DEPARTMENT OF THE INTERIOR

# WATER-SUPPLY

AND

# IRRIGATION PAPERS

OF THE

## UNITED STATES GEOLOGICAL SURVEY

## No. 34

GEOLOGY AND WATER RESOURCES OF A PORTION OF SOUTHEASTERN SOUTH DAKOTA.—TODD

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

# IRRIGATION REPORTS.

The following list contains titles and brief descriptions of the principal reports relating to water supply and irrigation prepared by the United States Geological Survey since 1890:

## 1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888-89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

## 1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889-90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 29 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890-91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell; quarto.

No. 35, Irrigation in Arizona; No. 60, Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

## 1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc., of irrigated holdings, the total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps showing the location and relative extent of the irrigated areas.

## 1893.

Thirteenth Annual Report of the United States Geological Survey, 1891-92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering" and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnoissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 15 plates. Bulletin No. 108 of the United States Geological Survey; price, 15 cents.

Contains a description of the examination of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

## 1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892-93, in two parts; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; and "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.

(Continued on third page of cover.)

DEPARTMENT OF THE INTERIOR

# WATER-SUPPLY

AND

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WASHINGTON
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1900

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

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# GEOLOGY AND WATER RESOURCES

OF A PORTION OF

# SOUTHEASTERN SOUTH DAKOTA

BY

JAMES EDWARD TODD

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

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# ILLUSTRATIONS.

# LETTER OF TRANSMITTAL.

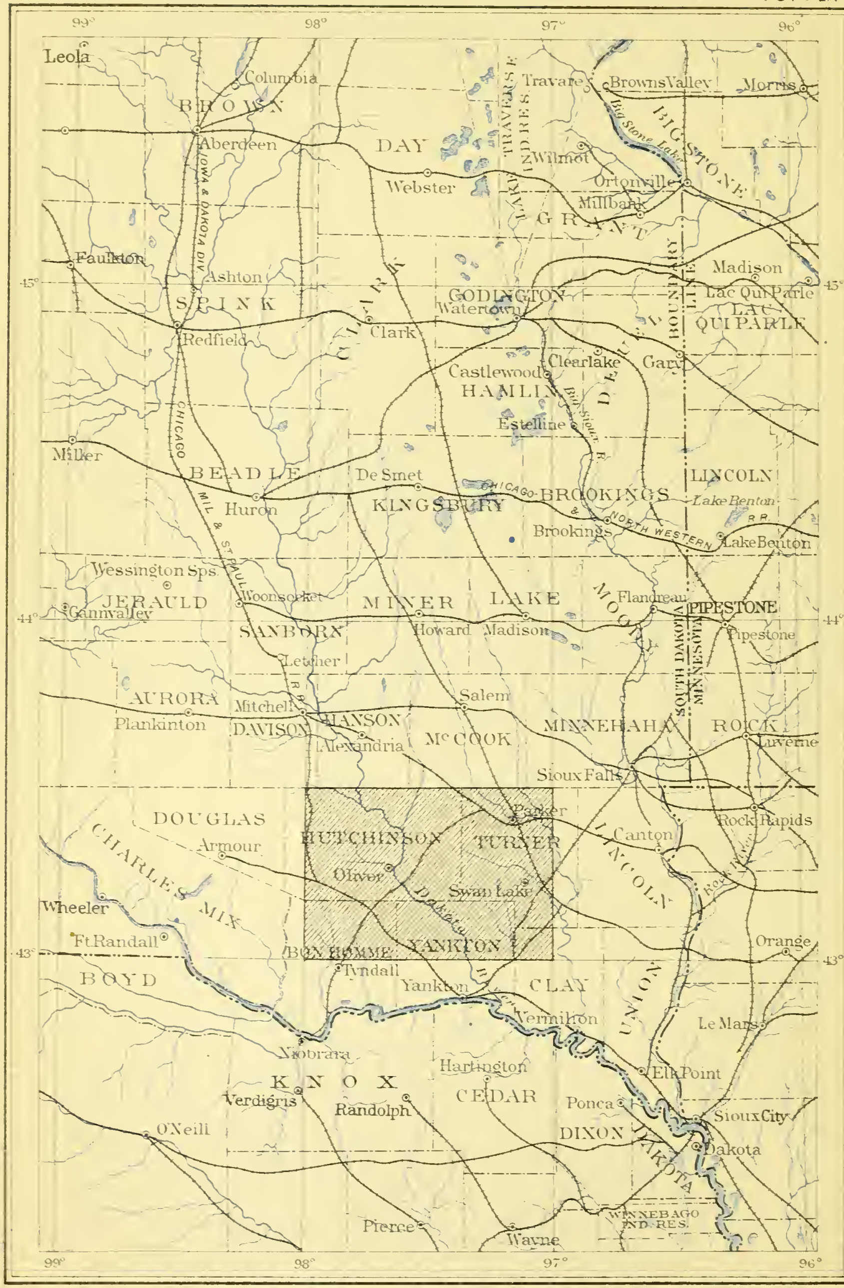
DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
*Washington, February 15, 1900.*

SIR: I have the honor to transmit herewith a manuscript giving the results of investigations of underground waters of a portion of southeastern South Dakota, prepared by Prof. James E. Todd, and to recommend that it be printed in the series of Water-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL,
*Hydrographer in Charge.*

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




# INDEX MAP OF EASTERN SOUTH DAKOTA

Showing area under consideration

BY J. E. TODD 1899.

Scale

25 0 25 50 MILES

JULIUS BIEN & CO. N.Y.

# GEOLOGY AND WATER RESOURCES OF A PORTION OF SOUTHEASTERN SOUTH DAKOTA.

By James E. Todd.

## LOCATION OF REGION.

The area to which this paper relates is represented on the Olivet and Parker sheets of the Topographic Atlas of the United States, published by the United States Geological Survey.[1] It occupies large portions of Turner and Hutchinson counties, and small portions of Bonhomme, Yankton, and Clay counties, South Dakota. It is especially instructive from the fact that it includes typical areas of the valleys of James and Vermilion rivers, and Turkey Ridge, which forms a portion of the divide between the two streams. Moreover, it exhibits characteristic features of two kinds of artesian supply, viz, that from the Dakota sandstone, and that from the sands underlying the drift. It also exhibits plainly the typical conditions of most forms of shallow wells, as well as the tubular wells common to the eastern portion of South Dakota. The region for the greater part is prairie and rarely so rough as to be unfavorable for ordinary agriculture. It includes wider ranges of altitude than most areas of similar extent in the Mississippi Valley; in the immediate valleys of Vermilion River, Clay Creek, and James River the surface is not over 1,180 feet above the sea, while in the northern culmination of Turkey Ridge it reaches 1,750 feet, and in the southwestern portion of the region it attains an altitude of 1,650 feet, which is considerably below the higher points of the Choteau Creek Hills a little farther west.

## GENERAL GEOLOGY.

Nearly the whole surface of the area is covered with glacial drift. The exceptions are the alluvial flats in the larger valleys, and scattered exposures of older rocks occurring mainly along the sides of the canyons in the southern part of Turkey Ridge and in the bottoms of the

[1] These sheets may be procured at 5 cents each by addressing The Director, United States Geological Survey, Washington, D. C.

river channels. The strata lie nearly horizontal everywhere. No folds, faults, or igneous outflows have been discovered. Frequent borings have been made to a depth of 200 or 300 feet in obtaining wells, and a few have been sunk to 600 or 700 feet. These have furnished important facts concerning the position of strata below the surface.

## ALGONKIAN.

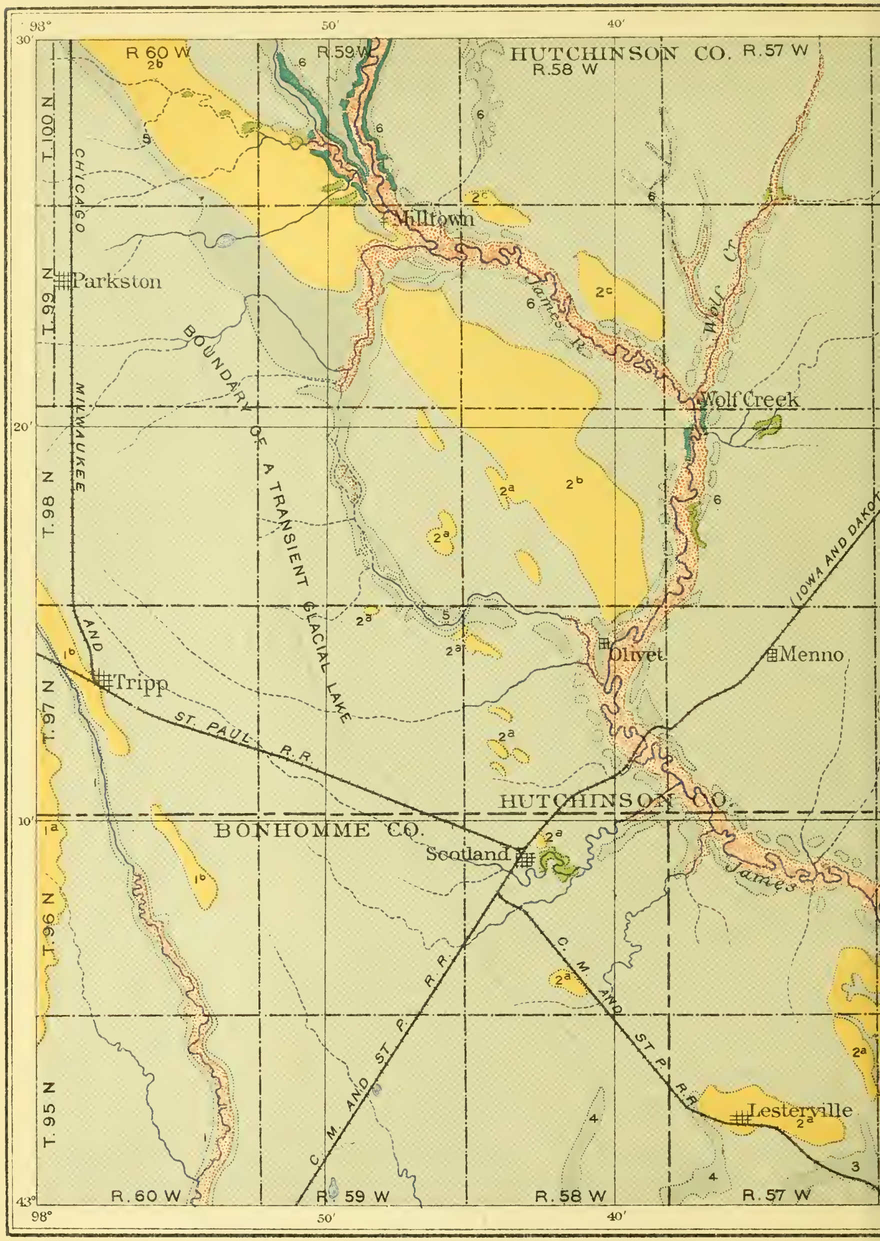
### SIOUX QUARTZITE.

The oldest rock exposed in natural outcrops or by borings is the Sioux quartzite, a name given by Dr. C. A. White, when State geologist of Iowa. Exposures are found at a number of points along the East Fork of Vermilion River from the north line of Turner County to the vicinity of Parker, their location being indicated on Pl. III. Borings some distance from these exposures have shown that this formation is "bed rock," and the depth to its surface is indicated upon the map (Pl. IV). The rock is frequently called Sioux Falls "granite," from the extensive exposures and numerous quarries in the vicinity of Sioux Falls. It is for the most part a red or purplish quartzite of intensely compact and durable character, and is susceptible of a fine polish. It lies in strata which dip generally to the north at an angle of 3° to 5°. In sec. 8, T. 100 N., R. 53 W., it is in layers which are generally not more than 6 inches in thickness. East of Parker it is more massive, and the layers are 2 or 3 feet in thickness. No trace of slate or pipestone has been found in any of these exposures. No fossils have been noted in the formation anywhere, except some small lingulæ found by Prof. N. H. Winchell near Pipestone, Minnesota.[1] This formation is generally referred to the Algonkian. Its thickness has not been determined. At Sioux Falls a boring 500 feet deep revealed no important difference in the character of the rock.

## THE PALEOZOIC GAP.

In this region there are no traces of Paleozoic formations nor of the Triassic and Jurassic of Mesozoic time. The surface of the Sioux quartzite shows marks of long erosion at an elevation of several hundred feet above sea level. The nearest occurrence of Paleozoic rock that has been discovered is in the borings at Ponca, Nebraska, and Sioux City, Iowa. While the mountain masses of the Appalachian region and the extensive coal fields of the eastern part of the Mississippi Valley were forming this area was probably a barren mountainous region. It is possible that soils and vegetations which may have extended over it were removed by the advance of the sea during Cretaceous time. At any rate, no traces of soil are now found upon

[1] Sixteenth Ann. Rept. Geol. Nat. Hist. Survey Minnesota.




# GEOLOGICAL MAP OF A PORTI

BY J.E

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ALGONKIAN

SIOUX QUARTZITE

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DAKOTA FORMATION

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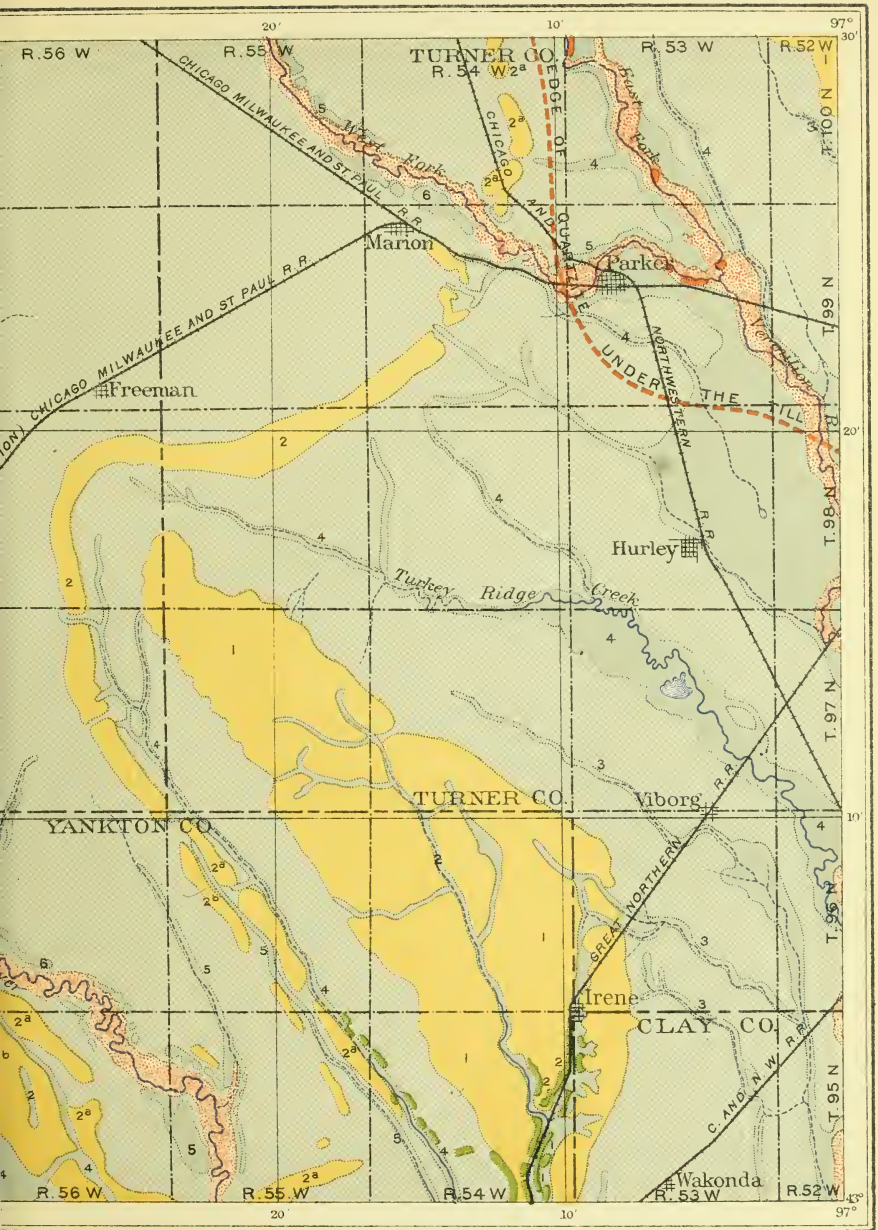


N OF EASTERN SOUTH DAKOTA

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ANCIENT CHANNELS (Numbered in order of occupation)

ALLUVIUM

the surface of the quartzite. Since several hundred feet of strata of marine origin, representing all the ages of Paleozoic time, are found in the Black Hills, the shore of the Paleozoic sea must have extended across South Dakota somewhere west of the present course of the Missouri River. Moreover, as the Triassic formations of the Black Hills testify to an inclosed sea, barren of life, we must believe that during that epoch this inland sea was detached from the ocean.

## CRETACEOUS.

Resting upon the Sioux quartzite, as revealed by borings, there are sands, chalk, and clays belonging to the Cretaceous. We have no trace of the earlier beds which represent this age elsewhere, but several hundred feet of the later Cretaceous deposits underlie much of the area.

### DAKOTA SANDSTONE.

Resting upon the quartzite, as shown by many borings, there is a series of sandstone and shale which Dr. F. V. Hayden, the first United States geologist who examined this region, named the Dakota formation, from extensive outcrops near the town of Dakota, in Nebraska. This formation is only exposed in this area along James River and Twelvemile Creek above Milltown, and about the junction of Wolf Creek and James River. Its general distribution underground is, however, well shown by the borings of the deeper artesian wells. From these data the formation is known to underlie the area, except in the region about Parker and northeastward. As the surface of the quartzite is uneven and the upper portion of the Dakota sandstone is more or less eroded, the margin is quite ragged and uneven. In the southern part of the area, the Dakota deposits probably have a thickness of 300 or 400 feet, but as deep borings in that region are few, and none are known to have penetrated to bed rock, this is only an estimate. From borings in this area and from exposures elsewhere, it is known that the formation is composed of sheets of sand or sandstone more or less completely separated by thick beds of clay and shale. The sandstone strata are usually of fine-grained, well-washed materials, and vary in thickness from 10 to 100 feet. The clay deposits are in general thick, and very often form a hard shale; locally they include compact limestone, plastic clay, and iron pyrites. The last is very hard and forms a serious obstacle in drilling. The number of sand strata which are water bearing increases toward the south, where the formation thickens.

In eastern South Dakota the upper part of the sandstone is a stratum generally presenting harder layers often spoken of as "cap rock." They are sometimes so hard as to give the impression that the red quartzite has been struck, but in all cases, so far as known, the cement is calcareous or ferruginous rather than siliceous, as in the quartzite. Its calcareous character is revealed by use of an acid, which causes effervescence; the ferruginous cement is shown by its dark color.

The Dakota sandstone underlies all the area except a small district near Parker. It is exposed extensively along the James River and Twelvemile Creek above Milltown, and also near the mouth of Wolf Creek. At the latter place it seems to be in a low arch or anticline lifted to a height of 25 or 30 feet above the level of the James River. The principal exposures are upon the west side of the river, in sec. 6, T. 98 N., R. 57 W. The material here is a soft, irregularly stratified sandstone scarcely hard enough for building purposes. Exposures on the James River above Milltown begin about a mile above that point in the form of low barren slopes on both sides of the river, which gradually rise until south of Elmspring the upper portion of the formation is about 60 feet above the level of the James River. Here it exhibits a few castellated cliffs. About 1½ miles south of Elmspring, upon the east side of the valley, the following section is exposd:

*Section 1½ miles south of Elmspring, South Dakota.*

| | Feet. |
|---|---|
| Slope of till | 50 |
| Soft brown sandstone, some pebbles above; irregularly stratified, springs below | 35 |
| Slope mostly clay, evidently Dakota, to the level of the James River | 20 |

Farther south, about a mile above Milltown, the sandstone is more perfectly consolidated and shows much oblique lamination, and it has been quarried to some extent for building purposes. The sandstone appears on both sides of Twelvemile Creek, following the main stream for 3 or 4 miles. North of the northeast corner of sec. 34, T. 100 N., R. 59 W., it has been quarried considerably. The following section of a well near Elmspring exhibits this formation more completely:

*Section in well at Elmspring, South Dakota.*

| | Feet. |
|---|---|
| (1) Yellow and blue clay (till) with water at 60 feet | 83 |
| (2) Sandstone | 8 |
| (3) Sand | 20 |
| (4) Sandstone and clay, irregularly stratified | 20 |
| (5) "Blue clay" (shale), with one or two strata of sandstone | 116 |
| (6) Red quartzite | 70 |

All except No. 1 and No. 6 belong to the Dakota formation.

The formation thickens by the intercalation of other strata, both toward the west and south. Near the James River, at the southern portion of the area, wells indicate that the Dakota formation may be from 300 to 400 feet in thickness. A characteristic view of the upper portion of the formation, as shown on the Firesteel northwest of Mitchell, is given on Pl. IX, *A*.

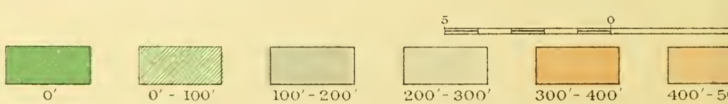
U.S. GEOLOGICAL SURVEY

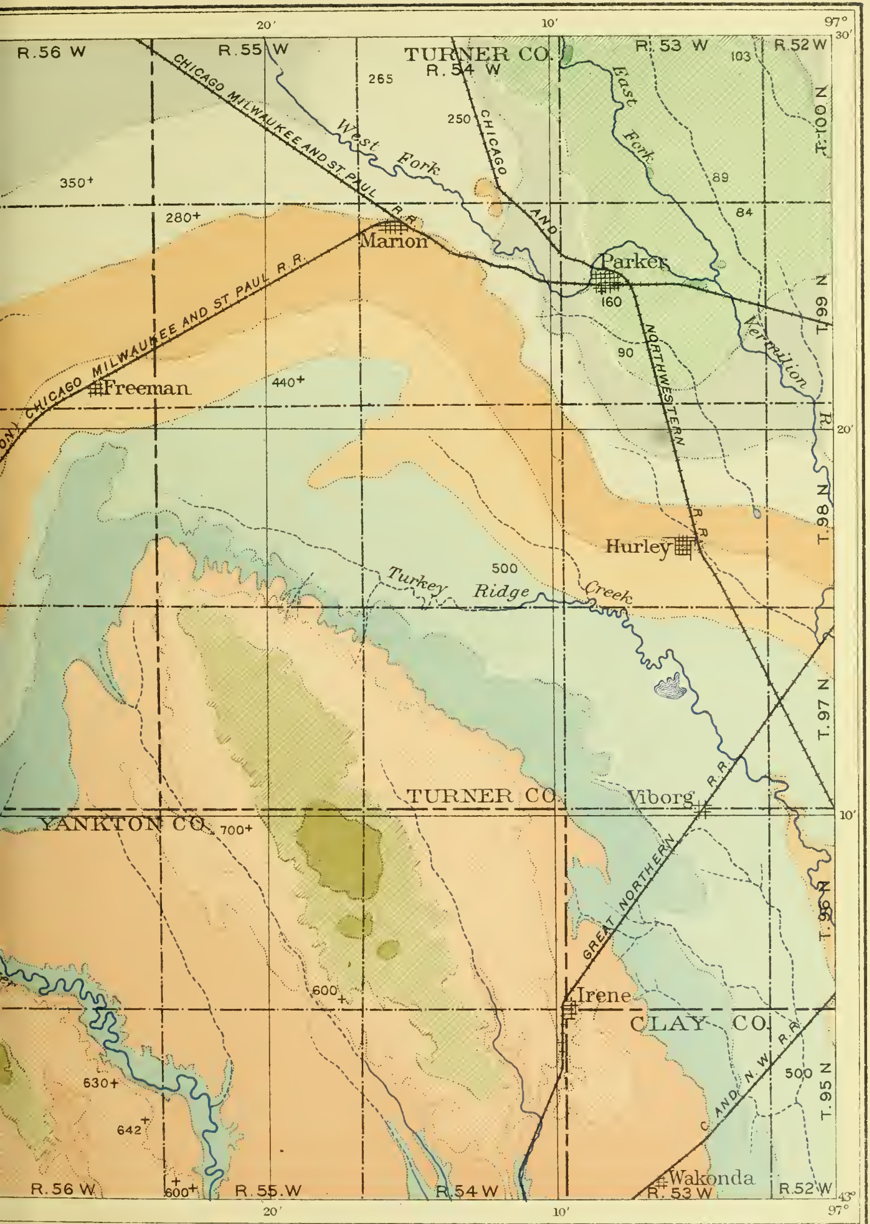

Note: Figures denote depths of borings
If without + sign quartzite was met with at that depth
All depth areas estimated averages
The quartzite surface has many local irregularities

MAP OF A PORTION OF

Showing d

BY J





JULIUS BIEN & CO. LITH. N.Y.

STERN SOUTH DAKOTA

to bed rock

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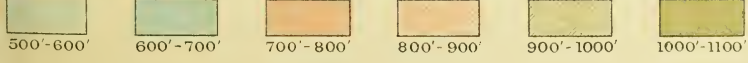


## COLORADO FORMATION.

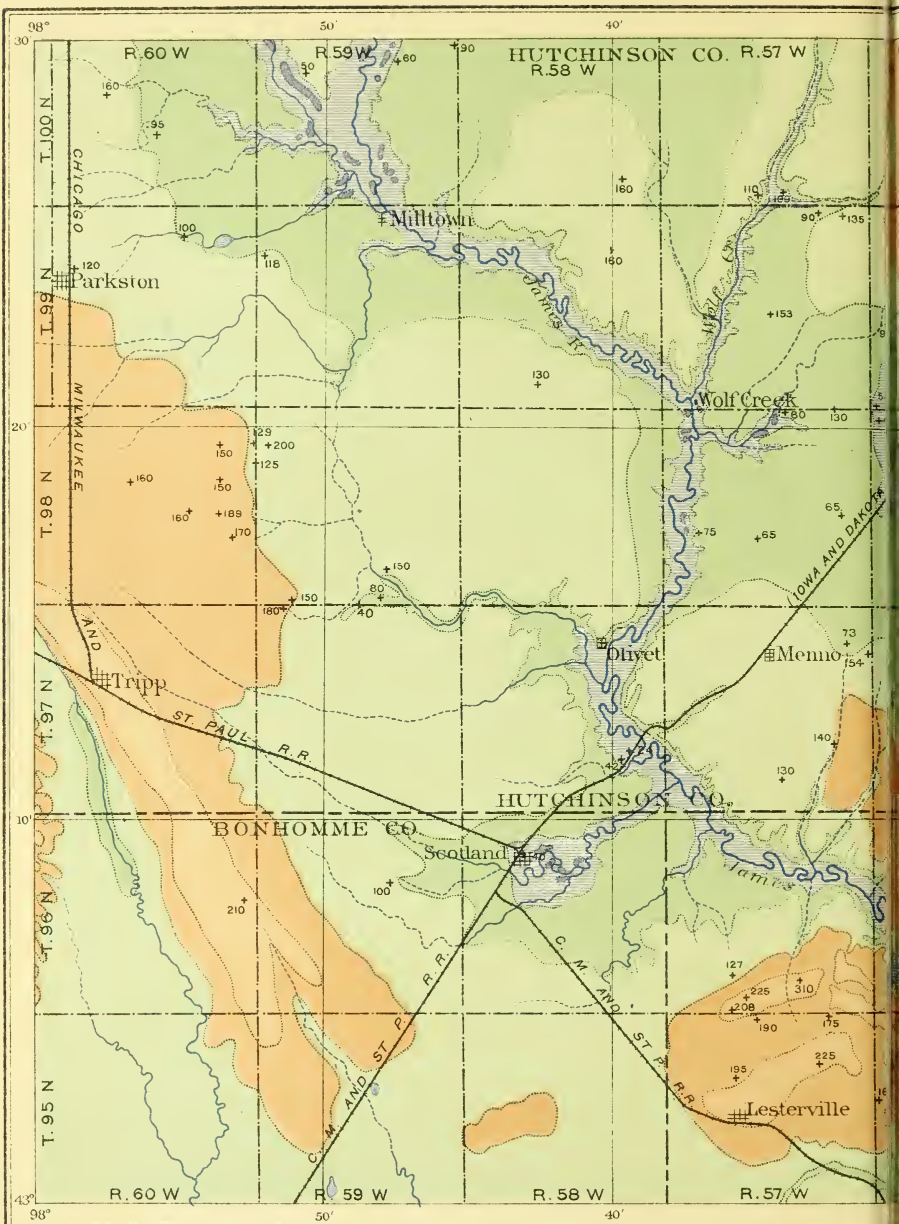
This includes two series of deposits, which were first separated by Dr. F. V. Hayden. The lower series, composed mostly of shale and clay, was named Benton, from its great development near Fort Benton, Montana, and the upper series, composed largely of chalkstone, was called Niobrara. These two subdivisions, though usually differing considerably in lithologic character, are often grouped together because of the similarity of the fossils which appear in them. Moreover, the line between them is not easily established, because in many places the chalk grades into the clay and shale; and even when fairly pure, enough protoxide of iron is present to give it a bluish tint resembling the shale. It has been found very difficult to separate them in this area by means of the reports of well-borers. One well-borer will say that within a given region he has struck no chalk, but has struck shale and clay. Another will distinguish between the chalk and the clay, recognizing the fact that the former differs from blue shale or "soapstone," while a third may speak of the chalk as a fine sand. Practically, the distinction which is most obvious to the well-borer is that chalk does not become plastic by becoming wet, but acts more like fine sand. On the other hand, the shale, or "soapstone," as it is frequently called, becomes plastic and sticky, and not easily distinguished from the clay except by its hardness.

The Colorado formation is exposed in this region only at a few localities, which are indicated upon the map, viz: Along the South Fork of Twelvemile Creek; on Wolf Creek, about 6 miles above its mouth; 2 or 3 miles south and east of the latter point, and still more prominently in the vicinity of Scotland. It also appears conspicuously along Turkey Creek between Irene and Volin, and also along Clay Creek north of the latter place. From a study of the formations along the Missouri River it is inferred that the Niobrara chalkstone is quite evenly stratified, compact, with some of its layers forming a hard limestone, but more frequently the clayey material is more prominent. From the exposures along the river it would seem that it has a thickness of 150 to 200 feet. Its original thickness was probably not uniform, but it was accumulated in large lenticular masses.

At Scotland and near Milltown the stone has been quarried and used for building. When first taken out it is easily cut with a knife and shaped to any form desired. When thoroughly seasoned it resists the weather so that buildings formed of it have stood for twenty-five or thirty years. When exposed upon a slope it crumbles under the action of frost and becomes a white earthy mass. The protoxide of iron, which colors it blue or light gray when exposed to the weather, becomes a yellow oxide or a carbonate, so that where it is near the surface the chalk soon becomes a light yellow or pure white color. It contains fossils that characterize it elsewhere in the Missouri River Valley, including *Ostrea congesta*, different species of *Inoceramus*, some of them of large size, but usually much broken; a large shell apparently a *Pinna*, and numerous scales and teeth of fishes, both of sharks and common bony fishes. Elsewhere the bones of large reptiles have been found in this formation, but as yet none have been found in it in this area. The chalk rarely shows noticeable shells of Foraminifera, but the mass of the deposit is found by microscopic examination to be composed of coccoliths and other minute organisms found in the chalk elsewhere. At some points the chalk is found to pass laterally into a light-gray clay, and it would seem that chalk and clay might have been formed contemporaneously in neighboring parts of the sea bottom. The difficulty of determining the real thickness of the chalk in this region arises from the fact that well-borers do not readily distinguish between it and the overlying and underlying clays and shales. In no case has it been reported thicker than 100 feet except at Tripp, where it is stated to be nearly 300 feet thick. It is probable that it varies greatly in different localities, though in general it appears to thicken toward the southwest, like the other formations which we have considered. It has not been so much removed by erosion in that direction.

The Benton shale is not clearly exposed at any point in this area. From the study of it along the Missouri River it is found usually to be composed of a dark clay, easily absorbing water and quickly becoming very plastic. At a locality southwest of Mitchell it is excavated for making brick, and one quite striking feature is that the sides of the pit are constantly sliding in, and even in the adjoining prairie the slope is marked with crevasses or cracks, indicating its creeping nature. Similar features have been noted in sec. 33, T. 100 N., R. 59 W., on a slope above the Dakota sandstone and below the level of the chalkstone. It is impossible to estimate the thickness of the formation with any accuracy, but there is clear evidence that the clayey member corresponding to the Benton is found here in considerable quantity. It is probably 50 feet thick. Elsewhere it has been reported in borings as underlying the chalkstone and lying on the sandstones of the Dakota.

Before the deposition of the Colorado formation the Dakota sandstone seems to have been somewhat eroded, especially in the highest portions adjoining the quartzite. Possibly this was due to "contemporaneous erosion" rather than to true unconformity; that is, it was due to the action of tidal currents or waves cutting out channels without any exposure to the action of streams upon a land surface. Moreover, the Colorado overlaps considerably beyond the edge of the Dakota sandstone.




+ 210 (etc.)
Representative wells and their depth in feet which obtain pump water at base of till

# MAP OF A PORTION OF E

Showing depths to w

BY J.E.T

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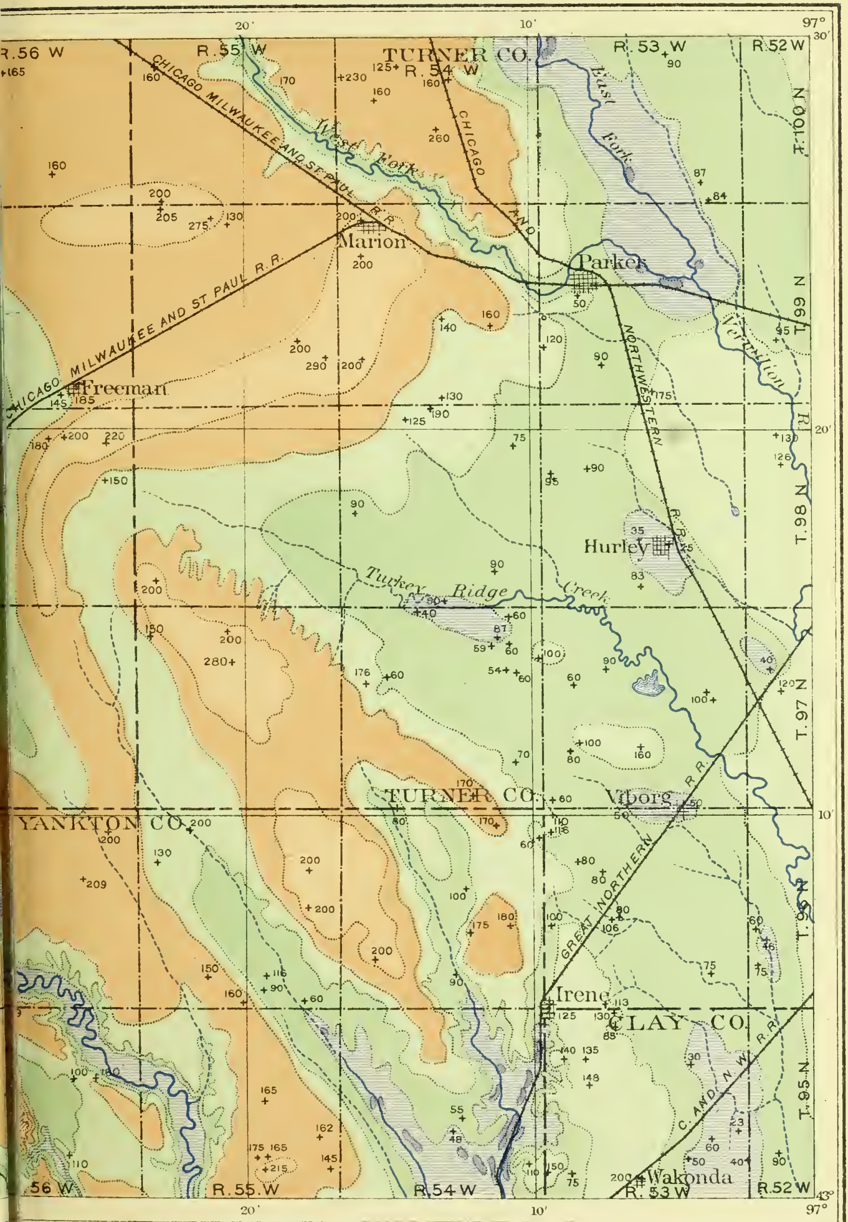



JULIUS BIEN & CO. LITH. N.Y.

ERN SOUTH DAKOTA

at base of the till

99

10 15 MILES

0'-200' 200'-250' 250'-300' 300'-350'

### PIERRE SHALE.

Pierre shale follows next in succession to the Colorado formation, and is very thickly developed along the Missouri River above the Niobrara chalk. It undoubtedly overlies that formation also in the Choteau Creek Hills, though it has not been distinctly recognized there in exposures or in wells. Upon Turkey Creek, on the east side of sec. 11, T. 95 N., R. 54 W., a few feet of dark, plastic clay overlies the chalkstone, which doubtless is Pierre. Careful examination will probably reveal other similar exposures. It is a formation which often contains remains of marine reptiles and many cephalopod shells. The shales are quite calcareous and their fossils are frequently embedded in large concretions of limestone.

### TERTIARY DEPOSITS.

The only natural exposures in the area under consideration which may possibly belong to the Tertiary are beds of a yellow loam resembling loess, which occur overlying the Cretaceous at several points on Turkey Creek, also southeast of the mouth of Wolf Creek. These are underneath the glacial drift and may possibly belong to the Pliocene. Borings in the higher portions of Turkey Ridge and the Choteau Creek Hills reveal thick deposits of sand underneath the till. These also may belong to the Tertiary, and may be even as old as the Loup Fork. On the other hand, it is possible that they are accumulations preceding the deposition of the drift during the Pleistocene. No fossils have been discovered, so no conclusion can be confidently expressed as to their age.

### PLEISTOCENE DEPOSITS.

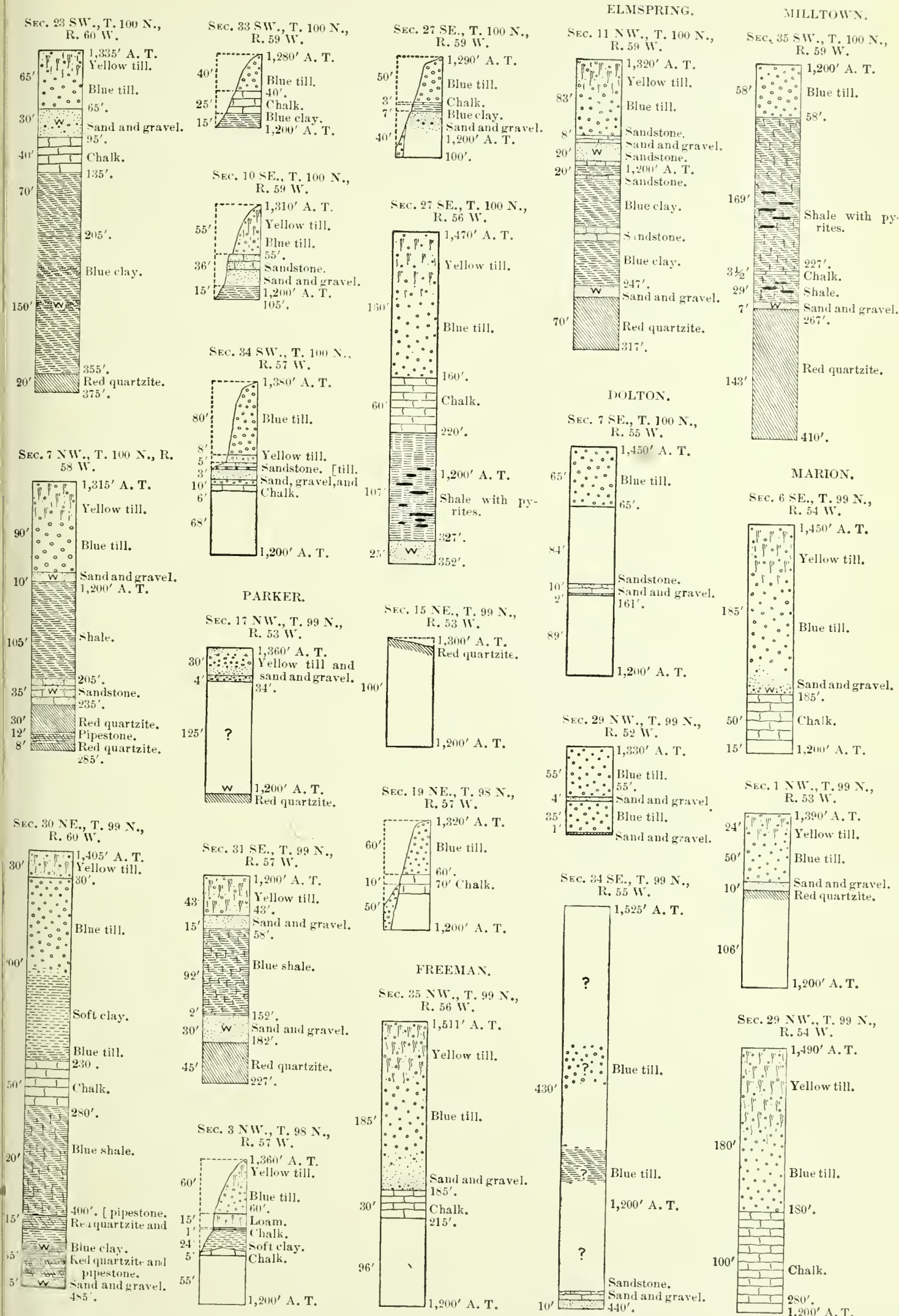
In this region the Pleistocene deposits are very prominent and cover very nearly the entire surface. All the exposures of older rock do not occupy more than 4 or 5 square miles. The deposits of this epoch may be enumerated in chronological order, as follows: (1) The preglacial or circumglacial sands and gravels; (2) the glacial till or bowlder clay, separable into the upper or yellow bowlder clay and the lower or blue bowlder clay; (3) the moraines, which include those of two distinct epochs, with minor subdivisions; (4) terraces and ancient channels, which may be referred to three or four different stages of the glacial occupation of the country; (5) alluvium.

### PREGLACIAL OR CIRCUMGLACIAL DEPOSITS.

The preglacial surface was probably covered with silt and clays resembling those of the region now found west of the Missouri. The surface there, however, is probably now eroding faster than at that time, for the base-level of drainage was probably much higher relatively and of gentler grade. The hillside wash and alluvium was perhaps more marked than is now found in the trans-Missouri region, but as the ice sheet, which resembled that of Greenland at the present time, slowly advanced from the north there was spread before it almost everywhere a fringe or apron of torrential deposits. Heavy sand and gravel bars accumulated along the channels of the principal streams leading from the ice sheet. A less amount of similar deposit was accumulated in all water courses as their upper portions began to be supplied from the melting ice. Hence, most of the surface became covered with a nearly continuous but uneven layer of sand and gravel, and as the result of the process we find to-day nearly everywhere below the till, or blue clay, of this region a stratum of sand and gravel, containing in most cases abundant water. The finer portions of preglacial soil and surficial deposits of that time seem to have been washed away, leaving the sand clean and porous. This deposit of sand, which may be compared to a blanket, lies over the uneven surface of the Cretaceous clays, mantling the upland as well as the lowland. It appears to be generally thicker upon the higher points, where its accumulation may have been due in part to the action of winds. It is needless, perhaps, to remark that the sands of this deposit, like the bowlder clay above, contain pebbles of granite, greenstone, and limestone. This deposit is rarely exposed, but there are a few places along the base of the bluffs of the James River where it appears. The more notable ones are about a mile below Milltown, and at intervals for 2 or 3 miles above the mouth of Wolf Creek. It may be recognized at other points by the appearance of springs near the level of the stratum. It appears, usually with less thickness, above the older rocks wherever they are exposed. There, however, it is less frequently the source of springs, because such points are more elevated, and because the bowlder clay has crept down and covered it more often than where it has been more recently exposed by the action of the streams. Sometimes this deposit attains a thickness of 100 feet, but generally it is very much thinner. In some cases it may be entirely wanting, so that the well-borer passes from the bowlder clay into the Cretaceous beds without noticing the transition. This formation plays an important part in the water supply of the region and will be further described under that head.

### TILL OR BOWLDER CLAY.

This formation presents the same features that are found in corresponding regions elsewhere, as in central Minnesota, Iowa, and Illinois. It is an unstratified mixture of clay, sand, and worn pebbles and bowlders, the last mentioned sometimes attaining a diameter of several feet. In this formation are found local developments of stratified sand, commonly spoken of as pockets, though they are



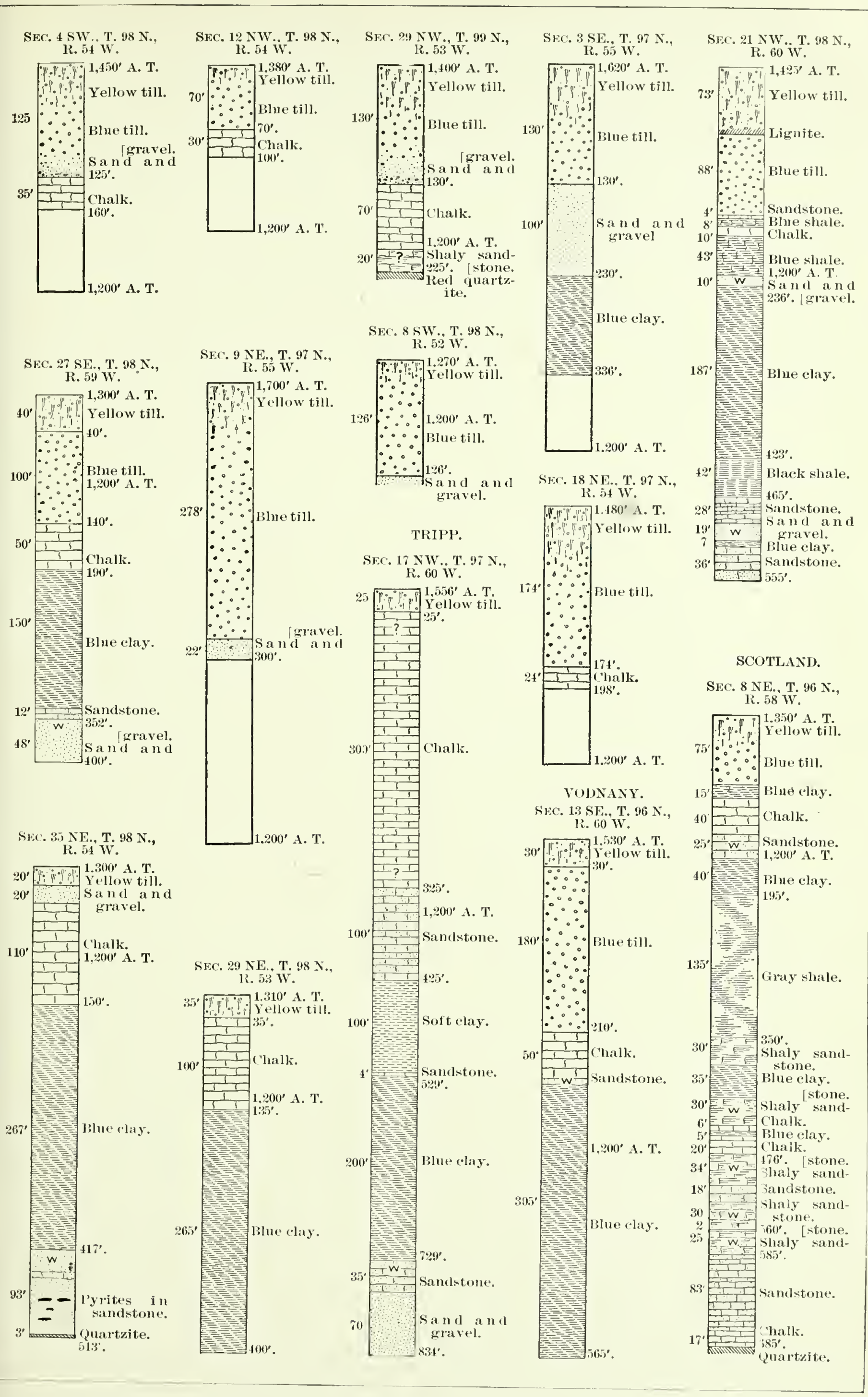

LOGS OF WELLS IN HUTCHINSON COUNTY, SOUTH DAKOTA.

sometimes known to be portions of channels of considerable length, and also of sheets that may locally separate the bowlder clay into two or more members. The till of this region is much more clayey than at points farther east because for some distance the ice had moved over and deeply eroded the dark-colored clays of the Cretaceous. For this reason the erratics are perhaps less frequently striated and planed. The bowlders most widely distributed are gray and reddish granites, and peculiarly compact and fine-grained limestones of a straw color or clear white. The latter contain *Favosites* and cup-corals, with occasional Brachiopods, indicating their Paleozoic origin. Next in prominence are bowlders of a fine-grained trap or greenstone. Besides these, in some portions of the area, a large percentage of the erratics, usually those of smaller size, came from a red quartzite ridge lying to the north. The distribution of these is so remarkable about Turkey Ridge as to attract popular attention. In the main part of this ridge they form about 90 per cent of all bowlders, but outside of or across the valleys of Clay and Turkey Ridge creeks they are very rare. The till varies in thickness from 80 to 250 feet. In general it is thickest upon the higher elevations—as, for example, the Choteau Creek Hills and James Ridge. Near the exposures of the older rocks, which we may suppose to represent points that have resisted preglacial erosion so that they are relatively more elevated, a thickness of less than 50 feet is found, as in the vicinity of Scotland and Elmspring, but over the even surface between Parkston and Olivet it amounts to 125 or 150 feet. Between the Choteau Creek Hills and James Ridge the thickness is frequently 300 feet. It is probable that the thickness is not very uniform and may vary greatly within short intervals. Apparently the surest evidence of reaching the bottom of the till is that the water when struck rises promptly and to a considerable height. This is a fact which well-borers remember and recognize more distinctly than any discrimination of material, for pebbles and bowlders are found in both the till and the sand below. It is not uncommon for two neighbors to sink wells, one having to go to a depth of 250 or 300 feet, while the other may obtain water within 150 or 200 feet. This evidence is not always decisive, for there are sometimes within the till local developments of sand which yield abundant water. However, in many cases the wells have gone farther and demonstrated that in such cases, no till is found below the sand.

It has been noted in other regions that the till consists of two or more numbers belonging to different epochs, and it would seem not improbable that such occurrences may be discovered in this area, but thus far we have been unable to ascertain that this is the case. This is the more remarkable when we consider the number of borings which have extended not only through the till, but to the Dakota sandstone below. However, since well-borers are not discriminating in this matter, more careful observations may eventually reveal the fact that such a division of the till really exists, at least in the vicinity of moraines. We may mention in this connection a singular phenomenon which occurs about 6 miles east of Wolf Creek colony. In the extreme northeastern corner of T. 98 N., R. 57 W., and in the sections adjoining, are three or four flowing wells obtaining water from a depth of from 55 to 65 feet, while 1½ miles farther west no water is obtained until a depth of about 150 feet is reached, and then it has not sufficient head to flow. This would suggest a division of the till into two members, separated by a sand deposit which does not extend to the second locality mentioned above. This may prove to be a separation of the earlier and older deposit of till, and may extend farther east, and may be caused by the recession and readvance of the ice, corresponding to the interval between the Altamont and Gary moraines. Another explanation may be equally satisfactory, viz, that at one time there existed in the region of flowing wells a subglacial channel which deposited a sheet of sand, which would be strictly subglacial, upon the formation of till already laid down by the glaciers while the till above was of englacial origin and was deposited above the sand deposits of said stream during the final melting of the ice sheet. Similar suppositions may explain similar flowing wells both north and south of the area named and also east of Parkston.

As elsewhere, the upper part of the till has, when weathered, a light buff or yellowish color. This is so prevalent that it is only at unusually recent natural exposures, or in the digging of deep wells, that the blue character of the unweathered till appears. An impression prevails that it differs materially in character from the yellow till, since the yellow till contains water, often in considerable quantity, which supplies the shallow or surface wells of the country. It is a general rule that if sufficient water is not struck before the blue clay is reached, no more can be expected until that formation is completely penetrated. The blue clay is frequently spoken of as joint clay, from the fact that it is usually divided into polygonal masses by irregular joints crossing one another. These allow slight motion whenever the formation lies upon a slope, so that in the vicinity of streams, though less plastic than the Cretaceous clays, it is subject to landslides, which cause it to cover the underlying sands.

The surface of the till, as elsewhere, abounds more or less in shallow basins or lake beds, which may be filled with water in the wet season. In some localities these are so deep that they retain water several feet in depth year after year, but more frequently they are dried up by the advancing summer and are capable of tillage. Since none of them are supplied except by rainfall, even the deepest are apt to become empty after a succession of dry years.




LOGS OF WELLS IN HUTCHINSON COUNTY AND IN NORTHEASTERN PORTION OF BONHOMME COUNTY, SOUTH DAKOTA.

## MORAINES.

These are local developments of the till in the form of elevated ridges, usually with the surface rougher than elsewhere. In other words, the surface rises into abrupt ridges or knolls perhaps to the height of 25 or 30 feet, though we do not find the best examples of such topography in this area. The intervening depressions and basins are also more numerous than elsewhere. Moreover, the moraines usually present a larger number of bowlders and beds of gravel, and bear other marks of abundant and free-flowing water. They are generally looked upon as marking the line where the edge of the ice sheet remained stationary for a considerable length of time. While the ice gradually brought materials to that point, the process of melting prevented its farther advance, and as the ice melted the clay and gravel contained in it were dropped along its edge. With this explanation we can easily understand how some areas would be much more abundantly supplied with materials than others, because of differences in velocity and load of the ice and in its relation to the attending waters. We rarely find the edge of the ice sheet clearly marked for any great distance by morainal deposits. The moraines are usually best developed at higher levels. Where the edge of the ice sheet rested in still water, whether in a lake or a sluggish stream, the material brought up by the ice would be widely distributed by the water and a comparatively level surface would be formed. Where the edge of the ice was washed by the stream for some distance, the material contributed by the ice would be carried away and hence not deposited as an accumulation.

In the area under consideration we have portions of two systems of moraines, with minor subdivisions. These are believed to belong to the Wisconsin stage of the Glacial epoch, and are known as the first, or Altamont moraine, and the second, or Gary moraine. The first moraine includes the hills in the northeastern corner of the Parker quadrangle, and the main portions of Turkey Ridge and James Ridge, and the whole of the Choteau Creek Hills. The surface in all these areas is more elevated than the region within the moraine, and is usually marked with stony hills, with more numerous and deeper basins between.

The second, or Gary moraine, is represented by the ridge beginning east of the West Fork of the Vermilion and forming the divide between it and the East Fork of the Vermilion. It passes south and southeast around the head of Turkey Ridge, then south along the east side of the same to the southern line of the area, where it turns west and skirts the eastern slope and around the northern end of James Ridge; thence, for several miles, it is imperfectly represented by the ridges near Lesterville and the gravelly hills at Scotland. These seem to mark the earlier stage of its deposition. North of Olivet it again appears more continuous, but of subdued form, and extends northwest along the divide south of Twelvemile Creek to the northwest corner of the area. In general, this moraine is of lower elevation than the first, and has its knolls less prominent. Its highest portion is southeast of Freeman, where it attains an altitude of more than 1,600 feet.

### ANCIENT DRAINAGE SYSTEMS.

Connected with these moraines are ancient systems of drainage, quite distinct at several points from those of the present time. We will not dwell upon them further than to call attention to some of the more notable cases. During the occupation of the first moraine the drainage from between the lobes of ice occupying the Vermilion Valley and the James was by means of Turkey Creek and its branches. Similarly, upon James Ridge, between the James River lobe of ice and the one to the west, are imperfect traces of a similar system. During the occupation of the second moraine the drainage was largely down the present course of the West Fork of the Vermilion River, Turkey Ridge Creek, Clay Creek, and Beaver Creek, and at that time a lake of considerable extent occupied the Vermilion Valley, east of Hurley. A much more transient one also occupied the region west of the ice sheet northwest of Scotland, which, for a time, drained toward the south into the upper part of Beaver Creek, but soon found its outlet down the James River Valley. The latter stage of this lake seems to have persisted along the valley of Dry Creek, east of Parkston, until the formation of the later part of the Gary moraine.

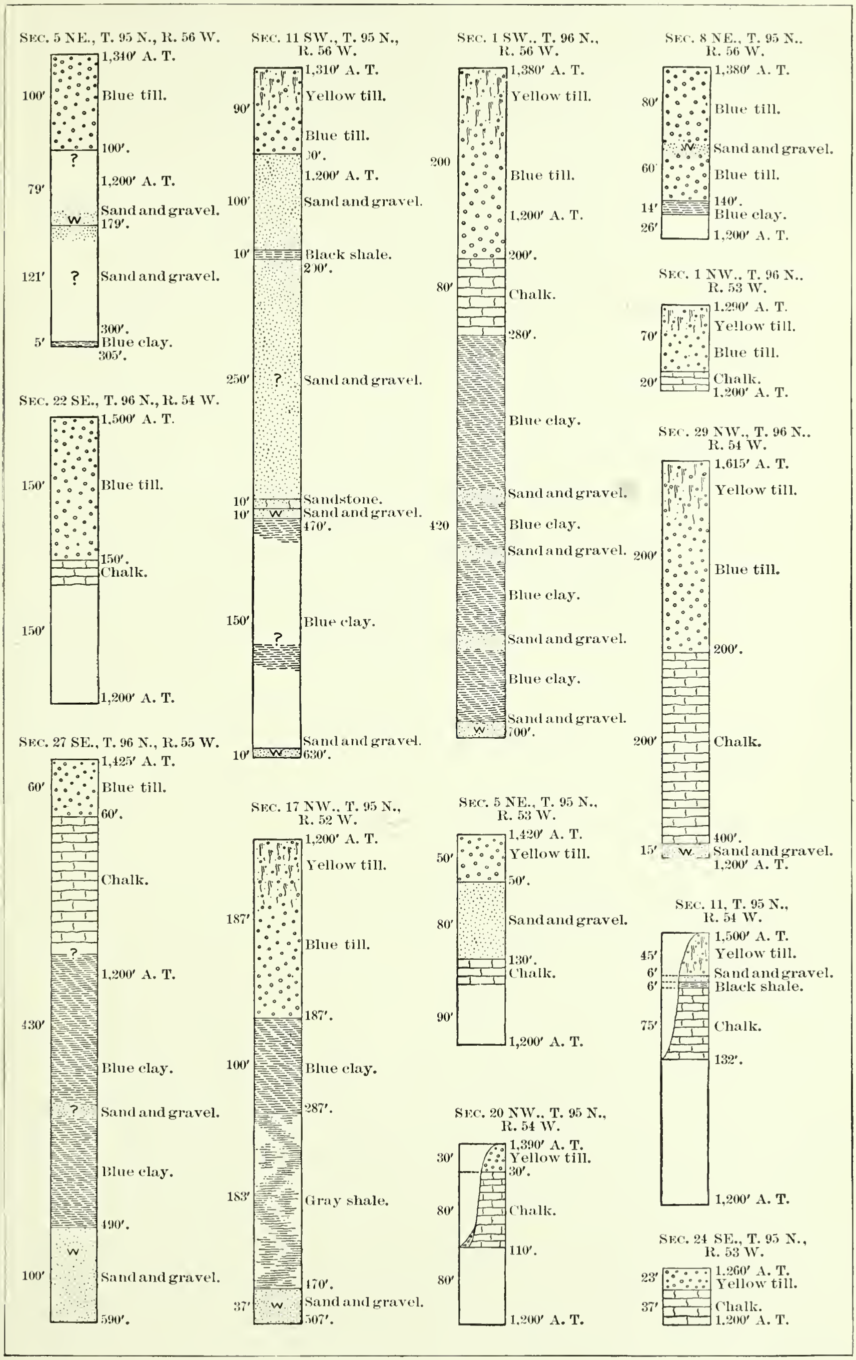
## WATER SUPPLY.

Under this head are included the most important economic results of the study of the geology of this area. The subject of water supply is divided into surface waters and underground waters. Under the former are included lakes, springs, and streams, and under the latter are included the supplies which furnish shallow wells, artesian wells, and tubular or pump wells.

### SURFACE WATERS.

#### LAKES.

These receive their waters directly from the rainfall and endure according to the extent of their drainage basin, the depth of their reservoir, and the dryness of successive years. The rainfall of the region varies greatly during different seasons. Its average is about 25 inches. After a succession of wet years, the lake beds over the whole region are filled with water, and in the spring also, if there has been much snow, the same is true. However, in the latter part




LOGS OF WELLS IN YANKTON AND CLAY COUNTIES, SOUTH DAKOTA.

of summer nearly all of them become dry. Some of the more important are marked upon the map as regular lakes. Within the last twenty-five years some lakes have passed through a summer with 10 or 15 feet of water, and a few years later have become dry enough for tillage.

### SPRINGS.

Permanent springs are rarely found, but a few occur along the James River and its principal tributaries. They receive their waters from the various formations which are treated more fully under the head of underground waters.

One class of springs which, perhaps, are not often recognized as such derive their waters from the rainfall seeping through the upper part of the drift into the water courses. Since the water from them is contained in isolated basins or waterholes in the water courses, many may not recognize the fact that the water supplied comes from below the surface, but this is doubtless the fact. To the constant movement of the water, more fully described under the head of underground waters, is to be traced the purity of the water in the ponds and their freedom from stagnant properties.

Other springs are derived from the gravel and clay deposits capping the ancient terraces or lining the old water courses of the Glacial epoch. As an example of this may be mentioned a spring in the southwest corner of sec. 34, T. 100 N., R. 59 W., which is supplied from the gravel deposits in an old channel of the James River about 100 feet above the present stream. Another less copious spring appears on sec. 3 of the same township, where the same channel meets the deeper valley of Dry Creek. Another spring from these same deposits appears on or near sec. 15 of the township to the south. It is probable that careful examination would reveal several more of similar origin.

Still other springs derive their waters from the sands below the bowlder clay. These fail to bring water to the surface except where it rests upon underlying clays, probably Cretaceous, although this can not always be easily demonstrated. Springs of this sort have been noted at the base of the bluffs on the right bank of the James River at a number of points between the mouth of Dry Creek and Wolf Creek. It is probable that a further search would discover many more.

A few springs are known to come from joints or porous strata in the chalkstone. Such are found near Scotland and along Turkey Creek. Their waters are frequently unpalatable from impregnation with alum salts.

Other springs seem to be supplied from the sandstone of the Dakota formation. Cases of this kind have been noted a mile or two south of Elmspring, where the water escapes from the base of the sandstone as it rests upon the shaly clay below. Other springs which we believe are supplied from the same geological stratum are found near Olivet. They are two in number, the smaller appearing 10 or 12 rods southeast of the bridge crossing the James River east of Olivet; the other about a quarter of a mile farther north, within a few rods of the edge of the bottom adjoining the river. Both of these springs or ponds, as they may be called, are surrounded with bulrushes and are of circular form. The water rises nearly to the level of the bottom land, which is 10 feet higher than the ordinary stage of the James River nearby. Since they are more than a half mile from the base of the bluffs on the east, and the water is higher than can be found at ordinary stages in the James River within 2 or 3 miles farther upstream, it seems clear that the supply is derived from a stratum of the Dakota sandstone, and that we have here, as it were, natural artesian wells. The large spring has a diameter of about 150 feet of open area besides that occupied by bulrushes. Quite similar to the Olivet springs is the one 5 miles north of Mitchell, shown on Pl. IX, *B*. It differs only in having higher banks. Pl. X, *A* shows another type, escaping close to Sioux quarzite ledges on Enemy Creek, southeast of Mitchell. It is probable that similar leaks from the artesian stratum escape into the trough of the James River below the water, or at least below the surface. Some of the small marshes which are found upon the flood plain may be supplied from this source, although probably most are supplied from the waters escaping from the sand sheet below the till.

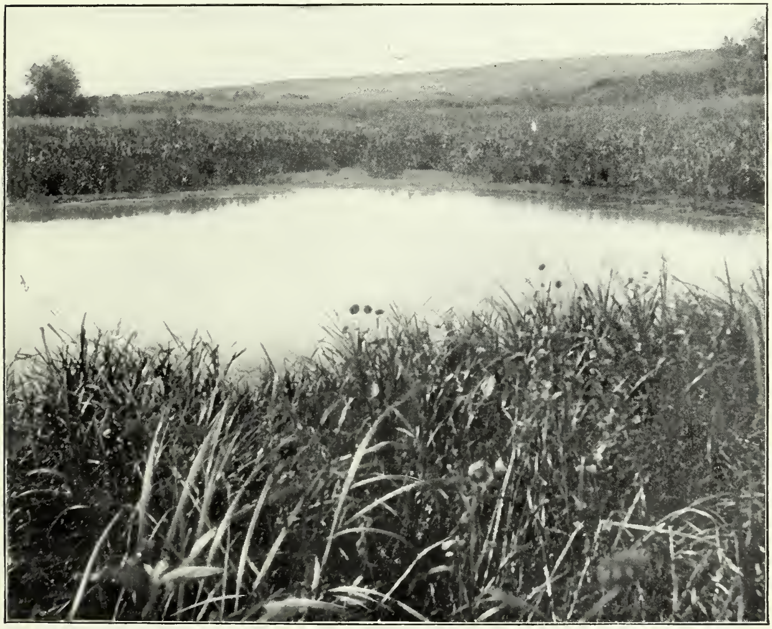
## STREAMS.

The James River is the only stream in this area which may be depended upon to contain running water at all times. The lower portions of Wolf Creek, Twelvemile Creek, and Lonetree Creek are rarely entirely dry, but above the last mile or two of their course the water in the latter part of summer rarely flows upon the surface.

## UNDERGROUND WATERS.

The most accessible underground waters are those flowing near the surface of the ground or seeping through the upper portion of the till toward a water course, where there are shallow accumulations of sand, which form conduits for it. It flows slowly through the lower portions of these sand accumulations and appears at intervals in waterholes along the upper portions of the more prominent streams. In these it rarely comes forth in sufficient strength to attract attention. Where the slope of the surface is toward an undrained basin, the water, flowing on yellow till, contributes to the level of the water in an open lake until the water level sinks below the surface, as it soon does in the great majority

*A*. DAKOTA SANDSTONE ON FIRESTEEL CREEK, IN TOWNSHIP 104 NORTH, RANGE 61 WEST.



*B*. ARTESIAN SPRING, IN TOWNSHIP 104 NORTH, RANGE 60 WEST.

such cases no water is likely to be reached short of the main artesian supply. The deep wells supplied from this source are commonly known as tubular wells, though that term strictly indicates the construction of the pumps used. Hence, we may conveniently speak of the Pleistocene subtill sands as the "tubular-well supply."

It seems evident that the original source of this supply is the rainfall, the same as in the case of shallow wells, but it is a more constant supply, because the water enters it more gradually. It is more continuous, and does not waste in evaporation as in shallow wells. It should not, however, be considered inexhaustible, because if a tubular well is drawn upon too freely it may be expected to gradually fail, especially if it is in an elevated region.

The way in which the water enters this stratum is not well understood. In general, the till seems to be so perfectly impervious that, especially at lower levels, it prevents the escape of the water below quite completely. We have before called attention to the joints in the clay, which, at certain times, especially in more abrupt portions of the surface, and after drought, are probably opened sufficiently to allow water to enter from the surface. Besides, it is not improbable that the bottom of the ancient channels may at some points cut through the till to the lower Pleistocene sands in such a way as to add materially to this supply.

## WATER FROM THE OLDER STRATA.

In case sands belonging to the Tertiary should be discovered in the region it is likely that they will be closely connected with the lower Pleistocene sands, and hence we need not discuss them separately. The chalkstone of the Colorado formation is porous and water bearing; in fact, springs are occasionally found flowing from it. We have already spoken of springs from it at Scotland. It exists in such detached masses, and wherever it affects wells is so closely underneath the drift that it need not be treated at any length separate from the tubular-well supply.

It has been found convenient in some places to use chalk as a filter to keep out the sand from the bottom of the well. Moreover, there appears in some places, although not certainly in this area, a stratum of sandstone in the chalk which affords water more copiously and may sometimes have a relation similar to that of the Dakota sandstone underneath.

## MAIN ARTESIAN SUPPLY.

Those who have studied the matter universally agree that the main artesian supply is from the sandstone and sand beds of the Dakota formation. This remarkable formation is the source of water in Texas and Colorado, as well as in this region. It owes its efficiency to four

*A*. SHERRILL SPRING, ON LOWER ENEMY CREEK.

*B*. KILBURN RUN, FED BY KILBURN WELL, NORTH OF MOUNT VERNON, SOUTH DAKOTA.

conditions: (1) Its great extent, underlying most of the Great Plains from the Rocky Mountains to about the ninety-fifth meridian. (2) Its highly elevated western border, located in the moist region of the mountains and crossed by numerous mountain streams. (3) The fact that it is extensively sealed on its eastern margin by the overlapping clays of the Colorado formation, and where that is not the case, by the till sheet of the Glacial epoch. (4) The excavation of wide areas, especially in Dakota, by older streams, so as to bring the land surface below the pressure height or "head" generated by the elevated western border of the formation. From this source also are derived the copious pumping supplies of water over wide areas, where the pressure is not sufficient to produce flowing wells.

Pl. X, *B* gives a vivid impression of the possibilities of such wells. The flow is through a 3-inch pipe and from a depth of only 337 feet. The stream rivals the Firesteel nearby in the amount of flowing water. It is estimated to furnish over 1,000 gallons a minute. Most of the wells in the area are much smaller and are much more convenient for ordinary farm use, besides being more enduring.

The Dakota deposits underlie nearly the entire area treated in this report, but from the relation of pressure to surface the true artesian area is limited approximately as represented upon the map (Pl. II).

In boring wells the term "flow" is used by some persons to indicate that the water has sufficient pressure to rise some distance in the well, but it is more customary to limit the term to those cases in which there is sufficient force for the water to rise to or over the top of the well. From a comparison of the sections of different wells it appears that the sheets of sand are more or less separated by intercalated sheets of clay, the permeable sandy deposits extending out into thin, wing-like sheets. In this way there are in this area at least three horizons with well-marked flows. The first or uppermost of these probably corresponds to the stratum which is exposed above Milltown. This bed, of course, can not hold water under pressure sufficient to produce flowing wells in the vicinity of its exposure where the head is lost by leakage. The second flow is that which supplies most of the wells northeast of the town of Tripp. The third is that probably reached in the deep well at Tripp. Probably others occur still deeper in the southeast portion of the Olivet quadrangle.

From a study of the sections of the wells it is evident that the successive flows rise somewhat toward the exposures of quartzite, but that the higher water-bearing strata considerably overlap those below. In other words, the lowest sandstone stratum of the Dakota does not extend as far northeast by several miles as those higher up. There has been no effort to express on the map the extent of the different water-bearing strata, but they may be inferred from the irregularities in the depths given.

### PRESSURE.

From a superficial study of artesian wells it might be thought that the water, especially in particular artesian basins, has the same head or would everywhere rise to the same plane. Such, however, is far from the fact in the wells of South Dakota. In general, the pressure declines toward the margin of the water-bearing strata. This is readily explained, as noted above, in the shallow basins by supposing that the water is moving as a slow current toward leaks along the margin of the formation where it joins the older rocks or where fissures may connect it with the bottom of streams. Each flow, in general, shows this same decline in pressure toward the northeast.

Moreover, from what we have said about the relation of the Dakota sandstone to the Sioux quartzite and Colorado clays, one can easily understand how the lower flows are found to have higher pressure. Their leakage is much less free. Upon the map (Pl. II) there are contours representing the altitude of "head," which in its downward slope east may be regarded as a "hydraulic gradient." From the nature of the case, it would be impossible to represent the pressure for each water-bearing stratum, and we have therefore taken the data from the more important wells; or, in other words, the lines of altitude of "head" may be taken as representing the relative pressure in the more available and accessible stratum. It is not unlikely that the sinking of wells 300 to 500 feet in depth, to the third or fourth flow, may show considerably increased pressures. It will be observed that the lines have a distinct curve toward the south and east. This may be ascribed, especially in the case of the 1,400-foot line, to the fact of locally increased leakage along the James River Valley, together with the general diminution of supply to the south and east in eastern South Dakota.

The pressure in the wells of this area has not been very generally noted. Many of the wells are small and intended simply for farm supply, so that the pressure has not been an important consideration. At Tripp the pressure was 10 pounds and at Scotland perhaps 4 or 5 pounds, soon after the wells were finished, but at present they barely flow. The wells southeast of Parkston are reported to have a pressure of 40 pounds, and at that place 55 pounds has been recorded recently.

### VARIATION OF PRESSURE.

This brings us to a consideration of certain influences that affect pressure. Under this head we shall consider, briefly, a variety of influences that have been found to affect pressure, and will give others the cause of which has not been discovered.

(1) Variation in adjacent wells. Places are not infrequent, although not notable in this area, where wells at nearly the same point have

widely different pressure. In some cases it is evident that the wells are supplied from different sources or flows. This conceivably may be true, even when the water is from the same depth; for, as before stated, the water-bearing strata branch, and do not always extend upon the same level. More frequently, however, these wide local variations are due to the pressure from the stronger flow expending itself along the outside of the pipe into an upper stratum of less pressure.

(2) Variation in the same well at different depths. This need not be dwelt upon, for we have already explained how lower strata are more perfectly sealed on their eastward margin and therefore display higher pressure.

(3) Variations in the same well because of wells in the vicinity. The distance to which the influence of the escape of water from a well extends may reasonably be supposed to be directly proportional to the amount of water discharged. We may conceive that the flow of the well produces a depression in the surface, or "head," so to speak, proportional to the amount of water discharged, somewhat as in the case of an opening in the bottom of a reservoir. If the flow is rapid the depression may be great, so that if the well is closed its pressure will be at first, perhaps, several pounds below the original pressure, but as the water flows in from adjacent areas the pressure in the well will gradually regain its former amount. So, if two wells are near each other, we can not expect that the closed pressure of one will approach very closely to the original figure if the other is left open.

(4) Effect from varying barometer. As the pressure taken is with a gage affected by the pressure of the air, it follows that when the barometer is high the pressure of the fluid within will be correspondingly diminished. The influence is, of course, slight, and will be overlooked unless the pressure in the well is very weak. Under such circumstances, however, an increase of the pressure of the air may sometimes be sufficient to stop the flow and, conversely, a low barometer may increase the flow.

(5) Periodic variations. In a number of the weaker wells there has not only been a decline of pressure, but from time to time an increase. This increase has been in some cases related to the time of year, the spring being sometimes marked by a stronger flow. This again varies according to years, and it is believed to be most satisfactorily explained by supposing that the water is obtained from the melting of snows or from streams subject to floods.

(6) Effect of varying leakage in the vicinity. This has been observed in wells near the Missouri River. When the river is high the pressure in the wells increases. It is easily explained by supposing that there are points of leakage underneath the surface of the river, and that the increase of hydrostatic pressure from the stream checks the leakage to such an extent that it increases the pressure in adjacent wells. While

this has not been noted in the area, it is not improbable that examples occur near the James River. This variation, of course, is slight, and would be unnoticed except in very weak wells.

Upon the map (Pl. II) approximate depth to the surface of the Dakota sandstone is represented. As was stated in the discussion of that formation, this does not always directly mark the upper limits, but more definitely the level from which flowing wells may be obtained. In cases where water is not found at the depth indicated the boring may be hopefully carried through lower horizons to bed rock, the depth of which is shown on Pl. IV. In the southeastern corner of the area and along its western side the Dakota sandstone is thicker and probably carries more water-bearing strata.

## HINTS ON THE CONSTRUCTION OF WELLS.

Although the practical application of the following hints belongs to the work of the well-borer, and may be discussed more efficiently from the standpoint of an engineer, yet they may be advantageously noted here in connection with the geological facts.

(1) Since the pressure in the upper flows is less than in the lower by many pounds to the inch, it is very important that the communication between the lower flows and the higher should be entirely cut off. Otherwise the full pressure from the lower stratum will not be observed at the mouth of the well, but will expend itself by leaking into the strata below the surface. The desire of the well-digger to keep his pipe loose may tempt him to leave the bore too large—hence the danger we speak of.

(2) It is very desirable that the larger pipe lining the bore be firmly fixed in the hard stratum above the water-bearing rock. This may be done in most localities, as a compact stone is found just above the porous sands which bring the water. Much depends upon this, for if a pipe be left loose, and the opening in the rock left incompletely stopped, water is likely to escape around the pipe and, if not checked, may eventually destroy the well.

(3) A well should be sunk as rapidly as consistent with good work, especially after water has been reached. Otherwise, the great pressure of the water may cause it to erode an irregular opening and prevent the accomplishment of the two points already given.

## PERMANENCE OF ARTESIAN SUPPLY.

All natural products are liable to exhaustion. With gold, coal, and other metallic products no general rules can be laid down by which we may foretell how soon the supply may fail. With water it is otherwise. As we have already said, multiplication of wells must tend to exhaustion. If, however, the loss by wells and leakage does not exceed the annual supply which enters the formation on the west, an equilibrium may be gained which will be as constant as in a river. It may be expected to have similar fluctuations. At present the pressure in wells in the area discussed is generally slightly declining. Some wells of original low pressure have ceased to flow, as at Scotland, Tripp, in sec. 12, T. 95 N., R. 56 W., and in other places, but the great majority have failed but little. There is no apprehension of early failure.

From the sheet-like form of the water strata and their nearly horizontal position, the decline of pressure will necessarily be very regular and gradual. If, to illustrate, a well having a pressure of 50 pounds should show a decline of 2 pounds a year, under similar conditions it would last twenty-five years with gradually decreasing flow. Moreover, it is possible, if not probable, from the wide extent of the Dakota sandstone at high altitudes toward the west, that there is a reserve supply which may become more available as the head declines.

Many of the reported cases of failure from other portions of the artesian area have been shown to be due to stoppage by sand or to subterranean leakage resulting from the rusting of the pipe or imperfect construction, and sometimes from the breaking of the pipe by caving.

Until more is known of the circumstances controlling the supply little more can be said upon this point.

# INDEX.

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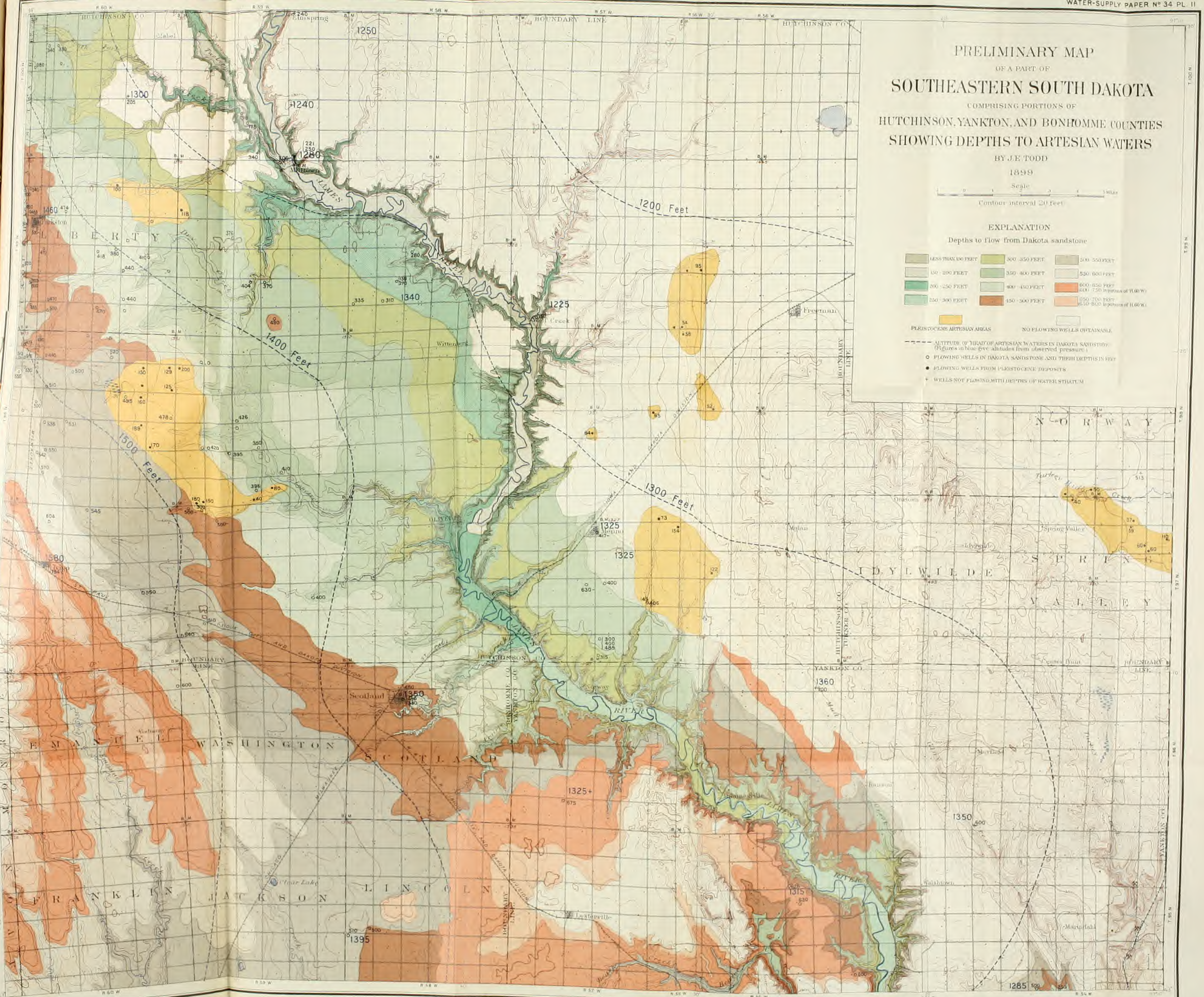
PRELIMINARY MAP
OF A PART OF
SOUTHEASTERN SOUTH DAKOTA
COMPRISING PORTIONS OF
HUTCHINSON, YANKTON, AND BONHOMME COUNTIES
SHOWING DEPTHS TO ARTESIAN WATERS
BY J.E. TODD
1899
Scale
Contour interval 20 feet
EXPLANATION
Depths to flow from Dakota sandstone
LESS THAN 150 FEET
150 - 200 FEET
200 - 250 FEET
250 - 300 FEET
300 - 350 FEET
350 - 400 FEET
400 - 450 FEET
450 - 500 FEET
500 - 550 FEET
550 - 600 FEET
600 - 650 FEET (600 - 750 in portions of R.60 W.)
650 - 700 FEET (650 - 800 in portions of R.60 W.)
PLEISTOCENE ARTESIAN AREAS
NO FLOWING WELLS OBTAINABLE
ALTITUDE OF HEAD OF ARTESIAN WATERS IN DAKOTA SANDSTONE (Figures in blue give altitudes from observed pressure.)
FLOWING WELLS IN DAKOTA SANDSTONE AND THEIR DEPTHS IN FEET
FLOWING WELLS FROM PLEISTOCENE DEPOSITS
WELLS NOT FLOWING, WITH DEPTHS OF WATER STRATUM
1200 Feet
1300 Feet
1400 Feet
1500 Feet
HUTCHINSON CO.
YANKTON CO.
BONHOMME CO.
BOUNDARY LINE
LIBERTY
NORWAY
IDYLWILDE
SPRING VALLEY
EMANUEL
WASHINGTON
SCOTLAND
FRANKLIN
JACKSON
LINCOLN
MONROE
JAMES RIVER
Scotland
Freeman
Menno
Olivet
Tripp
Wittenberg
Lesterville
Clear Lake

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## 1895.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Robert Hay.

