.65 | 5.65 | 4.65 | 4.90 | 5.00 | 6.60 | 5.70 | 4.65 |
| 4 | 4.90 | 5.25 | 5.30 | 9.05 | 6.60 | 5.50 | 4.80 | 4.90 | 5.00 | 6.60 | 5.60 | 4.70 |
| 5 | 4.90 | 5.10 | 5.40 | 8.65 | 6.50 | 5.50 | 4.80 | 4.90 | 5.00 | 6.60 | 5.50 | 4.70 |
| 6 | 4.80 | 5.00 | 5.45 | 8.30 | 6.40 | 5.50 | 4.80 | 4.90 | 5.20 | 6.45 | 5.55 | 4.70 |
| 7 | 4.65 | 5.90 | 5.55 | 8.20 | 6.35 | 5.40 | 4.80 | 4.80 | 5.35 | 6.30 | 5.60 | 4.65 |
| 8 | 4.60 | 5.00 | 6.05 | 8.00 | 6.25 | 5.40 | 5.00 | 4.80 | 5.30 | 6.05 | 5.50 | 4.60 |
| 9 | 4.60 | 5.00 | 6.70 | 7.90 | 6.10 | 5.30 | 5.20 | 4.80 | 5.20 | 6.15 | 5.40 | 4.60 |
| 10 | 4.60 | 5.00 | 7.40 | 7.95 | 6.05 | 5.25 | 5.15 | 4.75 | 5.10 | 6.30 | 5.40 | 4.60 |
| 11 | 4.65 | 5.15 | 7.35 | 7.95 | 5.95 | 5.20 | 5.00 | 4.70 | 5.10 | 5.65 | 5.30 | 4.60 |
| 12 | 4.70 | 5.35 | 7.50 | 8.05 | 5.55 | 5.05 | 4.80 | 4.70 | 5.10 | 5.50 | 5.45 | 4.65 |
| 13 | 4.70 | 5.30 | 7.20 | 7.90 | 5.50 | 5.00 | 4.80 | 4.65 | 5.05 | 5.60 | 5.00 | 4.65 |
| 14 | 4.70 | 5.30 | 7.30 | 7.90 | 5.50 | 5.00 | 4.80 | 4.65 | 4.90 | 5.60 | 4.80 | 4.65 |
| 15 | 4.70 | 5.20 | 7.10 | 7.65 | 5.50 | 5.00 | 4.80 | 4.60 | 4.90 | 5.55 | 4.80 | 4.65 |
| 16 | 4.70 | 5.20 | 6.85 | 7.40 | 5.45 | 4.80 | 4.70 | 4.60 | 4.90 | 5.50 | 4.80 | 4.70 |
| 17 | 4.70 | 5.20 | 6.60 | 7.30 | 5.30 | 4.70 | 4.70 | 4.60 | 4.90 | 5.50 | 4.80 | 4.60 |
| 18 | 4.70 | 5.20 | 6.25 | 7.10 | 5.30 | 4.70 | 4.75 | 4.60 | 4.90 | 5.45 | 4.75 | 4.60 |
| 19 | 4.70 | 5.20 | 5.95 | 6.85 | 5.30 | 4.70 | 4.80 | 4.60 | 4.90 | 5.40 | 4.70 | 4.60 |
| 20 | 4.70 | 5.20 | 5.80 | 6.45 | 5.60 | 4.70 | 4.80 | 4.50 | 4.90 | 5.40 | 4.70 | 4.50 |
| 21 | 4.65 | 5.20 | 5.85 | 6.40 | 5.85 | 4.70 | 4.80 | 4.50 | 4.95 | 5.50 | 4.75 | 4.50 |
| 22 | 4.70 | 5.20 | 5.60 | 6.30 | 6.10 | 4.60 | 4.80 | 4.50 | 5.00 | 5.55 | 4.70 | 4.50 |
| 23 | 4.70 | 5.15 | 5.90 | 6.35 | 6.05 | 4.60 | 4.80 | 4.50 | 5.00 | 5.45 | 4.70 | 4.50 |
| 24 | 4.85 | 5.25 | 6.65 | 6.40 | 6.00 | 4.65 | 4.85 | 4.65 | 5.05 | 5.55 | 4.70 | 4.50 |
| 25 | 5.25 | 5.30 | 7.20 | 6.40 | 6.00 | 4.70 | 5.00 | 4.85 | 4.90 | 5.60 | 4.70 | 4.50 |
| 26 | 5.80 | 5.30 | 8.25 | 6.30 | 5.95 | 4.70 | 5.05 | 5.00 | 4.90 | 5.60 | 4.70 | 4.50 |
| 27 | 6.10 | 5.20 | 9.15 | 6.25 | 5.85 | 4.65 | 5.10 | 5.10 | 5.10 | 5.70 | 4.70 | 4.60 |
| 28 | 6.15 | 5.20 | 9.60 | 6.25 | 5.60 | 4.70 | 5.10 | 5.15 | 5.45 | 5.70 | 4.70 | 4.70 |
| 29 | 5.90 | 5.20 | 9.95 | 6.50 | 5.50 | 4.70 | 5.20 | 5.10 | 5.55 | 5.80 | 4.65 | 4.80 |
| 30 | 5.70 | ..... | 9.90 | 6.60 | 5.50 | 4.65 | 5.10 | 5.10 | 6.10 | 5.70 | 4.60 | 5.15 |
| 31 | 5.45 | ..... | 9.65 | ..... | 5.40 | ..... | 5.00 | 5.10 | ..... | 5.75 | ..... | 5.10 |

NOTE.—The river seldom freezes on account of the swiftness of its current.

## RAQUETTE RIVER AT MASSENA SPRINGS, N. Y.

Observations at the dam of the Hannawa Falls Power Company on Raquette River were taken from September 31, 1902, to March 31, 1903. The discharge has not been computed. A gaging station was established at Massena Springs highway bridge on Raquette River September 21, 1903. Observations were continued until October 17, 1903, when the station was temporarily abandoned. It was resumed 1904. The gage is a vertical scale attached to the right abutment on the upstream side of the bridge. The bench mark is a cross painted on the outside downstream corner of the foundation adjacent to the sulphur springs. Its elevation is 12.21 feet above gage datum. The bridge has a single span of 167.5 feet. The current is swift and uniform. The banks are not subject to overflow. The channel is straight for 300 feet above and 1,000 feet below the bridge. The headwaters of Raquette River are on an elevated plateau dotted with mountains interspersed with lakes. The region is timbered, but

numerous marsh and swamp areas exist. Many of these are on the divide and feed streams flowing in opposite directions. Raquette River drains a long, narrow basin extending from Hamilton County to St. Lawrence River. Above Piercefield the drainage basin broadens out, including a region containing many lakes and ponds and affording ample opportunities for storage development, as shown by the following list of lakes.

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

*Discharge measurements of Raquette River at Massena Springs, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| April 9 | C. C. Covert | 1,097 | 3.69 | 5.15 | 4,052 |
| July 2 | do | 449 | 2.34 | 1.60 | 1,050 |
| July 3 | do | 484 | 2.39 | 1.85 | 1,153 |
| August 19 | do | 375 | 1.87 | 1.18 | 702 |
| August 21 | do | 340 | 1.97 | .75 | 670 |
| August 22 | do | 177 | 1.27 | .10 | 226 |
| August 23 | do | 302 | 1.69 | .72 | 511 |
| August 26 | do | 451 | 2.08 | 1.50 | 937 |
| August 27 | do | 434 | 1.96 | 1.40 | 848 |
| October 20 | A. M. Evans | 719 | 2.92 | 2.86 | 2,102 |

*Mean daily gage height, in feet, of Raquette River at Massena Springs, N. Y., for 1904.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 5.20 | 5.80 | 1.90 | 0.60 | 1.00 | 4.05 | 3.95 | 2.60 |
| 2 | ..... | 5.10 | 5.50 | 1.90 | .55 | 1.05 | 3.80 | 4.55 | 2.90 |
| 3 | ..... | 5.10 | 5.45 | 1.70 | .60 | 1.25 | 3.85 | 4.30 | 2.90 |
| 4 | ..... | 4.85 | 5.25 | 2.40 | .60 | 1.35 | 3.60 | 4.15 | 2.55 |
| 5 | ..... | 4.70 | 5.10 | 2.85 | .35 | 2.35 | 3.85 | 3.95 | 1.85 |
| 6 | ..... | 4.85 | 4.90 | 2.60 | .55 | 2.25 | 3.80 | 3.80 | 2.65 |
| 7 | ..... | 4.50 | 4.70 | 2.20 | .40 | 1.45 | 3.60 | 3.65 | 3.20 |
| 8 | ..... | 5.80 | 4.50 | 2.30 | .35 | 1.40 | 3.40 | 3.30 | 3.30 |
| 9 | 5.25 | 6.20 | 3.95 | 2.00 | .30 | 1.30 | 3.30 | 3.40 | 3.30 |
| 10 | 6.50 | 6.25 | 3.55 | 1.15 | .30 | 1.30 | 3.25 | 3.25 | [a]3.30 |
| 11 | 6.15 | 6.00 | 3.05 | 1.65 | .45 | 1.60 | 3.25 | 3.10 | 3.30 |
| 12 | 6.75 | 5.70 | 3.10 | 2.20 | .75 | 1.45 | 3.45 | 2.90 | 3.30 |
| 13 | 6.20 | 5.35 | 3.10 | 2.90 | .60 | 1.45 | 3.60 | 2.75 | 3.40 |
| 14 | 5.85 | 5.45 | 3.40 | 2.65 | 1.10 | 1.75 | 3.50 | 2.60 | 3.40 |
| 15 | 5.30 | 5.10 | 3.60 | 1.50 | 1.30 | 1.50 | 3.20 | 2.35 | 3.40 |
| 16 | 5.20 | 5.35 | 3.30 | 1.90 | 1.15 | 1.15 | 3.05 | 2.30 | 3.30 |
| 17 | 5.10 | 5.55 | 2.90 | .75 | 1.15 | 1.25 | 3.15 | 2.55 | 3.30 |
| 18 | 5.10 | 5.75 | 3.10 | .90 | .85 | 1.45 | 2.90 | 3.15 | 3.20 |
| 19 | 5.20 | 5.75 | 4.10 | 1.10 | 1.30 | 1.45 | 2.95 | 2.75 | 3.20 |
| 20 | 4.90 | 5.55 | 3.90 | 1.25 | 1.35 | 1.55 | 2.90 | 1.75 | 3.10 |
| 21 | 5.00 | 5.30 | 3.40 | 1.75 | 1.40 | 1.70 | 2.85 | 2.00 | 3.05 |
| 22 | 5.15 | 5.05 | 3.35 | 1.20 | .35 | 1.60 | 2.95 | 2.05 | 3.00 |
| 23 | 6.10 | 5.10 | 3.35 | .90 | .85 | 1.25 | 3.10 | 1.90 | 3.00 |
| 24 | 4.10 | 4.50 | 3.25 | .55 | 1.05 | 1.05 | 3.40 | 1.90 | 2.95 |
| 25 | 5.20 | 4.75 | 2.65 | .30 | 1.38 | 1.20 | 3.30 | 2.10 | 2.90 |
| 26 | 5.15 | 4.60 | 1.90 | .25 | 1.60 | 1.60 | 4.00 | 2.25 | 2.90 |
| 27 | 5.80 | 4.35 | 2.25 | .35 | 1.45 | 2.05 | 4.05 | 3.05 | 2.90 |
| 28 | 5.00 | 4.35 | 1.45 | .20 | 1.55 | 1.95 | 4.10 | 3.25 | 2.85 |
| 29 | 5.25 | 5.15 | 1.45 | .30 | 1.30 | 1.95 | 4.05 | 3.20 | 2.80 |
| 30 | 4.90 | 5.45 | 1.90 | .90 | 1.10 | 3.50 | 4.00 | 2.95 | 2.80 |
| 31 | ..... | 5.60 | ..... | .60 | .95 | ..... | 3.95 | ..... | 2.80 |

[a] Ice conditions December 10 to 31.

## RAQUETTE RIVER NEAR SOUTH COLTON, N. Y.

A temporary gaging station, for use during low water, was established on the Lindsay farm, 2½ miles upstream from South Colton, N. Y., August 17, 1904. The stream stage is observed twice daily by William McDonald from a standard staff gage. Current-meter measurements are made by boat from a rope ferry. The stream bed is of rock, forming a single channel 150 feet in width at ordinary stages, but partially divided by a submerged rock ridge.

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

*Discharge measurements of Raquette River near South Colton, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| August 17 | Covert and Beebe | 627 | 1.14 | 0.87 | 714 |
| August 18 | do | 626 | .96 | .80 | 602 |
| August 24 | C. C. Covert | 694 | 1.41 | 1.24 | 980 |
| September 22 | A. M. Evans | 680 | 1.23 | 1.10 | 835 |
| October 19 | do | 750 | 2.38 | 2.16 | 1,782 |

*Mean daily gage height, in feet, of Raquette River near South Colton, N. Y., for 1904.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 0.88 | 2.62 | 3.38 | 1.38 | 17 | ..... | 1.05 | 1.85 | 1.55 | 2.55 |
| 2 | ..... | .95 | 2.52 | 3.20 | 1.50 | 18 | 0.72 | 1.10 | 2.35 | 1.35 | 2.55 |
| 3 | ..... | 1.35 | 2.50 | 3.00 | 1.35 | 19 | .28 | .90 | 2.18 | 1.50 | 2.85 |
| 4 | ..... | 1.58 | 2.75 | 2.92 | 2.05 | 20 | .18 | .48 | 1.95 | 1.45 | 1.65 |
| 5 | ..... | 1.32 | 2.45 | 2.82 | 1.70 | 21 | .80 | .42 | 2.02 | 1.45 | 2.78 |
| 6 | ..... | .90 | 2.55 | 2.70 | 2.00 | 22 | .95 | 1.05 | 2.55 | 1.30 | 2.60 |
| 7 | ..... | .85 | 2.55 | 2.35 | 2.25 | 23 | .95 | 1.50 | 2.70 | 1.50 | 2.50 |
| 8 | ..... | 1.25 | 2.45 | 2.58 | 2.10 | 24 | 1.22 | 1.15 | 2.70 | 1.35 | 2.30 |
| 9 | ..... | .98 | 2.48 | 2.40 | 2.15 | 25 | 1.10 | 1.25 | 2.95 | 1.40 | 2.00 |
| 10 | ..... | .92 | 2.32 | 2.30 | 2.30 | 26 | 1.12 | 1.10 | 2.95 | 1.38 | 2.30 |
| 11 | ..... | .98 | 2.65 | 2.28 | [a]2.50 | 27 | .95 | 1.20 | 3.00 | 1.28 | 1.80 |
| 12 | ..... | .88 | 2.60 | 2.10 | 2.65 | 28 | .70 | 1.65 | 2.98 | 1.02 | 1.25 |
| 13 | ..... | .45 | 2.45 | 2.30 | 2.20 | 29 | .55 | 1.80 | 2.90 | 1.50 | 3.20 |
| 14 | ..... | .85 | 2.42 | 1.35 | 2.90 | 30 | .30 | 2.55 | 3.00 | 1.35 | 2.85 |
| 15 | ..... | 1.38 | 2.35 | 1.95 | 2.80 | 31 | .85 | ..... | 3.02 | ..... | 2.60 |
| 16 | ..... | 1.20 | 2.20 | 2.22 | 2.80 | | | | | | |

[a] Ice conditions December 11 to 31.

*Mean daily discharge, in second-feet, of Raquette River near South Colton, N. Y., for 1904.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 671 | (a) | (a) | 1,102 | 17 | ..... | 823 | 1,513 | 1,254 | (a) |
| 2 | ..... | 736 | (a) | (a) | 1,211 | 18 | (b) | 866 | 1,944 | 1,081 | (a) |
| 3 | ..... | 1,081 | 2,073 | (a) | 1,081 | 19 | (b) | 693 | 1,793 | 1,211 | (a) |
| 4 | ..... | 1,276 | (a) | (a) | 1,685 | 20 | (b) | (b) | 1,599 | 1,167 | 1,340 |
| 5 | ..... | 1,060 | 2,030 | (a) | 1,383 | 21 | 606 | (b) | 1,664 | 1,167 | (a) |
| 6 | ..... | 693 | (a) | (a) | 1,642 | 22 | 736 | 823 | (a) | 1,038 | (a) |
| 7 | ..... | 649 | (a) | 1,944 | 1,857 | 23 | 736 | 1,211 | (a) | 1,211 | 2,073 |
| 8 | ..... | 995 | 2,030 | (a) | 1,728 | 24 | 974 | 909 | (a) | 1,081 | 1,901 |
| 9 | ..... | 758 | 2,051 | 1,987 | 1,771 | 25 | 866 | 995 | (a) | 1,124 | 1,642 |
| 10 | ..... | 714 | 1,923 | 1,901 | 1,901 | 26 | 888 | 866 | (a) | 1,102 | 1,091 |
| 11 | ..... | 758 | (a) | 1,879 | 2,073 | 27 | 736 | 952 | (a) | 1,016 | 1,470 |
| 12 | ..... | 671 | (a) | 1,728 | (a) | 28 | (b) | 1,340 | (a) | 802 | 995 |
| 13 | ..... | (b) | 2,030 | 1,901 | 1,814 | 29 | (b) | 1,470 | (a) | 1,211 | (a) |
| 14 | ..... | 649 | 2,008 | 1,081 | (a) | 30 | (b) | (a) | (a) | 1,081 | (a) |
| 15 | ..... | 1,102 | 1,944 | 1,599 | (a) | 31 | 649 | ..... | (a) | ..... | (a) |
| 16 | ..... | 952 | 1,814 | 1,836 | (a) | | | | | | |

[a] Above limit of rating curve. [b] Below limit of rating curve.

## LAKE CHAMPLAIN DRAINAGE BASIN.

Lake Champlain occupies a depression between the Adirondack Mountains in New York and the Green Mountains of Vermont. Its surface elevation is normally about 95 feet above tide. The lake forms a boundary between the States of New York and Vermont. Its outlet at Rouses Point is on the boundary line between United States and Canada, and Richelieu River, which receives its outflow, lies entirely in Canada, emptying in the St. Lawrence at Sorel.

Its drainage enters chiefly through large water courses, including Pike River in Quebec, Missoquoi, and Winooski rivers and Otter Creek in Vermont, and the following-named streams in New York:

*Tributaries of Lake Champlain in New York.*

| | Total drainage. |
|---|---|
| | *Sq. miles.* |
| Big Chazy River | 299 |
| Little Chazy River | 62.9 |
| Saranac River | 630 |
| Salmon River | 63.8 |
| Little Au Sable River | 75.1 |
| Ausable River | 521 |
| Bouquet River | 269 |
| Lake George outlet | 220 |
| Mettawee River | 290 |
| Poultney River | 266 |

The inflow through the principal Vermont tributaries is measured at gaging stations in that State. The inflow through Saranac River and Lake George outlet is measured at gaging stations in New York, and temporary stations have also been maintained on Ausable and Bouquet rivers during the low-water season of the present year.

The entire surface of Lake Champlain freezes over nearly every winter. The freezing over of the lake may affect the discharge in two ways:

(1) By holding back as surface storage the depth of water on the frozen lake, equal to about seven-eighths of the ice thickness, thus water being held from the time that freezing takes place in the early winter until the ice melts in the spring.

(2) The freezing modifies the evaporation, the loss from this source probably being less from frozen surface than from open water.

### RICHELIEU RIVER AT FORT MONTGOMERY, N. Y.

A record of the height of Lake Champlain at Rouse Point, the head of Richelieu River, the outlet of the lake, has been kept by the United States Corps of Engineers, beginning 1875.

Through the courtesy of Capt. Harry Taylor, the gage readings taken by William McComb, fort keeper, at 9 a. m. each day are reported weekly to the United States Geological Survey.

The depth of water is taken on a reference mark on the base of the scarp wall, north face of bastian B, about 3 feet from the angle with the east curtain of Fort Montgomery. This reference point is 1.50 feet above an assumed zero, and 1.50 is added to the measured depth to determine the gage reading. In winter the depth as the water rises in a hole in the ice is commonly taken. On windy days the depth is taken in a well within the fort inclosure by measuring the depth on a flagstone in the bottom of the well.

| | Above tide. |
|---|---|
| Elevation of reference point on carp wall of Fort Montgomery [a] | 94.998 |
| Elevation of gage zero | 93.501 |
| Assumed high water, Lake Champlain | 102.611 |
| Assumed low water, Lake Champlain | 93.361 |

The range of rise and fall of the lake is thus seen to be 9.25 feet, representing an available storage volume of 6.24 inches on the entire catchment area. A variation in level of 1 foot per month is equivalent to a continuous storage or draft at the rate of 4,685 second-feet.

The daily discharge from the lake has been determined from observations of the depth and discharge over the Chambly Dam, 35 miles below the head of Richelieu River, made in 1898 by the United States Deep Waterways Survey.

Estimates of the drainage area of Lake Champlain differ considerably. The run-off given in previous reports has been estimated on the basis of a land surface drainage area of 7,750 square miles above the outlet at Rouses Point. The mean monthly discharge, 1875 to 1898, inclusive, has been taken from the computation of the United States Deep Waterways Surveys. The monthly mean corresponds to the mean of the daily gage readings. Beginning with 1899, the mean of the daily discharges taken out for each day of the month is used.

[a] U. S. Deep Waterways Report, Pt. 1, p. 429.