A geological reconnoissance of northwestern Wyoming, by George H. Eldridge, 1894; octavo, 72 pp. Bulletin No. 119 of the United States Geological Survey; price, 10 cents.

Contains a description of the geologic structure of portions of the Bighorn Range and Bighorn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 176 pp. Bulletin No. 131 of the United States Geological Survey; price, 15 cents.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in a number of counties in western Nebraska, western Kansas, and eastern Colorado.

## 1896.

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett; and "Preliminary report on the artesian waters of a portion of the Dakotas," by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 230 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey; price, 20 cents.

Gives a description of the geologic conditions of the coastal region from Long Island, N. Y., to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey; price, 25 cents.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

## 1897.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part IV, Hydrography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the calendar year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in South Dakota," by N. H. Darton; and "Reservoirs for irrigation," by J. D. Schuyler.

## 1899.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Part IV, Hydrography, 1899; octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton; and "A preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

## 1900.

Twentieth Annual Report of the United States Geological Survey, 1898–99, Part IV, Hydrography, 1900; octavo, 660 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell, and "Hydrography of Nicaragua," by A. P. Davis.

### Water-Supply and Irrigation Papers, 1896–1900.

This series of papers is designed to present in pamphlet form the results of stream measurements and of special investigations. A list of these, with other information, is given on the outside (or fourth) page of this cover.

Survey bulletins can be obtained only by prepayment of cost, as noted above. Money should be transmitted by postal money order or express order, made payable to the Director of the United States Geological Survey. Postage stamps, checks, and drafts can not be accepted. Correspondence relating to the publications of the Survey should be addressed to **The Director, United States Geological Survey, Washington, D. C.**

## WATER-SUPPLY AND IRRIGATION PAPERS.

1. Pumping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phœnix, Arizona, by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A reconnoissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill, 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E. C. Murphy, 1897.
9. Irrigation near Greeley, Colorado, by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Underground waters of southeastern Nebraska, by N. H. Darton, 1898.
13. Irrigation systems in Texas, by William Ferguson Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15. Operations at river stations, 1897, Part I, 1898.
16. Operations at river stations, 1897, Part II, 1898.
17. Irrigation near Bakersfield, California, by C. E. Grunsky, 1898.
18. Irrigation near Fresno, California, by C. E. Grunsky, 1898.
19. Irrigation near Merced, California, by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of northern Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems in the Bighorn Mountains, by Elwood Mead, 1899.
24. Water resources of the State of New York, Part I, by George W. Rafter, 1899.
25. Water resources of the State of New York, Part II, by George W. Rafter, 1899.
26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett, 1899.
27. Operations at river stations, 1898, Part I, 1899.
28. Operations at river stations, 1898, Part II, 1899.
29. Wells and windmills in Nebraska, by Erwin Hinckley Barbour, 1899.
30. Water resources of the Lower Peninsula of Michigan, by Alfred C. Lane, 1899.
31. Lower Michigan mineral waters, by Alfred C. Lane, 1899.
32. Water resources of Puerto Rico, by H. M. Wilson, 1900.
33. Storage of water on Gila River, Arizona, by J. B. Lippincott, 1900.
34. Geology and water resources of southeastern S. Dak., by J. E. Todd, 1900.

In addition to the above, there are in various stages of preparation other papers relating to the measurement of streams, the storage of water, the amount available from underground sources, the efficiency of windmills, the cost of pumping, and other details relating to the methods of utilizing the water resources of the country. Provision has been made for printing these by the following clause in the sundry civil act making appropriations for the year 1896–97:

*Provided,* That hereafter the reports of the Geological Survey in relation to the gaging of streams and to the methods of utilizing the water resources may be printed in octavo form, not to exceed 100 pages in length and 5,000 copies in number; 1,000 copies of which shall be for the official use of the Geological Survey, 1,500 copies shall be delivered to the Senate, and 2,500 copies shall be delivered to the House of Representatives, for distribution. [Approved June 11, 1896; Stat. L., vol. 29, p. 453.]

The maximum number of copies available for the use of the Geological Survey is 1,000. This number falls far short of the demand, so that it is impossible to supply all requests. Attempts are made to send these pamphlets to persons who have rendered assistance in their preparation through replies to schedules or who have furnished data. Requests specifying a certain paper and stating a reason for asking for it are granted whenever practicable, but it is impossible to comply with general requests, such as to have all of the series sent indiscriminately.

Application for these papers should be made either to Members of Congress or to

THE DIRECTOR,

UNITED STATES GEOLOGICAL SURVEY,

*Washington, D. C.*

DEPARTMENT OF THE INTERIOR



# WATER-SUPPLY

AND

# IRRIGATION PAPERS

OF THE

## UNITED STATES GEOLOGICAL SURVEY



## No. 35

OPERATIONS AT RIVER STATIONS, 1899.—Part I

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

## IRRIGATION REPORTS.

The following list contains titles and brief descriptions of the principal reports relating to water supply and irrigation, prepared by the United States Geological Survey since 1890:

### 1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888-89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

### 1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889-90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 29 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890-91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell; quarto.

No. 35, Irrigation in Arizona; No. 60, Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

### 1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc., of irrigated holdings, the total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps, showing the location and relative extent of the irrigated areas.

### 1893.

Thirteenth Annual Report of the United States Geological Survey, 1891-92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering" and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnaissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 15 plates. Bulletin No. 108 of the United States Geological Survey; price, 15 cents.

Contains a description of the examination of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

### 1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892-93, in two parts; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.



(Continued on third page of cover.)

DEPARTMENT OF THE INTERIOR

# WATER-SUPPLY

AND

# IRRIGATION PAPERS

OF THE

## UNITED STATES GEOLOGICAL SURVEY

## No. 35

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

# OPERATIONS AT RIVER STATIONS, 1899

A REPORT OF THE

DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

## PART I

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

# CONTENTS.

# LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
*Washington, March 1, 1900.*

SIR: I have the honor to transmit herewith a manuscript giving the results of operations at the river stations in the eastern portion of the country during the calendar year 1899, together with related data, for publication in the series of papers upon water supply and irrigation. The data for the central and western portions of the country will be transmitted as the succeeding numbers of the series.

Very respectfully,

F. H. NEWELL,
*Hydrographer in Charge.*

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

# OPERATIONS AT RIVER STATIONS, 1899.

## PART I.

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### INTRODUCTION.

The following pages contain descriptions of the river stations maintained during 1899 by the United States Geological Survey, together with tables of the average daily height of water and results of measurements of discharge. The rating tables constructed from the latter and applicable in general for the calendar year will be given at the end of the publication. Similar facts have been printed for the year 1896 in Water-Supply Paper No. 11, for 1897 in Water-Supply Papers Nos. 15 and 16, and for 1898 in Water-Supply Papers Nos. 27 and 28. The stations have been arranged in geographic order. A description of each station is given, together with all of the discharge measurements, followed by the tables of gage heights and ratings.

The material above noted consists essentially of the results of operations at the river stations, and forms the basis for computations of daily, monthly, and annual flow. In order to make these necessary computations considerable time and labor is involved and the resulting facts can be most clearly and concisely given by diagrams. The preparation of the computations and the diagrams necessitates unavoidable delays, and therefore it has been the custom to present the facts, such as are given herewith, as soon as possible after the close of the calendar year, so that the original data may be available at an early date to all who are concerned with their use. While these original figures are being printed the computations of final results are being prepared, and, with the illustrations, have in the past been made to form a part of the annual report of the Director of the Geological Survey. For example, the results for 1896, mentioned above, as given in Water-Supply Paper No. 11, are fully discussed in Part IV of the Eighteenth Annual Report; the original data for 1897, given in Water-Supply Papers Nos. 15 and 16, are published in final form in the Nineteenth Annual Report, Part IV, and the data for 1898, given in Water-Supply Papers Nos. 27 and 28, are published in the Twentieth Annual Report, Part IV. In the same way the figures herewith given form the basis for conclusions being prepared for publication in Part IV of the Twenty-first Annual Report.

ACKNOWLEDGMENTS.

Most of the measurements herewith presented have been obtained through local hydrographers, a comparatively small part of the work having been conducted directly from the office of the Geological Survey at Washington. Acknowledgment is therefore due to each of these persons individually. Thanks should also be extended to individuals and corporations who have cooperated in various ways, either by furnishing readings of height of water or assisting in transportation. The following list gives the names of the resident hydrographers or persons cooperating, this being arranged alphabetically by States·

Arizona: W. A. Farish, civil engineer, Phenix.

California: J. B. Lippincott, civil engineer, Los Angeles.

Colorado: A. L. Fellows, civil engineer, Denver.

Georgia and Alabama: Prof. B. M. Hall, civil engineer, Atlanta, and Prof. W. S. Yeates, State geologist, Atlanta.

Idaho: N. S. Dils, civil engineer, Caldwell.

Kansas: W. G. Russell, Russell; Prof. E. C. Murphy, State University, Lawrence.

Maryland: Prof. W. B. Clark, State geologist, Baltimore.

Montana: S. M. Emery, director experiment station, Bozeman; Prof. Samuel Fortier, Bozeman; Prof. Fred. D. Smith, Missoula.

Nebraska: Prof. O. V. P. Stout, State University, Lincoln, assisted by Adna Dobson and Glenn E. Smith.

Nevada: L. H. Taylor, civil engineer, Golconda.

New Mexico: P. E. Harroun, civil engineer, Albuquerque.

North and South Carolina: Prof. J. A. Holmes, State geologist, Chapel Hill, North Carolina, assisted by E. W. Myers.

Texas: Prof. Thomas U. Taylor, State University, Austin.

Utah: Prof. Samuel Fortier, civil engineer, Corinne, assisted by J. L. Rhead and J. S. Baker; later, Prof. George L. Swendsen, Logan.

Virginia and West Virginia: Prof. D. C. Humphreys, Washington and Lee University, Lexington, Virginia.

Washington: Sydney Arnold, civil engineer, North Yakima; William J. Ware, civil engineer, Port Angeles.

Wyoming: A. J. Parshall, civil engineer, Cheyenne.

In a number of instances related data have been inserted, such, for example, as results of computation of daily flow at mill dams, made by local engineers, and data of river heights obtained from the United States Weather Bureau, or Corps of Engineers, United States Army. Reference to these facts, mainly unpublished, has been, or will be, made in other publications of this survey, and they are therefore placed in consecutive order for convenience of reference.

The methods of measuring the discharge of various streams and of preparing the computations have been described on pages 18 to 30 of the Nineteenth Annual Report, Part IV, and on pages 20 to 22 of the Twentieth Annual Report, Part IV. The tables used in facilitating computations are also given on pages 29 to 32 of Bulletin No. 140.

## CLASSIFICATION OF FIELD WORK.

In order to make a comprehensive study of the surface waters of the United States four classes of work are in hand:

1. Maintenance of long-record river stations.
2. Maintenance of short-record river stations.
3. Reconnaissance along streams.
4. Detailed reservoir surveys.

The long-record river stations are designed to show the influence of climatic fluctuations upon the volume of a river at a given locality. Only a few of these long-record stations can be maintained in any one State or section. Under this head are included only the localities where the conditions are highly favorable for accuracy of results as furnishing a standard of comparison. At such points especial care is taken to verify the gage readings and to make frequent measurements of discharge to give assurance that the rating table is correct. From the results obtained here it is possible to compare one year with another and ascertain which are years of high or low water or of medium flow.

The short-record river stations are established for the purpose of obtaining the flow at a given point for a short period. Each short-record station is discontinued as soon as the results are considered sufficient for probable industrial development. Reasonable care is taken to verify the results at these stations, but necessarily not the same refinement needed as in the case of the long-record stations.

Reconnaissance along important streams is systematically carried forward whenever the season is favorable, preferably during low water. Measurements of discharge are made wherever practicable during the progress of this work and observation of height maintained at some one point during the time of the reconnaissance. At important points level lines are run to obtain the fall, particularly where water power may be developed.

Reservoir sites are being examined and surveyed in various parts of the country whenever suitable localities are discovered by reconnaissance or are brought to attention in other ways. Contour maps are prepared of the lands to be flooded, showing the capacity of the reservoir at various depths. More detailed surveys are also made at the dam sites, and in some cases holes drilled down to and into the bed rock to ascertain the character of the foundations. From the information thus obtained estimates of cost are made. The matter is more fully described in the Twentieth Annual Report, Part IV, pages 25 to 43.

## ACCURACY OF RESULTS.

In making the survey and examinations of the flow of streams in various parts of the United States the object in view has been to obtain facts of general application at a cost commensurate with the probable application of the results. It is recognized that with a given expenditure the number of measurements made will depend largely upon the accuracy and precautions employed, and the question at once arises as to what degree of precision should be sought. For example, to ascertain the flow of water at a certain point within 5 per cent of the actual flow may cost $10; within 3 per cent, $25; within 2 per cent, $100, and so on, the cost increasing in an ascending ratio as an approach is made to absolute accuracy. In the example given it is a matter of judgment whether to make measurements at a cost of $100 at ten points within 5 per cent of the flow, or at one point within 2 per cent. For general information concerning the hydrography of the country, such as that sought by this survey, it is obvious that the measurements at the ten points are better than the single measurement of greater accuracy; on the other hand, conditions may be imagined, for example, where water or power is being purchased, when the more expensive single measurement is important.

It is impracticable to assign definite limits to the degree of accuracy of the measurements and computations of river flow, since circumstances vary widely, but as a rule the limit has been set, as above stated, that they shall be within the range of ordinary practical application. The low-water flow or the floods of a given season are never repeated, being higher or lower in subsequent years. By continuing measurements through a decade the range within general limits is known, but may be passed during the succeeding decade. Great accuracy, therefore, in ascertaining the flow at any given time is not necessary for drawing general conclusions, as various assumptions must enter to modify the application of the facts.

In stating results of discharge measurements whole numbers have been used and decimals dropped from the figures obtained by computation. This rule is applied in all cases where the flow exceeds 10 cubic feet per second; where it is less than this decimals may or may not be used, although even here a false conception of accuracy may be given. In obtaining averages or totals representing the flow through considerable periods of time there may be some discrepancies involved through this omission of fractions, but it is not believed that the practical value of the work can be improved by introducing into the computation a higher degree of refinement than is possible or desirable in the field work.

## EXPENSE OF MAINTAINING STATIONS.

During 1899 blank forms were sent to all resident hydrographers of the Geological Survey, with the request that they give a full description of each station, with reasons for its establishment and maintenance, together with an itemized statement of the costs incurred in making the measurements and in computing the results. These estimates have been compared with the actual expense incurred during the calendar year, and the results have been analyzed to ascertain what may be called the normal cost of maintaining river stations in various parts of the United States, and to ascertain which of the stations were requiring an expenditure out of proportion to the value of the results.

Whenever the cost of a station is excessive, a careful study of the necessity of that station has been made to determine whether the data obtained are of sufficient value to warrant the extra expenditure. In a few cases it has seemed advisable to discontinue stations on account of the expense of maintenance; but on the whole the result of the analysis has been gratifying, inasmuch as it has shown very few stations which could be considered excessively expensive, and in most of these cases the results obtained have been considered sufficiently valuable to warrant their continuance.

The conditions obtaining in the various parts of the country are so different that the annual cost of maintenance is not fairly comparable. This difference is due to several causes, the chief of which is the great distance between stations in some of the Western States when compared with stations in the Eastern States. This makes additional expense for railroad fare and also for services for the increased time spent in traveling. In most States passes are granted the hydrographers by the railroad companies when upon official business, but this is not true in all States. The beds of some rivers are rocky and permanent in character, necessitating only a few measurements a year, while others are sandy and shifting, requiring many measurements in order to construct discharge curves of any value. An extreme example of the latter case is the Gila River upon which measurements were made nearly every day in the year. The pay of the local observer varies with the distance he is obliged to travel daily to reach the gage.

For the reasons given above, the country has been divided into several sections according to the conditions at the stations. All of the stations in the States bordering on the Atlantic Ocean are considered in one class. These are 57 in number and are under the charge of 4 resident hydrographers. The rivers in the northern part of this section, as far south as Virginia, have as a rule been gaged at points where their beds are rocky, and require only about 4 measurements a year in order to construct reliable discharge curves, as the curves constructed in the previous years need few changes. South of Virginia the gagings have been made where the beds of the rivers are for the most part soft and changeable, requiring from 6 to 8 measurements a year.

The normal cost of each gaging in the Atlantic States is $11.50. This includes every expense incident to the gaging, and may be divided approximately as follows:

| | |
|---|---|
| Hydrographer's services in the field | $5.00 |
| Hydrographer's services for computation | 2.00 |
| Services of assistant | .50 |
| Cost of local transportation | 1.00 |
| Sundry expenses, including board, lodging, etc | 3.00 |
| Total | 11.50 |

Hydrographers are obliged to travel, on the average, 200 miles for each gaging, but with few exceptions passes have been granted.

The pay of the observer averages $36 a year. This makes the total cost of an ordinary station in the Atlantic States $82 if 4 gagings are made during the year and $105 if 6 gagings are made.

The river stations in Kansas and Nebraska are in general under the same conditions, and are here considered together. The river beds are more or less changeable, so that, in order to obtain reliable discharge curves, it is necessary to make from 10 to 20 gagings a year at each station, with an average of about 12. The normal cost of each gaging is $12, divided in about the same proportion as in the Atlantic States. For the ordinary stations, therefore, the total cost of gaging for one year would be $144, and adding $40, the average cost of observers' services for one year in this section, gives $184 as the total cost of maintaining the station.

In Colorado the character of the river beds varies considerably in the different parts of the State. Some have a rocky, permanent bed, and others a soft, changeable one, requiring frequent gagings. For this reason the number of gagings required each year at the different stations varies from 2 to 10, with an average of about 6. The average cost of making a measurement is $13; the average cost of observations is $30, making a total cost of $108 for one year. The expense incurred in 1899 has not been as great as here mentioned, as fewer measurements per year have been made.

In Montana, at those stations under the charge of Prof. Fred. D. Smith, from whom reports have been received, the average cost of a gaging is found to be $10; and allowing 10 measurements a year and $30 for observations, the normal cost of maintaining a station for one year is $130.

In Wyoming the average cost of gagings is $30. Allowing 7 measurements a year and $26 for observations, this makes $236 as the normal cost of maintaining a station for one year. This large expenditure is necessitated by the great distances traveled.

In Idaho the average cost of making a gaging is $20. Allowing 6 measurements a year at each station and $36 for observers, we have $156 as the normal cost of each station for one year.

In California we can say, roughly, that the average cost of a gaging is $30, and making 10 measurements a year; and paying $36 for observers, we have a total cost of $336 a year as the expense of maintaining a station.

These comparisons have been made in order that some idea might be obtained as to the proper cost of maintaining stations. If the cost of any particular station is much higher than the normal cost of stations in that section, it is important that a careful study be made to determine whether or not the measurements are of such value as to warrant the additional expenditure. If not, the station should be discontinued.

## DETERMINATION OF DISCHARGE FROM SLOPE.

At various times attempts have been made to obtain data as to slope or fall per mile of the water surface of various rivers, in order to use this factor in estimates of the flow of the stream, and thus make comparison with the discharge as measured by current meters. It has been quite difficult, however, to do this, and the results have been somewhat unsatisfactory, owing to the uncertainty in determining the slope of the stream, considerable latitude of judgment being possible.

Careful leveling along the banks of most streams of moderate size shows that the water surface is alternately approximately level, then has a distinct fall, and again is nearly level; in other words, as expressed in the South, the stream consists alternately of pools and riffles. These may be imperceptible to the eye, but are detected by careful leveling. In determining the slope of the stream the question therefore arises as to whether this shall be determined for the immediate proximity of a given cross section, either at a pool or a riffle, or be taken to include a number of these, and thus extend several thousand feet or even several miles. On the selection of this distance depends, to a large extent, the slope of the stream, the amount varying within wide limits.

The desirability of again taking up this matter was brought to the attention of this office in July, 1899, by Mr. Desmond FitzGerald, chief engineer, to the special commissioners of the Chicago Drainage Canal. Instructions were sent to each field party to endeavoi to make such measurements wherever it could be done without notable increase of cost. So many practical difficulties were encountered it has been found that for these observations to have value they should be made by a field party especially equipped for the purpose and provided with appliances such as are rarely at hand in making ordinary meter measurements.

A few such measurements were made during the past season by different hydrographers, and they will now be considered. The following abbreviations will be used in this connection: D=discharge; A=area, in square feet; V=velocity, in feet per second; W=width, in feet, or practically wetted perimeter; $R=\frac{A}{W}$, hydraulic mean radius; S=slope; n=coefficient of roughness. Kutter's formula has the form $V=C\sqrt{R\ S}$, in which C is a constant to be found.

*Etowah River at Canton, Georgia.*—On September 5, 1899, B. M. Hall made a survey of this river to find the correct value of n for a 1,500-foot section along the stream. After measuring 1,500 feet, running levels, and placing temporary gage at upper point, he did not have time to make a discharge measurement, but applied the slope to the measurement made August 28, 1897, when the following were found: Gage height, 0.30 foot; area, 423 square feet; mean velocity, 1.061 feet per second; discharge, 449 second-feet. The slope was 0.06 foot in 1,500 feet=0.00004. W=115; therefore $R=\frac{423}{115}=3.68$, and $\sqrt{R\ S}=0.012132$. Substituting in the formula $V=C\sqrt{R\ S}$, we get C=87.4, and from the table in Trautwine, 17th edition, page 276, we find n=0.022.

*Loup River at Columbus, Nebraska.*—A series of slope measurements to determine the value of n were made by Glenn E. Smith, under the direction of Prof. O. V. P. Stout, of the University of Nebraska, at the gaging station on Loup River. Gage heights were taken on two gages, the auxiliary gage being placed 1,200 feet downstream from the main gage rod. The following were the three observations:

*Measurements of Loup River at Columbus, Nebraska.*

| Date. | Main gage. | Lower gage. | Width. | Area. | Mean velocity. | Discharge. | R |
|---|---|---|---|---|---|---|---|
| 1899. | *Feet.* | *Feet.* | *Feet.* | *Square feet.* | *Feet per second.* | *Second-feet.* | |
| Sept. 3 | 4.40 | 3.30 | 525 | 875 | 2.17 | 1,902 | 1.67 |
| Sept. 17 | 4.40 | 3.31 | 525 | 826 | 2.23 | 1,840 | 1.57 |
| Oct. 5 | 4.60 | 3.52 | 525 | 953 | 2.52 | 2,402 | 1.81 |

The following are the computations for the three days: September 3: $S=\frac{1.1}{1,200}=0.00093$; R=1.67; V=2.17. Substituting in the formula $V=C\sqrt{R\ S}$, we obtain C=55.0, and from the table n=0.028.

September 17: S=0.00091; R=1.57; V=2.23. C, therefore, =59.0 and n=0.026.

October 5: S=0.00090; R=1.81; V=2.52. C is found to equal in this case 62.3 and n = 0.026.

*Niobrara River at Fort Niobrara, Nebraska.*—The following table shows the results of similar measurements made on this river under the direction of Professor Stout. All gage heights are referred to the zero of the main gage. The upper auxiliary gage is 600 feet above and the lower auxiliary gage 600 feet below the main rod.

*Measurements of Niobrara River at Fort Niobrara, Nebraska.*

| Date. | Main gage. | Upper gage. | Lower gage. | Area. | Mean velocity. | Discharge. | Width. | R |
|---|---|---|---|---|---|---|---|---|
| 1899. | *Feet.* | *Feet.* | *Feet.* | *Square feet.* | *Feet per second.* | *Second-feet.* | *Feet.* | |
| Aug. 30 | 1.35 | 2.32 | 0.60 | 196 | 3.57 | 700 | 154 | 1.27 |
| Sept. 13 | 1.15 | 2.20 | .60 | 200 | 3.47 | 695 | 154 | 1.30 |
| Sept. 26 | 1.05 | 2.10 | .40 | 198 | 3.70 | 732 | 154 | 1.29 |
| Oct. 7 | 1.15 | 2.05 | .55 | 215 | 3.61 | 776 | 154 | 1.40 |
| Oct. 20 | .80 | 2.08 | .30 | 199 | 4.27 | 849 | 154 | 1.29 |

As there were three gages read, three different slopes can be determined, as follows: Between the upper and middle gage, between the middle and lower gage, and, finally, between the upper and lower gage. They do not correspond well, as shown in the table immediately following, the slope between the middle and lower gage being constantly less than the slope between the upper and middle gage, and of course the slope between the upper and lower gage is the mean between them.

*Comparison of slope measurements at Fort Niobrara, Nebraska.*

| Gage rod. | Aug. 30. | Sept. 13. | Sept. 26. | Oct. 7. | Oct. 20. |
|---|---|---|---|---|---|
| Upper and middle | 0.00161 | 0.00175 | 0.00175 | 0.00150 | 0.00213 |
| Middle and lower | .00125 | .00091 | .00109 | .00100 | .00083 |
| Lower and upper | .00143 | .00133 | .00142 | .00125 | .00148 |

The following determinations of the values of C and n are based on the slope as found by the readings on the upper and lower gages. The computations are not carried out, but the results are shown in the following table:

*Table showing values of C and n.*

| | C | n |
|---|---|---|
| 1899. | | |
| August 30 | 84.1 | 0.018 |
| September 13 | 83.5 | .018 |
| September 26 | 86.8 | .018 |
| October 7 | 86.5 | .018 |
| October 20 | 97.7 | .016 |

One comparison is made between the values of C and n as determined by considering the three different slopes for a single measurement, and for this purpose the gaging on September 13 is used. On this date R=1.30; V=3.47; S, for upper and middle gage, =0.00175; C is found to equal 73.5 and n 0.020. For middle and lower rod, S=0.00091, and C, therefore, =101.0, and n= 0.015. The following table shows these values of C and n for the three slopes on September 13:

*Table showing values of C and n on September 13, 1899.*

| Gage rod. | C | n |
|---|---|---|
| Upper and middle | 73.5 | 0.020 |
| Middle and lower | 101.0 | .015 |
| Lower and upper | 83.5 | .018 |

For comparison with results obtained on September 13 it is assumed that the slope determined was made between the upper and lower gages 0.00133. Substituting in Kutter's formula the value of n, as found from the determinations of the slope of the upper and middle rod, we get a discharge of 840 second-feet. Assuming the same slope as above—that is, between the upper and lower rod—and taking the value of n as found between the middle and lower rod, =0.015, and substituting again in Kutter's formula, we get a discharge of 610 second-feet. These latter results are not satisfactory. In this case, with 0.015, 0.018, 0.020 as the three assumed values of n, we get discharges of 610, 695, and 840 second-feet, respectively. The measured discharge, as determined by current meter, for this date was 695 second-feet.

Readings on slope gages were taken for a short period in 1896 on Frenchman River, at Palisade, Nebraska, as shown in the Eighteenth Annual Report, Part IV, page 198, and in Water-Supply Paper No. 11, page 56.

*Bear River at Battlecreek, Idaho, and Collinston, Utah.*—Measurements of the fall of the surface of Bear River at Battlecreek, Idaho, and at Collinston, Utah, were made by Prof. Samuel Fortier. Stakes were driven into the channel of the stream about 10 feet from each shore line, at points 100 feet below and 100 feet above the cable suspended across the stream. These four stakes were pointed on the top and driven about 1.5 inches below the surface of the water. A small wire nail was driven into the top of each stake until level with the surface of the water, allowance being made for the pulsation of the surface. The elevations of the tops of these nails were then carefully ascertained with a level.

At Battlecreek, Idaho, the bed of Bear River consists of clay near the right bank, small cobblestones in the center, and gravel and pebbles near the left side. The banks are somewhat irregular. The fall, S = 0.00062; water area, A = 443 square feet; mean velocity, V = 2.36 feet per second; hydraulic mean radius, R = 2.31; wetted perimeter, 191 feet; n = 0.027; C, in Chezy's formula, 62.58; the discharge, D, was 1,046 second-feet.

At Collinston, Utah, the bed of Bear River consists of cobble rock stones and bowlders. The fall was found to be, S = 0.00131; A = 427 square feet; V = 2.333 feet per second; R = 1.58; wetted perimeter, 270; n = 0.029; C, in Chezy's formula, 51.28; the discharge, 996 second-feet.

## ESTIMATION OF DISCHARGES AT MILLDAMS.

On rivers which, like those in New England, have been used for water power, it is often difficult to find a section where measurements with the current meter can be readily made. The milldams placed at short intervals back up water or introduce conditions unfavorable to direct measurement of flow. On the other hand, the facilities at the milldams are often excellent for noting the height of water, as gages are frequently maintained in the interest of the mill owners. In a number of cases where controversies have arisen concerning water power or there now exist contracts for the division of the available flow, elaborate computations have been made showing the discharge over the dams and through the various openings leading to the mill wheels. Occasionally these computations of flow are sufficiently extensive to have general interest in showing the run-off from a given drainage area, but more often the results are fragmentary.

Probably the earliest and most thorough determination of the flow of a river by estimating the amount taken by mills and passing over the dam is that begun by Mr. J. B. Francis over a half century ago on the Merrimac River at Lawrence, Massachusetts. This may be considered as the model of all attempts of this kind. Similar computations, based upon the Francis formula, have been made on other New England streams, notably on Connecticut River at Holyoke, Massachusetts, and on Kennebec River at Waterville, Maine. The uncertainty as to the application of certain constants or factors is such that estimates of this kind are apt to be misleading unless made by an engineer thoroughly familiar not only with the fundamental data, but with all of the varying local conditions. In order to make computations of daily discharge and correction for changes in the conduits diverting water above the dam, it is necessary to maintain records of various facts besides the height of water. To facilitate the keeping of such records blanks have usually been prepared with a space for entering the depth of water on the crest of the dam, and the length of this in linear feet—especially when modified from day to day by the use of flashboards. These records of depth are usually made night and morning, and occasionally are noted every two or three hours throughout the day. Besides these, spaces are provided for reading the height of water at the headrace and tailrace of each mill, giving data for the working head on the water wheels. The number of wheels, the size and kind, the number of hours operated, and other facts concerning their use are also given, in order to compute the probable flow through each wheel and add this to the amount passing over the dam. Corrections must usually be introduced for leakage and for the amount escaping through waste ways. It is evident that for any given locality with a number of mills the recording of the facts not only requires care and time, but some display of intelligence on the part of the workmen, to whom the recording is necessarily intrusted.

All of the conditions above noted, and the uncertainty regarding accuracy of the constants used in the computations, tend to make the estimates not only complicated, but introduce more or less doubt as to the value of the results. This is particularly true when there are a number of mills taking water from the impounded river and in seasons of low water when the greater proportion passes through the mill wheels. At a number of localities where such estimates are made all of the water enters the mill races during the summer, leaving the crest of the dam dry.

Estimates of the flow of streams at milldams have been recently extended to certain streams in New York, most of which are tributary to Mohawk River. These were begun in October, 1898, by Mr. George W. Rafter, who was at that time employed on special water-supply investigations for the United States Board of Engineers on Deep Waterways. This board, consisting of three engineers designated by the President, one from the Engineer Corps of the United States Army, one from the Coast and Geodetic Survey, and one from civil life, was authorized by act of Congress approved June 4, 1897 (30 Stat. L., 50). Its purpose is to make surveys and examinations, including estimates of cost of deep waterways between the Great Lakes and the Atlantic tide waters, as recommended by the report of the Deep Waterways Commission, transmitted to Congress on January 18, 1897.[1] The work of the board was continued by the act of July 1, 1898 (30 Stat. L., 636), providing that estimates should be prepared for cost of waterways 21 and 30 feet in depth, and by act of March 3, 1899 (30 Stat L., 1109).

Under the direction of Mr. Rafter about 20 stations for studying sources of supply for deep waterways have been established in the State of New York, the locations of which are shown by fig. 12, on page 79 of Part IV of the Twentieth Annual Report of the Geological Survey.

In each case these points of measurement are at dams built to furnish power for mills, or constructed by the State for supplying water to the Erie Canal and its feeders. The dams thus employed as weirs are of various sections and materials. A few are of stone, solidly built, but most are of timber. Some of the latter are tight, while others

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[1] Report of the United States Deep Waterways Commission, prepared at Detroit, Michigan, December 18-22, 1896, House Doc. No. 192, Fifty-fourth Congress, second session.

leak, and in these cases estimates have been made of the quantity flowing through the dam. Usually the estimate was made at the establishment of the river station, and leakage was considered as being constant. In a few instances current-meter measurements were made of the leakage, and the quantity found was used as a correction in the computations.

In examining the dams in the rivers it was found that many of them were irregular in longitudinal profile of crest. In a number of cases they were so repaired as to give a horizontal crest, but at several localities it was impossible to eliminate this irregularity. In these cases a careful profile of the crest was plotted and divided into parts in such a way that the crest of each portion could be considered as horizontal without introducing serious errors. Computations were then made of the flow through each section irrespective of its neighbor, and the quantities in all sections were added together to give the total flow over the dam. These computations were made for different heights of water and plotted graphically with the head on the crest in feet as ordinates and the discharge in second-feet as abscissas. A smooth curve was then drawn through these points, from which discharges have been read for various heads. In a number of instances these curves have been revised, using coefficients determined at a later time.

In order to compute the discharge over dams, it is necessary to make certain assumptions or employ coefficients obtained by experiment. The coefficients for determining the flow over broad-crested weirs are somewhat uncertain, especially with high heads. The most reliable coefficients are those determined by experiments of Bazin's, published in the Annales des Ponts et Chaussées.[1] In those experiments the head on the crest of the weir never exceeded 1½ feet. As the coefficients over broad-crested weirs vary considerably with the head, it is a matter of judgment what coefficients to apply when the heights exceed those experimented upon by Bazin. Profiles of the dams as constructed in the river seldom correspond exactly with the profile for which the coefficients were determined. For each case it is necessary to assume an experimental profile which corresponds most closely with the measuring dam. In order to eliminate these two sources of error, experiments were instituted at Cornell University to determine coefficients for experimental flat-crested weirs as used by Bazin with heads on crest as high as 6 feet, and also upon other forms of weirs corresponding to those of the dams over which measurements are made.[2]

In making these experiments the first question that arose was to determine the actual quantity of water flowing over the experimental

[1] Annales des Ponts et Chaussées, Ire partie, 1898, 2e Trimestre, No. 24, p. 151 to 264. Expériences Nouvelles sur l'Écoulement en Déversoir (6e article), par M. H. Bazin, Inspecteur général des Ponts et Chaussées.

[2] On flow of water over dams, by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, pp. 226-319.

weirs. To determine this a sharp-crested weir was constructed of exactly the same dimensions as that experimented upon by Bazin, for which he (Bazin) has published accurate coefficients. Bazin's coefficients for this sharp-crested weir were determined only for small heads.

In order to obtain accurate coefficients for sharp-crested weirs for a greater head, another weir of shorter length was placed below the Bazin weir in the same flume. Knowing the actual quantity flowing over the Bazin weir, and carrying the height on crest to the limit of the Bazin experiments, it was possible to determine coefficients for sharp-crested weirs for heads as high as about 6 feet. The coefficients determined from this second sharp-crested weir were then used to find the actual quantity of water flowing over all experimental sections used thereafter. Gates were so arranged that the quantity of water flowing in the flumes could be varied at will, and starting with a high head the water was gradually reduced in quantity, reducing thereby the head on the crest to zero. The gates were allowed to remain in each of the eight or ten positions from ten minutes to an hour, so that the flow for that interval was constant. By reading the head of the sharp-crested weir, the water flowing at the given width of gate opening could be determined. At the same time the head on the experimental weir was read and, noting the quantity, the coefficients computed for use in the formula $q = CLH^{\frac{3}{2}}$. In this formula $C = m\sqrt{2g}$ of Bazin's formula. One run was made for each experimental weir, and eight or ten points of the curve were determined. The experimental weir, which was constructed of wood, was then torn out and one of another section put in its place. When all worked well it required one day for experimentation on each section. Experiments were made on forms of weirs corresponding to nearly all of the dams over which the flow was measured.[1]

Practically all the computations of the flow of streams made by the Board on Deep Waterways had been completed before these coefficients for high heads were determined, so that Bazin's coefficients were used instead of the Cornell coefficients, although in Mr. Rafter's opinion the Cornell coefficients would be more accurate. It was proposed to recompute back records, using the Cornell coefficients, but lack of time and funds have prevented. The monthly totals have, however, been approximately corrected. There are some discrepancies between Bazin's and the Cornell coefficients, even for low heads, which are attributed to difference in the construction of the experimental weirs and the consequent action of the air cushion. It is possible that the conditions in the Cornell experiments are nearer those in actual dams.

As has been stated, most of the measuring stations are dams furnishing power for mills, and of course a large quantity of water passes

[1] On flow of water over dams, by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, pp. 226-319.

through the mill race and wheels and not over the dam. In order to determine this quantity of water, gages are used, as before noted, above the wheels in the headrace and below the wheels in the tailrace, so that by simultaneous readings the head on the wheels at any time may be determined. The size and type of wheels used in each mill and the dimension of the gates were ascertained. In many cases, especially in the case of new wheels, records of careful ratings made at Holyoke, Massachusetts, were obtained for the particular wheels installed in the mills. Where these could be obtained they were used to determine the flow through the wheels. In other cases it was necessary to rely upon the figures published in the trade catalogues for the quantity of water flowing through the various wheels at the various heads, although these quantities are not always accurate. In some of the headraces there are overflows which must be taken into account as the head increases, and over which the flow is somewhat uncertain. When the State dams were used, as in most cases, in New York the flow through the canal feeders was measured once and assumed to be constant thereafter.

The following table gives a list of the New York streams, the flow of which has been computed as described above. Their drainage areas are also given. The numbers in the first column are those shown in the Twentieth Annual Report, Part IV, fig. 12, where the location of the points of observation is given.

*Streams measured by the United States Board of Engineers on Deep Waterways.*

| No. | Streams. | Locality. | Drainage area. |
|---|---|---|---|
| | | | Sq. miles. |
| 1 | Seneca River | Baldwinsville | 3,103 |
| 2 | Oswego River | Fulton | 4,916 |
| 3 | Chittenango Creek | Bridgeport | 307 |
| 4 | Oneida Creek | Kenwood | 59 |
| 5 | Wood Creek | Near mouth | |
| 6 | Fish Creek, west branch | McConnellsville | 187 |
| 7 | Fish Creek, east branch | Above Point Rock | 104 |
| 8 | Salmon River | About 1 mile above falls | 191 |
| 9 | Mohawk River | Ridge Mills | 153 |
| 10 | Ninemile Creek | 1 mile below Stittville | 63 |
| 11 | Oriskany Creek | State Dam, Oriskany | 144 |
| 12 | do | Coleman | 141 |
| 13 | Sauquoit Creek | New York Mills | 52 |
| 14 | West Canada Creek | Middleville | 519 |
| 15 | Mohawk River | Little Falls | 1,306 |
| 16 | East Canada Creek | Dolgeville | 256 |
| 17 | Garoga Creek | 3 miles above the Mohawk | 81 |
| 18 | Cayadutta Creek | Below Johnstown | 40 |
| 19 | Schoharie Creek | State Dam, Fort Hunter | 947 |
| 20 | Mohawk River | State Dam, Rexford Flats | 3,385 |
| 21 | Hudson River | Mechanicville | 4,500 |
| 22 | do | Fort Edward | |
| 23 | Schroon River | Warrensburg | 563 |
| 24 | Black River | Watertown | 1,389 |

The results obtained at the localities named above, from September, 1898, to May, 1899, inclusive, as computed by Mr. George W. Rafter, are given in the following table. The numbers in the first column of the preceding table refer to the same numbers in this table:

*Estimated monthly discharge of various New York rivers in cubic feet per second.*

| No. | 1898. | | | | 1899. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. |
| 1 | | | 3,137 | 2,689 | 2,851 | 1,769 | 3,875 | 4,543 | 2,568 |
| 2 | | | 6,220 | 5,300 | 6,150 | 4,075 | 7,830 | 11,000 | 6,586 |
| 3 | 129 | 320 | 550 | 530 | 600 | 450 | 711 | 820 | 230 |
| 4 | | 76 | 95 | 75 | 97 | 79 | 126 | 160 | 58 |
| 5 | | | | | | | | | |
| 6 | 108 | 300 | 340 | 180 | 385 | 170 | 530 | 1,040 | 215 |
| 7 | 250 | 310 | 380 | 201 | 209 | 251 | 342 | 751 | 295 |
| 8 | | | 490 | 315 | 522 | 200 | 468 | 2,220 | 605 |
| 9 | | 324 | 356 | 216 | 332 | 199 | 422 | 952 | 275 |
| 10 | 398 | 98 | 92 | 135 | 225 | 85 | 210 | 340 | 47 |
| 11 | | 325 | 327 | 327 | 295 | 291 | 342 | 466 | 119 |
| 12 | | | | | | | | | |
| 13 | 27 | 56 | 57 | 57 | 58 | 58 | 111 | 127 | 38 |
| 14 | | 1,071 | 1,125 | 922 | 1,028 | 1,422 | 1,058 | 3,365 | 1,456 |
| 15 | 2,378 | 2.493 | 2,891 | 2,036 | 2,753 | 1,510 | 3,757 | 8,102 | 2,651 |
| 16 | 638 | 581 | 689 | 564 | 816 | 439 | 519 | 1,978 | 633 |
| 17 | | 140 | 190 | 77 | 43 | 47 | 160 | 500 | 99 |
| 18 | 16 | 64 | 91 | 44 | 39 | 31 | 74 | 251 | 31 |
| 19 | 409 | 1,422 | 2,447 | 1,853 | 2,584 | 2,224 | 4,072 | 4,380 | 858 |
| 20 | | | | 4,550 | 5,850 | 4,000 | 9,250 | 17,400 | 4,150 |
| 21 | 3,872 | 7,895 | 9,243 | 5,436 | 6,668 | 5,258 | 9,618 | 23,645 | 9,752 |
| 22 | | | | | | | | | |
| 23 | 166 | 263 | 464 | 783 | 606 | 478 | 564 | 2,877 | 3,150 |
| 24 | 1,744 | 3,607 | 4,510 | 2,752 | 4,704 | 2,381 | 5,112 | 14,172 | 5,840 |

## TURBIDITY.

Many attempts have been made to determine the amount of silt carried by water in suspension, but as a rule these necessitate elaborate operations of filtering, drying, and weighing. One of the most convenient methods for field work is that recently applied by Mr. Allen Hazen, who has prepared an arbitrary scale dependent upon the degree of opacity of the water. Observations of turbidity are taken by putting a stick into the water under examination and noting the distance beneath the surface at which a given object—usually a small wire—can be seen. The turbidity is then read from a scale graduated on this stick. This is most conveniently accomplished by having a second or smaller stick placed in front of the first, the end of which is brought to the water line at a point where the wire can just be seen. Upon removing the two together the position of the smaller stick on the scale gives the turbidity.

Observations are taken in the open air, as too high results are obtained under a roof, even with good light. They preferably should be made in the middle of the day, and not in direct sunlight. In case the sun is shining the observer can stand so that his shadow covers the water immediately above the stick and wire. The observer stands erect with his feet a little above the water, although some variation in this respect does not materially influence the results.

The stick should be about 5 feet long and five-eighths of an inch square. A platinum wire should be inserted at a point about 1 inch from the end at rightangles and projecting 1 inch. This wire should be about 0.04 inch in diameter. The stick is then graduated, the figures being inversely proportional to the distances from the wire, 1.00 coming at 1 inch. The following table gives the graduations up to 50 inches:

*Scale of turbidity.*

| Turbidity. | Inches. | Turbidity. | Inches. | Turbidity. | Inches. |
|---|---|---|---|---|---|
| 2.00 | 0.50 | 0.10 | 10.00 | 0.05 | 20.00 |
| 1.50 | .66 | .09 | 11.11 | .04 | 25.00 |
| 1.20 | .83 | .08 | 12.50 | .03 | 33.30 |
| 1.00 | 1.00 | .07 | 14.30 | .02 | 50.00 |
| .50 | 2.00 | .06 | 16.70 | .01 | 100.00 |

## MEASUREMENTS AT RIVER STATIONS.

### KENNEBEC RIVER AT WATERVILLE, MAINE.

This river has been described by Prof. Dwight Porter in the Nineteenth Annual Report, Part IV, pages 65 to 84, the general location of the stream being shown on Plate IX. Computations of discharge at Waterville, Maine, were made by Mr. Sumner Hollingsworth from about 1892 to the time of his death, which occurred June 27, 1899. Additional figures have been furnished by Mr. James L. Dean, engineer of the Hollingsworth & Whitney Company, a slightly different system of computation being employed by Mr. Dean, as it has been impracticable to introduce the corrections made by Mr. Hollingsworth, the principles upon which he worked not being fully recorded. Corrections were probably made for loss of head in the tailrace and leakage. The figures of daily discharge from 1892 to August 31, 1898, as computed by Mr. Sumner Hollingsworth, are given in Water-Supply Paper No. 27, page 14; those subsequent to the above date have been furnished by Mr. Dean.

Concerning those for 1899, Mr. Dean states that the figures subsequent to May 1 have not been computed with the same care as previous records, but they are believed to be correct for most practical purposes. The discharge over the dam was computed as usual, but that from the wheels was not estimated separately for each day, using the head of each wheel, and the speed of rotation, as heretofore done. Instead of this the average performance was taken. A comparison of gage readings and water discharges shows little connection, as flashboards are used on the dam. The Sunday flow is also irregular, as the mill at Waterville is sometimes operated Saturday night, drawing the water from the pond, so that there is no flow except leakage on Sunday. During the season of low water there is usually less passing on Sunday than on week days, as at many mills on the river the dams are closed in order to fill the ponds.

*Daily discharge in second-feet of Kennebec River at Waterville, Maine.*

1898.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,475 | 2,539 | 4,170 | 20,385 | 36,048 | 14,341 | 4,385 | 3,790 | 2,477 | 2,691 | 6,382 | 3,752 |
| 2 | 2,284 | 2,955 | 4,188 | 16,556 | 39,372 | 13,776 | 4,343 | 2,707 | 2,489 | 2,862 | 5,182 | 3,740 |
| 3 | 2,222 | 2,687 | 5,648 | 13,871 | 38,301 | 10,900 | 3,440 | 2,887 | 2,453 | 2,180 | 4,691 | 3,667 |
| 4 | 2,715 | 3,090 | 5,163 | 12,143 | 37,358 | 8,791 | 3,490 | 2,833 | 1,437 | 1,831 | 4,115 | 1,747 |
| 5 | 2,771 | 2,775 | 2,997 | 10,830 | 37,730 | 9,846 | 4,343 | 2,809 | 2,510 | 1,865 | 3,467 | 3,336 |
| 6 | 3,431 | 3,068 | 4,094 | 10,150 | 37,569 | 10,301 | 4,272 | 3,712 | 2,392 | 2,119 | 3,231 | 3,227 |
| 7 | 1,807 | 3,475 | 5,070 | 7,080 | 31,580 | 9,189 | 4,477 | 3,252 | 3,093 | 1,570 | 3,880 | 3,221 |
| 8 | 4,826 | 2,994 | 5,033 | 6,563 | 29,880 | 9,098 | 4,203 | 4,374 | 3,073 | 1,269 | 3,675 | 3,262 |
| 9 | 5,434 | 3,744 | 4,767 | 7,472 | 28,753 | 12,541 | 5,464 | 4,218 | 3,018 | 1,150 | 4,133 | 2,995 |
| 10 | 4,492 | 3,154 | 4,623 | 10,457 | 25,636 | 14,318 | 1,745 | 4,017 | 3,042 | 961 | 3,351 | 2,635 |
| 11 | 3,025 | 3,829 | 5,329 | 15,299 | 22,059 | 12,086 | 4,111 | 3,048 | 3,050 | 1,585 | 5,332 | 1,792 |
| 12 | 3,286 | 3,317 | 6,752 | 19,848 | 21,899 | 11,322 | 4,484 | 3,413 | 3,057 | 1,731 | 5,856 | 3,268 |
| 13 | 3,240 | 3,680 | 8,397 | 44,854 | 24,042 | 11,003 | 4,267 | 2,927 | 2,505 | 1,585 | 4,896 | 2,235 |
| 14 | 3,287 | 3,912 | 9,880 | 47,141 | 34,332 | 10,777 | 3,776 | 1,130 | 1,913 | 1,288 | 3,332 | 1,873 |
| 15 | 4,909 | 4,026 | 11,534 | 50,381 | 32,988 | 12,514 | 4,327 | 3,443 | 1,480 | 1,299 | 3,465 | 1,888 |
| 16 | 3,717 | 4,042 | 12,816 | 49,415 | 27,500 | 11,295 | 3,994 | 2,499 | 1,560 | 3,665 | 3,264 | 1,883 |
| 17 | 3,891 | 3,764 | 12,215 | 47,112 | 24,756 | 10,584 | 3,611 | 2,560 | 1,530 | 6,031 | 3,490 | 2,160 |
| 18 | 3,453 | 3,221 | 11,918 | 47,321 | 23,440 | 9,478 | 3,896 | 2,491 | 1,570 | 5,055 | 3,698 | 1,723 |
| 19 | 3,460 | 3,267 | 12,484 | 44,700 | 23,153 | 9,196 | 3,938 | 2,622 | 1,607 | 4,454 | 5,018 | 2,315 |
| 20 | 3,505 | 2,885 | 13,218 | 39,327 | 20,592 | 11,129 | 3,747 | 2,526 | 1,876 | 3,264 | 8,798 | 2,447 |
| 21 | 3,893 | 3,172 | 14,580 | 36,671 | 19,088 | 10,855 | 3,835 | 913 | 2,223 | 2,872 | 8,935 | 2,560 |
| 22 | 4,614 | 3,764 | 17,177 | 33,789 | 18,570 | 9,950 | 5,038 | 3,425 | 1,851 | 2,690 | 8,046 | 2,274 |
| 23 | 2,542 | 2,133 | 16,615 | 30,792 | 17,073 | 8,334 | 3,871 | 2,866 | 1,888 | 6,036 | 7,184 | 2,778 |
| 24 | 2,321 | 3,437 | 15,987 | 34,352 | 15,277 | 9,483 | 3,418 | 3,425 | 1,916 | 6,318 | 6,007 | 3,013 |
| 25 | 2,866 | 4,352 | 17,812 | 52,119 | 15,993 | 8,864 | 3,747 | 2,849 | 3,689 | 4,924 | 7,811 | 2,489 |
| 26 | 2,032 | 3,933 | 17,029 | 45,520 | 15,589 | 7,568 | 3,879 | 4,432 | 5,443 | 4,288 | 7,923 | 2,471 |
| 27 | 3,136 | 3,653 | 16,560 | 38,083 | 15,639 | 5,267 | 3,385 | 4,218 | 4,788 | 6,514 | 10,037 | 2,761 |
| 28 | 2,905 | 4,387 | 18,928 | 37,354 | 14,611 | 4,326 | 4,189 | 3,940 | 3,581 | 15,319 | 3,672 | 2,464 |
| 29 | 2,727 | ....... | 19,762 | 33,652 | 16,632 | 5,689 | 3,444 | 3,396 | 3,778 | 11,127 | 2,758 | 2,499 |
| 30 | 1,738 | ....... | 17,711 | 31,767 | 16,962 | 6,715 | 3,204 | 3,555 | 3,247 | 9,229 | 3,723 | 2,067 |
| 31 | 2,607 | ....... | 27,432 | ........ | 16,298 | ........ | 2,832 | 2,857 | ....... | 7,672 | ....... | 2,178 |
| Mean, | 3,213 | 3,402 | 11,287 | 29,833 | 25,120 | 9,983 | 3,908 | 3,133 | 2,618 | 4,047 | 5,178 | 2,620 |

1899.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,529 | 2,458 | 3,382 | 6,343 | 41,348 | 13,292 | 6,386 | 4,020 | 1,985 | 1,200 | 1,405 | 1,405 |
| 2 | 2,202 | 2,198 | 3,047 | 6,114 | 39,433 | 12,783 | 4,924 | 3,800 | 1,985 | 1,297 | 2,759 | 1,405 |
| 3 | 2,274 | 2,187 | 3,333 | 6,080 | 36,354 | 10,632 | 5,164 | 4,380 | 1,403 | 1,445 | 4,025 | 1,000 |
| 4 | 2,159 | 2,163 | 3,324 | 5,945 | 36,864 | 11,573 | 3,178 | 4,088 | 1,695 | 1,269 | 4,025 | 2,855 |
| 5 | 2,452 | 1,580 | 1,960 | 6,125 | 30,725 | 12,183 | 5,080 | 4,380 | 1,985 | 1,823 | 1,636 | 3,476 |
| 6 | 2,451 | 2,509 | 3,331 | 6,135 | 30,358 | 11,076 | 4,943 | 2,865 | 1,695 | 1,303 | 3,258 | 3,040 |
| 7 | 2,449 | 2,173 | 3,563 | 6,343 | 30,025 | 10,516 | 5,264 | 4,788 | 1,985 | 1,330 | 3,039 | 1,950 |
| 8 | 1,739 | 2,071 | 3,516 | 6,859 | 29,257 | 11,679 | 5,164 | 4,968 | 1,985 | 800 | 2,565 | 1,985 |
| 9 | 2,757 | 2,057 | 3,502 | 7,441 | 26,688 | 12,450 | 3,836 | 4,234 | 2,275 | 1,069 | 2,275 | 1,695 |
| 10 | 2,519 | 2,152 | 3,428 | 8,904 | 24,760 | 12,450 | 4,943 | 4,015 | 1,646 | 755 | 2,058 | 900 |
| 11 | 2,400 | 2,141 | 3,357. | 9,472 | 22,244 | 10,638 | 4,943 | 4,015 | 2,275 | 561 | 1,695 | 1,405 |
| 12 | 2,386 | 2,244 | 2,302 | 9,272 | 20,182 | 10,213 | 4,832 | 3,880 | 1,985 | 1,564 | 1,200 | 1,105 |
| 13 | 2,404 | 2,348 | 3,353 | 10,999 | 18,665 | 6,024 | 4,943 | 2,420 | 1,985 | 1,822 | 1,478 | 1,985 |
| 14 | 2,436 | 1,964 | 3,423 | 19,504 | 19,543 | 7,006 | 5,738 | 3,880 | 1,985 | 1,245 | 1,985 | 4,898 |
| 15 | 1,678 | 1,844 | 3,624 | 22,940 | 14,849 | 6,693 | 4,943 | 3,400 | 1,985 | 924 | 1,985 | 4,501 |
| 16 | 2,731 | 2,392 | 3,773 | 37,830 | 14,944 | 7,432 | 4,943 | 3,400 | 1,695 | 1,405 | 1,985 | 4,608 |
| 17 | 2,439 | 2,434 | 3,501 | 30,458 | 17,275 | 5,881 | 4,832 | 3,120 | 1,200 | 1,695 | 1,768 | 2,400 |
| 18 | 2,631 | 2,727 | 3,253 | 30,190 | 15,044 | 6,707 | 5,180 | 3,500 | 1,405 | 1,405 | 1,695 | 2,638 |
| 19 | 2,434 | 2,198 | 1,960 | 36,964 | 15,044 | 7,274 | 5,180 | 2,560 | 1,985 | 1,115 | 1,100 | 1,985 |
| 20 | 2,628 | 2,915 | 3,320 | 41,348 | 15,597 | 6,453 | 4,832 | 1,670 | 2,275 | 1,405 | 1,405 | 2,565 |
| 21 | 2,440 | 2,734 | 3,080 | 34,395 | 16,162 | 7,006 | 5,424 | 2,634 | 2,275 | 1,115 | 2,275 | 2,275 |
| 22 | 2,094 | 2,744 | 2,778 | 30,090 | 18,296 | 7,237 | 6,210 | 3,220 | 2,565 | 918 | 1,695 | 2,275 |
| 23 | 2,709 | 2,451 | 2,711 | 38,466 | 17,275 | 7,237 | 5,588 | 2,840 | 2,275 | 1,405 | 2,058 | 2,265 |
| 24 | 2,154 | 2,745 | 2,837 | 45,172 | 15,872 | 9,432 | 6,368 | 2,534 | 1,500 | 1,400 | 1,985 | 1,900 |
| 25 | 2,435 | 2,929 | 2,770 | 41,348 | 15,791 | 5,593 | 5,785 | 2,180 | 1,885 | 1,105 | 1,985 | 1,900 |
| 26 | 2,450 | 1,420 | 2,030 | 42,736 | 11,380 | 7,274 | 5,785 | 2,158 | 1,615 | 1,115 | 1,400 | 1,900 |
| 27 | 2,454 | 3,039 | 2,786 | 45,422 | 12,539 | 7,237 | 5,424 | 1,620 | 1,320 | 1,115 | 1,405 | 2,275 |
| 28 | 2,434 | 3,362 | 2,740 | 39,533 | 12,203 | 6,849 | 5,785 | 2,120 | 2,104 | 1,115 | 1,695 | 2,775 |
| 29 | 1,245 | ....... | 2,998 | 41,248 | 13,027 | 7,006 | 4,088 | 2,560 | 2,116 | 1,000 | 1,695 | 1,695 |
| 30 | 2,513 | ....... | 3,962 | 29,200 | 13,535 | 6,386 | 2,400 | 2,100 | 2,100 | 1,115 | 1,100 | 1,405 |
| 31 | 2,453 | ....... | 6,820 | ........ | 12,783 | ........ | 4,020 | 2,380 | ....... | 1,115 | ....... | 1,405 |
| Mean | 2,357 | 2,364 | 3,218 | 23,429 | 21,228 | 8,807 | 5,036 | 3,217 | 1,906 | 1,224 | 2,021 | 2,254 |

## ANDROSCOGGIN RIVER AT RUMFORD FALLS, MAINE.

This river receives the drainage from the Rangeley and other lakes, near the border line between Maine and New Hampshire. It flows in a general southerly and southeasterly direction, descending with rapid fall and furnishing considerable power. It is described by Prof. Dwight Porter in the Nineteenth Annual Report, Part IV, pages 84 to 97. The discharge at Rumford Falls since 1892 has been ascertained by Mr. Charles A. Mixer, resident engineer of the Rumford Falls Power Company. Figures of daily discharge up to the end of December, 1895, have been printed in Water-Supply Paper No. 27, pages 11 to 14. The table is continued for the years 1896 to 1898 in the Twentieth Annual Report, Part IV, pages 67 to 69. These figures are obtained by adding the actual measured quantities passing through the wheels and the computed flow over the dam, using the customary Francis weir formula.

Mr. Mixer has prepared a table giving the departure of the precipitation of 1899 from the normal, which is taken at 43.41 inches, showing that for this latter year there was only 31.58 inches, or a deficiency of 27 per cent. This emphasizes the importance of water storage, not only for such rare periods, but also for equalizing the fluctuations from month to month during every year. The lowest monthly run-off, 0.71 inch in depth, was in August, the month of greatest evaporation. At this time the run-off was 0.07 inch more than the precipitation. The lowest daily discharge for the year, 1,124 second-feet, was 0.48 second-foot per square mile. The total annual run-off averages 53 per cent of the total precipitation as measured at Rumford Falls; but in 1899 the percentage rose to 59, the increase presumably being due to storage. The records of precipitation have not been kept for a sufficiently long period to give a wide range in fluctuation, but, judging from the effect on the wells, there has been no such period of drought for from fifty to seventy-five years.

*Comparison of rainfall at Rumford Falls, Maine.*

| | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Normal | 3.23 | 4.28 | 3.55 | 2.99 | 3.92 | 3.63 | 4.48 | 3.49 | 3.34 | 2.78 | 4.74 | 2.98 |
| 1899 | 3.18 | 2.56 | 5.89 | 1.50 | 1.59 | 2.27 | 4.71 | .64 | 3.00 | 2.05 | 1.94 | 1.95 |
| Normal accumulation | 3.23 | 7.51 | 11.06 | 14.05 | 17.97 | 21.60 | 26.08 | 29.57 | 32.91 | 35.69 | 40.43 | 43.41 |
| 1899 accumulation | 3.18 | 5.74 | 11.63 | 13.13 | 15.02 | 17.29 | 22.00 | 22.64 | 25.64 | 27.69 | 29.63 | 31.58 |
| Accumulated excess | ------ | ------ | .57 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| Accumulated deficiency | .05 | 1.77 | ------ | .88 | 2.95 | 4.31 | 4.08 | 6.93 | 7.27 | 8.00 | 10.80 | 11.83 |

*Daily discharge in second-feet of Androscoggin River at Rumford Falls, Maine, for 1899.*

[Drainage area, 2,320 square miles.]

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 .... | 2,398 | 1,832 | 1,926 | 2,029 | 24,057 | 3,773 | 3,224 | 1,521 | 1,359 | 2,130 | 2,186 | 1,230 |
| 2 .... | 2,441 | 1,861 | 1,955 | 2,088 | 24,077 | 3,495 | 3,600 | 1,557 | 1,453 | 1,784 | 3,172 | 1,247 |
| 3 .... | 1,933 | 1,736 | 1,877 | 1,998 | 21,468 | 3,383 | 2,800 | 1,492 | 1,247 | 1,709 | 2,865 | 1,700 |
| 4 .... | 2,124 | 1,825 | 1,791 | 1,974 | 19,480 | 3,400 | 1,700 | 1,601 | 1,455 | 1,532 | 2,232 | 1,792 |
| 5 .... | 2,255 | 1,810 | 1,738 | 2,024 | 16,631 | 3,042 | 1,510 | 1,758 | 1,466 | 1,566 | 2,030 | 1,289 |
| 6 .... | 2,613 | 1,789 | 1,780 | 2,009 | 15,111 | 2,988 | 1,485 | 1,717 | 1,469 | 1,454 | 1,925 | 1,170 |
| 7 .... | 2,675 | 1,768 | 1,978 | 2,129 | 14,368 | 3,574 | 1,718 | 1,636 | 1,434 | 1,527 | 2,060 | 1,290 |
| 8 .... | 2,275 | 1,773 | 2,017 | 2,436 | 14,358 | 3,625 | 1,823 | 1,325 | 1,332 | 1,330 | 1,899 | 1,018 |
| 9 .... | 2,267 | 1,619 | 1,801 | 2,460 | 13,970 | 3,264 | 1,900 | 1,442 | 1,328 | 1,368 | 1,843 | 1,016 |
| 10 .... | 2,192 | 1,606 | 1,712 | 2,688 | 12,874 | 3,295 | 1,779 | 1,274 | 1,141 | 1,400 | 1,778 | 1,010 |
| 11 .... | 2,074 | 1,462 | 1,706 | 2,954 | 12,035 | 3,761 | 1,934 | 1,335 | 1,281 | 1,482 | 1,674 | 1,084 |
| 12 .... | 1,931 | 1,812 | 1,754 | 3,147 | 11,182 | 3,150 | 1,589 | 1,357 | 1,357 | 1,351 | 1,230 | 1,253 |
| 13 .... | 2,316 | 1,814 | 1,646 | 2,975 | 10,721 | 2,984 | 2,366 | 1,317 | 1,319 | 1,231 | 1,170 | 5,274 |
| 14 .... | 2,059 | 1,957 | 2,037 | 3,054 | 10,054 | 3,012 | 1,818 | 1,261 | 1,368 | 1,452 | 1,171 | 3,354 |
| 15 .... | 2,084 | 1,981 | 2,007 | 4,236 | 9,122 | 2,797 | 1,494 | 1,209 | 1,529 | 1,230 | 1,516 | 1,965 |
| 16 .... | 2,127 | 1,929 | 1,913 | 6,808 | 7,630 | 3,494 | 1,651 | 1,250 | 1,274 | 1,234 | 1,476 | 1,626 |
| 17 .... | 2,135 | 1,919 | 1,846 | 6,490 | 7,134 | 3,524 | 1,250 | 1,221 | 1,243 | 1,413 | 1,561 | 1,183 |
| 18 .... | 2,137 | 1,920 | 1,843 | 7,457 | 5,960 | 3,230 | 1,232 | 1,326 | 1,300 | 1,432 | 1,343 | 1,331 |
| 19 .... | 2,325 | 1,886 | 1,834 | 9,509 | 5,340 | 3,186 | 1,563 | 1,455 | 1,470 | 1,405 | 1,300 | 1,781 |
| 20 .... | 1,924 | 1,824 | 1,826 | 11,127 | 5,706 | 3,079 | 1,173 | 1,453 | 1,524 | 2,096 | 1,489 | 1,795 |
| 21 .... | 1,848 | 1,899 | 1,819 | 11,543 | 6,497 | 3,024 | 1,271 | 1,349 | 1,788 | 1,744 | 1,860 | 2,051 |
| 22 .... | 1,835 | 1,960 | 1,823 | 12,461 | 6,028 | 3,529 | 2,433 | 1,331 | 2,043 | 1,500 | 1,914 | 1,929 |
| 23 .... | 2,093 | 2,029 | 1,818 | 14,599 | 5,369 | 3,198 | 3,682 | 1,676 | 2,202 | 1,368 | 1,866 | 1,805 |
| 24 .... | 2,058 | 2,111 | 1,816 | 17,372 | 4,821 | 3,049 | 1,927 | 1,462 | 1,794 | 1,347 | 1,825 | 1,412 |
| 25 .... | 2,003 | 1,928 | 1,818 | 17,371 | 4,443 | 3,060 | 1,634 | 1,571 | 1,124 | 1,455 | 1,628 | 1,298 |
| 26 .... | 2,106 | 1,819 | 1,862 | 20,017 | 4,328 | 2,793 | 1,490 | 1,557 | 1,381 | 1,443 | 1,500 | 1,689 |
| 27 .... | 1,944 | 1,816 | 1,763 | 23,287 | 4,019 | 3,127 | 1,443 | 1,265 | 2,971 | 1,637 | 1,370 | 1,343 |
| 28 .... | 2,098 | 1,931 | 1,831 | 20,787 | 4,151 | 2,717 | 1,233 | 1,329 | 2,397 | 1,511 | 1,571 | 1,278 |
| 29 .... | 1,697 | ....... | 1,839 | 21,319 | 4,465 | 3,297 | 1,142 | 1,382 | 2,223 | 2,767 | 1,382 | 1,097 |
| 30 .... | 1,760 | ....... | 1,948 | 22,920 | 4,290 | 3,282 | 1,170 | 1,464 | 2,124 | 2,548 | 1,224 | 1,048 |
| 31 .... | 1,721 | ....... | 1,976 | ........ | 3,849 | ........ | 1,267 | 1,372 | ....... | 2,220 | ....... | 1,437 |
| Mean | 2,111 | 1,843 | 1,848 | 8,709 | 10,114 | 3,238 | 1,817 | 1,428 | 1,580 | 1,604 | 1,733 | 1,606 |

## COBBOSSEECONTEE RIVER AT RESERVOIR DAM NEAR AUGUSTA, MAINE.

This stream receives the overflow from a group of lakes lying from 5 to 15 miles westerly from Augusta, Maine, and empties into Kennebec River 8 miles below that city. It is described by Prof. Dwight Porter in the Nineteenth Annual Report, Part IV, page 79. A record of the water passing the upper dam on this stream has been furnished by Mr. Alexander H. Twombly, engineer of the Forest Paper Company, Yarmouthville, Maine. At the reservoir dam are gates by which the supply of water for the mill is regulated, and there is also a water wheel which operates a pumping station. When this wheel is in operation the regulating gates are shut down enough to deliver a constant supply of water to the mill, as shown by the tables on page 29. The great Cobbosseecontee dam furnishes a supplemental supply to this reservoir and water is occasionally drawn from it. At the point of measurement the water is shut back entirely on Sundays and holidays, as shown by the table. In the tables the reference "Gates up; all that flows" covers the period when there was no means of ascertaining the discharge, it being less than 220 second-feet and from that as low as 120 second-feet, diminishing probably at a constant rate. After November 1, 1899, the discharge, however small, can be measured.

*Daily discharge in second-feet of Cobbosseecontee River, at the upper dam, near Augusta, Maine.*

[Drainage area, 230 square miles.]

1890.

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | ------ | 300 | 290 | 290 | 290 | 393 | 300 |
| 2 | ------ | 300 | 290 | 290 | 290 | 379 | 300 |
| 3 | ------ | 300 | ------ | 290 | 290 | 379 | 300 |
| 4 | ------ | ------ | 290 | 290 | 290 | 379 | 300 |
| 5 | ------ | 306 | 290 | 290 | ------ | 368 | 300 |
| 6 | ------ | 326 | 290 | 290 | 290 | 357 | 300 |
| 7 | ------ | 356 | 290 | ------ | 290 | 347 | ------ |
| 8 | ------ | 374 | 290 | 290 | 300 | 347 | 300 |
| 9 | ------ | 374 | 290 | 290 | 300 | 333 | 300 |
| 10 | ------ | 340 | ------ | 290 | 300 | 333 | 300 |
| 11 | ------ | 314 | 290 | 290 | 300 | 326 | 300 |
| 12 | ------ | 306 | 290 | 290 | ------ | 300 | 300 |
| 13 | ------ | 156 | 290 | 290 | 300 | 300 | 300 |
| 14 | ------ | 300 | 290 | ------ | 300 | 300 | ------ |
| 15 | ------ | 300 | 290 | 290 | 300 | 300 | 300 |
| 16 | 340 | 300 | 290 | 290 | 300 | ------ | 300 |
| 17 | 356 | 300 | ------ | 290 | 300 | 300 | 300 |
| 18 | 356 | ------ | 290 | 290 | 300 | 379 | 300 |
| 19 | 356 | ------ | 290 | 290 | ------ | 445 | 300 |
| 20 | 340 | 290 | 290 | 290 | 300 | 431 | 300 |
| 21 | 326 | 290 | 290 | 290 | 300 | 418 | ------ |
| 22 | ------ | 290 | 290 | 290 | 300 | 405 | 300 |
| 23 | 300 | 290 | 290 | 290 | 300 | 393 | 300 |
| 24 | 300 | 290 | 34 | 290 | 337 | 379 | 300 |
| 25 | 306 | 290 | 290 | 290 | 337 | 368 | ------ |
| 26 | 314 | 290 | 290 | 290 | 337 | 357 | 290 |
| 27 | 314 | ------ | 280 | 290 | 345 | 347 | 290 |
| 28 | 306 | 290 | 290 | ------ | 345 | 337 | ------ |
| 29 | ------ | 290 | 290 | 290 | 345 | 337 | 290 |
| 30 | 300 | 290 | 290 | 290 | 379 | 300 | 290 |
| 31 | ------ | 290 | ------ | ------ | 393 | ------ | 290 |
| Mean | 324 | 307 | 290 | 290 | 313 | 356 | 298 |

1891.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 290 | 850 | 839 | 2,169 | 300 | 300 | 300 | 290 | 285 | 260 | (*a*) | (*a*) |
| 2 | 290 | 780 | 774 | 2,114 | 300 | 300 | 300 | ------ | 285 | 260 | (*a*) | (*a*) |
| 3 | 290 | 713 | 713 | 2,059 | ------ | 300 | 300 | 285 | 280 | 260 | (*a*) | (*a*) |
| 4 | ------ | 713 | 653 | 2,059 | 300 | 300 | ------ | 285 | 280 | ------ | (*a*) | (*a*) |
| 5 | 290 | 682 | 594 | 2,059 | 300 | 300 | ------ | 285 | 280 | 260 | (*a*) | (*a*) |
| 6 | 290 | 620 | 567 | 1,940 | 300 | 300 | 300 | 285 | ------ | 250 | (*a*) | 220 |
| 7 | 290 | 590 | 540 | 1,836 | 300 | ------ | 300 | 290 | 280 | 250 | (*a*) | 220 |
| 8 | 290 | ------ | 540 | 1,782 | 300 | 300 | 300 | 290 | 280 | 250 | (*a*) | 220 |
| 9 | 290 | 373 | 515 | 1,598 | 300 | 300 | 300 | ------ | 280 | 250 | (*a*) | 220 |
| 10 | 290 | 435 | 540 | 1,567 | ------ | 300 | 300 | 285 | 280 | 250 | (*a*) | (*a*) |
| 11 | ------ | 458 | 743 | 1,495 | 300 | 300 | 300 | 285 | 280 | ------ | (*a*) | (*a*) |
| 12 | 300 | 458 | 807 | 1,514 | 300 | 300 | ------ | 285 | 270 | 250 | (*a*) | (*a*) |
| 13 | 300 | 458 | 807 | 1,514 | 300 | 300 | 290 | 285 | ------ | 250 | (*a*) | (*b*) |
| 14 | 300 | 548 | 1,801 | 1,365 | 300 | ------ | 290 | 285 | 270 | 250 | (*a*) | (*a*) |
| 15 | 300 | 529 | 1,753 | 1,223 | 300 | 300 | 290 | 285 | 270 | 250 | (*a*) | (*a*) |
| 16 | 300 | 590 | 1,573 | 1,270 | 300 | 300 | 290 | ------ | 270 | 250 | (*a*) | (*a*) |
| 17 | 300 | 602 | 1,364 | 1,318 | ------ | 300 | 290 | 285 | 270 | 250 | (*a*) | (*a*) |
| 18 | 300 | 574 | 1,286 | 1,318 | 300 | 300 | 290 | 285 | 270 | ------ | (*a*) | (*a*) |
| 19 | 300 | 516 | 1,241 | 1,318 | 300 | 300 | ------ | 285 | 270 | 220 | (*a*) | (*a*) |
| 20 | 300 | 516 | 1,204 | 1,318 | 306 | 300 | 290 | 285 | ------ | 220 | (*a*) | (*b*) |
| 21 | 300 | 483 | 1,167 | 1,273 | 314 | ------ | 290 | 285 | 270 | 220 | (*a*) | (*a*) |
| 22 | 300 | 483 | 1,531 | 1,050 | 316 | 300 | 290 | 285 | 270 | 220 | (*a*) | (*a*) |
| 23 | 503 | 363 | 2,199 | 1,013 | 300 | 300 | 290 | ------ | 270 | 220 | (*a*) | (*a*) |
| 24 | 1,120 | 363 | 2,365 | 300 | ------ | 300 | 290 | 285 | 260 | 220 | (*a*) | 220 |
| 25 | 1,100 | 393 | 2.365 | 300 | 300 | 300 | 290 | 285 | 260 | ------ | (*a*) | (*b*) |
| 26 | 1,063 | 620 | 2,585 | 314 | 300 | 300 | ------ | 285 | 260 | 220 | (*a*) | (*b*) |
| 27 | 1,063 | 942 | 2,531 | 306 | 300 | 300 | 290 | 285 | ------ | (*a*) | (*a*) | (*b*) |
| 28 | 1,063 | 907 | 2,344 | 306 | 300 | ------ | 290 | 285 | 260 | (*a*) | (*a*) | 220 |
| 29 | 1,063 | ------ | 2,344 | 300 | 300 | 300 | 290 | 285 | 260 | (*a*) | (*a*) | 220 |
| 30 | 1,079 | ------ | 2,344 | 300 | 300 | 300 | 290 | ------ | 260 | (*a*) | (*a*) | 220 |
| 31 | 1,001 | ------ | 2,295 | ------ | ------ | ------ | 290 | 285 | ------ | (*a*) | ------ | 220 |
| Mean | 516 | 576 | 1,385 | 1,277 | 301 | 300 | 293 | 286 | 272 | 242 | ------ | ------ |

*a* Water so low only gage record kept.
*b* Water shut back Sundays and holidays.

*Daily discharge in second-feet of Cobbosseecontee River, at the upper dam, near Augusta, Maine*—Continued.

1892.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 270 | 280 | 280 | ....... | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| 2 | 220 | 270 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | ....... | 280 | 280 |
| 3 | ....... | 270 | 280 | ....... | 280 | 280 | ....... | 280 | 280 | 280 | 280 | 280 |
| 4 | 220 | 280 | 280 | 280 | 280 | 280 | ....... | 280 | ....... | 280 | 280 | ....... |
| 5 | 250 | 280 | 280 | 280 | 280 | ....... | 280 | 280 | 280 | 280 | 280 | 280 |
| 6 | 250 | 280 | ....... | 294 | 280 | 280 | 280 | 280 | 280 | 280 | ....... | 280 |
| 7 | 250 | ....... | 280 | 294 | 280 | 280 | 280 | ....... | 280 | 280 | 280 | 280 |
| 8 | 250 | 280 | 280 | 294 | ....... | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| 9 | 250 | 280 | 280 | 286 | 280 | 280 | 280 | 280 | 280 | ....... | 280 | 280 |
| 10 | ....... | 280 | 280 | ....... | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| 11 | 250 | 280 | 280 | 306 | 280 | 280 | (*a*) | 280 | ....... | 280 | 280 | ....... |
| 12 | 250 | 280 | 280 | 294 | 280 | ....... | (*a*) | 280 | 280 | 280 | 280 | 280 |
| 13 | 250 | 280 | ....... | 280 | 280 | 280 | (*a*) | 280 | 280 | 280 | ....... | 280 |
| 14 | 250 | ....... | 280 | 280 | 280 | 280 | (*a*) | ....... | 280 | 280 | 280 | 280 |
| 15 | 270 | 280 | 280 | 280 | ....... | 280 | (*a*) | 280 | 280 | 280 | 280 | 280 |
| 16 | 270 | 280 | 280 | 280 | 280 | 280 | (*a*) | 280 | 280 | ....... | 280 | 280 |
| 17 | ....... | 280 | 280 | ....... | 280 | 280 | (*a*) | 280 | 280 | 280 | 280 | 280 |
| 18 | 270 | 280 | 280 | 280 | 280 | ....... | 280 | 280 | ....... | 280 | 280 | ....... |
| 19 | 270 | 280 | 280 | 280 | 280 | ....... | 280 | 280 | 280 | 280 | 280 | 280 |
| 20 | 276 | 280 | ....... | 280 | 280 | 280 | 280 | 280 | 280 | 280 | ....... | 280 |
| 21 | 276 | ....... | 280 | 280 | 280 | 280 | 280 | ....... | 280 | 280 | 280 | 280 |
| 22 | 270 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| 23 | 270 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | ....... | 280 | 280 |
| 24 | ....... | 280 | 280 | ....... | 280 | 280 | ....... | 280 | 280 | 280 | ....... | 280 |
| 25 | 270 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | ....... | 280 | 280 | ....... |
| 26 | 270 | 280 | 280 | 280 | 280 | ....... | 280 | 280 | 280 | 280 | 280 | 280 |
| 27 | 270 | 280 | ....... | 280 | 280 | 280 | 280 | 280 | 280 | 280 | ....... | 280 |
| 28 | 270 | ....... | 280 | 280 | 280 | 280 | 280 | ....... | 280 | 280 | 280 | 280 |
| 29 | 270 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| 30 | 270 | ....... | 280 | 280 | 280 | 280 | 280 | 280 | 280 | ....... | 280 | 280 |
| 31 | ....... | ....... | 280 | ....... | 280 | ....... | ....... | 280 | ....... | 280 | ....... | 280 |
| Mean | 258 | 279 | 280 | 283 | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |

*a* Water shut back.

1893.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ....... | 280 | 280 | 535 | 435 | 300 | 280 | 280 | (*a*) | ....... | 250 | 220 |
| 2 | 280 | 280 | 280 | 314 | 458 | 390 | ....... | 280 | (*a*) | 250 | 250 | 220 |
| 3 | 280 | 280 | 280 | 300 | 509 | 300 | 280 | 280 | (*a*) | 250 | 250 | ....... |
| 4 | 280 | 280 | 280 | 300 | 596 | ....... | ....... | 280 | 270 | 250 | 250 | 220 |
| 5 | 280 | 280 | ....... | 300 | 1,079 | 300 | 280 | 280 | (*a*) | 220 | ....... | 220 |
| 6 | 280 | 280 | 280 | 300 | 1,295 | 300 | 280 | ....... | (*a*) | (*a*) | 220 | 220 |
| 7 | 280 | 280 | 280 | 300 | 1,179 | 300 | 280 | 280 | (*a*) | (*a*) | 220 | 220 |
| 8 | ....... | 280 | 280 | 300 | 985 | 300 | 280 | 270 | (*a*) | (*a*) | 220 | 220 |
| 9 | 280 | 280 | 280 | ....... | 713 | 300 | ....... | 270 | 270 | 220 | 220 | 220 |
| 10 | 280 | 280 | 280 | 300 | 620 | 300 | 280 | 270 | ....... | 220 | 220 | ....... |
| 11 | 280 | 280 | 280 | 314 | 590 | ....... | 280 | 270 | 270 | 220 | 220 | 220 |
| 12 | 280 | ....... | ....... | 481 | 562 | 280 | 280 | 270 | 270 | 220 | ....... | 220 |
| 13 | 280 | 280 | 280 | 682 | 562 | 280 | 280 | ....... | 270 | (*a*) | 220 | 220 |
| 14 | 280 | 280 | 509 | 650 | 887 | 280 | 280 | 270 | 270 | (*a*) | 220 | 220 |
| 15 | ....... | 280 | 620 | 650 | 1,262 | 280 | 280 | 270 | (*a*) | (*a*) | 220 | 220 |
| 16 | 280 | 280 | 620 | 1,040 | 1,354 | 280 | ....... | 270 | (*a*) | 220 | 220 | 220 |
| 17 | 280 | 280 | 535 | 1,079 | 1,552 | 280 | 280 | 270 | (*a*) | 220 | 220 | ....... |
| 18 | 280 | 280 | 509 | 1,001 | 2,680 | ....... | 280 | 270 | 270 | 220 | 220 | 220 |
| 19 | 280 | ....... | 458 | 962 | 2,481 | 280 | 280 | 270 | 270 | (*a*) | ....... | 220 |
| 20 | 280 | 280 | 435 | 925 | 2,002 | 280 | 280 | ....... | 270 | (*a*) | 220 | 220 |
| 21 | 280 | 280 | 393 | 887 | 1,900 | 280 | 280 | 270 | 270 | (*a*) | 220 | 220 |
| 22 | ....... | 280 | 393 | 962 | 1,752 | 280 | 280 | 270 | (*a*) | (*a*) | 220 | 220 |
| 23 | 280 | 280 | 356 | 962 | 1,660 | 280 | ....... | 270 | (*a*) | (*a*) | 220 | 220 |
| 24 | 280 | 280 | 356 | 925 | 1,428 | 280 | 280 | 270 | (*a*) | (*a*) | 220 | ....... |
| 25 | 280 | 280 | 356 | 780 | 1,052 | ....... | 280 | 270 | 250 | 250 | 220 | ....... |
| 26 | 280 | ....... | 458 | 713 | 562 | 280 | 280 | 270 | 250 | 250 | ....... | 220 |
| 27 | 280 | 280 | 590 | 620 | 326 | 280 | 280 | ....... | 250 | 250 | 220 | 220 |
| 28 | 280 | 280 | 620 | 650 | 326 | 280 | 280 | 270 | 250 | 250 | 220 | 220 |
| 29 | ....... | ....... | 562 | 620 | 326 | 280 | 280 | 270 | 250 | ....... | 220 | 220 |
| 30 | 280 | ....... | 780 | 393 | 326 | 280 | ....... | 270 | 250 | 250 | ....... | 220 |
| 31 | 280 | ....... | 620 | ....... | 307 | ....... | 280 | 270 | ....... | 250 | ....... | ....... |
| Mean | 280 | 280 | 422 | 629 | 1,025 | 287 | 280 | 272 | 263 | 236 | 225 | 220 |

*a* Water shut back.

*Daily discharge in second-feet of Cobbosseecontee River, at the upper dam, near Augusta, Maine*—Continued.