*Mean daily gage height, in feet, of Richelieu River at Fort Montgomery, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.05 | 1.15 | ..... | 5.10 | 5.50 | 4.35 | 2.75 | 1.75 | 1.40 | 1.50 | 2.50 | 1.70 |
| 2 | 1.05 | 1.10 | 1.40 | 5.00 | 5.60 | 4.35 | 2.70 | 1.60 | 1.15 | 1.60 | 2.60 | 1.50 |
| 3 | 1.00 | 1.00 | 1.70 | 5.10 | 5.65 | 4.25 | 2.55 | 1.55 | 1.25 | 1.65 | 2.70 | 1.60 |
| 4 | .98 | 1.05 | 1.55 | 5.20 | 5.60 | 4.20 | 2.55 | 1.50 | 1.25 | 1.80 | 2.60 | 1.55 |
| 5 | 1.05 | 1.10 | 1.45 | 5.25 | 5.60 | 4.10 | 2.60 | 1.80 | 1.30 | 1.95 | 2.40 | 1.70 |
| 6 | 1.05 | 1.10 | 1.50 | 5.20 | 5.58 | 4.05 | 2.55 | 1.60 | 1.25 | 1.65 | 2.40 | 1.50 |
| 7 | 1.05 | 1.12 | 1.50 | 5.10 | 5.65 | 4.00 | 2.47 | 1.45 | 1.30 | 1.85 | 2.35 | 1.55 |
| 8 | 1.10 | 1.05 | 1.65 | 5.15 | 5.55 | 4.00 | 2.50 | 1.40 | 1.20 | 2.15 | 2.27 | 1.45 |
| 9 | 1.00 | 1.10 | 1.70 | 5.25 | 5.50 | 3.95 | 2.53 | 1.45 | 1.40 | 1.80 | 2.25 | 1.42 |
| 10 | 1.05 | 1.10 | 1.80 | 5.30 | 5.35 | 3.90 | 2.50 | 1.70 | 1.35 | 2.30 | 2.20 | 1.40 |
| 11 | 1.02 | 1.12 | 1.85 | 5.45 | 5.20 | 3.85 | 2.45 | 1.35 | 1.55 | 1.70 | 2.20 | 1.38 |
| 12 | 1.00 | 1.10 | 1.80 | 5.60 | 5.15 | 3.80 | 2.40 | 1.30 | 1.25 | 1.80 | 2.45 | 1.35 |
| 13 | 1.05 | 1.12 | 1.98 | 5.60 | 5.05 | 3.75 | 2.35 | 1.40 | 1.15 | 1.75 | 2.05 | 1.33 |
| 14 | 1.07 | 1.15 | 2.05 | 5.55 | 5.15 | 3.80 | 2.40 | 1.30 | 1.50 | 1.70 | 1.90 | 1.30 |
| 15 | 1.00 | 1.15 | 2.15 | 5.60 | 5.00 | 3.75 | 2.35 | 1.25 | 1.10 | 1.70 | 2.15 | 1.30 |
| 16 | 1.05 | 1.10 | 2.15 | 5.50 | 4.90 | 3.40 | 2.40 | 1.30 | 1.25 | 1.80 | 2.00 | 1.28 |
| 17 | .98 | 1.12 | 2.10 | 5.45 | 4.90 | 3.40 | 2.10 | 1.20 | 1.15 | 1.85 | 2.03 | 1.30 |
| 18 | 1.05 | 1.15 | 2.15 | 5.40 | 4.80 | 3.20 | 2.20 | 1.15 | 1.30 | 1.75 | 2.10 | 1.28 |
| 19 | .98 | 1.18 | 2.25 | 5.40 | 4.85 | 3.20 | 2.15 | 1.15 | 1.10 | 1.78 | 1.95 | 1.28 |
| 20 | 1.05 | 1.20 | 2.20 | 5.35 | 4.83 | 3.15 | 2.00 | 1.50 | 1.45 | 2.00 | 2.00 | 1.20 |
| 21 | .95 | 1.25 | 2.20 | 5.30 | 5.05 | 3.05 | 1.90 | 1.20 | 1.05 | 2.10 | 1.90 | 1.15 |
| 22 | 1.08 | 1.35 | 2.35 | 5.15 | 5.10 | 3.00 | 1.88 | 1.55 | 1.10 | 2.25 | 2.05 | 1.05 |
| 23 | 1.05 | 1.40 | 2.30 | 5.15 | 5.15 | 3.10 | 1.90 | 1.20 | 1.30 | 2.50 | 1.85 | 1.08 |
| 24 | 1.05 | 1.30 | 2.53 | 5.30 | 4.80 | 3.15 | 1.85 | 1.40 | 1.50 | 2.47 | 1.85 | 1.10 |
| 25 | 1.00 | 1.35 | 2.85 | 5.10 | 4.85 | 3.00 | 1.80 | 1.55 | 1.15 | 2.85 | 1.83 | 1.08 |
| 26 | 1.03 | 1.30 | 3.25 | 5.05 | 4.85 | 2.85 | 1.80 | 1.25 | 1.40 | 2.55 | 1.80 | 1.10 |
| 27 | 1.07 | 1.30 | 3.90 | 5.10 | 4.75 | 2.65 | 1.85 | 1.35 | 1.30 | 2.50 | 1.78 | 1.10 |
| 28 | 1.05 | 1.35 | 4.50 | 5.15 | 4.70 | 2.80 | 1.85 | 1.40 | 1.40 | 2.80 | 1.75 | 1.12 |
| 29 | 1.10 | 1.33 | 4.70 | 5.20 | 4.65 | 2.85 | 1.83 | 1.20 | 1.70 | 2.90 | 2.10 | 1.15 |
| 30 | 1.10 | ..... | 4.80 | 5.40 | 4.60 | 2.75 | 1.80 | 1.25 | 1.60 | 2.50 | 1.75 | 1.20 |
| 31 | 1.12 | ..... | 4.80 | ..... | 4.45 | ..... | 1.90 | 1.20 | ..... | 2.55 | ..... | 1.25 |

*Mean daily discharge, in second-feet, of Richelieu River at Fort Montgomery, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6,870 | 7,210 | [a]7,980 | 22,180 | 24,100 | 18,870 | 12,700 | 9,250 | 8,060 | 8,400 | 11,800 | 9,080 |
| 2 | 6,870 | 7,040 | 8,060 | 21,700 | 24,620 | 18,870 | 12,520 | 8,740 | 7,210 | 8,740 | 12,160 | 8,400 |
| 3 | 6,700 | 6,700 | 9,080 | 22,180 | 24,880 | 18,450 | 11,980 | 8,570 | 7,550 | 8,910 | 12,520 | 8,740 |
| 4 | 6,620 | 6,870 | 8,570 | 22,660 | 24,620 | 18,240 | 11,980 | 8,400 | 7,550 | 9,420 | 12,160 | 8,570 |
| 5 | 6,870 | 7,040 | 8,230 | 22,900 | 24,620 | 17,820 | 12,160 | 9,420 | 7,720 | 9,930 | 11,460 | 9,080 |
| 6 | 6,870 | 7,040 | 8,400 | 22,660 | 24,490 | 17,610 | 11,980 | 8,740 | 7,550 | 8,910 | 11,460 | 8,400 |
| 7 | 6,870 | 7,120 | 8,400 | 22,180 | 24,880 | 17,400 | 11,720 | 8,230 | 7,720 | 9,590 | 11,290 | 8,570 |
| 8 | 7,040 | 6,870 | 8,910 | 22,420 | 24,360 | 17,400 | 11,800 | 8,060 | 7,380 | 10,610 | 11,040 | 8,230 |
| 9 | 6,700 | 7,040 | 9,080 | 22,900 | 24,100 | 17,310 | 11,890 | 8,230 | 8,060 | 9,420 | 10,950 | 8,140 |
| 10 | 6,870 | 7,040 | 9,420 | 23,140 | 23,380 | 17,020 | 11,800 | 9,080 | 7,890 | 11,120 | 10,780 | 8,060 |
| 11 | 6,780 | 7,120 | 9,590 | 23,860 | 22,660 | 16,830 | 11,630 | 7,890 | 8,570 | 9,080 | 10,780 | 8,980 |
| 12 | 6,700 | 7,040 | 9,420 | 24,620 | 22,420 | 16,640 | 11,460 | 7,720 | 7,550 | 9,420 | 11,630 | 7,890 |
| 13 | 6,870 | 7,120 | 10,020 | 24,620 | 21,940 | 16,450 | 11,290 | 8,060 | 7,210 | 9,250 | 10,270 | 7,800 |
| 14 | 6,960 | 7,210 | 10,270 | 24,360 | 22,420 | 16,640 | 11,460 | 7,720 | 8,400 | 9,080 | 9,760 | 7,720 |
| 15 | 6,700 | 7,210 | 10,610 | 24,620 | 21,700 | 16,450 | 11,290 | 7,550 | 7,040 | 9,080 | 10,610 | 7,720 |
| 16 | 6,870 | 7,040 | 10,610 | 24,100 | 21,260 | 15,120 | 11,460 | 7,720 | 7,550 | 9,420 | 10,100 | 7,640 |

[a] Interpolated.

*Mean daily discharge, in second-feet, of Richelieu River at Fort Montgomery, N. Y., for 1904*—Continued.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | 6,620 | 7,120 | 10,440 | 23,860 | 21,260 | 15,120 | 10,440 | 7,720 | 7,210 | 9,590 | 10,180 | 7,720 |
| 18 | 6,870 | 7,210 | 10,610 | 23,620 | 20,820 | 14,360 | 10,780 | 7,210 | 7,720 | 9,250 | 10,440 | 7,640 |
| 19 | 6,620 | 7,300 | 10,950 | 23,620 | 21,040 | 14,360 | 10,610 | 7,210 | 7,040 | 9,340 | 9,930 | 7,640 |
| 20 | 6,870 | 7,380 | 10,780 | 23,380 | 20,930 | 14,170 | 10,100 | 8,400 | 8,230 | 10,100 | 10,100 | 7,380 |
| 21 | 6,530 | 7,550 | 10,780 | 23,140 | 21,940 | 13,790 | 9,760 | 7,380 | 6,870 | 10,440 | 9,760 | 7,210 |
| 22 | 6,960 | 7,890 | 11,290 | 22,420 | 22,180 | 13,600 | 9,680 | 8,570 | 7,040 | 10,950 | 10,270 | 6,870 |
| 23 | 6,870 | 8,060 | 11,120 | 22,420 | 22,420 | 13,980 | 9,760 | 7,380 | 7,720 | 11,800 | 9,590 | 6,960 |
| 24 | 6,870 | 7,720 | 11,890 | 23,140 | 20,820 | 14,170 | 9,590 | 8,060 | 8,400 | 11,720 | 9,590 | 7,040 |
| 25 | 6,700 | 7,890 | 13,060 | 22,180 | 21,040 | 13,600 | 9,420 | 8,570 | 7,210 | 13,060 | 9,500 | 6,960 |
| 26 | 6,780 | 7,720 | 14,550 | 21,940 | 21,040 | 13,060 | 9,420 | 7,550 | 8,060 | 11,980 | 9,420 | 7,040 |
| 27 | 6,960 | 7,720 | 17,020 | 22,180 | 20,600 | 12,340 | 9,590 | 7,890 | 7,720 | 11,800 | 9,340 | 7,040 |
| 28 | 6,870 | 7,890 | 19,500 | 22,420 | 20,380 | 12,880 | 9,590 | 8,060 | 8,060 | 12,880 | 9,250 | 7,120 |
| 29 | 7,040 | 7,800 | 20,380 | 22,660 | 20,160 | 13,060 | 9,500 | 7,380 | 9,080 | 13,240 | 10,440 | 7,210 |
| 30 | 7,040 | ..... | 20,820 | 23,620 | 19,940 | 12,700 | 9,420 | 7,550 | 8,740 | 11,800 | 9,250 | 7,380 |
| 31 | 7,120 | ..... | 20,820 | ..... | 19,290 | ..... | 9,760 | 7,380 | ..... | 11,980 | ..... | 7,550 |

*Estimated monthly discharge of Richelieu River at Fort Montgomery, N. Y., for 1904.*

[Drainage area, 7,750 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January | 7,120 | 6,530 | 6,835 | 0.882 | 1.02 |
| February | 8,060 | 6,700 | 7,309 | .943 | 1.02 |
| March[a] | 20,820 | 8,060 | 11,630 | 1.50 | 1.73 |
| April | 24,620 | 21,700 | 23,060 | 2.98 | 3.32 |
| May | 24,880 | 19,290 | 22,270 | 2.87 | 3.31 |
| June | 18,870 | 12,340 | 15,610 | 2.01 | 2.24 |
| July | 12,700 | 9,420 | 10,860 | 1.40 | 1.61 |
| August | 9,420 | 7,210 | 8,055 | 1.04 | 1.20 |
| September | 9,080 | 6,870 | 7,737 | .998 | 1.11 |
| October | 13,240 | 8,400 | 10,330 | 1.33 | 1.53 |
| November | 12,520 | 9,250 | 10,530 | 1.36 | 1.52 |
| December | 9,080 | 6,870 | 7,799 | 1.01 | 1.16 |
| The year | 24,880 | 6,530 | 11,840 | 1.53 | 20.77 |

[a] March 1 interpolated.

SARANAC RIVER NEAR PLATTSBURG, N. Y.

The headwaters of Saranac River lie in the southern part of Franklin County. The southern boundary of the drainage basin is the Ampersand Mountain range. The stream drains the north slope of the most elevated region of the State.

In 1854 a timber dam was built below Lower Saranac Lake for the purpose of flooding logs. In 1899–1901 a masonry dam and lock were erected by the State at this point, raising the water level of Lower Saranac Lake 18 inches.

*Drainage areas of Saranac River.*[a]

| Location. | Area. | |
|---|---|---|
| | Place to place. | Total. |
| | *Sq. miles.* | *Sq. miles.* |
| Above Saranac Lake State dam | ---------- | 157.5 |
| Above Saranac Lake village | 44.9 | 202.4 |
| Above Franklin Falls | 104.3 | 306.7 |
| North Branch Saranac River | 136.6 | 136.6 |
| At junction North Branch | ---------- | 498.8 |
| Above High Falls | 19.6 | 518.4 |
| Above Cadyville | 74.6 | 593.0 |
| Above Kent Falls | 2.9 | 595.9 |
| Above Morrisonville | 2.0 | 597.9 |
| Above Lozier dam | 26.1 | 624.0 |
| Above mouth | 5.6 | 629.6 |

[a] From Bien's Atlas of New York State.

About 16.2 per cent of the upper drainage area is water surface.

Saranac River enters Lake Champlain at Plattsburg, and owing to its somewhat equalized flow and rapid fall presents numerous opportunities for power development.

A gaging station was established at this dam March 27, 1903. The record includes the flow over a straight spillway crest 190 feet in length; the discharge through two 5-foot waste gates when open, and the discharge through four 33-inch Victor turbines controlled by automatic governors. Experiments have been made at Cornell University hydraulic laboratory on a model of the ogee section of the dam, from which coefficients have been derived for calculation of the discharge. The gages are read and the record furnished by A. E. Hare.

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

*Mean daily discharge, in second-feet, of Saranac River near Plattsburg, N. Y., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 634 | 448 | 374 | 1,480 | 2,050 | 715 | 415 | 342 | 297 | (a) | (a) | 512 |
| 2 | 498 | 399 | 448 | 1,860 | 1,940 | 783 | 522 | 341 | 297 | (a) | (a) | 496 |
| 3 | 496 | 416 | 501 | 1,930 | 1,810 | 650 | 658 | 621 | 624 | 1,160 | (a) | 399 |
| 4 | 490 | 400 | 400 | 1,950 | 1,900 | 770 | 572 | 360 | 754 | 945 | 496 | 131 |
| 5 | 664 | 361 | 381 | 2,200 | 1,530 | 754 | 600 | 232 | 646 | 803 | 566 | 340 |
| 6 | 610 | 386 | 305 | 1,990 | 1,500 | 688 | 561 | 422 | 601 | 753 | 702 | 277 |
| 7 | 656 | 181 | 519 | 1,840 | 1,490 | 669 | 398 | 273 | 580 | 756 | 697 | 228 |
| 8 | 523 | 390 | 719 | 1,950 | 1,280 | 630 | 384 | 341 | 566 | (a) | 647 | 227 |
| 9 | 432 | 515 | 853 | 2,390 | 1,230 | 692 | 462 | 238 | 418 | (a) | 697 | 380 |
| 10 | 485 | 564 | 634 | 3,020 | 1,050 | 628 | 107 | 324 | 422 | (a) | 574 | 264 |
| 11 | 370 | 606 | 581 | 2,390 | 1,070 | 654 | (a) | 291 | 405 | (a) | 439 | 124 |
| 12 | 428 | 547 | 519 | 1,820 | 997 | 493 | 434 | 279 | 400 | 672 | 383 | 242 |
| 13 | 426 | 498 | 431 | 1,560 | 875 | 444 | 420 | 384 | 407 | 778 | 383 | 328 |
| 14 | 404 | 421 | 700 | 1,180 | 934 | 386 | 381 | 386 | 362 | 808 | 549 | 263 |
| 15 | 428 | 451 | 743 | 1,050 | 873 | 403 | 415 | 416 | 420 | 790 | 629 | 262 |
| 16 | 400 | 554 | 643 | 1,160 | 1,050 | 384 | 401 | 266 | 407 | 706 | 493 | 308 |
| 17 | 283 | 477 | 579 | 1,110 | 1,300 | 401 | 292 | 325 | 521 | 642 | 521 | 240 |
| 18 | 446 | 460 | 599 | 987 | 1,160 | 456 | 360 | 265 | 464 | 643 | 395 | 195 |
| 19 | 417 | 395 | 568 | 985 | 1,080 | (a) | 282 | 281 | 434 | 475 | 407 | 369 |
| 20 | 414 | 489 | 349 | 907 | 1,240 | 361 | 278 | 462 | 400 | (a) | 495 | 375 |
| 21 | 329 | 263 | 646 | 828 | 1,340 | 251 | 252 | 706 | (a) | (a) | 496 | 252 |
| 22 | 373 | 428 | 686 | 987 | 1,250 | 280 | 220 | 614 | (a) | (a) | 455 | 261 |
| 23 | 526 | 403 | 911 | 1,350 | 1,150 | 398 | 290 | 800 | 444 | (a) | 399 | 381 |
| 24 | 388 | 486 | 1,790 | 1,450 | 969 | 436 | 224 | 640 | 530 | (a) | 476 | 343 |
| 25 | 451 | 451 | 1,970 | 1,720 | 926 | 520 | 324 | 619 | 572 | (a) | 486 | 233 |
| 26 | 414 | 444 | 4,460 | 1,950 | 922 | 493 | 382 | 475 | 629 | (a) | 448 | 579 |
| 27 | 524 | 400 | 4,680 | 1,720 | 969 | 455 | 409 | 496 | 707 | (a) | 338 | 467 |
| 28 | 403 | 219 | 3,470 | 1,600 | 1,010 | 277 | 311 | 348 | 647 | (a) | 225 | 279 |
| 29 | 407 | 350 | 2,120 | 1,630 | 923 | 294 | 402 | 453 | 618 | (a) | 335 | 383 |
| 30 | 404 | ..... | 1,620 | 2,030 | 941 | 342 | 366 | 510 | 970 | 615 | 280 | 368 |
| 31 | 405 | ..... | 1,570 | ..... | 692 | ..... | 367 | 338 | ..... | 676 | ..... | 621 |

a No record. Water being drawn down.

*Estimated monthly discharge of Saranac River near Plattsburg, N. Y., for 1904.*

[Drainage area, 624 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| January | 664 | 283 | 455 | 0.729 | 0.840 |
| February | 606 | 181 | 428 | .686 | .740 |
| March | 4,680 | 305 | 1,122 | 1.80 | 2.08 |
| April | 3,016 | 828 | 1,634 | 2.62 | 2.92 |
| May | 2,053 | 692 | 1,208 | 1.94 | 2.24 |
| June, 29 days[a] | 783 | 251 | 507 | .812 | .876 |
| July, 30 days[a] | 658 | 107 | 383 | .614 | .685 |
| August | 800 | 232 | 414 | .663 | .764 |
| September, 28 days[a] | 970 | 297 | 519 | .832 | .866 |
| October, 15 days[a] | 1,160 | 475 | 748 | 1.20 | .669 |
| November, 27 days[a] | 702 | 225 | 482 | .772 | .775 |
| December | 621 | 124 | 327 | .524 | .604 |

[a] Water being drawn down during the missing days.

## AUSABLE RIVER NEAR KEESEVILLE, N. Y.

The drainage basin of Ausable River lies north of Bouquet River, and the stream enters Lake Champlain from the west. This stream drains a rugged mountainous area nearly all timber covered. Two main branches unite at Ausable Forks, about 20 miles from the mouth of the stream along river. In this portion a total descent of 460 feet occurs, a portion of which is in the famous Ausable chasm. The East Branch of Ausable River drains a long, narrow basin, extending northeasterly and southwesterly. There are few lakes or marshes in this area aside from Ausable lakes at the head of the stream. Tributaries numerous and branching.

The North Branch of Ausable River receives the outflow from Lake Placid at elevation 1,864 feet. Numerous smaller lakes feed this branch of the river. Its drainage basin occupies a plateau at a general elevation of 800 to 1,200 feet, the mountainous boundaries of the watershed rising to altitudes of 3,000 to 5,000 feet.