1894.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 220 | 220 | ...... | 300 | 925 | ...... | 280 | 280 | 270 | 250 | 250 |
| 2 | 220 | 220 | 220 | 314 | 300 | 889 | 280 | 280 | ...... | 250 | 250 | ...... |
| 3 | 220 | 220 | 220 | 314 | 300 | 674 | 280 | 280 | ...... | 250 | 250 | 250 |
| 4 | 220 | ...... | ...... | 306 | 280 | 326 | ...... | 280 | 280 | 250 | ...... | 250 |
| 5 | 220 | 220 | 220 | 306 | 280 | 326 | 280 | ...... | 280 | 250 | 250 | 250 |
| 6 | 220 | 220 | 220 | 306 | ...... | 326 | 280 | 280 | 280 | 250 | 250 | 250 |
| 7 | ...... | 220 | 220 | 306 | 280 | 326 | 280 | 280 | 270 | ...... | 250 | 250 |
| 8 | 220 | 220 | 220 | 26 | 280 | 326 | ...... | 280 | 270 | 250 | 250 | 250 |
| 9 | 220 | 220 | 220 | 326 | 280 | 326 | 280 | 280 | ...... | 250 | 250 | ...... |
| 10 | 220 | 220 | 220 | 314 | 280 | 200 | 280 | 280 | 270 | 250 | 250 | 250 |
| 11 | 220 | ...... | ...... | 314 | 280 | 326 | 280 | 280 | 270 | 250 | ...... | 250 |
| 12 | 220 | 220 | 276 | 314 | 280 | 314 | 280 | ...... | 270 | 250 | 250 | 250 |
| 13 | 220 | 220 | 483 | 314 | ...... | 300 | 280 | 280 | 270 | 250 | 250 | 250 |
| 14 | ...... | 220 | 483 | 314 | 280 | 300 | 280 | 280 | 270 | ...... | 250 | 250 |
| 15 | 220 | 220 | 426 | ...... | 280 | 280 | ...... | 280 | 270 | 250 | 250 | 250 |
| 16 | 220 | 220 | 426 | 430 | 280 | 280 | 280 | 280 | ...... | 250 | 250 | ...... |
| 17 | 220 | 220 | 410 | 430 | 280 | ...... | 280 | 280 | 270 | 250 | 250 | 250 |
| 18 | 220 | ...... | 405 | 430 | 280 | 280 | 280 | 280 | 270 | 250 | ...... | 250 |
| 19 | 220 | 220 | 405 | 314 | 280 | 280 | 280 | ...... | 270 | 250 | 250 | 250 |
| 20 | 220 | 220 | 630 | 314 | ...... | 280 | 280 | 280 | 270 | 250 | 250 | 250 |
| 21 | ...... | 220 | 900 | 314 | 280 | 280 | 280 | 280 | 270 | ...... | 250 | 250 |
| 22 | 220 | 220 | 887 | 26 | 280 | 280 | ...... | 280 | 270 | 250 | 250 | 250 |
| 23 | 220 | 220 | 692 | 326 | 280 | 280 | 280 | 280 | ...... | 250 | 250 | ...... |
| 24 | 220 | 220 | 306 | 314 | 280 | ...... | 280 | 280 | 270 | 250 | 250 | 250 |
| 25 | 220 | ...... | 14 | 314 | 280 | 280 | 280 | 280 | 270 | 250 | ...... | ...... |
| 26 | 220 | 220 | 314 | 306 | 336 | 280 | 280 | ...... | 270 | 250 | 250 | 250 |
| 27 | 220 | 220 | 314 | 300 | 523 | 280 | 280 | 280 | 270 | 250 | 250 | 250 |
| 28 | ...... | 220 | 314 | 300 | 499 | 280 | 280 | 280 | 270 | ...... | 250 | 250 |
| 29 | 220 | ...... | 300 | ...... | 370 | 280 | ...... | 280 | 270 | 250 | ...... | 250 |
| 30 | 220 | ...... | 300 | 300 | 523 | 280 | 280 | 280 | ...... | 250 | 250 | ...... |
| 31 | 220 | ...... | 300 | ...... | 862 | ...... | 280 | 280 | ...... | 250 | ...... | 250 |
| Mean | 220 | 220 | 364 | 303 | 333 | 350 | 280 | 280 | 272 | 251 | 250 | 250 |

1895.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 250 | 250 | ...... | 250 | 385 | 280 | 280 | 280 | ...... | 220 | (*a*) | ...... |
| 2 | 250 | 250 | ...... | 250 | 318 | ...... | 280 | 280 | 270 | 220 | (*a*) | 220 |
| 3 | 250 | ...... | ...... | 250 | 300 | 280 | 280 | 280 | 270 | 220 | ...... | 220 |
| 4 | 250 | 220 | 220 | 250 | 290 | 280 | ...... | ...... | 270 | (*a*) | (*a*) | 220 |
| 5 | 250 | 220 | 220 | 250 | ...... | 280 | 280 | 280 | 270 | (*a*) | (*a*) | 220 |
| 6 | ...... | 220 | 220 | 250 | 280 | 280 | 280 | 280 | 270 | ...... | (*a*) | 220 |
| 7 | 250 | 220 | 220 | 14 | 280 | 280 | ...... | 280 | 270 | 220 | (*a*) | 220 |
| 8 | 250 | 220 | ...... | 343 | 280 | 280 | 280 | 280 | ...... | (*a*) | (*a*) | ...... |
| 9 | 250 | 220 | 220 | 733 | 280 | ...... | 280 | 280 | 270 | (*a*) | (*a*) | 220 |
| 10 | 250 | ...... | ...... | 2,619 | 280 | 280 | 280 | 280 | 250 | (*a*) | ...... | 220 |
| 11 | 250 | 220 | 220 | 1,301 | 280 | 280 | 280 | ...... | 250 | (*a*) | (*a*) | 220 |
| 12 | 250 | 220 | 220 | 1,384 | ...... | 280 | 280 | 270 | 250 | (*a*) | (*a*) | 220 |
| 13 | ...... | 220 | 220 | 300 | 280 | 280 | 280 | 270 | 250 | ...... | (*a*) | 220 |
| 14 | 250 | 220 | 220 | 74 | 280 | 280 | ...... | 270 | 250 | (*a*) | (*a*) | 220 |
| 15 | 250 | 220 | 220 | 2,603 | 280 | 280 | 280 | 270 | ...... | (*a*) | (*a*) | ...... |
| 16 | 250 | 220 | 220 | 2,461 | 280 | ...... | 280 | 270 | 250 | (*a*) | (*a*) | 220 |
| 17 | 250 | ...... | ...... | 1,698 | 280 | 280 | 280 | 270 | 250 | (*a*) | ...... | 220 |
| 18 | 250 | 220 | 220 | 1,609 | 280 | 280 | 280 | ...... | 250 | (*a*) | 220 | 220 |
| 19 | 250 | 220 | 220 | 1,400 | ...... | 280 | 280 | 270 | 250 | (*a*) | 220 | 220 |
| 20 | ...... | 220 | 220 | 1,271 | 280 | 280 | 280 | 270 | (*a*) | ...... | 220 | 220 |
| 21 | 250 | 220 | 220 | 480 | ...... | 280 | ...... | 270 | (*a*) | (*a*) | 220 | 220 |
| 22 | 250 | 220 | 220 | 664 | 280 | 280 | 280 | 270 | ...... | (*a*) | 220 | ...... |
| 23 | 250 | 220 | 220 | 358 | 280 | ...... | 280 | 270 | 220 | (*a*) | 220 | 220 |
| 24 | 250 | ...... | ...... | 385 | 280 | 280 | 280 | 270 | 220 | (*a*) | ...... | 220 |
| 25 | 250 | 220 | 220 | 385 | 280 | 280 | 280 | ...... | 220 | (*a*) | 220 | ...... |
| 26 | 250 | 220 | 220 | 385 | ...... | 280 | 280 | 270 | 220 | (*a*) | 220 | 250 |
| 27 | ...... | 220 | 220 | 385 | 280 | 280 | 280 | 270 | 220 | ...... | 220 | 250 |
| 28 | 250 | ...... | 220 | 409 | 280 | 280 | ...... | 270 | 220 | (*a*) | ...... | 250 |
| 29 | 250 | ...... | 220 | 409 | 280 | 280 | 280 | 270 | ...... | (*a*) | 220 | 14 |
| 30 | 250 | ...... | 220 | 409 | 280 | ...... | 280 | 270 | 220 | (*a*) | 220 | 264 |
| 31 | 250 | ...... | ...... | ...... | 280 | ...... | 280 | 270 | ...... | (*a*) | ...... | 343 |
| Mean | 250 | 223 | 220 | 785 | 287 | 280 | 280 | 273 | 247 | 220 | 220 | 222 |

*a* Gates up; natural flow.

*Daily discharge in second-feet of Cobbosseecontee River, at the upper dam, near Augusta, Maine*—Continued.

1896.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ....... | 270 | ....... | 901 | 300 | 280 | 280 | 280 | 250 | 250 | ....... | 250 |
| 2 | 451 | ....... | 1,959 | 993 | 300 | 280 | 280 | ....... | 250 | 250 | 220 | 250 |
| 3 | 276 | 270 | 2,698 | 901 | ....... | 280 | 280 | 280 | 250 | 250 | 220 | 250 |
| 4 | 264 | 270 | 1,959 | 856 | 300 | 280 | ....... | 280 | 250 | ....... | 220 | 250 |
| 5 | ....... | 270 | 1,637 | 856 | 300 | 280 | ....... | 270 | 250 | 250 | 220 | 250 |
| 6 | 270 | 270 | 1,219 | 856 | 300 | 280 | 280 | 270 | ....... | 250 | 220 | ....... |
| 7 | 270 | 270 | 1,219 | 856 | 280 | ....... | 280 | 270 | 250 | 250 | 220 | 250 |
| 8 | 270 | 270 | 1,226 | 856 | 280 | 280 | 280 | 270 | 250 | 250 | ....... | 250 |
| 9 | 270 | ....... | 1,368 | 769 | 280 | 280 | 280 | ....... | 250 | 250 | 220 | 250 |
| 10 | 270 | 270 | 1,368 | 727 | ....... | 280 | 280 | 270 | 250 | 250 | 220 | 250 |
| 11 | 270 | 270 | 946 | 727 | 280 | 280 | 280 | 270 | 250 | ....... | 220 | 250 |
| 12 | ....... | 270 | 1,038 | 727 | 280 | 280 | ....... | 270 | 250 | 250 | 220 | 250 |
| 13 | 270 | 270 | 1,086 | 727 | 280 | 280 | 280 | 270 | ....... | 250 | 220 | ....... |
| 14 | 270 | 270 | 1,038 | 812 | 280 | ....... | 280 | 270 | 250 | 220 | 220 | 250 |
| 15 | 270 | 270 | 901 | 812 | 280 | 280 | 280 | 270 | 270 | 220 | ....... | 250 |
| 16 | 270 | ....... | 769 | 901 | 280 | 280 | 280 | ....... | 270 | 220 | 220 | 250 |
| 17 | 270 | 270 | 727 | 946 | ....... | 280 | 280 | 270 | 270 | 220 | 220 | 250 |
| 18 | 270 | 270 | 685 | 1,188 | 280 | 280 | 280 | 270 | 250 | ....... | 250 | 250 |
| 19 | ....... | 270 | 856 | 1,236 | 280 | 280 | ....... | 270 | 250 | 220 | 250 | 250 |
| 20 | 270 | 270 | 993 | 1,039 | 280 | 280 | 280 | 270 | ....... | 220 | 250 | ....... |
| 21 | 270 | 270 | 1,581 | 901 | 280 | ....... | 280 | 270 | 250 | 220 | 250 | 250 |
| 22 | 270 | 270 | 1,429 | 992 | 280 | 280 | 280 | 270 | 250 | 220 | ....... | 250 |
| 23 | 270 | ....... | 1,275 | 1,039 | 280 | 280 | 280 | ....... | 250 | 220 | 250 | 250 |
| 24 | 270 | 280 | 1,056 | 901 | ....... | 280 | 280 | 270 | 250 | 220 | 250 | 250 |
| 25 | 270 | 280 | 728 | 769 | 280 | 280 | 280 | 270 | 250 | ....... | 250 | ....... |
| 26 | ....... | 280 | 686 | 644 | 280 | 280 | ....... | 270 | 250 | 220 | ....... | 250 |
| 27 | 270 | 280 | 812 | 526 | 280 | 280 | 280 | 270 | ....... | 220 | 250 | ....... |
| 28 | 270 | 280 | 769 | 300 | 280 | ....... | 280 | 270 | 250 | 220 | 250 | 250 |
| 29 | 270 | 280 | 727 | 300 | 280 | 280 | 280 | 270 | 250 | 220 | ....... | 250 |
| 30 | 270 | ....... | 644 | 300 | ....... | 280 | 280 | ....... | 250 | 220 | 250 | 250 |
| 31 | 270 | ....... | 727 | ....... | ....... | ....... | 280 | 250 | ....... | 220 | ....... | 250 |
| Mean | 277 | 272 | 1,138 | 812 | 284 | 280 | 280 | 270 | 252 | 232 | 233 | 250 |

1897.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 250 | 250 | 250 | 497 | 280 | 600 | 280 | ....... | 280 | 280 | 270 | 270 |
| 2 | 250 | 250 | 250 | 517 | ....... | 477 | 280 | 280 | 280 | 280 | 270 | 270 |
| 3 | ....... | 250 | 250 | 574 | 368 | 573 | 280 | 280 | 280 | ....... | 270 | 270 |
| 4 | 250 | 250 | 250 | 350 | 624 | 523 | ....... | 280 | 280 | 280 | 270 | 270 |
| 5 | 250 | 250 | 250 | 620 | 630 | 477 | 100 | 280 | ....... | 280 | 270 | ....... |
| 6 | 250 | 250 | 250 | 650 | 320 | 262 | 280 | 280 | 280 | 280 | 270 | 270 |
| 7 | 250 | ....... | ....... | 650 | 320 | 336 | 280 | 280 | 280 | 280 | ....... | 270 |
| 8 | 250 | 250 | 250 | 650 | 320 | 336 | 280 | ....... | 280 | 280 | 270 | 270 |
| 9 | 250 | 250 | 250 | 620 | 74 | 320 | 280 | 280 | 280 | 280 | 270 | 270 |
| 10 | ....... | 250 | 250 | 620 | 373 | 320 | 280 | 280 | 280 | ....... | 270 | 270 |
| 11 | 250 | 250 | 250 | 650 | 393 | 512 | ....... | 280 | 280 | 280 | 270 | 270 |
| 12 | 250 | 250 | 250 | 590 | 393 | 559 | 280 | 280 | ....... | 280 | 270 | ....... |
| 13 | 250 | 250 | 250 | 421 | 393 | 679 | 280 | 280 | 280 | 280 | 270 | 270 |
| 14 | 250 | ....... | ....... | 310 | ....... | 679 | 280 | 280 | 280 | 270 | ....... | 270 |
| 15 | 250 | 250 | 250 | 356 | 489 | 436 | 280 | ....... | 280 | (*a*) | 270 | 270 |
| 16 | 250 | 250 | 250 | 522 | 244 | 354 | 280 | 280 | 280 | (*a*) | 270 | 270 |
| 17 | ....... | 250 | 250 | 497 | 509 | 320 | 280 | 280 | 280 | (*a*) | 270 | 270 |
| 18 | 250 | 250 | 250 | 497 | 833 | 294 | ....... | 280 | 280 | (*a*) | 270 | 280 |
| 19 | 250 | 550 | 250 | 473 | 769 | 286 | 280 | 280 | ....... | (*a*) | 270 | ....... |
| 20 | 250 | 250 | 250 | 453 | 739 | 6 | 280 | 280 | 280 | (*a*) | 270 | 280 |
| 21 | 250 | ....... | ....... | 320 | 709 | 286 | 280 | 280 | 280 | (*a*) | ....... | 280 |
| 22 | 250 | 250 | 250 | 294 | 391 | 436 | 280 | ....... | 280 | (*a*) | 270 | 280 |
| 23 | 250 | 250 | 250 | 286 | 6 | 654 | 280 | 280 | 280 | (*a*) | 270 | 280 |
| 24 | ....... | 250 | 250 | 280 | 280 | 365 | 280 | 280 | 280 | ....... | 270 | 280 |
| 25 | 250 | 250 | 250 | 14 | 280 | 294 | ....... | 280 | 280 | 270 | 270 | 21 |
| 26 | 250 | 250 | 250 | 286 | 280 | 286 | 280 | 280 | ....... | 270 | 270 | ....... |
| 27 | 250 | 250 | 250 | 280 | 280 | ....... | 280 | 280 | 280 | 270 | 270 | 280 |
| 28 | 250 | ....... | ....... | 286 | 320 | 280 | 280 | 280 | 280 | 270 | ....... | 280 |
| 29 | 250 | ....... | 250 | 286 | 19 | 280 | 280 | ....... | 280 | 270 | 270 | 280 |
| 30 | 250 | ....... | 250 | 280 | 914 | 280 | 280 | 280 | 280 | 270 | 270 | 280 |
| 31 | ....... | ....... | 306 | ....... | 772 | ....... | 280 | 280 | ....... | ....... | ....... | 280 |
| Mean | 250 | 250 | 252 | 438 | 425 | 397 | 273 | 280 | 280 | 276 | 270 | 265 |

*a* Gates up; all that flows.

*Daily discharge in second-feet of Cobbosseecontee River, at the upped dam, near Augusta, Maine*—Continued.

1898.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 280 | 280 | 413 | ...... | 478 | 280 | 280 | 280 | 270 | 250 | 250 | 250 |
| 2 | ...... | 280 | 394 | ...... | 478 | 280 | 280 | 280 | 270 | ...... | 250 | 250 |
| 3 | 280 | 280 | 443 | 1,016 | 478 | 280 | ...... | 280 | 270 | 250 | 250 | 250 |
| 4 | 280 | 280 | 408 | 1,038 | 455 | 280 | 19 | 280 | ...... | 250 | 250 | ...... |
| 5 | 280 | 280 | 408 | 1,038 | 455 | ...... | 280 | 280 | 250 | 250 | 250 | 270 |
| 6 | 280 | ...... | 387 | 1,038 | 433 | 280 | 280 | 280 | 250 | 250 | ...... | 270 |
| 7 | 280 | 280 | 466 | 1,038 | 433 | 280 | 280 | ...... | 250 | 250 | 250 | 270 |
| 8 | 280 | 280 | 529 | 1,038 | 273 | 280 | 280 | 280 | 250 | 250 | 250 | 270 |
| 9 | ...... | 280 | 503 | 1,038 | 333 | 280 | 280 | 280 | 250 | ...... | 250 | 270 |
| 10 | 280 | 280 | 474 | 1,003 | 333 | 280 | ...... | 280 | 250 | 250 | 250 | 270 |
| 11 | 280 | 280 | 456 | 584 | 314 | 280 | 280 | 280 | ...... | 250 | 250 | ...... |
| 12 | 280 | 280 | 559 | 531 | 300 | ...... | 280 | 280 | 250 | 250 | 250 | 270 |
| 13 | 280 | ...... | 597 | 326 | 300 | 280 | 280 | 280 | 250 | 250 | ...... | 270 |
| 14 | 280 | 280 | 821 | 326 | 300 | 280 | 280 | ...... | 250 | 250 | 250 | 270 |
| 15 | 280 | 280 | 1,148 | 334 | ...... | 280 | 280 | 280 | 250 | 250 | 250 | 270 |
| 16 | ...... | 300 | 1,111 | 376 | 300 | 280 | 280 | 270 | 250 | ...... | 250 | 270 |
| 17 | 280 | 300 | 1,039 | 413 | 300 | 280 | ...... | 270 | 250 | 220 | 250 | 270 |
| 18 | 280 | 300 | 969 | 433 | 300 | 280 | 280 | 270 | ...... | 220 | 250 | ...... |
| 19 | 280 | 300 | 969 | 433 | 300 | ...... | 280 | 270 | 250 | 220 | 250 | 270 |
| 20 | 280 | 300 | 1,016 | 433 | 300 | 280 | 280 | 270 | 250 | 220 | ...... | 270 |
| 21 | 280 | 328 | 1,222 | 433 | 300 | 280 | 280 | ...... | 250 | 220 | 250 | 270 |
| 22 | 280 | 328 | 1,184 | 433 | ...... | 280 | 280 | 270 | 250 | 220 | 250 | 270 |
| 23 | ...... | 333 | 1,147 | 433 | 300 | 280 | 280 | 270 | 250 | ...... | 250 | 270 |
| 24 | 280 | 445 | 1,222 | 433 | 300 | 280 | ...... | 270 | 250 | 220 | ...... | 270 |
| 25 | 280 | 504 | 1,261 | 555 | 280 | 280 | 280 | 270 | ...... | 220 | 250 | ...... |
| 26 | 280 | 477 | 1,222 | 732 | 280 | ...... | 280 | 270 | 250 | 220 | 250 | 270 |
| 27 | 280 | 435 | 1,125 | 682 | 280 | 280 | 280 | 270 | 250 | 220 | ...... | 270 |
| 28 | 280 | 433 | 1,147 | 478 | 280 | 280 | 280 | ...... | 250 | 250 | 250 | 270 |
| 29 | 280 | ...... | 1,184 | 478 | ...... | 280 | 280 | 270 | 250 | 250 | 250 | 270 |
| 30 | ...... | ...... | 1,147 | 620 | 280 | 280 | 280 | 270 | 250 | ...... | 250 | 270 |
| 31 | 280 | ...... | 1,147 | ...... | 280 | ...... | ...... | 270 | ...... | 250 | ...... | 270 |
| Mean | 280 | 324 | 843 | 633 | 337 | 280 | 270 | 275 | 252 | 238 | 250 | 268 |

1899.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | 270 | 270 | 300 | 300 | 280 | 280 | 280 | 270 | (*a*) | 160 | 160 |
| 2 | 270 | 270 | 270 | 306 | 300 | 280 | ...... | 280 | 270 | (*a*) | 180 | 160 |
| 3 | 270 | 270 | 270 | 306 | 300 | 280 | 280 | 280 | ...... | (*a*) | 180 | ...... |
| 4 | 270 | 270 | 270 | 306 | 300 | ...... | 19 | 280 | 270 | (*a*) | 170 | 180 |
| 5 | 270 | ...... | ...... | 359 | 300 | 280 | 280 | 280 | 250 | (*a*) | ...... | 180 |
| 6 | 270 | 270 | 270 | 373 | 300 | 280 | 280 | ...... | 250 | (*a*) | 180 | 180 |
| 7 | 270 | 270 | 250 | 395 | ...... | 280 | 280 | 280 | 250 | (*a*) | 175 | 170 |
| 8 | ...... | 270 | 270 | 502 | 300 | 280 | 280 | 280 | 250 | (*a*) | 170 | 150 |
| 9 | 270 | 270 | 270 | 842 | 300 | 280 | ...... | 280 | (*a*) | (*a*) | 170 | 135 |
| 10 | 270 | 270 | 270 | 1,198 | 300 | 280 | 280 | 280 | ...... | (*a*) | 150 | ...... |
| 11 | 270 | 270 | 270 | 1,262 | 300 | ...... | 280 | 280 | 250 | (*a*) | 150 | 120 |
| 12 | 270 | ...... | ...... | 984 | 300 | 280 | 280 | 280 | 250 | (*a*) | ...... | 120 |
| 13 | 270 | 270 | 270 | 772 | 300 | 280 | 280 | ...... | 250 | (*a*) | 150 | 120 |
| 14 | 270 | 270 | 270 | 809 | ...... | 280 | 280 | 280 | (*a*) | (*a*) | 150 | 120 |
| 15 | ...... | 270 | 270 | 809 | 290 | 280 | 280 | 280 | (*a*) | (*a*) | 140 | 120 |
| 16 | 270 | 270 | 270 | 787 | 290 | 280 | ...... | 270 | (*a*) | (*a*) | 130 | 140 |
| 17 | 270 | 270 | 270 | 947 | 290 | 280 | 280 | 270 | ...... | (*a*) | 130 | ...... |
| 18 | 270 | 270 | 270 | 1,243 | 290 | ...... | 280 | 270 | 250 | (*a*) | 130 | 140 |
| 19 | 270 | ...... | ...... | 1,387 | 290 | 280 | 280 | 270 | (*a*) | (*a*) | ...... | 135 |
| 20 | 270 | 270 | 270 | 1,427 | 290 | 280 | 280 | ...... | (*a*) | (*a*) | 160 | 135 |
| 21 | 270 | 270 | 270 | 1,403 | ...... | 280 | 280 | 270 | (*a*) | (*a*) | 170 | 135 |
| 22 | ...... | 270 | 270 | 1,331 | 280 | 280 | 280 | 270 | (*a*) | (*a*) | 180 | 135 |
| 23 | 270 | 270 | 270 | 1,145 | 20 | 280 | ...... | 270 | (*a*) | (*a*) | 180 | 135 |
| 24 | 270 | 270 | 270 | 1,130 | 280 | 280 | 280 | 270 | ...... | (*a*) | 180 | ...... |
| 25 | 270 | 270 | 270 | 870 | 280 | ...... | 280 | 270 | 220 | (*a*) | 180 | ...... |
| 26 | 270 | ...... | ...... | 669 | 280 | 280 | 280 | 270 | (*a*) | (*a*) | ...... | 150 |
| 27 | 270 | 270 | 270 | 635 | 280 | 280 | 280 | ...... | (*a*) | (*a*) | 170 | 150 |
| 28 | 270 | 270 | 270 | 470 | ...... | 280 | 280 | 270 | (*a*) | (*a*) | 165 | 140 |
| 29 | ...... | ...... | 280 | 324 | 280 | 280 | 280 | 270 | (*a*) | (*a*) | 150 | 140 |
| 30 | 270 | ...... | 280 | ...... | 280 | 280 | ...... | 270 | (*a*) | (*a*) | ...... | 140 |
| 31 | 270 | ...... | 280 | ...... | 280 | ...... | 280 | 270 | ...... | ...... | ...... | ...... |
| Mean | 270 | 270 | 270 | 803 | 281 | 280 | 270 | 275 | 252 | ...... | 162 | 144 |

*a* Gates up; all that flows.

### MERRIMAC RIVER AT MANCHESTER, NEW HAMPSHIRE.

This stream receives the drainage from a considerable portion of the White Mountain area in New Hampshire. Its flow is regulated by a number of large lakes near the headwaters, the outlets of many of which are controlled by dams. The fall of the stream is considerable and developments of water power have taken place to an extent probably greater than in any other part of the United States. At Manchester records of the height are taken several times a day, generally on the even hours. Mr. H. W. Allen, of the Amoskeag Manufacturing Company, states that the ordinary flow of Merrimac River at that place for eight months of the year is 2,100 second-feet. With this quantity all the water wheels can be run. The minimum low-season flow for this year he would call 1,084 second-feet. The length of the main dam is 400 feet, and the wing 231 feet. The dam is 177.99 feet above mean tide water at the mouth of the river. Three-foot flashboards can be used in all months except March, April, and May, and then only 2-foot boards. The pondage extends to Hooksett, 8 miles, and covers 443.65 acres. The highest water on the dam of which there is record was on March 2, 1896, when there was 10.95 feet in height, flowing over. The drainage area above Manchester is 2,839 square miles.

### MERRIMAC RIVER AT LAWRENCE, MASSACHUSETTS.

The longest and most careful series of computations of river flow are probably those kept at Lawrence, Massachusetts, having been begun by Mr. J. B. Francis for the Essex Company, and maintained by Mr. Hiram Mills and Mr. R. A. Hale. These extend over fifty years, but have never been published in full. The maximum, minimum, and mean discharge by months, from 1890 to 1897, has been printed in the Nineteenth Annual Report, Part IV, pages 113 to 115, and similar figures for 1898 have been given in the Twentieth Annual Report, Part IV, page 73, accompanied by a diagram showing the fluctuations from 1891 to 1898, inclusive.

*Daily discharge of Merrimac River, at Lawrence, Massachusetts, in cubic feet per second.*

1897.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,807 | 3,776 | 3,963 | 14,238 | 9,957 | 9,153 | 5,642 | 9,220 | 3,074 | 2,647 | 2,374 | 5,150 |
| 2 | 1,943 | 2,931 | 3,636 | 14,616 | 10,049 | 8,090 | 7,037 | 8,574 | 3,467 | 1,872 | 2,782 | 4,406 |
| 3 | 2,180 | 2,775 | 3,669 | 15,348 | 10,908 | 7,394 | 6,497 | 7,539 | 3,840 | 440 | 4,666 | 4,246 |
| 4 | 4,009 | 2,740 | 4,780 | 15,908 | 11,538 | 7,673 | 5,470 | 6,576 | 2,438 | 3,449 | 9,216 | 3,591 |
| 5 | 4,000 | 2,730 | 5,943 | 16,067 | 12,514 | 9,028 | 5,010 | 6,352 | 2,547 | 2,757 | 7,604 | 3,216 |
| 6 | 4,816 | 1,902 | 6,944 | 18,116 | 11,949 | 10,517 | 5,454 | 6,877 | 2,864 | 2,544 | 5,474 | 6,430 |
| 7 | 6,707 | 2,390 | 8,042 | 21,048 | 10,727 | 10,469 | 4,805 | 6,374 | 4,460 | 2,570 | 3,897 | 8,992 |
| 8 | 7,325 | 5,779 | 10,500 | 22,974 | 9,443 | 9,068 | 4,725 | 5,027 | 2,854 | 2,496 | 4,879 | 7,925 |
| 9 | 5,285 | 7,946 | 9,385 | 22,611 | 7,829 | 8,397 | 4,969 | 5,164 | 2,685 | 1,534 | 3,741 | 6,598 |
| 10 | 4,032 | 9,427 | 9,125 | 24,513 | 7,613 | 15,264 | 3,803 | 4,551 | 2,760 | 340 | 4,109 | 5,971 |
| 11 | 5,005 | 9,094 | 10,100 | 24,483 | 6,582 | 40,872 | 3,393 | 4,575 | 2,072 | 2,542 | 5,680 | 5,172 |
| 12 | 3,990 | 7,589 | 12,300 | 21,510 | 7,714 | 35,923 | 4,841 | 5,043 | 1,424 | 2,498 | 6,950 | 5,334 |
| 13 | 3,313 | 6,214 | 13,680 | 17,953 | 8,840 | 26,829 | 3,370 | 5,006 | 3,736 | 2,582 | 8,033 | 8,124 |
| 14 | 3,364 | 4,821 | 13,350 | 16,235 | 14,051 | 21,473 | 16,921 | 4,280 | 2,934 | 2,669 | 7,923 | 9,850 |
| 15 | 2,989 | 5,429 | 11,243 | 15,873 | 24,681 | 19,643 | 32,498 | 3,729 | 2,644 | 2,428 | 7,441 | 15,100 |
| 16 | 2,026 | 4,759 | 10,365 | 18,789 | 19,305 | 17,539 | 41,499 | 4,983 | 2,684 | 2,454 | 6,259 | 32,300 |
| 17 | 1,834 | 4,539 | 8,904 | 23,407 | 14,171 | 14,996 | 26,568 | 4,073 | 2,658 | 1,892 | 6,231 | 36,800 |
| 18 | 4,030 | 4,343 | 8,472 | 23,271 | 11,448 | 12,675 | 16,903 | 4,159 | 1,930 | 3,805 | 6,909 | 28,504 |
| 19 | 3,231 | 4,392 | 8,092 | 20,629 | 9,481 | 11,416 | 13,672 | 4,721 | 1,044 | 2,770 | 7,378 | 20,203 |
| 20 | 3,104 | 3,398 | 9,216 | 18,710 | 8,301 | 9,217 | 11,173 | 4,522 | 3,717 | 2,716 | 6,019 | 14,157 |
| 21 | 2,965 | 3,467 | 11,156 | 17,085 | 7,607 | 10,348 | 9,853 | 2,860 | 3,020 | 2,502 | 4,801 | 12,113 |
| 22 | 3,025 | 4,847 | 13,373 | 14,605 | 6,657 | 10,297 | 9,137 | 3,169 | 2,804 | 2,390 | 5,331 | 10,563 |
| 23 | 2,357 | 4,306 | 13,627 | 13,078 | 5,752 | 9,375 | 8,650 | 5,118 | 2,768 | 1,525 | 4,960 | 10,878 |
| 24 | 2,322 | 3,812 | 16,735 | 12,203 | 6,313 | 7,931 | 9,098 | 3,520 | 2,446 | 398 | 4,851 | 9,169 |
| 25 | 4,049 | 4,241 | 18,717 | 13,761 | 5,676 | 7,117 | 10,241 | 4,480 | 1,886 | 3,096 | 3,022 | 9,170 |
| 26 | 2,997 | 4,036 | 17,871 | 15,884 | 6,716 | 6,877 | 12,121 | 5,467 | 1,370 | 2,566 | 5,424 | 7,065 |
| 27 | 2,783 | 3,427 | 15,549 | 16,933 | 8,226 | 6,478 | 11,661 | 5,285 | 4,019 | 2,341 | 4,390 | 7,633 |
| 28 | 2,771 | 2,869 | 12,944 | 15,214 | 9,060 | 6,376 | 10,466 | 3,996 | 3,087 | 2,506 | 7,816 | 6,116 |
| 29 | 2,699 | ------- | 11,758 | 12,341 | 10,277 | 5,569 | 9,070 | 3,640 | 2,874 | 2,268 | 9,714 | 5,831 |
| 30 | 1,994 | ------- | 11,498 | 10,947 | 10,626 | 5,246 | 9,782 | 5,007 | 2,671 | 1,648 | 6,924 | 5,653 |
| 31 | 1,721 | ------- | 12,777 | ------- | 9,616 | ------- | 10,448 | 3,340 | ------- | 176 | ------- | 5,410 |
| Mean | 3,409 | 4,571 | 10,571 | 17,611 | 10,117 | 12,708 | 10,799 | 5,072 | 2,759 | 2,207 | 5,827 | 10,376 |

1898.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4,751 | 5,000 | 10,050 | 19,795 | 16,279 | 9,964 | 3,853 | 3,575 | 3,357 | 2,455 | 8,384 | 9,778 |
| 2 | 4,246 | 5,550 | 9,500 | 17,566 | 14,774 | 8,697 | 2,826 | 2,833 | 3,224 | 2,077 | 7,759 | 9,856 |
| 3 | 8,200 | 5,100 | 9,240 | 15,026 | 13,387 | 7,771 | 2,623 | 2,617 | 2,580 | 3,951 | 7,157 | 9,141 |
| 4 | 6,520 | 5,325 | 8,840 | 13,254 | 12,708 | 7,131 | 2,741 | 2,575 | 2,163 | 3,034 | 6,525 | 8,271 |
| 5 | 5,790 | 5,250 | 8,350 | 12,195 | 12,535 | 7,124 | 4,516 | 2,624 | 2,714 | 3,055 | 5,871 | 11,050 |
| 6 | 5,650 | 5,400 | 6,850 | 11,459 | 12,647 | 7,865 | 3,225 | 1,893 | 3,847 | 3,761 | 5,204 | 16,808 |
| 7 | 5,380 | 6,150 | 8,800 | 11,004 | 12,630 | 7,163 | 2,721 | 1,969 | 3,146 | 5,827 | 6,114 | 17,398 |
| 8 | 5,500 | 6,070 | 8,350 | 10,740 | 11,583 | 6,774 | 2,768 | 4,112 | 3,134 | 5,759 | 5,477 | 15,190 |
| 9 | 5,260 | 5,600 | 8,940 | 10,128 | 11,144 | 6,585 | 2,015 | 3,056 | 3,043 | 5,393 | 5,319 | 12,245 |
| 10 | 7,580 | 6,200 | 10,080 | 9,529 | 10,035 | 6,276 | 1,135 | 2,949 | 2,307 | 6,080 | 5,617 | 9,637 |
| 11 | 6,520 | 6,150 | 11,380 | 9,742 | 8,452 | 5,619 | 3,805 | 3,563 | 1,705 | 4,897 | 9,353 | 8,591 |
| 12 | 5,910 | 7,330 | 14,080 | 10,058 | 8,109 | 5,267 | 2,918 | 4,020 | 3,750 | 4,667 | 15,304 | 8,855 |
| 13 | 6,040 | 7,320 | 17,600 | 10,386 | 8,552 | 5,706 | 2,707 | 3,221 | 2,910 | 4,484 | 14,746 | 6,699 |
| 14 | 7,180 | 10,460 | 28,800 | 11,072 | 12,530 | 5,598 | 2,620 | 3,032 | 2,630 | 4,043 | 12,781 | 6,330 |
| 15 | 8,170 | 10,120 | 36,000 | 11,507 | 11,834 | 6,832 | 2,533 | 4,744 | 2,556 | 3,367 | 10,971 | 6,532 |
| 16 | 7,540 | 9,980 | 35,100 | 13,588 | 10,458 | 8,511 | 1,859 | 3,645 | 2,483 | 4,361 | 9,784 | 6,715 |
| 17 | 9,700 | 8,400 | 30,000 | 17,111 | 9,959 | 7,213 | 1,018 | 3,412 | 1,720 | 6,023 | 8,962 | 6,279 |
| 18 | 7,770 | 7,750 | 26,100 | 17,021 | 9,505 | 5,205 | 3,551 | 3,115 | 372 | 5,325 | 8,622 | 5,908 |
| 19 | 6,790 | 8,460 | 25,200 | 15,048 | 8,858 | 4,506 | 2,517 | 3,337 | 2,800 | 4,982 | 9,810 | 6,841 |
| 20 | 6,040 | 6,850 | 25,000 | 14,330 | 8,307 | 5,923 | 2,568 | 3,359 | 2,460 | 5,055 | 15,303 | 6,378 |
| 21 | 7,300 | 9,080 | 27,600 | 13,717 | 7,472 | 7,026 | 2,581 | 5,459 | 2,335 | 6,075 | 19,785 | 6,144 |
| 22 | 9,340 | 9,270 | 30,200 | 13,493 | 7,302 | 7,908 | 2,920 | 6,261 | 2,264 | 7,421 | 17,553 | 6,084 |
| 23 | 9,140 | 9,930 | 25,800 | 12,121 | 7,404 | 6,694 | 2,360 | 5,469 | 2,399 | 10,178 | 14,351 | 6,876 |
| 24 | 11,480 | 10,430 | 22,300 | 13,666 | 6,160 | 6,590 | 2,327 | 4,439 | 1,760 | 11,583 | 11,625 | 9,007 |
| 25 | 11,100 | 10,790 | 21,800 | 25,342 | 7,316 | 5,790 | 3,919 | 4,892 | 1,867 | 9,962 | 11,699 | 10,290 |
| 26 | 10,500 | 10,740 | 20,000 | 30,362 | 10,501 | 5,142 | 2,851 | 5,403 | 6,075 | 8,307 | 11,113 | 9,534 |
| 27 | 9,450 | 8,900 | 17,000 | 27,394 | 14,041 | 5,458 | 2,724 | 4,913 | 5,144 | 8,909 | 9,627 | 8,892 |
| 28 | 8,960 | 10,700 | 17,900 | 22,139 | 15,785 | 5,110 | 2,709 | 4,527 | 4,525 | 13,699 | 6,872 | 8,425 |
| 29 | 8,040 | ------- | 18,000 | 19,424 | 15,081 | 4,567 | 2,713 | 5,306 | 4,198 | 14,473 | 6,253 | 6,572 |
| 30 | 6,620 | ------- | 18,400 | 18,612 | 13,713 | 3,908 | 1,753 | 3,806 | 3,830 | 10,534 | 8,677 | 6,024 |
| 31 | 6,750 | ------- | 19,700 | ------- | 11,811 | ------- | 1,081 | 3,657 | ------- | 9,565 | ------- | 5,792 |
| Mean | 7,394 | 7,797 | 18,612 | 15,229 | 10,996 | 6,464 | 2,660 | 3,799 | 2,910 | 6,429 | 9,887 | 8,779 |

*Daily discharge of Merrimac River, at Lawrence, Massachusetts, in cubic feet per second*—Continued.

1899.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5,661 | 5,145 | 7,360 | 16,700 | 22,870 | 4,277 | 2,019 | 2,925 | 2,188 | 497 | 2,829 | 2,677 |
| 2 | 6,511 | 4,919 | 7,810 | 14,840 | 23,647 | 3,907 | 387 | 2,370 | 1,666 | 3,156 | 3,542 | 1,941 |
| 3 | 6,004 | 4,841 | 7,379 | 15,160 | 23,410 | 3,231 | 2,131 | 2,423 | 509 | 2,519 | 3,632 | 904 |
| 4 | 6,643 | 3,659 | 6,837 | 14,590 | 23,158 | 2,701 | 1,500 | 2,659 | 1,987 | 2,337 | 3,692 | 3,219 |
| 5 | 7,863 | 3,531 | 6,992 | 14,680 | 18,876 | 4,292 | 3,691 | 1,806 | 3,359 | 2,193 | 2,889 | 2,834 |
| 6 | 10,816 | 5,458 | 10,630 | 15,190 | 15,125 | 3,601 | 2,770 | 749 | 3,120 | 2,282 | 4,645 | 2,846 |
| 7 | 11,519 | 4,240 | 13,059 | 16,400 | 12,428 | 3,065 | 2,927 | 3,604 | 2,743 | 1,739 | 3,617 | 2,768 |
| 8 | 10,373 | 4,501 | 12,859 | 18,400 | 11,694 | 2,944 | 2,044 | 2,784 | 2,378 | 288 | 3,205 | 2,847 |
| 9 | 10,024 | 4,087 | 11,968 | 25,000 | 10,618 | 3,214 | 570 | 2,186 | 1,745 | 2,244 | 3,034 | 1,868 |
| 10 | 8,747 | 4,308 | 10,628 | 29,200 | 9,652 | 2,450 | 3,984 | 2,248 | 426 | 2,156 | 3,024 | 665 |
| 11 | 7,572 | 3,344 | 9,194 | 29,400 | 8,827 | 1,981 | 3,346 | 2,635 | 2,664 | 2,204 | 2,473 | 3,192 |
| 12 | 6,831 | 3,075 | 9,161 | 28.200 | 8,564 | 3,806 | 2,996 | 1,886 | 2,307 | 2,107 | 863 | 2,715 |
| 13 | 6,358 | 4,731 | 13,795 | 26,000 | 7,706 | 3,076 | 3,176 | 372 | 2,247 | 2,007 | 3,729 | 2,236 |
| 14 | 5,611 | 3,576 | 18,900 | 25,600 | 7,131 | 2,731 | 2,948 | 3,123 | 2,250 | 959 | 3,069 | 3,369 |
| 15 | 6,126 | 3,740 | 18,600 | 30,000 | 7,440 | 2,457 | 2,055 | 2,768 | 2,217 | 61 | 2,879 | 5,051 |
| 16 | 8,214 | 3,845 | 17,500 | 34,400 | 6,376 | 2,857 | 685 | 2,196 | 1,441 | 2,020 | 2,770 | 3,772 |
| 17 | 9,681 | 3,933 | 15,200 | 38,200 | 6,422 | 2,317 | 3,678 | 2,125 | 69 | 1,962 | 2,846 | 2,478 |
| 18 | 11,329 | 3,617 | 15,000 | 35,527 | 5,932 | 2,481 | 2,810 | 2,468 | 1,960 | 2,061 | 1,999 | 3,969 |
| 19 | 10,799 | 4,092 | 12,330 | 33,498 | 5,650 | 4,430 | 2,851 | 1,857 | 1,762 | 2,354 | 548 | 2,814 |
| 20 | 9,211 | 5,747 | 12,920 | 34,623 | 5,213 | 2,866 | 2,476 | 355 | 1,804 | 2,460 | 3,462 | 2,892 |
| 21 | 7,823 | 5,749 | 12,040 | 34,310 | 5,468 | 2,894 | 2,488 | 2,098 | 2,168 | 1,373 | 3,076 | 3,387 |
| 22 | 6,839 | 6,083 | 12,210 | 30,583 | 6,800 | 3,101 | 1,706 | 2,257 | 2,496 | 50 | 2,914 | 3,868 |
| 23 | 7,317 | 6,550 | 11,500 | 27,846 | 5,897 | 2,865 | 525 | 2,187 | 1,816 | 2,126 | 2,805 | 2,851 |
| 24 | 6,713 | 7,098 | 11,340 | 29,483 | 5,654 | 2,066 | 3,808 | 2,123 | 293 | 1,667 | 2,603 | 2,383 |
| 25 | 7,396 | 6,885 | 11,260 | 31,656 | 4,909 | 1,134 | 2,905 | 2,136 | 2,560 | 1,820 | 2,312 | 2,798 |
| 26 | 8,291 | 6,309 | 9,400 | 31 367 | 4,823 | 3,582 | 2,893 | 1,674 | 2,633 | 1,978 | 1,291 | 4,334 |
| 27 | 8,192 | 6,988 | 11,130 | 31,157 | 4,022 | 2,883 | 2,599 | 78 | 2,453 | 2,333 | 3,380 | 3,667 |
| 28 | 6,870 | 6,637 | 10,360 | 30,816 | 3,543 | 2,841 | 2,949 | 2,067 | 2,191 | 1,399 | 2,909 | 2,954 |
| 29 | 5,906 | ...... | 11,240 | 26,805 | 5,255 | 2,506 | 2,241 | 2,153 | 2,452 | 123 | 2,789 | 2,916 |
| 30 | 6,808 | ...... | 14,600 | 23,507 | 3,862 | 2,846 | 1,984 | 2,222 | 1,906 | 2,513 | 947 | 1,898 |
| 31 | 5,504 | ...... | 17,200 | ........ | 4,383 | ........ | 3,781 | 2,132 | ...... | 2,460 | ...... | 593 |
| Mean | 7,857 | 4,882 | 11,948 | 26,438 | 9,528 | 2,980 | 2,481 | 2,086 | 1,994 | 1,789 | 2,792 | 2,797 |

## NASHUA RIVER AT CLINTON, MASSACHUSETTS.

This river receives the drainage of a portion of central Massachusetts, and flows in a general northerly course into New Hampshire, emptying into Merrimac River. The principal part of the drainage basin is shown on the Worcester, Marlboro, Framingham, and Groton topographic atlas sheets. On its headwaters, near the town of Clinton, the metropolitan water board has under construction what is known as Wachusett reservoir, for the supply of Boston and neighboring towns. Measurements of the flow of Nashua River have been made at Clinton since July, 1896, but these have not been published, as there are unsettled claims for the diversion of the water. The rainfall on the watershed during 1897 was measured at four localities, and ranged from about 50 to 53 inches. The area and capacity of Wachusett reservoir are given for each 5 feet in elevation in the Report of the State Board of Health of Massachusetts for 1895 on "Metropolitan water supply," pages 127 and 128. The outline of the reservoir is also shown on an accompanying plan.

## SUDBURY RIVER.

This small stream of eastern Massachusetts, receives water from an area west of Framingham. It flows in a northerly course through meadows and swamps, and joins Assabet River to form Concord River, which in turn continues northerly, entering Merrimac River immediately below the city of Lowell. Storage reservoirs have been constructed by the city of Boston, controlling the greater part of the flow from this basin. The available water has been systematically measured by Mr. Desmond FitzGerald, the record beginning in 1875. The run-off in cubic feet per second, by months, from 1875 to 1898, is given in the Twentieth Annual Report, Part IV, page 75.[1] The following is a continuation of this table. It should be noted that during August the yield of Sudbury River is a minus quantity.

*Run-off of Sudbury River and Lake Cochituate watersheds in second-feet per square mile.*

| Month. | Sudbury River. | | Lake Cochituate. | |
|---|---|---|---|---|
| | 1899. | Averages, 1875–1899. | 1899. | Averages, 1863–1899. |
| January | 3.54 | 1.94 | 2.99 | 1.78 |
| February | 2.14 | 2.90 | 2.22 | 2.53 |
| March | 6.51 | 4.49 | 5.51 | 3.32 |
| April | 3.90 | 3.12 | 2.55 | 2.60 |
| May | .79 | 1.68 | .60 | 1.51 |
| June | .10 | .74 | .10 | .70 |
| July | .03 | .31 | .03 | .47 |
| August | −.05 | .48 | .08 | .67 |
| September | .15 | .38 | .45 | .65 |
| October | .18 | .83 | .54 | .92 |
| November | .47 | 1.47 | .45 | 1.33 |
| December | .34 | 1.61 | .35 | 1.46 |
| The year | 1.51 | 1.66 | 1.32 | 1.49 |

## LAKE COCHITUATE.

This lake drains into Sudbury River below the point of diversion for the water supply of the city of Boston, and has been considered as a separate watershed, with an area of 18.87 square miles, of which 7.6 per cent is water surface. Dudley Pond, which lies just north of the lake, is connected with it, and water is occasionally drawn into the lake. The watershed of this pond is not included in the 18.87 square miles; thus a corresponding deduction must be made in computing the yield. This correction has been made in the accompanying table. Figures of catchment on this area since 1863 are available, these not being considered quite as accurate as those for Sudbury River. The results in inches of depth of run-off from the watershed are given in the following table. The average yield per square mile of this watershed for thirty-seven years, 1863 to 1899,

[1] For low water flow, see Engineering Record, September 16, 1899.

inclusive, is given in the second table, which shows by months the second-feet per square mile, the corresponding depth of run-off in inches, the depth of rainfall, and the percentage collected:

*Yield of Lake Cochituate watershed in inches in depth.*

[Drainage area, 18.87 square miles.]

| Year. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1863...... | 1.91 | 3.12 | 3.71 | 4.41 | 1.44 | 0.66 | 2.94 | 1.54 | 0.99 | 1.31 | 2.64 | 2.19 | 26.87 |
| 1864...... | 2.41 | 1.56 | 4.09 | 2.65 | 1.61 | .49 | .41 | .67 | .49 | 1.42 | 1.24 | 1.17 | 18.22 |
| 1865...... | 2.06 | 1.76 | 4.66 | 2.71 | 4.75 | .33 | .46 | .48 | .44 | .69 | 1.02 | 1.13 | 20.49 |
| 1866...... | .74 | 2.84 | 1.78 | 1.62 | 1.29 | 1.09 | 1.26 | .64 | 1.32 | .94 | .97 | 1.55 | 16.03 |
| 1867...... | 1.10 | 5.24 | 3.47 | 2.86 | 2.18 | .66 | .56 | 2.10 | .31 | 1.05 | 1.11 | 1.12 | 21.77 |
| 1868...... | 1.23 | 1.12 | 3.85 | 3.49 | 6.18 | 1.60 | .46 | 1.15 | 1.82 | .95 | 1.99 | 1.17 | 24.99 |
| 1869...... | 1.82 | 1.87 | 3.33 | 2.48 | 2.17 | 1.05 | .75 | .59 | 1.11 | 2.33 | 1.30 | 3.16 | 21.96 |
| 1870...... | 4.73 | 3.95 | 3.37 | 6.86 | 1.66 | .97 | .53 | .40 | .64 | .96 | .80 | .78 | 25.66 |
| 1871...... | 1.03 | 2.28 | 2.53 | 1.58 | 2.00 | .87 | .43 | .70 | .28 | .61 | 1.23 | 1.18 | 14.74 |
| 1872...... | 1.10 | .89 | 1.35 | 2.96 | 1.10 | 1.48 | .14 | 1.32 | 1.70 | 1.70 | 1.99 | 1.20 | 16.94 |
| 1873...... | 3.10 | 1.58 | 3.90 | 6.08 | 2.66 | .45 | .61 | 1.43 | .79 | 2.02 | 1.86 | 2.69 | 27.17 |
| 1874...... | 3.12 | 2.20 | 1.84 | 3.18 | 2.79 | 1.96 | .95 | .92 | .53 | .52 | .57 | .51 | 19.09 |
| 1875...... | .15 | 2.93 | 2.66 | 3.17 | 1.39 | 1.50 | .25 | .61 | .58 | 1.21 | 1.98 | 1.22 | 17.65 |
| 1876...... | 1.08 | 1.77 | 5.20 | 4.21 | 1.43 | .51 | .85 | .28 | .58 | .36 | 1.85 | 1.00 | 19.12 |
| 1877...... | 1.20 | 1.37 | 6.81 | 3.24 | 2.04 | .92 | .64 | .66 | .40 | 1.12 | 2.69 | 1.97 | 23.06 |
| 1878...... | 3.25 | 3.97 | 5.40 | 2.86 | 1.66 | .76 | .47 | .84 | .29 | .73 | 2.07 | 4.04 | 26.34 |
| 1879...... | 1.29 | 2.32 | 3.30 | 4.48 | 1.40 | .77 | .33 | .95 | .61 | .60 | .72 | 1.04 | 17.81 |
| 1880...... | 1.47 | 2.24 | 1.79 | 1.57 | .44 | .06 | .33 | .23 | .24 | .28 | .66 | .59 | 9.90 |
| 1881...... | 1.19 | 2.23 | 5.66 | 1.79 | 1.26 | 1.31 | .16 | .09 | .23 | .18 | .84 | 1.40 | 16.34 |
| 1882...... | 1.84 | 3.00 | 3.67 | .93 | 1.55 | .62 | .06 | .07 | .97 | .84 | .58 | .92 | 15.05 |
| 1883...... | .84 | 1.59 | 2.04 | 1.66 | 1.26 | .07 | .02 | .07 | .44 | .44 | .40 | .94 | 9.76 |
| 1884...... | 1.84 | 2.86 | 4.67 | 4.00 | 1.39 | .67 | .26 | .61 | .13 | .34 | .62 | 1.82 | 19.21 |
| 1885...... | 1.90 | 2.00 | 2.21 | 2.36 | 1.61 | .43 | .00 | .33 | .25 | .79 | 2.05 | 1.64 | 15.57 |
| 1886...... | 2.28 | 7.93 | 3.51 | 2.52 | 1.09 | .18 | .25 | .14 | .30 | .42 | 1.20 | 2.10 | 21.92 |
| 1887...... | 4.06 | 4.34 | 4.70 | 3.36 | 1.35 | .82 | .72 | 1.33 | .64 | .49 | .70 | .96 | 23.47 |
| 1888...... | 1.13 | 2.77 | 4.76 | 3.45 | 2.37 | .53 | .47 | .94 | 2.31 | 2.57 | 4.21 | 5.46 | 30.97 |
| 1889...... | 4.50 | 1.85 | 2.08 | 2.17 | 1.20 | 1.18 | 1.63 | 3.43 | 1.79 | 1.91 | 2.95 | 3.26 | 27.95 |
| 1890...... | 1.92 | 2.04 | 5.87 | 2.23 | 1.85 | 1.41 | .33 | .46 | 1.40 | 3.40 | 1.49 | 2.11 | 24.51 |
| 1891...... | 6.26 | 6.62 | 8.03 | 4.31 | .88 | .77 | .50 | .72 | .76 | .79 | .83 | 1.26 | 31.73 |
| 1892...... | 8.03 | 1.54 | 3.02 | .90 | 2.03 | .49 | .33 | .56 | .60 | .57 | 1.09 | .84 | 15.02 |
| 1893...... | .64 | 2.55 | 4.12 | 2.42 | 1.83 | .75 | .38 | .77 | .42 | 1.08 | 0.83 | 1.48 | 17.27 |
| 1894...... | 1.21 | 1.67 | 2.55 | 2.15 | .91 | .45 | .38 | .41 | .46 | .66 | .92 | 1.14 | 12.91 |
| 1895...... | 1.58 | .75 | 3.50 | 3.35 | .97 | .40 | .55 | .50 | .69 | 1.97 | 3.51 | 2.40 | 20.17 |
| 1896...... | 1.72 | 3.69 | 5.52 | 2.01 | .62 | .71 | .38 | .47 | 1.03 | 1.28 | 1.40 | 1.31 | 20.14 |
| 1897...... | 1.64 | 1.65 | 3.22 | 1.85 | 1.39 | 1.19 | .75 | .63 | .46 | .43 | 1.68 | 2.16 | 17.05 |
| 1898...... | 2.27 | 4.06 | 3.11 | 2.69 | 1.86 | .78 | .37 | 1.30 | .31 | 1.61 | 2.31 | 2.74 | 23.41 |
| 1899...... | 3.45 | 2.31 | 6.35 | 2.84 | .69 | .11 | .03 | .09 | .50 | .63 | .50 | .41 | 17.91 |
| Mean.... | 2.056 | 2.662 | 3.828 | 2,903 | 1.738 | .784 | .539 | .767 | .725 | 1.059 | 1.482 | 1.677 | 20.220 |

*Average yield per square mile of Lake Cochituate watershed, 1863 to 1899, inclusive*

[Drainage area, 18.87 square miles.]

| Month. | Second-feet per square mile. | Run-off in inches. | Rainfall in inches. | Per cent. |
|---|---|---|---|---|
| January ............................ | 1.78 | 2.06 | 4.00 | 51.4 |
| February ............................ | 2.53 | 2.66 | 3.93 | 67.8 |
| March ............................ | 3.32 | 3.83 | 4.34 | 88.2 |
| April............................ | 2.60 | 2.90 | 3.51 | 82.7 |
| May............................ | 1.51 | 1.74 | 3.78 | 46.0 |
| June ............................ | .70 | .78 | 2.96 | 26.5 |
| July ............................ | .47 | .54 | 4.21 | 13.0 |
| August ............................ | .67 | .77 | 4.49 | 17.1 |
| September ............................ | .65 | .72 | 3.44 | 21.1 |
| October............................ | .92 | 1.06 | 4.56 | 23.2 |
| November............................ | 1.33 | 1.48 | 4.38 | 33.9 |
| December ............................ | 1.46 | 1.68 | 3.40 | 49.3 |
| The year............................ | 1.49 | 20.28 | 47.00 | 43.0 |

## MYSTIC LAKE.

The area tributary to Mystic Lake lies about 10 miles north of Boston and contains 26.9 square miles, including about 3 per cent of water surface. It has been the source of water supply for the city of Charlestown since 1864. Upon the annexation of that city to Boston the source of supply passed into the control of the Boston waterworks, this being in 1876. The records of run-off extend from 1878 to 1897, inclusive. On January 1, 1898, the lake was abandoned as a source of water supply and records after that date are not available. The table given below is from the third annual report of the water commissioners of the city of Boston. These records are somewhat less accurate than those for Lake Cochituate, as they involve not only storage in Mystic Lake, which has been determined with a fair degree of accuracy, but also the quantity of water pumped by five engines, the slip of which was somewhat uncertain, and the flow through a fishway. There are also a number of other points on the watershed whose storage should have been considered.

The yield from this watershed in depth in inches for the years 1878 to 1897, inclusive, is given in the table on page 40. The average yield per square mile is given in the following table, these figures being obtained from the engineering department of the Metropolitan Water Board, through Mr. Charles W. Sherman, assistant engineer:

*Average yield per square mile of Mystic Lake watershed, 1878 to 1897, inclusive.*

[Drainage area, 26.9 square miles.]

| Month. | Second-feet per square mile. | Run-off in inches. | Rainfall in inches. | Per cent. |
|---|---|---|---|---|
| January | 1.81 | 2.09 | 4.21 | 49.5 |
| February | 2.72 | 2.86 | 4.04 | 70.8 |
| March | 3.39 | 3.91 | 3.72 | 105 2 |
| April | 2.33 | 2.61 | 3.02 | 86.1 |
| May | 1.62 | 1.87 | 3.64 | 51.5 |
| June | .96 | 1.07 | 3.20 | 33.5 |
| July | .49 | .56 | 3.58 | 15.6 |
| August | .56 | .65 | 4.00 | 16.3 |
| September | .47 | .52 | 3.17 | 16.4 |
| October | .69 | .80 | 3.98 | 20.1 |
| November | 1.14 | 1.28 | 3.79 | 33.7 |
| December | 1.41 | 1.63 | 3.47 | 46.9 |
| The year | 1.46 | 19.85 | 43.82 | 45.3 |

Records are not available after 1897, although observations have been continued. The watershed is no longer in use as a source of supply, and so many complications enter into an estimate of yield that it is probable that it will not be computed.

*Run-off in inches on Mystic Lake watershed, 1878 to 1897, inclusive.*

[Drainage area, 26.9 square miles.]

| Year. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1878 | 3.55 | 3.97 | 4.91 | 2.21 | 2.16 | 0.78 | 0.48 | 1.11 | 0.56 | 0.71 | 1.75 | 3.63 | 25.82 |
| 1879 | 1.21 | 2.33 | 3.31 | 3.97 | 1.95 | .97 | .54 | .70 | .48 | .34 | .45 | .69 | 16.94 |
| 1880 | 1.70 | 2.54 | 1.95 | 1.50 | .96 | .51 | .67 | .54 | .45 | .36 | .44 | .59 | 12.21 |
| 1881 | .82 | 2.14 | 6.79 | 2.17 | 1.51 | 2.05 | .87 | .35 | .31 | .29 | .50 | .87 | 18.67 |
| 1882 | 1.37 | 3.03 | 4.19 | 1.16 | 1.85 | .81 | .35 | .22 | .53 | .58 | .39 | .57 | 15.05 |
| 1883 | .70 | 1.43 | 1.88 | 1.63 | 1.20 | .52 | .30 | .22 | .18 | .39 | .42 | .44 | 9.31 |
| 1884 | 1.49 | 3.89 | 5.42 | 3.85 | 1.48 | .85 | .58 | .60 | .23 | .27 | .35 | 1.17 | 20.18 |
| 1885 | 1.79 | 1.81 | 2.05 | 2.03 | 2.18 | .86 | .47 | .54 | .34 | .68 | 2.41 | 2.39 | 17.55 |
| 1886 | 2.31 | 7.70 | 3.91 | 3.24 | 1.27 | .55 | .41 | .25 | .32 | .38 | .88 | 1.43 | 22.65 |
| 1887 | 3.16 | 3.61 | 3.60 | 3.75 | 1.89 | 1.27 | .87 | 1.35 | .48 | .57 | .71 | .91 | 22.17 |
| 1888 | 1.43 | 3.32 | 4.28 | 3.27 | 2.88 | .84 | .39 | .54 | 1.31 | 2.74 | 5.04 | 5.08 | 31.12 |
| 1889 | 4.51 | 1.83 | 1.60 | 2.27 | 2.18 | 1.89 | 1.33 | 2.05 | 1.06 | 1.21 | 2.49 | 3.06 | 25.48 |
| 1890 | 2.07 | 2.23 | 5.37 | 2.93 | 3.00 | 1.92 | .43 | .46 | .58 | 2.61 | 1.95 | 2.49 | 26.04 |
| 1891 | 6.29 | 5.97 | 7.21 | 3.43 | 1.40 | 1.01 | .42 | .44 | .42 | .58 | .56 | .87 | 28.60 |
| 1892 | 2.49 | 1.76 | 3.03 | 1.33 | 2.10 | 1.17 | .66 | .49 | .56 | .45 | 1.07 | .87 | 15.98 |
| 1893 | .75 | 2.14 | 4.52 | 2.72 | 4.42 | 1.04 | .47 | .69 | .41 | .55 | .71 | 1.27 | 19.69 |
| 1894 | 1.37 | 1.87 | 3.05 | 2.27 | 1.31 | .91 | .49 | .38 | .36 | .58 | .91 | .90 | 14.40 |
| 1895 | 1.55 | .87 | 3.16 | 2.95 | 1.13 | .54 | .60 | .80 | .36 | 1.46 | 2.37 | 2.12 | 17.91 |
| 1896 | 1.85 | 3.40 | 4.50 | 3.26 | .77 | .75 | .39 | .34 | 1.06 | .89 | 1.11 | 1.23 | 19.55 |
| 1897 | 1.39 | 1.40 | 3.46 | 2.14 | 1.83 | 2.19 | .50 | .95 | .41 | .39 | 1.02 | 1.96 | 17.64 |
| Mean | 2.09 | 2.86 | 3.91 | 2.61 | 1.87 | 1.07 | .56 | .65 | .52 | .80 | 1.28 | 1.63 | 19.85 |

## CONNECTICUT RIVER AT HOLYOKE, MASSACHUSETTS.

This river, rising in northern New Hampshire and Vermont, flows in a general southerly course, forming the greater part of the boundary between these States, and crosses Massachusetts and Connecticut, emptying into Long Island Sound. Computations of discharge have been made in the southern part of its course at Holyoke, Massachusetts, a short distance above the Connecticut State line. The flow of the river is controlled at this point by the Holyoke Water Power Company. Data of stream flow have been obtained from Mr. A. F. Sickman, assistant engineer of the company. The quantities given are the daily amounts drawn from the pond above the dam, representing the discharge of the river excepting at such times as the surface falls below the crest, when water is ponded over night and Sunday. The results by months, from 1880 to 1895, are published in Bulletin No. 140, pages 37 to 41; for 1896 and 1897, in the Nineteenth Annual Report, Part IV, page 116; and for 1898, in the Twentieth Annual Report, Part IV, page 76.

*Daily mean discharge in second-feet of Connecticut River at Holyoke, Massachusetts.*

[Drainage area, 8,660 square miles.]

1896.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 47,350 | 5,500 | 66,950 | 34,400 | 18,300 | 6,550 | 3,900 | 2,300 | 2,700 | 4,650 | 12,050 | 17,900 |
| 2 | 39,050 | 4,850 | 112,050 | 36,100 | 16,050 | 6,350 | 3,800 | 2,450 | 2,850 | 4,700 | 11,750 | 15,750 |
| 3 | 29,700 | 5,350 | 103,450 | 32,300 | 14,700 | 6,450 | 2,350 | 3,900 | 2,700 | 3,600 | 11,550 | 12,300 |
| 4 | 23,850 | 4,850 | 65,050 | 24,650 | 15,000 | 6,200 | 750 | 3,700 | 2,700 | 3,500 | 12,100 | 8,250 |
| 5 | 12,200 | 4,800 | 37,900 | 19,600 | 14,350 | 5,800 | 1,700 | 3,750 | 2,100 | 4,550 | 12,800 | 6,450 |
| 6 | 9,300 | 5,550 | 25,100 | 18,550 | 13,900 | 4,650 | 2,050 | 3,650 | 700 | 4,600 | 26,800 | 6,500 |
| 7 | 7,750 | 17,150 | 22,050 | 18,350 | 13,700 | 3,850 | 2,900 | 3,800 | 6,150 | 5,200 | 30,450 | 8,550 |
| 8 | 7,300 | 20,750 | 19,050 | 17,550 | 13,550 | 5,100 | 3,450 | 2,850 | 7,750 | 5,250 | 25,300 | 8,850 |
| 9 | 7,600 | 19,700 | 17,950 | 17,700 | 11,900 | 4,900 | 4,450 | 4,100 | 8,050 | 5,550 | 23,900 | 9,700 |
| 10 | 7,850 | 17,700 | 16,900 | 19,900 | 11,000 | 7,100 | 6,050 | 4,650 | 7,200 | 4,750 | 21,000 | 13,900 |
| 11 | 7,100 | 14,300 | 14,050 | 22,700 | 11,050 | 8,850 | 4,500 | 4,000 | 6,450 | 4,300 | 17,650 | 13,800 |
| 12 | 7,250 | 11,650 | 10,900 | 26,950 | 10,700 | 8,750 | 4,300 | 3,750 | 4,800 | 4,500 | 15,800 | 11,000 |
| 13 | 8,250 | 10,600 | 9,350 | 37,300 | 10,700 | 7,750 | 4,150 | 3,750 | 3,900 | 4,250 | 15,050 | 10,400 |
| 14 | 8,250 | 9,600 | 9,300 | 59,350 | 11,000 | 6,450 | 4,100 | 3,800 | 4,400 | 6,600 | 12,550 | 9,900 |
| 15 | 7,700 | 8,750 | 8,900 | 71,100 | 11,000 | 6,600 | 4,000 | 2,050 | 4,100 | 10,200 | 11,600 | 9,350 |
| 16 | 7,900 | 7,600 | 8,550 | 77,500 | 9,050 | 5,950 | 4,150 | 1,300 | 3,800 | 20,100 | 11,400 | 5,950 |
| 17 | 7,700 | 7,800 | 8,950 | 84,450 | 7,800 | 5,700 | 4,100 | 2,800 | 3,650 | 16,850 | 10,700 | 4,300 |
| 18 | 5,800 | 6,400 | 10,350 | 89,200 | 7,650 | 5,050 | 2,650 | 2,800 | 3,450 | 14,750 | 10,000 | 4,650 |
| 19 | 6,450 | 6,250 | 10,750 | 88,600 | 7,700 | 5,050 | 450 | 2,800 | 2,350 | 13,950 | 9,650 | 5,000 |
| 20 | 7,400 | 6,600 | 25,250 | 81,200 | 7,350 | 4,250 | 4,200 | 2,800 | 4,650 | 13,300 | 9,150 | 5,150 |
| 21 | 7,100 | 6,400 | 29,250 | 71,050 | 7,150 | 3,500 | 3,900 | 2,800 | 6,200 | 14,150 | 7,900 | 6,050 |
| 22 | 7,100 | 5,550 | 25,150 | 61,950 | 6,900 | 4,300 | 3,400 | 2,800 | 6,850 | 18,300 | 8,150 | 5,250 |
| 23 | 6,950 | 5,150 | 22,300 | 54,600 | 5,900 | 4,400 | 3,700 | 550 | 8,450 | 22,100 | 9,450 | 4,750 |
| 24 | 6,900 | 6,550 | 18,400 | 46,450 | 5,650 | 4,450 | 4,300 | 3,300 | 8,100 | 21,850 | 8,750 | 3,900 |
| 25 | 6,200 | 6,800 | 15,300 | 38,300 | 6,050 | 4,300 | 4,150 | 3,350 | 6,850 | 20,500 | 8,400 | 3,650 |
| 26 | 6,000 | 6,500 | 15,050 | 30,800 | 5,800 | 4,350 | 4,100 | 3,300 | 4,550 | 19,500 | 10,500 | 4,200 |
| 27 | 6,800 | 6,300 | 19,750 | 26,750 | 5,850 | 2,550 | 4,550 | 2,950 | 4,250 | 16,800 | 13,300 | 3,400 |
| 28 | 6,350 | 6,100 | 23,250 | 23,150 | 4,850 | 3,300 | 4,450 | 2,700 | 4,500 | 14,500 | 13,600 | 4,550 |
| 29 | 6,100 | 9,600 | 22,250 | 20,900 | 5,350 | 4,050 | 4,300 | 1,900 | 4,450 | 13,000 | 14,600 | 4,400 |
| 30 | 6,100 | ...... | 24,050 | 19,500 | 5,150 | 4,150 | 4,350 | 450 | 4,400 | 12,050 | 17,550 | 4,250 |
| 31 | 6,000 | ...... | 26,150 | ...... | 5,100 | ...... | 4,000 | 2,800 | ...... | 12,200 | ...... | 4,300 |
| Mean | 10,882 | 9,096 | 27,216 | 42,363 | 9,684 | 5,357 | 3,684 | 2,965 | 4,768 | 10,971 | 14,115 | 7,624 |

1897.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3,350 | 3,900 | 4,400 | 21,900 | 32,950 | 22,900 | 10,200 | 22,350 | 6,200 | 4,950 | 3,850 | 21,050 |
| 2 | 3,350 | 3,600 | 3,550 | 22,950 | 27,800 | 19,300 | 9,550 | 18,950 | 6,150 | 3,450 | 4,550 | 16,650 |
| 3 | 3.350 | 3,600 | 3,500 | 25,150 | 28,000 | 16,750 | 9,900 | 16,050 | 5,300 | 3,350 | 17,050 | 12,800 |
| 4 | 4,700 | 3,750 | 4,450 | 24,600 | 27,100 | 16,100 | 9,550 | 13,950 | 4,550 | 5,000 | 19,400 | 10,700 |
| 5 | 4,700 | 4,300 | 5,700 | 27,050 | 27,500 | 18,100 | 8,100 | 12,800 | 4,600 | 4,350 | 15,850 | 11,150 |
| 6 | 7,550 | 2,950 | 7,550 | 37,100 | 26,350 | 19,600 | 7,650 | 12,750 | 4,800 | 3,400 | 13.200 | 16,800 |
| 7 | 10,100 | 2,550 | 11,750 | 46,250 | 23,900 | 20,350 | 7,950 | 10,550 | 4,650 | 3,150 | 10,100 | 15,600 |
| 8 | 10,350 | 11,100 | 12,150 | 44,900 | 20,550 | 19,050 | 9,950 | 8,750 | 4,500 | 3,250 | 9,850 | 18,700 |
| 9 | 8,400 | 13,600 | 10,550 | 42,150 | 17,050 | 20,200 | 13,200 | 8,950 | 4,450 | 2,950 | 9,150 | 16,850 |
| 10 | 8,600 | 14,250 | 10,250 | 45,150 | 16,150 | 60,600 | 11,950 | 8,400 | 4,450 | 1,300 | 14,900 | 16,500 |
| 11 | 7,500 | 11,150 | 12,550 | 36,250 | 14,500 | 75,350 | 9,350 | 9,150 | 3,650 | 3,550 | 18,050 | 15,850 |
| 12 | 6,650 | 8,400 | 15,700 | 31,350 | 15,400 | 56,950 | 8,550 | 13,650 | 2,550 | 3,000 | 17,850 | 16,650 |
| 13 | 5,900 | 6,500 | 15,300 | 26,600 | 17,500 | 41,300 | 13,050 | 12,600 | 5,050 | 3,900 | 16,200 | 22,950 |
| 14 | 5,100 | 7,250 | 13,050 | 25,550 | 35,800 | 35,300 | 37,000 | 10,200 | 3,900 | 5,100 | 13,700 | 23,600 |
| 15 | 4,750 | 6,150 | 12,250 | 28,700 | 44,050 | 30,000 | 57,250 | 8,150 | 3,450 | 5,300 | 12,900 | 59,850 |
| 16 | 3,750 | 5,100 | 10,300 | 41,300 | 36,550 | 24,500 | 58,350 | 9,600 | 3,450 | 4,400 | 11,550 | 70,650 |
| 17 | 3,450 | 5,200 | 9,150 | 48,550 | 30,000 | 21,050 | 50,200 | 9,150 | 4,000 | 2,050 | 15,400 | 63,850 |
| 18 | 5,100 | 5,250 | 8,200 | 50,950 | 24,900 | 17,800 | 39.350 | 11,050 | 3,700 | 4,900 | 19,300 | 52,600 |
| 19 | 4,900 | 4,950 | 8,100 | 49,350 | 19,700 | 15,250 | 31,350 | 12,300 | 2,250 | 4,700 | 17,700 | 37,050 |
| 20 | 4,900 | 3,950 | 15,650 | 44,500 | 16,850 | 12,300 | 23,250 | 11,800 | 3,700 | 4,350 | 14,600 | 25,550 |
| 21 | 4,400 | 3,600 | 23,750 | 39,700 | 14,600 | 13,300 | 18,750 | 9,750 | 3,550 | 3,900 | 12,700 | 18,950 |
| 22 | 4,700 | 4,950 | 23,750 | 34,500 | 13,600 | 13,800 | 17,550 | 9,050 | 3,550 | 4,650 | 12,650 | 15,750 |
| 23 | 3,350 | 4,900 | 25,850 | 30,250 | 12,450 | 12,750 | 19,350 | 8,650 | 3,950 | 2,900 | 12,350 | 14,100 |
| 24 | 3,000 | 4,800 | 34,650 | 27,300 | 13,400 | 11,250 | 21,400 | 8,750 | 4,650 | 3,050 | 11,150 | 13,200 |
| 25 | 4,100 | 4,850 | 33,350 | 29,050 | 14,050 | 10,000 | 20,550 | 9,400 | 4,450 | 4,400 | 8,250 | 10,350 |
| 26 | 3,500 | 4,850 | 25,850 | 34,650 | 16,250 | 8,300 | 21,100 | 9,700 | 4,050 | 3,750 | 9,000 | 8,950 |
| 27 | 3,350 | 3,700 | 18,600 | 37,350 | 18,950 | 7,900 | 27,300 | 9,500 | 5,150 | 3,700 | 22,050 | 10,450 |
| 28 | 3,600 | 2,700 | 16,750 | 37,250 | 20,350 | 9,950 | 24,800 | 7,850 | 4,950 | 3,150 | 29,550 | 10,450 |
| 29 | 4,200 | ...... | 16,350 | 36,950 | 23,050 | 9,700 | 44,150 | 7,050 | 4,900 | 3,100 | 28,300 | 9,550 |
| 30 | 2,300 | ...... | 16,250 | 37,050 | 24,600 | 9,900 | 53,650 | 7,250 | 4,850 | 3,050 | 25,250 | 9,050 |
| 31 | 2,400 | ...... | 19.350 | ...... | 24,350 | ...... | 32,900 | 6,450 | ...... | 1,750 | ...... | 8,950 |
| Mean | 5,011 | 5,780 | 14,471 | 35,478 | 22,524 | 22,320 | 23,458 | 10,792 | 4,313 | 3,668 | 14,880 | 21,779 |

*Daily mean discharge in second-feet of Connecticut River at Holyoke, Massachusetts*—Continued.

1898.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7,650 | 7,000 | 8,100 | 43,500 | 23,800 | 14,300 | 6,000 | 4,750 | 5,000 | 6,300 | 16,250 | 12,050 |
| 2 | 7,500 | 6,600 | 8,400 | 37,300 | 22,150 | 12,950 | 6,050 | 3,800 | 4,650 | 4,650 | 14,050 | 12,600 |
| 3 | 7,700 | 7,050 | 8,050 | 29,550 | 20,450 | 11,550 | 5,600 | 3,450 | 3,600 | 5,600 | 12,700 | 11,500 |
| 4 | 7,650 | 7,350 | 8,050 | 25,850 | 20,550 | 10,250 | 4,800 | 3,650 | 3,550 | 5,050 | 11,550 | 11,100 |
| 5 | 7,750 | 6,900 | 7,500 | 22,450 | 22,100 | 8,650 | 4,550 | 4,700 | 4,000 | 6,600 | 10,700 | 14,150 |
| 6 | 7,650 | 6,350 | 6,950 | 20,450 | 22,650 | 9,200 | 4,250 | 4,350 | 5,500 | 23,000 | 8,950 | 15,250 |
| 7 | 8,100 | 7,500 | 7,800 | 19,400 | 20,850 | 9,000 | 3,300 | 4,800 | 6,850 | 15,500 | 10,350 | 14,800 |
| 8 | 9,050 | 7,350 | 8,000 | 18,400 | 17,950 | 8,800 | 3,450 | 6,250 | 6,550 | 12,550 | 9,850 | 13,050 |
| 9 | 8,600 | 7,350 | 8,550 | 16,950 | 17,300 | 8,000 | 3,850 | 6,150 | 5,950 | 12,200 | 9,700 | 11,550 |
| 10 | 8,750 | 7,650 | 9,650 | 16,050 | 15,600 | 8,050 | 2,850 | 5,750 | 5,050 | 11,650 | 10,850 | 12,250 |
| 11 | 8,450 | 7,850 | 11,750 | 18,650 | 14,400 | 7,600 | 4,400 | 5,450 | 3,550 | 9,550 | 28,750 | 9,900 |
| 12 | 8,300 | 8,100 | 16,950 | 20,000 | 14,400 | 8,300 | 4,250 | 4,800 | 5,050 | 8,600 | 29,150 | 9,400 |
| 13 | 8,750 | 9,250 | 30,700 | 21,950 | 18,250 | 10,500 | 3,850 | 4,000 | 4,850 | 7,800 | 21,350 | 5,800 |
| 14 | 13,150 | 12,250 | 66,500 | 23,950 | 22,000 | 15,000 | 3,450 | 3,150 | 3,500 | 7,200 | 18,800 | 5,850 |
| 15 | 12,300 | 12,450 | 74,900 | 26,300 | 22,450 | 17,900 | 3,600 | 4,750 | 3,900 | 7,200 | 16,600 | 6,150 |
| 16 | 15,450 | 11,750 | 64,700 | 35,750 | 23,850 | 17,000 | 3,200 | 3,800 | 4,700 | 9,800 | 14,950 | 6,400 |
| 17 | 14,700 | 10,400 | 53,500 | 37,000 | 22,500 | 15,850 | 600 | 3,500 | 3,550 | 11,550 | 13,700 | 6,050 |
| 18 | 11,850 | 9,900 | 50,750 | 34,200 | 19,200 | 13,800 | 4,050 | 3,450 | 650 | 10,400 | 13,500 | 6,600 |
| 19 | 10,000 | 9,350 | 55,850 | 31,500 | 16,550 | 12,200 | 3,350 | 4,600 | 4,200 | 10,150 | 16,200 | 7,250 |
| 20 | 9,700 | 8,750 | 59,750 | 28,500 | 15,150 | 14,800 | 3,500 | 3,950 | 3,550 | 11,950 | 24,550 | 6,500 |
| 21 | 12,950 | 9,850 | 76,150 | 27,350 | 14,500 | 14,350 | 3,250 | 4,550 | 3,400 | 12,650 | 26,650 | 6,500 |
| 22 | 16,050 | 9,350 | 68,600 | 25,400 | 12,350 | 13,800 | 3,200 | 5,350 | 3,300 | 13,250 | 23,750 | 7,200 |
| 23 | 14,650 | 9,250 | 52,100 | 23,300 | 12,450 | 12,800 | 3,200 | 4,850 | 3,200 | 16,000 | 20,700 | 8,550 |
| 24 | 15,000 | 9,200 | 49,050 | 28,450 | 13,050 | 11,750 | 2,250 | 4,750 | 3,000 | 15,450 | 18,000 | 11,550 |
| 25 | 13,100 | 9,000 | 44,250 | 46,850 | 14,550 | 10,500 | 4,100 | 6,700 | 6,950 | 13,450 | 16,450 | 12,300 |
| 26 | 11,300 | 8,800 | 37,900 | 50,450 | 23,300 | 9,050 | 4,350 | 7,550 | 12,000 | 12,050 | 14,200 | 12.650 |
| 27 | 10,500 | 7,650 | 35,450 | 46,700 | 23,600 | 9,750 | 4,450 | 5,850 | 12,550 | 17,850 | 12,750 | 11,000 |
| 28 | 9,700 | 8,600 | 38,500 | 39,200 | 26,800 | 9,100 | 4,600 | 4,950 | 12,050 | 22,400 | 10,850 | 9,650 |
| 29 | 8,500 | ....... | 41,550 | 33,500 | 22,350 | 8,500 | 4,500 | 6,950 | 10,050 | 21,000 | 8,850 | 8,450 |
| 30 | 8,050 | ....... | 43,900 | 28,450 | 19,450 | 7,550 | 3,400 | 6,950 | 8,000 | 18,700 | 10,550 | 7,600 |
| 31 | 7,650 | ....... | 46,100 | ....... | 16,900 | ....... | 1,500 | 6,150 | ....... | 18,300 | ....... | 7,700 |
| Mean | 10,339 | 8,673 | 35,482 | 29,245 | 19,079 | 11,395 | 3,798 | 4,958 | 5,423 | 12,207 | 15,840 | 9,689 |

The figures for 1899 have not been computed at this time, April, 1900.

## CONNECTICUT RIVER AT HARTFORD, CONNECTICUT

Observations of the height of Connecticut River are maintained at a point near Hartford by the Connecticut River Bridge and Highway District, Edwin D. Graves, chief engineer, as noted in the Twentieth Annual Report, Part IV, page 77. Daily readings, beginning February 8, 1896, have been obtained, and are given below. Computations of discharge of the river at this point from 1871 to 1886 have been printed in the Fourteenth Annual Report, Part II, beginning on page 140. The gage now being read was placed at the same elevation as the old gage established by the Engineer Corps, United States Army, about 1872.

*Daily noon gage height in feet of Connecticut River at Highway Bridge, Hartford, Connecticut.*

1896.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ------- | ------- | 18.0 | 10.6 | 7.7 | 3.5 | 2.5 | 1.7 | 1.5 | 3.0 | 3.7 | 7.0 |
| 2 | ------- | ------- | 20.0 | 11.3 | 7.6 | 3.7 | 2.0 | 1.5 | 1.5 | 2.8 | 3.6 | 6.8 |
| 3 | ------- | ------- | 26.5 | 12.0 | 7.0 | 3.7 | 2.1 | 1.6 | 1.9 | 2.7 | 3.7 | 6.0 |
| 4 | ------- | ------- | 25,6 | 11.6 | 6.5 | 3.5 | 2.2 | 2.4 | 2.4 | 2.5 | 4.0 | 5.5 |
| 5 | ------- | ------- | 20.0 | 10.0 | 6.4 | 3.5 | 2.3 | 2.0 | 2.7 | 2.4 | 4.8 | 4.4 |
| 6 | ------- | ------- | 16.0 | 9.5 | 6.0 | 3.3 | 2.3 | 1.8 | 3.3 | 3.0 | 6.0 | 3.2 |
| 7 | ------- | ------- | 13.0 | 9.0 | 5.8 | 3.0 | 2.3 | 2.5 | 3.6 | 4.1 | 10.0 | 4.0 |
| 8 | ------- | 12.5 | 9.0 | 8.5 | 5.7 | 2.6 | 2.3 | 1.7 | 4.4 | 3.2 | 10.6 | 4.0 |
| 9 | ------- | 12.5 | 7.8 | 7.6 | 5.7 | 3.0 | 2.4 | 2.0 | 4.0 | 3.3 | 10.0 | 5.0 |
| 10 | ------- | 11.4 | 6.3 | 7.5 | 5.5 | 3.0 | 2.4 | 2.6 | 3.6 | 3.4 | 7.6 | 5.0 |
| 11 | ------- | 10.3 | 5.3 | 7.8 | 5.2 | 3.5 | 2.4 | 2.7 | 4.3 | 3.4 | 7.4 | 6.5 |
| 12 | ------- | 9.0 | 4.8 | 8.3 | 5.0 | 4.0 | 2.4 | 2.4 | 4.0 | 3.7 | 6.7 | 6.4 |
| 13 | ------- | 7.3 | 4.4 | 10.0 | 4.6 | 4.4 | 2.4 | 2.4 | 3.6 | 3.8 | 6.4 | 5.3 |
| 14 | ------- | 6.5 | 4.5 | 12.0 | 4.6 | 4.5 | 2.0 | 1.8 | 3.4 | 4.4 | 6.0 | 5.0 |
| 15 | ------- | 6.3 | 4.5 | 15.0 | 4.7 | 4.4 | 2.4 | 1.9 | 2.8 | 5.0 | 5.5 | 4.8 |
| 16 | ------- | 6.3 | 4.5 | 16.0 | 4.7 | 4.3 | 2.5 | 2.0 | 2.3 | 4.9 | 5.0 | 4.7 |
| 17 | ------- | 6.3 | 4.6 | 18.0 | 4.2 | 4.0 | 2.7 | 1.8 | 2.4 | 4.7 | 4.5 | 2.5 |
| 18 | ------- | 6.3 | 4.8 | 20.8 | 3.5 | 3.7 | 2.5 | 1.7 | 2.0 | 4.5 | 4.0 | 4.0 |
| 19 | ------- | 6.3 | 4.9 | 22.0 | 3.4 | 3.7 | 1.5 | 1.6 | 2.3 | 4.4 | 4.0 | 4.5 |
| 20 | ------- | 6.0 | 8.0 | 22.2 | 3.7 | 3.2 | .6 | 1.5 | 2.7 | 4.0 | 3.8 | 4.6 |
| 21 | ------- | 5.3 | 10.8 | 21.0 | 3.5 | 3.0 | 1.3 | 1.5 | 3.2 | 4.0 | 4.0 | 4.7 |
| 22 | ------- | 5.3 | 11.4 | 19.8 | 3.4 | 2.4 | 2.0 | 1.5 | 3.5 | 4.0 | 4.0 | 4.5 |
| 23 | ------- | 5.5 | 10.0 | 18.4 | 3.0 | 2.4 | 2.2 | 1.6 | 3.4 | 4.8 | 4.0 | 4.3 |
| 24 | ------- | 5.9 | 9.0 | 17.0 | 2.8 | 2.5 | 2.0 | 1.6 | 3.4 | 5.2 | 4.5 | 4.2 |
| 25 | ------- | 6.0 | 8.0 | 15.5 | 3.6 | 2.0 | 2.6 | 1.7 | 3.4 | 5.7 | 4.0 | 3.9 |
| 26 | ------- | 6.0 | 7.0 | 13.5 | 3.3 | 2.4 | 2.7 | 1.5 | 3.3 | 6.0 | 4.6 | 3.7 |
| 27 | ------- | 11.0 | 6.0 | 11.0 | 3.0 | 2.6 | 2.7 | 1.5 | 3.5 | 5.5 | 5.0 | 3.5 |
| 28 | ------- | 14.0 | 6.9 | 11.0 | 3.4 | 2.8 | 2.8 | 1.5 | 3.6 | 5.0 | 5.5 | 4.0 |
| 29 | ------- | 16.5 | 8.9 | 9.0 | 3.4 | 3.0 | 2.7 | 1.5 | 3.7 | 5.0 | 5.9 | 3.5 |
| 30 | ------- | ------- | 9.5 | 8.0 | 3.5 | 2.0 | 2.6 | 1.6 | 4.0 | 5.0 | 6.5 | 4.0 |
| 31 | ------- | ------- | 9.8 | ------- | 3.5 | ------- | 2.5 | 1.6 | ------- | 4.0 | ------- | 3.5 |

1897.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.4 | 3.7 | 3.8 | 8.8 | 13.5 | 10.0 | 5.0 | 17.0 | 4.3 | 2.5 | 3.0 | 9.5 |
| 2 | 3.4 | 3.8 | 4.0 | 9.6 | 12.4 | 9.0 | 5.1 | 13.0 | 3.8 | 3.3 | 3.9 | 8.0 |
| 3 | 3.4 | 3.9 | 3.8 | 9.8 | 11.7 | 8.0 | 5.0 | 10.5 | 4.6 | 3.5 | 5.0 | 6.8 |
| 4 | 3.4 | 4.5 | 4.8 | 10.2 | 11.0 | 8.0 | 4.8 | 8.6 | 3.9 | 3.0 | 8.0 | 6.0 |
| 5 | 4.8 | 4.0 | 5.0 | 10.5 | 11.4 | 7.0 | 4.8 | 8.5 | 3.5 | 2.7 | 7.3 | 6.0 |
| 6 | 5.9 | 3.8 | 6.5 | 12.2 | 11.0 | 8.0 | 4.5 | 8.2 | 3.3 | 2.6 | 6.8 | 7.4 |
| 7 | 5.7 | 4.1 | 7.0 | 13.5 | 10.3 | 6.7 | 4.2 | 7.7 | 3.3 | 2.7 | 5.6 | 10.0 |
| 8 | 5.6 | 6.8 | 8.2 | 15.5 | 9.3 | 8.6 | 4.0 | 6.7 | 3.3 | 2.8 | 4.7 | 9.7 |
| 9 | 5.5 | 9.4 | 7.5 | 15.3 | 7.6 | 7.1 | 5.0 | 5.5 | 2.8 | 2.8 | 4.6 | 8.8 |
| 10 | 5.5 | 9.5 | 6.8 | 17.4 | 7.4 | 12.0 | 5.8 | 5.5 | 2.8 | 2.0 | 4.7 | 8.0 |
| 11 | 4.5 | 9.0 | 7.1 | 17.0 | 7.0 | 18.0 | 5.0 | 5.0 | 3.3 | 1.6 | 5.5 | 8.0 |
| 12 | 5.0 | 8.1 | 8.0 | 15.2 | 6.5 | 20.6 | 4.6 | 7.2 | 3.0 | 3.0 | 8.0 | 8.0 |
| 13 | 4 5 | 7.0 | 9.0 | 13.7 | 7.0 | 18.3 | 5.0 | 8.2 | 3.0 | 2.5 | 8.5 | 9.1 |
| 14 | 3.9 | 6.4 | 8.9 | 11.4 | 9.6 | 16.3 | 11.5 | 7.0 | 3.2 | 2.8 | 7.8 | 11.5 |
| 15 | 3.5 | 5.7 | 8.8 | 10.8 | 15.0 | 13.8 | 18.6 | 6.2 | 2.8 | 3.0 | 6.8 | 14.0 |
| 16 | 4.0 | 5.8 | 7.8 | 11.0 | 14.7 | 12.0 | 20.8 | 5.0 | 3.0 | 3.0 | 6.0 | 19.6 |
| 17 | 3.0 | 5.4 | 6.7 | 15.0 | 14.0 | 10.1 | 20.0 | 6.8 | 3.0 | 2.6 | 5.8 | 20.4 |
| 18 | 3.4 | 5.2 | 5.6 | 16.5 | 12.1 | 9.0 | 18.3 | 6.9 | 3.0 | 2.4 | 6.5 | 19.0 |
| 19 | 3.5 | 5.5 | 5.6 | 17.3 | 10.5 | 8.0 | 16.8 | 6.0 | 2.9 | 2.8 | 7.5 | 16.0 |
| 20 | 3.8 | 5.4 | 7.8 | 16.7 | 9.4 | 7.2 | 14.0 | 6.0 | 2.8 | 3.0 | 7.6 | 13.0 |
| 21 | 4.3 | 5.3 | 10.0 | 15.6 | 8.0 | 6.0 | 10.0 | 6.5 | 2.8 | 3.7 | 7.1 | 9.4 |
| 22 | 4.5 | 5.2 | 11.0 | 14.5 | 7.9 | 6.0 | 9.0 | 5.0 | 2.6 | 4.0 | 6.5 | 8.0 |
| 23 | 3.9 | 5.9 | 11.0 | 13.0 | 6.8 | 6.0 | 12.2 | 5.3 | 2.7 | 3.7 | 6.0 | 6.5 |
| 24 | 3.5 | 6.2 | 12.2 | 11.8 | 6.4 | 5.8 | 12.7 | 5.2 | 3.0 | 3.6 | 5.5 | 5.5 |
| 25 | 3.2 | 5.6 | 13.8 | 11.8 | 6.3 | 5.3 | 12.7 | 4.9 | 3.0 | 3.2 | 5.0 | 6.2 |
| 26 | 2.7 | 5.0 | 12.8 | 12.0 | 6.7 | 4.6 | 11.5 | 5.2 | 3.0 | 2.7 | 5.3 | 7.5 |
| 27 | 2.6 | 5.0 | 11.4 | 13.3 | 7.0 | 4.4 | 10.2 | 6.0 | 3.0 | 4.0 | 6.0 | 8.5 |
| 28 | 2.8 | 4.0 | 9.8 | 13.5 | 8.0 | 3.8 | 12.0 | 5.2 | 3.0 | 3.0 | 9.0 | 8.6 |
| 29 | 3.0 | ------- | 8.5 | 13.4 | 8.6 | 4.4 | 12.4 | 5.6 | 2.9 | 3.0 | 11.0 | 8.6 |
| 30 | 3.6 | ------- | 7.8 | 13.5 | 9.2 | 4.7 | 19.3 | 4.2 | 3.4 | 3.0 | 10.4 | 8.6 |
| 31 | 3.7 | ------- | 8.0 | ------- | 10.0 | ------- | 20.6 | 4.5 | ------- | 3.0 | ------- | 8.4 |

*Daily noon gage height in feet of Connecticut River at Highway Bridge, Hartford, Connecticut*—Continued.

1898.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.0 | 7.8 | 6.0 | 15.4 | 13.2 | 8.0 | 4.5 | 4.0 | 3.7 | 5.0 | 8.1 | ........ |
| 2 | 7.7 | 7.8 | 5.8 | 15.5 | 12.5 | 7.0 | 4.2 | 4.0 | 3.2 | 4.0 | 7.4 | 6.5 |
| 3 | 7.5 | 7.8 | 5.6 | 13.8 | 11.6 | 6.7 | 4.0 | 4.3 | 3.0 | 4.5 | 6.6 | 6.6 |
| 4 | 7.4 | 7.7 | 5.4 | 12.4 | 10.9 | 6.4 | 4.0 | 4.6 | 3.0 | 3.2 | 6.3 | 7.5 |
| 5 | 7.2 | 7.6 | 5.0 | 10.5 | 10.0 | 6.2 | 4.0 | 4.5 | 3.0 | 4.0 | 5.8 | 8.5 |
| 6 | 6.9 | 7.5 | 4.6 | 9.9 | 10.4 | 6.0 | 3.8 | 4.4 | 3.2 | 6.1 | 5.6 | 9.5 |
| 7 | 6.8 | 7.4 | 4.9 | 9.4 | 10.5 | 5.8 | 3.4 | 4.2 | 3.4 | 9.0 | 5.4 | 8.8 |
| 8 | 7.5 | 7.3 | 5.4 | 9.0 | 9.8 | 5.6 | 3.0 | 4.0 | 3.7 | 6.0 | 5.1 | 8.5 |
| 9 | 7.4 | 7.3 | 5.8 | 8.6 | 9.0 | 4.8 | 3.0 | 3.9 | 3.6 | 5.8 | 5.3 | 7.3 |
| 10 | 7.3 | 7.5 | 6.4 | 8.5 | 8.4 | 4.7 | 2.8 | 4.0 | 3.7 | 5.6 | 5.0 | 6.2 |
| 11 | 7.2 | 7.5 | 6.8 | 8.4 | 7.9 | 4.5 | 2.7 | 3.8 | 3.4 | 5.1 | 8.6 | 6.3 |
| 12 | 7.0 | 7.4 | 8.0 | 8.7 | 7.6 | 4.7 | 2.6 | 3.2 | 3.0 | 5.0 | 13.0 | 6.3 |
| 13 | 6.8 | 8.5 | 10.8 | 9.0 | 8.0 | 5.0 | 2.4 | 3.5 | 3.0 | 4.5 | 12.0 | 5.8 |
| 14 | 8.1 | 9.7 | 17.4 | 9.5 | 9.6 | 6.5 | 2.2 | 3.4 | 3.2 | 5.0 | 10.0 | 5.7 |
| 15 | 9.5 | 9.8 | 20.0 | 9.7 | 9.8 | 8.0 | 2.0 | 3.2 | 3.2 | 5.5 | 9.0 | 5.9 |
| 16 | 9.8 | 9.0 | 21.0 | 10.0 | 10.2 | 7.7 | 1.9 | 3.0 | 3.4 | 5.8 | 7.9 | 6.0 |
| 17 | 9.8 | 8.4 | 20.0 | 12.0 | 10.4 | 7.4 | 1.8 | 2.7 | 3.0 | 6.0 | 7.6 | 6.0 |
| 18 | 8.8 | 7.6 | 19.0 | 14.5 | 10.2 | 7.0 | 1.6 | 2.6 | 2.5 | 5.8 | 7.2 | 5.9 |
| 19 | 7.5 | 7.8 | 18.0 | 13.0 | 9.0 | 7.2 | 3.0 | 2.6 | 2.0 | 5.5 | 10.0 | 6.0 |
| 20 | 6.0 | 8.2 | 18.8 | 12.2 | 8.2 | 7.4 | 3.1 | 4.0 | 2.2 | 5.7 | 11.3 | 6.0 |
| 21 | 8.2 | 12.0 | 19.1 | 11.6 | 7.8 | 7.5 | 3.1 | 4.6 | 3.2 | 6.3 | 12.4 | 6.0 |
| 22 | 10.0 | 12.0 | 21.2 | 12.5 | 7.3 | 7.0 | 3.3 | 3.9 | 2.4 | 7.2 | 11.7 | 5.9 |
| 23 | 10.6 | 10.3 | 20.5 | 13.5 | 6.8 | 6.5 | 3.3 | 3.7 | 3.2 | 7.1 | 10.7 | 6.0 |
| 24 | 11.4 | 9.0 | 18.2 | 14.5 | 7.4 | 6.0 | 3.4 | 3.4 | 3.0 | 7.0 | 9.6 | 8.0 |
| 25 | 10.4 | 7.8 | 17.3 | 15.5 | 8.0 | 5.8 | 3.5 | 4.4 | 4.5 | 7.2 | 9.0 | 7.7 |
| 26 | 9.0 | 6.8 | 16.5 | 16.5 | 10.0 | 5.5 | 3.5 | 5.2 | 5.5 | 6.6 | 8.2 | 7.5 |
| 27 | 9.0 | 6.5 | 15.5 | 17.0 | 11.2 | 5.4 | 3.6 | 4.9 | 6.3 | 7.1 | 7.5 | 7.0 |
| 28 | 8.5 | 6.0 | 14.5 | 16.5 | 13.6 | 5.1 | 3.7 | 4.0 | 6.6 | 9.7 | 6.4 | 6.5 |
| 29 | 7.8 | ........ | 14.8 | 14.9 | 12.7 | 4.8 | 3.8 | 4.0 | 6.3 | 9.7 | 6.1 | 6.5 |
| 30 | 7.5 | ........ | 15.3 | 14.0 | 11.8 | 4.5 | 3.8 | 4.3 | 5.0 | 9.2 | 6.0 | 6.4 |
| 31 | 7.0 | ........ | 15.4 | ........ | 10.3 | ........ | 3.9 | 4.5 | ........ | 8.7 | ........ | 6.7 |

1899.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.5 | 6.0 | 8.7 | 9.2 | 19.3 | 4.0 | 2.7 | 3.1 | 2.2 | 1.5 | 4.5 | 3.5 |
| 2 | 7.6 | 5.7 | 8.7 | 9.3 | 18.4 | 4.0 | 2.7 | 2.5 | 3.0 | .6 | 4.7 | 3.6 |
| 3 | 7.7 | 5.6 | 8.5 | 9.5 | 18.1 | 4.0 | 2.8 | 3.0 | 2.7 | .8 | 4.8 | 3.7 |
| 4 | 7.7 | 5.4 | 7.5 | 9.2 | 18.0 | 3.7 | 2.9 | 2.9 | 2.9 | 1.9 | 4.9 | 3.8 |
| 5 | 7.8 | 5.5 | 7.2 | 8.5 | 17.0 | 3.4 | 2.9 | 3.4 | 3.0 | 2.2 | 5.0 | 3.9 |
| 6 | 10.2 | 5.7 | 8.7 | 8.6 | 15.8 | 3.3 | 3.0 | 3.6 | 2.8 | 2.1 | 5.0 | 4.0 |
| 7 | 11.5 | 5.6 | 9.8 | 9.0 | 14.0 | 3.2 | 3.0 | 2.5 | 2.7 | 2.1 | 5.0 | 4.2 |
| 8 | 11.0 | 6.2 | 9.0 | 11.0 | 12.5 | 3.7 | 3.0 | 2.5 | 2.7 | 2.0 | 4.5 | 4.3 |
| 9 | 10.5 | 5.6 | 8.6 | 13.1 | 10.9 | 3.0 | 3.1 | 2.6 | 2.8 | 2.0 | 4.4 | 4.4 |
| 10 | 8.0 | 5.0 | 8.0 | 15.4 | 9.4 | 3.0 | 3.1 | 2.2 | 2.5 | 2.5 | 4.3 | 4.5 |
| 11 | 8.5 | 4.5 | 7.5 | 15.1 | 8.5 | 3.0 | 3.2 | 3.2 | 2.2 | 2.5 | 4.2 | 4.6 |
| 12 | 8.6 | 4.5 | 8.5 | 14.5 | 8.0 | 3.0 | 3.2 | 3.2 | 2.3 | 2.5 | 4.1 | 4.7 |
| 13 | 8.2 | 4.5 | 9.7 | 15.1 | 7.5 | 2.7 | 2.5 | 3.2 | 2.3 | 2.4 | 4.0 | 4.8 |
| 14 | 8.0 | 4.7 | 11.0 | 15.5 | 7.0 | 2.6 | 2.6 | 2.8 | 2.8 | 2.5 | 4.5 | 4.8 |
| 15 | 8.1 | 5.0 | 11.0 | 18.5 | 6.5 | 2.6 | 2.6 | 2.2 | 2.4 | 2.7 | 4.0 | 4.8 |
| 16 | 8.2 | 5.2 | 11.2 | 20.0 | 6.5 | 2.6 | 2.7 | 2.6 | 3.2 | 2.8 | 3.5 | 4.8 |
| 17 | 8.5 | 5.5 | 10.5 | 21.5 | 6.2 | 3.0 | 2.7 | 3.4 | 2.8 | 2.9 | 3.5 | 4.8 |
| 18 | 10.0 | 5.5 | 9.5 | 20.6 | 6.0 | 3.0 | 2.7 | 3.5 | 2.8 | 3.0 | 3.5 | 4.8 |
| 19 | 9.5 | 5.5 | 9.7 | 20.2 | 5.7 | 3.0 | 2.8 | 3.2 | 2.4 | 2.5 | 3.4 | 4.7 |
| 20 | 8.5 | 6.0 | 10.1 | 20.5 | 5.5 | 3.0 | 2.9 | 3.4 | 2.7 | 2.0 | 3.4 | 4.6 |
| 21 | 7.9 | 6.5 | 9.2 | 21.5 | 5.5 | 3.0 | 2.9 | 3.2 | 2.6 | 2.2 | 3.4 | 5.0 |
| 22 | 7.3 | 6.6 | 8.4 | 21.2 | 5.5 | 3.0 | 3.0 | 3.0 | 3.2 | 2.4 | 3.6 | 4.9 |
| 23 | 6.8 | 6.8 | 7.8 | 20.9 | 5.5 | 3.4 | 3.0 | 2.6 | 3.5 | 2.6 | 3.7 | 4.8 |
| 24 | 7.0 | 7.2 | 7.7 | 20.8 | 5.2 | 3.3 | 3.1 | 2.2 | 3.1 | 2.8 | 3.9 | 4.7 |
| 25 | 8.0 | 7.1 | 7.4 | 21.3 | 5.2 | 3.2 | 3.0 | 3.0 | 2.7 | 3.0 | 4.0 | 4.6 |
| 26 | 8.0 | 7.7 | 7.0 | 21.6 | 4.6 | 3.1 | 4.2 | 2.7 | 3.0 | 3.0 | 4.5 | 4.6 |
| 27 | 8.0 | 7.7 | 6.5 | 22.0 | 4.5 | 3.0 | 3.7 | 2.6 | 3.0 | 3.0 | 5.0 | 4.5 |
| 28 | 7.5 | 8.5 | 6.5 | 21.9 | 4.3 | 2.9 | 4.4 | 2.5 | 2.8 | 4.0 | 5.0 | 4.4 |
| 29 | 7.0 | ........ | 7.5 | 21.0 | 4.2 | 3.2 | 4.2 | 3.2 | 3.1 | 4.1 | 5.0 | 4.3 |
| 30 | 6.5 | ........ | 8.8 | 20.0 | 4.5 | 2.7 | 3.0 | 3.2 | 3.0 | 4.2 | 3.4 | 4.2 |
| 31 | 6.2 | ........ | 9.0 | ........ | 4.3 | ........ | 2.5 | 2.8 | ........ | 4.3 | ........ | 4.1 |

## MOHAWK RIVER AT RIDGE MILLS, NEW YORK.

Mohawk River rises in Lewis County, New York, and flows southerly through Oneida County, and turning to the east finally empties into Hudson River. It is shown through the greater portion of its length on the Oneida, Oriskany, Utica, Fonda, Amsterdam, Schenectady, and Cohoes topographic sheets of the United States Geological Survey. The measurements on this stream and its tributaries were instituted as previously described on page 20 by Mr. George W. Rafter for the United States Board of Engineers on Deep Waterways. The station at Ridge Mills is located at the dam of the Rome waterworks, 3 miles above Rome. The drainage area of the Mohawk River at this point is 153 square miles. Two gages are read twice a day by Daniel Brown, engineer at pumping station—one above the dam showing the height on the crest and one in the tailrace in order to determine the head on the wheels. The crest of the dam has an irregular profile, and in order to facilitate computation is divided into three parts. The flow over section *A* was computed from Bazin's experiments of November and December, 1895, series No. 162, with $q=8.025\ mLH^{\frac{3}{2}}$. The flow over sections *B* and *C*, which is over flashboards, is computed from Francis's formula for sharp-crested weirs. Experiments were conducted at Cornell University on an experimental weir corresponding to Bazin's series No. 162, and from the coefficients obtained a discharge curve plotted to correspond with the discharge curve of Bazin's. All computations of flow at this point made before June 1, 1899, were made by using Bazin's coefficients, but in subsequent computations the Cornell coefficients were used. The dam is of timber, backed with stone, and has very little leakage.[1]

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[1] On flow of water over dams, by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, p. 311.

*Estimated daily discharge in second-feet of Mohawk River at Ridge Mills, New York, for 1899.*

[Drainage area 153 square miles.]

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | 339 | 262 | 218 | ........ | 93 | 75 | 339 |
| 2 | 319 | 252 | 233 | ........ | 203 | 75 | 75 |
| 3 | 279 | 232 | 248 | ........ | 233 | 105 | 75 |
| 4 | 259 | 249 | 131 | ........ | 253 | 135 | 129 |
| 5 | 214 | 202 | 146 | ........ | 200 | 95 | 158 |
| 6 | 232 | 127 | 131 | ........ | 310 | 135 | 158 |
| 7 | 232 | 262 | 126 | ........ | 290 | 145 | 172 |
| 8 | 262 | 322 | 121 | ........ | 260 | 135 | 190 |
| 9 | 259 | 669 | 125 | 85 | 290 | 135 | 575 |
| 10 | 279 | 499 | 129 | 85 | 310 | 165 | 575 |
| 11 | 249 | 379 | 139 | 85 | 340 | 125 | 147 |
| 12 | 282 | 359 | 169 | 95 | 260 | 135 | ........ |
| 13 | 282 | 339 | 265 | 89 | 310 | 145 | ........ |
| 14 | 302 | 339 | 245 | 85 | 260 | 145 | ........ |
| 15 | 402 | 319 | 275 | 99 | 310 | 145 | ........ |
| 16 | 399 | 399 | 295 | 115 | 240 | 145 | 115 |
| 17 | 359 | 519 | 230 | 135 | 220 | 135 | 158 |
| 18 | 339 | 399 | 230 | 112 | 290 | 135 | 158 |
| 19 | 282 | 382 | 245 | 85 | 290 | 145 | ........ |
| 20 | 279 | 339 | 245 | 79 | 290 | 165 | ........ |
| 21 | 262 | 302 | 265 | 79 | 240 | 165 | ........ |
| 22 | 259 | 382 | 295 | 56 | 260 | 145 | 151 |
| 23 | 299 | 299 | 272 | 56 | 260 | 145 | 151 |
| 24 | 259 | 282 | 289 | 56 | 310 | 145 | 129 |
| 25 | 259 | 275 | 262 | 60 | 540 | 135 | 151 |
| 26 | 259 | 262 | 269 | 69 | 220 | 145 | 172 |
| 27 | 249 | 289 | 309 | 69 | 310 | 135 | 172 |
| 28 | 249 | 165 | 309 | 53 | 340 | 165 | 172 |
| 29 | 249 | 133 | 278 | 53 | 360 | ........ | 172 |
| 30 | 229 | 178 | 315 | 79 | 260 | ........ | 339 |
| 31 | ........ | 178 | 200 | ........ | 260 | ........ | 339 |
| Mean | 281 | 310 | 226 | 81 | 278 | 136 | 207 |

## NINEMILE CREEK AT STITTVILLE, NEW YORK.

This stream rises in the northern part of Oneida County, New York, and flows south into Mohawk River. A portion of its course is shown on the Oneida topographic sheet of the Geological Survey. Observations were made on this creek at Stittville, which is reached by the Rome, Watertown and Ogdensburg Railroad. The drainage area of Ninemile Creek at Stittville is 63 square miles. The station was located at an old timber dam built to furnish power to a gristmill and sawmill. One gage was read at the bridge above the dam, giving the height on crest, and one at tailrace below the dam, which, with the upper gage, gave the head on wheels. The dam had a somewhat irregular crest, but was repaired by the Board on Deep Waterways. The flow over section *A*, which is the bulkhead, is computed from Bazin's experiments in October, 1887, series No. 115, with $q=8.025mLH^{\frac{3}{2}}$. The flow over section *B*, which is a spillway, is computed from Bazin's experiments of July, 1894, series 130, with $q=8.025mLH^{\frac{3}{2}}$. A new curve was later drawn, based upon experiments carried on at Cornell University, corresponding to Bazin's series, Nos. 115 and 120. This dam leaks badly, so that low-water flows are of questionable accuracy. There are in the mill two standard Leffel wheels, one a 23-inch wheel and the other a 40-inch wheel, and a record was kept of the head on the wheels and the amount of openings, so that the quantity of water passing through the wheels can be computed. The results obtained from this station were of such questionable accuracy that the station was abandoned on June 30, 1899.

### ORISKANY CREEK AT COLEMAN, NEW YORK.

This stream rises in Oneida County, New York, and flows in a northerly direction, emptying into Mohawk River. It is shown through a part of its course on the Oriskany topographic sheet of the United States Geological Survey. Observations for the computation of flow of Oriskany Creek have been made at Coleman, 5 miles above the junction of the creek with Mohawk River, and at Oriskany, 2 miles farther down. The station at Coleman was located at Reeders Mills. The dam located here impounds water to furnish power for the picking mill and cotton mill on the west bank and for the grist-mill and sawmill on the east bank. The gages were read above the dam, giving the height on crest, and in the headraces and tailraces of each of the mills, giving the heads on wheels. The dam is of earth, with a timber crest, irregular in profile. For convenience in computation the crest has been divided into nine parts. The flow over this dam was computed from Bazin's experiments of November, 1895, series No. 170. The station was established September 20, 1898, and continued until February 28, 1899, when it was abandoned.

### ORISKANY CREEK AT ORISKANY, NEW YORK.

The drainage area of Oriskany Creek at this station is 144 square miles. The flow is measured over the State dam, the gage showing the height on crest being located on the left bank just above the dam. The crest is of irregular profile, and in order to facilitate computation is divided into three parts. No experiments have been made to determine coefficients for a dam of this section, so it was considered by Mr. George W. Rafter that the mean between the coefficients obtained by Bazin in his experiments, series Nos. 141 and 117, would best fit the conditions at this dam. Experiments were afterwards conducted at Cornell University on a similar section. For a cross section of this dam reference should be made to the paper on "Flow of water over dams," by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, p. 312. All computations of discharge up to June 1 were made from coefficients as determined by Bazin; all subsequent observations have been computed by using the Cornell coefficients. Water passing through the Erie Canal feeder is determined by knowing the relative heights of the gage above the dam and of the one below the gates in the feeder. The difference between these two readings gives the head on the gate. The stem of the gates is marked so that the amount of openings at any time can be determined. Readings of the two gages and the two gate stems are made twice a day by Frank Baker.

*Estimated daily discharge in second-feet of Oriskany Creek at Oriskany, New York, for 1899.*

[Drainage area, 144 square miles.]

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | 90 | (*a*) | 206 | 83 | 180 | 320 | 90 |
| 2 | 80 | (*a*) | 206 | 87 | 138 | 175 | 103 |
| 3 | 80 | (*a*) | 167 | 73 | 108 | 115 | 73 |
| 4 | 80 | (*a*) | 126 | 10 | 99 | 138 | 108 |
| 5 | 80 | (*a*) | 126 | 75 | 119 | 144 | 80 |
| 6 | 80 | 138 | 177 | 108 | 132 | 346 | 107 |
| 7 | 80 | 184 | 177 | 101 | 122 | 374 | 99 |
| 8 | 80 | 170 | 195 | 133 | 138 | 429 | 40 |
| 9 | 80 | 104 | 195 | 176 | 95 | 364 | 30 |
| 10 | 80 | 100 | 195 | 180 | 58 | 394 | 10 |
| 11 | 89 | 117 | 195 | 159 | 106 | 634 | 45 |
| 12 | 94 | 124 | 195 | 95 | 97 | 534 | 340 |
| 13 | 89 | 124 | 195 | 73 | 92 | 564 | 330 |
| 14 | 94 | 124 | 195 | 87 | 26 | 584 | 80 |
| 15 | 104 | 124 | 206 | 85 | 72 | 564 | 65 |
| 16 | 101 | 208 | 206 | 89 | 45 | 484 | 80 |
| 17 | 94 | 208 | 206 | 115 | 106 | 524 | 40 |
| 18 | 113 | 197 | 206 | 123 | 58 | 584 | 65 |
| 19 | 113 | 183 | 206 | 119 | 71 | 202 | 250 |
| 20 | 113 | 183 | 206 | 138 | 48 | 53 | 130 |
| 21 | 113 | 270 | 206 | 161 | 82 | 124 | 110 |
| 22 | 113 | 270 | 206 | 129 | 73 | 154 | 50 |
| 23 | 118 | 270 | 206 | 162 | 85 | 174 | 50 |
| 24 | 118 | 196 | 206 | 102 | 88 | 214 | 70 |
| 25 | 118 | 196 | 206 | 112 | 70 | 174 | 50 |
| 26 | 118 | 196 | 194 | 181 | 70 | 438 | 40 |
| 27 | 118 | 196 | 184 | 222 | 54 | 318 | 30 |
| 28 | 113 | 196 | 184 | 216 | 158 | 318 | 35 |
| 29 | 113 | 196 | 184 | 185 | 72 | 582 | 30 |
| 30 | 113 | 196 | 98 | 206 | 55 | 789 | 65 |
| 31 | ........ | 196 | 98 | ........ | 115 | ........ | 70 |
| Mean | 99 | 180 | 186 | 126 | 91 | 360 | 89 |

*a* No record July 1 to 5.

## SAUQUOIT CREEK AT NEW YORK MILLS, NEW YORK.

This creek rises in Oneida County, New York, and flows in a northerly direction, emptying into Mohawk River. It is shown in a part of its course on the Oriskany topographic sheet of the United States Geological Survey. Observations of flow are made on this creek at New York Mills, at which point the creek has a drainage area of 52 square miles. One gage is located at the dam, which furnishes power for mill No. 3, and is read by E. D. Cronk. A gage in the headrace near the mill wheels and one in the tailrace, are read by Robert Hughes. The first gage gives the head on crest of weir, and the two located at the mill give the head on wheels. The quantity flowing through the wheels is added to the flow over the dam to give the total flow of the creek. The dam is of earth, with plank facing, and there is little leakage. For a cross section of this dam see Mr. Rafter's paper on "Flow of water over dams." The profile of the crest of the dam is somewhat irregular, and in order to facilitate computation has been divided into nine parts. Each part is assumed to have a horizontal crest line.

The flow over each part has been computed separately for various heads and a curve drawn showing the relation of the total quantity flowing over the dam to various gage heights. From this curve the total quantity for each head can be read off at once without making a separate computation for each part of the dam. The flow over sections *A* to *E*, inclusive, in this dam was computed by using the coefficients determined by Bazin's experiments of 1895, series No. 175, with $q=8.025mLH^{\frac{3}{2}}$. The flow over sections *F* and *G*, which is over flashboards, was computed from Francis's formula for sharp-crested weirs, with $q=3.33LH^{\frac{3}{2}}$. In the mill there are two 27-inch Hercules turbines, and records are made of the head on wheels and the opening of the gates twice each day. These turbines were rated by the Holyoke Power Company, so that by noting the head and the gate openings the quantity of water passing through the wheels can be computed.

*Estimated daily discharge, in second-feet, of Sauquoit Creek at New York Mills, New York, for 1899.*

[Drainage area, 52 square miles.]

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | 42 | 12 | 17 | 18 | 0 | 53 | 19 |
| 2 | 34 | -------- | 11 | 5 | 29 | 42 | 13 |
| 3 | 18 | 27 | 43 | 0 | 24 | 21 | 23 |
| 4 | 30 | 10 | 30 | 0 | 21 | 26 | 32 |
| 5 | 42 | 30 | 12 | 33 | 15 | 29 | 22 |
| 6 | 56 | 27 | 0 | 32 | 16 | 32 | 26 |
| 7 | 48 | 18 | 26 | 6 | 8 | 32 | 26 |
| 8 | 39 | 16 | 25 | 21 | 13 | 24 | 19 |
| 9 | 23 | 25 | 22 | 12 | 18 | 24 | 12 |
| 10 | 34 | 31 | 0 | 0 | 18 | 19 | 14 |
| 11 | 31 | 30 | 25 | 22 | 18 | 29 | 16 |
| 12 | 28 | 27 | 14 | 19 | 18 | 29 | 72 |
| 13 | 20 | 19 | 0 | 19 | 16 | 29 | 64 |
| 14 | 19 | 22 | 25 | 8 | 7 | 24 | 38 |
| 15 | 30 | 13 | 22 | 5 | 13 | 24 | 32 |
| 16 | 34 | 30 | 18 | 15 | 18 | 21 | 35 |
| 17 | 38 | 23 | 5 | 0 | 15 | 24 | 35 |
| 18 | 34 | 27 | 18 | 19 | 16 | 21 | 38 |
| 19 | 30 | 27 | 5 | 19 | 18 | 24 | 32 |
| 20 | 30 | 19 | 0 | 13 | 14 | 26 | 42 |
| 21 | 23 | 11 | 22 | 14 | 12 | 26 | 54 |
| 22 | 21 | 3 | 19 | 21 | 18 | 26 | 35 |
| 23 | 25 | 0 | 16 | 10 | 24 | 25 | 32 |
| 24 | 23 | 27 | 5 | 0 | 18 | 21 | 30 |
| 25 | 24 | 30 | 15 | 22 | 22 | 18 | 25 |
| 26 | 26 | 22 | 10 | 15 | 19 | 22 | 32 |
| 27 | 20 | 27 | 0 | 22 | 15 | 24 | 28 |
| 28 | 19 | 11 | 22 | 13 | 7 | 24 | 16 |
| 29 | 20 | 14 | 30 | 18 | 19 | 21 | 19 |
| 30 | 21 | 0 | 18 | 10 | 32 | 21 | 13 |
| 31 | -------- | 27 | 5 | -------- | 26 | -------- | 14 |
| Mean | 29 | 20 | 15 | 14 | 17 | 26 | 29 |

## WEST CANADA CREEK AT MIDDLEVILLE, NEW YORK.

This creek rises in the southwestern part of Hamilton County, New York, and flows in a southwesterly direction through Herkimer County, emptying into Mohawk River. It has considerable fall throughout its length, with chances of water-power development. Measurements of flow have been made at Middleville, at the dam of the Nelson Knitting Company. The drainage area of West Canada

Creek at this point is 519 square miles. There is a gage located just above the dam which gives the depth of water on crest; also a gage in the headrace and one in the tailrace of the Nelson Knitting Mill. There are also gages in the tailraces of the gristmill and planing mill located below on the same headrace. By these gages the flow is determined over the dam, through the wheels of the Nelson Knitting Company's mill, and at the gristmill and planing mill. The dam is of timber, with very little leakage. In the Nelson Knitting Mill is one 66-inch standard Leffel turbine, in the planing mill one 24-inch Rochester turbine, in the sawmill one 28-inch Chase turbine, and in the gristmill one 36-inch Camden turbine. Observations of the height and amount of gate opening of these wheels are made twice a day by E. J. Nelson. Near the center of the dam there is an ice slide 56 feet in length. The profile of the crest is nearly horizontal except at the ice slide. The flow over this dam is computed from Bazin's experiments of December, 1895, series No. 170. The experimental section of weir corresponding to the Rexford Flats dam agrees more closely to the form of the Middleville dam than the experimental weir used by Bazin. A revised discharge curve has been drawn, using the coefficients as found in the Cornell University experiment No. 15, corresponding to the Rexford Flats dam. For a cross section of this dam see Mr. Rafter's paper "On flow of water over dams."[1]

*Estimated daily discharge in second-feet of West Canada Creek at Middleville, New York, for 1899.*

[Drainage area 519 square miles.]

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | 1,114 | 198 | 273 | 257 | 480 | 1,281 | 330 |
| 2 | 763 | 140 | 292 | 191 | 510 | 2,867 | 580 |
| 3 | 593 | 200 | 345 | 145 | 470 | 1,744 | 710 |
| 4 | 550 | 116 | 316 | 145 | 436 | 1,199 | 710 |
| 5 | 531 | 240 | 237 | 210 | 337 | 1,040 | 518 |
| 6 | 480 | 240 | 155 | 205 | 253 | 831 | 540 |
| 7 | 294 | 256 | 286 | 195 | 288 | 469 | 1,750 |
| 8 | 314 | 204 | 262 | 219 | 190 | 542 | 1,670 |
| 9 | 258 | 675 | 256 | 169 | 232 | 482 | 840 |
| 10 | 182 | 293 | 242 | 145 | 220 | 390 | 700 |
| 11 | 130 | 807 | 246 | 188 | 234 | 420 | 640 |
| 12 | 283 | 443 | 214 | 201 | 210 | 410 | 3,150 |
| 13 | 297 | 445 | 125 | 221 | 239 | 342 | 4,710 |
| 14 | 248 | 343 | 254 | 205 | 219 | 313 | 2,530 |
| 15 | 753 | 236 | 246 | 204 | 140 | 372 | 740 |
| 16 | 839 | 430 | 253 | 189 | 241 | 343 | 840 |
| 17 | 499 | 600 | 239 | 145 | 238 | 363 | 640 |
| 18 | 320 | 560 | 235 | 197 | 235 | 372 | 1,060 |
| 19 | 339 | 479 | 174 | 208 | 217 | 220 | 1,880 |
| 20 | 331 | 345 | 110 | 213 | 152 | 337 | 3,520 |
| 21 | 373 | 327 | 226 | 239 | 261 | 310 | 2,530 |
| 22 | 346 | 225 | 245 | 238 | 190 | 363 | 1,400 |
| 23 | 263 | 140 | 257 | 204 | 245 | 293 | 990 |
| 24 | 203 | 241 | 229 | 145 | 225 | 273 | 1,150 |
| 25 | 155 | 241 | 254 | 209 | 238 | 273 | 900 |
| 26 | 283 | 241 | 183 | 476 | 231 | 249 | 840 |
| 27 | 273 | 244 | 110 | 433 | 267 | 312 | 580 |
| 28 | 280 | 239 | 255 | 248 | 224 | 292 | 540 |
| 29 | 308 | 171 | 247 | 213 | 965 | 310 | 640 |
| 30 | 275 | 115 | 262 | 386 | 1,040 | 310 | 540 |
| 31 | ....... | 234 | 269 | ....... | 629 | ....... | 860 |
| Mean | 397 | 324 | 235 | 221 | 324 | 577 | 1,259 |

[1] Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, p. 315.

## MOHAWK RIVER AT LITTLE FALLS, NEW YORK.

The second point of measurement of Mohawk River was at Little Falls, where the drainage area of the Mohawk River is 1,306 square miles. There is at this point a stone dam which furnishes power for the Astronga Knitting Mill and the Little Falls Paper Company's mill. The gage in the headrace of the Astronga Knitting Mill gives the height on the crest of the dam and with the gage in the tailrace gives the head on the wheels. These two gages are read by J. J. Gilbert. There is a gage in the headrace and one in the tailrace of the Little Falls Paper Company's mill, giving the head on the wheels. Record of these gages is kept by William Hoffman. The dam varies somewhat in section from one side of the river to the other. The crest of the dam is horizontal and is divided into two parts to facilitate computation, on account of the variation in sections. The flow over section *A* was computed from Bazin's experiments of July, 1887, No. 117; and that over section *B*, from Bazin's experiments of June, 1894, series No. 135. A revised discharge curve was later used, based upon Cornell experiments Nos. 16 and 17. In the Astronga Knitting Mill there is installed one 43-inch and one 54-inch T. H. Risdon & Co.'s turbine; and in the Little Falls Paper Company's mill one 60-inch Camden, one 36-inch Camden, and one 42-inch Camden, also one 60-inch wheel built by M. Reddy. Records are kept of the flow through all of these wheels whenever running.

*Estimated daily discharge, in second-feet, of Mohawk River at Little Falls, New York, for 1899.*

[Drainage area, 1,306 square miles.]

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | 1,957 | 569 | 506 | 278 | 704 | 2,829 | 1,425 |
| 2 | 1,610 | 493 | 506 | 271 | 651 | 6,600 | 1,130 |
| 3 | 1,321 | 359 | 135 | 30 | 651 | 4,738 | 1,950 |
| 4 | 1,075 | 424 | 136 | 396 | 491 | 3,081 | 1,475 |
| 5 | 1,466 | 490 | 166 | 545 | 534 | 3,262 | 1,425 |
| 6 | 1,216 | 663 | 0 | 382 | 399 | 2,847 | 1,000 |
| 7 | 1,016 | 627 | 133 | 272 | 240 | 1,908 | 800 |
| 8 | 1,062 | 651 | 131 | 275 | 160 | 1,718 | 920 |
| 9 | 962 | 1,660 | 131 | 211 | 357 | 1,628 | 1,050 |
| 10 | 764 | 2,593 | 130 | 7 | 297 | 1,451 | 7,000 |
| 11 | 1,176 | 1,800 | 316 | 273 | 274 | 717 | 2,075 |
| 12 | 660 | 1,320 | 383 | 270 | 305 | 1,112 | 5,950 |
| 13 | 660 | 1,222 | 0 | 270 | 274 | 1,526 | 10,300 |
| 14 | 685 | 941 | 329 | 211 | 258 | 1,448 | 7,750 |
| 15 | 960 | 884 | 352 | 230 | 196 | 1,150 | 6,650 |
| 16 | 1,860 | 643 | 351 | 184 | 354 | 1,069 | 2,875 |
| 17 | 1,800 | 1,315 | 244 | 55 | 339 | 1,120 | 1,280 |
| 18 | 965 | 1,211 | 251 | 278 | 344 | 1,037 | 1,000 |
| 19 | 568 | 1,086 | 216 | 267 | 339 | 984 | 4,130 |
| 20 | 1,010 | 1,008 | 65 | 281 | 355 | 1,070 | 7,850 |
| 21 | 1,105 | 767 | 158 | 220 | 331 | 1,120 | 6,500 |
| 22 | 985 | 95 | 223 | 249 | 142 | 1,145 | 5,120 |
| 23 | 866 | 363 | 235 | 129 | 350 | 1,066 | 4,450 |
| 24 | 745 | 496 | 203 | 55 | 401 | 987 | 1,575 |
| 25 | 851 | 496 | 203 | 238 | 392 | 900 | 1,525 |
| 26 | 759 | 516 | 246 | 225 | 369 | 829 | 1,175 |
| 27 | 634 | 496 | 136 | 556 | 387 | 822 | 875 |
| 28 | 585 | 510 | 348 | 920 | 314 | 969 | 950 |
| 29 | 560 | 460 | 188 | 642 | 1,398 | 969 | 700 |
| 30 | 535 | 50 | 219 | 723 | 2,293 | 886 | 450 |
| 31 | ........ | 697 | 277 | ........ | 1,882 | ........ | 380 |
| Mean | 1,014 | 803 | 223 | 298 | 509 | 1,700 | 2,959 |

## EAST CANADA CREEK AT DOLGEVILLE, NEW YORK.

This creek rises in Hamilton County, New York, and flows in a southerly direction between Fulton and Herkimer counties into Mohawk River. Observations are taken on this creek at Dolgeville, about 7 miles from its junction with the Mohawk, reached from Little Falls by a branch of the New York Central Railroad. The station is located at the stone dam, which furnishes power for the Dolgeville Electric Light Company. The dam is about 19 feet high, of solid stone masonry, and the water impounded is conducted from the dam to the power house, a distance of about 500 feet, through a wrought-iron flume 10 feet in diameter. A gage located on the abutment of the dam and one in the tailrace of the power house are read twice each day by Henry Meyer, who is employed in the power house. The crest of the dam is horizontal, and flow over it is computed from Bazin's experiments of July, 1887, series No. 117. Experiments known as No. 13 were carried on at Cornell University to determine coefficients of flow over a weir of similar form. In the power house there are installed three Smith-Vaile Victor wheels; two of them 36 inch and one 15 inch. Records are kept of the daily head on these wheels and the amount of gate openings.

*Estimated daily discharge in second-feet of East Canada Creek at Dolgeville, New York, for 1899.*

[Drainage area 256 square miles.]

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | 390 | 145 | 165 | 108 | 70 | 1,000 | 175 |
| 2 | 320 | 100 | 225 | 178 | 165 | 1,560 | 310 |
| 3 | 240 | 148 | 240 | 178 | 150 | 840 | 330 |
| 4 | ........ | 94 | 180 | 99 | 150 | 710 | 400 |
| 5 | ........ | 150 | 135 | 128 | 145 | 480 | 310 |
| 6 | ........ | 150 | 99 | 118 | 140 | 520 | 260 |
| 7 | 220 | 170 | 165 | 113 | 140 | 410 | 190 |
| 8 | 260 | 230 | 160 | 108 | 130 | 380 | 190 |
| 9 | 220 | 309 | 160 | 75 | 120 | 360 | 190 |
| 10 | 220 | 383 | 160 | 108 | 140 | 340 | 200 |
| 11 | 238 | 283 | 170 | 108 | 130 | 310 | 230 |
| 12 | 220 | 213 | 180 | 120 | 125 | 110 | 1,850 |
| 13 | 220 | 213 | 50 | 108 | 120 | 260 | 2,820 |
| 14 | 230 | 213 | 40 | 108 | 120 | 260 | 1,420 |
| 15 | 280 | 195 | 20 | 108 | 150 | 260 | 1,040 |
| 16 | 270 | 294 | 125 | 108 | 120 | 310 | 880 |
| 17 | 192 | 380 | 30 | 108 | 125 | 230 | 710 |
| 18 | 154 | 280 | 125 | 108 | 160 | 260 | 1,240 |
| 19 | 180 | 210 | 40 | 108 | 150 | 150 | 1,590 |
| 20 | 200 | 170 | 40 | 125 | 155 | 260 | 610 |
| 21 | 300 | 165 | 120 | 125 | 150 | 240 | 1,330 |
| 22 | 230 | 135 | 120 | 120 | 115 | 220 | 840 |
| 23 | 210 | 99 | 120 | 120 | 125 | 220 | 740 |
| 24 | 162 | 145 | 130 | 120 | 150 | 220 | 490 |
| 25 | 134 | 165 | 140 | 120 | 145 | 190 | 390 |
| 26 | 190 | 175 | 120 | 225 | 145 | 180 | 240 |
| 27 | 190 | 160 | 40 | 225 | 140 | 180 | 360 |
| 28 | 180 | 175 | 120 | 180 | 140 | 180 | 310 |
| 29 | 160 | 165 | 120 | 170 | 300 | 180 | 310 |
| 30 | 160 | ........ | 120 | 190 | 380 | 180 | 280 |
| 31 | ........ | 155 | 120 | ........ | 262 | ........ | 160 |
| Mean | 221 | 196 | 122 | 127 | 153 | 367 | 658 |

## GAROGA CREEK AT FORT PLAIN, NEW YORK.

This stream rises in Fulton County, New York, and flows in a southwesterly direction into Mohawk River. Observations for the computation of flow have been taken at Levi Yoran's mill, at Fort Plain. The dam here located is of wood and fairly tight. Gages were read above the dam, giving the height on crest, and in the tailrace of the mill. The water is conducted from the creek above the dam through the mill by a 4-foot circular flume laid underground. The flow over this dam is computed from Bazin's experiments of July, 1894, series No. 130, with $q=8.025mLH^{\frac{3}{2}}$. Experiments were afterwards conducted at Cornell University, from which new coefficients were determined and a revised discharge curve plotted. In the mill there is installed one 28-inch and one 11-inch Lesner turbine, made at Fultonville, New York. These wheels were seldom used, but when they were run careful records were kept of the head and gate openings, so that the quantity passing through the wheels added to the flow over the dam would give the total flow of the creek. On May 30, 1899, observations at this station were discontinued.

## CAYADUTTA CREEK AT JOHNSTOWN, NEW YORK.

This creek rises in Fulton County, New York, and flows in a southerly direction into Mohawk River near Fonda. Observations are made at the dam of the Johnstown Electric Light and Power Company, 1 mile below Johnstown, the record being kept by E. Shook, superintendent. The dam is 33 feet high, is built of timber, and has very little leakage. The impounded water is carried from above the dam to the wheelhouse through a 5-foot circular wooden flume. Gages are read above the dam, giving the height on crest, and in the tailrace, which show the head on wheels. The profile of the crest is somewhat irregular, and to facilitate computation has been divided into four parts, the crest lines of each part being assumed horizontal. The flow over section *C*, which is the regular spillway, is computed from Bazin's experiments of July, 1894, series No. 130, with $q=8.025mLH^{\frac{3}{2}}$. The flow over sections *A*, *B*, and *D*, which are the bulkheads, is computed from Bazin's experiments of July, 1887, series No. 115. Experiments upon sections which are considered to correspond more closely with the conditions at Johnstown were carried on at Cornell University, and a revised discharge curve derived, using the coefficients determined by the Cornell experiments. In the computation for the revised discharge curve the coefficients derived from experiment No. 12, corresponding to Bazin's experiment No. 115, were used for sections *A*, *B*, and *D;* and those determined by experiment No. 2, corresponding to Bazin's series No. 135, were used for section *C*.

For a cross section of this dam see Mr. Rafter's paper "On flow of water over dams."[1]

*Estimated daily discharge in second-feet of Cayadutta Creek at Johnstown, New York, for 1899.*

[Drainage area, 40 square miles.]

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | 30 | 21 | 20 | 16 | 12 | 33 | 19 |
| 2 | 28 | 15 | 22 | 20 | 24 | 31 | ........ |
| 3 | 29 | 24 | 32 | 12 | 24 | 28 | 14 |
| 4 | 17 | 17 | 22 | 19 | 25 | 48 | 37 |
| 5 | 29 | 20 | 21 | 28 | 17 | 34 | 27 |
| 6 | 28 | 20 | 11 | 16 | 15 | 26 | 23 |
| 7 | 18 | 19 | 19 | 23 | 19 | 28 | 23 |
| 8 | 30 | 34 | 20 | 22 | 9 | 26 | 23 |
| 9 | 21 | 16 | 20 | 17 | 18 | 22 | 23 |
| 10 | 19 | 27 | 20 | 7 | 20 | 27 | 13 |
| 11 | 18 | 25 | 17 | 16 | 24 | 26 | 27 |
| 12 | 30 | 18 | 23 | 19 | 23 | 20 | 238 |
| 13 | 25 | 18 | 8 | 20 | 13 | 28 | 207 |
| 14 | 24 | 16 | 20 | 17 | 20 | 28 | 145 |
| 15 | 25 | 18 | 20 | 19 | 17 | 30 | 55 |
| 16 | 25 | 13 | 20 | 20 | 24 | 20 | 40 |
| 17 | 25 | 23 | 20 | 11 | 26 | 21 | 44 |
| 18 | 17 | 25 | 20 | 19 | 33 | 20 | 36 |
| 19 | 25 | 26 | 19 | 20 | 21 | 6 | 51 |
| 20 | 37 | 20 | 9 | 21 | (*a*) | 27 | 85 |
| 21 | 32 | 19 | 15 | 20 | (*a*) | 27 | 62 |
| 22 | 33 | 23 | 16 | 17 | (*a*) | 26 | 42 |
| 23 | 32 | 8 | 14 | 19 | (*a*) | 25 | 26 |
| 24 | 32 | 18 | 16 | 14 | 21 | 24 | 19 |
| 25 | 18 | 22 | 16 | 20 | 18 | 26 | 56 |
| 26 | 29 | 19 | 14 | 32 | 18 | 14 | 60 |
| 27 | 26 | 16 | 11 | 36 | 19 | 30 | 25 |
| 28 | 30 | 17 | 15 | 26 | 16 | 28 | 24 |
| 29 | 30 | 17 | 16 | 27 | 30 | 28 | 20 |
| 30 | 22 | 14 | 16 | 26 | 30 | 15 | 19 |
| 31 | ........ | 25 | 16 | ........ | ........ | ........ | 11 |
| Mean | 26 | 20 | 18 | 20 | 21 | 26 | 49 |

*a* Repairing dam; water drawn off October 20 to 23.

## SCHOHARIE CREEK AT FORT HUNTER, NEW YORK.

Schoharie Creek rises in Green County, New York, and flows in a northerly direction through Schoharie and Montgomery counties, and empties into Mohawk River near Tribes Hill Station. Observations for the computation of flow are made on this creek at the State dam, which impounds water for the feeder of the Erie Canal at Fort Hunter. The dam is of timber and practically free from leakage. The profile of the crest of the dam is somewhat irregular, and to facilitate computation is divided into six parts, each part being assumed horizontal. The value of the coefficients of flow over this dam has been obtained by taking the mean of the coefficients for series Nos. 117 and 141 of Bazin's experiments. Cornell experiments No. 114, performed upon the section corresponding to the Rexford Flats dam, was considered to conform more closely to the conditions at Fort Hunter than the sections used by Bazin, and a revised discharge curve was drawn,

[1] Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, p. 316.

using the Cornell coefficients.[1] A measurement of Schoharie Creek was made near the village of Schoharie, New York, by students of the Summer School of Surveying of the Massachusetts Institute of Technology in June, 1889, under the direction of Prof. George F. Swain. Measurement was made by means of a Fteley meter. The results showed a discharge of 972 second-feet.

*Estimated daily discharge in second-feet of Schoharie Creek at Fort Hunter, New York, for 1899.*

[Drainage area 947 square miles.]

| Day. | June. | July. *a* | Aug. *a* | Sept. *a* | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | 495 | | | | 4,147 | 1,215 | 661 |
| 2 | 495 | | | | 2,247 | 1,895 | 661 |
| 3 | 595 | | | | 2,047 | 1,795 | 711 |
| 4 | 595 | | | | 2,527 | 1,215 | 761 |
| 5 | 495 | | | | 2,747 | 1,215 | 841 |
| 6 | 495 | | | | 2,247 | 1,045 | 841 |
| 7 | 495 | | | | 2,047 | 1,215 | 786 |
| 8 | 425 | | | | 1,827 | 1,215 | 786 |
| 9 | 405 | | | | 2,047 | 1,065 | 841 |
| 10 | 395 | | | | 1,247 | 1,045 | 786 |
| 11 | 395 | | | | 1,247 | 1,215 | 841 |
| 12 | 395 | | | | 1,827 | 1,895 | 786 |
| 13 | 395 | | | | 1,827 | 2,115 | 881 |
| 14 | 395 | | | | 2,247 | 1,795 | 961 |
| 15 | 395 | | | | 1,827 | 1,795 | 1,111 |
| 16 | 395 | | | | 2,527 | 1,215 | 1,181 |
| 17 | 395 | | | | 1,247 | 1,215 | 1,051 |
| 18 | 395 | | | | 1,077 | 1,045 | 1,111 |
| 19 | 395 | | | | 867 | 1,045 | 1,261 |
| 20 | 395 | | | | 1,247 | 1,045 | 1,111 |
| 21 | 395 | | | | 1,077 | 915 | 1,261 |
| 22 | 395 | | | | 867 | 915 | 1,261 |
| 23 | 395 | | | | 1,247 | 735 | 1,261 |
| 24 | 395 | | | | 1,077 | 735 | 1,111 |
| 25 | 395 | | | | 2,247 | 795 | 1,051 |
| 26 | 395 | | | | 2,047 | 735 | 1,051 |
| 27 | 395 | | | | 2,427 | 705 | 961 |
| 28 | 395 | | | | 1,827 | 615 | 961 |
| 29 | 395 | | | | 2,247 | 615 | 1,261 |
| 30 | 395 | | | | 2,427 | 575 | 1,261 |
| 31 | | | | | 1,827 | | 1,261 |
| Mean | 413 | | | | 1,880 | 1,155 | 989 |

*a* Data not sufficient to compute record for July, August, and September

## MOHAWK RIVER AT SCHENECTADY, NEW YORK.

A few measurements of the flow of Mohawk River have been made at Freeman's toll bridge, about one-fourth of a mile above the Delaware and Hudson Canal Company's railroad bridge and about 1 mile below the New York Central and Hudson River Railroad bridge. A temporary station was established here on January 28, 1899, and maintained until September 30, 1899, by Prof. Elton D. Walker, of Union College, Schenectady, New York. The observer is Mrs. J. Diggin. The equipment consists of a wire gage with a 4-pound iron sash weight and galvanized line. The graduated rod is fastened to the guard rail on the upstream side of the northwest section of the

[1] On flow of water over dams, by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, p. 317.

bridge and is marked in tenths of a foot from zero to 17 feet. There is a bench mark on the upstream end of the top of the capstone on the pier nearest the northwest or right bank of the river. A second bench mark is the southerly corner of the top of the masonry bridge seat on the upstream end of the northwest abutment. Both bench marks are 23.96 feet above the zero of the gage. The initial point for soundings is the face of the bridge seat on the upstream end of the southeast abutment. The channel is approximately straight and of uniform width for 600 feet above and half a mile below the site. The section is obstructed by three piers and crib foundations, but is otherwise good. The swiftest current is through the southeast span. The right bank is low and liable to overflow, but the road running to the northwest prevents the overflow passing around the bridge except in unusually high freshets. The left bank is high, being the tow-path of the Erie Canal, and is not liable to overflow except in extremely high freshets occurring at the time of an ice jam in the river below. Measurements are made from the upstream side of the bridge. The three following discharge measurements were made during 1899 by Prof. E. D. Walker: April 3, gage height 7.18 feet, discharge 5,298 second-feet; May 26, gage height 6.22 feet, discharge 2,092 second-feet; June 30, gage height 5.38 feet, discharge 482 second-feet.

*Daily gage height in feet of Mohawk River at Schenectady, New York, for 1899.*

| Day. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1 | 6.60 | 8.15 | 7.45 | 8.60 | (*a*) | 5.33 | 5.20 | 5.10 |
| 2 | 6.30 | 8.05 | 7.60 | 8.45 | (*a*) | 5.30 | 5.18 | 5.17 |
| 3 | 6.10 | 7.50 | 7.40 | 8.75 | (*a*) | 5.30 | 5.35 | 5.15 |
| 4 | 6.10 | 7.20 | 7.10 | 7.95 | (*a*) | 5.30 | 5.35 | 5.17 |
| 5 | 6.10 | 8.00 | 7.80 | 7.40 | (*a*) | 5.23 | 5.40 | 5.20 |
| 6 | 6.70 | 13.80 | 8.43 | 7.00 | (*a*) | 5.23 | 5.38 | 5.18 |
| 7 | 6.10 | 10.93 | 9.53 | 6.70 | (*a*) | 5.22 | 5.20 | 5.15 |
| 8 | 6.10 | 9.00 | 10.15 | 6.55 | 5.50 | 5.30 | 5.20 | 5.20 |
| 9 | 6.20 | 8.80 | 11.13 | 6.45 | 5.45 | 5.33 | 5.15 | 5.20 |
| 10 | 6.30 | 8.20 | 9.80 | 6.25 | 5.43 | 5.78 | 5.15 | 5.12 |
| 11 | 6.10 | 7.85 | 9.30 | 6.20 | 5.40 | 6.10 | 5.15 | 5.10 |
| 12 | 5.90 | 7.65 | 10.90 | 6.20 | 5.38 | 5.98 | 5.18 | 5.10 |
| 13 | 5.90 | 11.84 | 11.80 | 6.45 | 5.30 | 5.70 | 5.20 | 5.08 |
| 14 | 5.90 | 10.15 | 12.93 | 6.50 | 5.28 | 5.50 | 5.20 | 5.05 |
| 15 | 5.95 | 9.40 | 13.50 | 6.60 | 5.33 | 5.48 | 5.15 | 5.05 |
| 16 | 6.00 | 8.70 | 12.88 | 6.55 | 5.30 | 5.45 | 5.12 | 5.05 |
| 17 | 6.00 | 8.60 | 11.55 | 6.40 | 5.70 | 5.40 | 5.10 | 5.00 |
| 18 | 6.00 | 7.70 | 11.25 | 6.58 | 5.72 | 5.70 | 5.12 | 5.03 |
| 19 | 6.00 | 7.30 | 11.20 | 6.80 | 5.53 | 5.68 | 5.05 | 5.00 |
| 20 | 6.15 | 8.40 | 11.50 | 6.98 | 5.43 | 5.55 | 5.12 | 5.10 |
| 21 | 6.30 | 8.50 | 11.55 | 7.35 | 5.45 | 5.45 | 5.10 | 5.10 |
| 22 | 6.85 | 7.90 | 11.10 | 7.25 | 5.90 | 5.45 | 5.08 | 5.10 |
| 23 | 8.85 | 7.65 | 10.70 | 6.95 | 5.55 | 5.30 | 5.05 | 5.10 |
| 24 | 8.84 | 7.75 | 10.69 | 6.58 | 5.45 | 5.25 | 5.10 | 5.10 |
| 25 | 8.00 | 7.95 | 10.60 | 6.35 | 5.40 | 5.23 | 5.10 | 5.08 |
| 26 | 7.70 | 7.70 | 10.45 | 6.22 | 5.40 | 5.20 | 5.08 | 6.53 |
| 27 | 7.35 | 7.80 | 10.40 | 6.10 | 5.38 | 5.20 | 5.10 | 8.05 |
| 28 | 8.10 | 7.25 | 10.00 | 6.05 | 5.33 | 5.20 | 5.12 | 6.35 |
| 29 | ........ | 7.10 | 9.45 | 6.20 | 5.38 | 5.20 | 5.05 | 5.90 |
| 30 | ........ | 7.75 | 8.85 | 6.70 | 5.35 | 5.32 | 5.10 | 5.75 |
| 31 | ........ | 7.23 | ........ | 7.00 | ........ | 5.15 | 5.10 | (*b*) |

*a* Repairing bridge. *b* Discontinued September 30.

## MOHAWK RIVER AT REXFORD FLATS, NEW YORK.

Observations of river height are made at Rexford Flats, 4 miles below Schenectady, for the computation of flow of Mohawk River. This is a State dam, built of solid masonry, with a timber apron, and furnishes water for the feeder of the Erie Canal. Gages are read showing the height on crest of the dam and the head on the feeder gate, so that the amount of water flowing over the dam into the feeder can be determined. The profile of the crest of the dam is irregular, and to facilitate computation has been divided into five sections. The value of the coefficients for any depth on the crest of this dam has been obtained by taking the mean of the corresponding coefficients for series Nos. 117 and 141 of Bazin's experiments. Experiments were carried on at Cornell University to determine the coefficients of flow over an experimental weir of the exact form of the one located at Rexford Flats. This was known as "Cornell experiment No. 14." A revised discharge curve was computed, using the coefficients as determined by these experiments. H. R. Betts is the observer at this station. In comparing the results obtained at Little Falls and Rexford Flats, Mr. Robert E. Horton, who has made the computations, states that he has not been able to reconcile them, the former appearing to be the more accurate and the latter too small in proportion. For a cross section of this dam see the paper "On flow of water over dams," by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, p. 312.

*Daily discharge in second-feet of Mohawk River at Rexford Flats, New York, for 1899.*

[Drainage area, 3,385 square miles.]

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | 2,288 | 928 | 328 | 228 | 2,728 | 1,368 | 1,328 |
| 2 | 2,288 | 928 | 328 | 228 | 2,928 | 1,368 | 1,328 |
| 3 | 2,078 | 679 | 438 | 228 | 2,928 | 2,928 | 3,208 |
| 4 | 2,078 | 608 | 438 | 228 | 2,628 | 5,028 | 2,448 |
| 5 | 2,078 | 608 | 528 | 228 | 2,628 | 6,528 | 2,628 |
| 6 | 1,538 | 608 | 608 | 228 | 2,628 | 6,528 | 2,908 |
| 7 | 1,538 | 438 | 328 | 228 | 2,478 | 8,628 | 3,578 |
| 8 | 1,538 | 438 | 278 | 228 | 2,328 | 9,028 | 4,548 |
| 9 | 1,378 | 608 | 278 | 228 | 2,178 | 7,928 | 6,078 |
| 10 | 1,378 | 528 | 278 | 228 | 1,428 | 4,828 | 8,328 |
| 11 | 1,128 | 438 | 278 | 228 | 728 | 2,778 | 8,958 |
| 12 | 1,128 | 438 | 278 | 228 | 728 | 2,178 | 10,028 |
| 13 | 928 | 378 | 278 | 228 | 728 | 1,578 | 10,828 |
| 14 | 928 | 328 | 278 | 228 | 728 | 1,928 | 15,828 |
| 15 | 1,038 | 328 | 278 | 238 | 1,228 | 2,078 | 21,358 |
| 16 | 1,038 | 328 | 278 | 278 | 1,578 | 1,578 | 24,228 |
| 17 | 2,928 | 758 | 278 | 278 | 1,828 | 1,368 | 19,128 |
| 18 | 3,528 | 928 | 278 | 278 | 1,928 | 1,368 | 13,128 |
| 19 | 4,628 | 678 | 278 | 278 | 1,428 | 1,128 | 8,128 |
| 20 | 5,128 | 678 | 228 | 278 | 1,348 | 1,128 | 10,228 |
| 21 | 2,628 | 438 | 228 | 278 | 1,348 | 1,228 | 6,328 |
| 22 | 3,228 | 328 | 228 | 278 | 1,348 | 1,478 | 4,928 |
| 23 | 2,168 | 328 | 228 | 278 | 1,228 | 1,578 | 4,578 |
| 24 | 2,168 | 308 | 228 | 278 | 1,148 | 1,578 | 4,578 |
| 25 | 2,078 | 288 | 228 | 278 | 1,128 | 1,468 | 2,428 |
| 26 | 1,538 | 288 | 278 | 3,228 | 1,028 | 1,368 | 2,928 |
| 27 | 1,538 | 328 | 278 | 9,178 | 828 | 1,128 | 2,928 |
| 28 | 1,538 | 438 | 238 | 6,328 | 728 | 1,128 | 2,828 |
| 29 | 1,428 | 328 | 208 | 1,678 | 1,228 | 1,128 | 2,628 |
| 30 | 1,538 | 378 | 208 | 2,778 | 1,348 | 1,368 | 2,428 |
| 31 | .......... | 338 | 208 | .......... | 1,348 | .......... | 2,228 |
| Mean | 2,014 | 498 | 294 | 980 | 1,608 | 2,824 | 7,001 |

## SCHROON RIVER AT WARRENSBURG, NEW YORK.

This river rises in Essex County, along the southern slopes of the highest mountains in the Atlantic group, and flows in a general southerly direction for about 45 miles, until it joins Hudson River, as described in Water-Supply Paper No. 24, page 43. There are no developed water powers excepting that at Warrensburg, near the mouth. At this point records of river height have been kept by J. Goodfellow, the superintendent of the Schroon River Pulp Company, The dam at this point was built in 1893, and is said to be as tight as any of its kind. The observations were begun in 1895, the gages being established by Mr. George W. Rafter in connection with his investigations of the Upper Hudson storage surveys, in progress at that time. Mr. Wallace Greenalch, as assistant to Mr. Rafter, computed the flow of the river, but in his opinion these computations were to a certain extent vitiated by the possible leakage through the dam and complications introduced by flashboards being continually changed.

## HUDSON RIVER AT FORT EDWARD, NEW YORK.

This river, as a whole, has been described in Water-Supply Papers Nos. 24 and 25. Estimates of flow have been made at two points, the upper at Fort Edward, about halfway between the mouth of Schroon River and Albany, and the lower at Mechanicville, above the mouth of Mohawk River. Records are being kept of the height of water surface above the crest of the dam at Fort Edward by the International Paper Company, B. A. Carr, superintendent. The estimated discharge was computed at the office of the State engineer and surveyor, but without taking the modifications introduced by the flashboards into account. The data were later placed in the hands of Mr. Robert E. Horton, but he has had opportunity to compute the flow during only one or two months. There is a peculiarity in regard to the method of reading the gage, but otherwise the results are satisfactory and worthy of computation.

## HUDSON RIVER AT MECHANICVILLE, NEW YORK.

A daily record of the height of water passing over the dam of the Duncan Company, at Mechanicville, New York, has been kept, with few omissions, since 1887, as described in the report prepared by George W. Rafter.[1] These observations are made twice daily, at 7 a. m. and at 4 p. m., except Sundays, when the afternoon observations are omitted. The depth of the water on the crest of the dam is measured at a point sufficiently removed from the crest not to be influenced by the curve of the water surface. Besides these readings,

[1] Water-Supply and Irrigation Paper No. 24, page 78.

the difference in elevation between the surface of the water at the entrance and discharge from the water wheels is noted. The flow, as stated by R. P. Bloss, the engineer of the Duncan Company, is obtained by the use of Francis's formula for weirs with wide crests: $q=3\ LH^{\frac{3}{2}}$, in which q is the discharge in cubic feet per second, H the head in feet on crest of the dam, and L the length of the dam, which, in this case, is 794 feet. The coefficient used (3) was determined for dam of similar cross section. When the water wheels are in operation the head on wheels is determined by observation, and the amount of water used on each wheel under the given head is taken directly from the table given by the water-wheel builder. There being no leakage of the dam or canal the sum of the flow over the dam and the flow through the wheels gives the total flow of the river at the time of the observation.

*Daily discharge in second-feet of Hudson River at Mechanicville, New York.*

[Drainage area, 4,500 square miles.]

1896.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 ..... | 24,147 | 3,177 | 22,189 | 21,647 | 9,050 | 6,627 | 2,324 | 2,374 | 2,077 | 2,991 | 3,484 | 13,028 |
| 2 ..... | 22,847 | 3,289 | 32,900 | 20,147 | 7,252 | 6,627 | 2,324 | 2,736 | 1,770 | 3,441 | 3,652 | 11,650 |
| 3 ..... | 19,547 | 3,402 | 27,525 | 18,947 | 7,027 | 6,027 | 2,234 | 3,099 | 1,770 | 3.916 | 3,332 | 8,200 |
| 4 ..... | 15,627 | 3,402 | 25,880 | 16,097 | 6,802 | 4,752 | 2,324 | 2,949 | 1,770 | 4,016 | 3,332 | 7,290 |
| 5 ..... | 11,652 | 3,527 | 26,230 | 14,774 | 6,202 | 4,477 | 2,324 | 2,674 | 1,770 | 4,116 | 3,652 | 7,450 |
| 6 ..... | 7,677 | 3,477 | 18,122 | 13,452 | 6,202 | 4,477 | 2,324 | 2,324 | 3,055 | 3,841 | 23,335 | 7,575 |
| 7 ..... | 5,677 | 13,327 | 17,247 | 14,327 | 5,677 | 4,389 | 2,999 | 2,324 | 4,341 | 3,666 | 25,735 | 7,700 |
| 8 ..... | 5,602 | 7,427 | 16,822 | 13,127 | 5,402 | 4,302 | 2,724 | 2,324 | 3,316 | 3,916 | 24,235 | 6,853 |
| 9 ..... | 5,677 | 6,302 | 16,397 | 13,127 | 4,902 | 5,277 | 2,799 | 2,412 | 2,916 | 3,916 | 22,735 | 7,850 |
| 10 ..... | 5,602 | 5,177 | 14,247 | 13,677 | 5,002 | 6,227 | 2,774 | 2,499 | 2,791 | 3,441 | 19,085 | 11,493 |
| 11 ..... | 5,377 | 5,177 | 11,837 | 13,827 | 5,102 | 8,127 | 2,774 | 2,449 | 2,616 | 3,678 | 16,985 | 10,922 |
| 12 ..... | 5,139 | 4,377 | 8,502 | 15,708 | 4,477 | 7,927 | 2,624 | 2,399 | 2,541 | 3,916 | 15,735 | 10,067 |
| 13 ..... | 4,902 | 4,202 | 7,327 | 17,589 | 4,527 | 6,027 | 2,474 | 2,424 | 2,441 | 3,391 | 14,135 | 9,259 |
| 14 ..... | 4,902 | 4,027 | 7,127 | 25,314 | 3,802 | 6,127 | 2,624 | 2,399 | 2,341 | 3,791 | 12,680 | 8,450 |
| 15 ..... | 4,702 | 4,377 | 6,789 | 34,414 | 3,602 | 6,227 | 2,324 | 2,374 | 2,491 | 7,416 | 11,582 | 7,950 |
| 16 ..... | 4,302 | 3,864 | 6,452 | 39,775 | 3,877 | 5,677 | 2,324 | 2,384 | 2,491 | 6,766 | 10,485 | 6,253 |
| 17 ..... | 4,152 | 3,352 | 6,027 | 48,300 | 3,877 | 6,127 | 2,324 | 2,394 | 2,291 | 5,741 | 10,680 | 9,125 |
| 18 ..... | 3,877 | 3,677 | 5,602 | 55,400 | 3,877 | 4,677 | 2,324 | 2,424 | 2,241 | 5,278 | 9,635 | 6,750 |
| 19 ..... | 4,127 | 4,077 | 5,677 | 59,393 | 3,352 | 4,152 | 2,324 | 2,499 | 2,266 | 4,816 | 8,380 | 5,350 |
| 20 ..... | 4,377 | 4,152 | 15,702 | 52,050 | 3,227 | 4,077 | 2,324 | 2,474 | 3,503 | 4,366 | 7,635 | 5,138 |
| 21 ..... | 4,152 | 3,752 | 11,977 | 45,400 | 3,227 | 4,139 | 2,949 | 2,394 | 4,741 | 4,016 | 6,965 | 4,925 |
| 22 ..... | 4,027 | 3,677 | 10,077 | 37,436 | 2,977 | 4,202 | 4,324 | 2,374 | 4,691 | 4,541 | 7,025 | 4,300 |
| 23 ..... | 3,952 | 3,739 | 8,177 | 32,314 | 2,952 | 3,177 | 5,349 | 2,361 | 4,116 | 4,166 | 7,085 | 4,400 |
| 24 ..... | 3,677 | 3,802 | 6,102 | 26,230 | 3,052 | 3,002 | 4,774 | 2,349 | 3,716 | 4,166 | 6,585 | 3,435 |
| 25 ..... | 3,802 | 3,952 | 6,302 | 21,672 | 3,152 | 2,777 | 3,424 | 2,374 | 3,666 | 4,141 | 6,385 | 3,918 |
| 26 ..... | 3,877 | 3,802 | 7,877 | 18,349 | 2,977 | 2,677 | 3,074 | 2,324 | 2,991 | 4,116 | 9,185 | 4,400 |
| 27 ..... | 3,952 | 3,677 | 13,997 | 15,027 | 3,152 | 2,427 | 2,724 | 2,324 | 2,991 | 3,116 | 10,485 | 4,350 |
| 28 ..... | 3,527 | 3,677 | 9,177 | 12,102 | 3,527 | 2,489 | 2,449 | 2,324 | 2,991 | 2,916 | 11,535 | 4,300 |
| 29 ..... | 3,277 | 11,477 | 12,787 | 10,077 | 3,802 | 2,552 | 2,349 | 2,324 | 2,791 | 3,116 | 12,110 | 3,675 |
| 30 ..... | 3,177 | ....... | 16,397 | 9,477 | 5,027 | 2,377 | 2,474 | 2,324 | 2,866 | 3,241 | 12,685 | 3,950 |
| 31 ..... | 3,177 | ....... | 20,147 | ........ | 5,827 | ....... | 2,374 | 2,324 | ....... | 3,316 | ........ | 4,300 |
| Mean | 6,791 | 4,668 | 13,600 | 24,972 | 4,610 | 4,738 | 2,772 | 2,442 | 2,879 | 4,106 | 11,352 | 6,913 |

*Daily discharge in second-feet of Hudson River at Mechanicville, New York*—Continued.