On August 1, 1904, a temporary low-water station was established 3½ miles above Keeseville. It was discontinued September 29.

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

*Drainage areas of Ausable River.*[a]

| Location. | Area. | |
|---|---|---|
| | Place to place. | Total. |
| | *Sq. miles.* | *Sq. miles.* |
| Lake Placid water surface | ..... | 3.8 |
| Lake Placid drainage area | 21.8 | 21.8 |
| West Branch from foot Lake Placid to junction of East Branch | 211.2 | 233.0 |
| East Branch above forks | 196.9 | 429.9 |
| Above gaging station | 40.1 | 470.0 |
| Gaging station to Keeseville | 6.1 | 476.1 |
| Keeseville to Birmingham | 27.4 | 503.5 |
| Birmingham to mouth | 17.8 | 521.3 |

[a] From Willsboro, Ausable, Lake Placid, Mount Marcy, and Elizabethtown sheets of the United States Geological Survey Topographic Atlas.

*Discharge measurements of Ausable River near Keeseville, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| August 4 | Covert and Chase | 157 | 1.53 | 1.22 | 239 |
| August 17 | E. D. Chase | 143 | 1.35 | 1.10 | 193 |
| August 22 | do | 267 | 2.88 | 2.14 | 770 |
| August 29 | do | 148 | 1.34 | 1.12 | 198 |
| September 9 | do | 155 | 1.40 | 1.21 | 217 |

*Mean daily gage height, in feet, of Ausable River near Keeseville, N. Y., for 1904.*

| Day: | Aug. | Sept. | Oct. | Day. | Aug. | Sept. | Oct. | Day. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 1.1 | 3.2 | 12 | 1.1 | 1.1 | 1.7 | 22 | 2.3 | ..... | ..... |
| 2 | ..... | 1.1 | 2.1 | 13 | 1.0 | 1.0 | ..... | 23 | 2.0 | 1.1 | ..... |
| 3 | ..... | 1.2 | 2.4 | 14 | 1.1 | 1.0 | ..... | 24 | 1.9 | 1.3 | ..... |
| 4 | ..... | 1.3 | ..... | 15 | 1.0 | 1.1 | 2.4 | 25 | 1.6 | 4.0 | ..... |
| 5 | ..... | 1.3 | 1.9 | 16 | 1.0 | 1.4 | ..... | 26 | 1.4 | 2.7 | ..... |
| 6 | ..... | 1.4 | ..... | 17 | 1.0 | 1.3 | ..... | 27 | 1.3 | 2.6 | ..... |
| 7 | 1.1 | 1.3 | 1.7 | 18 | 1.1 | 1.2 | ..... | 28 | 1.2 | 2.0 | ..... |
| 8 | 1.1 | 1.2 | 1.4 | 19 | 1.0 | 1.1 | ..... | 29 | 1.2 | 1.9 | ..... |
| 9 | 1.1 | ..... | 1.9 | 20 | 1.0 | 1.1 | ..... | 30 | 1.2 | ..... | ..... |
| 10 | 1.0 | 1.2 | 1.8 | 21 | 3.7 | 1.2 | ..... | 31 | 1.1 | ..... | ..... |
| 11 | 1.0 | 1.1 | 1.8 | | | | | | | | |

*Mean daily discharge, in second-feet, of Ausable River near Keeseville, N. Y., for 1904.*

| Day. | Aug. | Sept. | Day. | Aug. | Sept. | Day. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 193 | 12 | 193 | 193 | 22 | 1,008 | ..... |
| 2 | ..... | 193 | 13 | 170 | 170 | 23 | 636 | 193 |
| 3 | ..... | 218 | 14 | 193 | 170 | 24 | 547 | 246 |
| 4 | ..... | 246 | 15 | 170 | 193 | 25 | 360 | (a) |
| 5 | ..... | 246 | 16 | 170 | 280 | 26 | 280 | (a) |
| 6 | ..... | 280 | 17 | 170 | 246 | 27 | 246 | (a) |
| 7 | 193 | 246 | 18 | 193 | 218 | 28 | 218 | 636 |
| 8 | 193 | 218 | 19 | 170 | 193 | 29 | 218 | 547 |
| 9 | 193 | ..... | 20 | 170 | 193 | 30 | 218 | ..... |
| 10 | 170 | 218 | 21 | (a) | 218 | 31 | 193 | ..... |
| 11 | 170 | 193 | | | | | | |

a Discharge beyond limits of rating curve.

## BOUQUET RIVER NEAR WILLSBORO, N. Y.

Bouquet River is tributary to Lake Champlain from the west at a point near Willsboro, N. Y. This stream drains an irregular rectangular area, its eastern edge lying at a distance of 3 to 5 miles from Lake Champlain. The basin is moderately rolling, and has an altitude varying from 300 to 800 feet in the valleys and central portion. The margins of the basin are formed by precipitous mountain ranges rising to altitudes of from 2,000 to 4,000 feet, the greater portion of this rise occurring usually within a few miles of the watershed divide. The interior basin contains a few small lakes and numerous narrow valley marshes. The main stream comprises two branches, the basin of the north branch occupying the northern half of the drainage area. All portions of the catchment area are well drained by branching tributaries.

*Drainage areas of Bouquet River.* a

| Location. | Area. | |
|---|---|---|
| | Place to place. | Total. |
| | *Sq. miles.* | *Sq. miles.* |
| Above Wadhams Mills | 134.6 | 134.6 |
| Wadhams Mills to Whallonsburg | 20.8 | 155.4 |
| Whallonsburg to junction of North Branch | 9.8 | 165.2 |
| North Branch | 100.4 | 265.6 |
| Junction of branches to Willsboro | 3.9 | 269.5 |
| Willsboro to mouth | 2.5 | 272.0 |

a From Elizabethtown, Port Henry, Mount Marcy, Ausable, and Willsboro sheets of the United States Geological Survey Topographic Atlas.

During the low-water season of 1904 current-meter measurements were made by boat and cable at a point below the New York and Pennsylvania Company's dam in Willsboro.

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

*Discharge measurements of Bouquet River near Willsboro, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Feet per sec.* | *Feet.* | *Second-feet.* |
| July 30 | C. C. Covert | 113 | 1.67 | 1.46 | 188 |
| August 2 | do | 96 | .92 | 1.04 | 88 |
| August 4 | Covert and Chase | 94 | 1.00 | 1.00 | 94 |
| August 11 | E. D. Chase | 88 | .88 | .72 | 77 |
| August 21 | Howell and Chase | 206 | 3.95 | 2.62 | 814 |
| August 26 | E. D. Chase | 88 | 1.23 | .85 | 108 |
| September 2 | do | 77 | .92 | .67 | 71 |

*Mean daily gage height, in feet, of Bouquet River near Willsboro, N. Y., for 1904.*

| Day. | Aug. | Sept. | Day. | Aug. | Sept. | Day. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1 | | 0.50 | 12 | −1.20 | | 22 | 0.65 | |
| 2 | 0.10 | − .40 | 13 | −1.50 | | 23 | .40 | |
| 3 | .15 | − .40 | 14 | | | 24 | .40 | |
| 4 | .10 | | 15 | − .20 | | 25 | .20 | |
| 5 | .10 | | 16 | − .40 | | 26 | .18 | |
| 6 | − .25 | | 17 | − .10 | | 27 | .00 | |
| 7 | − .50 | | 18 | − .60 | | 28 | − .10 | |
| 8 | − .60 | | 19 | − .25 | | 29 | .00 | |
| 9 | −1.20 | | 20 | − .20 | | 30 | .10 | |
| 10 | −2.00 | | 21 | 1.15 | | 31 | − .80 | |
| 11 | − .60 | | | | | | | |

## LAKE GEORGE OUTLET AT TICONDEROGA, N. Y.[a]

Lake George occupies a valley extending in a northeasterly and southwesterly direction and lying between Schroon River on the west and the south arm of Lake Champlain on the east. The lake has a general width of from 1 to 2 miles, contains numerous islands, and has precipitous forest-covered slopes reaching to the shore on either side. The inflow is through small tributaries in deep-cut gulleys on the side slopes. The lake lies at elevation 323 feet above tide, and the adjacent hills rise to elevation 1,200 to 2,000 feet within 1 or 2 miles of the lake margin. Outside of the main lake, there is but little water surface within the drainage basin. The total area tributary to the

[a] The drainage basin of Lake George is shown on the Glens Falls, Bolton, Whitehall, Ticonderoga, and adjacent sheets of the United States Geological Survey Topographic Atlas.

lake above its outlet is 220 square miles. Of this 45 square miles are water surface representing 20.5 per cent of the total area.

The outlet of Lake George is a stream 3 miles in length entering Lake Champlain at Fort Ticonderoga. This stream leaves Lake George at a distance of about 1½ miles from Lake Champlain and at an elevation 220 feet greater. It makes an abrupt bend in which occur naturally several cascades over rock. The water power is at present developed by dams located successively along the stream, the uppermost dam controlling the outflow from Lake George.

A gaging station was established at the "B" mill of the International Paper Company at Ticonderoga August 24, 1904. This is the second dam below Lake George. Observations of the depth on the crest of the dam and in the tailrace are taken four times each day by C. E. Carpenter. The dam is of masonry, without leakage, and has a horizontal crest 6 feet in breadth and substantially level. The discharge through the turbines is determined from current meter measurements in the tailrace below the pulp mill.

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

*Discharge measurements of Lake George outlet at Ticonderoga, N. Y., in 1904.*

| Date. | Hydrographer. | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Second-feet.* |
| July 30 | C. C. Covert | [a] 7.40 | [b] 242 |
| August 30 | E. D. Chase | [a] 3.50 | [c] 179 |
| September 6 | do | [a] 3.65 | [c] 178 |
| October 5 | A. M. Evans | [d] 4.14 | [c] 286 |

[a] Distance to water surface from mark on bridge support.
[b] Below Lower Falls.
[c] At highway bridge above "A" mill.
[d] Distance to water surface, first projection below bridge seat, downstream corner of left abutment.

*Discharge measurements of Lake George outlet at Ticonderoga, N. Y., in 1904.*

[Tailrace International Paper Company's "B" mill.]

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Feet per sec.* | *Feet.* | *Second-feet.* |
| July 30 | C. C. Covert | 130 | 1.87 | 2.41 | 242 |
| August 5 | Covert and Chase | 132 | 1.30 | 2.15 | 172 |
| August 24 | Horton and Beebe | 150 | 1.45 | 2.22 | 217 |
| August 30 | E. D. Chase | 143 | 1.48 | 2.15 | 212 |
| August 30 | do | 136 | 1.14 | 1.98 | 155 |
| September 6 | do | 142 | 1.39 | 2.10 | 198 |
| October 5 | A. M. Evans | 160 | 1.57 | 2.36 | 252 |
| November 12 | H. R. Beebe | 136 | 2.00 | 2.40 | 272 |

METTAWEE RIVER AND TRIBUTARIES IN NEW YORK AND VERMONT.

Mettawee River is an interstate stream rising in Dorset Mountains, Vermont, crossing the State line into New York and Grandville and entering the south arm of Lake Champlain below Whitehall. The drainage basin is a rugged area of rock, mostly forest covered, and tributaries are rather numerous and branching, there being no lakes or marshes. Near Whitehall the stream is joined by Wood Creek.

Wood Creek flowed naturally in a tortuous course in a flat valley skirted by bold slopes, the general course being northerly from a point 5 miles east of Hudson River at Fort Edward. From Smith basin northerly, it is alternately paralleled by and canalized to form Champlain canal, so that the flow of this portion of the stream is artificially controlled.

Half Way Creek, the principal tributary of Wood Creek, enters at Fort Ann. This stream receives the drainage from Putnam Mountain, an adjacent group of small lakes. A declivity of 60 feet occurs at Kane's falls.

*Drainage areas of Mettawee River, New York.*[a]

| Location. | Area. | |
|---|---|---|
| | Place to place. | Total. |
| Wood Creek: | *Sq. miles.* | *Sq. miles.* |
| Above Fort Ann[b] | 63.7 | 63.7 |
| Fort Ann to mouth | 141.2 | 204.9 |
| Mettawee River: | | |
| Above Middle Granville | 161.5 | 161.5 |
| Middle Granville to junction of Wood Creek | 46.1 | 207.6 |
| Wood Creek | 204.9 | 412.5 |
| Wood Creek to Whitehall | 14.1 | 426.6 |
| Whitehall to mouth | 1.2 | 427.8 |

[a] From Fort Ann Whitehall, Mettawee, and Glens Falls sheets of the United States Geological Survey Topographic Atlas.
[b] Including Halfway Creek.

The discharge of Mettawee River at the first bridge above the junction of Wood Creek was measured by current meter September 17, 1903, the flow being 57.8 second-feet. Water surface 12.74 feet below coping right-hand abutment downstream corner. The measured discharge is equivalent to .280 second-foot per square mile from the tributary area of 206.5 square miles at this point.

The discharge of Wood Creek at a farm bridge 3 miles above the junction of Mettawee River September 17, 1903, was 84.5 second-feet; water surface 10.58 feet below top of downstream guard rail 5 feet

from left-hand end of bridge. The equivalent discharge in second-feet per square mile was .430. Tributary drainage area, 196.5 square miles.

The precipitation at Glens Falls preceding these measurements was as follows:

| | Inch. |
|---|---|
| August 28 to September 2 | 0.82 |
| September 2 to 16 | 0 |

## POULTNEY RIVER AND TRIBUTARIES IN NEW YORK AND VERMONT.

Poultney River rises in a group of lakes in Rutland County, Vt. Above Poultney the drainage is rugged and precipitous. From Poultney to its outlet in the south arm of Lake Champlain the thread of the river forms a boundary line between New York and Vermont.

Castleton River, the principal tributary, enters near Fairhaven. The drainage of this stream lies entirely in Vermont. Castleton River rises in a valley between two parallel ridges of the Green Mountains, flows southward to Rutland, then westward through a low divide of the mountains and receives at Hydeville the outlet of Bomoseen Lake. This lake in turn receives the discharge of a number of smaller tributary lakes. The water-surface elevation of Bomoseen Lake is 413 feet above tide.

*Drainage areas of Poultney River.*[a]

| Location. | Area. | |
|---|---|---|
| | Place to place. | Total. |
| Bomoseen Lake: | *Sq. miles.* | *Sq. miles.* |
| Bomoseen Lake water surface | ---------- | 3.9 |
| Bomoseen Lake total drainage | ---------- | 38.2 |
| Castleton River: | | |
| Above Hydeville | 57.8 | 96.0 |
| Hydeville to mouth | 4.9 | 100.9 |
| Poultney River: | | |
| Above Castleton River | 78.4 | 179.3 |
| Junction Castleton River to Carver Falls | 10.6 | 189.9 |
| Carver Falls to mouth | 75.9 | 265.8 |

[a] From Whitehall, Castleton, Mettawee, and Fort Ann sheets of the United States Geological Survey Topographic Atlas.

A current-meter measurement of the flow of Poultney River at Delaware and Hudson River Railroad bridge above junction with Castleton River, September 17, 1903, showed a discharge of 15.1 second-feet. Flow probably influenced by pond storage above.

At Carver Falls, 2 miles below the junction of Poultney and Castleton rivers, occurs a descent of 126 feet over rock. Electric power is developed for transmission to adjoining towns.

### GREAT AND LITTLE CHAZY RIVERS AND TRIBUTARIES IN NEW YORK AND VERMONT.

These streams are tributary to the north end of Lake Champlain, from the New York side.

Great Chazy River flows at one point within one-half mile of the United States and Canada boundary line. Its drainage is, however, chiefly from the south and in the United States. The catchment area, which is mostly shown on the Mooers and Rouse Point sheets of the United States Geological Survey Topographic Atlas, is relatively flat and contains numerous swamp areas. At Mooers Forks two main branches of the stream unite. A measurement of the spring freshet discharge April 25, 1899, was made by the United States Deep Waterways Engineers at Champlain, 6 miles above the mouth of the stream; discharge 1,038 second-feet, equivalent to 4 second-feet per square mile from the tributary drainage area of 257 square miles.

Little Chazy River, which enters Lake Champlain 2 miles to the south, has a drainage area of similar character.

### FISH CREEK AT BURGOYNE, N. Y.

Fish Creek forms the outlet of Saratoga Lake and is 8 miles in length below the limit of slack water from the lake. It enters Hudson River at Schuylerville, at which point water power is developed. The stream descends 100 feet in the lower 4 miles of its course, the greater portion of this fall being concentrated at Victory Mills.

The drainage basin of Saratoga Lake lies mostly to the north and west of the lake and is chiefly tributary through Kayaderosseras Creek. This stream drains a highland region, having its sources in a range of hills which rise about 800 feet above the general plateau and run in a northwesterly and southeasterly direction. On the main plateau the topography is moderately rolling, tributaries rather sparse, and soil sandy, with few marsh or lake areas.

A temporary gage was attached to the right-hand abutment of Brandt's bridge at Burgoyne station August 25, 1904. Observations of the stage of the stream are taken once each day by G. R. Warner. Current-meter measurements have been made from the bridge. The discharge is not a continuous function of the stage of the stream, however, owing to the growth of grass and aquatic plants in the river channal, thereby causing the velocity to vary with the season. The channel is occasionally cleared of grass by the water-power users in order to facilitate the flow.

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

*Drainage area of Fish Creek.*[a]

| Location. | Area. | |
|---|---|---|
| | Place to place. | Total. |
| | *Sq. miles.* | *Sq. miles.* |
| Kayaderosseras Creek above Middle Grove | 43.8 | 43.8 |
| Kayaderosseras Creek, Middle Grove to Ballston Springs | 65.8 | 109.6 |
| Kayaderosseras Creek, Ballston Springs to mouth | 85.1 | 194.7 |
| Saratoga Lake water surface | 6.8 | |
| Total direct drainage into Saratoga Lake[b] | 41.1 | 235.8 |

[a] From Saratoga, Schuylerville, Schenectady, Glens Falls, Luzerne, and Broadalbin sheets of the United States Geological Survey Topographic Atlas.
[b] Above Brandt's bridge.

*Discharge measurements of Fish Creek at Burgoyne, N. Y., in 1904.*

| Date. | Hydrographer. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Second-feet.* |
| August 25 | Horton and Beebe | 355 | 0.80 | 1.46 | [a] 283 |
| October 5 | A. M. Evans | 339 | .92 | 1.47 | 311 |
| September 16 | R. E. Horton | | | 1.65 | 301 |
| November 11 | H. R. Beebe | | | 1.25 | [a] 321 |

[a] Some grass in channel.

*Mean daily gage height, in feet, of Fish Creek at Burgoyne, N. Y., for 1904.*

| Day. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.05 | 1.55 | 1.82 | 0.80 | 17 | | 1.46 | 1.54 | 1.25 | 0.30 |
| 2 | 1.10 | | 1.80 | .80 | 18 | | 1.52 | 1.52 | 1.22 | [a].30 |
| 3 | 1.08 | | 1.77 | .70 | 19 | | 1.54 | 1.50 | 1.20 | .30 |
| 4 | 1.20 | | 1.70 | .75 | 20 | | 1.45 | 1.45 | 1.20 | .20 |
| 5 | 1.17 | | 1.62 | .75 | 21 | | 1.37 | 1.42 | 1.15 | .20 |
| 6 | 1.05 | | 1.56 | .70 | 22 | | 1.32 | 1.80 | 1.15 | .20 |
| 7 | 1.05 | | 1.53 | .55 | 23 | | 1.30 | 2.10 | 1.10 | .20 |
| 8 | 1.05 | | 1.45 | .50 | 24 | | 1.29 | 2.18 | 1.10 | .20 |
| 9 | 1.00 | 1.30 | 1.40 | .60 | 25 | | 1.30 | 2.20 | 1.10 | .20 |
| 10 | 1.00 | 1.31 | 1.36 | .55 | 26 | 1.45 | 1.28 | 2.12 | 1.10 | .50 |
| 11 | 1.00 | 1.36 | 1.30 | .45 | 27 | 1.42 | 1.28 | 2.12 | 1.10 | .30 |
| 12 | .96 | 1.40 | 1.25 | .40 | 28 | 1.40 | 1.26 | 2.10 | .95 | .70 |
| 13 | .90 | 1.46 | 1.20 | .35 | 29 | 1.26 | 1.20 | 2.08 | .90 | 1.00 |
| 14 | .88 | 1.50 | 1.22 | .30 | 30 | 1.15 | 1.42 | 2.00 | .85 | 1.00 |
| 15 | 1.30 | 1.52 | 1.26 | .35 | 31 | 1.12 | | 1.96 | | 1.05 |
| 16 | 1.40 | 1.55 | 1.28 | .30 | | | | | | |

[a] Ice conditions December 18 to 31.

## OTTER CREEK AT MIDDLEBURY, VT.

This station was established April 1, 1903, by H. K. Barrows. It is located at the railroad bridge in the village of Middlebury, above and within the influence of the dam used for power purposes. The water, however, never falls below the crest of the dam. The drainage area at this point is 615 square miles. A chain gage is attached to the downstream truss of this bridge; length of chain is 17.52 feet to the 10-foot tag. It is referred to a bench mark on top of south bolt in bridge seat on downstream side of north abutment; elevation 20.08 feet above gage datum. Measurements are made from a boat at medium stages, and from a stone-arch highway bridge about one-quarter mile downstream at low stages of the river. The current at the gage is small, except at high stages of the river; at the stone-arch bridge it is medium at low stages of the river. The banks are high and not subject to overflow, and the bed is permanent. The gage is read twice daily by R. P. Bingham, of Middlebury.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

*Discharge measurement of Otter Creek at Middlebury, Vt., in 1904.*

| Date. | Hydrographer. | Width. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|
| | | *Feet.* | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Sec.-feet.* |
| October 29 | H. K. Barrows | 118 | 408 | 3.18 | 13.68 | [a] 1,300 |

[a] From arch bridge.