1897.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4,110 | 3,595 | 3,000 | 13,028 | 13,950 | 9,300 | 5,950 | 14,290 | 4,000 | 2,290 | 2,150 | 17,121 |
| 2 | 4,550 | 3,300 | 2,664 | 12,906 | 13,100 | 8,400 | 5,050 | 13,650 | 3,800 | 2,245 | 3,475 | 15,655 |
| 3 | 4,485 | 3,675 | 3,065 | 13,028 | 12,250 | 6,830 | 4,500 | 11,810 | 3,295 | 3,065 | 10,550 | 13,539 |
| 4 | 4,420 | 4,512 | 11,193 | 13,789 | 12,114 | 11,950 | 4,500 | 11,650 | 3,295 | 2,290 | 10,149 | 11,466 |
| 5 | 4,300 | 3,300 | 7,050 | 14,550 | 12,728 | 13,950 | 4,500 | 9,450 | 3,033 | 2,170 | 8,817 | 13,509 |
| 6 | 6,623 | 4,230 | 13,950 | 18,670 | 12,250 | 12,425 | 4,500 | 8,825 | 2,770 | 2,150 | 7,314 | 20,531 |
| 7 | 5,600 | 6,346 | 11,225 | 21,450 | 13,150 | 10,900 | 3,932 | 7,400 | 2,715 | 2,150 | 5,915 | 16,404 |
| 8 | 5,350 | 8,450 | 8,500 | 21,300 | 11,810 | 8,725 | 4,650 | 6,485 | 2,664 | 2.150 | 5,752 | 15,435 |
| 9 | 5,185 | 5,975 | 8,815 | 20,750 | 10,155 | 10,600 | 5,430 | 5,570 | 2,540 | 2,150 | 5,752 | 14,437 |
| 10 | 5,130 | 5,350 | 12,900 | 23,806 | 8,500 | 25,986 | 4,750 | 5,150 | 2,450 | 3,180 | 9,266 | 13,462 |
| 11 | 5,075 | 4,200 | 14,550 | 18,890 | 8,400 | 27,188 | 4,650 | 6,025 | 2,340 | 2,150 | 9,224 | 12,927 |
| 12 | 3,880 | 3,932 | 14,110 | 13,973 | 9,350 | 24,790 | 4,550 | 13,350 | 2,370 | 2,150 | 11,254 | 13,000 |
| 13 | 3,595 | 3,180 | 12,900 | 15,918 | 10,450 | 22,170 | 6,750 | 11,350 | 2,400 | 2,450 | 12,243 | 17,150 |
| 14 | 3,370 | 3,328 | 10,925 | 15,550 | 22,550 | 19,550 | 23,150 | 9,650 | 2,664 | 3,000 | 13,768 | 15,559 |
| 15 | 3,300 | 3,475 | 8,950 | 16,940 | 19,625 | 17,280 | 31,060 | 9,238 | 2,370 | 3,135 | 10,794 | 31,178 |
| 16 | 3,595 | 3,180 | 8,400 | 22,269 | 17,188 | 15,900 | 22,750 | 8,825 | 2,715 | 3,065 | 10,000 | 35,706 |
| 17 | 3,853 | 3,295 | 7,150 | 23,340 | 14,750 | 13,150 | 18,670 | 9,450 | 2,450 | 4,110 | 13,300 | 32,515 |
| 18 | 4,110 | 3,135 | 6,830 | 23,908 | 13,650 | 11,200 | 16,390 | 8,250 | 2,340 | 2,664 | 11,800 | 29,702 |
| 19 | 3,300 | 2,930 | 6,830 | 24,476 | 11,500 | 9,220 | 14,110 | 7,550 | 4,000 | 2,900 | 11,620 | 23,114 |
| 20 | 3,300 | 2,820 | 12,900 | 23,621 | 12,100 | 9,220 | 11,950 | 7,775 | 2,290 | 2,664 | 10,650 | 15,379 |
| 21 | 3,300 | 3,058 | 15,375 | 20,950 | 11,300 | 9,220 | 11,193 | 7,050 | 2,664 | 2,370 | 8,628 | 12,207 |
| 22 | 3,350 | 3,295 | 17,850 | 19,625 | 11,810 | 8,950 | 11,350 | 6,500 | 2,540 | 2,346 | 9,354 | 8,486 |
| 23 | 3,435 | 4,120 | 18,470 | 17,150 | 10,980 | 7,025 | 11,950 | 5,950 | 2,180 | 2,150 | 8,182 | 6,900 |
| 24 | 3,555 | 4,212 | 23,010 | 16,941 | 10,150 | 7,250 | 12,230 | 6,830 | 2,380 | 3,070 | 7,451 | 4,819 |
| 25 | 3,675 | 3,135 | 23,957 | 19,346 | 9,300 | 6,220 | 11,425 | 7,775 | 2,290 | 2,290 | 6,368 | 2,785 |
| 26 | 2,925 | 3,050 | 19,950 | 21,750 | 10,000 | 5,820 | 10,620 | 7,775 | 3,930 | 2,150 | 7,395 | 2,293 |
| 27 | 2,875 | 3,000 | 17,973 | 25,200 | 10,330 | 5,485 | 9,450 | 6,750 | 2,664 | 2,150 | 15,402 | 4,122 |
| 28 | 3,350 | 3,000 | 15,912 | 22,450 | 11,650 | 5,150 | 8,950 | 6,025 | 2,770 | 2,150 | 15,848 | 7,047 |
| 29 | 3,530 | ....... | 13,850 | 19,017 | 10,950 | 4,400 | 19,550 | 5,513 | 2,370 | 2,150 | 19,456 | 6,467 |
| 30 | 3,530 | ....... | 13,028 | 17,625 | 10,700 | 7,400 | 20,950 | 5,000 | 2,380 | 2,150 | 16,984 | 6,467 |
| 31 | 3,563 | ....... | 13,350 | ........ | 10,450 | ....... | 14,930 | 4,550 | ....... | 3,135 | ........ | 6,467 |
| Mean | 4,007 | 3,895 | 12,214 | 19,074 | 12,167 | 11,855 | 11,109 | 8,241 | 2,756 | 2,524 | 9,995 | 14,382 |

1898.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5,512 | 5,235 | 5,295 | 20,306 | 13,474 | 9,490 | 3,179 | 3,005 | *a*4,345 | 3,222 | 7,954 | 6,300 |
| 2 | 4,689 | 5,095 | 5,280 | 18,018 | 11,545 | 8,159 | 3,014 | 3,888 | *a*4,007 | 2,877 | 7,667 | 6,130 |
| 3 | 5,035 | 5,272 | 5,208 | 15,810 | 9,702 | 7,558 | 3,007 | 6,225 | *a*4,145 | 2,835 | 6,590 | 5,698 |
| 4 | 5,186 | 4,151 | 5,208 | 13,890 | 10,820 | 6,292 | 3,007 | 5,722 | *a*4,340 | 2,780 | 6,500 | 5,185 |
| 5 | 5,306 | 4,353 | 5,055 | 11,932 | 10,570 | 5,808 | 3,364 | 6,031 | 4,547 | 11,210 | 5,890 | 5,994 |
| 6 | 5,485 | 6,475 | 5,200 | 10,692 | 11,300 | 5,508 | 2,588 | 5,832 | 4,145 | 20,089 | 5,803 | 6,500 |
| 7 | 6,626 | 5,203 | 5,250 | 9,928 | 11,032 | 4,729 | 2,453 | 5,415 | 4,007 | 9,472 | 5,890 | 6,322 |
| 8 | 7,256 | 5,000 | 5,186 | 8,787 | 10,250 | 4,399 | 2,314 | 5,091 | 4,930 | 8,261 | 5,503 | 5,456 |
| 9 | 5,890 | 4,826 | 6,819 | 8,158 | 9,700 | 4,249 | 2,220 | 4,335 | 4,217 | 7,872 | 5,872 | 4,150 |
| 10 | 6,168 | 4,826 | 7,431 | 7,924 | 8,695 | 3,978 | 1,163 | 3,926 | 3,813 | 6,960 | 6,238 | 4,675 |
| 11 | 5,951 | 6,325 | 10,361 | 7,915 | 7,875 | 3,425 | 2,000 | 3,743 | 3,368 | 6,038 | 20,256 | 4,345 |
| 12 | 5,298 | 10,022 | 20,994 | 7,646 | 8,420 | 3,857 | 2,182 | 3,387 | 3,304 | 6,109 | 16,262 | 4,290 |
| 13 | 11,499 | 13,042 | 27,300 | 8,553 | 11,054 | 4,299 | 2,058 | 3,331 | 3,188 | 5,331 | 14,510 | 3.739 |
| 14 | 10,975 | 10,425 | 39,389 | 9,815 | 10,585 | 4,945 | 2,080 | 3,148 | 2,732 | 4,829 | 13,202 | 3,540 |
| 15 | 10,160 | 9,074 | 36,375 | 9,824 | 10,161 | 7,662 | 2,184 | 3,362 | 2,597 | 6,888 | 11,385 | 3.850 |
| 16 | 10,647 | 8,100 | 32,325 | 12,188 | 9,967 | 6,872 | 2,159 | 3,250 | 2,487 | 7,838 | 10,366 | 4,007 |
| 17 | 9,672 | 5,682 | 30,625 | 12,575 | 10,082 | 5,681 | 1,163 | 3,223 | 2,597 | 8,125 | 9,722 | 4,495 |
| 18 | 7,515 | 7,480 | 32,325 | 12,188 | 10,637 | 4,620 | 2,192 | 3,235 | 2,873 | 7,250 | 8,910 | 4,590 |
| 19 | 7,008 | 7,788 | 29,935 | 11,155 | 9,404 | 4,851 | 2,224 | 3,660 | 2,873 | 6,500 | 8,922 | 4,590 |
| 20 | 7,952 | 7,571 | 30,000 | 11,157 | 9,412 | 5,593 | 2,175 | 4,507 | 3,365 | 6.508 | 10,505 | 4,885 |
| 21 | 13,757 | 8,009 | 36,235 | 10,922 | 8,355 | 4,603 | 2,192 | 4,495 | 2,975 | 6,418 | 11,167 | 5,035 |
| 22 | 10,170 | 7,906 | 34,035 | 10,127 | 7,954 | 4,399 | 3,188 | 4,718 | 2,899 | 6.310 | 10.366 | 5,035 |
| 23 | 9,780 | 7,258 | 30,615 | 9,815 | 8,000 | 4,198 | 3,565 | 3,927 | 2,666 | 6,894 | 9,610 | 6,908 |
| 24 | 11,458 | 6,542 | 27,450 | 9,627 | 8,400 | 4,348 | 3,549 | 5,779 | 3,297 | 7,578 | 8,898 | 8,369 |
| 25 | 9,436 | 6,263 | 24,860 | 20,440 | 9,491 | 4,097 | 3,928 | *a*11,167 | 5,231 | 7,178 | 8,685 | 7,747 |
| 26 | 8,628 | 5,992 | 21,860 | 24,210 | 11,953 | 4,024 | 4,565 | *a*9,953 | 6,878 | 6,693 | 7,847 | 6,885 |
| 27 | 7,788 | 5,294 | 19,600 | 24,338 | 14,758 | 4,115 | 4,258 | *a*8,125 | 5,706 | 9,382 | 6,413 | 5,872 |
| 28 | 7,719 | 5,911 | 19,910 | 20,440 | 15,327 | 3,556 | 3,656 | *a*8,250 | 4,775 | 11,042 | 5,820 | 4,618 |
| 29 | 6,624 | ....... | 20,660 | 18,165 | 14,140 | 3,508 | 3.352 | *a*6,109 | 4,345 | 10,485 | 6,300 | 4,628 |
| 30 | 5,361 | ....... | 23,560 | 14,873 | 12,727 | 3,238 | 3,175 | *a*4,829 | 3,650 | 10,059 | 6,300 | 4,828 |
| 31 | 4,860 | ....... | 22,640 | ........ | 10,490 | ....... | 3,015 | *a*4,217 | ....... | 9,953 | ........ | 5,348 |
| Mean | 7,723 | 6,754 | 20,225 | 13,047 | 10,525 | 5,069 | 2,751 | 5,029 | 3,810 | 7,516 | 8,978 | 5,291 |

*a* Discharge August 25 to September 4, not exact, owing to irregular flashboards.

*Daily discharge in second-feet of Hudson River at Mechanicville, New York*—Continued.

1899.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4,262 | 3,910 | 7,847 | 7,980 | 26,900 | 3,990 | 2,220 | 1,520 | 1,713 | ------- | 4,564 | 3,005 |
| 2 | 4,262 | 4,268 | 7,040 | 7,159 | 27,617 | 3,796 | 1,047 | 629 | 1,561 | 4,042 | 8,889 | 3,414 |
| 3 | 5,209 | 4,268 | 6,403 | 6,955 | 25,551 | 3,601 | 2,128 | 1,213 | ------- | 3,453 | 12,020 | 3,753 |
| 4 | 6,065 | 4,150 | -------- | 7,934 | 22,472 | 2,220 | ------- | 1,153 | 1,293 | 2,850 | 11,899 | 5,545 |
| 5 | 9,146 | 4,002 | -------- | 9,405 | 19,242 | 2,990 | 2,741 | 1,085 | 1,860 | 2,745 | 10,346 | 6,678 |
| 6 | 8,460 | 4,223 | 16,501 | 9,955 | 15,152 | 2,840 | 1,610 | ------- | 1,764 | 2,650 | 11,049 | 5,974 |
| 7 | 8,355 | 4,048 | 12,266 | 11,719 | 12,662 | 2,728 | 1,670 | 1,494 | 1,706 | 2,571 | 9,308 | 5,210 |
| 8 | 8,350 | 4,275 | 9,077 | 19,708 | 10,960 | 2,805 | 1,211 | 1,616 | 1,680 | ------- | 8,140 | 4,558 |
| 9 | 8,026 | 3,448 | 8,665 | 18,275 | 9,270 | 2,525 | ------- | 1,475 | 1,466 | 2,590 | 7,166 | 3,806 |
| 10 | 6,562 | 3,665 | 7,909 | 15,062 | 8,587 | 2,290 | 3,000 | 484 | ------- | 2,712 | 6,662 | 3,265 |
| 11 | 5,766 | 3,622 | 7,315 | 15,582 | 7,446 | ------- | 3,533 | 1,148 | 1,480 | 2,903 | 6,182 | 3,569 |
| 12 | 5,250 | 4,062 | 11,739 | 16,875 | 7,550 | 2,399 | 3,296 | 993 | 1,598 | 2,874 | 5,490 | 4,979 |
| 13 | 5,272 | 4,196 | 15,437 | 17,145 | 7,155 | 2,505 | 3,243 | ------- | 1,471 | 2,926 | 6,321 | 11,183 |
| 14 | 5,960 | 4,508 | 12,153 | 21,378 | 7,060 | 2,230 | 3,002 | 1,580 | 1,567 | 2,353 | 5,536 | 14,576 |
| 15 | 7,435 | 4,600 | 10,555 | 27,975 | 7,772 | 2,135 | 2,800 | 1,680 | 1,484 | ------- | 5,179 | 14,979 |
| 16 | 8,910 | 4,798 | 10,012 | 29,730 | 7,346 | 3,078 | ------- | 1,501 | 1,549 | 2,177 | 4,858 | 13,452 |
| 17 | 10,155 | 5,598 | 9,080 | 31,112 | 5,738 | 3,060 | 2,861 | 1,815 | ------- | 2,132 | 5,283 | 9,646 |
| 18 | 9,685 | 5,691 | 7,895 | 29,667 | 5,729 | 2,762 | 3,338 | 979 | 711 | 1,853 | 4,857 | 9,534 |
| 19 | 7,339 | 5,620 | 9,322 | 29,711 | 5,928 | 2,950 | 2,860 | 1,390 | 1,636 | 1,798 | 4,359 | 9,968 |
| 20 | 6,385 | 5,267 | 11,350 | 33,940 | 5,917 | 2,508 | 2,560 | ------- | 957 | 1,997 | 4,838 | 10,950 |
| 21 | 6,297 | 4,855 | 9,670 | 36,210 | 5,925 | 2,372 | 2,485 | 1,610 | 941 | 2,185 | 4,729 | 11,048 |
| 22 | 5,770 | 5,686 | 9,337 | 36,210 | 6,187 | 2,280 | 2,295 | 1,123 | 1,448 | ------- | 4,587 | 10,721 |
| 23 | 5,697 | 10,083 | 8,645 | 37,146 | 5,313 | 2,105 | ------- | 1,743 | 1,464 | 2,466 | 4,297 | 9,642 |
| 24 | 5,522 | 7,501 | 8,657 | 38,283 | 4,756 | 1,878 | 2,240 | 2,460 | ------- | 2,698 | 3,964 | 8,068 |
| 25 | 6,950 | 5,583 | 8,095 | 39,064 | 4,710 | 304 | 2,233 | 1,383 | 1,516 | 2,372 | 3,731 | 8,241 |
| 26 | 5,775 | 5,255 | 7,492 | 41,475 | 4,462 | 1,878 | 2,188 | 1,463 | 2,116 | 2,304 | 3,472 | 7,821 |
| 27 | 5,438 | 6,450 | 6,895 | 40,064 | 4,117 | 2,241 | 2,021 | ------- | 6,000 | 2,128 | 4,027 | 5,832 |
| 28 | 4,545 | 10,326 | 6,615 | 38,300 | 3,985 | 2,290 | 2,140 | 1,756 | 5,127 | 2,216 | 3,495 | 5,435 |
| 29 | 4,290 | ------- | 7,835 | 33,908 | 4,125 | 2,368 | 1,686 | 1,738 | 4,413 | ------- | 3,439 | 4,889 |
| 30 | 4,345 | ------- | 8,765 | 30,292 | 3,787 | 2,512 | ------- | 1,739 | 4,870 | 3,198 | 3,318 | 4,075 |
| 31 | 4,066 | ------- | 7,602 | -------- | 3,918 | ------- | 2,055 | 1,477 | ------- | 3,815 | -------- | 2,585 |
| Mean | 6,437 | 5,141 | 9,316 | 24,607 | 9,591 | 2,539 | 2,402 | 1,417 | 2,054 | 2,616 | 6,066 | 7,303 |

## SAWKILL RIVER NEAR KINGSTON, NEW YORK.

The Sawkill, a small stream which supplies Kingston, New York, with water, has been measured by Mr. William Rich Hutton, at a point about 4.5 miles above its mouth in Esopus Creek, its discharge being 1.25 second-feet. On two occasions after heavy rains the discharge at the same place has been more than 8,000 second-feet from a drainage area of 35 square miles. This quantity continued a very short time, probably about an hour. The location of this stream is shown on the Kaaterskill topographic sheet. It rises behind Overlook Mountain, flows by the village of Woodstock, and joins the Esopus about 4 miles below the city of Kingston. Reservoir No. 1 is shown on the map, but reservoir No. 2, constructed in 1897, about 1½ miles below Woodstock, is not given.

In April, 1895, the mountains being covered with snow 12 inches deep, there occurred a south wind and light rain for two days followed by twelve hours of very heavy rain. On the evening of April 4 the water in reservoir No. 1 began to rise rapidly, and about 9 p. m. the noise of the floating logs and ice and the rapidly rising water alarmed the gate keeper so that he moved his more important furniture by boat to higher ground. At midnight the water was at its highest and by 8 a. m. on April 5 it was falling rapidly. From the maximum height of water on the spillway it is computed that the outflow of the reservoir was a little less than 8,000 second-feet. In 1896 it is estimated that a similar flood furnished over 8,000 second-feet.

## CROTON RIVER.

This stream receives its waters from the drainage area immediately north of the city of New York and east of Hudson River. It flows in a general southerly and westerly course, emptying into the Hudson above Sing Sing. A number of reservoirs have been built within its basin for the water supply of the city of New York, and a new dam is being constructed about 3.2 miles above the mouth, at what is known as the "Cornell site." The location of the river and principal reservoirs is shown on the West Point, Carmel, Tarrytown, and Stamford topographic sheets of the United States Geological Survey. Figures of the yield of this watershed have been prepared by the engineers of the aqueduct commission. The monthly discharges in second-feet for the years 1870 to 1898 have been printed in the Twentieth Annual Report, Part IV, page 83. The following table, obtained from Mr. W. R. Hill, chief engineer, gives a continuation of this for 1899. The figures of rainfall are those obtained at Boyds Corners, in Croton basin.

*Rainfall and run-off of Croton River watershed for 1899.*

[Drainage area, 338 square miles.]

| Month. | Rainfall. | Run-off. | Month. | Rainfall. | Run-off. |
|---|---|---|---|---|---|
| | *Inches.* | *Sec.-feet.* | | *Inches.* | *Sec.-feet.* |
| January | 4.38 | 1,210 | August | 0.48 | 114 |
| February | 5.07 | 943 | September | 8.81 | 305 |
| March | 7.58 | 2,217 | October | 1.48 | 237 |
| April | 1.99 | 1,240 | November | 2.05 | 277 |
| May | 1.80 | 344 | December | 2.75 | 263 |
| June | 5.38 | 152 | | | |
| July | 5.99 | 344 | The year | 47.76 | 636 |

The total depth of run-off in inches during 1899 was 25.55, this being 53 per cent of the rainfall, as given in the above table.

## DELAWARE RIVER AT LAMBERTVILLE, NEW JERSEY.

This river rises in Delaware County, New York, flows in a southerly direction, forming the boundary between the States of Pennsylvania and New Jersey, and empties into Delaware Bay. Measurements of flow were made in 1891 by Prof. Dwight Porter and students at the Delaware Water Gap, Pennsylvania. The results show a flow of from 2,000 to 2,200 second-feet during the latter half of June, 1891. This was said to be the lowest June stage for five years. Measurements were made during the drought of 1895 by Prof. L. M. Haupt at Point Pleasant, Pennsylvania, near the intake of the Delaware and Raritan Canal feeder. The discharge above the bridge was 1,657 second-feet and below the bridge 1,328 second-feet. Delaware River was measured by E. G. Paul, June 4, 1899, at Martins Creek, Pennsylvania, 7 miles above the mouth of Lehigh River, and a discharge of 2,724 second-feet was found. Lehigh River was measured on June 5, 1899, by E. G. Paul, at the Glendon Bridge at Easton, Pennsylvania, and was discharging 991 second-feet. Systematic measurements of river height were begun on July 23, 1897, at the covered toll bridge at Lambertville, New Jersey, a town on the Belvidere division of the Pennsylvania Railroad, 16 miles above Trenton. The gage, established by E. G. Paul, consists of a stamped-link brass chain 33 feet long, with a 6-pound sash weight attached. The chain passes over a pulley and the index is referred to a scale painted on a horizontal board 32 feet long, fastened to the studding and inclosed in a wooden cover. The zero of the gage chain is marked by a copper rivet, which is 28.85 feet from the end of the weight, and reads 2 feet when the water is at zero on a gage on the first bridge pier. Measurements are made from the windows of this covered bridge. The initial point for soundings is on the left bank. The channel above and below is nearly straight, the water being sluggish for a short space on the left side. The right bank is high and the bed of the stream is of gravel and sand. The observer is Charles H. Naylor, collector of bridge tolls, Lambertville, New Jersey. Records of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 122; 1898, Twentieth Annual Report, Part IV, page 85. Three measurements were made during 1899, by E. G. Paul, as follows: March 31, gage height 6.30 feet, discharge 27,737 second-feet; June 2, gage height 3.70 feet, discharge 6,410 second-feet; September 19, gage height 2.75 feet, discharge 2,430 second-feet.

*Daily gage height, in feet, of Delaware River at Lambertville, New Jersey, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.95 | (*a*) | 6.80 | 6.25 | 4.75 | 3.60 | 4.40 | 4.20 | 3.45 | 4.65 | 3.40 | 3.80 |
| 2 | (*a*) | (*a*) | 6.80 | 6.25 | 4.60 | 3.60 | 4.30 | 4.00 | 3.35 | 4.45 | 3.80 | 3.80 |
| 3 | (*a*) | (*a*) | 6.30 | 5.95 | 4.60 | 3.30 | 3.95 | 4.00 | 3.35 | 4.25 | 4.05 | 3.80 |
| 4 | (*a*) | (*a*) | 6.25 | 5.80 | 4.50 | 3.20 | 3.75 | 3.90 | 3.30 | 4.10 | 4.65 | 3.80 |
| 5 | 5.40 | 4.50 | 7.95 | 5.65 | 4.40 | 3.05 | 3.65 | 3.85 | 3.45 | 4.05 | 4.75 | 3.95 |
| 6 | 6.05 | 4.45 | 8.30 | 5.70 | 4.30 | 2.90 | 3.65 | 3.70 | 4.90 | 3.95 | 4.60 | 3.85 |
| 7 | 7.00 | 4.40 | 9.65 | 5.90 | 4.20 | 2.95 | 3.65 | 3.90 | 4.35 | 3.90 | 4.55 | 3.90 |
| 8 | 6.55 | 4.40 | 8.20 | 7.40 | 4.10 | 2.85 | 3.60 | 3.65 | 3.95 | 3.85 | 4.35 | 3.75 |
| 9 | 6.10 | (*a*) | 7.20 | 9.10 | 4.00 | 2.90 | 3.90 | 3.55 | 3.85 | 3.75 | 3.75 | 3.75 |
| 10 | 5.80 | (*a*) | 6.45 | 8.70 | 3.90 | 2.90 | 3.80 | 3.45 | 3.75 | 3.70 | 4.10 | 3.85 |
| 11 | 5.35 | (*a*) | 6.20 | 7.65 | 3.85 | 2.85 | 3.75 | 3.65 | 3.50 | 3.60 | 4.10 | 3.70 |
| 12 | 5.00 | (*a*) | 6.30 | 7.15 | 4.00 | 2.70 | 3.70 | 3.55 | 3.90 | 3.60 | 4.10 | 3.75 |
| 13 | 4.80 | (*a*) | 7.50 | 7.75 | 4.00 | 2.60 | 3.75 | 3.35 | 3.65 | 3.60 | 4.25 | 4.20 |
| 14 | 4.90 | (*a*) | 9.15 | 8.45 | 4.00 | 2.65 | 3.55 | 3.15 | 3.45 | 3.50 | 4.50 | 5.30 |
| 15 | 5.05 | (*a*) | 8.10 | 8.85 | 3.90 | 2.60 | 3.55 | 3.10 | 3.35 | 3.50 | 4.45 | 5.60 |
| 16 | 5.40 | (*a*) | 7.70 | 9.00 | 3.80 | 2.60 | 3.45 | 2.95 | 3.15 | 3.40 | 4.35 | 5.30 |
| 17 | 5.95 | (*a*) | 6.90 | 8.90 | 3.80 | 2.50 | 3.60 | 2.80 | 3.10 | 3.40 | 4.35 | 5.10 |
| 18 | 6.10 | (*a*) | 6.45 | 7.85 | 3.70 | 2.60 | 3.60 | 2.75 | 2.85 | 3.45 | 4.50 | 4.85 |
| 19 | 5.50 | (*a*) | 7.40 | 7.25 | 3.80 | 2.45 | 3.70 | 2.50 | 2.75 | 3.40 | 4.50 | 4.70 |
| 20 | 5.30 | 7.60 | 8.70 | 7.05 | 3.90 | 2.40 | 3.75 | 2.80 | 3.90 | 3.40 | 4.45 | 4.65 |
| 21 | 5.30 | 6.65 | 9.00 | 7.15 | 3.90 | 2.40 | 3.55 | 2.65 | 3.90 | 3.40 | 4.30 | 4.75 |
| 22 | 4.95 | 5.70 | 8.05 | 7.00 | 3.80 | 2.45 | 3.50 | 2.75 | 3.90 | 3.45 | 4.20 | 4.75 |
| 23 | 5.05 | 6.05 | 7.70 | 6.70 | 3.70 | 2.75 | 3.35 | 2.90 | 3.75 | 3.35 | 4.20 | 4.65 |
| 24 | 4.95 | 5.95 | 7.35 | 6.15 | 3.60 | 3.00 | 3.25 | 2.85 | 3.70 | 3.30 | 4.20 | 5.10 |
| 25 | 7.30 | 5.65 | 7.25 | 5.95 | 3.60 | 3.25 | 3.10 | 2.60 | 3.65 | 3.25 | 4.10 | 5.45 |
| 26 | 6.00 | 5.45 | 7.00 | 5.70 | 3.50 | 3.70 | 3.15 | 2.75 | 5.40 | 3.20 | 4.00 | 5.45 |
| 27 | 5.60 | 8.25 | 6.65 | 5.50 | 3.40 | 4.30 | 3.40 | 3.95 | 6.05 | 3.20 | 4.00 | 5.20 |
| 28 | 5.25 | 7.20 | 6.60 | 5.40 | 3.40 | 4.05 | 4.15 | 4.20 | 6.25 | 3.20 | 3.95 | 5.00 |
| 29 | 4.95 | ...... | 7.40 | 5.10 | 3.20 | 4.00 | 4.00 | 3.75 | 5.40 | 3.45 | 3.90 | (*a*) |
| 30 | 4.95 | ...... | 6.80 | 4.90 | 3.20 | 4.00 | 3.85 | 3.55 | 5.00 | 3.25 | 3.90 | (*a*) |
| 31 | 4.75 | ...... | 6.40 | ..... | 3.40 | ...... | 4.30 | 3.65 | ...... | 3.20 | ...... | (*a*) |

*a* Ice.

## TOHICKON CREEK AT POINT PLEASANT, PENNSYLVANIA.

This stream drains an area of 102 square miles in the eastern portion of Pennsylvania and, flowing easterly, discharges into Delaware River about 8 miles above Lambertville, New Jersey. Measurements of the stream were begun in 1885 by Mr. Rudolph Hering, and continued by Mr. John E. Codman, hydrographer for the water department of the city of Philadelphia. The results by months from 1890 to 1898, inclusive, are given in the Twentieth Annual Report, Part IV, beginning on page 98. The following table gives the figures of daily flow for 1899:

*Daily discharge in second-feet of Tohickon Creek at Point Pleasant, Pennsylvania, for 1899.*

[Drainage area, 102.2 square miles.]

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 144 | 158 | 793 | 178 | 35 | 15 | 14 | 4 | 18 | 46 | 52 | 34 |
| 2 | 136 | 125 | 601 | 131 | 31 | 9 | 11 | 399 | 13 | 40 | 181 | 34 |
| 3 | 154 | 118 | 601 | 97 | 31 | 9 | 19 | 267 | 9 | 27 | 121 | 44 |
| 4 | 204 | 151 | 708 | 79 | 31 | 10 | 12 | 113 | 93 | 25 | 921 | 49 |
| 5 | 1,172 | 184 | 2,819 | 68 | 31 | 9 | 10 | 52 | 42 | 23 | 366 | 44 |
| 6 | 1,360 | 210 | 1,109 | 61 | 27 | 8 | 10 | 28 | 28 | 18 | 121 | 39 |
| 7 | 1,400 | 189 | 520 | 73 | 23 | 7 | 8 | 22 | 19 | 20 | 73 | 39 |
| 8 | 503 | 142 | 277 | 1,328 | 23 | 7 | 8 | 17 | 16 | 23 | 58 | 39 |
| 9 | 503 | 180 | 217 | 389 | 23 | 5 | 7 | 15 | 287 | 20 | 53 | 31 |
| 10 | 413 | 183 | 203 | 160 | 20 | 8 | 6 | 254 | 210 | 17 | 40 | 23 |
| 11 | 124 | 110 | 418 | 108 | 28 | 6 | 7 | 417 | 203 | 17 | 35 | 27 |
| 12 | 158 | 90 | 1,225 | 92 | 35 | 6 | 5 | 182 | 499 | 16 | 42 | 44 |
| 13 | 169 | 119 | 1,702 | 87 | 27 | 7 | 7 | 66 | 163 | 13 | 51 | 95 |
| 14 | 186 | 102 | 416 | 79 | 31 | 5 | 11 | 38 | 58 | 11 | 53 | 101 |
| 15 | 311 | 65 | 709 | 70 | 31 | 3 | 9 | 28 | 46 | 10 | 47 | 60 |
| 16 | 432 | 157 | 994 | 153 | 20 | 5 | 5 | 19 | 36 | 9 | 46 | 49 |
| 17 | 569 | 416 | 308 | 393 | 17 | 5 | 7 | 14 | 18 | 9 | 47 | 44 |
| 18 | 488 | 782 | 502 | 144 | 20 | 4 | 7 | 12 | 18 | 9 | 45 | 39 |
| 19 | 258 | 767 | 2,492 | 84 | 23 | 3 | 8 | 11 | 23 | 9 | 38 | 39 |
| 20 | 177 | 695 | 938 | 68 | 20 | 2 | 8 | 8 | 708 | 9 | 34 | 85 |
| 21 | 116 | 914 | 308 | 61 | 17 | 2 | 3 | 8 | 545 | 9 | 33 | 101 |
| 22 | 84 | 1,414 | 1,051 | 58 | 17 | 7 | 5 | 6 | 404 | 9 | 33 | 65 |
| 23 | 79 | 1,582 | 1,006 | 53 | 20 | 2 | 3 | 7 | 239 | 14 | 49 | 53 |
| 24 | 526 | 1,000 | 449 | 49 | 17 | 2 | 3 | 7 | 61 | 16 | 57 | 879 |
| 25 | 2,032 | 541 | 220 | 49 | 17 | 7 | 3 | 3 | 42 | 18 | 44 | 913 |
| 26 | 392 | 616 | 624 | 45 | 15 | 7 | 4 | 2 | 1,522 | 18 | 35 | 203 |
| 27 | 230 | 3,222 | 633 | 41 | 12 | 12 | 4 | 359 | 604 | 11 | 30 | 97 |
| 28 | 145 | 1,058 | 779 | 39 | 9 | 5 | 4 | 317 | 158 | 11 | 31 | 79 |
| 29 | 166 | ...... | 1,307 | 39 | 12 | 17 | 6 | 62 | 78 | 10 | 36 | 65 |
| 30 | 169 | ...... | 520 | 39 | 14 | 27 | 7 | 34 | 51 | 12 | 39 | 53 |
| 31 | 184 | ...... | 239 | ...... | 15 | ...... | 4 | 27 | ...... | 17 | ...... | 49 |
| Mean | 419 | 546 | 797 | 144 | 22 | 7 | 7 | 90 | 27 | 17 | 94 | 113 |

## NESHAMINY CREEK AT FORKS, PENNSYLVANIA.

The drainage basin of this creek is immediately south of that of Tohickon Creek. The waters of Big Neshaminy flow in a general easterly course, and after joining the Little Neshaminy continue southerly and empty into Delaware River about 12 miles above the city of Philadelphia. Measurements of the discharge of the stream have been made at the forks, where the drainage area is 139 square miles. The monthly discharges from 1890 to 1898 are given in the

Twentieth Annual Report, Part IV, beginning on page 104. The following table gives the daily discharge for 1899:

*Daily discharge in second-feet of Neshaminy Creek at Forks, Pennsylvania, for 1899.*

[Drainage area, 139.3 square miles.]

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 527 | 213 | 611 | 349 | 67 | 31 | 15 | 27 | 15 | 36 | 144 | 54 |
| 2 | 453 | 213 | 569 | 280 | 73 | 31 | 13 | 248 | 15 | 31 | 154 | 51 |
| 3 | 97 | 213 | 540 | 243 | 67 | 27 | 9 | 2,162 | 28 | 31 | 162 | 48 |
| 4 | 71 | 213 | 686 | 221 | 61 | 19 | 10 | 104 | 41 | 27 | 1,257 | 57 |
| 5 | 405 | 173 | 3,687 | 201 | 53 | 17 | 14 | 43 | 32 | 22 | 252 | 54 |
| 6 | 2,105 | 119 | 913 | 176 | 50 | 17 | 13 | 23 | 19 | 38 | 145 | 48 |
| 7 | 1,298 | 97 | 573 | 255 | 47 | 13 | 10 | 15 | 15 | 59 | 107 | 41 |
| 8 | 306 | 97 | 377 | 1,047 | 45 | 13 | 13 | 15 | 15 | 53 | 85 | 41 |
| 9 | 277 | 105 | 388 | 362 | 46 | 15 | 14 | 14 | 13 | 36 | 81 | 36 |
| 10 | 213 | 97 | 343 | 245 | 38 | 19 | 14 | 488 | 43 | 27 | 81 | 36 |
| 11 | 213 | 80 | 510 | 204 | 64 | 19 | 13 | 2,577 | 58 | 22 | 81 | 36 |
| 12 | 213 | 72 | 959 | 186 | 89 | 17 | 10 | 151 | 80 | 19 | 85 | 36 |
| 13 | 213 | 72 | 1,318 | 176 | 73 | 17 | 10 | 71 | 68 | 19 | 85 | 65 |
| 14 | 228 | 72 | 407 | 166 | 53 | 15 | 10 | 48 | 23 | 22 | 77 | 80 |
| 15 | 203 | 72 | 1,172 | 159 | 48 | 15 | 8 | 36 | 15 | 19 | 72 | 60 |
| 16 | 189 | 89 | 813 | 193 | 48 | 15 | 8 | 27 | 15 | 19 | 68 | 45 |
| 17 | 457 | 319 | 242 | 301 | 43 | 15 | 9 | 22 | 15 | 22 | 68 | 36 |
| 18 | 252 | 553 | 722 | 177 | 54 | 15 | 9 | 19 | 13 | 123 | 68 | 31 |
| 19 | 145 | 574 | 2,490 | 149 | 68 | 15 | 8 | 19 | 41 | 113 | 56 | 36 |
| 20 | 115 | 974 | 742 | 139 | 57 | 15 | 6 | 17 | 430 | 57 | 51 | 57 |
| 21 | 105 | 1,373 | 382 | 129 | 36 | 15 | 6 | 14 | 166 | 41 | 48 | 72 |
| 22 | 105 | 1,373 | 1,765 | 115 | 36 | 15 | 6 | 19 | 138 | 32 | 41 | 57 |
| 23 | 100 | 1,402 | 976 | 105 | 44 | 15 | 6 | 19 | 65 | 27 | 77 | 41 |
| 24 | 1,117 | 849 | 405 | 105 | 51 | 13 | 6 | 19 | 41 | 27 | 147 | 792 |
| 25 | 1,927 | 446 | 414 | 105 | 47 | 11 | 6 | 19 | 41 | 22 | 90 | 401 |
| 26 | 333 | 809 | 490 | 105 | 36 | 13 | 11 | 13 | 578 | 22 | 74 | 125 |
| 27 | 242 | 3,950 | 417 | 101 | 31 | 13 | 23 | 11 | 204 | 22 | 72 | 89 |
| 28 | 213 | 815 | 1,398 | 92 | 31 | 13 | 27 | 13 | 89 | 17 | 63 | 72 |
| 29 | 213 | ...... | 2,417 | 88 | 27 | 14 | 22 | 13 | 63 | 24 | 63 | 72 |
| 30 | 213 | ...... | 588 | 73 | 22 | 15 | 325 | 14 | 48 | 17 | 63 | 63 |
| 31 | 213 | ...... | 443 | ...... | 27 | ...... | 68 | 15 | ...... | 24 | ...... | 48 |
| Mean | 411 | 551 | 895 | 208 | 49 | 16 | 23 | 174 | 80 | 34 | 130 | 89 |

## PERKIOMEN CREEK AT FREDERICK, PENNSYLVANIA.

The drainage area of this stream is immediately west of that of Tohickon Creek. It flows in a general southerly course, emptying into Schuylkill River about 18 miles above Philadelphia. The point of measurement is at Frederick, about 12 miles above the mouth and above two large tributaries, known as West Swamp Creek and Northeast Branch. The monthly discharges from 1890 to 1898, inclusive, are printed in the Twentieth Annual Report, Part IV, beginning on page 90.

The following tables give the daily flow from the time the gage was established to 1899:

*Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania.*

[Drainage area, 152 square miles.]

1884.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 100 | 44 | 155 | 93 |
| 2 | | | | | | | | | 79 | 58 | 59 | 64 |
| 3 | | | | | | | | | 71 | 58 | 57 | 64 |
| 4 | | | | | | | | | 63 | 61 | 71 | 79 |
| 5 | | | | | | | | | 60 | 58 | 342 | 78 |
| 6 | | | | | | | | | 53 | 46 | 140 | 828 |
| 7 | | | | | | | | | 53 | 48 | 91 | 3,425 |
| 8 | | | | | | | | | 50 | 41 | 70 | 380 |
| 9 | | | | | | | | | 46 | 41 | 50 | 230 |
| 10 | | | | | | | | | 44 | 41 | 48 | 179 |
| 11 | | | | | | | | | 38 | 37 | 47 | 187 |
| 12 | | | | | | | | | 39 | 40 | 62 | 981 |
| 13 | | | | | | | | | 38 | 36 | 69 | 600 |
| 14 | | | | | | | | | 33 | 33 | 75 | 256 |
| 15 | | | | | | | | | 35 | 25 | 75 | 2,409 |
| 16 | | | | | | | | | 37 | 25 | 73 | 516 |
| 17 | | | | | | | | | 37 | 25 | 52 | 292 |
| 18 | | | | | | | | | 37 | 20 | 48 | 236 |
| 19 | | | | | | | | | 38 | 16 | 48 | 186 |
| 20 | | | | | | | | 60 | 37 | 16 | 57 | 139 |
| 21 | | | | | | | | 58 | 37 | 21 | 76 | 106 |
| 22 | | | | | | | | 56 | 47 | 23 | 96 | 465 |
| 23 | | | | | | | | 56 | 47 | 48 | 93 | 449 |
| 24 | | | | | | | | 45 | 41 | 51 | 768 | 320 |
| 25 | | | | | | | | 47 | 37 | 43 | 223 | 247 |
| 26 | | | | | | | | 50 | 32 | 40 | 142 | 182 |
| 27 | | | | | | | | 54 | 23 | 41 | 121 | 171 |
| 28 | | | | | | | | 58 | 23 | 45 | 121 | 199 |
| 29 | | | | | | | | 89 | 29 | 87 | 262 | 241 |
| 30 | | | | | | | | 110 | 40 | 168 | 142 | .367 |
| 31 | | | | | | | | 130 | | 238 | | 1,239 |
| Mean | | | | | | | | 68 | 48 | 51 | 124 | 491 |

1885.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,639 | 113 | 123 | 1,582 | 124 | 85 | 35 | 28 | 28 | 23 | 86 | 175 |
| 2 | 373 | 109 | 204 | 710 | 126 | 79 | 25 | 19 | 36 | 23 | 706 | 194 |
| 3 | 229 | 109 | 242 | 495 | 129 | 58 | 25 | 1,582 | 24 | 21 | 306 | 200 |
| 4 | 174 | 111 | 222 | 3,192 | 115 | 47 | 17 | 1,673 | 8 | 26 | 155 | 184 |
| 5 | 173 | 112 | 521 | 627 | 102 | 44 | 9 | 174 | 9 | 34 | 113 | 166 |
| 6 | 2,600 | 104 | 703 | 454 | 93 | 44 | 24 | 89 | 16 | 35 | 89 | 153 |
| 7 | 981 | 100 | 568 | 319 | 244 | 28 | 17 | 65 | 25 | 41 | 78 | 124 |
| 8 | 435 | 100 | 238 | 315 | 805 | 41 | 29 | 277 | 23 | 31 | 613 | 115 |
| 9 | 359 | 98 | 197 | 273 | 358 | 65 | 26 | 135 | 30 | 31 | 862 | 250 |
| 10 | 291 | 2,107 | 189 | 255 | 227 | 47 | 25 | 73 | 31 | 26 | 267 | 970 |
| 11 | 232 | 210 | 164 | 237 | 192 | 46 | 32 | 60 | 27 | 8 | 162 | 340 |
| 12 | 251 | 252 | 151 | 238 | 161 | 35 | 31 | 51 | 24 | 15 | 132 | 181 |
| 13 | 615 | 217 | 151 | 209 | 133 | 36 | 30 | 43 | 20 | 22 | 113 | 1,250 |
| 14 | 313 | 184 | 211 | 189 | 128 | 31 | 22 | 76 | 24 | 70 | 101 | 2,546 |
| 15 | 290 | 193 | 223 | 157 | 132 | 33 | 33 | 86 | 28 | 67 | 83 | 583 |
| 16 | 587 | 1,795 | 418 | 143 | 120 | 41 | 35 | 61 | 32 | 45 | 81 | 308 |
| 17 | 1.372 | 832 | 322 | 143 | 95 | 34 | 27 | 50 | 27 | 42 | 86 | 239 |
| 18 | 283 | 857 | 204 | 133 | 87 | 28 | 23 | 37 | 19 | 26 | 73 | 217 |
| 19 | 271 | 274 | 176 | 112 | 90 | 28 | 12 | 34 | 25 | 24 | 60 | 204 |
| 20 | 228 | 234 | 136 | 117 | 77 | 28 | 21 | 41 | 15 | 22 | 65 | 159 |
| 21 | 201 | 190 | 136 | 115 | 69 | 23 | 24 | 34 | 20 | 118 | 57 | 140 |
| 22 | 181 | 149 | 93 | 98 | 80 | 32 | 23 | 32 | 16 | 243 | 46 | 143 |
| 23 | 163 | 147 | 67 | 92 | 92 | 22 | 15 | 29 | 14 | 95 | 349 | 133 |
| 24 | 144 | 130 | 81 | 94 | 95 | 28 | 14 | 39 | 21 | 54 | 685 | 139 |
| 25 | 141 | 115 | 185 | 100 | 87 | 29 | 14 | 41 | 19 | 37 | 440 | 113 |
| 26 | 153 | 121 | 652 | 150 | 94 | 25 | 10 | 42 | 19 | 38 | 382 | 79 |
| 27 | 151 | 111 | 911 | 201 | 90 | 21 | 15 | 40 | 10 | 46 | 348 | 67 |
| 28 | 155 | 101 | 992 | 171 | 74 | 16 | 17 | 46 | 19 | 39 | 261 | 85 |
| 29 | 145 | | 538 | 139 | 62 | 18 | 26 | 35 | 17 | 39 | 206 | 100 |
| 30 | 120 | | 250 | 124 | 58 | 30 | 29 | 26 | 24 | 228 | 192 | 87 |
| 31 | 113 | | 985 | | 60 | | 17 | 28 | | 175 | | 292 |
| Mean | 431 | 327 | 331 | 373 | 142 | 37 | 23 | 16 | 22 | 56 | 240 | 321 |

*Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania*—Continued.

1886.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 452 | 280 | 237 | 1,548 | 96 | 101 | 83 | 95 | 38 | 30 | 52 | 141 |
| 2 | 218 | 235 | 214 | 482 | 79 | 88 | 73 | 86 | 41 | 29 | 67 | 114 |
| 3 | 167 | 236 | 193 | 335 | 89 | 111 | 67 | 74 | 35 | 22 | 33 | 73 |
| 4 | 950 | 304 | 174 | 303 | 87 | 137 | 71 | 57 | 28 | 27 | 30 | 62 |
| 5 | 3,044 | 214 | 177 | 449 | 84 | 104 | 59 | 50 | 22 | 22 | 51 | 55 |
| 6 | 516 | 172 | 163 | 4,021 | 83 | 76 | 52 | 47 | 28 | 17 | 36 | 44 |
| 7 | 300 | 155 | 143 | 1,626 | 90 | 79 | 47 | 57 | 29 | 23 | 53 | 65 |
| 8 | 222 | 159 | 163 | 640 | 3,094 | 78 | 50 | 61 | 34 | 20 | 55 | 59 |
| 9 | 255 | 162 | 143 | 445 | 893 | 72 | 42 | 57 | 32 | 23 | 53 | 71 |
| 10 | 237 | 163 | 153 | 365 | 323 | 181 | 329 | 62 | 26 | 16 | 49 | 63 |
| 11 | 245 | 4,388 | 134 | 282 | 242 | 255 | 190 | 56 | 34 | 29 | 41 | 59 |
| 12 | 199 | 3,638 | 138 | 267 | 209 | 122 | 101 | 50 | 30 | 24 | 36 | 50 |
| 13 | 152 | 4,395 | 150 | 358 | 466 | 73 | 93 | 42 | 29 | 23 | 96 | 116 |
| 14 | 153 | 1,120 | 139 | 327 | 816 | 1,967 | 68 | 35 | 33 | 19 | 131 | 374 |
| 15 | 143 | 809 | 151 | 241 | 349 | 780 | 215 | 34 | 29 | 21 | 77 | 268 |
| 16 | 148 | 711 | 160 | 203 | 584 | 311 | 280 | 38 | 28 | 19 | 68 | 173 |
| 17 | 156 | 349 | 152 | 191 | 311 | 231 | 368 | 47 | 36 | 17 | 46 | 171 |
| 18 | 171 | 304 | 141 | 174 | 217 | 217 | 171 | 44 | 44 | 25 | 373 | 212 |
| 19 | 164 | 310 | 173 | 176 | 246 | 143 | 401 | 43 | 40 | 25 | 330 | 820 |
| 20 | 177 | 282 | 184 | 160 | 253 | 111 | 161 | 37 | 31 | 25 | 143 | 445 |
| 21 | 168 | 135 | 1,163 | 146 | 297 | 98 | 120 | 33 | 33 | 30 | 99 | 252 |
| 22 | 234 | 213 | 651 | 131 | 196 | 97 | 133 | 26 | 31 | 28 | 54 | 172 |
| 23 | 213 | 202 | 329 | 118 | 278 | 839 | 120 | 25 | 29 | 27 | 382 | 138 |
| 24 | 152 | 182 | 219 | 125 | 204 | 447 | 84 | 33 | 28 | 23 | 385 | 182 |
| 25 | 146 | 1,555 | 196 | 127 | 198 | 276 | 64 | 34 | 26 | 28 | 1,236 | 762 |
| 26 | 143 | 1,661 | 180 | 138 | 173 | 216 | 90 | 30 | 31 | 23 | 1,597 | 249 |
| 27 | 156 | 363 | 184 | 131 | 138 | 153 | 225 | 32 | 30 | 58 | 280 | 203 |
| 28 | 707 | 225 | 550 | 136 | 181 | 120 | 378 | 27 | 27 | 114 | 168 | 179 |
| 29 | 1,191 | ....... | 535 | 121 | 148 | 100 | 171 | 25 | 25 | 87 | 145 | 123 |
| 30 | 877 | ....... | 1,302 | 106 | 109 | 88 | 111 | 23 | 35 | 89 | 134 | 102 |
| 31 | 359 | ....... | 1,827 | ....... | 104 | ....... | 84 | 29 | ....... | 58 | ....... | 91 |
| Mean | 400 | 819 | 336 | 462 | 343 | 256 | 145 | 45 | 31 | 33 | 210 | 190 |

1887.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 425 | 274 | 326 | 203 | 118 | 93 | 36 | 1,416 | 52 | 101 | 46 | 53 |
| 2 | 338 | 193 | 264 | 212 | 120 | 136 | 34 | 537 | 50 | 79 | 49 | 40 |
| 3 | 246 | 184 | 269 | 250 | 110 | 140 | 31 | 259 | 50 | 65 | 42 | 42 |
| 4 | 153 | 269 | 217 | 242 | 109 | 103 | 29 | 158 | 42 | 82 | 41 | 42 |
| 5 | 90 | 244 | 198 | 197 | 103 | 57 | 1,129 | 133 | 42 | 65 | 40 | 67 |
| 6 | 85 | 196 | 194 | 157 | 92 | 55 | 1,474 | 117 | 53 | 84 | 22 | 95 |
| 7 | 110 | 674 | 395 | 144 | 173 | 101 | 290 | 139 | 71 | 54 | 23 | 77 |
| 8 | 99 | 1,160 | 969 | 133 | 279 | 115 | 156 | 95 | 53 | 47 | 26 | 63 |
| 9 | 90 | 874 | 788 | 138 | 286 | 89 | 130 | 83 | 31 | 39 | 39 | 58 |
| 10 | 76 | 515 | 1,156 | 121 | 180 | 71 | 437 | 66 | 29 | 36 | 47 | 124 |
| 11 | 112 | 899 | 649 | 128 | 139 | 61 | 168 | 66 | 25 | 47 | 59 | 1,250 |
| 12 | 102 | 592 | 324 | 117 | 119 | 47 | 107 | 82 | 559 | 46 | 68 | 372 |
| 13 | 92 | 244 | 285 | 104 | 96 | 41 | 74 | 84 | 278 | 41 | 51 | 195 |
| 14 | 908 | 206 | 277 | 104 | 79 | 47 | 62 | 66 | 151 | 46 | 42 | 163 |
| 15 | 1,107 | 648 | 208 | 102 | 63 | 41 | 54 | 54 | 111 | 41 | 54 | 384 |
| 16 | 401 | 658 | 190 | 112 | 71 | 37 | 49 | 68 | 56 | 33 | 52 | 523 |
| 17 | 288 | 377 | 163 | 98 | 74 | 36 | 373 | 67 | 63 | 30 | 48 | 207 |
| 18 | 356 | 2,369 | 162 | 143 | 64 | 47 | 129 | 114 | 51 | 40 | 47 | 128 |
| 19 | 280 | 2,061 | 170 | 279 | 55 | 52 | 79 | 128 | 49 | 48 | 47 | 180 |
| 20 | 205 | 530 | 149 | 322 | 54 | 50 | 68 | 77 | 74 | 45 | 106 | 187 |
| 21 | 152 | 412 | 160 | 166 | 52 | 55 | 60 | 58 | 53 | 77 | 126 | 267 |
| 22 | 261 | 501 | 530 | 133 | 45 | 49 | 70 | 58 | 52 | 136 | 91 | 325 |
| 23 | 641 | 428 | 469 | 146 | 41 | 887 | 627 | 239 | 66 | 72 | 70 | 300 |
| 24 | 4,099 | 703 | 365 | 201 | 54 | 295 | 561 | 919 | 50 | 54 | 57 | 238 |
| 25 | 869 | 417 | 763 | 155 | 71 | 123 | 214 | 266 | 39 | 66 | 60 | 177 |
| 26 | 560 | 291 | 546 | 252 | 67 | 73 | 140 | 140 | 48 | 65 | 58 | 174 |
| 27 | 324 | 809 | 314 | 209 | 54 | 56 | 313 | 96 | 59 | 59 | 47 | 155 |
| 28 | 255 | 504 | 883 | 159 | 47 | 60 | 126 | 69 | 53 | 48 | 52 | 756 |
| 29 | 1,987 | ....... | 477 | 227 | 48 | 47 | 104 | 68 | 62 | 50 | 66 | 995 |
| 30 | 1,069 | ....... | 226 | 176 | 57 | 38 | 131 | 70 | 106 | 46 | 56 | 517 |
| 31 | 445 | ....... | 227 | ....... | 60 | ....... | 1,198 | 58 | ....... | 44 | ....... | 432 |
| Mean | 523 | 615 | 397 | 171 | 96 | 103 | 273 | 189 | 83 | 58 | 54 | 277 |

*Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania*—Continued.

1888.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4,305 | 109 | 278 | 424 | 129 | 136 | 50 | 31 | 55 | 110 | 108 | 179 |
| 2 | 3,318 | 103 | 279 | 369 | 124 | 82 | 43 | 77 | 49 | 117 | 144 | 149 |
| 3 | 765 | 121 | 311 | 317 | 112 | 69 | 38 | 24 | 38 | 96 | 136 | 138 |
| 4 | 429 | 95 | 338 | 248 | 92 | 62 | 31 | 26 | 44 | 72 | 130 | 143 |
| 5 | 363 | 257 | 252 | 432 | 75 | 57 | 29 | 36 | 40 | 70 | 120 | 135 |
| 6 | 279 | 604 | 207 | 2,750 | 88 | 55 | 29 | 63 | 38 | 69 | 124 | 144 |
| 7 | 318 | 461 | 183 | 556 | 104 | 52 | 30 | 85 | 34 | 348 | 119 | 134 |
| 8 | 773 | 272 | 168 | 347 | 101 | 51 | 27 | 52 | 33 | 161 | 101 | 128 |
| 9 | 528 | 321 | 153 | 279 | 92 | 48 | 25 | 64 | 175 | 109 | 160 | 143 |
| 10 | 325 | 253 | 193 | 1,545 | 92 | 43 | 84 | 60 | 157 | 83 | 541 | 262 |
| 11 | 241 | 241 | 692 | 1,937 | 117 | 46 | 67 | 38 | 99 | 71 | 491 | 173 |
| 12 | 209 | 156 | 1,150 | 525 | 173 | 50 | 44 | 111 | 211 | 79 | 227 | 146 |
| 13 | 186 | 146 | 352 | 424 | 186 | 82 | 36 | 180 | 229 | 87 | 176 | 120 |
| 14 | 288 | 150 | 396 | 341 | 155 | 40 | 30 | 99 | 142 | 87 | 159 | 92 |
| 15 | 234 | 154 | 380 | 314 | 148 | 39 | 22 | 58 | 101 | 87 | 1,307 | 115 |
| 16 | 255 | 168 | 521 | 517 | 138 | 37 | 19 | 42 | 99 | 81 | 715 | 80 |
| 17 | 209 | 172 | 862 | 456 | 109 | 42 | 22 | 38 | 2,691 | 81 | 381 | 4,786 |
| 18 | 201 | 125 | 512 | 284 | 87 | 47 | 19 | 40 | 5,305 | 90 | 249 | 2,775 |
| 19 | 174 | 159 | 444 | 247 | 123 | 43 | 18 | 32 | 576 | 88 | 1,344 | 601 |
| 20 | 151 | 1,167 | 779 | 251 | 139 | 35 | 27 | 28 | 342 | 107 | 825 | 328 |
| 21 | 128 | 3,285 | 3,539 | 241 | 96 | 36 | 27 | 912 | 2,804 | 104 | 370 | 265 |
| 22 | 121 | 1,171 | 1,533 | 198 | 79 | 32 | 24 | 3,336 | 424 | 81 | 275 | 230 |
| 23 | 112 | 843 | 429 | 174 | 75 | 29 | 19 | 311 | 253 | 85 | 220 | 201 |
| 24 | 104 | 708 | 347 | 159 | 82 | 32 | 13 | 137 | 194 | 114 | 193 | 174 |
| 25 | 113 | 2,459 | 403 | 151 | 95 | 33 | 15 | 92 | 170 | 141 | 190 | 179 |
| 26 | 99 | 2,322 | 934 | 134 | 118 | 28 | 17 | 60 | 207 | 100 | 225 | 191 |
| 27 | 121 | 1,290 | 1,656 | 124 | 111 | 24 | 23 | 52 | 167 | 525 | 368 | 364 |
| 28 | 144 | 368 | 1,009 | 127 | 129 | 32 | 45 | 52 | 125 | 833 | 327 | 469 |
| 29 | 121 | 312 | 1,412 | 120 | 313 | 147 | 55 | 40 | 106 | 592 | 224 | 235 |
| 30 | 108 | ....... | 691 | 118 | 171 | 72 | 46 | 43 | 93 | 270 | 201 | 161 |
| 31 | 114 | ....... | 544 | ....... | 124 | ....... | 53 | 48 | ....... | 184 | ....... | 186 |
| Mean | 475 | 643 | 676 | 470 | 122 | 53 | 33 | 202 | 500 | 165 | 338 | 433 |

1889.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 190 | 208 | 75 | 351 | 241 | 2,187 | 245 | 1,648 | 60 | 153 | 268 | 352 |
| 2 | 177 | 190 | 125 | 850 | 199 | 729 | 775 | 657 | 80 | 162 | 226 | 335 |
| 3 | 168 | 185 | 605 | 333 | 171 | 320 | 1,401 | 461 | 78 | 187 | 1,004 | 314 |
| 4 | 159 | 169 | 4,235 | 231 | 155 | 232 | 1,063 | 393 | 70 | 113 | 679 | 278 |
| 5 | 215 | 174 | 1,480 | 190 | 142 | 209 | 715 | 412 | 67 | 103 | 353 | 236 |
| 6 | 787 | 190 | 628 | 168 | 125 | 182 | 334 | 334 | 71 | 104 | 266 | 246 |
| 7 | 508 | 166 | 364 | 142 | 115 | 134 | 232 | 229 | 80 | 123 | 224 | 246 |
| 8 | 310 | 143 | 282 | 123 | 105 | 118 | 182 | 181 | 71 | 115 | 246 | 305 |
| 9 | 834 | 142 | 218 | 115 | 94 | 116 | 150 | 164 | 72 | 103 | 5,389 | 523 |
| 10 | 918 | 128 | 185 | 106 | 93 | 172 | 133 | 181 | 78 | 90 | 1,147 | 327 |
| 11 | 360 | 123 | 175 | 100 | 158 | 170 | 398 | 173 | 83 | 87 | 560 | 287 |
| 12 | 290 | 101 | 165 | 109 | 119 | 374 | 264 | 136 | 132 | 90 | 453 | 281 |
| 13 | 220 | 104 | 160 | 139 | 104 | 239 | 361 | 131 | 222 | 193 | 1,792 | 221 |
| 14 | 203 | 122 | 165 | 143 | 127 | 153 | 440 | 1,234 | 252 | 285 | 1,421 | 300 |
| 15 | 183 | 104 | 158 | 113 | 137 | 387 | 4,016 | 1,613 | 208 | 389 | 508 | 366 |
| 16 | 178 | 197 | 150 | 105 | 110 | 754 | 550 | 352 | 219 | 231 | 373 | 322 |
| 17 | 1,553 | 791 | 150 | 93 | 86 | 446 | 276 | 227 | 3,130 | 150 | 300 | 616 |
| 18 | 634 | 1,182 | 166 | 91 | 76 | 752 | 199 | 181 | 3,020 | 131 | 330 | 537 |
| 19 | 374 | 452 | 173 | 91 | 60 | 244 | 188 | 158 | 603 | 119 | 2,268 | 282 |
| 20 | 209 | 219 | 167 | 82 | 343 | 162 | 458 | 143 | 410 | 115 | 1,029 | 355 |
| 21 | 578 | 185 | 257 | 71 | 745 | 133 | 223 | 131 | 302 | 209 | 725 | 297 |
| 22 | 526 | 149 | 558 | 82 | 339 | 168 | 157 | 123 | 234 | 186 | 926 | 252 |
| 23 | 480 | 113 | 302 | 81 | 189 | 119 | 130 | 115 | 173 | 207 | 471 | 234 |
| 24 | 281 | 101 | 206 | 71 | 134 | 93 | 113 | 115 | 173 | 178 | 347 | 198 |
| 25 | 340 | 113 | 184 | 63 | 115 | 90 | 104 | 107 | 439 | 140 | 816 | 193 |
| 26 | 359 | 114 | 150 | 593 | 148 | 881 | 96 | 100 | 416 | 134 | 620 | 349 |
| 27 | 724 | 102 | 137 | 1,894 | 630 | 627 | 132 | 98 | 261 | 3,356 | 670 | 285 |
| 28 | 871 | 82 | 173 | 1,210 | 723 | 249 | 172 | 90 | 185 | 1,202 | 2,803 | 202 |
| 29 | 393 | ....... | 175 | 536 | 268 | 175 | 163 | 84 | 153 | 451 | 715 | 181 |
| 30 | 248 | ....... | 143 | 262 | 177 | 225 | 598 | 74 | 139 | 294 | 462 | 171 |
| 31 | 235 | ....... | 126 | ....... | 232 | ....... | 5,567 | 67 | ....... | 256 | ....... | 161 |
| Mean | 436 | 216 | 395 | 285 | 208 | 361 | 640 | 326 | 383 | 311 | 913 | 298 |

*Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania*—Continued.

1890.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 151 | 192 | 687 | 415 | 133 | 104 | 45 | 54 | 83 | 55 | 140 | 64 |
| 2 | 189 | 156 | 372 | 377 | 135 | 136 | 447 | 62 | 71 | 57 | 129 | 84 |
| 3 | 171 | 213 | 289 | 290 | 117 | 176 | 535 | 49 | 60 | 948 | 125 | 78 |
| 4 | 193 | 249 | 237 | 1,246 | 153 | 167 | 304 | 49 | 64 | 249 | 118 | 125 |
| 5 | 188 | 298 | 225 | 1,124 | 1,084 | 117 | 149 | 54 | 69 | 137 | 115 | 130 |
| 6 | 238 | 192 | 202 | 387 | 536 | 127 | 95 | 74 | 63 | 182 | 112 | 110 |
| 7 | 186 | 148 | 190 | 360 | 456 | 179 | 71 | 77 | 62 | 451 | 106 | 116 |
| 8 | 172 | 3,699 | 245 | 381 | 283 | 120 | 60 | 65 | 59 | 329 | 89 | 133 |
| 9 | 152 | 7,051 | 165 | 1,149 | 220 | 98 | 58 | 148 | 59 | 192 | 83 | 124 |
| 10 | 141 | 445 | 215 | 847 | 181 | 89 | 52 | 88 | 64 | 135 | 91 | 94 |
| 11 | 142 | 1,521 | 736 | 407 | 165 | 92 | 48 | 64 | 54 | 112 | 138 | 93 |
| 12 | 132 | 303 | 806 | 316 | 243 | 243 | 43 | 70 | 57 | 108 | 196 | 86 |
| 13 | 143 | 257 | 444 | 277 | 145 | 664 | 38 | 62 | 796 | 102 | 140 | 85 |
| 14 | 132 | 1,030 | 1,156 | 254 | 510 | 189 | 37 | 85 | 331 | 135 | 117 | 80 |
| 15 | 1,368 | 874 | 1,397 | 225 | 1,172 | 125 | 52 | 95 | 842 | 143 | 104 | 70 |
| 16 | 1,215 | 325 | 626 | 199 | 436 | 103 | 72 | 64 | 876 | 122 | 92 | 71 |
| 17 | 440 | 287 | 412 | 191 | 268 | 97 | 88 | 45 | 453 | 821 | 200 | 314 |
| 18 | 202 | 257 | 351 | 177 | 202 | 95 | 125 | 92 | 213 | 264 | 308 | 1,006 |
| 19 | 236 | 228 | 306 | 171 | 175 | 79 | 89 | 119 | 161 | 186 | 174 | 298 |
| 20 | 386 | 827 | 352 | 167 | 288 | 60 | 61 | 803 | 120 | 191 | 136 | 183 |
| 21 | 341 | 827 | 1,507 | 157 | 375 | 67 | 46 | 260 | 95 | 156 | 112 | 132 |
| 22 | 201 | 248 | 4,048 | 146 | 187 | 122 | 54 | 267 | 91 | 129 | 102 | 145 |
| 23 | 144 | 212 | 2,082 | 139 | 147 | 105 | 53 | 162 | 87 | 623 | 92 | 136 |
| 24 | 154 | 363 | 699 | 143 | 133 | 107 | 48 | 106 | 75 | 1,754 | 91 | 121 |
| 25 | 154 | 357 | 510 | 198 | 122 | 93 | 109 | 91 | 71 | 632 | 94 | 104 |
| 26 | 145 | 332 | 855 | 215 | 1,514 | 64 | 1,018 | 91 | 60 | 349 | 80 | 135 |
| 27 | 190 | 259 | 425 | 200 | 2,510 | 55 | 212 | 699 | 98 | 246 | 79 | 108 |
| 28 | 129 | 527 | 1,583 | 203 | 497 | 49 | 115 | 256 | 86 | 191 | 73 | 97 |
| 29 | 138 | ....... | 801 | 160 | 278 | 48 | 113 | 139 | 71 | 173 | 76 | 100 |
| 30 | 368 | ....... | 459 | 142 | 206 | 50 | 103 | 124 | 68 | 238 | 71 | 108 |
| 31 | 254 | ....... | 395 | ....... | 179 | ....... | 71 | 101 | ....... | 171 | ....... | 93 |
| Mean | 271 | 774 | 735 | 355 | 421 | 127 | 142 | 146 | 179 | 309 | 119 | 149 |

1891.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 75 | 1,917 | 238 | 433 | 105 | 48 | 28 | 163 | 236 | 54 | 51 | 196 |
| 2 | 1,931 | 892 | 206 | 364 | 103 | 54 | 28 | 113 | 210 | 48 | 42 | 53 |
| 3 | 941 | 760 | 288 | 870 | 214 | 50 | 34 | 84 | 156 | 50 | 42 | 51 |
| 4 | 298 | 607 | 201 | 421 | 243 | 46 | 36 | 172 | 129 | 38 | 37 | 1,225 |
| 5 | 219 | 322 | 211 | 315 | 139 | 45 | 33 | 187 | 2,367 | 38 | 44 | 1,184 |
| 6 | 176 | 260 | 199 | 242 | 115 | 40 | 36 | 146 | 880 | 38 | 49 | 256 |
| 7 | 149 | 451 | 217 | 211 | 94 | 66 | 33 | 144 | 396 | 42 | 37 | 734 |
| 8 | 128 | 762 | 236 | 179 | 90 | 117 | 43 | 74 | 235 | 73 | 27 | 456 |
| 9 | 101 | 652 | 711 | 174 | 92 | 78 | 77 | 53 | 178 | 88 | 30 | 225 |
| 10 | 94 | 977 | 1,260 | 165 | 78 | 52 | 53 | 48 | 145 | 59 | 38 | 169 |
| 11 | 1,705 | 424 | 509 | 379 | 83 | 41 | 37 | 46 | 120 | 42 | 89 | 113 |
| 12 | 3,431 | 303 | 551 | 786 | 76 | 37 | 29 | 45 | 108 | 49 | 124 | 75 |
| 13 | 400 | 272 | 1,352 | 320 | 65 | 36 | 23 | 58 | 99 | 51 | 71 | 75 |
| 14 | 246 | 239 | 630 | 233 | 67 | 32 | 31 | 58 | 91 | 45 | 59 | 75 |
| 15 | 206 | 181 | 314 | 205 | 68 | 34 | 45 | 220 | 85 | 42 | 41 | 75 |
| 16 | 168 | 1,312 | 462 | 181 | 96 | 38 | 43 | 151 | 80 | 49 | 52 | 75 |
| 17 | 206 | 1,323 | 233 | 180 | 97 | 38 | 38 | 86 | 77 | 49 | 123 | 75 |
| 18 | 483 | 781 | 224 | 177 | 77 | 55 | 162 | 228 | 71 | 40 | 193 | 75 |
| 19 | 304 | 410 | 209 | 160 | 78 | 69 | 413 | 406 | 66 | 31 | 110 | 75 |
| 20 | 239 | 363 | 883 | 147 | 72 | 65 | 142 | 155 | 51 | 275 | 71 | 60 |
| 21 | 209 | 832 | 4,803 | 135 | 70 | 58 | 73 | 109 | 52 | 173 | 79 | 59 |
| 22 | 3,945 | 1,012 | 1,275 | 140 | 67 | 84 | 54 | 176 | 66 | 134 | 50 | 80 |
| 23 | 970 | 432 | 1,007 | 158 | 59 | 73 | 47 | 116 | 49 | 220 | 114 | 895 |
| 24 | 390 | 339 | 640 | 155 | 61 | 54 | 81 | 1,169 | 45 | 118 | 303 | 1,197 |
| 25 | 539 | 342 | 426 | 129 | 59 | 36 | 91 | 1,915 | 53 | 72 | 138 | 928 |
| 26 | 446 | 397 | 325 | 107 | 60 | 30 | 47 | 374 | 49 | 67 | 100 | 791 |
| 27 | 379 | 381 | 298 | 111 | 72 | 20 | 45 | 355 | 47 | 79 | 94 | 779 |
| 28 | 341 | 215 | 299 | 113 | 65 | 27 | 46 | 573 | 47 | 79 | 83 | 408 |
| 29 | 782 | ....... | 278 | 104 | 51 | 26 | 812 | 274 | 40 | 70 | 66 | 307 |
| 30 | 1,315 | ....... | 245 | 103 | 55 | 28 | 425 | 362 | 52 | 48 | 49 | 725 |
| 31 | 852 | ....... | ....... | ....... | ....... | ....... | 352 | 368 | ....... | 48 | ....... | 261 |
| Mean | 699 | 613 | 624 | 247 | 89 | 49 | 111 | 272 | 209 | 74 | 80 | 379 |

*Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania—*
**Continued.**

1892.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 201 | 184 | 2,073 | 229 | 83 | 127 | 275 | 239 | 75 | 26 | 31 | 174 |
| 2 | 1,482 | 202 | 610 | 213 | 100 | 105 | 184 | 146 | 67 | 24 | 29 | 130 |
| 3 | 861 | 217 | 246 | 237 | 167 | 90 | 375 | 211 | 56 | 22 | 26 | 117 |
| 4 | 303 | 178 | 338 | 238 | 153 | 479 | 557 | 126 | 36 | 26 | 26 | 106 |
| 5 | 235 | 201 | 319 | 203 | 122 | 150 | 192 | 71 | 32 | 28 | 34 | 100 |
| 6 | 196 | 146 | 311 | 183 | 106 | 144 | 111 | 52 | 33 | 24 | 32 | 89 |
| 7 | 204 | 155 | 393 | 164 | 114 | 124 | 78 | 45 | 34 | 22 | 26 | 71 |
| 8 | 214 | 191 | 1,673 | 153 | 95 | 96 | 58 | 41 | 32 | 27 | 27 | 427 |
| 9 | 198 | 216 | 1,341 | 138 | 85 | 93 | 51 | 37 | 29 | 28 | 32 | 369 |
| 10 | 180 | 185 | 625 | 125 | 84 | 429 | 46 | 36 | 28 | 26 | 295 | 186 |
| 11 | 158 | 173 | 437 | 122 | 71 | 182 | 45 | 134 | 31 | 30 | 319 | 130 |
| 12 | 182 | 126 | 458 | 120 | 77 | 110 | 42 | 359 | 23 | 32 | 133 | 116 |
| 13 | 3,674 | 121 | 262 | 112 | 74 | 84 | 40 | 135 | 20 | 26 | 76 | 120 |
| 14 | 3,769 | 137 | 190 | 127 | 94 | 69 | 38 | 62 | 71 | 26 | 54 | 357 |
| 15 | 1,066 | 147 | 207 | 265 | 263 | 53 | 39 | 51 | 90 | 29 | 652 | 550 |
| 16 | 572 | 154 | 178 | 212 | 214 | 50 | 37 | 51 | 54 | 23 | 2,836 | 297 |
| 17 | 412 | 113 | 167 | 146 | 102 | 297 | 27 | 39 | 40 | 24 | 472 | 231 |
| 18 | 404 | 96 | 145 | 133 | 111 | 149 | 32 | 34 | 34 | 29 | 769 | 180 |
| 19 | 1,879 | 97 | 153 | 128 | 117 | 71 | 31 | 35 | 27 | 31 | 602 | 152 |
| 20 | 699 | 131 | 150 | 111 | 397 | 71 | 26 | 28 | 23 | 30 | 268 | 142 |
| 21 | 412 | 159 | 165 | 129 | 365 | 77 | 36 | 25 | 27 | 31 | 192 | 124 |
| 22 | 316 | 154 | 153 | 204 | 420 | 57 | 36 | 24 | 33 | 30 | 156 | 112 |
| 23 | 300 | 158 | 173 | 247 | 337 | 41 | 23 | 24 | 42 | 29 | 168 | 117 |
| 24 | 275 | 151 | 462 | 169 | 241 | 49 | 18 | 26 | 56 | 40 | 88 | 100 |
| 25 | 288 | 144 | 906 | 131 | 160 | 65 | 18 | 51 | 59 | 43 | 76 | 48 |
| 26 | 251 | 189 | 570 | 125 | 872 | 59 | 20 | 571 | 61 | 33 | 84 | 58 |
| 27 | 207 | 209 | 1,688 | 106 | 1,491 | 64 | 23 | 155 | 58 | 30 | 68 | 58 |
| 28 | 178 | 155 | 1,074 | 87 | 400 | 171 | 22 | 87 | 46 | 29 | 326 | 52 |
| 29 | 176 | 158 | 1,479 | 91 | 219 | 102 | 88 | 68 | 40 | 17 | 506 | 45 |
| 30 | 185 | ....... | 315 | 102 | 175 | 80 | 176 | 62 | 57 | 4 | 229 | 35 |
| 31 | 168 | ....... | 259 | ....... | 155 | ....... | 379 | 72 | ....... | 32 | ....... | 33 |
| Mean. | 634 | 166 | 565 | 158 | 241 | 125 | 101 | 100 | 44 | 27 | 288 | 155 |

1893.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 258 | 257 | 213 | 157 | 249 | 78 | 36 | 21 | 50 | 26 | 43 | 108 |
| 2 | 1,169 | 597 | 264 | 144 | 343 | 78 | 37 | 30 | 46 | 30 | 41 | 143 |
| 3 | 268 | 702 | 252 | 138 | 998 | 158 | 37 | 25 | 46 | 27 | 42 | 301 |
| 4 | 166 | 535 | 202 | 136 | 5,139 | 96 | 36 | 22 | 44 | 24 | 867 | 806 |
| 5 | 128 | 335 | 184 | 118 | 857 | 86 | 36 | 19 | 43 | 25 | 1,470 | 265 |
| 6 | 128 | 244 | 187 | 101 | 979 | 156 | 34 | 16 | 41 | 25 | 372 | 199 |
| 7 | 94 | 1,021 | 168 | 113 | 479 | 197 | 35 | 14 | 36 | 30 | 202 | 204 |
| 8 | 93 | 714 | 217 | 208 | 349 | 107 | 35 | 15 | 38 | 29 | 158 | 158 |
| 9 | 122 | 383 | 2,224 | 177 | 283 | 68 | 63 | 18 | 41 | 26 | 386 | 137 |
| 10 | 138 | 3,247 | 3,546 | 190 | 185 | 59 | 62 | 22 | 32 | 27 | 168 | 168 |
| 11 | 128 | 1,534 | 1,221 | 392 | 201 | 51 | 46 | 24 | 32 | 28 | 102 | 243 |
| 12 | 165 | 512 | 3,401 | 345 | 185 | 54 | 40 | 24 | 38 | 29 | 84 | 171 |
| 13 | 170 | 602 | 1,493 | 172 | 177 | 58 | 39 | 22 | 28 | 32 | 87 | 126 |
| 14 | 145 | 854 | 1,039 | 436 | 177 | 49 | 39 | 22 | 25 | 1,939 | 91 | 101 |
| 15 | 132 | 913 | 937 | 1,537 | 183 | 44 | 33 | 19 | 40 | 105 | 160 | 109 |
| 16 | 138 | 1,190 | 385 | 506 | 260 | 38 | 97 | 14 | 978 | 53 | 177 | 989 |
| 17 | 169 | 566 | 320 | 299 | 548 | 37 | 118 | 13 | 315 | 50 | 112 | 1,091 |
| 18 | 190 | 300 | 325 | 235 | 249 | 37 | 60 | 13 | 140 | 36 | 88 | 346 |
| 19 | 174 | 318 | 297 | 196 | 175 | 43 | 42 | 16 | 93 | 30 | 71 | 226 |
| 20 | 165 | 251 | 275 | 486 | 138 | 40 | 33 | 1,129 | 67 | 34 | 76 | 137 |
| 21 | 172 | 224 | 353 | 1,061 | 122 | 38 | 24 | 289 | 52 | 34 | 84 | 139 |
| 22 | 173 | 226 | 369 | 407 | 115 | 63 | 22 | 92 | 43 | 34 | 341 | 121 |
| 23 | 171 | 193 | 315 | 268 | 116 | 86 | 26 | 55 | 39 | 38 | 231 | 135 |
| 24 | 160 | 173 | 340 | 212 | 115 | 71 | 31 | 1,166 | 34 | 74 | 133 | 137 |
| 25 | 138 | 163 | 335 | 201 | 106 | 43 | 28 | 269 | 33 | 78 | 104 | 141 |
| 26 | 118 | 153 | 300 | 195 | 97 | 77 | 23 | 110 | 36 | 45 | 78 | 177 |
| 27 | 102 | 147 | 240 | 320 | 91 | 93 | 21 | 59 | 38 | 43 | 83 | 113 |
| 28 | 102 | 166 | 206 | 355 | 88 | 67 | 24 | 44 | 29 | 263 | 1,118 | 98 |
| 29 | 116 | ....... | 178 | 211 | 97 | 54 | 26 | 187 | 21 | 161 | 347 | 129 |
| 30 | 258 | ....... | 172 | 186 | 96 | 39 | 23 | 150 | 25 | 93 | 199 | 149 |
| 31 | 304 | ....... | 169 | ....... | 84 | ....... | 14 | 69 | ....... | 65 | ....... | 117 |
| Mean. | 192 | 591 | 649 | 317 | 428 | 72 | 39 | 129 | 83 | 113 | 251 | 241 |

*Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania—*
**Continued.**

1894.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1..... | 109 | 138 | 166 | 120 | 96 | 509 | 131 | 23 | 17 | 36 | 412 | 78 |
| 2..... | 101 | 120 | 197 | 120 | 76 | 348 | 82 | 88 | 27 | 36 | 193 | 339 |
| 3..... | 101 | 98 | 464 | 109 | 57 | 277 | 70 | 154 | 25 | 46 | 908 | 364 |
| 4..... | 97 | 68 | 776 | 149 | 61 | 235 | 45 | 109 | 14 | 55 | 428 | 176 |
| 5..... | 120 | 74 | 822 | 333 | 64 | 212 | 40 | 57 | 15 | 63 | 805 | 126 |
| 6..... | 153 | 88 | 1.045 | 175 | 103 | 207 | 571 | 42 | 15 | 51 | 786 | 114 |
| 7..... | 145 | 80 | 1,024 | 135 | 128 | 206 | 241 | 35 | 17 | 38 | 369 | 103 |
| 8..... | 125 | 88 | 524 | 128 | 91 | 191 | 99 | 29 | 249 | 45 | 350 | 125 |
| 9..... | 111 | 704 | 390 | 123 | 67 | 167 | 68 | 31 | 483 | 36 | 429 | 387 |
| 10..... | 92 | 1,002 | 311 | 117 | 52 | 143 | 55 | 33 | 137 | 2,335 | 303 | 223 |
| 11..... | 74 | 638 | 280 | 168 | 48 | 131 | 43 | 31 | 292 | 530 | 261 | 638 |
| 12..... | 62 | 343 | 249 | 329 | 48 | 118 | 38 | 31 | 101 | 182 | 188 | 4,132 |
| 13..... | 59 | 198 | 214 | 1,119 | 41 | 118 | 38 | 35 | 59 | 209 | 165 | 1,641 |
| 14..... | 58 | 182 | 188 | 898 | 36 | 121 | 36 | 52 | 43 | 290 | 161 | 446 |
| 15..... | 67 | 172 | 169 | 446 | 38 | 104 | 34 | 57 | 43 | 160 | 146 | 326 |
| 16..... | 80 | 160 | 176 | 239 | 38 | 91 | 224 | 47 | 40 | 118 | 123 | 266 |
| 17..... | 89 | 152 | 170 | 229 | 37 | 84 | 44 | 43 | 63 | 98 | 133 | 226 |
| 18..... | 92 | 975 | 136 | 190 | 40 | 80 | 29 | 35 | 1,123 | 80 | 178 | 187 |
| 19..... | 80 | 1,175 | 136 | 170 | 52 | 81 | 23 | 41 | 2,490 | 59 | 130 | 161 |
| 20..... | 69 | 1,284 | 142 | 163 | 1,634 | 77 | 23 | 57 | 934 | 51 | 111 | 151 |
| 21..... | 56 | 632 | 132 | 183 | 8,769 | 72 | 31 | 50 | 243 | 48 | 115 | 145 |
| 22..... | 74 | 442 | 161 | 269 | 3,787 | 64 | 46 | 46 | 144 | 49 | 126 | 136 |
| 23..... | 88 | 308 | 479 | 262 | 539 | 60 | 38 | 40 | 99 | 55 | 119 | 117 |
| 24..... | 80 | 163 | 291 | 168 | 3,541 | 132 | 48 | 38 | 90 | 61 | 120 | 114 |
| 25..... | 97 | 187 | 156 | 138 | 1,398 | 298 | 75 | 36 | 71 | 717 | 101 | 111 |
| 26..... | 88 | 165 | 195 | 121 | 708 | 113 | 45 | 30 | 47 | 309 | 95 | 137 |
| 27..... | 62 | 154 | 161 | 113 | 566 | 94 | 38 | 24 | 54 | 179 | 100 | 123 |
| 28..... | 55 | 157 | 126 | 105 | 2,442 | 85 | 38 | 22 | 51 | 130 | 78 | 130 |
| 29..... | 76 | ....... | 158 | 93 | 1,822 | 68 | 37 | 32 | 46 | 108 | 70 | 145 |
| 30..... | 147 | ....... | 168 | 94 | 541 | 132 | 35 | 26 | 43 | 98 | 72 | 119 |
| 31..... | 168 | ....... | 138 | ....... | 519 | ....... | 31 | 14 | ....... | 513 | ....... | 102 |
| Mean. | 93 | 355 | 314 | 234 | 885 | 154 | 77 | 45 | 23 | 219 | 252 | 374 |

1895.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1..... | 102 | 138 | 1,192 | 168 | 236 | 51 | 393 | 31 | 30 | 16 | 84 | 51 |
| 2..... | 80 | 128 | 1,235 | 327 | 163 | 47 | 151 | 34 | 30 | 16 | 82 | 43 |
| 3..... | 80 | 122 | 454 | 463 | 133 | 43 | 70 | 34 | 33 | 18 | 64 | 155 |
| 4..... | 86 | 136 | 418 | 252 | 128 | 62 | 56 | 35 | 31 | 20 | 47 | 95 |
| 5..... | 84 | 143 | 416 | 181 | 114 | 79 | 667 | 39 | 31 | 25 | 54 | 67 |
| 6..... | 115 | 86 | 240 | 158 | 101 | 138 | 489 | 31 | 29 | 5 | 54 | 55 |
| 7..... | 607 | 98 | 249 | 143 | 108 | 115 | 172 | 22 | 22 | 21 | 44 | 45 |
| 8..... | 839 | 158 | 1,238 | 1,910 | 106 | 70 | 105 | 24 | 19 | 8 | 45 | 43 |
| 9..... | 544 | 178 | 789 | 4,203 | 94 | 50 | 71 | 28 | 23 | 19 | 44 | 38 |
| 10..... | 354 | 222 | 689 | 682 | 78 | 50 | 48 | 24 | 26 | 13 | 33 | 41 |
| 11..... | 2,372 | 243 | 711 | 380 | 73 | 55 | 45 | 75 | 26 | 17 | 49 | 45 |
| 12..... | 905 | 214 | 323 | 296 | 134 | 44 | 40 | 133 | 22 | 25 | 65 | 37 |
| 13..... | 566 | 196 | 845 | 1,018 | 151 | 52 | 39 | 104 | 18 | 117 | 38 | 33 |
| 14..... | 333 | 186 | 1,528 | 845 | 205 | 68 | 37 | 58 | 16 | 177 | 43 | 33 |
| 15..... | 244 | 171 | 448 | 393 | 271 | 55 | 33 | 39 | 6 | 63 | 26 | 30 |
| 16..... | 242 | 152 | 312 | 286 | 151 | 40 | 37 | 31 | 24 | 50 | 52 | 31 |
| 17..... | 249 | 136 | 242 | 232 | 114 | 36 | 43 | 31 | 20 | 41 | 46 | 25 |
| 18..... | 187 | 134 | 313 | 200 | 101 | 34 | 40 | 31 | 18 | 29 | 49 | 29 |
| 19..... | 157 | 141 | 512 | 175 | 87 | 30 | 36 | 29 | 22 | 33 | 55 | 30 |
| 20..... | 137 | 154 | 476 | 151 | 80 | 28 | 31 | 18 | 26 | 11 | 52 | 119 |
| 21..... | 136 | 184 | 317 | 156 | 91 | 30 | 26 | 18 | 26 | 22 | 41 | 127 |
| 22..... | 142 | 225 | 324 | 154 | 120 | 34 | 23 | 26 | 20 | 25 | 36 | 486 |
| 23..... | 151 | 193 | 306 | 154 | 92 | 36 | 26 | 27 | 27 | 24 | 35 | 197 |
| 24..... | 148 | 118 | 334 | 138 | 76 | 32 | 33 | 23 | 27 | 26 | 18 | 118 |
| 25..... | 125 | 114 | 456 | 126 | 72 | 31 | 36 | 18 | 24 | 22 | 39 | 80 |
| 26..... | 2,212 | 117 | 496 | 126 | 59 | 35 | 27 | 19 | 24 | 24 | 37 | 71 |
| 27..... | 559 | 198 | 282 | 266 | 236 | 88 | 21 | 23 | 22 | 12 | 39 | 117 |
| 28..... | 235 | 820 | 280 | 247 | 348 | 104 | 23 | 24 | 22 | 33 | 131 | 117 |
| 29..... | 191 | ....... | 222 | 177 | 139 | 87 | 21 | 26 | 4 | 21 | 85 | 71 |
| 30..... | 178 | ....... | 181 | 236 | 85 | 141 | 34 | 38 | 18 | 21 | 55 | 110 |
| 31..... | 165 | ....... | 161 | ....... | 66 | ....... | 30 | 41 | ....... | 24 | ....... | 1,191 |
| Mean. | 404 | 182 | 516 | 475 | 129 | 59 | 94 | 37 | 23 | 32 | 51 | 120 |

*Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania*—Continued.