*Mean daily gage height, in feet, of Otter Creek River at Middlebury, Vt., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | ..... | [a]13.0 | 16.1 | 15.3 | 12.65 | 12.6 | 12.25 | 12.0 | 14.5 | 13.1 | 12.4 |
| 2 | ..... | [a]12.7 | ..... | 15.7 | 15.4 | 12.6 | 12.7 | 12.3 | 12.05 | 14.4 | 13.0 | 12.4 |
| 3 | [b]12.8 | ..... | ..... | 15.4 | 15.4 | 12.5 | 13.1 | 12.4 | 12.05 | 13.8 | 12.85 | 12.3 |
| 4 | ..... | ..... | ..... | 14.9 | 15.3 | 12.45 | 12.85 | 12.5 | 12.4 | 13.5 | 12.80 | 12.2 |
| 5 | ..... | ..... | [a]14.6 | 14.3 | 15.1 | 12.45 | 12.45 | 12.35 | 12.1 | 13.25 | 12.75 | 11.9 |
| 6 | ..... | [a]12.6 | ..... | 13.9 | 14.7 | 12.4 | 12.5 | 12.2 | 12.2 | 13.0 | 12.7 | [c]12.1 |
| 7 | [d]12.6 | ..... | ..... | 14.0 | 14.25 | 13.2 | 12.4 | 12.2 | 12.25 | 12.9 | 12.65 | ..... |
| 8 | ..... | ..... | [a]15.6 | 14.4 | 13.7 | 12.85 | 12.3 | 11.9 | 12.2 | 12.8 | 12.6 | [c]12.2 |
| 9 | [d]12.5 | ..... | ..... | 14.7 | 13.3 | 13.3 | 12.2 | 12.0 | 12.15 | 12.8 | 12.5 | ..... |
| 10 | ..... | [a]14.7 | ..... | 15.0 | 13.2 | 13.05 | 12.15 | 12.1 | 12.1 | 12.7 | 12.4 | ..... |
| 11 | ..... | ..... | ..... | 15.0 | 13.3 | 12.85 | 11.9 | 12.05 | 12.1 | 12.9 | 12.4 | ..... |
| 12 | [d]12.5 | ..... | [f]14.7 | 15.1 | 13.4 | 12.65 | 11.95 | 12.15 | 11.9 | 13.4 | 12.4 | ..... |
| 13 | ..... | [f]13.7 | ..... | 15.1 | 13.25 | 12.4 | 12.35 | 12.25 | 11.9 | 13.4 | 12.4 | [g]12.1 |
| 14 | ..... | ..... | ..... | 15.0 | 13.1 | 12.4 | 12.35 | 12.25 | 12.0 | 13.3 | 12.4 | ..... |
| 15 | ..... | ..... | [a]13.4 | 14.7 | 13.0 | 12.3 | 12.3 | 12.05 | 12.5 | 13.2 | 12.4 | ..... |
| 16 | [h]12.5 | [f]13.0 | ..... | 14.15 | 13.1 | 12.3 | 12.2 | 12.1 | 13.55 | 13.05 | 12.4 | ..... |

[a] Ice 1.35 feet thick.
[b] Ice 0.65 foot thick.
[c] River frozen over.
[d] Ice 1 foot thick.
[e] Ice 0.15 foot thick.
[f] Ice 1.4 feet thick.
[g] Ice 0.6 foot thick.
[h] Ice 0.85 foot thick.

*Mean daily gage height, in feet, of Otter Creek River at Middlebury, Vt., etc.*—Cont'd.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | ..... | ..... | ..... | 13.75 | 14.1 | 12.3 | 12.1 | 12.2 | 13.5 | 12.9 | 12.4 | ..... |
| 18 | ..... | ..... | ..... | 13.7 | 14.25 | 12.2 | 11.9 | 12.15 | 13.15 | 12.8 | 12.2 | ..... |
| 19 | a12.5 | ..... | b12.9 | 13.8 | 14.0 | 12.1 | 12.1 | 12.05 | 12.95 | 12.7 | 12.3 | ..... |
| 20 | ..... | c12.8 | ..... | 13.85 | 14.3 | 11.85 | 12.1 | 12.05 | 12.8 | 12.7 | 12.35 | d12.05 |
| 21 | ..... | ..... | ..... | 13.7 | 14.5 | 12.1 | 12.0 | 12.5 | 13.0 | 12.85 | 12.4 | ..... |
| 22 | b12.4 | ..... | ..... | 13.7 | 14.5 | 12.2 | 12.0 | 12.8 | 12.85 | 14.8 | 12.95 | e12.15 |
| 23 | ..... | f14.5 | g13.4 | 13.7 | 14.2 | 12.2 | 11.9 | 12.9 | 12.7 | 14.8 | 12.95 | ..... |
| 24 | ..... | ..... | ..... | 13.8 | 13.7 | 12.15 | 12.0 | 12.8 | 12.5 | 14.65 | 12.9 | ..... |
| 25 | b13.0 | ..... | ..... | 14.05 | 13.35 | 12.1 | 11.8 | 12.65 | 13.0 | 14.25 | 12.7 | ..... |
| 26 | ..... | ..... | g15.3 | 14.4 | 13.3 | 12.1 | 11.85 | 12.45 | 13.35 | 13.8 | 12.7 | ..... |
| 27 | ..... | f13.6 | ..... | 14.4 | 13.35 | 11.95 | 12.1 | 12.3 | 13.6 | 13.85 | 12.55 | ..... |
| 28 | ..... | ..... | ..... | 14.65 | 13.15 | 12.1 | 12.4 | 12.3 | 13.45 | 14.1 | 12.25 | ..... |
| 29 | ..... | ..... | 15.35 | 15.05 | 12.9 | 12.1 | 12.3 | 11.9 | 13.3 | 13.8 | 12.15 | ..... |
| 30 | f12.7 | ..... | 16.0 | 15.3 | 12.7 | 12.1 | 12.4 | 12.0 | 14.4 | 13.5 | 12.3 | h13.5 |
| 31 | ..... | ..... | 16.3 | ..... | 12.65 | ..... | 12.5 | 12.1 | ..... | 13.2 | ..... | ..... |

*a* Ice 0.9 foot thick.
*b* Ice 1.25 feet thick.
*c* Ice 1.4 feet thick.
*d* Ice 0.85 foot thick.
*e* Ice 0.85 foot thick. Gage reading to surface of ice=12.2.
*f* Ice 1.35 feet thick.
*g* Ice covered with water.
*h* Water 1.25 feet deep on top of ice.

NOTE.—During frozen season gage heights are to surface of water in hole cut in ice.

*Rating table for Otter Creek at Middlebury, Vt., 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.* |
| 11.60 | 163 | 12.80 | 670 | 14.00 | 1,645 | 15.20 | 2,930 |
| 11.70 | 188 | 12.90 | 740 | 14.10 | 1,745 | 15.30 | 3,040 |
| 11.80 | 217 | 13.00 | 810 | 14.20 | 1,845 | 15.40 | 3,150 |
| 11.90 | 248 | 13.10 | 880 | 14.30 | 1,950 | 15.50 | 3,265 |
| 12.00 | 283 | 13.20 | 955 | 14.40 | 2,055 | 15.60 | 3,380 |
| 12.10 | 320 | 13.30 | 1,030 | 14.50 | 2,160 | 15.70 | 3,495 |
| 12.20 | 360 | 13.40 | 1,110 | 14.60 | 2,270 | 15.80 | 3,610 |
| 12.30 | 403 | 13.50 | 1,190 | 14.70 | 2,380 | 15.90 | 3,725 |
| 12.40 | 450 | 13.60 | 1,275 | 14.80 | 2,490 | 16.00 | 3,840 |
| 12.50 | 501 | 13.70 | 1,365 | 14.90 | 2,600 | 16.10 | 3,955 |
| 12.60 | 555 | 13.80 | 1,455 | 15.00 | 2,710 | 16.20 | 4,070 |
| 12.70 | 610 | 13.90 | 1,550 | 15.10 | 2,820 | 16.30 | 4,185 |

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 to gage height 14 feet. Above 14 feet it is determined by one measurement.

*Estimated monthly discharge of Otter Creek at Middlebury, Vt., for 1904.*

[Drainage area, 615 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| April | 3,955 | 1,365 | 2,198 | 3.57 | 3.98 |
| May | 3,150 | 582 | 1,623 | 2.64 | 3.04 |
| June | 1,030 | 232 | 471 | .766 | .855 |
| July | 880 | 217 | 396 | .644 | .742 |
| August | 740 | 248 | 398 | .647 | .746 |
| September | 2,055 | 248 | 661 | 1.07 | 1.19 |
| October | 2,490 | 610 | 1,225 | 1.99 | 2.29 |
| November | 880 | 340 | 545 | .886 | .988 |
| December 1–6 | 450 | 248 | 372 | .605 | .135 |

NOTE.—Ice conditions January 1 to March 31 and December 7–31. No estimate made.

WINOOSKI RIVER AT RICHMOND, VT.

This station was established June 25, 1903, by H. K. Barrows. It is located at the steel highway bridge about one-fourth mile from Richmond railway station on the road to Huntington. The drainage area at this point is 885 square miles. A standard chain gage is attached to the downstream truss; length of chain, 29.61 feet. It is referred to bench marks as follows: (1) On top of plate near north end of gage box; elevation, 28.76 feet. (2) Marked point on the west end of south abutment; elevation, 27.42 feet. Elevations are above gage datum. The channel is straight for 100 feet above and 100 feet below this station, and is about 175 feet wide. The bed is gravelly and permanent. The current is medium except at low water. Gagings at low stages of the river are made by wading at a point 2,500 feet upstream from bridge, where the bed is of gravel and the current swift. The banks are fairly high, but overflow at extreme high water. The gage is read twice daily by George Champang, a farmer, of Richmond.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

*Discharge measurements of Winooski River at Richmond, Vt., in 1904.*

| Date. | Hydrographer. | Width. | Area of section. | Mean velocity. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|
| | | *Feet.* | *Sq. feet.* | *Ft. per sec.* | *Feet.* | *Sec.-feet.* |
| May 4 | H. K. Barrows | 182 | 1,590 | 2.27 | 7.10 | 3,610 |
| May 7 | J. H. Ayres | 182 | 1,380 | 1.71 | 6.16 | 2,360 |
| May 10 | do | 182 | 1,370 | 1.41 | 5.89 | 1,930 |
| August 18 | H. K. Barrows | 161 | 171 | 2.06 | 4.08 | [a]352 |
| October 31 | do | 180 | 1,230 | .98 | 5.08 | 1,210 |

[a] Wading one-half mile upstream.