1896.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 327 | 56 | 586 | 351 | 63 | 65 | 51 | 123 | 21 | 179 | 42 | 236 |
| 2 | 150 | 91 | 338 | 322 | 55 | 53 | 39 | 84 | 20 | 60 | 43 | 160 |
| 3 | 124 | 106 | 188 | 256 | 57 | 42 | 44 | 73 | 21 | 45 | 54 | 126 |
| 4 | 91 | 111 | 124 | 189 | 71 | 39 | 41 | 64 | 22 | 38 | 57 | 125 |
| 5 | 58 | 85 | 119 | 161 | 71 | 36 | 38 | 45 | 38 | 45 | 2,439 | 116 |
| 6 | 47 | 6,789 | 95 | 156 | 50 | 34 | 36 | 40 | 758 | 66 | 829 | 97 |
| 7 | 42 | 2,181 | 99 | 166 | 45 | 28 | 39 | 40 | 212 | 60 | 295 | 109 |
| 8 | 31 | 381 | 92 | 148 | 49 | 30 | 60 | 35 | 81 | 41 | 344 | 120 |
| 9 | 37 | 347 | 72 | 117 | 42 | 41 | 260 | 28 | 52 | 41 | 377 | 406 |
| 10 | 40 | 335 | 78 | 120 | 34 | 91 | 457 | 83 | 42 | 39 | 217 | 223 |
| 11 | 35 | 291 | 80 | 133 | 37 | 95 | 133 | 66 | 39 | 33 | 191 | 150 |
| 12 | 34 | 196 | 59 | 120 | 38 | 44 | 69 | 35 | 30 | 585 | 282 | 118 |
| 13 | 34 | 177 | 63 | 108 | 37 | 31 | 47 | 34 | 23 | 2,711 | 231 | 102 |
| 14 | 37 | 569 | 67 | 99 | 23 | 36 | 41 | 32 | 23 | 476 | 178 | 100 |
| 15 | 38 | 360 | 55 | 86 | 39 | 78 | 40 | 25 | 30 | 259 | 137 | 98 |
| 16 | 31 | 415 | 60 | 80 | 39 | 82 | 41 | 25 | 39 | 164 | 119 | 85 |
| 17 | 20 | 121 | 82 | 81 | 25 | 118 | 38 | 26 | 37 | 122 | 113 | 87 |
| 18 | 22 | 123 | 96 | 98 | 25 | 177 | 33 | 31 | 358 | 98 | 100 | 95 |
| 19 | 30 | 112 | 1,854 | 109 | 32 | 75 | 25 | 34 | 95 | 82 | 89 | 81 |
| 20 | 31 | 112 | 3,150 | 89 | 34 | 49 | 23 | 32 | 81 | 71 | 82 | 60 |
| 21 | 34 | 90 | 875 | 125 | 65 | 39 | 1,532 | 32 | 56 | 63 | 77 | 73 |
| 22 | 34 | 54 | 618 | 127 | 92 | 40 | 863 | 31 | 52 | 63 | 75 | 70 |
| 23 | 36 | 52 | 521 | 83 | 65 | 36 | 1,143 | 25 | 39 | 52 | 84 | 55 |
| 24 | 193 | 93 | 259 | 81 | 38 | 37 | 169 | 26 | 31 | 125 | 88 | 58 |
| 25 | 379 | 116 | 316 | 149 | 35 | 66 | 115 | 31 | 30 | 138 | 87 | 58 |
| 26 | 156 | 75 | 655 | 114 | 35 | 94 | 79 | 26 | 33 | 82 | 72 | 55 |
| 27 | 105 | 70 | 700 | 84 | 38 | 125 | 70 | 26 | 34 | 68 | 65 | 52 |
| 28 | 86 | 69 | 301 | 78 | 165 | 71 | 177 | 31 | 26 | 60 | 175 | 55 |
| 29 | 60 | 638 | 2,520 | 66 | 300 | 124 | 297 | 24 | 36 | 57 | 895 | 58 |
| 30 | 43 | ....... | 1,052 | 67 | 119 | 88 | 1,938 | 17 | 287 | 57 | 379 | 47 |
| 31 | 43 | ....... | 465 | ...... | 74 | ....... | 250 | 20 | ...... | 53 | ....... | 36 |
| Mean | 78 | 493 | 504 | 132 | 61 | 65 | 264 | 41 | 88 | 195 | 280 | 107 |

1897.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 51 | 46 | 131 | 88 | 82 | 105 | 45 | 86 | 35 | 22 | 70 | 136 |
| 2 | 78 | 55 | 128 | 85 | 2,580 | 88 | 46 | 180 | 113 | 18 | 3,089 | 113 |
| 3 | 85 | 55 | 162 | 76 | 1,330 | 80 | 33 | 61 | 159 | 13 | 103 | 95 |
| 4 | 124 | 49 | 246 | 67 | 381 | 124 | 30 | 54 | 75 | 17 | 169 | 161 |
| 5 | 318 | 55 | 211 | 139 | 268 | 180 | 34 | 213 | 67 | 17 | 100 | 1,942 |
| 6 | 547 | 965 | 515 | 200 | 199 | 159 | 34 | 117 | 37 | 10 | 70 | 513 |
| 7 | 83 | 4,083 | 315 | 149 | 148 | 105 | 29 | 58 | 33 | 15 | 47 | 386 |
| 8 | 76 | 846 | 200 | 115 | 124 | 118 | 35 | 55 | 29 | 22 | 34 | 207 |
| 9 | 61 | 346 | 172 | 1,643 | 112 | 899 | 43 | 45 | 34 | 18 | 96 | 168 |
| 10 | 51 | 204 | 180 | 988 | 124 | 473 | 38 | 53 | 32 | 8 | 120 | 146 |
| 11 | 52 | 171 | 198 | 311 | 131 | 106 | 30 | 201 | 13 | 15 | 84 | 133 |
| 12 | 47 | 123 | 221 | 218 | 138 | 127 | 203 | 120 | 8 | 23 | 106 | 360 |
| 13 | 38 | 110 | 212 | 185 | 4,747 | 106 | 248 | 66 | 29 | 22 | 88 | 355 |
| 14 | 49 | 115 | 168 | 153 | 1,566 | 97 | 38 | 49 | 29 | 29 | 41 | 1,909 |
| 15 | 45 | 110 | 199 | 323 | 1,303 | 84 | 56 | 48 | 33 | 28 | 44 | 2,561 |
| 16 | 39 | 161 | 189 | 316 | 425 | 75 | 44 | 149 | 36 | 17 | 60 | 229 |
| 17 | 46 | 184 | 129 | 265 | 365 | 75 | 41 | 167 | 29 | 16 | 87 | 325 |
| 18 | 117 | 413 | 139 | 216 | 300 | 85 | 213 | 68 | 26 | 27 | 97 | 249 |
| 19 | 150 | 351 | 322 | 166 | 173 | 85 | 292 | 50 | 23 | 30 | 70 | 185 |
| 20 | 96 | 153 | 730 | 129 | 153 | 64 | 130 | 47 | 19 | 14 | 51 | 145 |
| 21 | 1,201 | 347 | 392 | 116 | 217 | 61 | 104 | 41 | 23 | 16 | 51 | 151 |
| 22 | 504 | 664 | 242 | 110 | 221 | 63 | 588 | 39 | 25 | 23 | 67 | 166 |
| 23 | 157 | 1,242 | 201 | 99 | 137 | 63 | 231 | 33 | 22 | 20 | 60 | 141 |
| 24 | 115 | 457 | 564 | 94 | 202 | 51 | 128 | 30 | 35 | 28 | 60 | 99 |
| 25 | 136 | 244 | 405 | 80 | 442 | 46 | 77 | 112 | 46 | 88 | 62 | 73 |
| 26 | 130 | 193 | 208 | 84 | 201 | 50 | 60 | 123 | 38 | 89 | 93 | 71 |
| 27 | 93 | 158 | 167 | 94 | 126 | 37 | 475 | 52 | 29 | 62 | 1,117 | 89 |
| 28 | 81 | 136 | 146 | 76 | 103 | 35 | 1,901 | 37 | 31 | 50 | 317 | 94 |
| 29 | 69 | ....... | 128 | 70 | 93 | 38 | 729 | 26 | 27 | 49 | 219 | 82 |
| 30 | 51 | ....... | 120 | 61 | 83 | 35 | 236 | 27 | 22 | 47 | 183 | 88 |
| 31 | 48 | ....... | 98 | ....... | 99 | ....... | 127 | 28 | ....... | 39 | ....... | 130 |
| Mean | 156 | 429 | 241 | 223 | 525 | 128 | 205 | 78 | 40 | 29 | 238 | 364 |

*Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania*—Continued.

1898.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 163 | 145 | 153 | 292 | 201 | 113 | 29 | 32 | 40 | 28 | 129 | 363 |
| 2 | 37 | 137 | 138 | 213 | 160 | 103 | 30 | 38 | 28 | 20 | 90 | 242 |
| 3 | 69 | 147 | 168 | 178 | 147 | 96 | 34 | 46 | 23 | 29 | 76 | 233 |
| 4 | 62 | 129 | 183 | 157 | 141 | 93 | 29 | 49 | 19 | 31 | 70 | 1,916 |
| 5 | 45 | 114 | 153 | 151 | 148 | 75 | 29 | 139 | 27 | 23 | 78 | 3,406 |
| 6 | 59 | 114 | 127 | 171 | 199 | 60 | 30 | 104 | 25 | 21 | 63 | 569 |
| 7 | 101 | 116 | 115 | 184 | 497 | 63 | 28 | 50 | 34 | 18 | 45 | 352 |
| 8 | 121 | 125 | 115 | 155 | 3,493 | 59 | 29 | 43 | 51 | 23 | 94 | 218 |
| 9 | 102 | 140 | 107 | 129 | 1,360 | 46 | 57 | 116 | 45 | 26 | 52 | 100 |
| 10 | 94 | 182 | 107 | 113 | 495 | 37 | 64 | 332 | 29 | 31 | 1,422 | 102 |
| 11 | 106 | 318 | 102 | 121 | 398 | 39 | 39 | 393 | 25 | 27 | 1,100 | 92 |
| 12 | 205 | 541 | 99 | 127 | 495 | 46 | 35 | 145 | 22 | 27 | 272 | 97 |
| 13 | 302 | 414 | 99 | 108 | 580 | 54 | 37 | 82 | 19 | 30 | 173 | 100 |
| 14 | 253 | 307 | 98 | 106 | 415 | 50 | 37 | 56 | 24 | 30 | 167 | 91 |
| 15 | 542 | 248 | 89 | 323 | 1,403 | 41 | 37 | 44 | 25 | 56 | 150 | 78 |
| 16 | 661 | 272 | 76 | 259 | 1,013 | 50 | 37 | 43 | 17 | 56 | 103 | 70 |
| 17 | 296 | 159 | 85 | 170 | 713 | 56 | 18 | 45 | 15 | 40 | 202 | 72 |
| 18 | 166 | 166 | 88 | 122 | 377 | 44 | 28 | 46 | 13 | 45 | 447 | 78 |
| 19 | 147 | 258 | 88 | 113 | 392 | 49 | 39 | 258 | 12 | 39 | 3,808 | 111 |
| 20 | 585 | 5,552 | 74 | 126 | 289 | 64 | 190 | 71 | 14 | 71 | 602 | 890 |
| 21 | 704 | 1,650 | 133 | 125 | 345 | 66 | 115 | 60 | 17 | 57 | 312 | 384 |
| 22 | 375 | 739 | 426 | 102 | 232 | 56 | 73 | 51 | 27 | 162 | 233 | 552 |
| 23 | 2,758 | 474 | 445 | 95 | 211 | 53 | 51 | 50 | 42 | 116 | 763 | 1,364 |
| 24 | 570 | 332 | 341 | 658 | 255 | 51 | 41 | 47 | 54 | 61 | 403 | 452 |
| 25 | 323 | 265 | 340 | 428 | 422 | 39 | 37 | 47 | 61 | 60 | 317 | 308 |
| 26 | 454 | 218 | 220 | 433 | 353 | 36 | 39 | 39 | 52 | 235 | 267 | 215 |
| 27 | 393 | 182 | 173 | 285 | 268 | 37 | 40 | 35 | 43 | 475 | 207 | 189 |
| 28 | 261 | 166 | 282 | 481 | 219 | 41 | 65 | 30 | 43 | 163 | 213 | 150 |
| 29 | 205 | ....... | 414 | 641 | 168 | 45 | 74 | 24 | 45 | 93 | 330 | 126 |
| 30 | 166 | ....... | 894 | 312 | 153 | 41 | 48 | 24 | 38 | 111 | 395 | 139 |
| 31 | 166 | ....... | 456 | ....... | 131 | ....... | 37 | 38 | ....... | 198 | ....... | 230 |
| Mean | 338 | 486 | 206 | 229 | 505 | 56 | 44 | 83 | 30 | 77 | 416 | 428 |

1899.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 313 | 131 | 651 | 346 | 78 | 76 | 84 | 72 | 53 | 147 | 294 | 68 |
| 2 | 239 | 130 | 635 | 262 | 82 | 66 | 52 | 346 | 140 | 101 | 286 | 114 |
| 3 | 239 | 120 | 589 | 248 | 98 | 49 | 45 | 722 | 922 | 99 | 181 | 84 |
| 4 | 222 | 182 | 753 | 252 | 101 | 38 | 41 | 177 | 318 | 101 | 724 | 69 |
| 5 | 1,014 | 193 | 3,525 | 230 | 84 | 36 | 41 | 90 | 174 | 93 | 309 | 71 |
| 6 | 1,315 | 143 | 975 | 185 | 83 | 36 | 41 | 77 | 106 | 98 | 184 | 56 |
| 7 | 1,476 | 148 | 588 | 245 | 74 | 38 | 36 | 66 | 57 | 119 | 138 | 55 |
| 8 | 394 | 152 | 391 | 1,366 | 70 | 39 | 41 | 52 | 43 | 105 | 109 | 64 |
| 9 | 311 | 174 | 365 | 428 | 87 | 41 | 816 | 48 | 290 | 95 | 107 | 56 |
| 10 | 239 | 183 | 345 | 296 | 73 | 48 | 163 | 157 | 227 | 80 | 104 | 44 |
| 11 | 195 | 158 | 475 | 251 | 101 | 49 | 71 | 1,021 | 213 | 72 | 88 | 43 |
| 12 | 165 | 170 | 1,519 | 219 | 213 | 43 | 43 | 224 | 369 | 67 | 110 | 146 |
| 13 | 150 | 222 | 1,552 | 187 | 129 | 38 | 42 | 90 | 189 | 57 | 112 | 250 |
| 14 | 245 | 236 | 510 | 178 | 125 | 39 | 43 | 66 | 97 | 53 | 62 | 127 |
| 15 | 410 | 225 | 848 | 170 | 123 | 44 | 38 | 54 | 71 | 57 | 62 | 84 |
| 16 | 475 | 255 | 879 | 260 | 83 | 34 | 35 | 46 | 54 | 48 | 92 | 75 |
| 17 | 789 | 233 | 437 | 501 | 93 | 26 | 38 | 52 | 46 | 51 | 77 | 67 |
| 18 | 443 | 683 | 853 | 263 | 201 | 29 | 42 | 42 | 55 | 65 | 60 | 55 |
| 19 | 196 | 992 | 2,423 | 196 | 210 | 27 | 42 | 37 | 58 | 80 | 58 | 133 |
| 20 | 192 | 1,311 | 780 | 160 | 129 | 26 | 40 | 36 | 748 | 81 | 67 | 182 |
| 21 | 164 | 1,495 | 421 | 146 | 86 | 82 | 33 | 29 | 385 | 67 | 65 | 127 |
| 22 | 145 | 1,507 | 1,146 | 136 | 70 | 65 | 27 | 53 | 206 | 63 | 53 | 79 |
| 23 | 147 | 1,767 | 893 | 118 | 96 | 41 | 25 | 61 | 184 | 57 | 159 | 57 |
| 24 | 1,081 | 869 | 517 | 113 | 98 | 43 | 25 | 44 | 115 | 49 | 200 | 662 |
| 25 | 2,693 | 469 | 417 | 120 | 70 | 83 | 26 | 39 | 110 | 34 | 116 | 531 |
| 26 | 378 | 1,184 | 534 | 114 | 57 | 110 | 70 | 34 | 3,363 | 34 | 79 | 177 |
| 27 | 289 | 4,043 | 513 | 99 | 60 | 74 | 82 | 502 | 462 | 60 | 75 | 133 |
| 28 | 212 | 883 | 1,002 | 87 | 60 | 165 | 98 | 197 | 258 | 62 | 81 | 91 |
| 29 | 201 | ....... | 1,377 | 81 | 71 | 501 | 89 | 84 | 174 | 51 | 66 | 59 |
| 30 | 153 | ....... | 555 | 76 | 122 | 220 | 817 | 64 | 168 | 71 | 65 | 51 |
| 31 | 129 | ....... | 466 | ....... | 93 | ....... | 158 | 63 | ....... | 78 | ....... | 47 |
| Mean | 472 | 659 | 869 | 245 | 100 | 74 | 104 | 150 | 332 | 74 | 139 | 124 |

## WISSAHICKON CREEK NEAR PHILADELPHIA, PENNSYLVANIA.

The drainage basin of this creek is immediately adjacent to Philadelphia, and between Little Neshaminy and Perkiomen creeks. Measurements of flow were begun in April, 1897, under the direction of Mr. John E. Codman, at a point about 100 yards above the junction of the creek with Schuylkill River. The results for 1897 and 1898 have been printed in the Twentieth Annual Report, Part IV, and the daily flow to June 1, 1899, is given in the following table:

*Daily discharge in second-feet of Wissahickon Creek, near Philadelphia, Pennsylvania, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | Day. | Jan. | Feb. | Mar. | Apr. | May. | June. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 141 | 119 | 285 | 191 | 89 | 45 | 18 | 147 | 227 | 273 | 129 | 96 | ...... |
| 2 | 106 | 106 | 245 | 175 | 96 | 42 | 19 | 118 | 350 | 603 | 129 | 90 | ...... |
| 3 | 106 | 110 | 233 | 175 | 103 | 42 | 20 | 116 | 466 | 340 | 123 | 73 | ...... |
| 4 | 120 | 204 | 233 | 173 | 93 | 33 | 21 | 115 | 436 | 202 | 115 | 68 | ...... |
| 5 | 412 | 204 | 1,059 | 159 | 80 | 21 | 22 | 106 | 779 | 521 | 106 | 75 | ...... |
| 6 | 574 | 113 | 365 | 151 | 80 | ...... | 23 | 106 | 630 | 328 | 106 | 96 | ...... |
| 7 | 573 | 113 | 241 | 166 | 87 | ...... | 24 | 259 | 359 | 232 | 106 | 96 | ...... |
| 8 | 220 | 113 | 204 | 451 | 87 | ...... | 25 | 925 | 250 | 202 | 106 | 75 | ...... |
| 9 | 194 | 113 | 186 | 205 | 75 | ...... | 26 | 184 | 245 | 216 | 106 | 64 | ...... |
| 10 | 154 | 113 | 198 | 152 | 75 | ...... | 27 | 142 | 1,285 | 198 | 106 | 64 | ...... |
| 11 | 140 | 113 | 198 | 140 | 105 | ...... | 28 | 133 | 423 | 434 | 101 | 54 | ...... |
| 12 | 132 | 113 | 198 | 140 | 108 | ...... | 29 | 136 | ...... | 813 | 98 | 50 | ...... |
| 13 | 118 | 113 | 540 | 140 | 90 | ...... | 30 | 136 | ...... | 260 | 95 | 59 | ...... |
| 14 | 144 | 113 | 208 | 137 | 87 | ...... | 31 | 136 | ...... | 218 | ...... | 54 | ...... |
| 15 | 149 | 113 | 346 | 129 | 87 | ...... | | | | | | | |
| 16 | 140 | 113 | 359 | 142 | 87 | ...... | Mean | 207 | 271 | 326 | 146 | 81 | ...... |
| 17 | 232 | 149 | 186 | 142 | 87 | ...... | | | | | | | |

## SCHUYLKILL RIVER NEAR PHILADELPHIA, PENNSYLVANIA.

This river receives the drainage of the portion of southeastern Pennsylvania lying between the Lehigh River on the north and the Susquehanna River on the south. It flows in a general southeasterly course, emptying into Delaware River, the city of Philadelphia being located at the junction of these streams. Records of the height of the river at Fairmount pool have been kept for many years, but not in such form as to be useful in computing daily discharges. In 1898, however, careful estimates were prepared by Mr. John E. Codman, the results being given in the Twentieth Annual Report, Part IV, page 97. The figures for 1899 are given in the following table:

These do not represent the total flow of the stream, but the amount wasted over the flashboards at Fairmount dam. To this must be added the pumpage from the river, amounting to 275,000,000 gallons per day, or 425 second-feet; also the leakage, amounting to 71,000,000 gallons per day, or 110 second-feet; also the quantity used for power at Fairmount, amounting to an average per day of 272,000,000 gallons, or 421 second-feet. There has been no method for obtaining the daily flow when the water does not waste over the flashboards. When the water is below the overflow line recourse is had to pumping, and the draft is on the storage of the pool. As soon as the water begins to rise after a rain the turbine wheels are started and, thus it often occurs that no water flows to waste for from one to three months in succession.

*Daily discharge in second-feet of Schuylkill River above Philadelphia, Pennsylvania, for 1899, being amount wasted over flashboards at Fairmount Dam.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 573 | 566 | 11,170 | 5,321 | ...... | 440 | 385 | 514 | ...... | ...... | 60 | ...... |
| 2 | 170 | 566 | 8,532 | 4,156 | ...... | 204 | ...... | ...... | ...... | ...... | 605 | ...... |
| 3 | 26 | 347 | 6,717 | 3,352 | ...... | 341 | ...... | 2,421 | 964 | ...... | 477 | ...... |
| 4 | 135 | 1,023 | 6,421 | 2,910 | ...... | 179 | ...... | 414 | 217 | ...... | 1,961 | ...... |
| 5 | 3,033 | 1,250 | 17,735 | 2,481 | ...... | ...... | ...... | ...... | ...... | ...... | 3,002 | ...... |
| 6 | 6,017 | 781 | 13,186 | 2,210 | ...... | ...... | ...... | ...... | ...... | ...... | 1,415 | ...... |
| 7 | 8,945 | 825 | 4,748 | 2,945 | ...... | ...... | ...... | ...... | ...... | ...... | 703 | ...... |
| 8 | 2,521 | 342 | 7,120 | 7,735 | ...... | ...... | ...... | ...... | ...... | ...... | 831 | ...... |
| 9 | 1,470 | 31 | 5,504 | 7,651 | ...... | ...... | 1,185 | ...... | ...... | ...... | 733 | ...... |
| 10 | 1,035 | ...... | 4,805 | 5,068 | 46 | ...... | 385 | ...... | 179 | ...... | 622 | ...... |
| 11 | 816 | ...... | 4,468 | 3,824 | ...... | ...... | ...... | 4,775 | ...... | ...... | ...... | ...... |
| 12 | 511 | ...... | 4,961 | 3,920 | 357 | ...... | ...... | 2,213 | 173 | ...... | ...... | ...... |
| 13 | 248 | ...... | 11,906 | 2,478 | 369 | ...... | ...... | 641 | 130 | ...... | 83 | 857 |
| 14 | 436 | ...... | 7,918 | 2,478 | 31 | ...... | ...... | ...... | ...... | ...... | 83 | 1,012 |
| 15 | 693 | ...... | 7,046 | 2,478 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 159 |
| 16 | 950 | 50 | 8,948 | 2,478 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 260 |
| 17 | 1,854 | 902 | 5,619 | 2,902 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 18 | 1,421 | 3,301 | 5,310 | 2,478 | 277 | ...... | ...... | ...... | ...... | ...... | ...... | 68 |
| 19 | 569 | 3,858 | 14,442 | 2,075 | 1,061 | ...... | ...... | ...... | ...... | ...... | ...... | 570 |
| 20 | 523 | 4,990 | 10,540 | 1,582 | 532 | ...... | ...... | ...... | 550 | ...... | ...... | 610 |
| 21 | 526 | 5,908 | 10,748 | 1,012 | 240 | ...... | ...... | ...... | 1,489 | ...... | ...... | 331 |
| 22 | 305 | 8,656 | 11,230 | 849 | 25 | ...... | ...... | ...... | 1,042 | ...... | ...... | 331 |
| 23 | 305 | 9,746 | 11,548 | 337 | ...... | ...... | ...... | ...... | 49 | ...... | ...... | ...... |
| 24 | 4,226 | 4,914 | 8,034 | 212 | ...... | ...... | ...... | ...... | ...... | ...... | 397 | 1,201 |
| 25 | 14,980 | 4,984 | 6,326 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 397 | 3,854 |
| 26 | 7,082 | 1,605 | 6,134 | ...... | ...... | 624 | ...... | ...... | 10,923 | ...... | ...... | 2,902 |
| 27 | 1,752 | 17,177 | 5,874 | ...... | ...... | 241 | ...... | 1,775 | 5,653 | ...... | ...... | 2,489 |
| 28 | 1,951 | 18,045 | 8,622 | ...... | ...... | ...... | ...... | 637 | 2,155 | ...... | ...... | 2,077 |
| 29 | 1,175 | ...... | 13,757 | ...... | ...... | 1,238 | ...... | ...... | 1,154 | ...... | ...... | 1,277 |
| 30 | 967 | ...... | 9,085 | ...... | ...... | 1,752 | 215 | 468 | 494 | ...... | ...... | 298 |
| 31 | 1,120 | ...... | 6,718 | ...... | 519 | ...... | 1,920 | 336 | ...... | ...... | ...... | ...... |

*Total monthly yield, in cubic feet, of Schuylkill River above Philadelphia, Pennsylvania, for 1899.*

| | | | |
|---|---|---|---|
| January | 11,445,838,000 | July | 3,475,700,000 |
| February | 12,484,000,000 | August | 3,964,400,000 |
| March | 28,187,700,000 | September | 5,258,910,000 |
| April | 11,957,000,000 | October | 2,587,900,000 |
| May | 5,153,450,000 | November | 4,896,500,000 |
| June | 3,856,560,000 | December | 5,086,600,000 |

## NORTH BRANCH OF SUSQUEHANNA RIVER AT WILKESBARRE, PENNSYLVANIA.

This stream rises in New York State and flows in a southwesterly direction until it crosses the Pennsylvania State line, when it flows to the southeast, turning again near Wilkesbarre to the southwest, and joins the West Branch of the Susquehanna on the western border of Northumberland County to form Susquehanna River. Measurements of flow are made at Wilkesbarre and Danville, Pennsylvania.

Observations of fluctuations of Susquehanna River are made by the Weather Bureau above Wilkesbarre, at Towanda, Pennsylvania, where the drainage area is estimated to be 8,000 square miles. The river gage, made of iron 1 foot wide and one-half inch thick, is on the east side of the road bridge over Susquehanna River, and is securely bolted to the masonry of the pier. The graduation is from 0 to 25 feet. The highest water was 29 feet in March, 1869, and the lowest,

—0.1, in October, 1895. The danger line is at 16 feet. The elevation of the zero is 633.7 feet.

The Wilkesbarre station was established by E. G. Paul on March 30, 1899, and is located at the Market street bridge. The gage is a sash chain and weight inclosed in a long, narrow box, covering 12 feet of the scale board. The scale board is divided into feet and tenths and painted the color of the ironwork. The length of the chain from zero to extreme end of weight is 40.83 feet. The initial point of sounding is at the end of the iron guard rail on the left bank. The channel is straight for a quarter of a mile above and below the station, the current sluggish but unobstructed. The right bank is low and liable to overflow; the left bank is above ordinary floods. The bed of the stream is of sand and gravel, somewhat shifting. The observer is O. Hemstreet, the bridge superintendent, Wilkesbarre, Pennsylvania. When this gage was established there was found to be a gage painted on the bridge pier, being a portion of one established by the Weather Bureau. The lower part of this gage, erected in January, 1898, originally consisted of heavy cast-brass plates graduated to feet and tenths. The gage plates were made in 4-foot sections and bolted to the stone bridge pier. The two lower sections of the brass plates had been torn away by ice, so that there was no graduation below the 8-foot mark, but readings were made by the figures painted on the stone pier. The zero of this old gage is at the base of the dressed-stone portion of the pier, and is reported to be 535 feet above sea level. During low stages of the river the water recedes from the pier, rendering it impracticable to read the gage. So far as could be ascertained, this has not been connected with the city datum. On account of the low water, which in 1897 had gone below the city datum, it was decided to put the zero of the new gage 4 feet below the zero of the old Weather Bureau gage, so as to obviate minus readings. In order, therefore, to compare with former records, it is necessary to add 4 feet to the old figures. The danger mark of this Weather Bureau gage is at 14 feet, or 18 feet of new gage, as at this elevation the west bank of the river is under water in places. River reports from this locality were furnished as early as 1888. During low water, measurements were made by wading at a better cross section, at Retreat, 10 miles below Wilkesbarre. The following measurements were made by E. G. Paul during 1899:

*Measurements of North Fork of Susquehanna River at Wilkesbarre, Pennsylvania.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Second-ft.* | 1899. | *Feet.* | *Second-ft.* |
| March 30 | 9.00 | 24,800 | September 17 | 2.30 | 851 |
| June 6 | 4.30 | 3,668 | September 18 | 2.30 | *a* 1,096 |
| July 26 | 2.80 | *a* 1,924 | October 16 | 2.35 | *a* 1,114 |
| July 27 | 2.80 | 1,357 | | | |

*a* Made at Retreat, Pennsylvania, 10 miles below Wilkesbarre.

*Daily gage height, in feet, of North Branch of Susquehanna River at Wilkesbarre, Pennsylvania, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ........ | 8.40 | 6.40 | 4.50 | 3.60 | 2.70 | 3.10 | 2.50 | 2.50 | 3.40 |
| 2 | ........ | 8.10 | 6.20 | 5.50 | 3.30 | 2.60 | 2.90 | 2.50 | 3.00 | 3.40 |
| 3 | ........ | 7.70 | 6.30 | 5.30 | 3.30 | 2.70 | 2.60 | 2.50 | 8.30 | 3.40 |
| 4 | ........ | 7.20 | 6.30 | 5.10 | 3.20 | 2.60 | 2.60 | 2.50 | 6.70 | 3.40 |
| 5 | ........ | 6.90 | 6.40 | 4.60 | 3.00 | 3.20 | 2.50 | 2.50 | 7.30 | 3.50 |
| 6 | ........ | 6.90 | 6.10 | 4.30 | 3.00 | 3.00 | 2.50 | 2.60 | 6.60 | 3.50 |
| 7 | ........ | 7.40 | 5.70 | 3.60 | 2.80 | 2.80 | 2.50 | 2.60 | 6.90 | 3.50 |
| 8 | ........ | 10.35 | 5.60 | 3.50 | 2.90 | 2.50 | 2.40 | 2.50 | 5.30 | 3.70 |
| 9 | ........ | 14.10 | 5.40 | 3.50 | 2.80 | 2.50 | 2.40 | 2.50 | 5.00 | 3.60 |
| 10 | ........ | 14.20 | 5.30 | 3.50 | 2.80 | 2.50 | 2.40 | 2.50 | 4.50 | 3.50 |
| 11 | ........ | 12.80 | 5.10 | 3.30 | 2.80 | 2.50 | 2.40 | 2.50 | 4.20 | 3.50 |
| 12 | ........ | 11.10 | 5.20 | 3.20 | 2.90 | 2.50 | 2.50 | 2.50 | 4.30 | 3.60 |
| 13 | ........ | 11.30 | 5.10 | 3.20 | 2.90 | 2.70 | 2.50 | 2.40 | 4.90 | 7.70 |
| 14 | ........ | 14.00 | 5.00 | 3.20 | 3.00 | 2.80 | 2.50 | 2.40 | 4.70 | 9.60 |
| 15 | ........ | 14.30 | 5.00 | 3.00 | 3.20 | 2.80 | 2.40 | 2.40 | 4.60 | 9.60 |
| 16 | ........ | 13.90 | 4.80 | 3.10 | 3.30 | 2.80 | 2.40 | 2.40 | 4.50 | 8.50 |
| 17 | ........ | 13.40 | 4.80 | 3.20 | 3.10 | 2.90 | 2.30 | 2.30 | 5 20 | 7.70 |
| 18 | ........ | 12.50 | 4.70 | 3.20 | 3.00 | 2.70 | 2.30 | 2.30 | 5.20 | 7.30 |
| 19 | ........ | 11.30 | 4.90 | 3.00 | 3.00 | 2.40 | 2.30 | 2.30 | 5.30 | 6.50 |
| 20 | ........ | 10.50 | 4.90 | 3.00 | 3.00 | 2.30 | 2.30 | 2.30 | 5.00 | 6.50 |
| 21 | ........ | 9.90 | 5.40 | 3.10 | 3.10 | 2.30 | 2.30 | 2.30 | 4.70 | 8.30 |
| 22 | ........ | 9.40 | 5.90 | 3.00 | 3.00 | 2.60 | 2.30 | 2.30 | 4.60 | 8.40 |
| 23 | ........ | 9.00 | 5.80 | 3.00 | 3.00 | 2.50 | 2.30 | 2.30 | 4.30 | 7.40 |
| 24 | ........ | 8.50 | 5.70 | 2.90 | 2.90 | 2.50 | 2.30 | 2.30 | 4.20 | 6.60 |
| 25 | ........ | 8.00 | 5.50 | 2.90 | 2.80 | 2.40 | 2.20 | 2.30 | 4.00 | 8.40 |
| 26 | ........ | 7.40 | 5.40 | 3.10 | 2.80 | 2.40 | 2.50 | 2.20 | 3.80 | 8.00 |
| 27 | ........ | 7.60 | 5.10 | 3.10 | 2.80 | 2.40 | 2.40 | 2.30 | 3.80 | 7.40 |
| 28 | ........ | 7.40 | 4.90 | 3.30 | 2.80 | 2.40 | 2.50 | 2.30 | 3.70 | 6.30 |
| 29 | ........ | 7.10 | 4.80 | 3.80 | 2.80 | 4.60 | 2.50 | 2.50 | 3.60 | 9.10 |
| 30 | 9.00 | 6.60 | 4.80 | 4.00 | 2.60 | 4.10 | 2.60 | 2.50 | 3.50 | 7.90 |
| 31 | 8.70 | ........ | 4.70 | ........ | 2.60 | 3.40 | ........ | 2.50 | ........ | ........ |

## NORTH BRANCH OF SUSQUEHANNA RIVER AT DANVILLE, PENNSYLVANIA.

This station, 52 miles below Wilkesbarre and 11 miles above the mouth of the West Branch, was established on March 25, 1899, by E. G. Paul. It is located at the Mill street bridge, 600 feet south of the public square, Danville, Pennsylvania. The length of the wire gage from zero to the end of the weight is 42.85 feet. This gage is referred to a pine-board scale nailed to the hand rail of the bridge and divided into feet and tenths. The initial point of soundings is at the end of the wooden hand rail on right bank. The channel is straight for half a mile above and below the station. The left bank is high, but the right bank is subject to overflow. The bed of the stream is rocky, with some gravel, and is unchangeable. The following measurements were made by E. G. Paul during 1899:

March 25, gage height, 10.00 feet; discharge, 47,646 second-feet.
June 8, gage height, 3.00 feet; discharge, 3,927 second-feet.
July 27, gage height, 2.40 feet; discharge, 2,272 second-feet.
September 16, gage height, 2.00 feet; discharge, 1,427 second-feet.
October 17, gage height, 1.90 feet; discharge, 1,163 second-feet.

*Daily gage height, in feet, of North Branch of Susquehanna River at Danville, Pennsylvania, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 6.95 | 4.80 | 3.30 | 3.20 | 2.20 | 2.80 | 2.10 | 2.10 | 3.10 |
| 2 | | 6.80 | 4.65 | 3.40 | 3.00 | 2.20 | 2.60 | 2.10 | 2.60 | 3.00 |
| 3 | | 6.35 | 4.60 | 3.70 | 2.80 | 2.60 | 2.50 | 2.10 | 2.60 | 3.00 |
| 4 | | 6.00 | 4.60 | 3.60 | 2.70 | 2.30 | 2.50 | 2.10 | 6.10 | 3.00 |
| 5 | | 5.65 | 4.60 | 3.50 | 2.60 | 2.20 | 2.30 | 2.00 | 5.40 | 3.00 |
| 6 | | 5.50 | 4.55 | 3.30 | 2.60 | 2.20 | 2.20 | 2.00 | 5.70 | 2.90 |
| 7 | | 5.65 | 4.35 | 3.20 | 2.60 | 2.50 | 2.20 | 2.00 | 5.20 | 3.10 |
| 8 | | 6.90 | 4.15 | 3.00 | 2.50 | 2.30 | 2.10 | 2.00 | 4.70 | 3.10 |
| 9 | | 10.50 | 3.80 | 3.00 | 2.50 | 2.20 | 2.40 | 2.10 | 4.30 | 3.10 |
| 10 | | 11.60 | 3.70 | 2.90 | 2.50 | 2.20 | 2.20 | 2.10 | 3.90 | 3.00 |
| 11 | | 10.45 | 3.70 | 2.90 | 2.50 | 2.60 | 2.10 | 2.00 | 7.30 | 3.00 |
| 12 | | 9.15 | 3.75 | 2.90 | 2.40 | 2.30 | 2.20 | 2.00 | 3.90 | 3.10 |
| 13 | | 8.95 | 3.80 | 2.70 | 2.60 | 2.40 | 2.10 | 2.00 | 3.70 | 4.20 |
| 14 | | 10.75 | 3.70 | 2.70 | 2.70 | 2.30 | 2.10 | 1.90 | 4.00 | 6.80 |
| 15 | | 11.55 | 3.70 | 2.60 | 2.60 | 2.30 | 2.10 | 1.90 | 3.90 | 7.80 |
| 16 | | 11.40 | 3.60 | 2.60 | 2.80 | 2.30 | 2.00 | 1.90 | 3.80 | 7.60 |
| 17 | | 10.85 | 3.60 | 2.60 | 2.80 | 2.30 | 1.90 | 1.90 | 3.90 | 6.70 |
| 18 | | 10.05 | 3.70 | 2.60 | 2.70 | 2.30 | 1.90 | 1.90 | 4.30 | 6.10 |
| 19 | | 9.05 | 3.60 | 2.60 | 2.70 | 2.30 | 1.80 | 1.90 | 4.40 | 5.70 |
| 20 | | 8.25 | 3.60 | 2.50 | 2.50 | 2.20 | 1.80 | 1.90 | 4.30 | 5.40 |
| 21 | | 7.75 | 3.60 | 2.50 | 2.50 | 2.10 | 1.90 | 1.90 | 4.10 | 5.60 |
| 22 | | 7.35 | 3.80 | 2.50 | 2.50 | 2.10 | 1.90 | 1.90 | 3.80 | 6.90 |
| 23 | | 7.05 | 3.80 | 2.50 | 2.50 | 2.10 | 1.80 | 1.90 | 3.90 | 6.30 |
| 24 | | 6.65 | 3.80 | 2.50 | 2.50 | 2.10 | 1.80 | 1.90 | 3.60 | 6.30 |
| 25 | 10.00 | 6.20 | 3.80 | 2.50 | 2.50 | 2.00 | 1.80 | 1.90 | 3.40 | 6.50 |
| 26 | 9.25 | 5.85 | 3.70 | 2.70 | 2.40 | 2.00 | 1.90 | 1.90 | 3.40 | 7.10 |
| 27 | 8.10 | 5.70 | 3.60 | 2.60 | 2.40 | 2.00 | 1.90 | 1.90 | 3.30 | 6.90 |
| 28 | 7.35 | 5.65 | 3.50 | 2.60 | 2.40 | 2.30 | 1.80 | 1.80 | 3.20 | 6.40 |
| 29 | 7.30 | 5.35 | 3.30 | 2.90 | 2.40 | 2.20 | 1.90 | 1.90 | 3.10 | 5.80 |
| 30 | 7.55 | 5.10 | 3.20 | 3.20 | 2.40 | 3.50 | 2.10 | 1.90 | 3.10 | 5.00 |
| 31 | 7.45 | | 3.20 | | 2.30 | 3.20 | | 1.90 | | |

## WEST BRANCH OF SUSQUEHANNA RIVER AT ALLENWOOD, PENNSYLVANIA.

The West Branch of Susquehanna River rises in Cambria County, Pennsylvania, and flows in a general northeasterly direction, meeting the North Branch on the western border of Northumberland County and forming Susquehanna River.

Observations of height of water on the West Branch have been made by the Weather Bureau at Lockhaven, Pennsylvania, 47 miles above Allenwood. The drainage area is given as 3,740 square miles, and the width of river 1,125 feet. The gage is in two sections. The lower section is painted on the side wall of the canal lock, and the upper is on the highway bridge over the river. The elevation of the zero is 555.7 feet. The highest water was 18 feet, on June 1, 1889, and the danger line is at ten feet.

Below the junction of the North and West Branches of Susquehanna River observations have been made of height of water by the Weather Bureau at Selins Grove, 45 miles above Harrisburg. The drainage area is given as 17,600 square miles. The river at this point is about 1 mile wide, including an island 400 feet wide. The gage is on the west abutment of a railroad bridge.

A gaging station was established on the West Branch by E. G. Paul on March 25, 1899, at Allenwood, Pennsylvania, 20 miles above the junction with the North Branch. Measurements are made from the public highway bridge, one-fourth of a mile east of the railroad station at Allenwood. The wire gage is 42.15 feet from zero to the end of the weight, and is referred to a pine-board scale fastened to ironwork of the bridge and divided into feet and tenths. The initial point of soundings is at the end of the iron guard rail on the right bank. The channel is straight for one-half a mile above and below the station. The current is sluggish, but unobstructed. The banks are low and subject to overflow at time of high water. The bed of the stream is rocky and constant. The observer is Frank L. Allen, a farmer living 200 feet from the gage. The following measurements were made by E. G. Paul during 1899:

March 24, gage height, 4.90 feet; discharge, 32,031 second-feet.
June 8, gage height, 3.00 feet; discharge, 3,988 second-feet.
July 28, gage height, 2.05 feet; discharge, 1,360 second-feet.
September 15, gage height, 1.90 feet; discharge, 1,234 second-feet.
October 17, gage height, 1.70 feet; discharge, 842 second-feet.

*Daily gage height, in feet, of West Branch of Susquehanna River at Allenwood, Pennsylvania, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ........ | 6.70 | 3.80 | 3.50 | 2.90 | 2.00 | 2.70 | 2.00 | 2.20 | 2.90 |
| 2 | ........ | 6.30 | 3.80 | 3.50 | 2.70 | 2.00 | 2.70 | 2.00 | 3.60 | 2.80 |
| 3 | ........ | 5.80 | 3.80 | 3.40 | 2.50 | 2.00 | 2.70 | 1.90 | 4.20 | 2.70 |
| 4 | ........ | 5.35 | 3.90 | 3.40 | 2.50 | 1.80 | 2.50 | 1.90 | 5.20 | 2.70 |
| 5 | ........ | 5.05 | 3.80 | 3.30 | 2.40 | 1.70 | 2.40 | 1.90 | 4.60 | 2.70 |
| 6 | ........ | 4.90 | 3.60 | 3.20 | 2.40 | 1.70 | 2.30 | 1.90 | 4.00 | 2.60 |
| 7 | ........ | 4.80 | 3.50 | 3.00 | 2.30 | 1.70 | 2.10 | 1.90 | 3.40 | 2.60 |
| 8 | ........ | 6.45 | 3.30 | 3.00 | 2.40 | 1.70 | 2.00 | 1.90 | 3.20 | 2.60 |
| 9 | ........ | 7.80 | 3.40 | 2.90 | 2.20 | 1.70 | 2.00 | 1.90 | 3.00 | 2.60 |
| 10 | ........ | 7.40 | 3.50 | 2.90 | 2.00 | 1.70 | 2.00 | 1.80 | 3.00 | 2.60 |
| 11 | ........ | 6.60 | 3.60 | 2.70 | 2.10 | 1.70 | 1.90 | 1.80 | 3.00 | 2.60 |
| 12 | ........ | 6.20 | 3.70 | 2.60 | 2.30 | 1.70 | 1.90 | 1.80 | 3.20 | 5.30 |
| 13 | ........ | 6.50 | 3.50 | 2.60 | 2.20 | 1.90 | 1.90 | 1.70 | 3.30 | 8.40 |
| 14 | ........ | 7.00 | 3.40 | 2.60 | 2.20 | 1.90 | 1.90 | 1.70 | 3.40 | 7.40 |
| 15 | ........ | 6.90 | 3.30 | 2.50 | 2.30 | 1.90 | 1.90 | 1.70 | 3.50 | 6.50 |
| 16 | ........ | 6.80 | 3.20 | 2.50 | 2.20 | 1.90 | 1.90 | 1.70 | 3.60 | 5.80 |
| 17 | ........ | 6.40 | 3.40 | 2.50 | 2.30 | 1.90 | 1.90 | 1.70 | 3.80 | 5.10 |
| 18 | ........ | 5.60 | 3.80 | 2.40 | 2.40 | 1.90 | 1.90 | 1.70 | 3.90 | 4.90 |
| 19 | ........ | 5.40 | 7.40 | 2.40 | 2.60 | 1.80 | 1.90 | 1.70 | 4.10 | 4.80 |
| 20 | ........ | 5.00 | 6.50 | 2.40 | 2.80 | 1.70 | 1.90 | 1.70 | 4.30 | 4.70 |
| 21 | ........ | 4.80 | 5.75 | 2.40 | 3.00 | 1.70 | 1.90 | 1.60 | 4.10 | 4.30 |
| 22 | ........ | 4.70 | 5.15 | 2.30 | 2.70 | 1.70 | 1.90 | 1.60 | 4.00 | 4.20 |
| 23 | 4.90 | 4.50 | 4.70 | 2.20 | 2.50 | 1.70 | 1.90 | 1.60 | 3.90 | 4.20 |
| 24 | 4.90 | 4.40 | 4.35 | 2.20 | 2.30 | 1.60 | 1.90 | 1.60 | 3.80 | 5.15 |
| 25 | 4.60 | 4.30 | 4.00 | 2.80 | 2.20 | 1.60 | 1.90 | 1.60 | 3.70 | 7.25 |
| 26 | 4.20 | 4.30 | 3.80 | 2.50 | 2.20 | 1.60 | 1.90 | 1.60 | 3.60 | 5.60 |
| 27 | 4.30 | 4.30 | 3.60 | 2.60 | 2.10 | 1.70 | 2.00 | 1.60 | 3.40 | 5.00 |
| 28 | 6.20 | 4.20 | 3.50 | 2.70 | 2.00 | 3.70 | 2.00 | 1.60 | 3.30 | 4.50 |
| 29 | 6.70 | 4.30 | 3.40 | 2.70 | 1.90 | 3.00 | 2.00 | 1.60 | 3.20 | 4.10 |
| 30 | 7.80 | 4.10 | 3.40 | 2.80 | 1.80 | 2.60 | 2.00 | 1.60 | 3.10 | 3.60 |
| 31 | 7.35 | ........ | 3.50 | ........ | 2.00 | 2.60 | ........ | 1.60 | ........ | ........ |

## JUNIATA RIVER AT NEWPORT, PENNSYLVANIA.

Juniata River rises in Center County, Pennsylvania, and flows in a general southeasterly direction into Susquehanna River 15 miles above Harrisburg. Its drainage area is mountainous and for the most part covered with forest growth. The station was established at Newport, about 15 miles above its junction with the Susquehanna, on March 21, 1899, by E. G. Paul. It is at the covered wagon bridge, 800 feet east of the public square, Newport, Pennsylvania. The wire gage is 39.54 feet long from the end of the weight to the index. A scale board is nailed to the bridge timbers inside of the structure and is divided into feet and tenths. The initial point of soundings is at the end of the woodwork of the bridge on the right bank. The channel is straight for half a mile above and below the station. The current is swift and unobstructed. The banks are high and not subject to overflow. The bed of the stream is rocky and the section constant. The observer is A. R. Bortel, a laborer living in Newport, Pennsylvania, about 800 feet from the gage. The following measurements were made by E. G. Paul during 1899:

March 21, gage height, 6.60 feet; discharge, 13,094 second-feet.
June 9, gage height, 3.20 feet; discharge, 1,903 second-feet.
July 31, gage height, 2.90 feet; discharge, 682 second-feet.
September 14, gage height, 4.55 feet; discharge, 4,625 second-feet.
October 18, gage height, 2.90 feet; discharge, 829 second-feet.

*Daily gage height, in feet, of Juniata River at Newport, Pennsylvania, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ........ | 7.00 | 3.40 | 3.11 | 2.70 | 3.00 | 3.50 | 3.20 | 2.70 | 3.30 |
| 2 | ........ | 6.10 | 3.40 | 3.60 | 2.70 | 3.00 | 3.50 | 3.10 | 4.00 | 3.30 |
| 3 | ........ | 5.50 | 3.60 | 3.50 | 2.60 | 3.00 | 3.40 | 3.10 | 4.90 | 3.30 |
| 4 | ........ | 5.10 | 3.70 | 3.40 | 2.50 | 3.00 | 3.40 | 3.10 | 4.60 | 3.30 |
| 5 | ........ | 4.90 | 3.50 | 3.30 | 3.00 | 3.00 | 3.20 | 3.00 | 4.20 | 3.30 |
| 6 | ........ | 4.50 | 3.40 | 3.40 | 3.00 | 3.00 | 3.30 | 3.00 | 3.90 | 3.20 |
| 7 | ........ | 4.30 | 3.40 | 3.30 | 3.00 | 3.30 | 3.30 | 3.00 | 3.70 | 3.10 |
| 8 | ........ | 5.60 | 3.40 | 3.20 | 3.00 | 3.50 | 3.30 | 3.00 | 3.50 | 3.10 |
| 9 | ........ | 7.80 | 3.60 | 3.20 | 3.10 | 3.30 | 3.30 | 2.90 | 3.50 | 3.10 |
| 10 | ........ | 6.90 | 3.60 | 2.80 | 3.30 | 3.20 | 3.30 | 2.90 | 3.40 | 3.10 |
| 11 | ........ | 5.80 | 4.00 | 2.80 | 3.30 | 3.10 | 3.30 | 2.90 | 3.30 | 3.10 |
| 12 | ........ | 5.50 | 4.10 | 2.80 | 3.30 | 3.10 | 3.40 | 2.90 | 3.30 | 3.70 |
| 13 | ........ | 5.10 | 4.00 | 2.80 | 3.10 | 3.40 | 4.80 | 2.90 | 3.30 | 4.80 |
| 14 | ........ | 4.90 | 3.80 | 2.70 | 3.10 | 3.10 | 4.80 | 2.90 | 3.20 | 5.50 |
| 15 | ........ | 4.80 | 3.80 | 2.70 | 3.10 | 3.10 | 3.80 | 2.90 | 3.20 | 5.10 |
| 16 | ........ | 4.70 | 3.60 | 2.70 | 3.00 | 3.00 | 3.50 | 2.90 | 3.20 | 4.80 |
| 17 | ........ | 5.50 | 3.70 | 2.70 | 2.90 | 3.00 | 3.30 | 2.90 | 3.20 | 4.30 |
| 18 | ........ | 4.40 | 4.10 | 2.70 | 2.90 | 3.00 | 3.10 | 2.90 | 3.10 | 4.00 |
| 19 | ........ | 4.30 | 8.00 | 2.60 | 2.90 | 3.00 | 3.10 | 2.90 | 3.10 | 4.00 |
| 20 | ........ | 4.10 | 7.30 | 2.60 | 3.00 | 3.10 | 3.10 | 2.90 | 3.10 | 3.70 |
| 21 | 6.50 | 4.00 | 7.60 | 2.60 | 3.00 | 3.00 | 3.10 | 2.90 | 3.10 | 3.70 |
| 22 | 6.00 | 3.90 | 5.10 | 2.60 | 3.00 | 3.00 | 3.10 | 2.90 | 3.10 | 5.00 |
| 23 | 5.70 | 3.80 | 4.70 | 2.50 | 3.00 | 2.90 | 3.10 | 2.80 | 3.10 | 5.00 |
| 24 | 6.00 | 3.80 | 4.40 | 2.50 | 3.00 | 2.90 | 3.10 | 2.80 | 3.40 | 5.00 |
| 25 | 5.50 | 3.70 | 4.00 | 2.50 | 3.00 | 2.90 | 3.10 | 2.80 | 4.00 | 5.80 |
| 26 | 5.20 | 3.60 | 3.70 | 2.50 | 3.00 | 2.90 | 3.10 | 2.80 | 4.00 | 5.50 |
| 27 | 5.10 | 3.60 | 3.70 | 2.50 | 2.80 | 2.90 | 3.10 | 2.80 | 3.80 | 4.50 |
| 28 | 5.10 | 3.60 | 3.70 | 2.60 | 2.90 | 4.40 | 3.20 | 2.80 | 3.60 | 4.30 |
| 29 | 8.80 | 3.50 | 3.70 | 2.70 | 2.90 | 4.10 | 3.30 | 2.80 | 3.50 | 4.10 |
| 30 | 10.30 | 3.40 | 4.10 | 2.70 | 2.90 | 5.00 | 3.30 | 2.70 | 3.40 | 4.10 |
| 31 | 8.30 | ........ | 3.11 | ........ | 2.90 | 4.40 | ........ | 2.70 | ........ | 4.10 |

## SUSQUEHANNA RIVER AT HARRISBURG, PENNSYLVANIA.

Observations of the height of water in the Susquehanna River have been made for several years at the pump house of the waterworks located in the western part of the city of Harrisburg, Pennsylvania, this being about 55 miles below the junction of the north and west branches. A float is located in the pump well connected with the river, which indicates the height of water upon a painted scale. The datum is the low-water mark of 1804. Observations are made by the engineer, C. M. Nagle, each morning before starting the pumps. The record since 1890 has been furnished by E. Mather, president of the Harrisburg Water Company. Measurements of discharge are made from the open iron bridge on Second street. The initial point for soundings is the iron upright on the east end of the bridge. The stream is divided into two channels, with a large island between. The channel above and below the station is straight for about 2,500 feet, the banks high, and the current of moderate velocity. The first measurement was made on March 31, 1897. The results of measurement may be found as follows: 1897, Nineteenth Annual Report, Part IV, pages 122–127; 1898, Twentieth Annual Report, Part IV, page 109. The following measurements were made by E. G. Paul during 1899:

June 11, gage height, 1.75 feet; discharge, 11,746 second-feet.
July 29, gage height, 0.91 foot; discharge, 6,534 second-feet.
September 12, gage height, 0.75 foot; discharge, 5,404 second-feet.
October 25, gage height, 0.16 foot; discharge, 3,625 second-feet.

*Daily gage height, in feet, of Susquehanna River at Harrisburg, Pennsylvania, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.25 | 2.50 | 8.41 | 7.25 | 3.41 | 2.50 | 1.75 | 0.75 | 1.83 | 1.08 | 0.50 | 1.75 |
| 2 | 3.16 | 2.00 | 8.16 | 6.41 | 3.08 | 2.58 | 1.66 | .75 | 1.50 | .83 | 1.66 | 1.58 |
| 3 | 2.75 | 1.91 | 7.83 | 5.83 | 3.08 | 2.50 | 1.66 | .75 | 1.25 | .83 | 2.50 | 1.50 |
| 4 | 3.25 | 2.25 | 7.41 | 5.33 | 3.41 | 2.50 | 1.50 | .75 | 1.08 | .75 | 3.25 | 1.50 |
| 5 | 3.50 | 2.58 | 8.00 | 4.91 | 3.16 | 2.50 | 1.33 | .75 | 1.08 | .66 | 4.50 | 1.50 |
| 6 | 5.00 | 2.66 | 12.50 | 4.41 | 3.16 | 2.33 | 1.25 | .91 | 1.00 | .66 | 3.91 | 1.50 |
| 7 | 8.00 | 2.83 | 13.00 | 4.25 | 3.00 | 2.08 | 1.25 | .75 | .91 | .58 | 3.75 | 1.50 |
| 8 | 6.83 | 2.41 | 11.41 | 4.75 | 2.75 | 1.91 | 1.16 | .75 | .91 | .58 | 3.16 | 1.50 |
| 9 | 6.08 | 2.50 | 9.25 | 6.83 | 2.83 | 1.91 | 1.16 | .83 | .83 | .58 | 2.83 | 1.50 |
| 10 | 5.41 | 2.41 | 7.66 | 8.75 | 2.66 | 1.91 | 1.16 | .75 | 1.00 | .66 | 2.50 | 1.50 |
| 11 | 4.58 | 2.41 | 6.50 | 8.41 | 2.75 | 1.75 | 1.41 | .66 | 1.00 | .58 | 2.25 | 1.50 |
| 12 | 4.00 | 4.41 | 5.75 | 7.75 | 2.75 | 1.66 | 1.25 | .66 | .75 | .58 | 2.16 | 1.50 |
| 13 | 3.33 | 4.41 | 5.75 | 6.75 | 2.91 | 1.66 | 1.16 | 1.08 | .83 | .50 | 2.08 | 2.75 |
| 14 | 3.16 | 4.58 | 7.50 | 6.75 | 2.83 | 1.58 | 1.16 | 1.08 | 1.41 | .50 | 2.00 | 5.50 |
| 15 | 3.33 | 4.58 | 8.41 | 8.00 | 2.58 | 1.50 | 1.16 | 1.25 | 1.25 | .51 | 2.25 | 6.33 |
| 16 | 3.66 | 4.66 | 8.00 | 8.00 | 2.50 | 1.50 | 1.08 | .91 | .83 | .41 | 2.41 | 6.00 |
| 17 | 4.83 | 4.83 | 7.41 | 7.83 | 2.50 | 1.41 | 1.00 | .66 | .75 | .41 | 2.41 | 5.33 |
| 18 | 7.00 | 4.83 | 6.41 | 7.33 | 2.58 | 1.25 | 1.25 | .66 | .75 | .41 | 2.41 | 4.58 |
| 19 | 6.33 | 4.91 | 4.33 | 6.83 | 3.75 | 1.25 | 1.25 | .50 | .58 | .41 | 2.83 | 4.08 |
| 20 | 5.66 | 4.75 | 7.16 | 6.00 | 4.75 | 1.25 | 1.25 | .50 | .66 | .33 | 3.00 | 3.75 |
| 21 | 4.91 | 4.91 | 8.50 | 5.41 | 5.16 | 1.25 | 1.25 | .50 | .75 | .33 | 2.91 | 3.75 |
| 22 | 4.33 | 5.33 | 8.16 | 5.08 | 4.25 | 1.16 | 1.33 | .50 | .66 | .33 | 2.58 | 3.83 |
| 23 | 4.25 | 7.50 | 7.50 | 4.91 | 3.91 | 1.08 | 1.33 | .50 | .66 | .33 | 2.50 | 4.50 |
| 24 | 4.08 | 7.50 | 7.16 | 4.50 | 3.58 | 1.00 | 1.33 | .50 | .66 | .16 | 2.25 | 4.25 |
| 25 | 4.16 | 7.16 | 7.41 | 4.41 | 3.16 | 1.41 | 1.16 | .50 | .66 | .16 | 2.25 | 5.83 |
| 26 | 5.25 | 6.83 | 7.41 | 4.00 | 3.00 | 2.00 | 1.00 | .41 | .66 | .25 | 2.25 | 6.75 |
| 27 | 4.50 | 7.33 | 6.83 | 3.91 | 2.91 | 1.66 | 1.00 | .66 | 1.00 | .33 | 2.16 | 5.25 |
| 28 | 3.83 | 9.00 | 6.33 | 3.75 | 2.66 | 1.50 | 1.00 | 4.00 | 1.33 | .33 | 2.00 | 4.58 |
| 29 | 3.25 | ...... | 6.83 | 3.66 | 2.50 | 1.50 | .91 | 2.66 | 1.16 | .41 | 2.00 | 3.83 |
| 30 | 3.00 | ...... | 7.83 | 3.50 | 2.50 | 1.75 | .83 | 2.50 | 1.08 | .33 | 1.83 | 3.00 |
| 31 | 3.00 | ...... | 8.08 | ...... | 2.50 | ...... | .75 | 2.16 | ...... | .33 | ...... | 2.25 |

## OCTORARO CREEK AT ROWLANDSVILLE, MARYLAND.

This stream rises in Lancaster County, Pennsylvania, and flows in a southwesterly direction between Lancaster and Chester counties into Maryland, where it empties into the Susquehanna River about five miles below the State line. This station was established November 21, 1896, at the wagon bridge in the village of Rowlandsville, Maryland. The situation is not a good one for making measurements, owing to an eddy along the left bank and the proximity of the mouth of a small tributary, which would cause cross currents in time of high water. The channel is straight, the current swift, the banks high and not subject to overflow. The observations and most of the gagings have been made by Hugh W. Caldwell, of Rowlandsville, Maryland. The record having been continued long enough to have determined the general flow of the stream the station was abandoned September 30, 1899. The following measurements were made by Hugh W. Caldwell during 1899:

*Measurements of Octoraro Creek at Rowlandsville, Maryland.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec. feet.* | 1899. | *Feet.* | *Sec. feet.* |
| January 24 | 6.40 | 1,505 | June 28 | 3.50 | 185 |
| February 4 | 4.40 | 531 | June 29 | 4.00 | 387 |
| March 15 | 5.00 | 666 | July 15 | 3.50 | 219 |
| March 31 | 4.80 | 722 | July 28 | 3.40 | 186 |
| April 15 | 4.30 | 507 | August 7 | 3.50 | 171 |
| April 21 | 4.20 | 470 | August 11 | 5.20 | 1,044 |
| May 8 | 4.50 | 538 | August 19 | 3.40 | 144 |
| May 20 | 4.00 | 413 | August 28 | 3.60 | 206 |
| June 5 | 3.80 | 333 | September 25 | 5.60 | 1,113 |
| June 16 | 3.70 | 189 | | | |

*Daily gage height, in feet, of Octoraro Creek at Rowlandsville, Maryland, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.60 | 3.90 | 4.30 | 4.50 | 4.00 | 3.80 | 3.50 | 3.35 | 3.50 |
| 2 | 4.80 | 4.00 | 4.45 | 4.40 | 4.00 | 3.80 | 3.40 | 3.30 | 3.45 |
| 3 | 4.95 | 4.00 | 4.50 | 4.20 | 4.00 | 3.80 | 3.40 | 3.25 | 3.40 |
| 4 | 4.80 | 4.30 | 4.80 | 4.10 | 4.00 | 3.70 | 3.40 | 3.30 | 3.30 |
| 5 | 4.95 | 4.40 | 7.45 | 4.00 | 4.00 | 3.70 | 3.55 | 3.30 | 3.20 |
| 6 | 5.45 | 4.40 | 6.70 | 3.90 | 4.00 | 3.70 | 3.90 | 3.30 | 3.15 |
| 7 | 5.55 | 4.30 | 5.75 | 5.30 | 4.00 | 3.60 | 3.60 | 3.55 | 3.20 |
| 8 | 4.80 | 4.10 | 5.15 | 5.05 | 4.35 | 3.75 | 3.85 | 3.40 | 3.20 |
| 9 | 4.55 | 4.00 | 4.50 | 4.85 | 4.35 | 3.75 | 3.85 | 3.35 | 3.40 |
| 10 | 4.50 | 3.90 | 4.05 | 4.75 | 4.05 | 3.90 | 3.55 | 5.30 | 3.40 |
| 11 | 4.50 | 3.85 | 3.80 | 4.65 | 4.20 | 3.75 | 3.50 | 3.55 | 3.45 |
| 12 | 4.30 | 4.20 | 3.75 | 4.30 | 4.25 | 3.70 | 3.45 | 3.45 | 3.70 |
| 13 | 4.75 | 4.85 | 6.30 | 4.30 | 4.05 | 3.70 | 3.45 | 3.45 | 3.50 |
| 14 | 4.40 | 5.00 | 4.60 | 4.30 | 4.15 | 3.70 | 3.45 | 3.40 | 3.40 |
| 15 | 4.30 | 4.70 | 5.15 | 4.30 | 4.00 | 3.70 | 3.50 | 3.40 | 3.40 |
| 16 | 4.25 | 4.65 | 4.70 | 4.20 | 4.05 | 3.70 | 3.50 | 3.40 | 3.30 |
| 17 | 4.15 | 7.20 | 4.40 | 4.25 | 4.00 | 3.65 | 3.40 | 3.40 | 3.30 |
| 18 | 4.00 | 6.90 | 4.30 | 4.20 | 4.25 | 3.60 | 3.55 | 3.40 | 3.30 |
| 19 | 3.90 | 6.80 | 4.25 | 4.20 | 4.05 | 3.60 | 3.45 | 3.40 | 3.35 |
| 20 | 3.85 | 6.45 | 4.20 | 4.20 | 4.00 | 3.60 | 3.40 | 3.30 | 3.85 |
| 21 | 3.70 | 6.15 | 4.05 | 4.20 | 4.00 | 3.65 | 3.35 | 3.25 | 3.70 |
| 22 | 3.70 | 5.75 | 4.00 | 4.20 | 3.95 | 3.60 | 3.35 | 3.40 | 3.60 |
| 23 | 3.60 | 5.50 | 4.00 | 4.20 | 3.90 | 3.50 | 3.30 | 3.35 | 3.35 |
| 24 | 6.30 | 5.25 | 3.90 | 4.10 | 3.90 | 3.50 | 3.35 | 3.30 | 3.30 |
| 25 | 6.10 | 5.05 | 5.20 | 4.10 | 3.85 | 3.65 | 3.30 | 3.30 | 3.50 |
| 26 | 5.60 | 5.55 | 4.70 | 4.10 | 3.80 | 3.65 | 3.65 | 3.30 | 6.30 |
| 27 | 4.90 | 5.05 | 4.50 | 4.00 | 3.80 | 3.50 | 3.65 | 3.50 | 4.95 |
| 28 | 4.45 | 4.55 | 6.95 | 4.00 | 3.80 | 3.50 | 3.40 | 3.55 | 4.65 |
| 29 | 4.25 | | 5.60 | 4.00 | 3.80 | 3.80 | 3.40 | 3.50 | 4.00 |
| 30 | 4.10 | | 5.00 | 4.00 | 3.85 | 3.60 | 3.40 | 3.50 | 4.15 |
| 31 | 4.05 | | 4.80 | | 3.80 | | 3.40 | 3.50 | |

Discontinued September 30, 1899.

## PATAPSCO RIVER AT WOODSTOCK, MARYLAND.

This river rises in the north-central part of Maryland, flows in a southeasterly direction between Baltimore and Howard counties, and empties into Chesapeake Bay. Its watershed is a hilly country largely under cultivation. A station was established at Woodstock August 6, 1896, by E. G. Paul. The drainage area is 251 square miles and is partly shown on the Ellicott and Frederick sheets of the topographic atlas. Measurements are made from the county bridge on the road from Woodstock to Granite, Maryland, 1½ miles below the junction with the North Branch, as shown on the Ellicott atlas sheet. The scale is a board graduated to feet and tenths with small nails, and fastened to the floor timber of the bridge. The bench mark is a United States Geological Survey standard copper bolt, set in the face of the retaining wall of the entrance to the college grounds at the north end of the bridge. It is 22.06 feet above gage datum. The bridge was repaired on January 20–25, 1899, and the gage destroyed. A new gage was established on January 30, 1899, and referred to the same bench mark. The channel is rough and rocky. The banks are high and not subject to overflow. At a time of extreme high water the channel is liable to changes. The observer is David Donovan, a storekeeper at Woodstock, Maryland. The three following measurements were made by E. G. Paul during 1899: January 30, gage height 4.30 feet, discharge 431 second-feet; May 22, gage height 4.20 feet, discharge 400 second-feet; September 6, gage height 3.60 feet, discharge 129 second-feet.

*Daily gage height, in feet, of Patapsco River at Woodstock, Maryland, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | (*a*) | 3.80 | 4.85 | 4.65 | 4.20 | 3.95 | 3.75 | 3.65 | 3.60 | 3.55 | 3.60 | 3.70 |
| 2 | (*a*) | 5.10 | 4.90 | 4.50 | 4.15 | 4.15 | 3.60 | 4.30 | 3.70 | 3.55 | 3.75 | 3.60 |
| 3 | (*a*) | 5.00 | 4.70 | 4.45 | 4.20 | 3.95 | 3.70 | 4.10 | 3.80 | 3.55 | 3.70 | 3.20 |
| 4 | (*a*) | 4.90 | 4.75 | 4.35 | 4.30 | 3.95 | 3.75 | 3.85 | 3.65 | 3.40 | 3.60 | 3.60 |
| 5 | (*a*) | 4.90 | 8.50 | 4.40 | 4.15 | 3.95 | 4.25 | 3.85 | 3.60 | 3.60 | 3.70 | 3.60 |
| 6 | (*a*) | 5.20 | 6.70 | 4.30 | 4.25 | 3.95 | 4.00 | 3.85 | 3.45 | 3.80 | 3.60 | 3.65 |
| 7 | (*a*) | 5.35 | 5.20 | 4.60 | 4.25 | 3.80 | 3.90 | 3.90 | 3.40 | 3.75 | 3.70 | 3.55 |
| 8 | (*a*) | Ice. | 4.90 | 5.90 | 4.35 | 3.85 | 3.90 | 3.75 | 3.75 | 3.60 | 3.70 | 3.60 |
| 9 | (*a*) | Ice. | 4.70 | 4.65 | 4.45 | 3.95 | 3.90 | 3.75 | 3.45 | 3.70 | 3.70 | 3.65 |
| 10 | (*a*) | Ice. | 4.70 | 4.65 | 4.25 | 4.20 | 3.95 | 3.70 | 3.70 | 3.70 | 3.70 | 3.75 |
| 11 | (*a*) | Ice. | 4.75 | 4.45 | 4.15 | 4.20 | 3.75 | 3.55 | 3.55 | 3.65 | 3.70 | 3.75 |
| 12 | (*a*) | Ice. | 4.75 | 4.50 | 4.35 | 4.15 | 3.65 | 3.60 | 3.55 | 3.55 | 3.50 | 4.05 |
| 13 | (*a*) | Ice. | 4.65 | 4.20 | 4.25 | 4.10 | 3.80 | 3.65 | 3.55 | 3.45 | 3.50 | 3.90 |
| 14 | (*a*) | Ice. | 4.55 | 4.35 | 4.25 | 4.05 | 4.05 | 3.85 | 3.50 | 3.50 | 3.75 | 3.80 |
| 15 | (*a*) | Ice. | 4.85 | 4.40 | 4.20 | 3.95 | 3.80 | 3.35 | 3.50 | 3.70 | 3.65 | 3.65 |
| 16 | (*a*) | Ice. | 4.80 | 4.45 | 4.15 | 4.00 | 3.80 | 3.80 | 3.45 | 3.65 | 3.60 | 3.60 |
| 17 | (*a*) | Ice. | 4.60 | 4.45 | 4.25 | 4.10 | 4.15 | 3.65 | 3.35 | 3.65 | 3.70 | 3.30 |
| 18 | (*a*) | Ice. | 4.75 | 4.40 | 4.85 | 4.00 | 4.15 | 3.75 | 3.45 | 3.65 | 3.70 | 3.85 |
| 19 | (*a*) | Ice. | 5.30 | 4.30 | 4.50 | 3.95 | 3.95 | 3.65 | 3.45 | 3.60 | 3.60 | 3.95 |
| 20 | (*a*) | Ice. | 4.85 | 4.30 | 4.25 | 3.75 | 3.80 | 3.65 | 3.35 | 3.70 | 3.80 | 3.95 |
| 21 | (*a*) | 6.20 | 4.70 | 4.30 | 4.20 | 3.85 | 3.75 | 3.65 | 4.00 | 3.55 | 3.75 | 3.85 |
| 22 | (*a*) | 5.75 | 5.00 | 4.30 | 4.20 | 4.00 | 3.75 | 3.60 | 3.45 | 3.40 | 3.75 | 3.80 |
| 23 | (*a*) | 5.40 | 4.90 | 4.25 | 4.25 | 3.85 | 3.70 | 3.55 | 3.40 | 3.40 | 3.70 | 3.20 |
| 24 | (*a*) | 4.95 | 4.50 | 4.25 | 4.20 | 3.80 | 3.90 | 3.50 | 3.45 | 3.55 | 3.65 | 3.30 |
| 25 | (*a*) | 5,15 | 4.40 | 4.30 | 4.10 | 3.80 | 3.85 | 3.50 | 3.55 | 3.55 | 3.70 | 4.40 |
| 26 | (*a*) | 4.80 | 4.40 | 4.25 | 4.05 | 3.85 | 3.90 | 3.60 | 5.90 | 3.60 | 3.70 | 3.95 |
| 27 | (*a*) | 6.15 | 4.40 | 4.30 | 4.00 | 4.00 | 3.85 | 3.65 | 4.25 | 3.65 | 3.65 | 3.80 |
| 28 | (*a*) | 5.05 | 5.30 | 4.25 | 4.10 | 3.85 | 3.75 | 3.90 | 4.00 | 3.60 | 3.75 | 3.85 |
| 29 | (*a*) | ....... | 4.85 | 4.20 | 4.00 | 3.75 | 3.75 | 3.90 | 3.60 | 3.25 | 3.70 | 4.15 |
| 30 | 4.30 | ....... | 4.75 | 4.20 | 4.00 | 3.85 | 3.50 | 3.55 | 3.55 | 3.60 | 3.70 | 4.60 |
| 31 | 3.90 | ....... | 4.65 | ....... | 4.00 | ....... | 3.80 | 3.65 | ....... | 3.60 | ....... | ....... |

*a* Gage out; no readings.

## NORTH BRANCH OF POTOMAC RIVER AT PIEDMONT, WEST VIRGINIA.

This stream rises in the western part of West Virginia and flows in a northeasterly direction, forming the boundary between Maryland and West Virginia. At a point about 15 miles below Cumberland it is joined by the South Branch, forming the Potomac River. The drainage area is mapped on Piedmont, St. George, Accident, Grantsville, and Frostburg atlas sheets. Systematic measurements of discharge have been made at Piedmont, West Virginia. This station, established June 27, 1899, by E. G. Paul, is located at the iron highway bridge connecting Luke, Maryland, with Piedmont, West Virginia. The wire gage is 38.87 feet from index to end of weight, and is referred to a scale board 14 feet long, attached to the bridge 90 feet from the first pier, and is divided into feet and tenths. The channel is straight for an eighth of a mile above and below the station. The current is swift and unobstructed. The right bank is high and rocky, but the left bank is low and liable to overflow. The bed of the stream is rocky and permanent in section. The observer is Charles W. Beck, a bookkeeper at Piedmont, West Virginia. A measurement was made by E. G. Paul on June 27, 1899, at a gage height of 3.00 feet, when the discharge was 350 second-feet.

*Daily gage height, in feet, of North Branch of Potomac River at Piedmont, West Virginia, for 1899.*

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | | 3.15 | 2.50 | 2.20 | 2.20 | 3.75 | 2.60 |
| 2 | | 2.90 | 2.35 | 2.20 | 2.20 | 3.90 | 2.60 |
| 3 | | 2.80 | 2.25 | 2.10 | 2.15 | 3.05 | 2.60 |
| 4 | | 2.70 | 2.40 | 2.00 | 2.10 | 2.80 | 2.55 |
| 5 | | 2.65 | 2.40 | 2.30 | 2.10 | 2.70 | 2.50 |
| 6 | | 2.70 | 2.40 | 2.20 | 2.10 | 2.55 | 2.40 |
| 7 | | 2.80 | 2.55 | 2.15 | 2.20 | 2.50 | 2.40 |
| 8 | | 2.70 | 2.30 | 2.10 | 2.10 | 2.40 | 2.40 |
| 9 | | 2.70 | 2.30 | 2.20 | 2.15 | 2.40 | 2.35 |
| 10 | | 2.70 | 2.25 | 2.30 | 2.10 | 2.40 | 2.40 |
| 11 | | 2.65 | 2.10 | 2.95 | 2.10 | 2.40 | 2.50 |
| 12 | | 2.50 | 2.15 | 3.40 | 2.20 | 2.40 | 5.20 |
| 13 | | 2.40 | 2.10 | 2.75 | 2.10 | 2.30 | 4.60 |
| 14 | | 2.85 | 2.10 | 2.45 | 2.10 | 2.30 | 3.75 |
| 15 | | 2.85 | 2.10 | 2.35 | 2.00 | 2.30 | 3.60 |
| 16 | | 2.50 | 2.00 | 2.30 | 2.20 | 2.30 | 3.35 |
| 17 | | 2.70 | 2.00 | 2.30 | 2.10 | 2.30 | 3.05 |
| 18 | | 2.90 | 2.00 | 2.15 | 2.10 | 2.20 | 3.15 |
| 19 | | 2.65 | 2.00 | 2.10 | 2.10 | 2.40 | 3.20 |
| 20 | | 2.50 | 2.00 | 2.45 | 2.10 | 3.35 | 3.70 |
| 21 | | 2.35 | 2.00 | 2.90 | 2.10 | 3.00 | 3.30 |
| 22 | | | 1.95 | 2.65 | 2.00 | 2.80 | 3.20 |
| 23 | | 2.30 | 1.90 | 2.40 | 2.00 | 2.85 | 3.10 |
| 24 | | 2.30 | 1.90 | 2.40 | 2.10 | 3.30 | 3.00 |
| 25 | | 2.30 | 1.90 | 2.25 | 2.10 | 3.20 | 3.00 |
| 26 | | 2.20 | 1.90 | 2.20 | 2.10 | 3.00 | 2.90 |
| 27 | 3.00 | 2.15 | 2.10 | 2.30 | 2.10 | 2.80 | 2.80 |
| 28 | 2.90 | 2.50 | 3.00 | 2.55 | 2,10 | 2.80 | 2.80 |
| 29 | 3.85 | 2.35 | 2.90 | 2.40 | 2.20 | 2.70 | 2.80 |
| 30 | 3.50 | 2.30 | 2.55 | 2.25 | 2.15 | 2.60 | 2.80 |
| 31 | | 2.45 | 2.35 | | 2.15 | | 2.70 |

## SOUTH BRANCH OF POTOMAC RIVER AT SPRINGFIELD, WEST VIRGINIA.

This stream rises in Highland County, West Virginia, and flows in a northeasterly direction, joining the North Branch of Potomac River about 15 miles below Cumberland, Maryland, forming Potomac River. The drainage area of the South Branch consists of long, narrow, mountain valleys, sparsely settled and little cultivated, being for the greater part covered with timber. The region being free from manufacturing industries and mining operations, no pollution of the waters occurs. The drainage area is mapped on the following atlas sheets: Romney, Piedmont, Beverly, Franklin, Woodstock, Staunton, and Monterey. A gaging station was established at the railroad bridge, 2 miles south of Springfield, West Virginia, in April, 1894, by Cyrus C. Babb, but was discontinued in 1896 for want of an observer. The present station, established June 26, 1899, by E. G. Paul, is located on the iron highway bridge, one-fourth of a mile from Graces Station and 1 mile from Springfield. The wire gage is 39.4 feet from the zero to the extreme end of the weight, and is referred to a scale graduated to feet and tenths, on the guard rail on the upper side of the bridge 80 feet from the abutment on the left bank. The channel of the stream at this point is curved and the current too sluggish to make satisfactory discharge measurements, and they are, therefore, made from the railroad bridge over the stream 1 mile above. The observer is John E. Grace, of Springfield, West Virginia. A measurement was made by E. G. Paul, June 26, 1899, at a gage height of 4.00 feet, when the discharge was 617 second-feet.

*Daily gage height, in feet, of South Branch of Potomac River at Springfield, West Virginia, for 1899.*

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | | 3.20 | 3.40 | 3.40 | 3.40 | 4.60 | 4.60 |
| 2 | | 3.70 | 3.60 | 3.40 | 3.40 | 4.80 | 4.10 |
| 3 | | 3.70 | 3.50 | 3.50 | 3.40 | 4.80 | 4.00 |
| 4 | | 3.70 | 3.40 | 3.60 | 3.30 | 4.80 | 4.00 |
| 5 | | 3.60 | 3.20 | 3.60 | 3.30 | 4.60 | 3.80 |
| 6 | | 3.60 | 3.20 | 3.60 | 3.20 | 4.60 | 3.70 |
| 7 | | 3.60 | 3.20 | 3.50 | 3.20 | 4.50 | 3.70 |
| 8 | | 3.70 | 3.20 | 3.50 | 3.20 | 4.40 | 3.50 |
| 9 | | 4.20 | 3.10 | 3.50 | 3.20 | 4.20 | 3.40 |
| 10 | | 3.90 | 3.10 | 3.50 | 3.20 | 4.10 | 3.80 |
| 11 | | 3.80 | 3.10 | 3.40 | 3.10 | 4.10 | 4.00 |
| 12 | | 3.60 | 3.00 | 3.40 | 3.10 | 4.00 | 5.80 |
| 13 | | 3.40 | 3.00 | 3.40 | 3.10 | 4.00 | 5.60 |
| 14 | | 3.20 | 3.10 | 3.40 | 3.20 | 4.00 | 5.60 |
| 15 | | 3.10 | 3.20 | 3.50 | 3.20 | 3.90 | 5.40 |
| 16 | | 3.00 | 3.20 | 3.50 | 3.20 | 3.80 | 5.60 |
| 17 | | 2.90 | 3.10 | 3.50 | 3.20 | 3.70 | 5.60 |
| 18 | | 3.00 | 3.10 | 3.40 | 3.20 | 3.60 | 5.50 |
| 19 | | 3.40 | 3.00 | 3.40 | 3.10 | 3.60 | 5.50 |
| 20 | | 3.20 | 3.00 | 3.40 | 3.10 | 3.90 | 5.40 |
| 21 | | 3.20 | 3.10 | 3.30 | 3.10 | 4.90 | 5.40 |
| 22 | | 3.20 | 3.20 | 3.30 | 3.10 | 5.90 | 5.40 |
| 23 | | 3.40 | 3.20 | 3.20 | 3.00 | 5.80 | 5.00 |
| 24 | | 3.50 | 3.30 | 3.10 | 3.00 | 5.60 | 4.00 |
| 25 | | 3.50 | 3.30 | 3.10 | 3.20 | 5.60 | Ice. |
| 26 | 4.00 | 3.40 | 3.20 | 3.00 | 3.40 | 5.40 | Ice. |
| 27 | 4.20 | 3.40 | 3.20 | 3.00 | 3.50 | 5.20 | Ice. |
| 28 | 3.90 | 3.20 | 3.10 | 3.20 | 3.50 | 4.80 | Ice. |
| 29 | 4.10 | 3.20 | 3.10 | 3.30 | 3.80 | 4.70 | Ice. |
| 30 | 3.40 | 3.20 | 3.20 | 3.40 | 4.20 | 4.60 | Ice. |
| 31 | | 3.20 | 3.20 | | 4.40 | | Ice. |

## ANTIETAM CREEK AT SHARPSBURG, MARYLAND.

This stream rises in the western part of Maryland and flows in a southerly direction, entering the Potomac 10 miles above Harpers Ferry. Its drainage area is mostly of a hilly character and largely cultivated. A station was established at Myers Mill, 1 mile east of Sharpsburg, Maryland, on the road to Keedysville, Maryland, on June 24, 1897, by Arthur P. Davis. The measurements are made from a three-fourths inch iron cable with 85-foot span, supported by large trees on either side of the stream. The gage is a post driven into the gravel of the stream bed and bolted to an overhanging tree. The initial point for soundings is on the left bank. The channel both above and below the station is straight for 300 feet. The right bank is low and liable to overflow. The left bank is high and rocky. The current is of moderate velocity and the flow unobstructed. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 149; 1898, Twentieth Annual Report, Part IV, page 122. The following measurements were made by E. G. Paul during 1899: January 27, gage height 2.80 feet, discharge 495 second-feet; May 20, gage height 2.60 feet, discharge 418 second-feet; September 5, gage height 1.80 feet, discharge 118 second-feet.

*Daily gage height, in feet, of Antietam Creek at Sharpsburg, Maryland, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.80 | 2.70 | 4.75 | 3.40 | 2.40 | 2.40 | 2.10 | 1.70 | 1.80 | 1.80 | 2.40 | 1.60 |
| 2 | 2.70 | 2.60 | 4.20 | 3.30 | 2.45 | 3.75 | 1.90 | 1.60 | 1.80 | 1.80 | 2.25 | 1.60 |
| 3 | 2.60 | 2.60 | 4.10 | 3.20 | 2.90 | 2.60 | 2.00 | 2.55 | 1.70 | 1.70 | 2.00 | 1.60 |
| 4 | 2.70 | 2.60 | 3.85 | 3.20 | 2.50 | 2.60 | 1.85 | 1.90 | 2.00 | 1.60 | 1.80 | 1.50 |
| 5 | 3.00 | 2.80 | 4.80 | 3.10 | 2.50 | 2.40 | 1.90 | 1.80 | 1.80 | 1.60 | 1.80 | 1.60 |
| 6 | 3.40 | 2.80 | 4.40 | 3.00 | 2.50 | 2.40 | 1.80 | 1.70 | 1.80 | 1.50 | 1.90 | 1.50 |
| 7 | 3.55 | 2.50 | 4.05 | 2.90 | 2.40 | 2.30 | 2.00 | 1.90 | 1.70 | 1.50 | 1.80 | 1.50 |
| 8 | 3.20 | 2.40 | 3.90 | 3.25 | 2.55 | 2.30 | 1.90 | 1.70 | 1.70 | 1.50 | 1.50 | 1.60 |
| 9 | 3.00 | 2.60 | 3.60 | 3.10 | 2.70 | 2.45 | 1.90 | 1.70 | 1.85 | 1.70 | 1.60 | 1.60 |
| 10 | 3.00 | 2.80 | 3.50 | 3.00 | 2.55 | 2.70 | 2.00 | 1.80 | 1.60 | 1.60 | 1.70 | 1.50 |
| 11 | 2.90 | 2.60 | 3.50 | 2.90 | 2.50 | 2.65 | 1.90 | 1.80 | 2.30 | 1.50 | 1.60 | 1.50 |
| 12 | 2.80 | 2.80 | 3.40 | 2.80 | 2.50 | 2.40 | 1.80 | 2.35 | 2.10 | 1.50 | 1.70 | 1.60 |
| 13 | 2.90 | 2.80 | 3.30 | 2.80 | 2.50 | 2.40 | 2.15 | 1.90 | 1.85 | 1.50 | 1.70 | 1.60 |
| 14 | 3.00 | 2.80 | 3.20 | 2.80 | 2.40 | 2.35 | 2.00 | 2.00 | 1.80 | 1.50 | 1.60 | 1.70 |
| 15 | 3.00 | 2.90 | 3.20 | 2.80 | 2.30 | 2.30 | 1.90 | 1.90 | 1.70 | 1.40 | 1.60 | 1.80 |
| 16 | 3.00 | 2.90 | 3.50 | 2.80 | 2.40 | 2.30 | 1.85 | 1.80 | 1.60 | 1.80 | 1.60 | 1.80 |
| 17 | 3.00 | 2.80 | 3.20 | 2.70 | 2.20 | 2.30 | 1.95 | 1.90 | 1.60 | 1.70 | 1.80 | 1.70 |
| 18 | 3.00 | 2.90 | 3.20 | 2.70 | 3.15 | 2.20 | 1.80 | 1.80 | 1.70 | 1.60 | 1.70 | 1.70 |
| 19 | 2.90 | 2.90 | 3.70 | 2.70 | 2.80 | 2.25 | 1.85 | 1.80 | 2.00 | 1.60 | 1.70 | 1.60 |
| 20 | 2.80 | 2.80 | 3.75 | 2.60 | 2.60 | 2.20 | 1.80 | 1.60 | 1.90 | 1.60 | 1.70 | 1.60 |
| 21 | 2.80 | 3.20 | 3.40 | 2.60 | 2.50 | 2.20 | 1.80 | 1.80 | 1.90 | 1.60 | 1.70 | 1.70 |
| 22 | 2.80 | 4.30 | 3.40 | 2.60 | 2.50 | 2.10 | 1.80 | 1.70 | 1.80 | 1.60 | 1.80 | 1.60 |
| 23 | 2.80 | 4.10 | 3.50 | 2.50 | 2.50 | 2.00 | 2.05 | 1.80 | 1.80 | 1.70 | 1.80 | 1.60 |
| 24 | 2.80 | 3.70 | 3.40 | 2.40 | 2.40 | 2.10 | 1.90 | 1.70 | 1.70 | 1.60 | 1.70 | 1.85 |
| 25 | 3.25 | 3.50 | 3.30 | 2.50 | 2.30 | 2.05 | 1.70 | 1.65 | 1.90 | 1.60 | 1.60 | 2.65 |
| 26 | 2.90 | 4.50 | 3.20 | 2.45 | 2.30 | 2.20 | 1.75 | 1.70 | 1.90 | 1.50 | 1.60 | 1.90 |
| 27 | 2.90 | 5.40 | 3.00 | 2.50 | 2.30 | 2.10 | 1.70 | 3.45 | 1.80 | 1.50 | 1.70 | 2.00 |
| 28 | 2.80 | 5.15 | 3.50 | 2.50 | 2.30 | 2.15 | 1.60 | 2.80 | 1.80 | 1.50 | 1.60 | 1.90 |
| 29 | 2.80 | ....... | 3.90 | 2.50 | 2.20 | 2.10 | 1.60 | 2.30 | 1.90 | 1.50 | 1.70 | 1.80 |
| 30 | 2.70 | ....... | 3.70 | 2.40 | 2.45 | 2.20 | 1.60 | 2.00 | 1.90 | 1.60 | 1.70 | 1.60 |
| 31 | 2.70 | ....... | 3.50 | ....... | 2.40 | ....... | 1.80 | 1.90 | ....... | 1.60 | ....... | ....... |

## NORTH AND SOUTH RIVERS AT PORT REPUBLIC, VIRGINIA.

North and South rivers rise in Rockbridge County, Virginia, and flow in a southeasterly direction, joining at Port Republic to form the

South Fork of the Shenandoah River. The drainage areas of these two rivers are entirely mapped on Franklin, Harrisonburg, Staunton, Buckingham, and Lexington sheets. Systematic measurements are made on the North and South rivers at Port Republic. These stations, described in the Eighteenth Annual Report, Part IV, page 25, were established in August, 1895, by D. C. Humphreys.

The gage for the North River is located on the county highway bridge at Port Republic, Virginia, 500 feet above the mouth of South River. A painted rod is fastened to the third panel of the first span on the lower side of the bridge. It is nailed to the wooden uprights and fastened by wire to the diagonals. Bench mark No. 1, the lower end of the third floor beam from the right bank, is 24.97 feet above zero of the gage. Bench mark No. 2, the bridge seat on lower end of right bank abutment, is 24.60 feet above the datum of the gage.

The gage for South River is located on the county iron bridge just east of the town, 300 feet above the mouth of North River. The graduations of the rod are marked by tacks driven into the rail on the upper side of the bridge at the fourth panel, the zero being 1 foot from the edge of the pulley. Bench mark No. 1, the top of the third floor beam from right bank upper side of bridge, is 22.52 feet above gage datum. The zero of North River gage is 2.56 feet below the zero of South River gage. All gagings of South River include the discharge of mill race. The observer at both gages is T. S. Davis, storekeeper, Port Republic, Virginia. In September, 1898, a new bridge was built to replace the old one, and the stations were soon afterwards abandoned (April 1, 1899), as measurements were made lower down, at Front Royal. Records of measurements may be found as follows: 1895–96, Eighteenth Annual Report, Part IV, pages 25, 26. One measurement was made at each station by E. G. Paul in 1899, as follows: North River, March 11, gage height, 4.80 feet; discharge, 3,423 second-feet. South River, March 11, gage height, 3.70 feet; discharge, 1,592 second-feet.

*Daily gage height, in feet, of North River at Port Republic, Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | Day. | Jan. | Feb. | Mar. | Apr. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.75 | 2.30 | 7.10 | *a*3.00 | 17 | 2.70 | 3.00 | 4.00 | |
| 2 | 2.75 | 2.30 | 5.50 | | 18 | 2.70 | 3.00 | 3.70 | |
| 3 | 2.70 | 2.30 | 5.00 | | 19 | 2.60 | 3.40 | 4.00 | |
| 4 | 2.65 | 2.30 | 7.40 | | 20 | 2.60 | 4.00 | 4.30 | |
| 5 | 2.65 | 2.30 | 14.00 | | 21 | 2.60 | 5.50 | 3.90 | |
| 6 | 5.40 | 2.30 | 8.90 | | 22 | 2.60 | 7.00 | 3.60 | |
| 7 | 6.70 | 2.30 | 7.50 | | 23 | 2.60 | 7.60 | 3.40 | |
| 8 | 5.00 | 2.40 | 5.80 | | 24 | 2.60 | 6.00 | 3.20 | |
| 9 | 4.00 | 2.40 | 4.80 | | 25 | 2.60 | 4.90 | 3.10 | |
| 10 | 3.60 | 2.50 | 5.30 | | 26 | 2.60 | 4.90 | 3.10 | |
| 11 | 3.40 | 2.50 | 4.80 | | 27 | 2.60 | 6.00 | 3.00 | |
| 12 | 3.20 | 2.50 | 4.60 | | 28 | 2.60 | 9.00 | 3.00 | |
| 13 | 3.00 | 2.50 | 4.00 | | 29 | 2.50 | | 3.00 | |
| 14 | 2.90 | 2.70 | 3.80 | | 30 | 2.50 | | 3.00 | |
| 15 | 2.80 | 2.80 | 4.50 | | 31 | 2.40 | | 3.00 | |
| 16 | 2.80 | 3.00 | 4.20 | | | | | | |

*a* Discontinued April 1.

*Daily gage height, in feet, of South River at Port Republic, Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | Day. | Jan. | Feb. | Mar. | Apr. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.50 | 2.10 | 4.00 | a 2.50 | 17 | 2.50 | 2.60 | 3.20 | |
| 2 | 2.50 | 2.10 | 3.60 | | 18 | 2.40 | 2.60 | 2.90 | |
| 3 | 2.40 | 2.10 | 3.50 | | 19 | 2.20 | 2.80 | 3.20 | |
| 4 | 2.30 | 2.10 | 5.10 | | 20 | 2.20 | 3.00 | 2.70 | |
| 5 | 2.30 | 2.10 | 12.00 | | 21 | 2.20 | 3.50 | 3.50 | |
| 6 | 3.40 | 2.10 | 6.70 | | 22 | 2.20 | 5.00 | 3.20 | |
| 7 | 5.00 | 2.10 | 5.50 | | 23 | 2.20 | 5.60 | 3.10 | |
| 8 | 3.80 | 2.20 | 4.00 | | 24 | 2.20 | 4.10 | 2.90 | |
| 9 | 3.60 | 2.20 | 3.60 | | 25 | 2.20 | 3.50 | 2.80 | |
| 10 | 3.00 | 2.30 | 3.90 | | 26 | 2.20 | 4.40 | 2.80 | |
| 11 | 2.90 | 2.30 | 3.70 | | 27 | 2.20 | 6.50 | 2.80 | |
| 12 | 2.75 | 2.30 | 3.60 | | 28 | 2.20 | 5.30 | 2.70 | |
| 13 | 2.60 | 2.30 | 3.40 | | 29 | 2.20 | | 2.70 | |
| 14 | 2.60 | 2.40 | 3.30 | | 30 | 2.20 | | 2.60 | |
| 15 | 2.60 | 2.50 | 3.40 | | 31 | 2.10 | | 2.50 | |
| 16 | 2.60 | 2.60 | 3.30 | | | | | | |

*a* Discontinued April 1.

## NORTH BRANCH OF SHENANDOAH RIVER AT RIVERTON, VIRGINIA.

This stream rises in Rockingham County, Virginia, and flows in a northeasterly direction, joining with the South Branch of the Shenandoah at Riverton, Virginia. The station was established at Riverton by A. P. Davis June 26, 1899. Measurements were made from an iron-wire cable, about 260 feet in span, stretched across the river on timber supports, 2 miles northwest of Riverton. The station is most easily reached by a private conveyance from Front Royal, Virginia. The gage is a vertical timber, graduated to feet and tenths, bolted to a large sycamore tree on the right bank of the stream. The initial point of soundings is on the right bank. The channel is straight above and below the station for about 600 feet. The banks are low and liable to overflow in time of high water. Bed of stream is rocky and constant. The observer is O. Menefee, a farmer, Riverton, Virginia. Two observations of river height are taken daily. Two measurements were made by E. G. Paul during 1899, both on September 2, with a gage height of 2.85 feet in each case. One measurement was made at the cross section at the point where the cable spans the stream, giving a discharge of 270 second-feet. The other measurement was made by wading, at a better cross section, 300 feet below the regular station, giving a discharge of 287 second-feet.

*Daily gage height, in feet, of North Branch of Shenandoah River at Riverton, Virginia, for 1899.*

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | | 2.80 | 2.68 | 2.88 | 2.70 | 3.20 | |
| 2 | | 2.80 | 2.68 | 2.88 | 2.68 | 2.95 | |
| 3 | | 2.78 | 2.68 | 2.95 | 2.60 | 2.95 | 2.65 |
| 4 | | 2.80 | 2.70 | 2.85 | 2.65 | 2.95 | 2.65 |
| 5 | | 2.73 | 2.65 | 2.73 | 2.70 | 2.85 | 2.63 |
| 6 | | 2.73 | 3.00 | 2.73 | 2.68 | 2.80 | 2.60 |
| 7 | | 2.80 | 2.95 | 2.73 | 2.65 | 2.80 | 2.63 |
| 8 | | 2.80 | 2.95 | 2.70 | 2.65 | 2.80 | 2.65 |
| 9 | | 2.80 | 2.83 | 2.70 | 2.68 | 2.80 | 2.60 |
| 10 | | 2.80 | 2.80 | 2.70 | 2.70 | 2.80 | 2.63 |
| 11 | | 2.80 | 2.73 | 2.70 | 2.70 | 2.78 | 2.65 |
| 12 | | 2.78 | 2.70 | 2.73 | 2.70 | 2.75 | 2.68 |
| 13 | | 2.75 | 2.70 | 2.73 | 2.70 | 2.73 | 2.80 |
| 14 | | 2.75 | 2.73 | 2.70 | 2.70 | 2.70 | 2.85 |
| 15 | | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 2.90 |
| 16 | | 2.68 | 2.78 | 2.68 | 2.65 | 2.70 | 2.90 |
| 17 | | 2.68 | 2.78 | 2.70 | 2.65 | 2.70 | 2.90 |
| 18 | | 2.78 | 2.78 | 2.68 | 2.70 | 2.70 | 2.90 |
| 19 | | 2.75 | 2.70 | 2.60 | 2.68 | 2.70 | 2.88 |
| 20 | | 2.70 | 2.65 | 2.80 | 2.70 | 2.70 | 2.80 |
| 21 | | 2.68 | 2.63 | 2.80 | 2.65 | 2.70 | 2.80 |
| 22 | | 2.68 | 2.63 | 2.80 | 2.65 | 2.70 | 2.80 |
| 23 | | 2.65 | 2.68 | 2.80 | 2.65 | 2.70 | 2.80 |
| 24 | | 2.58 | 2.65 | 2.80 | 2.65 | 2.70 | 2.80 |
| 25 | | 2.63 | 2.63 | 2.80 | 2.70 | 2.70 | 2.83 |
| 26 | 2.85 | 2.70 | 2.65 | 2.80 | 2.70 | | 2.88 |
| 27 | 2.88 | 2.68 | 2.63 | 2.78 | 2.70 | | 3.00 |
| 28 | 2.88 | 2.85 | 2.70 | 2.75 | 2.70 | | 3.00 |
| 29 | 2.88 | 3.13 | 2.68 | 2.70 | 2.70 | | 3.00 |
| 30 | 2.80 | 2.80 | 2.95 | 2.70 | 2.68 | | 3.00 |
| 31 | | 2.70 | 2.90 | | 2.75 | | |

## SOUTH BRANCH OF SHENANDOAH RIVER AT FRONT ROYAL, VIRGINIA.

This stream rises in Augusta County, Virginia, and flows in a northeasterly direction, joining the North Branch of the Shenandoah at Riverton to form Shenandoah River. A station was established on the South Branch by A. P. Davis, June 26, 1899. The measurements of flow are made from an iron wire cable 300 feet in span, stretched across the stream 3 miles southwest of Front Royal, Virginia. The gage is a vertical timber divided into feet and tenths and bolted to the trunk of a tree on the left bank of the stream. The initial point for sounding is on the left bank. The channel is straight 600 feet above and below the station, and the current sluggish. The left bank is low and liable to overflow. The bed of the stream is rocky in part, with patches of sand somewhat shifting. The observer is Miss Brentie Johnson, Front Royal, Virginia. One measurement of discharge was made by E. G. Paul, September 1, 1899; gage height, 4.40 feet; discharge, 616 second-feet.

*Daily gage height, in feet, of South Branch of Shenandoah River at Front Royal, Virginia, for 1899.*

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | ........ | 4.30 | 4.40 | 4.40 | 4.45 | 5.50 | 4.40 |
| 2 | ........ | 4.30 | 4.35 | 4.35 | 4.40 | 8.05 | 4.40 |
| 3 | ........ | 4.20 | 4.20 | 4.30 | 4.30 | 6.70 | 4.30 |
| 4 | ........ | 4.20 | 4.25 | 4.20 | 4.30 | 5.85 | 4.30 |
| 5 | ........ | 4.10 | 4.25 | 4.50 | 4.30 | 5.80 | 4.20 |
| 6 | ........ | 4.20 | 4.20 | 4.30 | 4.30 | 5.65 | 4.20 |
| 7 | ........ | 4.20 | 4.30 | 4.20 | 4.30 | 5.35 | 4.20 |
| 8 | ........ | 4.25 | 4.65 | 4.15 | 4.35 | 5.20 | 4.20 |
| 9 | ........ | 4.55 | 4.30 | 4.25 | 4.40 | 5.05 | 4.30 |
| 10 | ........ | 4.70 | 4.50 | 4.75 | 4.40 | 4.85 | 4.30 |
| 11 | ........ | 4.30 | 4.45 | 4.65 | 4.40 | 4.80 | 4.30 |
| 12 | ........ | 4.20 | 4.30 | 4.55 | 4.40 | 4.70 | 4.45 |
| 13 | ........ | 4.15 | 4.20 | 4.45 | 4.30 | 4.70 | 6.95 |
| 14 | ........ | 4.20 | 4.20 | 4.40 | 4.30 | 4.60 | 6.25 |
| 15 | ........ | 4.15 | 4.20 | 4.30 | 4.30 | 4.60 | 5.75 |
| 16 | ........ | 4.25 | 4.30 | 4.30 | 4.20 | 4.55 | 5.45 |
| 17 | ........ | 4.15 | 4.35 | 4.30 | 4.20 | 4.50 | 5.25 |
| 18 | ........ | 4.15 | 4.25 | 4.20 | 4.20 | 4.50 | 5.15 |
| 19 | ........ | 4.15 | 4.30 | 4.20 | 4.20 | 4.50 | 5.00 |
| 20 | ........ | 4.10 | 4.25 | 4.55 | 4.20 | 4.50 | 4.95 |
| 21 | ........ | 4.10 | 4.20 | 5.80 | 4.10 | 4.50 | 4.85 |
| 22 | ........ | 4.10 | 4.10 | 5.30 | 4.15 | 4.40 | 4.75 |
| 23 | ........ | 4.15 | 4.10 | 4.85 | 4.20 | 4.40 | 4.70 |
| 24 | ........ | 4.10 | 4.00 | 4.60 | 4.20 | 4.50 | 4.90 |
| 25 | ........ | 4.10 | 3.90 | 5.00 | 4.20 | 4.50 | 4.90 |
| 26 | 4.40 | 4.05 | 4.00 | 4.60 | 4.20 | 4.55 | 5.10 |
| 27 | 4.30 | 4.10 | 4.00 | 4.55 | 4.20 | 4.50 | 5.10 |
| 28 | 4.25 | 4.20 | 4.30 | 4.60 | 4.20 | 4.40 | 5.00 |
| 29 | 4.35 | 4.30 | 5.15 | 4.50 | 4.20 | 4.40 | 5.00 |
| 30 | 4.30 | 4.80 | 5.05 | 4.50 | 4.20 | 4.40 | 5.15 |
| 31 | ........ | 4.25 | 4.60 | ........ | 4.20 | ........ | ........ |

## SHENANDOAH RIVER AT MILLVILLE, WEST VIRGINIA.

This river, formed by the junction of the North Fork and the South Fork at Riverton, Virginia, flows in a northeasterly direction into West Virginia, where it empties into the Potomac at Harpers Ferry.

Observations of the height of Potomac River at the junction of Shenandoah River have been made by the Weather Bureau at Harpers Ferry, West Virginia. The gage is on the west face and north end of the second abutment of the old railroad bridge from the West Virginia side of the river. It is of Portland cement, 15 inches wide, plastered on the face of the pier extending to 32 feet, and continued on the iron upright of the bridge to 36 feet. The top surface of the 6-by-6-inch-square capstone corresponds to the 32-foot mark on the gage. The elevation is 235.5 feet above mean sea level.

A station was established at Millville, West Virginia, April 15, 1895, on Shenandoah River, 4 miles above its mouth. A vertical gage was placed in the river and fastened to a tree, a deep notch being cut in the tree opposite the 8-foot mark. This gage is referred to a bench mark consisting of a copper bolt driven in the foot of a large sycamore tree on the left bank of the river 150 feet below the gage rod, at an elevation of 6.78 feet above the zero mark on the gage. Measurements are made from a cable stretched across the river. The old cable was carried away by the flood of 1896, and a new three-fourths inch galvanized iron wire cable was put in place on June 23, 1897. The cable, about 500 feet in length, is supported on either bank by a large sycamore tree, and is securely anchored on both sides. The channel is straight, current swift and unobstructed. The banks are low and subject to overflow. The observer is W. R. Nicewarner. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 28; 1897, Nineteenth Annual Report, Part IV, page 151; 1898, Twentieth Annual Report, Part IV, page 127. The following measurements were made by E. G. Paul during 1899:

January 27, gage height, 2.40 feet; discharge, 3,156 second-feet.
March 10, gage height, 5.00 feet; discharge, 10,838 second-feet.
May 16, gage height, 2.10 feet; discharge, 2,753 second-feet.
September 3, gage height, 0.90 foot; discharge, 1,086 second-feet.
October 29, gage height, 0.60 foot; discharge, 766 second-feet.

*Daily gage, height in feet, of Shenandoah River at Millville, West Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.50 | 2.30 | Ice. | 3.10 | 1.70 | 2.05 | 0.90 | 1.00 | 1.10 | 0.80 | 1.55 | 0.80 |
| 2 | 2.20 | 2.10 | Ice. | 3.00 | 1.60 | 2.35 | .90 | .80 | .90 | .70 | 2.75 | .80 |
| 3 | 2.80 | 1.70 | Ice. | 2.80 | 1.60 | 3.00 | .80 | .90 | .90 | .70 | 3.20 | .75 |
| 4 | 2.60 | 2.00 | Ice. | 2.70 | 1.60 | 2.10 | .80 | 1.30 | 1.10 | .70 | 2.40 | .70 |
| 5 | 3.30 | 2.40 | Ice. | 2.60 | 2.00 | 1.80 | .80 | .90 | .80 | .70 | 1.90 | .75 |
| 6 | 3.80 | 2.50 | Ice. | 2.50 | 1.90 | 1.50 | .80 | .80 | .70 | .70 | 1.80 | .70 |
| 7 | 4.60 | 2.30 | Ice. | 2.40 | 1.90 | 1.40 | .70 | 1.10 | .80 | .70 | 1.60 | .70 |
| 8 | 6.70 | 2.50 | Ice. | 2.50 | 1.80 | 1.40 | .80 | 1.00 | .70 | .70 | 1.40 | .70 |
| 9 | 5.00 | 2.50 | Ice. | 3.10 | 2.00 | 1.50 | .90 | 1.20 | .70 | .80 | 1.30 | .70 |
| 10 | 4.50 | 2.30 | 5.00 | 3.00 | 2.30 | 1.40 | 1.00 | 1.00 | .70 | .80 | 1.20 | .70 |
| 11 | 3.80 | 2.40 | 5.50 | 2.90 | 3.10 | 1.30 | .90 | 1.60 | .80 | .70 | 1.10 | .70 |
| 12 | 3.50 | (*a*) | 5.20 | 2.70 | 2.80 | 1.40 | .80 | .90 | 1.20 | .80 | 1.00 | .75 |
| 13 | 3.30 | (*a*) | 4.60 | 2.60 | 2.60 | 1.40 | .80 | .80 | .90 | .70 | 1.90 | .90 |
| 14 | 3.00 | 2.30 | 4.00 | 2.50 | 2.70 | 1.30 | .70 | .90 | .80 | .70 | 1.00 | 2.90 |
| 15 | 2.90 | 2.40 | 4.00 | 2.40 | 2.20 | 1.30 | .70 | .80 | .80 | .70 | .90 | 2.20 |
| 16 | 3.00 | 2.50 | 4.00 | 2.30 | 2.10 | 1.30 | .90 | .70 | .70 | .60 | .90 | 1.90 |
| 17 | 2.90 | 2.70 | 4.50 | 2.20 | 1.90 | 1.20 | .80 | .80 | .70 | .60 | .90 | 1.60 |
| 18 | 2.90 | 3.00 | 3.90 | 2.20 | 1.90 | 1.10 | .70 | .80 | .60 | .60 | .80 | 1.40 |
| 19 | 2.90 | 3.00 | 3.80 | 2.20 | 2.50 | 1.00 | .70 | .80 | .60 | .60 | .90 | 1.30 |
| 20 | 2.80 | 3.40 | 3.80 | 2.20 | 2.30 | 1.00 | .70 | .70 | .80 | .60 | .80 | 1.20 |
| 21 | 2.60 | 4.00 | 3.80 | 2.20 | 2.00 | 1.00 | .70 | .70 | .90 | .60 | .80 | 1.20 |
| 22 | 2.40 | Ice. | 3.70 | 1.90 | 1.90 | .90 | .70 | .60 | .90 | .60 | .80 | 1.10 |
| 23 | 2.40 | Ice. | 3.50 | 1.90 | 1.70 | 1.00 | .60 | .60 | 1.50 | .60 | .80 | 1.10 |
| 24 | 2.40 | Ice. | 3.30 | 1.90 | 1.70 | .90 | .60 | .60 | 1.10 | .60 | .80 | 1.10 |
| 25 | 2.40 | Ice. | 3.10 | 1.80 | 1.60 | .90 | 70 | .50 | 1.00 | .60 | .80 | 1.30 |
| 26 | 2.30 | Ice. | 3.00 | 2.00 | 1.50 | .90 | .60 | .50 | .90 | .50 | .85 | 1.20 |
| 27 | 2.50 | Ice. | 2.90 | 1.90 | 1.50 | .90 | .60 | .60 | .90 | .60 | .85 | 1.70 |
| 28 | 2.30 | Ice. | 2.90 | 1.80 | 1.40 | .90 | .60 | .70 | .90 | .60 | .80 | 1.40 |
| 29 | 2.20 | ...... | 3.00 | 1.80 | 1.40 | .90 | .60 | .80 | .80 | .60 | .80 | 1.65 |
| 30 | 2.10 | ...... | 3.60 | 1.70 | 1.30 | 1.00 | 1.50 | 1.00 | .80 | .60 | .80 | 1.10 |
| 31 | 2.10 | ...... | 3.30 | ...... | 1.60 | ...... | 1.00 | 1.30 | ...... | .70 | ...... | 1.10 |

*a* No readings.

## POTOMAC RIVER AT POINT OF ROCKS, MARYLAND.

This station was established February 17, 1895, as described in Bulletin 140, page 54. It is about 6 miles above the mouth of Monocacy River, and also above a number of smaller streams, and therefore the measurements of discharge do not represent the entire flow of

Potomac River. The drainage area here is estimated to be 9,654 square miles. It is largely mapped on topographic atlas sheets—Harpers Ferry, Winchester, Romney, Piedmont, Warrensburg, Luray, Woodstock, Franklin, Beverly, Harrisonburg, Staunton, Monterey, Buckingham, and Lexington. Catoctin Creek enters the Potomac 1,000 feet above the station. The measurements are made from the highway bridge at Point of Rocks. The wire gage is on the east side of the first span, the scale being marked on the hand rail of the bridge. The gage is referred to two bench marks—one, a copper bolt in a large capstone on the lower wing wall of the north abutment, about 10 feet from the north end of the first iron truss, is 41.30 feet above the datum of the gage. The length of the wire gage is 44.22 feet. The gage was verified on October 29, 1899. The observer is G. H. Hickman. The records of flow may be found as follows: 1895–96, Eighteenth Annual Report, Part IV, page 32; 1897, Nineteenth Annual Report, Part IV, pages 152–153; 1898, Twentieth Annual Report, Part IV, page 131. The following measurements were made by E. G. Paul during 1899:

January 28, gage height, 3.80 feet; discharge, 17,330 second-feet.
May 20, gage height, 8.15 feet; discharge, 45,986 second-feet.
September 5, gage height, 0.80 foot; discharge, 2,360 second-feet.
October 29, gage height, 0.50 foot; discharge, 1,628 second-feet.

Mr. William Rich Hutton, of 35 Broadway, New York, states that in the summer of 1856 he made a careful examination of the flow of Potomac River a short distance below the Great Falls, using loaded poles reaching as near as possible to the bottom and placed at 5-foot intervals across the width of the river. The water was then at the lowest stage known to persons who had observed the river for many years. The discharge was 1,063 second-feet. Mr. Hutton was of the opinion that the river was as low in 1862, but no measurements were made in that year.

In 1839 a civil engineer, Mr. M. C. Ewing, assistant to Major Turnbull, United States topographic engineer, during the construction of the Alexandria Aqueduct above Georgetown, reported the discharge below Little Falls to be 1,904 second-feet. Mr. Thomas L. Patterson, of Cumberland, is reported to have found the discharge at that point in the low water of 1838 to be 24 second-feet, and at Patterson Creek, some 12 miles below, 48 second-feet. Figures of discharge of Potomac River are given in the statement regarding the extension of the Chesapeake and Ohio Canal in House Ex. Doc. No. 208, Forty-third Congress, first session; also in House Ex. Doc. No. 137, Forty-fourth Congress, first session.

*Daily gage height, in feet, of Potomac River at Point of Rocks, Maryland, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.00 | 2.40 | 11.90 | 5.30 | 1.60 | 2.00 | 1.00 | 0.70 | 0.90 | 0.70 | 0.80 | 0.80 |
| 2 | 3.40 | 2.00 | 9.20 | 4.50 | 1.60 | 2.40 | 1.00 | .70 | .90 | .60 | 1.50 | .80 |
| 3 | 2.90 | 2.10 | 8.20 | 4.00 | 2.10 | 3.80 | 1.10 | .70 | .80 | .60 | 2.50 | .80 |
| 4 | 2.70 | 2.10 | 7.60 | 3.60 | 1.70 | 2.60 | 1.00 | .90 | .80 | .60 | 2.00 | .80 |
| 5 | 2.30 | 2.00 | 8.50 | 3.30 | 1.70 | 2.10 | .90 | 1.00 | .80 | .60 | 1.80 | .80 |
| 6 | 4.10 | 2.00 | 16.55 | 3.00 | 2.10 | 1.80 | 1.00 | 1.10 | .70 | .60 | 1.40 | .70 |
| 7 | 6.90 | 2.00 | 12.90 | 2.80 | 2.00 | 1.60 | 2.00 | 1.10 | .70 | .70 | 1.40 | .70 |
| 8 | 8.10 | 2.30 | 10.00 | 3.00 | 1.90 | 1.50 | 1.00 | 1.10 | .60 | .70 | 1.30 | .70 |
| 9 | 6.80 | 2.30 | 8.10 | 3.50 | 2.00 | 1.40 | 1.00 | 1.00 | .60 | .70 | 1.20 | .70 |
| 10 | 5.40 | 3.60 | 6.00 | 3.40 | 2.40 | 1.70 | .90 | 1.00 | .60 | .60 | 1.00 | .70 |
| 11 | 4.60 | 4.20 | 5.80 | 4.20 | 4.50 | 1.80 | .90 | .90 | .60 | .60 | .90 | .70 |
| 12 | 3.90 | 4.20 | 5.60 | 4.50 | 3.80 | 1.70 | .80 | .80 | .80 | .60 | .90 | .80 |
| 13 | 3.60 | 4.00 | 5.00 | 3.40 | 3.40 | 1.70 | .80 | .60 | 1.20 | .60 | .80 | .80 |
| 14 | 3.40 | 3.90 | 4.80 | 3.20 | 3.20 | 1.60 | .80 | .60 | 1.10 | .50 | .80 | 1.20 |
| 15 | 3.40 | 3.80 | 4.50 | 3.00 | 2.80 | 1.50 | .90 | .60 | 1.00 | .50 | .80 | 3.00 |
| 16 | 4.00 | 4.00 | 4.60 | 2.80 | 2.50 | 1.50 | 1.10 | .70 | .90 | .50 | .80 | 2.10 |
| 17 | 5.70 | 4.50 | 4.70 | 2.70 | 2.30 | 1.40 | .90 | .70 | .80 | .50 | .80 | 1.70 |
| 18 | 5.20 | 5.00 | 4.40 | 2.60 | 2.40 | 1.40 | .70 | .60 | .70 | .50 | .70 | 1.50 |
| 19 | 4.70 | 5.20 | 5.20 | 2.50 | 8.55 | 1.30 | .70 | .60 | .70 | .50 | .70 | 1.60 |
| 20 | 4.40 | 5.40 | 5.40 | 2.40 | 6.30 | 1.30 | .70 | .60 | .90 | .50 | .70 | 1.50 |
| 21 | 4.00 | 6.00 | 5.30 | 2.20 | 5.00 | 1.20 | .70 | .60 | .70 | .50 | .70 | 1.30 |
| 22 | 3.50 | 8.50 | 4.70 | 2.10 | 3.60 | 1.20 | .70 | .50 | .80 | .50 | .70 | 1.10 |
| 23 | 3.30 | 14.80 | 4.20 | 2.00 | 3.00 | 1.10 | .70 | .50 | .90 | .50 | .80 | 1.00 |
| 24 | 3.20 | 13.70 | 4.00 | 2.00 | 2.70 | 1.10 | .60 | .50 | .90 | .50 | .80 | 1.20 |
| 25 | 3.30 | 9.00 | 3.90 | 2.00 | 2.40 | 1.00 | .60 | .50 | .90 | .50 | .90 | 1.80 |
| 26 | 4.80 | 6.00 | 3.70 | 1.90 | 2.10 | 1.00 | .60 | .50 | 1.00 | .50 | .90 | 2.10 |
| 27 | 4.70 | 9.25 | 3.50 | 1.90 | 2.00 | 1.00 | .60 | 1.20 | .80 | .50 | .80 | 1.60 |
| 28 | 3.90 | 13.90 | 3.40 | 1.80 | 1.80 | 1.20 | .60 | 1.10 | .70 | .50 | .80 | 1.50 |
| 29 | 3.20 | ....... | 3.60 | 1.70 | 1.70 | 1.10 | .50 | 1.10 | .70 | .50 | .80 | 1.60 |
| 30 | 2.80 | ....... | 8.60 | 1.70 | 1.70 | 1.00 | .80 | 1.00 | .80 | .50 | .80 | 1.60 |
| 31 | 2.60 | ....... | 7.00 | ....... | 1.80 | ....... | .80 | 1.00 | ....... | .60 | ....... | 1.60 |

## MONOCACY RIVER AT FREDERICK, MARYLAND.

Monocacy River rises in the south-central part of Pennsylvania and flows in a southerly direction through Frederick County, Maryland, entering Potomac River near the Montgomery County line. A station was established by E. G. Paul, August 4, 1896, at the county iron bridge on the turnpike, 4 miles northeast of Frederick, on the road leading from Frederick to Mount Pleasant, Maryland, and about 2,000 feet above the mouth of Israel Creek and 3,000 feet below the mouth of Tuscarora Creek, as shown on the Frederick atlas sheet. The drainage area is 665 square miles at this point and 1,000 square miles at the mouth. The gage is attached to the floor timber on the lower side of the bridge. The length of the wire is 35.20 feet. The bench mark is a cross cut in the top face of the capstone on the lower retaining wall of the bridge abutment on the right bank of the stream, and is 29.17 feet above gage datum. The stream at this station has two channels, being divided by a small, low island, which serves as a foundation for the middle pier of the bridge. The right channel is measured from the lower side of the bridge, and the left channel from the upper side, as these sections are freer from rocks than a continuous section on either side of the bridge. The stream is subject to high water and sudden floods, owing to the character of its upper watershed. The observer is E. L. Derr, a farmer near Frederick, Maryland. Records of measurement can be found as follows:

1896, Eighteenth Annual Report, Part IV, page 35; 1897, Nineteenth Annual Report, Part IV, pages 153–155; 1898, Twentieth Annual Report, Part IV, page 129. Two measurements were made by E. G. Paul during 1899. The first, May 22, at a gage height of 5.20 feet, when the dischage was 633 second-feet. The second one was on September 6, at a gage height of 4.00 feet, with a discharge of 153 second-feet.

*Daily gage height in feet of Monocacy River at Frederick, Maryland, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.40 | 5.20 | 11.50 | 7.10 | 4.80 | 7.10 | 4.10 | 3.90 | 4.30 | 4.00 | 7.30 | 4.10 |
| 2 | 5.00 | 5.20 | 10.10 | 6.90 | 4.80 | 11.10 | 4.10 | 4.00 | 4.30 | 3.90 | 6.40 | 4.10 |
| 3 | 5.50 | 5.80 | 9.20 | 6.50 | 5.00 | 7.05 | 4.10 | 5.10 | 5.40 | 3.90 | 6.30 | 4.10 |
| 4 | 6.00 | 5.60 | 8.70 | 6.10 | 4.90 | 5.20 | 4.00 | 5.00 | 5.00 | 3.90 | 6.00 | 4.10 |
| 5 | 6.30 | 5.90 | 17.15 | 6.00 | 4.90 | 4.90 | 4.00 | 5.00 | 4.50 | 3.80 | 5.30 | 4.10 |
| 6 | 12.75 | 5.70 | 11.45 | 6.00 | 4.80 | 4.70 | 4.50 | 4.90 | 4.00 | 3.80 | 5.00 | 4.00 |
| 7 | 14.85 | 5.50 | 8.90 | 7.60 | 4.80 | 4.50 | 4.40 | 4.50 | 3.90 | 3.90 | 4.50 | 4.00 |
| 8 | 12.50 | 5.40 | 7.80 | 12.60 | 5.20 | 4.50 | 4.20 | 4.00 | 3.80 | 3.90 | 4.40 | 3.90 |
| 9 | 10.20 | 6.00 | 7.50 | 8.50 | 6.60 | 5.50 | 4.30 | 4.00 | 3.70 | 4.10 | 4.30 | 3.90 |
| 10 | 6.10 | 6.00 | 7.40 | 6.90 | 5.60 | 6.85 | 4.20 | 4.00 | 4.00 | 4.10 | 4.30 | 3.90 |
| 11 | 6.10 | 6.00 | 7.40 | 6.50 | 5.40 | 6.90 | 4.20 | 4.00 | 4.00 | 4.00 | 4.20 | 3.90 |
| 12 | 5.70 | 6.00 | 7.30 | 6.20 | 5.80 | 6.50 | 4.10 | 4.20 | 3.90 | 4.00 | 4.10 | 4.80 |
| 13 | 5.80 | 6.00 | 7.10 | 5.90 | 5.40 | 5.20 | 4.30 | 4.00 | 3.90 | 3.90 | 4.10 | 5.95 |
| 14 | 6.00 | 6.00 | 6.50 | 5.60 | 5.00 | 4.90 | 4.20 | 3.90 | 3.80 | 3.90 | 4.10 | 5.50 |
| 15 | 6.80 | 6.00 | 6.50 | 5.60 | 5.00 | 6.20 | 4.20 | 3.90 | 3.80 | 3.90 | 4.10 | 4.50 |
| 16 | 6.60 | 6.00 | 9.70 | 5.60 | 4.90 | 5.10 | 4.50 | 3.90 | 3.80 | 3.90 | 4.10 | 4.40 |
| 17 | 6.60 | 6.20 | 6.90 | 5.60 | 5.20 | 4.80 | 4.30 | 3.90 | 3.70 | 3.90 | 4.10 | 4.40 |
| 18 | 7.10 | 6.80 | 7.90 | 5.60 | 6.50 | 4.50 | 4.30 | 3.80 | 3.70 | 4.00 | 4.10 | 4.30 |
| 19 | 6.40 | 7.90 | 13.90 | 5.60 | 7.70 | 4.40 | 4.20 | 3.80 | 3.70 | 3.90 | 4.10 | 4.20 |
| 20 | 5.60 | 9.00 | 10.10 | 5.40 | 6.90 | 4.40 | 4.10 | 3.80 | 6.00 | 3.90 | 4.10 | 4.20 |
| 21 | 5.60 | 12.50 | 7.90 | 5.20 | 6.50 | 4.40 | 4.00 | 3.80 | 5.30 | 3.80 | 4.10 | 4.50 |
| 22 | 5.60 | 13.50 | 7.80 | 5.10 | 5.20 | 4.30 | 3.90 | 3.80 | 5.00 | 3,80 | 4.10 | 4.40 |
| 23 | 5.60 | 15.65 | 7.60 | 5.10 | 5.20 | 4.30 | 3.90 | 3.80 | 4.90 | 3.80 | 4.10 | 4.30 |
| 24 | 5.70 | 11.60 | 7.20 | 5.00 | 5.00 | 4.30 | 3.90 | 3.80 | 4.50 | 3.80 | 5.30 | 7.10 |
| 25 | 10.40 | 9.10 | 6.70 | 5.00 | 4.90 | 4.20 | 4.30 | 3.80 | 4.30 | 3.80 | 4.70 | 6.90 |
| 26 | 8.20 | 9.10 | 6.70 | 5.00 | 4.80 | 4.20 | 4.50 | 3.80 | 5.25 | 3.80 | 4.40 | 6.20 |
| 27 | 6.50 | 17.80 | 6.70 | 5.00 | 4.70 | 4.20 | 4.40 | 4.70 | 5.50 | 3.80 | 4.30 | 6.00 |
| 28 | 5.20 | 12.50 | 10.15 | 4.90 | 4.70 | 4.20 | 4.30 | 4.95 | 5.30 | 3.80 | 4.30 | 5.10 |
| 29 | 5.20 | ------- | 11.00 | 4.90 | 4.60 | 4.20 | 4.20 | 4.70 | 5.00 | 3.80 | 4.30 | 5.10 |
| 30 | 5.20 | ------- | 8.10 | 4.80 | 5.00 | 4.20 | 4.00 | 4.30 | 4.50 | 3.80 | 4.20 | 5.10 |
| 31 | 5.20 | ------- | 7.90 | ------- | 5.00 | ------- | 3.90 | 4.30 | ------- | 5.00 | ------- | ------- |

ROCK CREEK AT ZOOLOGICAL PARK, DISTRICT OF COLUMBIA.

This creek rises in Montgomery County, Maryland, and flows in a southerly direction through the District of Columbia, emptying into Potomac River. A study of the discharge of Rock Creek was begun in 1892, at the request of the Commissioners of the District of Columbia, and a gage rod established by Cyrus C. Babb at Lyons Mill. In August, 1892, a self-registering gage was placed at the bridge, and the record continued until November 30, 1894. The present station was established January 18, 1897, by E. G. Paul, at the bridge of the National Zoological Park, District of Columbia. The upper part of the gage is vertical and is fastened to the bridge abutment, the lower part being inclined and fastened to the iron rods. The bench mark consists of a cross cut in the stone of the bridge pier. It is 9.13 feet above the zero of the gage. The observer is W. V. Kramer, a park watchman.

*Daily gage height in feet of Rock Creek at Zoological Park, District of Columbia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.05 | 2.78 | 3.30 | 3.00 | 2.75 | 2.88 | 2.40 | 2.35 | 2.40 | 2.58 | 3.65 | 2.53 |
| 2 | 2.75 | 2.88 | 3.23 | 2.93 | 2.70 | 2.68 | 2.40 | 2.35 | 2.40 | 2.50 | 2.83 | 2.58 |
| 3 | 2.88 | 2.88 | 3.13 | 2.90 | 2.73 | 2.63 | 2.35 | 3.90 | 2.40 | 2.50 | 2.80 | 2.53 |
| 4 | 2.90 | 2.95 | 3.10 | 2.90 | 2.70 | 2.60 | 2.35 | 3.20 | 2.40 | 2.50 | 3.10 | 2.50 |
| 5 | 3.33 | 3.13 | 4.50 | 2.90 | 2.70 | 2.55 | 2.60 | 2.65 | 2.38 | 2.50 | 2.80 | 2.50 |
| 6 | 3.60 | 3.00 | 3.40 | 2.90 | 2.70 | 2.55 | 2.58 | 2.90 | 2.30 | 2.75 | 2.70 | 2.50 |
| 7 | 4.25 | 3.00 | 3.18 | 2.95 | 2.75 | 2.55 | 2.70 | 2.55 | 2.30 | 2.70 | 2.63 | 2.50 |
| 8 | 3.23 | 2.93 | 3.10 | 3.80 | 2.75 | 2.55 | 2.50 | 2.50 | 2.30 | 2.58 | 2.60 | 2.50 |
| 9 | 3.05 | 2.63 | 3.10 | 3.08 | 3.23 | 2.50 | 2.78 | 2.48 | 2.30 | 2.60 | 2.60 | 2.50 |
| 10 | 3.00 | 2.93 | 3.08 | 3.00 | 2.83 | 3.63 | 2.48 | 2.53 | 2.30 | 2.58 | 2.60 | 2.50 |
| 11 | 3.00 | 2.78 | 3.23 | 2.90 | 2.83 | 2.98 | 2.43 | 2.50 | 2.40 | 2.55 | 2.60 | 2.50 |
| 12 | 3.10 | 2.78 | 3.18 | 2.90 | 2.98 | 2.73 | 2.40 | 2.48 | 2.43 | 2.50 | 2.58 | 2.78 |
| 13 | 2.90 | 2.78 | 3.13 | 2.90 | 2.78 | 2.65 | 2.50 | 2.45 | 2.30 | 2.50 | 2.55 | 2.75 |
| 14 | 3.00 | 2.78 | 3.00 | 2.90 | 2.73 | 2.63 | 2.70 | 2.75 | 2.30 | 2.50 | 2.55 | 2.63 |
| 15 | 3.00 | 2.95 | 3.10 | 2.85 | 2.70 | 2.55 | 2.45 | 2.50 | 2.30 | 2.50 | 2.55 | 2.53 |
| 16 | 3.00 | 2.95 | 3.30 | 3.05 | 2.68 | 2.50 | 2.45 | 2.70 | 2.25 | 2.50 | 2.55 | 2.50 |
| 17 | 3.10 | 4.00 | 3.00 | 3.00 | 2.73 | 2.50 | 2.90 | 2.50 | 2.25 | 2 50 | 2.55 | 2.50 |
| 18 | 3.08 | 4.25 | 3.05 | 2.90 | 3.25 | 2.50 | 2.58 | 2.45 | 2.30 | 2.50 | 2.55 | 2.55 |
| 19 | 2.98 | 4.43 | 3.90 | 2.85 | 2.95 | 2.50 | 2.45 | 2.43 | 2.43 | 2.50 | 2.58 | 2.60 |
| 20 | 2.93 | 4.05 | 3.33 | 2.85 | 2.78 | 2.50 | 2.40 | 2.40 | 3.00 | 2.50 | 2.55 | 2.60 |
| 21 | 3.13 | 3.88 | 3.10 | 2.80 | 2.70 | 2.48 | 2.40 | 2.40 | 2.63 | 2.50 | 2.55 | 2.60 |
| 22 | 2.85 | 4.18 | 3.18 | 2.80 | 2.70 | 2.45 | 2.40 | 2.73 | 2.55 | 2.45 | 2.55 | 2.55 |
| 23 | 2.85 | 4.10 | 3.18 | 2.80 | 2.68 | 2.45 | 2.40 | 2.45 | 2.40 | 2.45 | 2.60 | 2.50 |
| 24 | 2.85 | 3.50 | 3.03 | 2.80 | 2.65 | 2.45 | 2.40 | 2.35 | 2.35 | 2.48 | 2.63 | 2.93 |
| 25 | 3.68 | 3.20 | 3.00 | 2.80 | 2.60 | 2.48 | 2.40 | 2.30 | 2.65 | 2.45 | 2.60 | 2.95 |
| 26 | 3.08 | 3.15 | 3.00 | 2.80 | 2.60 | 2.53 | 2.50 | 2.30 | 5.25 | 2.45 | 2.60 | 2.68 |
| 27 | 3.00 | 3.70 | 3.00 | 2.83 | 2.60 | 2.50 | 2.50 | 2.55 | 3.75 | 2.50 | 2.55 | 2.53 |
| 28 | 2.88 | 3.33 | 3.23 | 2.78 | 2.60 | 2.48 | 2.40 | 2.75 | 2.85 | 2.50 | 2.55 | 2.60 |
| 29 | 2.85 | ....... | 3.45 | 2.75 | 2.65 | 2.45 | 2.40 | 2.48 | 2.60 | 2.50 | 2.55 | 2.53 |
| 30 | 2.83 | ....... | 3.15 | 2.75 | 2.60 | 2.43 | 2.40 | 2.40 | 2.60 | 2.50 | 2.55 | 2.53 |
| 31 | 2.85 | ....... | 3.03 | ....... | 2.60 | ....... | 2.38 | 2.40 | ....... | 2.63 | ....... | 2.50 |

## NORTH ANNA RIVER, VIRGINIA.

Measurements of North Anna River, a tributary of Pamunkey River, were made in August, 1896, by J. O. Smith and A. Langstaff Johnston, of Richmond, Virginia, at Mr. Smith's mill, at a point about 1 mile above the Hanover County line; also at McGeehees Bridge, about 3 miles above the mill. At that time the river was at its lowest stage for the year. During the winter the volume is believed to be four or five times greater. The measurements at the mill gave an average area of 148 square feet and an average velocity of 0.69 foot per second, the total discharge being 102 second-feet. The measurements at McGeehees Bridge showed an average area of 184 square feet and an average velocity of 0.50 foot per second, giving a discharge of 92 second-feet.

## NORTH RIVER AT GLASGOW, VIRGINIA.

This river rises on the western slope of the Shenandoah Mountains, and flows in a southeasterly direction across the valley between the Shenandoah and Blue Ridge ranges, emptying into James River about 17 miles south of Lexington, Virginia. Its watershed is largely under cultivation, except in the upper part, where it is mountainous and covered with forest growth. The entire drainage area is mapped on the Lexington, Monterey, Staunton, and Natural Bridge atlas sheets. This station was established at the East Glasgow County Bridge, about 1 mile above the mouth of North River, by C. C. Babb and D. C. Humphreys, on August 21, 1895. The height of water is observed by means of a wire gage, the board being placed on the guard rail on the lower side of the bridge, and graduated in feet and tenths. This gage is referred to a bench mark at the top of the top chord of the bridge over the gage pulley at an elevation of 32.24 feet. The distance from the end of the weight to the marker of the gage is 27.86 feet. The measurements of discharge are made from the bridge, the initial point for soundings being on the left bank. The channel is straight for about 200 feet above and below the station; the current rather sluggish, but with sufficient velocity for measurements. There is a dam on the North River 10 miles above the station, but its influence on the flow is scarcely noticeable. The right bank is high, but the left bank is subject to overflow in very high water. The bed is of rock and gravel, and fairly permanent. The observer is B. G. Baldwin, a merchant of Glasgow, Virginia. Results of measurements may be found as follows: 1895–96, Eighteenth Annual Report, Part IV, page 38; 1897, Nineteenth Annual Report, Part IV, page 162; 1898, Twentieth Annual Report, Part IV, page 135. The following discharge measurements were made during 1899 by D. C. Humphreys:

March 30, gage height, 2.82 feet; discharge, 2,039 second-feet.
June 27, gage height, 0.95 foot; discharge, 227 second-feet.
August 7, gage height, 0.92 foot, discharge 218 second-feet.
At this last measurement the velocity was barely sufficient to turn the meter and surface floats indicated that the discharge should be somewhat greater.

*Daily gage height, in feet, of North River at Glasgow, Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.05 | 1.80 | (*a*) | 2.60 | 1.42 | 1.38 | 0.90 | 0.72 | 0.85 | 0.95 | 2.50 | 0.73 |
| 2 | 2.10 | 1.72 | (*a*) | 2.43 | 1.42 | 1.48 | .80 | .72 | .82 | .90 | 1.50 | .75 |
| 3 | 2.00 | 1.80 | (*a*) | 2.35 | 1.43 | 1.40 | .82 | .73 | .82 | .85 | 1.35 | .78 |
| 4 | 2.30 | 2.30 | (*a*) | 2.20 | 1.42 | 1.30 | .80 | .75 | .82 | .85 | 1.25 | .76 |
| 5 | 2.52 | *b* 2.80 | 13.05 | 2.15 | 1.42 | 1.25 | .80 | .75 | .80 | .85 | 1.29 | .76 |
| 6 | 4.01 | 3.30 | (*a*) | 2.10 | 1.48 | 1.21 | .78 | .75 | .71 | .85 | 1.10 | .78 |
| 7 | 7.00 | 3.15 | (*a*) | 2.10 | 1.52 | 1.15 | .80 | .90 | .71 | .84 | 1.05 | .75 |
| 8 | *b* 5.38 | 2.80 | (*a*) | 2.80 | 1.62 | 1.12 | .80 | .80 | .70 | .87 | 1.00 | .78 |
| 9 | 3.75 | 2.30 | (*a*) | 2.55 | 3.75 | 1.10 | .80 | .73 | 1.10 | .98 | .95 | .78 |
| 10 | 3.30 | 2.30 | (*a*) | 2.42 | 2.85 | 1.10 | .95 | .73 | 1.00 | .90 | .93 | .75 |
| 11 | 2.95 | 2.28 | (*a*) | 2.35 | 2.45 | 1.08 | .88 | .72 | .90 | .85 | .92 | .73 |
| 12 | 2.60 | *b* 2.27 | (*a*) | 2.30 | 1.85 | 1.30 | .80 | .72 | 1.00 | .82 | .92 | 1.25 |
| 13 | 2.45 | 2.26 | (*a*) | 2.22 | 2.30 | 1.40 | .80 | .73 | .95 | .80 | .92 | 2.10 |
| 14 | 2.45 | 2.25 | (*a*) | 2.12 | 2.25 | 1.30 | .80 | .77 | .90 | .75 | .84 | 1.85 |
| 15 | 2.38 | 2.25 | (*a*) | 2.10 | 2.15 | 1.20 | .80 | 1.92 | .80 | .70 | .80 | 1.50 |
| 16 | 2.35 | 2.26 | (*a*) | 2.00 | 2.00 | 1.20 | .80 | 1.10 | .75 | .65 | .80 | 1.42 |
| 17 | 2.28 | 2.30 | (*a*) | 1.94 | 1.90 | 1.18 | .80 | .88 | .73 | .68 | .83 | 1.25 |
| 18 | 2.25 | 2.45 | (*a*) | 1.90 | 1.80 | 1.10 | .80 | .80 | .72 | .68 | .80 | 1.12 |
| 19 | 2.20 | 2.75 | (*a*) | 1.82 | 1.80 | 1.02 | .75 | .72 | .72 | .70 | .65 | 1.12 |
| 20 | 2.10 | 3.30 | (*a*) | 1.80 | 1.62 | 1.00 | .72 | .72 | 2.62 | .70 | .80 | 1.08 |
| 21 | 2.05 | 4.80 | (*a*) | 1.77 | 1.58 | .95 | .72 | .72 | 1.32 | .72 | .79 | 1.05 |
| 22 | 2.02 | 6.85 | (*a*) | 1.72 | 1.55 | .92 | .72 | .70 | 1.22 | .70 | .78 | 1.00 |
| 23 | 2.00 | 5.45 | (*a*) | 1.68 | 1.52 | .90 | .70 | .70 | 1.15 | .73 | .78 | 1.10 |
| 24 | 1.90 | 5.35 | (*a*) | 1.65 | 1.46 | .90 | .70 | .63 | 1.00 | .73 | .74 | 1.12 |
| 25 | 2.00 | 5.15 | (*a*) | 1.62 | 1.38 | .95 | .71 | .62 | 1.00 | .72 | .74 | 1.20 |
| 26 | 2.05 | ...... | (*a*) | 1.65 | 1.30 | 1.00 | .72 | .62 | .98 | .72 | .72 | 1.30 |
| 27 | 2.00 | 6.15 | (*a*) | 1.62 | 1.28 | .95 | .75 | *b* 1.00 | 1.10 | .72 | .70 | 1.10 |
| 28 | 2.00 | ...... | (*a*) | 1.60 | 1.25 | .95 | .75 | 1.62 | 1.08 | .72 | .65 | 1.15 |
| 29 | 1.95 | ...... | (*a*) | 1.53 | 1.22 | 1.00 | .74 | 1.35 | 1.00 | .71 | .70 | 1.20 |
| 30 | 1.90 | ...... | 2.90 | 1.48 | 1.48 | .97 | .72 | 1.02 | .98 | .70 | .75 | 1.21 |
| 31 | 1.85 | ...... | 2.72 | ...... | 1.46 | ...... | .72 | .92 | ...... | .85 | ...... | 1.00 |

*a* No observations. *b* Interpolated.

### JAMES RIVER AT BUCHANAN, VIRGINIA.

This river rises in the Allegheny Mountains, on the western border of Virginia, and flows in an easterly direction across the State into Chesapeake Bay. The upper part of its drainage area is mountainous and largely covered with forests, while in the eastern part of the State the river flows through a flat and cultivated area. Measurements of flow are made at Buchanan, in Botetourt County, and at Cartersville, 50 miles above Richmond. The station at Buchanan was established by C. C. Babb and D. C. Humphreys, August 18, 1895. It is about 20 miles above the mouth of North River and one-half mile above the mouth of Purgatory Creek, as shown on the Natural Bridge topographic atlas sheet. The area as far as this point is mapped on the Natural Bridge, Staunton, Monterey, Lewisburg, Dublin, Christiansburg, and Roanoke sheets. The United States Weather Bureau had maintained a gage here for about two years before measurements were made by the Geological Survey. The wire gage is suspended from the steel highway bridge which crosses the river on two spans. On April 3, 1897, the zero of this gage was lowered 2 feet to avoid negative readings. The gage is referred to a scale divided into feet and tenths, and to two bench marks. First, the top of the upper end of the third floor beam from left bank is 30.00 feet above the zero of the gage. Second, the top of a stone post under the southwest corner of the porch of the Chesapeake and Ohio Railroad passenger station is 24.68 feet above zero of gage. A third bench mark is on a permanent ledge of rock on the left bank about 500 feet above the bridge, and at an elevation of 17.48 feet above the zero of the gage. The initial point of soundings is on the left bank, upper side of the bridge, marked with the end pin of the truss. The channel is straight, the flow fairly swift, and without obstructions. The bed is rocky; banks high and not subject to overflow. The observer is U. H. Hyde, a telegraph operator for the Chesapeake and Ohio Railroad, at Buchanan, Virginia. The results of measurement may be found as follows: 1895–96, Eighteenth Annual Report, Part IV, page 41; 1897, Nineteenth Annual Report, Part IV, page 172; 1898, Twentieth Annual Report, Part IV, page 136. During 1899 three measurements of discharge were made by D. C. Humphreys; the first on March 30, at a gage height of 5.54 feet, gave a discharge 6,804 second-feet; the second on July 6, at a gage height of 2.06 feet, gave a discharge 558 second-feet, and the third on August 11, at a gage height of 1.80 feet, gave a discharge of 364 second-feet.

*Daily gage height, in feet, of James River at Buchanan, Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.45 | 3.10 | 7.45 | 4.75 | 3.80 | 3.60 | 3.00 | 1.90 | 1.90 | 1.90 | 1.80 | 1.80 |
| 2 | 3.55 | 3.00 | 6.55 | 4.40 | 3.80 | 3.70 | 2.10 | 1.90 | 1.90 | 1.90 | 1.90 | 1.80 |
| 3 | 3.40 | 3.00 | 6.40 | 4.30 | 3.80 | 3.60 | 2.10 | 1.80 | 1.90 | 1.90 | 2.10 | 1.80 |
| 4 | 3.40 | 3.40 | 11.20 | 4.20 | 3.80 | 3.60 | 2.00 | 1.80 | 2.00 | 1.90 | 2.30 | 1.80 |
| 5 | 3.95 | 4.90 | 19.05 | 4.10 | 3.70 | 3.60 | 2.00 | 1.80 | 2.10 | 1.90 | 2.20 | 1.80 |
| 6 | 5.95 | 6.80 | 13.55 | 4.10 | 3.70 | 3.50 | 2.05 | 1.80 | 2.00 | 1.80 | 2.20 | 1.80 |
| 7 | 10.25 | 8.40 | 8.15 | 4.00 | 4.05 | 3.40 | 2.12 | 1.80 | 1.90 | 1.80 | 2.10 | 1.80 |
| 8 | 7.70 | 7.30 | 6.70 | 5.00 | 5.35 | 3.30 | 2.35 | 1.90 | 1.80 | 1.80 | 2.10 | 1.80 |
| 9 | 5.95 | 6.30 | 5.90 | 5.75 | 7.70 | 3.30 | 2.35 | 1.90 | 2.00 | 1.80 | 2.10 | 1.80 |
| 10 | 5.20 | 4.50 | 5.55 | 5.40 | 6.65 | 3.30 | 2.15 | 1.90 | 2.10 | 1.80 | 2.00 | 1.80 |
| 11 | 4.60 | 4.05 | 5.35 | 5.00 | 5.85 | 3.30 | 2.00 | 1.90 | 2.20 | 1.80 | 2.00 | 1.80 |
| 12 | 4.20 | 4.00 | 5.15 | 4.85 | 5.65 | 3.30 | 2.00 | 1.90 | 2.10 | 1.80 | 1.90 | 2.30 |
| 13 | 4.00 | 4.00 | 4.95 | 4.70 | 5.60 | 4.45 | 2.00 | 1.90 | 2.10 | 1.80 | 1.90 | 3.50 |
| 14 | 3.85 | 3.95 | 4.65 | 4.60 | 6.20 | 4.50 | 2.00 | 2.00 | 2.00 | 1.80 | 1.90 | 3.05 |
| 15 | 4.15 | 3.50 | 4.75 | 4.45 | 5.70 | 4.25 | 1.90 | 2.60 | 2.00 | 1.80 | 1.90 | 2.95 |
| 16 | 4.30 | 3.60 | 5.55 | 4.45 | 5.20 | 3.95 | 1.90 | 2.45 | 1.90 | 1.80 | 1.90 | 2.60 |
| 17 | 4.20 | 3.75 | 5.30 | 4.30 | 4.85 | 3.70 | 1.90 | 2.20 | 1.90 | 1.80 | 1.80 | 2.45 |
| 18 | 4.20 | 4.15 | 5.05 | 4.05 | 4.65 | 3.55 | 1.90 | 2.00 | 1.80 | 1.80 | 1.80 | 2.30 |
| 19 | 4.05 | 4.85 | 7.15 | 4.00 | 4.50 | 3.40 | 1.90 | 1.90 | 2.45 | 1.80 | 1.80 | 2.20 |
| 20 | 3.75 | 5.70 | 7.80 | 3.90 | 4.35 | 3.30 | 1.90 | 1.90 | 3.60 | 1.80 | 1.80 | 2.20 |
| 21 | 3.60 | 8.20 | 6.35 | 3.90 | 4.05 | 3.20 | 1.90 | 1.80 | 3.40 | 1.70 | 1.80 | 2.10 |
| 22 | 3.50 | 10.20 | 5.65 | 3.80 | 4.00 | 3.10 | 1.80 | 1.80 | 2.65 | 1.70 | 1.80 | 2.10 |
| 23 | 3.50 | 9.35 | 5.20 | 3.80 | 3.90 | 3.10 | 1.80 | 1.80 | 2.35 | 1.70 | 1.80 | 2.10 |
| 24 | 3.40 | 7.35 | 4.80 | 3.70 | 3.90 | 3.00 | 1.80 | 1.80 | 2.20 | 1.70 | 1.80 | 2.10 |
| 25 | 3.40 | 6.15 | 4.55 | 3.70 | 3.90 | 3.15 | 1.80 | 1.80 | 2.10 | 1.70 | 1.80 | 2.10 |
| 26 | 3.60 | 5.40 | 4.25 | 3.85 | 3.80 | 3.10 | 1.80 | 1.80 | 2.10 | 1.70 | 1.80 | 2.25 |
| 27 | 3.50 | 8.90 | 4.10 | 4.20 | 3.60 | 3.65 | 1.90 | 1.90 | 2.00 | 1.70 | 1.80 | 2.30 |
| 28 | 3.40 | 9.65 | 4.00 | 4.00 | 3.60 | 3.30 | 1.90 | 1.80 | 2.00 | 1.70 | 1.80 | 2.20 |
| 29 | 3.30 | ....... | 4.80 | 4.00 | 3.50 | 3.20 | 2.00 | 2.00 | 2.00 | 1.70 | 1.80 | 2.20 |
| 30 | 3.20 | ....... | 5.55 | 3.90 | 3.60 | 3.10 | 2.00 | 1.90 | 1.90 | 1.70 | 1.80 | 2.20 |
| 31 | 3.10 | ....... | 5.75 | ....... | 3.60 | ....... | 1.90 | 1.90 | ....... | 1.70 | ....... | 2.20 |

## JAMES RIVER AT CARTERSVILLE, VIRGINIA.

Observations of the height of James River are made by the Weather Bureau at Lynchburg, Virginia, 48 miles below Buchanan and about 100 miles above Cartersville. The drainage area is given as 3,700 square miles. The gage is on the first pier of the Amherst bridge, at the foot of Ninth street, on the side facing Lynchburg, about 100 feet from the shore. The elevation is 494.7 feet above mean sea level. The highest water was about 27 feet on September 30, 1870, and the lowest —0.3 foot on September 12–15, 1895.

Gages were established on James River in 1893 by Mr. F. B. Isaacs, engineer for water power of the Chesapeake and Ohio Railway Company, at Ninemile Locks, Columbia, Scottsville, Lynchburg, Balcony Falls, Buchanan, Eagle Mountain, and Clifton Forge. Records of heights of water at these points were made twice daily from 1893 to 1897, and freshet reports were obtained for these years. The gages were not referred to any fixed datum, but the zero of each gage was set at what was considered ordinary low water in the river. During the latter part of 1899 records have been resumed, excepting at Scottsville, Balcony Falls, and Eagle Mountain, where the gages have been abandoned.

At Bosher's dam, 9 miles above Richmond, is a gage where the height of water is recorded twice daily, showing the supposed head on the crest of dam. This crest, however, is so irregular that the coefficient of discharge has not been ascertained. Another complication exists in the fact that water is deflected into a canal, the quantity not being known.

Observations are maintained by the Weather Bureau at Richmond, Virginia, the gage being at the foot of Virginia street, near Fourteenth, immediately east of the Richmond and Danville Railroad bridge. It is a standard brass Weather Bureau gage embedded in the cement buttress. The elevation of the zero is 2.8 feet.

A gaging station was established January 1, 1899, by Prof. D. C. Humphreys, and is located at the highway bridge crossing the James at Cartersville, one-half mile from railroad station and 50 miles above Richmond, Virginia. The drainage area is mapped on the following atlas sheets: Goochland, Farmville, Palmyra, Gordonsville, Harrisonburg, Buckingham, Lexington, Lynchburg, Appomatox, Natural Bridge, Lewisburg, Christiansburg, Roanoke, Staunton, Monterey, and Dublin. The wire gage is attached to a horizontal gage rod fastened to the bridge and is referred to a bench mark, the top of the lower end of the fourth floor beam from the right bank, which is 32.04 feet above the zero of the gage. The gage was verified June 23, 1899. The channel is straight for one-third of a mile above and 1 mile below the station, the current fairly swift, and the bottom somewhat sandy and shifting. The banks are high and not subject to overflow except in extreme high water. The observer is Julien I. Palmore, clerk in a store at Cartersville, Virginia. The following measurements were made by Prof. D. C. Humphreys and F. H. Anschutz. Prior to 1899 two measurements were made, which have not previously been published:

September 8, 1897, gage height, 0.42 foot; discharge, 603 second-feet.
July 16, 1898, gage height, 1.04 feet; discharge, 1,323 second-feet.
January 3, 1899, gage height, 3.82 feet; discharge, 7,156 second-feet.
June 23, 1899, gage height, 1.46 feet; discharge, 2,686 second-feet.

*Daily gage height, in feet, of James River at Cartersville, Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.40 | 3.30 | 13.90 | 6.05 | 3.00 | 2.30 | 1.53 | 1.30 | 1.40 | 1.30 | 4.97 | 1.20 |
| 2 | 4.40 | 3.25 | 10.35 | 5.62 | 2.85 | 2.20 | 1.35 | 1.10 | 1.32 | 1.15 | 4.15 | 1.20 |
| 3 | 3.70 | 3.20 | 8.80 | 5.15 | 2.80 | 2.70 | 1.25 | 1.00 | 2.90 | 1.10 | 3.60 | 1.20 |
| 4 | 4.00 | 4.30 | 9.40 | 4.65 | 3.05 | 2.40 | 1.12 | .90 | 1.44 | 1.10 | 5.30 | 1.20 |
| 5 | 4.00 | 5.65 | 20.25 | 4.60 | 2.80 | 2.27 | 1.22 | .85 | 1.35 | 1.10 | 3.30 | 1.20 |
| 6 | 8.20 | 7.50 | 24.70 | 4.25 | 2.80 | 2.10 | 1.25 | 2.30 | 1.15 | 1.05 | 2.80 | 1.20 |
| 7 | 19.50 | 8.80 | 19.25 | 4.15 | 3.65 | 2.05 | 1.30 | 2.00 | 1.15 | 1.00 | 2.50 | 1.20 |
| 8 | 15.40 | 10.50 | 13.17 | 9.55 | 4.50 | 1.97 | 1.47 | 1.45 | 1.30 | 1.80 | 2.20 | 1.15 |
| 9 | 11.74 | 8.75 | 10.40 | 8.50 | 5.00 | 1.75 | 1.20 | 1.35 | 1.60 | 2.00 | 1.95 | 1.10 |
| 10 | 9.00 | 6.40 | 10.90 | 8.15 | 6.20 | 1.80 | 1.15 | 1.10 | 1.44 | 2.05 | 1.85 | 1.00 |
| 11 | 7.05 | 5.10 | 8.60 | 7.12 | 6.50 | 2.00 | 1.06 | 1.00 | 1.27 | 1.50 | 1.60 | 1.00 |
| 12 | 5.98 | 5.10 | 7.30 | 6.15 | 7.30 | 2.30 | 1.24 | 1.26 | 1.20 | 1.40 | 1.50 | 1.10 |
| 13 | 5.40 | 5.10 | 7.10 | 4.90 | 5.05 | 3.10 | 1.09 | 1.19 | 1.30 | 1.30 | 1.45 | 3.15 |
| 14 | 5.17 | 5.10 | 6.90 | 4.70 | 5.65 | 3.45 | 1.02 | 1.09 | 1.31 | 1.20 | 1.75 | 2.80 |
| 15 | 5.17 | 6.00 | 8.12 | 4.50 | 5.15 | 3.40 | 1.00 | 1.10 | 1.13 | 1.10 | 1.50 | 3.10 |
| 16 | 4.70 | 7.75 | 10.65 | 4.15 | 5.15 | 3.47 | 1.07 | 2.64 | 1.05 | 1.10 | 1.30 | 2.90 |
| 17 | 5.47 | 14.00 | 8.30 | 4.07 | 4.45 | 3.00 | 1.00 | 2.12 | 1.00 | 1.00 | 1.30 | 2.80 |
| 18 | 5.15 | 9.75 | 8.05 | 3.95 | 3.90 | 2.10 | 1.04 | 1.40 | .92 | 1.20 | 1.25 | 2.40 |
| 19 | 4.73 | 10.55 | 17.33 | 3.75 | 3.65 | 2.00 | 1.15 | 1.30 | .85 | 1.10 | 1.25 | 1.80 |
| 20 | 4.50 | 10.55 | 18.32 | 3.60 | 3.40 | 1.78 | 1.05 | 1.15 | 3.40 | 1.00 | 1.25 | 1.80 |
| 21 | 4.20 | 14.00 | 12.83 | 3.55 | 3.17 | 1.70 | .88 | .97 | 5.40 | .98 | 1.25 | 1.60 |
| 22 | 4.05 | 16.10 | 8.80 | 3.47 | 2.86 | 1.50 | .82 | .80 | 3.40 | .97 | 1.25 | 1.50 |
| 23 | 3.85 | 16.30 | 8.00 | 3.32 | 2.80 | 1.48 | .80 | .80 | 2.65 | .98 | 1.25 | 1.45 |
| 24 | 3.75 | 13.75 | 7.60 | 3.17 | 2.70 | 1.40 | .77 | .82 | 2.10 | 1.00 | 1.25 | 1.60 |
| 25 | 4.30 | 11.00 | 6.65 | 3.08 | 2.50 | 1.40 | .70 | .76 | 1.30 | 1.00 | 1.25 | 1.80 |
| 26 | 4.10 | 8.65 | 6.15 | 3.05 | 2.45 | 1.70 | .80 | .66 | 3.50 | .98 | 1.25 | 2.00 |
| 27 | 3.80 | 10.90 | 5.85 | 3.20 | 2.45 | 2.10 | 2.23 | 7.00 | 2.35 | .97 | 1.20 | 2.10 |
| 28 | 3.75 | 12.30 | 5.25 | 3.25 | 2.15 | 1.60 | 2.30 | 6.45 | 1.70 | .97 | 1.20 | 2.00 |
| 29 | 3.55 | ...... | 6.35 | 3.30 | 2.05 | 1.40 | 1.33 | 3.50 | 1.40 | .97 | 1.20 | 1.80 |
| 30 | 3.50 | ...... | 6.15 | 3.10 | 2.20 | 1.80 | 1.40 | 2.70 | 1.30 | .97 | 1.20 | 1.75 |
| 31 | 3.42 | ...... | 6.55 | ...... | 2.25 | ...... | 1.70 | 1.84 | ...... | .97 | ...... | 1.65 |

NOTE.—Data concerning other rivers are given in succeeding papers of this series, beginning on page 107 of Water-Supply Paper No 36. By the law approved June 11, 1896 (Stat. L., vol. 29, p. 453), the reports of this series are limited to 100 pages each. It is therefore necessary to arbitrarily subdivide this report on operations at river stations.



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**1895.**

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Robert Hay.

A geological reconnaissance of northwestern Wyoming, by George H. Eldridge 1894; octavo, 72 pp. Bulletin No. 119 of the United States Geological Survey, price, 10 cents.

Contains a description of the geologic structure of portions of the Bighorn Range and Bighorn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 176 pp. Bulletin No. 131 of the United States Geological Survey; price, 15 cents.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in a number of counties in western Nebraska, western Kansas, and eastern Colorado.

**1896.**

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett, and "Preliminary report on the artesian waters of a portion of the Dakotas," by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 230 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey; price, 20 cents.

Gives a description of the geologic conditions of the coastal region from Long Island, N. Y., to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey; price, 25 cents.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

**1897.**

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part IV, Hydrography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the calendar year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in South Dakota," by N. H. Darton, and "Reservoirs for irrigation," by J. D. Schuyler.

**1899.**

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Part IV, Hydrography, 1899; octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton, and "A preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

**1900.**

Twentieth Annual Report of the United States Geological Survey, 1898–99, Part IV, Hydrography, 1900; octavo, 660 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell, and "Hydrography of Nicaragua," by A. P. Davis.

WATER-SUPPLY AND IRRIGATION PAPERS, 1896–1900.

This series of papers is designed to present in pamphlet form the results of stream measurements and of special investigations. A list of these, with other information, is given on the outside (or fourth) page of this cover.

Survey bulletins can be obtained only by prepayment of cost, as noted above. Money should be transmitted by postal money order or express order, made payable to the Director of the United States Geological Survey. Postage stamps, checks, and drafts can not be accepted. Correspondence relating to the publications of the Survey should be addressed to **The Director, United States Geological Survey, Washington, D. C.**

## WATER-SUPPLY AND IRRIGATION PAPERS.

1. Pumping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phœnix, Arizona, by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A reconnoissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill. 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E. C. Murphy, 1897.
9. Irrigation near Greeley, Colorado, by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Water resources of southeastern Nebraska, by Nelson Horatio Darton, 1898.
13. Irrigation systems in Texas, by William Ferguson Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15. Operations at river stations, 1897, Part I, 1898.
16. Operations at river stations, 1897, Part II, 1898.
17. Irrigation near Bakersfield, California, by C. E. Grunsky, 1898.
18. Irrigation near Fresno, California, by C. E. Grunsky, 1898.
19. Irrigation near Merced, California, by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of northern Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems of the Bighorn Mountains, by Elwood Mead, 1899.
24. Water resources of the State of New York, Part I, by George W. Rafter, 1899.
25. Water resources of the State of New York, Part II, by George W. Rafter, 1899.
26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett, 1899.
27. Operations at river stations, 1898, Part I, 1899.
28. Operations at river stations, 1898, Part II, 1899.
29. Wells and windmills in Nebraska, by Erwin Hinckley Barbour, 1899.
30. Water resources of the Lower Peninsula of Michigan, by Alfred C. Lane, 1899.
31. Lower Michigan mineral waters, by Alfred C. Lane, 1899.
32. Water resources of Puerto Rico, by H. M. Wilson, 1900.
33. Storage of water on Gila River, Arizona, by J. B. Lippincott, 1900.
34. Underground waters of a portion of southeastern S. Dak., by J. E. Todd, 1900.
35. Operations at river stations, 1899, Part I, 1900.
36. Operations at river stations, 1899, Part II, 1900.
37. Operations at river stations, 1899, Part III, 1900.

In addition to the above, there are in various stages of preparation other papers relating to the measurement of streams, the storage of water, the amount available from underground sources, the efficiency of windmills, the cost of pumping, and other details relating to the methods of utilizing the water resources of the country. Provision has been made for printing these by the following clause in the sundry civil act making appropriations for the year 1896–97:

*Provided*, That hereafter the reports of the Geological Survey in relation to the gaging of streams and to the methods of utilizing the water resources may be printed in octavo form, not to exceed 100 pages in length and 5,000 copies in number; 1,000 copies of which shall be for the official use of the Geological Survey, 1,500 copies shall be delivered to the Senate, and 2,500 copies shall be delivered to the House of Representatives, for distribution. [Approved June 11, 1896; Stat. L., vol. 29, p. 453.]

The maximum number of copies available for the use of the Geological Survey is 1,000. This number falls far short of the demand, so that it is impossible to supply all requests. Attempts are made to send these pamphlets to persons who have rendered assistance in their preparation through replies to schedules or who have furnished data. Requests specifying a certain paper and stating a reason for asking for it are granted whenever practicable, but it is impossible to comply with general and indiscriminate demands, such as to have all of the series sent.

Application for these papers should be made either to Members of Congress or to

THE DIRECTOR,

UNITED STATES GEOLOGICAL SURVEY,

*Washington, D. C.*

DEPARTMENT OF THE INTERIOR



# WATER-SUPPLY

AND

# IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY



## No. 36

OPERATIONS AT RIVER STATIONS, 1899.—Part II

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

## IRRIGATION REPORTS.

The following list contains the titles and brief descriptions of the principal reports relating to water supply and irrigation prepared by the United States Geological Survey since 1890:

### 1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888-89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

### 1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889-90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 29 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890-91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; and "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell; quarto.

No. 35, Irrigation in Arizona; No. 60, Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

### 1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc., of irrigated holdings, the total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps showing the location and relative extent of the irrigated areas.

### 1893.

Thirteenth Annual Report of the United States Geological Survey, 1891-92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering" and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; and "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnoissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 15 plates. Bulletin No. 108 of the United States Geological Survey; price, 15 cents.

Contains a description of the examination of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

### 1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892-93, in two parts; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; and "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.

(Continued on third page of cover.)

DEPARTMENT OF THE INTERIOR

# WATER-SUPPLY

AND

# IRRIGATION PAPERS

OF THE

## UNITED STATES GEOLOGICAL SURVEY

## No. 36

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

# OPERATIONS AT RIVER STATIONS, 1899

A REPORT OF THE

DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

## PART II

WASHINGTON

GOVERNMENT PRINTING OFFICE

1900

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# OPERATIONS AT RIVER STATIONS, 1899.

## Part II.

### MEASUREMENTS AT RIVER STATIONS.[1]

#### ROANOKE RIVER AT ROANOKE, VIRGINIA.

This river rises in Montgomery County, Virginia. Its headwaters are near those of New River on the west. This stream lower down is known as Staunton River, and joins the Dan at Danville to form the main lower Roanoke River. There are a number of fine water powers along its length, described more fully in the Nineteenth Annual Report, Part IV, page 176. The drainage area is mapped on the Roanoke and Christiansburg sheets. The gaging station was established by Prof. D. C. Humphreys July 10, 1896, and is located on the edge of the town of Roanoke, Virginia, on the Walnut street car line. The gage is of wire, with the rod fastened to the floor of the bridge. The top of the lower end of the first floor beam is 21.99 feet above gage datum. The length of gage wire is 24.39 feet. The right bank is above high water, but the left is liable to overflow in extreme high stages. The channel is nearly straight and the current good. The results of discharge measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 42; 1897–98, Twentieth Annual Report, Part IV, page 140. The following measurements were made during 1899 by D. C. Humphreys: The first, on May 29, at a gage height of 2.51 feet, gave a discharge of 1,123 second-feet; the second one, on June 27, at a gage height of 1.32 feet, gave a discharge of 290 second-feet; the third, on August 7, at a gage height of 0.88 foot, gave a discharge of 135 second-feet.