*Mean daily gage height, in feet, of Winooski River at Richmond, Vt., for 1904.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | a5.8 | b5.7 | c6.1 | 7.0 | 8.65 | 4.75 | 4.15 | 4.1 | 3.9 | 7.6 | 4.8 | 4.5 |
| 2 | ..... | ..... | ..... | 6.8 | 7.9 | 4.75 | 4.3 | 4.2 | 3.95 | 7.95 | 4.8 | 4.55 |
| 3 | ..... | ..... | ..... | 6.9 | 7.4 | 4.7 | 4.8 | 4.2 | 4.0 | 6.6 | 4.7 | 4.65 |
| 4 | ..... | ..... | d5.9 | 6.45 | 7.3 | 4.6 | 4.4 | 4.1 | 5.1 | 5.95 | 4.7 | e4.95 |
| 5 | f5.65 | g5.75 | ..... | 6.55 | 7.0 | 4.5 | 4.25 | 4.2 | 4.8 | 5.5 | 4.7 | ..... |
| 6 | ..... | ..... | ..... | 7.2 | 6.5 | 4.55 | 4.3 | 4.05 | 4.5 | 5.4 | 4.6 | ..... |
| 7 | ..... | ..... | h6.7 | 7.85 | 6.2 | 4.6 | 4.2 | 4.0 | 4.35 | 5.3 | 4.6 | ..... |
| 8 | i5.75 | ..... | ..... | 7.8 | 6.1 | 4.8 | 4.05 | 3.9 | 4.25 | 5.0 | 4.5 | ..... |
| 9 | ..... | j5.95 | ..... | 9.15 | 5.9 | 5.3 | 4.1 | 4.0 | 4.1 | 5.0 | 4.5 | k5.2 |
| 10 | ..... | ..... | ..... | 9.2 | 5.85 | 4.9 | 4.0 | 4.0 | 4.05 | 4.9 | 4.35 | ..... |
| 11 | ..... | ..... | l6.4 | 8.4 | 5.75 | 4.6 | 4.0 | 4.0 | 4.0 | 5.2 | 4.3 | ..... |
| 12 | i5.8 | m6.2 | ..... | 7.6 | 5.7 | 4.4 | 4.0 | 4.05 | 3.85 | 5.25 | 4.3 | ..... |
| 13 | ..... | ..... | ..... | 7.35 | 5.4 | 4.4 | 4.9 | 4.0 | 3.9 | 5.05 | 4.4 | ..... |
| 14 | ..... | ..... | ..... | 6.65 | 5.3 | 4.3 | 4.8 | 4.0 | 4.0 | 5.15 | 4.4 | ..... |
| 15 | n5.75 | ..... | l6.5 | 6.3 | 5.1 | 4.25 | 4.45 | 4.3 | 4.3 | 5.2 | 4.5 | ..... |
| 16 | ..... | m6.1 | ..... | 6.05 | 6.3 | 4.4 | 4.15 | 4.2 | 5.15 | 5.1 | 4.4 | o4.95 |
| 17 | ..... | ..... | ..... | 5.8 | 7.5 | 4.2 | 4.05 | 4.15 | 4.6 | 4.9 | 4.5 | ..... |
| 18 | ..... | ..... | p6.6 | 6.2 | 6.2 | 4.0 | 4.0 | 3.95 | 4.25 | 4.8 | 4.35 | ..... |
| 19 | n5.7 | m6.05 | ..... | 6.3 | 6.0 | 4.0 | 4.0 | 3.9 | 4.5 | 4.7 | 4.7 | ..... |
| 20 | ..... | ..... | ..... | 6.1 | 7.85 | 4.05 | 3.9 | 4.0 | 4.8 | 4.7 | 4.6 | ..... |
| 21 | ..... | ..... | ..... | 6.2 | 7.1 | 4.1 | 3.9 | 6.6 | 6.6 | 5.85 | 4.65 | ..... |
| 22 | q5.85 | ..... | ..... | 6.25 | 6.2 | 4.2 | 3.9 | 5.25 | 5.4 | 10.0 | 5.1 | ..... |
| 23 | ..... | c6.0 | ..... | 6.8 | 5.9 | 4.25 | 3.9 | 5.25 | 4.9 | 6.6 | 4.7 | r5.0 |
| 24 | ..... | ..... | 11.15 | 7.1 | 5.7 | 4.2 | 3.9 | 4.7 | 5.05 | 5.95 | 4.6 | ..... |
| 25 | ..... | ..... | 12.7 | 8.4 | 5.55 | 4.1 | 3.75 | 4.4 | 6.7 | 5.6 | 4.6 | ..... |
| 26 | s5.8 | c6.0 | 17.95 | 8.6 | 5.6 | 4.0 | 3.95 | 4.2 | 5.75 | 5.4 | 4.6 | ..... |
| 27 | ..... | ..... | 15.3 | 7.5 | 5.6 | 4.15 | 4.35 | 4.1 | 5.7 | 5.8 | 4.4 | ..... |
| 28 | ..... | ..... | 13.4 | 7.65 | 5.35 | 4.05 | 4.6 | 4.0 | 5.3 | 5.7 | 4.4 | ..... |
| 29 | b5.75 | ..... | 9.7 | 8.9 | 5.0 | 4.1 | 4.5 | 3.85 | 5.0 | 5.6 | 4.5 | ..... |
| 30 | ..... | ..... | 6.7 | 9.95 | 4.9 | 4.15 | 4.35 | 3.9 | 8.55 | 5.35 | 4.6 | t5.0 |
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a Gage reading to ice surface=5.85; ice 1.35 feet thick.
b Gage reading to ice surface=5.85; ice 2.1 feet thick.
c Gage reading to ice surface=6.5; ice 2.75 feet thick.
d Gage reading to ice surface=6.4; ice 2.65 feet thick.
e River frozen over December 4.
f Gage reading to ice surface=5.7; ice 1.45 feet thick.
g Gage reading to ice surface=5.85; ice 2.15 feet thick.
h Gage reading to ice surface=7.0; ice 2.65 feet thick.
i Gage reading to ice surface=5.8; ice 1.6 feet thick.
j Gage reading to ice surface=6.2; ice 2.4 feet thick.
k Gage reading to ice surface=5.3; ice 0.6 foot thick.
l Gage reading to ice surface=6.9; ice 2.65 feet thick.
m Gage reading to ice surface=6.6; ice 2.75 feet thick.
n Gage reading to ice surface=5.8; ice 1.65 feet thick.
o Gage reading to ice surface=5.05; ice 1.1 feet thick.
p Gage reading to ice surface=6.75; ice 2.6 feet thick.
q Gage reading to ice surface=5.85; ice 1.6 feet thick.
r Gage reading to ice surface=5.05; ice 1.4 feet thick.
s Gage reading to ice surface=5.85; ice 1.85 feet thick.
t Gage reading to ice surface=5.4; ice 1.65 feet thick.

NOTE.—During frozen season gage readings to surface of water in hole cut in ice.

*Rating table for Winooski River at Richmond, Vt., 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.* |
| 3.70 | 140 | 4.90 | 900 | 6.00 | 2,090 | 7.10 | 3,610 |
| 3.80 | 165 | 5.00 | 1,000 | 6.10 | 2,220 | 7.20 | 3,750 |
| 3.90 | 195 | 5.10 | 1,100 | 6.20 | 2,350 | 7.30 | 3,890 |
| 4.00 | 235 | 5.20 | 1,200 | 6.30 | 2,490 | 7.40 | 4,030 |
| 4.10 | 285 | 5.30 | 1,300 | 6.40 | 2,630 | 7.60 | 4,310 |
| 4.20 | 340 | 5.40 | 1,410 | 6.50 | 2,770 | 7.80 | 4,590 |
| 4.30 | 400 | 5.50 | 1,520 | 6.60 | 2,910 | 8.00 | 4,870 |
| 4.40 | 470 | 5.60 | 1,630 | 6.70 | 3,050 | 8.20 | 5,150 |
| 4.50 | 540 | 5.70 | 1,740 | 6.80 | 3,190 | 8.40 | 5,430 |
| 4.60 | 620 | 5.80 | 1,850 | 6.90 | 3,330 | 8.60 | 5,710 |
| 4.70 | 710 | 5.90 | 1,970 | 7.00 | 3,470 | 8.80 | 5,990 |
| 4.80 | 800 | | | | | | |

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 3.7 feet and 7.5 feet. The table has been extended above gage height 7.50 feet. Above gage height 6.20 feet the rating curve is a tangent, the difference being 140 per tenth.

*Estimated monthly discharge of Winooski River at Richmond, Vt., for 1904.*

[Drainage area, 885 square miles.]

| Month. | Discharge in second-feet. | | | Run-off. | |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Second-feet per square mile. | Depth in inches. |
| April | 7,600 | 1,850 | 3,893 | 4.40 | 4.91 |
| May | 5,780 | 800 | 2,412 | 2.73 | 3.15 |
| June | 1,300 | 235 | 482 | .545 | .608 |
| July | 900 | 152 | 365 | .412 | .475 |
| August | 2,910 | 180 | 433 | .489 | .564 |
| September | 5,640 | 180 | 998 | 1.13 | 1.26 |
| October | 7,670 | 710 | 1,822 | 2.06 | 2.38 |
| November | 1,100 | 400 | 599 | .677 | .755 |

NOTE.—River frozen during January, February, March, and December. No estimate made.

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# PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 129.]

The publications of the United States Geological Survey consist of (1) Annual Reports; (2) Monographs; (3) Professional Papers; (4) Bulletins; (5) Mineral Resources; (6) Water-Supply and Irrigation Papers; (7) Topographic Atlas of United States, folios and separate sheets thereof; (8) Geologic Atlas of United States, folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

Most of the above publications may be obtained or consulted in the following ways:

1. A limited number are delivered to the Director of the Survey, from whom they may be obtained, free of charge (except classes 2, 7, and 8), on application.

2. Every member of Congress is allotted a certain number, from whom they may be obtained, free of charge, on application.

3. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they may be had at practically cost.

4. Copies of all Government publications are furnished to the principal public libraries in the large cities throughout the United States, where they may be consulted by those interested.

The Professional Papers, Bulletins, and Water-Supply Papers treat of a variety of subjects, and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, General hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports.

*Series P.*—The hydrographic progress reports contain the results of stream measurements. A report is issued for every calendar year, containing the results of data collected during that year. These reports were first published as a part of the Director's annual report or as a bulletin; they are now published as water-supply and irrigation papers. The following is a list, by years, of the publications containing the progress reports of stream measurements. A detailed index of these reports (1888-1903) is published as 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.
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1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
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1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
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