[1] Continued from Water-Supply and Irrigation Paper No. 35.

*Daily gage height, in feet, of Roanoke River at Roanoke, Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.80 | 2.25 | 3.20 | 2.00 | 1.43 | 1.15 | 1.00 | 0.90 | 0.75 | 0.65 | 1.20 | 0.80 |
| 2 | 1.80 | 2.20 | 2.95 | 1.88 | 1.40 | 1.30 | 1.05 | .80 | .85 | .65 | 1.17 | .80 |
| 3 | 1.75 | 2.05 | 2.85 | 1.79 | 1.39 | 1.18 | 1.03 | .80 | 1.00 | .65 | 1.25 | .75 |
| 4 | 2.00 | 3.10 | 6.15 | 1.75 | 1.35 | 1.06 | 1.00 | .70 | .85 | .65 | 1.30 | .75 |
| 5 | 1.90 | 3.50 | 8.15 | 1.73 | 1.32 | 1.00 | 1.00 | .70 | .75 | .65 | 1.10 | .75 |
| 6 | 3.13 | 3.75 | 4.70 | 1.67 | 1.32 | .98 | 1.00 | .80 | .75 | .63 | 1.05 | .75 |
| 7 | 5.85 | 4.08 | 3.68 | 1.62 | 1.41 | .97 | 1.05 | .90 | .70 | .60 | 1.00 | .77 |
| 8 | 3.55 | 3.90 | 3.10 | 2.10 | 1.80 | .95 | .98 | .85 | .65 | .85 | .95 | .80 |
| 9 | 2.90 | 3.85 | 3.00 | 1.90 | 2.03 | .90 | .93 | .85 | .70 | .90 | .90 | .78 |
| 10 | 2.40 | 3.60 | 2.80 | 1.80 | 1.85 | .95 | .90 | .85 | .65 | .80 | .85 | .75 |
| 11 | 2.50 | 3.50 | 2.70 | 1.75 | 1.76 | 1.00 | .85 | .75 | .60 | .85 | .83 | .75 |
| 12 | 2.40 | 2.45 | *a*3.10 | 1.70 | 1.70 | 1.75 | .82 | .75 | .57 | .80 | .80 | 1.50 |
| 13 | 2.30 | 2.25 | *a*3.50 | 1.66 | 1.82 | 2.25 | .80 | .95 | .70 | .75 | .80 | 1.55 |
| 14 | 2.80 | *a*2.22 | 3.90 | 1.63 | 1.85 | 1.90 | .80 | 1.00 | .65 | .70 | .80 | 1.30 |
| 15 | 2.70 | 2.20 | 4.75 | 1.60 | 1.75 | 1.65 | .95 | 1.00 | .65 | .70 | .80 | 1.15 |
| 16 | 2.55 | 2.20 | 4.25 | 1.55 | 1.66 | 1.45 | .83 | .95 | .65 | .80 | .78 | 1.05 |
| 17 | 2.45 | 3.55 | 3.70 | 1.52 | 1.57 | 1.30 | .75 | .90 | .65 | .77 | .78 | .95 |
| 18 | 2.30 | 3.25 | 3.45 | 1.47 | 1.46 | 1.18 | 1.05 | .80 | .65 | .75 | .75 | .90 |
| 19 | 2.20 | 3.50 | 7.10 | 1.45 | 1.40 | 1.15 | .90 | .75 | 1.46 | .73 | .75 | .90 |
| 20 | 2.15 | 3.95 | 4.90 | 1.40 | 1.31 | 1.10 | .85 | .72 | 2.05 | .70 | .73 | .90 |
| 21 | 2.10 | 4.50 | 3.90 | 1.40 | 1.28 | 1.08 | .82 | .70 | 1.25 | .70 | .73 | .88 |
| 22 | 2.07 | 4.40 | 3.55 | 1.37 | 1.25 | 1.05 | .78 | .67 | 1.00 | .68 | .70 | .85 |
| 23 | 2.05 | 3.75 | 3.35 | 1.36 | 1.35 | 1.00 | .80 | .65 | .85 | .68 | .75 | .80 |
| 24 | 2.50 | 3.25 | 3.15 | 1.34 | 1.27 | 1.00 | .85 | .63 | .80 | .68 | .75 | 1.10 |
| 25 | 2.25 | 2.90 | 3.00 | 1.38 | 1.20 | 1.10 | .90 | .60 | .80 | .68 | .75 | 1.05 |
| 26 | 2.15 | 2.70 | 2.35 | 1.75 | 1.16 | 2.15 | .85 | .65 | .75 | .65 | .73 | .95 |
| 27 | 2.10 | 5.00 | 2.40 | 1.70 | 1.15 | 1.45 | 1.15 | .75 | .85 | .65 | .73 | .90 |
| 28 | 2.05 | 3.65 | 2.45 | 1.60 | 1.13 | 1.15 | 1.00 | .85 | .75 | .65 | .75 | 1.25 |
| 29 | *a*2.10 | ....... | 2.30 | 1.50 | 1.10 | 1.05 | .85 | 1.00 | .70 | .65 | 1.00 | 1.30 |
| 30 | *a*2.20 | ....... | 2.15 | 1.48 | 1.20 | 1.00 | .82 | .85 | .65 | .73 | .85 | 1.45 |
| 31 | 2.25 | ....... | 2.10 | ....... | 1.13 | ....... | 1.05 | .80 | ....... | .80 | ....... | 1.60 |

*a* Interpolated.

Main Roanoke River is formed by the junction of Dan and Staunton rivers at Clarksville, Virginia, and flows southerly, entering Albemarle Sound. The United States Weather Bureau has a station on Dan River at Danville, Virginia, 55 miles above the mouth of Staunton River. The gage is of timber, and is attached to the first pier of the iron bridge between North and South Danville. The highest water was 13.0, on September 13, 1893; lowest, 0.02, on January 26, 1894. The danger line is at 8 feet. The drainage area above the station is 1,900 square miles, according to the United States Weather Bureau.

A second gaging station is maintained by the United States Weather Bureau on Roanoke River at Clarksville, Virginia, 65 miles above Weldon, North Carolina. The river gage is on the south side of the river, attached to a tree leaning over the water. The highest recorded water was 13.5 feet, on September 14, 1893, and the lowest—0.2 foot, on July 19, 1894. It is reported that on November 27, 1877, a height of 27 feet was reached. The danger line is at 12 feet. The drainage area above the station is 6,900 square miles, according to the United States Weather Bureau.

The third station maintained by the Weather Bureau on this river is erected at Weldon, North Carolina, 30 miles above Neal and 90 miles above Albemarle Sound. The river gage is located below the Atlantic Coast Line Railroad bridge, on the south side of the river. The gage is of white pine and is made of three sections, the lowest section, 4 feet to 17 feet, is of detached pieces fastened to trees which lean over the river; the second section, 17 feet to 47 feet, is attached to the fore bay of the Roanoke mills; above 47 feet the gage is painted on the mill building. The zero of the gage is 4 feet below a large rock, known as "Big Cuba." It is 31 feet below the railroad crossing. The highest recorded water is 46.8 feet, on November 26, 1877; the lowest, —0.3, on August 21, 1893. The danger line is at 27 feet. The drainage area above Weldon, according to the United States Weather Bureau, is 8,180 square miles.

### ROANOKE RIVER AT NEAL, NORTH CAROLINA.

This station, described in the Eighteenth Annual Report, Part IV, page 47, was established July 27, 1896, and is on the Norfolk and Carolina Railroad bridge, near Neal, North Carolina. The bench marks for the gage rod are described in Water-Supply Paper No. 15, page 28. The length of the gage wire is 44.66 feet. The section is a fairly good one, the course of the river being straight for some distance above and below the station and the bottom smooth. Being muddy, however, the bed is apt to cut out in seasons of high water and both banks are subject to overflow. The observer is the bridge watchman, Mr. W. M. Adams, of Neal, North Carolina. Records of measurement may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 48; 1897, Nineteenth Annual Report, Part IV, page 181; 1898, Twentieth Annual Report, Part IV, page 142. The measurements made by E. W. Myers during 1899 are as follows:

February 5, gage height, 20.80 feet; discharge, 23,998 second-feet.
May 25, gage height, 6.41 feet; discharge, 6,045 second-feet.
June 7, gage height, 6.45 feet; discharge, 6,110 second-feet.
October 12, gage height, 8.60 feet; discharge, 7,973 second-feet.
November 28, gage height, 4.13 feet; discharge, 4,439 second-feet.

*Daily gage height, in feet, of Roanoke River at Neal, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.40 | 9.10 | 22.80 | 20.60 | 10.50 | 8.10 | 8.40 | 7.30 | 11.00 | 3.60 | 4.30 | 4.00 |
| 2 | 7.60 | 10.20 | 23.40 | 19.10 | 9.50 | 10.30 | 7.20 | 6.50 | 8.20 | 3.00 | 10.50 | 4.20 |
| 3 | 10.50 | 10.70 | 22.80 | 17.40 | 9.00 | 12.20 | 5.70 | 5.90 | 5.70 | 2.70 | 12.30 | 4.30 |
| 4 | 14.20 | 11.00 | 21.80 | 16.00 | 9.10 | 12.60 | 4.70 | 5.10 | 4.10 | 2.50 | 12.00 | 4.20 |
| 5 | 13.10 | 20.75 | 22.70 | 15.20 | 9.00 | 10.50 | 4.20 | 3.80 | 3.90 | 2.30 | 13.40 | 4.10 |
| 6 | 11.35 | 22.35 | 24.00 | 14.90 | 8.80 | 8.30 | 4.20 | 3.50 | 5.70 | 2.80 | 14.15 | 3.95 |
| 7 | 10.80 | 23.95 | 25.25 | 15.00 | 8.70 | 6.50 | 4.60 | 3.60 | 5.00 | 5.30 | 12.10 | 3.80 |
| 8 | 17.25 | 25.55 | 26.08 | 17.70 | 8.60 | 5.40 | 7.10 | 4.20 | 4.00 | 6.90 | 9.50 | 3.50 |
| 9 | 23.25 | 26.80 | 26.10 | 21.40 | 8.70 | 4.90 | 11.10 | 5.60 | 3.10 | 7.80 | 7.60 | 3.30 |
| 10 | 25.50 | 27.05 | 25.10 | 23.00 | 8.90 | 4.60 | 11.20 | 6.70 | 2.70 | 9.10 | 6.30 | 3.20 |
| 11 | 27.75 | 26.40 | 23.20 | 23.60 | 10.80 | 5.00 | 9.80 | 6.20 | 3.70 | 9.90 | 5.50 | 3.10 |
| 12 | 26.80 | 24.50 | 21.20 | 22.30 | 11.30 | 8.10 | 7.50 | 5.00 | 5.80 | 8.70 | 5.10 | 3.20 |
| 13 | 24.55 | 21.30 | 19.20 | 20.20 | 13.00 | 17.80 | 5.50 | 5.40 | 6.00 | 6.90 | 4.60 | 3.50 |
| 14 | 22.25 | 17.50 | 17.60 | 18.30 | 12.60 | 21.50 | 4.20 | 7.30 | 5.50 | 5.50 | 4.30 | 7.00 |
| 15 | 21.80 | 14.30 | 17.70 | 16.80 | 11.90 | 22.40 | 3.50 | 5.40 | 4.30 | 4.50 | 4.10 | 11.50 |
| 16 | 21.00 | 12.50 | 22.80 | 15.40 | 11.40 | 22.40 | 3.20 | 4.50 | 3.40 | 3.90 | 4.00 | 11.50 |
| 17 | 19.05 | 12.90 | 23.80 | 14.30 | 10.40 | 21.00 | 3.10 | 6.50 | 2.90 | 3.60 | 3.90 | 9.20 |
| 18 | 18.00 | 19.50 | 25.70 | 13.40 | 9.20 | 18.10 | 3.30 | 10.90 | 2.40 | 3.45 | 3.80 | 7.20 |
| 19 | 16.90 | 19.60 | 26.80 | 12.60 | 8.10 | 15.20 | 3.40 | 9.20 | 2.10 | 3.30 | 3.70 | 6.00 |
| 20 | 15.80 | 24.70 | 26.10 | 11.90 | 7.50 | 12.40 | 4.20 | 7.20 | 2.00 | 3.25 | 3.60 | 5.10 |
| 21 | 14.40 | 26.80 | 26.10 | 11.40 | 7.10 | 10.20 | 4.50 | 5.40 | 2.00 | 3.00 | 3.50 | 4.70 |
| 22 | 13.20 | 27.25 | 27.80 | 10.50 | 6.90 | 8.60 | 4.80 | 4.30 | 11.25 | 3.20 | 3.40 | 4.40 |
| 23 | 12.20 | 26.90 | 30.00 | 10.00 | 6.60 | 7.30 | 3.90 | 3.30 | 14.00 | 2.90 | 3.35 | 4.30 |
| 24 | 11.30 | 26.20 | 29.35 | 9.70 | 6.30 | 6.30 | 3.80 | 2.80 | 10.60 | 2.80 | 3.35 | 4.45 |
| 25 | 10.80 | 25.20 | 27.40 | 9.40 | 6.40 | 5.20 | 4.70 | 2.40 | 7.55 | 2.70 | 3.60 | 6.40 |
| 26 | 10.30 | 23.60 | 25.50 | 9.10 | 6.90 | 4.80 | 4.80 | 2.10 | 5.40 | 2.60 | 3.80 | 8.40 |
| 27 | 10.10 | 22.00 | 22.80 | 9.40 | 7.00 | 4.40 | 7.20 | 1.80 | 4.70 | 2.60 | 4.00 | 8.60 |
| 28 | 9.90 | 21.80 | 20.70 | 11.80 | 6.40 | 4.30 | 7.30 | 1.60 | 4.90 | 2.60 | 4.10 | 8.10 |
| 29 | 8.70 | ...... | 19.60 | 12.30 | 5.90 | 6.30 | 11.80 | 1.70 | 5.10 | 2.70 | 3.80 | 6.80 |
| 30 | 8.20 | ...... | 20.10 | 11.60 | 5.60 | 6.70 | 11.90 | 13.70 | 4.60 | 2.70 | 3.70 | 5.60 |
| 31 | 8.60 | ...... | 21.00 | ...... | 5.90 | ...... | 9.50 | 12.90 | ...... | 3.00 | ...... | 3.50 |

## TAR RIVER AT TARBORO, NORTH CAROLINA.

Tar River rises in the north-central part of North Carolina and flows in a southeasterly direction into Pamlico River. It crosses the fall line at Rocky Mount, North Carolina, where is located the principal power on the river. The fall below this point is from 1 to 1½ feet per mile. The fall above this point is about 2 feet per mile, concentrated at a number of points where small powers can be developed. The drainage basin is largely covered with forest. The stream is subject to violent freshets and periods of very low flow. The gaging station, as described in the Eighteenth Annual Report, Part IV, page 50, is on the Atlantic Coast Line bridge, crossing the river at Tarboro, North Carolina, and was established by E. W. Myers on July 24, 1896. The length of the wire gage is 38.30 feet. The channel is straight, the current moderately swift, the banks low and flooded in high water. The bed is sandy and fairly constant. Sand bars slightly obstruct the flow of the river. The observer is R. H. Williams, who reads the gage once a day. Measurements of discharge are made at the highway bridge which crosses the stream about 200 yards above, this point furnishing a better station. Records of flow may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 52; 1897, Nineteenth Annual Report, Part IV, page 184; 1898, Twentieth Annual Report, Part IV, page 143. The following measurements were made by E. W. Myers during 1899:

February 5, gage height, 9.10 feet; discharge, 5,165 second-feet.
May 24, gage height, 2.60 feet: discharge, 1,125 second-feet.
June 7, gage height, 2.00 feet; discharge, 798 second-feet.
October 16, gage height, 2.95 feet; discharge, 1,150 second-feet.
November 28, gage height, 2.20 feet; discharge, 875 second-feet.

*Daily gage height, in feet, of Tar River at Tarboro, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.20 | 6.30 | 15.00 | 8.60 | 4.60 | 2.40 | 1.00 | 10.00 | 0.60 | 1.70 | 4.30 | 3.70 |
| 2 | 3.10 | 7.20 | 14.80 | 7.80 | 4.10 | 3.50 | 1.00 | 10.60 | .50 | 1.30 | 6.50 | 2.80 |
| 3 | 3.40 | 8.30 | 15.40 | 7.20 | 3.90 | 3.00 | .95 | 9.60 | .40 | 1.40 | 9.30 | 2.70 |
| 4 | 3.70 | 8.50 | 16.70 | 6.30 | 4.00 | 2.90 | 1.00 | 7.70 | .30 | .90 | 9.70 | 3.00 |
| 5 | 3.50 | 8.90 | 16.50 | 7.00 | 3.90 | 3.00 | .95 | 5.50 | .60 | .80 | 6.50 | 3.20 |
| 6 | 3.30 | 12.50 | 17.80 | 8.00 | 3.80 | 2.50 | .70 | 4.50 | .50 | 1.40 | 5.70 | 2.80 |
| 7 | 3.40 | 15.70 | 18.30 | 8.90 | 3.60 | 2.00 | 3.20 | 4.00 | .40 | 2.20 | 5.20 | 2.60 |
| 8 | 3.50 | 18.60 | 18.60 | 11.70 | 3.50 | 1.60 | 2.50 | 3.70 | .50 | 7.00 | 4.60 | 2.50 |
| 9 | 3.40 | 21.90 | 18.40 | 14.50 | 3.60 | 1.50 | 2.00 | 4.50 | .70 | 8.70 | 4.20 | 2.30 |
| 10 | 4.30 | 24.10 | 16.40 | 16.50 | 3.70 | 3.00 | 1.50 | 4.90 | 3.00 | 7.30 | 3.60 | 2.30 |
| 11 | 3.40 | 25.00 | 13.80 | 17.80 | 3.80 | 2.80 | 1.60 | 3.80 | 1.60 | 6.80 | 3.40 | 2.00 |
| 12 | 3.30 | Ice. | 11.10 | 18.30 | 3.60 | 2.50 | 2.50 | 3.10 | 3.60 | 6.00 | 3.00 | 2.20 |
| 13 | 3.70 | Ice. | 9.00 | 17.00 | 3.50 | 5.40 | 1.60 | 2.60 | 5.00 | 5.20 | 2.70 | 2.40 |
| 14 | 4.80 | Ice. | 8.20 | 14.40 | 4.30 | 7.60 | 1.40 | 3.00 | 3.30 | 4.30 | 2.60 | 3.00 |
| 15 | 6.80 | 14.75 | 9.80 | 10.70 | 4.00 | 9.30 | 1.10 | 4.10 | 2.10 | 3.50 | 2.40 | 3.70 |
| 16 | 8.80 | 11.70 | 13.80 | 8.00 | 4.30 | 10.60 | 1.00 | 3.80 | 1.60 | 3.00 | 2.30 | 3.50 |
| 17 | 10.30 | 11.80 | 16.70 | 7.00 | 3.70 | 9.50 | .90 | 4.30 | 1.50 | 2.70 | 2.40 | 2.90 |
| 18 | 10.40 | 14.10 | 19.00 | 6.20 | 3.10 | 9.80 | 1.10 | 5.20 | 1.10 | 2.40 | 2.20 | 2.60 |
| 19 | 9.10 | 17.00 | 20.90 | 5.80 | 2.80 | 8.80 | 1.40 | 6.00 | 1.00 | 2.20 | 2.00 | 2.50 |
| 20 | 8.30 | 19.00 | 21.00 | 5.40 | 2.60 | 5.30 | 3.80 | 5.40 | .80 | 2.00 | 1.80 | 2.40 |
| 21 | 7.00 | 22.00 | 19.70 | 5.50 | 2.80 | 3.70 | 3.20 | 4.80 | .70 | .80 | 2.10 | 2.30 |
| 22 | 5.90 | 23.00 | 17.50 | 5.30 | 2.60 | 3.00 | 2.30 | 4.20 | .62 | 1.60 | 2.00 | 2.50 |
| 23 | 5.30 | 23.40 | 16.30 | 5.00 | 2.70 | 2.40 | 1.70 | 3.00 | .50 | 1.50 | 1.90 | 2.10 |
| 24 | 4.90 | 23.10 | 13.70 | 4.60 | 2.70 | 2.00 | 1.30 | 2.80 | .60 | 1.40 | 1.80 | 2.90 |
| 25 | 4.50 | 22.00 | 10.00 | 4.30 | 2.80 | 1.50 | 1.50 | 2.50 | 1.30 | 1.80 | 1.90 | 5.40 |
| 26 | 4.40 | 20.50 | 8.60 | 4.10 | 2.70 | 1.40 | 2.60 | 1.80 | 1.00 | 1.40 | 2.00 | 7.80 |
| 27 | 4.50 | 18.20 | 7.80 | 4.30 | 2.50 | 1.50 | 3.90 | 1.70 | .50 | 1.30 | 1.90 | 8.50 |
| 28 | 4.70 | 16.30 | 7.50 | 5.40 | 2.30 | 1.40 | 6.90 | 1.50 | 3.50 | 1.10 | 2.20 | 6.80 |
| 29 | 4.10 | ....... | 7.40 | 7.50 | 1.90 | 1.00 | 8.20 | 1.40 | 3.80 | 1.30 | 2.40 | 5.40 |
| 30 | 4.20 | ....... | 7.90 | 6.20 | 2.10 | .98 | 8.50 | 1.10 | 2.60 | 2.50 | 2.70 | 5.00 |
| 31 | 4.30 | ....... | 8.50 | ....... | 1.70 | ....... | 9.45 | .80 | ....... | 3.20 | ....... | 4.10 |

## NEUSE RIVER AT SELMA, NORTH CAROLINA.

Neuse River rises in the north-central part of North Carolina, and flows in a southeasterly direction, emptying into Pamlico Sound. The stream crosses the fall line at Smithfield, below which point there is no power. The elevation of the river at Smithfield is about 106 feet. At the crossing of the Seaboard Air Line Railroad, some 35 miles above, the elevation is about 175 feet, making the fall in this part of the river about 2 feet per mile. Above this point the fall is much greater. A large part of the area drained by this stream is forest covered. The river is subjected to violent freshets and to periods of low flow. The minimum flow per square mile decreases rapidly as the stream is ascended. A weir measurement of Eno River where the drainage area was about 100 square miles, gave a flow of 3,000,000 gallons per twenty-four hours, or 4.64 second-feet, or at the rate of 0.046 cubic feet per second per square mile. This measurement was made during the severe drought of the summer of 1897. There are a number of localities where power can be developed. The gaging station described in the Eighteenth Annual Report, Part IV, page 52, is located on the Southern Railway bridge, about 3 miles from Selma, North Carolina. It was established by E. W. Myers, July 29, 1896. The bed of the river here is sandy and muddy and is liable to change in high water. The flow is obstructed by one pier of the bridge; the channel is straight, the current moderately swift and confined to one channel. The gage rod was moved February 6, 1899, to the highway bridge, crossing the river about 200 yards below. The zero of the gage rod is 33.7 feet west of the center rod of the truss of the bridge, and on the downstream side. The outer rim of the pulley wheel is 4.75 feet east of the zero of the gage rod, and the distance from the end of the weight to the marker on wire is 35.00 feet. When this station was visited on May 23, 1899, the gage was measured, and this distance was found to be 35.35 feet. When visited in June this length was found to be 35.37 feet; in October 35.48 feet, and at the November visit it was found to be 35.50 feet. This error has been allowed to accumulate, and gage heights on the attached sheet have been adjusted by these measurements. The observer is C. Richardson, engineer at pumping station, Selma, North Carolina. Records of flow may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 53; 1897, Nineteenth Annual Report, Part IV, page 186; 1898, Twentieth Annual Report, Part IV, page 144. The following measurements were made by E. W. Myers during 1899:

February 6, gage height, 15.68 feet; discharge, 7,807 second-feet.
May 23, gage height, 4.28 feet; discharge, 1,262 second-feet.
June 5, gage height, 3.10 feet; discharge, 773 second-feet.
October 12, gage height, 1.79 feet; discharge, 574 second-feet.
November 26, gage height, 1.30 feet; discharge, 356 second-feet.

*Daily gage height, in feet, of Neuse River at Selma, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.40 | 6.50 | 13.39 | 4.79 | 1.84 | 4.44 | 1.21 | 10.68 | 0.95 | 1.43 | 10.50 | 1.10 |
| 2 | 1.30 | 5.90 | 12.99 | 4.99 | 1.69 | 3.54 | 1.21 | 9.58 | .85 | 1.23 | 11.20 | 1.50 |
| 3 | 1.30 | 5.60 | 14.19 | 4.99 | 2.69 | 3.14 | 1.11 | 7.98 | .75 | 1.02 | 11.40 | 1.60 |
| 4 | 2.00 | 6.00 | 15.48 | 5.78 | 2.89 | 3.23 | 1.11 | 6.18 | .75 | .72 | 11.20 | 1.40 |
| 5 | 2.50 | 11.30 | 18.28 | 6.28 | 3.13 | 3.13 | 1.21 | 2.18 | .85 | .52 | 4.20 | 1.20 |
| 6 | 2.00 | 13.40 | 17.98 | 8.48 | 2.38 | 2.63 | 1.31 | 2.28 | .65 | .62 | 3.30 | 1.20 |
| 7 | 2.10 | 19.90 | 17.87 | 9.77 | 2.48 | 1.83 | 1.40 | 2.68 | .45 | 3.92 | 2.70 | 1.20 |
| 8 | 7.10 | 20.09 | 16.47 | 13.97 | 3.13 | 1.83 | 2.50 | 3.18 | .55 | 6.82 | 2.30 | 1.20 |
| 9 | 6.50 | 20.98 | 13.97 | 16.67 | 3.42 | 2.63 | 3.00 | 3.67 | .65 | 7.12 | 2.10 | 1.20 |
| 10 | 6.40 | 20.28 | 10.06 | 14,76 | 4.02 | 5.23 | 2.60 | 3.57 | .55 | 7.42 | 2.10 | 1.20 |
| 11 | 3.50 | 18.97 | 8.16 | 11.76 | 4.77 | 7.03 | 2.40 | 3.47 | .44 | 3.92 | 2.00 | 1.20 |
| 12 | 3.40 | 12.37 | 9.26 | 7.06 | 4.47 | 7.83 | 1.60 | 2.57 | .84 | 2.72 | 1.50 | 1.40 |
| 13 | 3.20 | 10.36 | 9.15 | 4.95 | 3.76 | 9.73 | 1.40 | 2.47 | .94 | 2.12 | 1.40 | 1.90 |
| 14 | 3.70 | 9.96 | 10.35 | 4.75 | 5.26 | 6.27 | 1.10 | 3.07 | 1.04 | 1.51 | 2.00 | 3.80 |
| 15 | 8.90 | 9.55 | 11.95 | 4.55 | 5.31 | 3.22 | 1.00 | 3.17 | .94 | 1.31 | 2.00 | 3.20 |
| 16 | 8.90 | 6.45 | 18.05 | 4.54 | 4.46 | 2.62 | 1.00 | 2.57 | .84 | 1.11 | 1.80 | 2.40 |
| 17 | 8.00 | 13.55 | 16.94 | 4.34 | 3.26 | 2.42 | 1.60 | 1.67 | .74 | .71 | 1.60 | 1.30 |
| 18 | 6.20 | 15.54 | 14.94 | 4.24 | 3.05 | 2.32 | 4.39 | 1.77 | .64 | 1.01 | 1.50 | 1.20 |
| 19 | 5.20 | 17.34 | 18.23 | 4.03 | 4.10 | 2.02 | 5.59 | 1.67 | .64 | 1.21 | 1.50 | 1.00 |
| 20 | 4.20 | 18.13 | 17.73 | 3.73 | 5.90 | 1.82 | 4.79 | 1.06 | .74 | 1.31 | 1.50 | 1.00 |
| 21 | 3.20 | 18.73 | 12.53 | 3.63 | 5.35 | 1.72 | 2.79 | .96 | .64 | 1.31 | 1.40 | 1.50 |
| 22 | 2.40 | 17.02 | 9.82 | 3.52 | 4.80 | 1.62 | 2.39 | .96 | .63 | 1.31 | 1.30 | 1.90 |
| 23 | 2.50 | 17.32 | 8.02 | 3.32 | 4.40 | 1.52 | 1.59 | .86 | .73 | 1.31 | 1.20 | 3.00 |
| 24 | 2.50 | 15.32 | 6.82 | 3.12 | 3.74 | 1.42 | 1.29 | .86 | .83 | 1.11 | 1.10 | 3.00 |
| 25 | 2.40 | 14.21 | 5.41 | 3.21 | 3.44 | 1.42 | 3.59 | .96 | .83 | 1.01 | 1.00 | 2.20 |
| 26 | 3.10 | 15.51 | 5.21 | 3.41 | 2.84 | 1.31 | 6.59 | .96 | 1.43 | .80 | 1.00 | 1.90 |
| 27 | 3.10 | 15.20 | 5.11 | 4.21 | 2.44 | 1.31 | 10.19 | .96 | 1.67 | .70 | .90 | 1.40 |
| 28 | 3.00 | 14.00 | 5.60 | 4.70 | 2.14 | 1.31 | 7.71 | .96 | 2.53 | .70 | .80 | 1.20 |
| 29 | 2.30 | ....... | 6.50 | 5.50 | 1.94 | 1.21 | 5.68 | .86 | 2.87 | .80 | .70 | 1.20 |
| 30 | 2.40 | ....... | 6.90 | 1.95 | 3.04 | 1.21 | 6.58 | .96 | 1.53 | .80 | .70 | 1.20 |
| 31 | 2.40 | ....... | 7.60 | ....... | 5.04 | ....... | 8.28 | .95 | ....... | 10.70 | ....... | 1.30 |

## HAW RIVER AT MONCURE, NORTH CAROLINA.

This station, established May 6, 1898, by E. W. Myers, is located 1¾ miles north of Moncure, Chatham County, North Carolina, at the bridge of the Seaboard Air Line, which crosses the river here, and about 2 miles from the junction of the river with Deep River to form the Cape Fear. The observer is M. A. Moore, Moncure, North Carolina, who also attends the station on Deep River. The gage is a horizontal rod well painted, divided into feet and tenths, securely nailed to the outer side of the guard rail of the bridge on the upstream side. The 2-foot mark on the rod is over the center of the second floor beam from the south end of the second span from the south end of the bridge. The length of gage was last verified November 26, 1899. The initial point for sounding is a notch cut in the guard rail opposite the south end of the bridge and on the upstream side, the section here being better than that on the downstream side. The channel is straight for some distance above and below the station. The velocity is good and uniformly distributed across the stream. Both banks are rather low and subject to overflow in time of flood. The bed of the stream is of coarse sand and gravel, and is probably not subject to any decided change in high water. The current here is somewhat modified by a fish dam about 150 yards above the bridge. The station is reached by private conveyance from Moncure. When the station was established in May, 1898, the distance from the end of the weight to the pointer on the wire was 43.45 feet. When it was visited in

August, 1898, the wire was measured and this distance was found to be 43.67 feet. In February, 1899, the gage was measured and found to be 43.75 feet. This length remained the same at the subsequent visits during the year, in June, October, and November. The error was not corrected on the gage at each visit, it being considered preferable to change the gage heights after the stretch was found to have become fixed. The gage heights for 1899, as published below, have been corrected. The following measurements were made during 1899 by E. W. Myers:

February 4, gage height, 8.96 feet; discharge, 5,594 second-feet.
May 26, gage height, 2.20 feet; discharge, 751 second-feet.
June 5, gage height, 2.99 feet; discharge, 1,275 second-feet.
October 12, gage height, 1.85 feet; discharge, 756 second-feet.
November 26, gage height, 1.37 feet; discharge, 358 second-feet.

*Daily gage height, in feet, of Haw River at Moncure, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.03 | 4.98 | 15.70 | 5.54 | 2.94 | 2.62 | 1.43 | 4.16 | 1.07 | 1.04 | 10.53 | 1.28 |
| 2 | 3.68 | 4.48 | 9.06 | 4.68 | 2.70 | 2.60 | 1.31 | 3.42 | .96 | 1.02 | 6.87 | 1.16 |
| 3 | 3.30 | 4.30 | 9.98 | 4.46 | 2.60 | 3.94 | 1.20 | 2.68 | .91 | .82 | 3.96 | 1.54 |
| 4 | 2.86 | 8.70 | 15.66 | 3.92 | 2.42 | 3.56 | 1.18 | 2.26 | 1.04 | .82 | 4.61 | 1.52 |
| 5 | 2.84 | 16.40 | 18.48 | 3.86 | 2.38 | 2.98 | 7.90 | 1.48 | 1.02 | .85 | 3.54 | 1.48 |
| 6 | 2.48 | 22.42 | 14.84 | 8.84 | 2.44 | 2.20 | 2.24 | 1.42 | 1.03 | 7.65 | 2.66 | 1.32 |
| 7 | 12.08 | 24.66 | 13.56 | 4.86 | 1.98 | 1.84 | 2.08 | 4.85 | .98 | 5.62 | 2.09 | 1.30 |
| 8 | 10.32 | 26.13 | 9.41 | 11.12 | 7.86 | 1.62 | 2.22 | 4.92 | .98 | 7.37 | 1.64 | 1.12 |
| 9 | 8.62 | 26.62 | 6.68 | 13.42 | 6.14 | 1.40 | 1.22 | 4.90 | 1.00 | 5.98 | 1.67 | 1.06 |
| 10 | 4.98 | 17.70 | 5.16 | 7.08 | 4.50 | 1.52 | 1.04 | 4.46 | 2.51 | 4.13 | 1.62 | 1.12 |
| 11 | 3.84 | 12.34 | 4.52 | 5.98 | 4.42 | 2.45 | 1.70 | 2.02 | 2.84 | 2.97 | 1.57 | 1.22 |
| 12 | 3.62 | 6.92 | 4.34 | 4.64 | 4.98 | 5.18 | 1.46 | 1.56 | 3.40 | 1.80 | 1.57 | 3.12 |
| 13 | 3.94 | 6.62 | 4.06 | 4.12 | 8.06 | 4.44 | 1.38 | 1.58 | 1.70 | 1.62 | 1.33 | 1.84 |
| 14 | 5.14 | 5.84 | 6.34 | 3.70 | 8.62 | 4.12 | 1.20 | 1.20 | 1.90 | 1.35 | 1.31 | 1.82 |
| 15 | 11.62 | 5.46 | 22.07 | 3.38 | 5.04 | 2.94 | 1.30 | 1.14 | 1.24 | 1.29 | 1.43 | 1.68 |
| 16 | 7.96 | 7.42 | 23.36 | 3.62 | 4.10 | 2.55 | 1.23 | 1.80 | 1.20 | 1.34 | 1.15 | 1.36 |
| 17 | 6.88 | 18.92 | 17.18 | 3.08 | 3.86 | 2.40 | 1.14 | 1.52 | 1.16 | 1.11 | 1.08 | 1.52 |
| 18 | 5.04 | 18.38 | 8.62 | 2.95 | 2.90 | 1.72 | 1.32 | 1.26 | 1.12 | 1.29 | 1.32 | 1.48 |
| 19 | 4.44 | 18.41 | 14.93 | 2.82 | 2.92 | 1.60 | 1.34 | 1.42 | 1.98 | 1.24 | 1.42 | 1.44 |
| 20 | 3.70 | 14.72 | 14.34 | 2.70 | 2.86 | 1.62 | 1.28 | 1.06 | 1.02 | 1.21 | 1.44 | 1.28 |
| 21 | 4.16 | 11.62 | 10.98 | 2.80 | 2.00 | 1.54 | 1.30 | 1.04 | 1.07 | 1.22 | 1.40 | 1.32 |
| 22 | 2.90 | 9.18 | 7.61 | 2.64 | 1.92 | 1.33 | 1.36 | .92 | 1.46 | 1.20 | 1.38 | 1.26 |
| 23 | 2.98 | 8.26 | 5.44 | 3.44 | 2.94 | 1.59 | 1.34 | .90 | 1.18 | 1.07 | 1.34 | 1.18 |
| 24 | 3.08 | 7.28 | 4.92 | 2.40 | 2.96 | 1.48 | 1.23 | 1.08 | 1.08 | .94 | 1.26 | 1.54 |
| 25 | 3.16 | 5.40 | 4.72 | 2.42 | 2.62 | 1.36 | 1.28 | 1.08 | 2.04 | .94 | 1.28 | 1.56 |
| 26 | 3.18 | 6.18 | 4.62 | 4.84 | 2.32 | 1.30 | 1.50 | 1.30 | 1.38 | 1.13 | 1.32 | 1.52 |
| 27 | 3.15 | 6.84 | 4.07 | 5.08 | 2.06 | 1.20 | 7.14 | .92 | 1.24 | 1.17 | 1.98 | 1.38 |
| 28 | 3.10 | 13.58 | 6.34 | 4.10 | 1.90 | 1.38 | 6.30 | 1.00 | 1.06 | 1.04 | 2.84 | 1.32 |
| 29 | 2.50 | ...... | 10.58 | 3.52 | 1.84 | 1.10 | 3.48 | 1.06 | 1.09 | 1.19 | 2.90 | 1.24 |
| 30 | 3.32 | ...... | 7.46 | 2.98 | 2.20 | 1.54 | 2.02 | 1.40 | .98 | 1.92 | 2.56 | 1.14 |
| 31 | 3.98 | ...... | 6.34 | ...... | 3.16 | ...... | 5.68 | 1.18 | ...... | 3.46 | ...... | 2.38 |

## DEEP RIVER AT MONCURE, NORTH CAROLINA.

This station, established May 5, 1898, by E. W. Myers, is located about one-fourth of a mile south of Moncure, Chatham County, North Carolina, at the covered wooden bridge of the Seaboard Air Line, which crosses the river here. It is about 2 miles above the junction with the Haw River to form the Cape Fear. The observer is M. A. Moore, of Moncure, North Carolina, a farmer and bridge watchman living about 100 yards from the bridge. The gage is a horizontal rod, well painted, divided into feet and tenths, and securely nailed to the guard rail of the bridge. The zero of the rod is 50 feet south of the north end of the second span of the bridge from the north. The initial point of sounding is a notch cut in the guard rail opposite the south end of the bridge and on the downstream side. The channel is straight for some distance above and below the station. The banks are low and the bed probably slightly shifting during high water. The velocity is not great, but sufficient for proper measurement, and is well distributed across the stream. When the station was established on May 5, 1898, the distance from the end of the weight to the pointer on the wire was 45.16 feet. At every subsequent trip the gage wire has been measured, and it was discovered that the length was gradually increasing. When the station was visited on August 20, 1898, the length of the wire was found to be 45.27 feet. February, 1899, the length was found to be 45.38 feet; in May, 45.40 feet; in June, 45.45 feet; in October, 45.57 feet, and in November, 45.60 feet. These errors were allowed to accumulate to see if the wire had any definite fixed rate of stretch under a constant weight. The gage heights as published below have been adjusted from the measurements noted above. Records of flow may be found in the Twentieth Annual Report, Part IV, page 146. The following measurements were made during 1899 by E. W. Myers:

February 4, gage height, 7.03 feet; discharge, 4,590 second-feet.
May 27, gage height, 2.16 feet; discharge, 447 second-feet.
June 5, gage height, 2.51 feet; discharge, 610 second-feet.
October 12, gage height, 1.89 feet; discharge, 449 second-feet.
November 26, gage height, 1.32 feet; discharge, 290 second-feet.

*Daily gage height, in feet, of Deep River at Moncure, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.03 | 4.58 | 6.91 | 7.12 | 2.99 | 2.84 | 1.52 | 4.54 | 0.85 | 0.83 | 12.74 | 2.77 |
| 2 | 3.21 | 5.00 | 6.25 | 4.70 | 2.85 | 2.61 | 1.36 | 4.36 | .79 | .78 | 5.86 | 1.85 |
| 3 | 3.41 | 6.78 | 6.39 | 4.52 | 2.56 | 3.45 | 1.34 | 3.46 | .75 | .88 | 4.23 | 1.83 |
| 4 | 3.27 | 7.06 | 13.25 | 5.16 | 2.51 | 3.13 | 1.18 | 3.08 | .91 | .79 | 3.48 | 2.19 |
| 5 | 2.79 | 16.40 | 14.43 | 8.64 | 2.29 | 2.49 | 4.20 | 1.46 | .73 | .87 | 3.04 | 2.15 |
| 6 | 2.47 | 20.48 | 15.77 | 6.18 | 2.25 | 1.95 | 2.42 | 1.20 | .71 | 7.20 | 2.74 | 1.49 |
| 7 | 10.27 | 23.21 | 15.67 | 6.40 | 2.47 | 1.65 | 2.72 | 4.54 | .89 | 6.49 | 2.24 | 1.27 |
| 8 | 9.13 | 25.92 | 13.62 | 17.76 | 8.85 | 1.49 | 2.11 | 4.11 | 1.19 | 6.70 | 1.91 | 1.19 |
| 9 | 7.71 | 20.90 | 10.61 | 15.04 | 6.09 | 1.58 | 2.19 | 4.15 | 1.10 | 7.11 | 1.86 | 1.11 |
| 10 | 5.59 | 18.70 | 7.39 | 8.28 | 4.43 | 2.55 | 2.10 | 3.37 | 1.82 | 3.96 | .84 | 1.19 |
| 11 | 4.99 | 12.26 | 5.05 | 6.16 | 3.85 | 3.23 | 1.79 | 1.39 | 2.10 | 3.19 | .89 | 4.03 |
| 12 | 5.83 | 7.19 | 4.41 | 5.40 | 5.89 | 4.72 | 1.67 | 1.41 | 2.55 | 1.97 | 1.09 | 5.95 |
| 13 | 6.07 | 6.98 | 4.67 | 4.86 | 7.99 | 3.78 | 1.34 | 1.25 | 2.04 | 1.72 | 1.02 | 4.69 |
| 14 | 9.79 | 6.06 | 3.91 | 4.48 | 9.23 | 3.40 | 1.19 | 1.21 | 4.86 | 1.59 | 1.09 | 3.39 |
| 15 | 13.07 | 5.10 | 21.19 | 3.76 | 5.99 | 2.56 | 1.09 | 1.29 | 1.96 | 1.31 | .96 | 2.35 |
| 16 | 8.61 | 6.76 | 22.51 | 3.98 | 4.46 | 2.42 | 1.28 | 1.31 | 1.04 | 1.17 | .98 | 1.39 |
| 17 | 7.91 | 16.20 | 16.21 | 4.10 | 3.97 | 2.40 | .90 | 1.17 | .93 | 1.27 | 1.08 | 1.34 |
| 18 | 6.93 | 21.26 | 9.99 | 4.04 | 3.75 | 1.68 | 1.14 | 1.09 | .84 | 1.04 | 1.26 | 1.47 |
| 19 | 5.99 | 19.34 | 14.69 | 3.54 | 3.69 | 1.58 | 1.11 | 1.25 | .87 | 1.06 | 1.14 | 1.39 |
| 20 | 4.73 | 15.30 | 15.31 | 3.32 | 3.05 | 1.49 | 1.02 | .88 | 1.71 | 1.12 | 1.02 | .63 |
| 21 | 3.15 | 9.92 | 9.02 | 3.46 | 2.89 | 1.50 | 1.02 | .74 | 1.99 | .97 | .98 | 1.27 |
| 22 | 3.36 | 9.05 | 7.15 | 2.97 | 2.67 | 1.47 | 1.02 | .78 | 1.49 | .90 | 1.10 | 1.13 |
| 23 | 3.08 | 8.22 | 5.87 | 3.10 | 3.25 | 1.77 | 1.19 | .90 | 1.17 | .87 | 1.05 | 1.07 |
| 24 | 3.17 | 7.92 | 5.43 | 2.96 | 2.85 | 1.37 | 1.11 | .95 | .87 | .85 | 1.04 | 1.19 |
| 25 | 3.25 | 6.24 | 4.91 | 2.97 | 2.75 | 1.55 | 1.52 | 1.06 | 2.34 | .91 | 1.00 | 1.13 |
| 26 | 3.27 | 6.92 | 4.41 | 5.60 | 2.51 | 1.57 | 1.67 | .84 | 1.53 | .92 | 1.32 | 1.11 |
| 27 | 3.54 | 12.94 | 4.14 | 5.54 | 2.25 | 1.71 | 5.19 | 1.00 | 1.35 | 1.01 | 1.92 | 1.07 |
| 28 | 3.19 | 18.22 | 7.07 | 4.46 | 2.02 | 2.15 | 4.35 | .96 | 1.09 | .98 | 1.83 | .95 |
| 29 | 2.55 | ...... | 11.65 | 3.50 | 1.91 | 1.68 | 3.77 | 1.20 | 1.17 | .94 | 3.78 | 1.03 |
| 30 | 2.21 | ...... | 10.31 | 3.04 | 2.54 | 1.60 | 2.11 | 1.22 | 1.04 | .89 | 2.84 | .97 |
| 31 | 3.23 | ...... | 8.44 | ...... | 2.96 | ...... | 6.28 | .89 | ...... | 1.13 | ...... | 1.03 |

## CAPE FEAR RIVER AT FAYETTEVILLE, NORTH CAROLINA.

Cape Fear River is formed by the junction of the Haw and Deep rivers near Moncure, Chatham County, North Carolina, and flows in a southeasterly direction, emptying into the Atlantic Ocean near Wilmington. Its watershed for the most part is flat and well covered with forest growth. Measurements are made on both the Haw and the Deep at Moncure, and on the Cape Fear at Fayetteville. The measurements are of value in the study of the valuable water powers of the Cape Fear and its tributaries. The gaging station described in the Eighteenth Annual Report, Part IV, page 54, is at the bridge of the Alantlc Coast Line, about a mile east of Fayetteville, North Carolina. The Weather Bureau has a gage fastened on the lower side of the east abutment of the covered highway bridge, this being about 400 feet above the railroad bridge, from which discharge measurements are made. The lower 29 feet of this gage consists of a rod divided into feet and tenths and firmly fastened to the abutment. Above the 29-foot mark the scale is painted on the rock. The observer is Frank Glover, who has charge of the steamboat landing just below the railroad bridge. For his convenience he has placed a subsidiary gage at the steamboat landing reading about the same as the official gage, and from this observations are taken. The channel is straight and the current moderately swift and not influenced by dams or other obstructions. The banks are high and the total flow of the river is in one channel, even during the highest floods. The bed is fairly constant. Records of flow may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 56; 1897, Nineteenth Annual Report, Part IV, page 93; 1898, Twentieth Annual Report, Part IV, page 145. The following measurements were made by E. W. Myers during 1899:

February 7, gage height, 46.50 feet; discharge, 61,921 second-feet.
May 24, gage height, 6.40 feet; discharge, 3,142 second-feet.
June 6, gage height, 4.20 feet; discharge, 1,577 second-feet.
October 13, gage height, 6.00 feet; discharge, 2,132 second-feet.
November 29, gage height, 9.65 feet; discharge, 7,742 second-feet.

*Daily gage height, in feet, of Cape Fear River at Fayetteville, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.50 | 11.00 | 30.80 | 17.80 | 7.20 | 6.00 | 2.90 | 11.50 | 2.40 | 2.00 | 11.00 | 8.00 |
| 2 | 4.60 | 18.10 | 25.00 | 17.00 | 6.00 | 6.40 | 6.40 | 10.00 | 2.20 | 1.70 | 21.40 | 6.40 |
| 3 | 6.50 | 14.00 | 21.00 | 14.00 | 6.00 | 8.00 | 8.00 | 8.80 | 1.90 | 1.70 | 17.50 | 6.50 |
| 4 | 6.50 | 12.80 | 28.60 | 12.20 | 5.50 | 7.60 | 7.60 | 7.00 | 1.60 | 1.50 | 12.80 | 7.00 |
| 5 | 5.80 | 23.00 | 34.40 | 15.60 | 5.50 | 6.10 | 6.10 | 5.50 | 1.50 | 1.40 | 10.40 | 6.70 |
| 6 | 5.50 | 31.90 | 33.20 | 21.00 | 5.50 | 4.20 | 4.20 | 4.20 | 1.60 | 2.10 | 8.30 | 5.50 |
| 7 | 5.50 | 41.00 | 27.40 | 17.60 | 5.60 | 4.20 | 4.20 | 3.20 | 1.40 | 14.40 | 6.50 | 5.10 |
| 8 | 17.00 | 50.80 | 25.00 | 23.20 | 8.60 | 3.80 | 3.80 | 2.60 | 2.00 | 13.50 | 5.00 | 4.90 |
| 9 | 21.40 | 52.00 | 20.00 | 35.50 | 14.20 | 3.50 | 8.30 | 7.00 | 1.80 | 17.00 | 5.00 | 4.70 |
| 10 | 14.90 | 47.30 | 15.00 | 30.30 | 13.00 | 4.50 | 9.30 | 10.20 | 1.90 | 13.20 | 5.00 | 4.30 |
| 11 | 10.20 | 37.40 | 11.50 | 23.00 | 9.80 | 7.50 | 6.40 | 7.00 | 1.80 | 10.00 | 4.80 | 4.30 |
| 12 | 8.00 | 30.00 | 10.20 | 19.40 | 10.90 | 8.10 | 5.00 | 5.50 | 5.70 | 7.00 | 4.50 | 4.50 |
| 13 | 9.30 | 20.80 | 9.40 | 15.80 | 11.00 | 10.00 | 3.60 | 4.60 | 4.00 | 5.00 | 4.60 | 4.00 |
| 14 | 10.00 | 12.30 | 8.70 | 13.50 | 15.40 | 11.10 | 3.10 | 3.70 | 4.00 | 4.50 | 4.30 | 14.00 |
| 15 | 19.00 | 10.00 | 18.60 | 10.20 | 17.30 | 8.00 | 2.60 | 3.00 | 4.60 | 3.80 | 4.00 | 10.00 |
| 16 | 23.60 | 12.50 | 38.60 | 9.80 | 12.00 | 5.80 | 2.40 | 2.70 | 4.00 | 3.50 | 4.00 | 7.50 |
| 17 | 17.20 | 24.00 | 42.00 | 9.00 | 9.70 | 5.00 | 2.40 | 2.50 | 2.50 | 3.50 | 4.00 | 6.00 |
| 18 | 14.50 | 36.50 | 38.00 | 10.00 | 7.20 | 4.60 | 4.50 | 2.40 | 1.80 | 3.00 | 3.90 | 5.40 |
| 19 | 13.40 | 42.60 | 28.00 | 9.20 | 5.50 | 4.10 | 4.00 | 2.70 | 1.60 | 3.30 | 3.80 | 5.00 |
| 20 | 11.00 | 43.00 | 28.80 | 9.40 | 5.30 | 3.70 | 3.50 | 2.70 | 1.80 | 3.00 | 3.60 | 4.80 |
| 21 | 9.20 | 38.50 | 32.00 | 9.00 | 5.20 | 3.20 | 3.00 | 2.30 | 2.50 | 2.70 | 3.50 | 4.50 |
| 22 | 8.00 | 34.00 | 25.00 | 8.50 | 5.00 | 3.20 | 2.40 | 2.20 | 4.00 | 2.50 | 3.30 | 4.00 |
| 23 | 7.00 | 28.30 | 18.00 | 8.40 | 5.30 | 3.00 | 2.30 | 5.00 | 3.70 | 2.20 | 3.30 | 4.20 |
| 24 | 6.20 | 23.00 | 14.70 | 8.00 | 6.30 | 3.10 | 2.80 | 3.70 | 3.20 | 2.30 | 3.80 | 5.40 |
| 25 | 6.20 | 18.20 | 12.00 | 6.60 | 6.00 | 2.90 | 4.00 | 2.50 | 2.60 | 2.10 | 4.00 | 10.00 |
| 26 | 6.00 | 16.40 | 10.00 | 7.00 | 5.50 | 2.50 | 6.40 | 2.70 | 2.90 | 2.10 | 4.00 | 12.00 |
| 27 | 7.00 | 17.00 | 10.00 | 10.00 | 5.30 | 2.80 | 7.00 | 2.10 | 3.70 | 2.10 | 4.50 | 9.70 |
| 28 | 6.80 | 28.40 | 12.00 | 11.40 | 4.70 | 3.10 | 12.80 | 1.60 | 3.90 | 2.10 | 5.60 | 7.30 |
| 29 | 6.60 | ------- | 17.80 | 10.00 | 4.20 | 3.50 | 11.70 | 1.60 | 3.00 | 2.10 | 10.00 | 6.00 |
| 30 | 6.60 | ------- | 21.70 | 8.80 | 4.20 | 3.20 | 9.90 | 1.50 | 2.50 | 2.10 | 9.50 | 5.90 |
| 31 | 7.00 | ------- | 19.20 | ------- | 5.00 | ------- | 7.60 | 2.90 | ------- | 4.20 | ------- | ------- |

## YADKIN RIVER AT SALISBURY, NORTH CAROLINA.

This river rises in the west-central part of North Carolina, flows easterly, and then turning abruptly south continues across the central part of North Carolina and through the northeastern part of South Carolina into the Atlantic Ocean. Throughout the upper part of its course the topography of its watershed is rough and mountainous, but as it approaches the ocean the land becomes flat and marshy. The upper portion of its watershed is well timbered. The drainage area is partly mapped on the Statesville, Hickory, Wilkesboro, Yadkinville, and Hillsville atlas sheets. There are a number of places where water powers may be developed, and measurements have been made to determine the available amount. A station has been established near Salisbury, North Carolina, and another one about 50 miles nearer its mouth, at Norwood, North Carolina. The Salisbury station, described in the Eighteenth Annual Report, Part IV, page 57, was established by C. C. Babb September 24, 1895, and is located at the Southern Railway bridge near Holtsburg, near the mouth of Grant Creek, and about 6 miles from Salisbury, North Carolina. The length of the wire gage is 55.10 feet. The observer is W. L. Owen, fireman of pumping station, located just below the bridge. The station is easily reached by private conveyance from Salisbury. Discharge measurements are made from the lower side of the deck bridge, the zero point being on the left bank. The channel is obstructed by three piers with large rafts of driftwood lodged against each and sand bars below each. The channel is straight, current swift, and the bed rough and rocky. The banks are rather low, but all of the water passes beneath the bridge during floods. Records of discharge may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 59; 1897, Nineteenth Annual Report, Part IV, page 201; 1898, Twentieth Annual Report, Part IV, page 146. The following measurements were made by E. W. Myers during 1899:

*Measurements of Yadkin River at Salisbury, North Carolina.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| February 9 | 6.60 | 14,781 | June 9 | 2.38 | 4,264 |
| March 20 | 18.80 | 115,085 | October 4 | 1.70 | 1,847 |
| April 14 | 3.75 | 8,795 | November 24 | 1.70 | 1,957 |
| June 8 | 2.30 | 4,264 | December 14 | 3.00 | 5,952 |

*Daily gage height, in feet, of Yadkin River at Salisbury, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.00 | 3.20 | 4.70 | 4.30 | 3.10 | 2.40 | 2.20 | 2.80 | 2.00 | 1.60 | 2.00 | 1.90 |
| 2 | 2.00 | 3.00 | 4.00 | 3.90 | 3.10 | 2.90 | 2.10 | 2.30 | 2.10 | 1.60 | 2.20 | 1.90 |
| 3 | 2.10 | 2.90 | 6.10 | 3.80 | 3.10 | 2.60 | 2.10 | 2.20 | 2.20 | 1.60 | 2.20 | 1.90 |
| 4 | 2.00 | 2.90 | 8.00 | 4.10 | 3.10 | 2.60 | 2.50 | 2.00 | 2.10 | 1.60 | 2.40 | 1.80 |
| 5 | 3.10 | 7.50 | 8.00 | 4.20 | 3.00 | 2.50 | 3.20 | 2.00 | 2.10 | 1.70 | 2.20 | 1.80 |
| 6 | 4.00 | 8.75 | 7.15 | 4.70 | 2.90 | 2.40 | 2.50 | 1.80 | 1.90 | 1.70 | 2.00 | 1.80 |
| 7 | 10.20 | 10.10 | 5.90 | 4.80 | 3.20 | 2.40 | 2.30 | 1.80 | 1.80 | 1.80 | 1.90 | 1.80 |
| 8 | 5.90 | 9.20 | 4.10 | 7.80 | 4.40 | 2.40 | 2.30 | 2.30 | 1.70 | 2.90 | 1.90 | 1.70 |
| 9 | 4.80 | 6.30 | 3.90 | 5.90 | 4.00 | 2.40 | 2.20 | 2.10 | 1.70 | 3.00 | 1.80 | 1.70 |
| 10 | 4.00 | 4.00 | 3.70 | 4.70 | 3.50 | 3.10 | 2.20 | 2.00 | 2.20 | 2.40 | 1.70 | 1.70 |
| 11 | 3.00 | 3.30 | 3.50 | 4.20 | 3.40 | 3.30 | 2.10 | 2.00 | 2.00 | 2.10 | 1.70 | 1.70 |
| 12 | 4.40 | 3.40 | 3.40 | 3.80 | 3.30 | 3.80 | 2.10 | 1.90 | 1.90 | 1.90 | 1.70 | 2.00 |
| 13 | 4.00 | 2.90 | 3.30 | 3.80 | 4.10 | 4.80 | 2.00 | 2.10 | 1.90 | 1.90 | 1.70 | 3.80 |
| 14 | 4.50 | 2.90 | 5.20 | 3.80 | 4.10 | 3.90 | 2.00 | 2.00 | 1.70 | 2.00 | 1.70 | 3.40 |
| 15 | 4.40 | 2.20 | 8.50 | 3.70 | 3.60 | 3.20 | 1.90 | 1.90 | 1.70 | 1.90 | 1.70 | 2.90 |
| 16 | 4.10 | 3.00 | 12.40 | 3.70 | 3.10 | 2.60 | 1.90 | 1.90 | 1.60 | 1.80 | 1.70 | 2.10 |
| 17 | 3.70 | 5.10 | 7.90 | 3.60 | 3.00 | 2.50 | 1.90 | 1.80 | 1.60 | 1.80 | 1.70 | 2.00 |
| 18 | 3.50 | 6.00 | 6.70 | 3.50 | 3.00 | 2.40 | 2.30 | 1.70 | 1.60 | 1.80 | 1.70 | 1.90 |
| 19 | 3.20 | 5.00 | 12.00 | 3.40 | 2.90 | 2.40 | 2.20 | 1.70 | 1.50 | 1.80 | 1.70 | 1.90 |
| 20 | 3.10 | 4.60 | 17.80 | 3.40 | 2.80 | 2.30 | 2.10 | 1.80 | 4.20 | 1.80 | 1.70 | 1.90 |
| 21 | 2.80 | 4.00 | 13.75 | 3.40 | 2.70 | 2.30 | 1.90 | 1.60 | 2.90 | 1.80 | 1.70 | 1.70 |
| 22 | 2.90 | 3.90 | 6.50 | 3.30 | 2.70 | 2.30 | 1.90 | 1.60 | 2.20 | 1.80 | 1.70 | 1.70 |
| 23 | 2.80 | 3.60 | 5.30 | 3.20 | 2.90 | 2.30 | 1.90 | 1.60 | 1.90 | 1.70 | 1.70 | 1.70 |
| 24 | 2.90 | 3.10 | 4.80 | 3.20 | 3.00 | 2.20 | 1.90 | 1.50 | 1.70 | 1.70 | 1.70 | 2.00 |
| 25 | 2.80 | 3.10 | 4.40 | 3.30 | 2.80 | 2.20 | 2.00 | 1.50 | 1.70 | 1.70 | 1.70 | 2.40 |
| 26 | 2.80 | 3.00 | 4.30 | 4.10 | 2.70 | 2.80 | 2.70 | 1.50 | 1.70 | 1.70 | 1.70 | 2.40 |
| 27 | 2.80 | 5.40 | 5.40 | 4.10 | 2.70 | 3.00 | 4.30 | 1.60 | 1.70 | 1.70 | 1.80 | 2.10 |
| 28 | 2.90 | 7.80 | 5.40 | 3.80 | 2.60 | 2.00 | 3.20 | 2.00 | 1.60 | 1.70 | 1.80 | 1.90 |
| 29 | 2.80 | ...... | 6.30 | 3.40 | 2.60 | 2.40 | 3.00 | 2.20 | 1.60 | 1.70 | 1.90 | 1.80 |
| 30 | 2.70 | ...... | 5.30 | 3.30 | 2.60 | 2.20 | 2.80 | 2.20 | 1.50 | 1.70 | 1.90 | 1.80 |
| 31 | 3.30 | ...... | 4.50 | ...... | 2.50 | ...... | 3.50 | 1.90 | ...... | 1.70 | ...... | 1.70 |

Yadkin River, after passing the State line into South Carolina, is known as Pedee River. The United States Weather Bureau has maintained a station at Cheraw, South Carolina, on Pedee River. The gage is a pine timber attached to the Cheraw toll bridge. The top of the rail on the Cheraw and Darlington Railroad bridge is 58 feet above zero of gage. The highest water was 37.3 feet on March 11, 1875; lowest, 0.0 feet, in August, 1866. The danger line is at 27 feet. The drainage area at this point is 6,960 square miles, according to the United States Weather Bureau. The second river-height station maintained by the United States Weather Bureau at Smiths Mills, South Carolina, is 100 miles below Cheraw and 45 miles above the mouth of the river. The gage is a 1 by 6 inch pine timber attached to the central front wooden pier of the E. P. Smith wharf. The zero of the gage is 25 feet below the doorsill of the house adjoining the wharf. The highest water was 16 feet in September, 1893; the lowest, —0.4 foot, on October 22, 1895. The danger line is at 16 feet.

### YADKIN RIVER AT NORWOOD, NORTH CAROLINA.

This station, described in the Eighteenth Annual Report, Part IV, page 60, was established by E. W. Myers September 1, 1896. It is at Blalocks Ferry, 1 mile above Richland Creek and about 2 miles from Norwood, North Carolina. The gage is a vertical rod divided into feet and tenths, and is securely spiked and braced to an overhanging tree near the ferry. The rod is referred to a bench mark consisting of a large nail driven into the root of a birch tree about 50 feet northwest of the rod. The zero of the gage rod is 5.93 feet below the bench mark. The river here is broad and shallow with smooth bottom of sand and gravel, giving a good section for discharge measurements, which are taken from the ferryboat. The channel is straight and free from all obstructions. The current is swift and the depth of the water uniform, except at a point about 100 feet from the right bank where the water is deep and very sluggish. The banks are low, and at the time of highest flood are overflowed for a distance of half a mile. The observer is W. B. Nichols, of Norwood, North Carolina, a farmer, who also carries the mail. Records of discharge may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 61; 1897, Nineteenth Annual Report, Part IV, page 203; 1898, Twentieth Annual Report, Part IV, page 147. Measurements made by E. W. Myers during 1899 are as follows:

April 9, gage height, 3.40 feet; discharge, 10,581 second-feet.
June 8, gage height, 1.95 feet; discharge, 4,474 second-feet.
June 9, gage height, 1.95 feet; discharge, 4,474 second-feet.
October 6, gage height, 1.35 feet; discharge, 2,629 second-feet.
October 6, gage height, 1.33 feet; discharge, 2,619 second-feet.
December 15, gage height, 2.23 feet; discharge, 6,299 second-feet.

The following table, computed by E. W. Myers, shows the comparative run-off of the Yadkin River at Salisbury and Norwood. At the former point the area drained is 3,399 square miles, and at the latter station 4,614 square miles. The table is of interest on account of the close results, especially in the run-off of second-feet per square mile between the two stations, which are about 50 miles apart and have a difference in drainage area of 1,215 square miles. The footnotes at the bottom of the table should be studied in the same connection, as the two stations were not established at the same time, and in the first part of the record are not entirely comparable. The table should be compared with a similar table for the Catawba River at Catawba and Rock Hill stations, given on page 122.

*Table showing comparative minimum flows for Yadkin River at Salisbury and Norwood, North Carolina.*

| Year. | Driest month. | | Mean flow for driest month. | | Mean flow for driest month per square mile. | | Minimum flow for year. | | Minimum flow for year per square mile. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Salisbury. | Norwood. | Salisbury. | Norwood. | Salisbury. | Norwood. | Salisbury. | Norwood. | Salisbury. | Norwood. |
| | | | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* |
| 1895 | Oct | (*a*) | 1,426 | (*a*) | 0.42 | (*a*) | 1,400 | (*a*) | 0.41 | (*a*) |
| 1896 | Aug | Sept.*b* | 2,411 | *b*2,409 | .71 | *b*0.52 | 1,000 | *b*1,450 | .29 | *b*0.31 |
| 1897 | Sept | Sept | 1,727 | 1,822 | .51 | .39 | 900 | 1,310 | .26 | .28 |
| 1898 | June | June | 1,832 | 2,626 | .54 | .57 | 1,100 | *c*1,380 | .32 | .30 |
| 1899 | Sept.*d* | Oct | 2,332 | 2,836 | .69 | .61 | 1,300 | 1,790 | .38 | .39 |

*a* Station not established during this year.

*b* Not directly comparable. Station not established until September.

*c* Minimum flow not in month of lowest mean flow, but in July.

*d* Figures for Norwood station for September are as follows: Mean flow, 3,346 cubic feet per second, 0.725 second-feet per square mile; minimum flow, 2,080 second-feet, 0.451 second-feet per square mile.

NOTE.—For 1897, where the difference is most marked, there is a higher stage of water reported from the Salisbury station than at the Norwood station, the crest of the flood probably passing the latter station at night. Had this been noted, it would further increase the mean flow for this station.

*Daily gage height, in feet, of Yadkin River at Norwood, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.80 | 3.00 | 4.50 | ...... | 2.60 | 2.10 | 1.90 | 2.70 | 1.50 | 1.30 | 1.70 | 1.20 |
| 2 | 4.30 | 2.90 | 3.70 | ...... | 2.50 | 2.20 | 1.80 | 2.20 | 1.70 | 1.20 | 1.90 | 1.20 |
| 3 | 3.30 | 2.50 | 4.30 | ...... | 2.70 | 2.50 | 1.70 | 2.70 | 1.20 | 1.20 | 1.80 | 1.50 |
| 4 | 2.30 | 2,70 | 6.70 | ...... | 2.60 | 2.10 | 1.70 | 1.70 | 1.80 | 1.20 | 1.70 | 1.50 |
| 5 | 2.50 | 8.00 | 7.50 | ...... | 2.50 | 2.10 | 3.00 | 1.20 | 1.80 | 1.10 | 1.90 | 1.50 |
| 6 | 2.40 | 10.50 | 6.10 | ...... | 2.40 | 2.00 | 3.00 | 1.60 | 1.70 | 1.30 | 1.80 | 1.40 |
| 7 | 7.80 | 10.20 | 4.10 | ...... | 2.60 | 2.00 | 2.20 | 1.50 | 1.50 | 1.40 | 1.70 | 1.40 |
| 8 | 9.00 | 9.60 | 4.00 | ...... | 3.20 | 1.90 | 2.00 | 1.50 | 1.40 | 2.00 | 1.70 | 1.30 |
| 9 | 7.00 | 7.40 | 3.80 | 3.40 | 3.50 | 2.00 | 2.00 | 1.80 | 1.80 | 2.20 | 1.80 | 1.30 |
| 10 | 3.80 | 4.60 | 3.40 | 3.00 | 3.00 | 2.10 | 1.90 | 1.70 | 1.70 | 2.40 | 1.40 | 1.40 |
| 11 | 3.10 | 3.20 | 2.00 | 2.90 | 3.00 | 3.40 | 1.90 | 1.60 | 1.90 | 2.10 | 1.40 | 1.40 |
| 12 | 3.00 | 3.10 | 2.10 | 2.80 | 2.80 | 3.50 | 1.60 | 1.50 | 1.70 | 1.70 | 1.40 | 2.40 |
| 13 | 2.90 | 3.00 | 2.40 | 2.80 | 4.50 | 3.40 | 1.60 | 1.80 | 1.50 | 1.40 | 1.40 | 3.10 |
| 14 | 4.20 | 2.40 | 3.10 | 2.70 | 4.00 | 3.80 | 1.60 | 1.70 | 1.60 | 1.30 | 1.40 | 3.10 |
| 15 | 4.50 | 2.30 | 8.10 | 2.70 | 3.50 | 3.00 | 1.50 | 1.60 | 1.50 | 1.50 | 1.40 | 2.40 |
| 16 | 3.90 | 5.60 | 10.40 | 3.40 | 2.80 | 2.50 | 1.50 | 1.50 | 1.40 | 1.50 | 1.40 | 2.10 |
| 17 | 3.80 | 5.80 | 10.30 | 3.00 | 2.50 | 2.20 | 1.50 | 1.50 | 1.20 | 1.50 | 1.30 | 1.80 |
| 18 | 3.30 | 6.90 | 8.80 | 2.80 | 2.40 | 2.10 | 1.60 | 1.40 | 1.50 | 1.40 | 1.30 | 1.30 |
| 19 | 3.10 | 5.60 | (*a*) | 2.80 | 2.20 | 2.00 | 1.80 | 1.40 | 1.30 | 1.40 | 1.20 | 1.20 |
| 20 | 2.80 | 5.00 | ...... | 2.70 | 2.50 | 2.00 | 1.50 | 1.30 | 1.20 | 1.40 | 1.30 | 1.20 |
| 21 | 2.60 | 4.20 | ...... | 2.70 | 2.30 | 1.90 | 1.50 | 1.30 | 3.00 | 1.40 | 1.40 | 1.50 |
| 22 | 2.50 | 3.60 | ...... | 2.50 | 2.20 | 1.90 | 1.40 | 1.40 | 2.80 | 1.30 | 1.30 | 1.50 |
| 23 | 2.40 | 3.60 | ...... | 2.50 | 2.40 | 1.90 | 1.40 | 1.30 | 1.70 | 1.30 | 1.40 | 1.50 |
| 24 | 2.30 | 3.40 | ...... | 2.40 | 2.60 | 1.80 | 1.50 | 1.20 | 1.70 | 1.20 | 1.40 | 1.80 |
| 25 | 2.50 | 2.90 | ...... | 2.30 | 2.50 | 1.70 | 1.70 | 1.20 | 1.40 | 1.30 | 1.30 | 2.10 |
| 26 | 2.40 | 3.80 | ...... | 2.80 | 2.30 | 1.70 | 1.60 | 1.20 | 1.30 | 1.20 | 1.30 | 2.10 |
| 27 | 2.40 | 5.90 | ...... | 3.50 | 2.20 | 2.40 | 4.00 | 1.20 | 1.30 | 1.20 | 1.30 | 1.70 |
| 28 | 2.30 | 7.60 | ...... | 3.10 | 2.10 | 2.30 | 2.00 | 1.20 | 1.40 | 1.20 | 1.50 | 1.80 |
| 29 | 2.30 | ...... | ...... | 2.80 | 2.10 | 2.10 | 2.50 | 1.60 | 1.30 | 1.20 | 1.70 | 1.20 |
| 30 | 2.20 | ...... | ...... | 2.70 | 2.20 | 2.00 | 2.30 | 1.80 | 1 20 | 1.20 | 1.70 | 1.20 |
| 31 | 2.70 | ...... | ...... | ...... | 2.20 | ...... | 2.10 | 2.00 | ...... | 1.70 | ...... | ...... |

*a* No readings March 19 to April 8; gage washed out by flood.

## CATAWBA RIVER AT CATAWBA, NORTH CAROLINA.

This river rises in the west-central part of North Carolina and flows in a general southerly direction into South Carolina, where it empties into Santee River. At a number of points along this river there are water powers which may be developed. Near its source Catawba River flows through a mountainous country, which becomes flatter as the South Carolina line is approached. The greater part of its watershed is covered with woodland or forest. The drainage area above Catawba is entirely mapped on the Hickory, Morganton, Wilkesboro, Mount Mitchell, and Cranberry atlas sheets. Systematic measurements have been made on the Catawba at Catawba, North Carolina, and near Rockhill, South Carolina. The station at Catawba, as described in the Eighteenth Annual Report, Part IV, page 64, was established by E. W. Myers, July 4, 1896, at the Southern Railway bridge, about one-half mile from Catawba, North Carolina. The river is straight for several miles above and below the bridge; the current is swift and evenly distributed across the stream. The channel is obstructed by three piers, riprap, and two trestles of false work. At time of highest water the west bank overflows slightly and the sandy bed cuts out in places. The observer is C. A. Reed, jr., a clerk in the post-office at Catawba, North Carolina. Discharge measurements are made from the plank walk underneath the bridge. The railway bridge here is a deck bridge, and the gage was located on a footway which was laid along the lower system of bracing. When the station was visited, in October, 1899, it was discovered that the span on which the gage was located was to be removed, so it became necessary to move the gage rod, which was done as follows:

A small temporary gage was installed to discover any change in the stage of the river while the gage was being removed. The distance from the weight to the pointer on the wire was measured and found to be correct when the gage-reading was taken and recorded, as was also the reading of the temporary gage. The rod was then moved to the position which was chosen for it, and securely fastened to the guard rail on the downstream side and on the second span of the bridge from the west. The zero of the rod is over the center of the second floor beam from the west end of the second span from the west end of the bridge. From the zero of the rod to the outer rim of the pulley wheel is 2.6 feet. The small temporary gage was then read and it was found that the reading was unchanged, so the gage in its new position was given the same reading as it had before. The length of the wire rope from the end of the weight to the pointer on the wire was then measured and found to be 55.25 feet. Records may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 65; 1897, Nineteenth Annual Report, Part IV, page 214; 1898, Twentieth

Annual Report, Part IV, page 149. The following measurements were made by E. W. Myers during 1899:

February 24, gage height, 3.26 feet; discharge, 3,598 second-feet.
February 24, gage height, 3.28 feet; discharge, 3,690 second-feet.
June 10, gage height, 2.94 feet; discharge, 2,820 second-feet.
October 9, gage height, 2.36 feet; discharge, 1,716 second-feet.
November 23, gage height, 2.20 feet; discharge, 1,118 second-feet.
December 16, gage height, 2.66 feet; discharge, 2,153 second-feet.

*Daily gage height, in feet, of Catawba River at Catawba, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.50 | 2.70 | 5.45 | 4.65 | 3.40 | 2.95 | 2.40 | 2.20 | 2.40 | 1.95 | 2.10 | 2.10 |
| 2 | 3.10 | 2.70 | 4.30 | 4.40 | 3.40 | 2.00 | 2.35 | 2.25 | 2.90 | 1.95 | 2.15 | 2.15 |
| 3 | 3.00 | 2.80 | 4.00 | 3.90 | 3.35 | 2.90 | 2.30 | 2.20 | 2.75 | 1.95 | 2.10 | 2.15 |
| 4 | 2.80 | 10.00 | 4.00 | 3.95 | 3.30 | 2.80 | 2.30 | 2.15 | 2.60 | 1.90 | 2.15 | 2.15 |
| 5 | 2.80 | 8.60 | 7.40 | 4.60 | 3.30 | 2.75 | 2.35 | 2.10 | 2.40 | 1.90 | 2.20 | 2.15 |
| 6 | 5.20 | 9.60 | 5.90 | 4.40 | 3.25 | 2.70 | 2.40 | 2.10 | 2.20 | 2.00 | 2.18 | 2.15 |
| 7 | 8.00 | 9.10 | 4.30 | 5.70 | 4.90 | 2.65 | 2.50 | 2.30 | 2.20 | 2.10 | 2.18 | 2.10 |
| 8 | 4.70 | 6.50 | 4.15 | 8.90 | 4.70 | 2.60 | 2.60 | 2.40 | 2.25 | 2.20 | 2.15 | 2.10 |
| 9 | 4.40 | 5.60 | 4.00 | 5.75 | 4.25 | 3.35 | 2.50 | 2.35 | 2.30 | 2.36 | 2.10 | 2.10 |
| 10 | 4.00 | 4.30 | 3.80 | 5.10 | 3.85 | 2.92 | 2.40 | 2.80 | 2.50 | 2.30 | 2.10 | 2.10 |
| 11 | 3.90 | 3.60 | 3.70 | 4.50 | 3.60 | 2.90 | 2.40 | 2.60 | 2.40 | 2.25 | 2.10 | 2.15 |
| 12 | 3.90 | 3.30 | 3.60 | 4.30 | 3.75 | 3.35 | 2.35 | 2.40 | 2.20 | 2.20 | 2.10 | 6.50 |
| 13 | 3.80 | 2.90 | 3.55 | 4.10 | 5.10 | 3.25 | 2.30 | 2.40 | 2.00 | 2 18 | 2.10 | 6.10 |
| 14 | 3.50 | 2.90 | 3.50 | 4.00 | 3.80 | 3.15 | 2.20 | 2.00 | 2.00 | 2.15 | 2.10 | 3.30 |
| 15 | 3.80 | 2.90 | 16.50 | 3.90 | 3.60 | 3.05 | 2.20 | 2.10 | 2.00 | 2.10 | 2.10 | 2.90 |
| 16 | 3.60 | 4.20 | 11.10 | 3.80 | 3.40 | 2.95 | 2.20 | 2.00 | 2.00 | 2.05 | 2.10 | 2.60 |
| 17 | 3.30 | 7.30 | 6.70 | 3.70 | 3.20 | 2.90 | 2.20 | 2.00 | 2.00 | 2.05 | 2.05 | 2.55 |
| 18 | 3.10 | 5.00 | 6.80 | 3.60 | 3.05 | 2.90 | 2.25 | 2.00 | 2.00 | 2.05 | 2.05 | 2.50 |
| 19 | 3.00 | 4.30 | 22.80 | 3.50 | 3.00 | 2.80 | 2.20 | 2.00 | 2.85 | 2.10 | 2.05 | 2.50 |
| 20 | 2.90 | 4.00 | 15.80 | 3.50 | 2.95 | 2.70 | 2.18 | 2.00 | 2.30 | 2.10 | 2.05 | 2.45 |
| 21 | 2.80 | 3.75 | 7.30 | 3.50 | 2.90 | 2.60 | 2.15 | 2.00 | 2.15 | 2.10 | 2.00 | 2.35 |
| 22 | 2.70 | 3.50 | 6.90 | 3.50 | 2.95 | 2.50 | 2.15 | 2.00 | 2.00 | 2.10 | 2.00 | 2.25 |
| 23 | 2.70 | 3.40 | 5.90 | 3.50 | 3.00 | 2.40 | 2.15 | 2.00 | 2.00 | 2.10 | 2.00 | 3.00 |
| 24 | 2.70 | 3.25 | 5.30 | 3.50 | 2.90 | 2.30 | 2.15 | 2.00 | 2.00 | 2.10 | 2.00 | 3.10 |
| 25 | 3.00 | 3.20 | 4.80 | 3.70 | 2.85 | 2.30 | 2.15 | 2.05 | 2.00 | 2.08 | 2.00 | 3.10 |
| 26 | 2.85 | 3.70 | 4.70 | 4.50 | 2.80 | 2.60 | 3.70 | 2.03 | 1.95 | 2.08 | 2.05 | 3.08 |
| 27 | 2.70 | 13.30 | 6.50 | 4.25 | 2.80 | 2.50 | 3.30 | 2.05 | 1.95 | 2.05 | 2.05 | 3.05 |
| 28 | 2.70 | 6.00 | 6.50 | 3.60 | 2.80 | 2.40 | 2.70 | 2.10 | 2.00 | 2.05 | 2.05 | 3.05 |
| 29 | 2.70 | ....... | 6.00 | 3.40 | 2.80 | 2.40 | 2.40 | 2.25 | 2.00 | 2.03 | 2.10 | 3.00 |
| 30 | 2.70 | ....... | 5.50 | 3.80 | 2.80 | 2.40 | 2.35 | 2.35 | 1.95 | 2.00 | 2.10 | 3.50 |
| 31 | 2.70 | ....... | 5.00 | ....... | 2.80 | ....... | 2.30 | 4.00 | ....... | 2.05 | ....... | 3.65 |

## CATAWBA RIVER AT ROCKHILL, SOUTH CAROLINA.

This station, described in the Eighteenth Annual Report, Part IV, page 61, was established by C. C. Babb September 3, 1895. It is located at the bridge of the Southern Railway, 3 miles south of Fort Mill, South Carolina, and is about 60 miles below the Catawba station. The gage is fastened to the upper side of the guard rail, the 2-foot mark of the rod being over the center of the second vertical of the second truss from the south end of the bridge. The bench mark is described in Water-Supply Paper No. 15, page 35. The length of the gage was verified December 18, 1899, when it was found to have stretched 0.4 foot. The gage heights as published are corrected for this error. This station is reached from Rockhill by private conveyance. The channel is straight, current swift, and flow uninterrupted. The banks are not subject to overflow and all of the water is confined to one channel. The bed of the stream is solid rock and very rough. The current is at an angle with the bridge. Altogether the section is a poor one. W. A. Morris, a farmer at Rockhill, is the observer. Records of flow can be found as follows: 1896, Eighteenth Annual Report, Part IV, page 63; 1897, Nineteenth Annual Report, Part IV, page 214; 1898, Twentieth Annual Report, Part IV, page 150. The following measurements were made by E. W. Myers during 1899:

February 23, gage height, 3.10 feet; discharge, 8,086 second-feet.
June 13, gage height, 2.45 feet; discharge, 6,065 second-feet.
October 3, gage height, 1.60 feet; discharge, 2,104 second-feet.
December 18, gage height, 2.00 feet; discharge, 2,848 second-feet.

The table below was computed by E. W. Myers, and shows the comparative minimum flows of Catawba River at Catawba and Rockhill stations, which are about 60 miles apart. The drainage area at Catawba, North Carolina, is 1,535 square miles, and at the lower point, or Rockhill, South Carolina, it is 2,987 square miles. This table is comparable with the one for Yadkin River, shown on page 119, and it will be seen that the run-off per square mile does not vary to any greater extent than one would expect. The Catawba station was not established until the year following the one at Rockhill, so that the results can not be compared in the early part of the record. These facts are brought out in the footnotes at the bottom of the tables.

*Table showing the comparative minimum flows for Catawba River, Catawba and Rockhill stations.*

| Year. | Driest month. | | Mean flow for driest month. | | Mean flow, driest month, per square mile. | | Minimum flow for year. | | Minimum flow for year per square mile. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rockhill. | Catawba. | Rockhill. | Catawba. | Rockhill. | Catawba. | Rockhill. | Catawba. | Rockhill. | Catawba. |
| | | | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* | *Sec.-ft.* |
| 1895 | Sept. *a* | ........ | 1,318 | ........ | 0.441 | ........ | 1,300 | ........ | 0.435 | ........ |
| 1896 | Aug | Oct | 1,604 | 865 | .54 | 0.56 | *b* 1,330 | 770 | .445 | 0.501 |
| 1897 | Sept | Sept | 1,817 | 1,017 | .61 | .66 | *c* 1,575 | *d* 850 | .526 | .553 |
| 1898 | June | June | 2,091 | 1,069 | .70 | .69 | 1,600 | 910 | .535 | .592 |
| 1899 | Nov | Nov | 2,492 | 1,340 | .835 | .873 | 2,300 | 1,220 | .770 | .793 |

*a* Seven days' record.
*b* Also in July, August, and September.
*c* Minimum occurred in January. September minimum was 1,700 second-feet, or 0.569 second-foot per square mile.
*d* Minimum in October. September minimum 900 second-feet, or 0.579 second-foot per square mile.

*Daily gage height, in feet, of Catawba River at Rockhill, South Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.20 | 2.40 | 6.20 | 4.00 | 2.80 | 2.20 | 2.10 | 2.10 | 2.00 | 1.70 | 1.90 | 1.70 |
| 2 | 2.80 | 2.50 | 4.10 | 3.70 | 2.80 | 2.20 | 2.00 | 2.00 | 3.50 | 1.60 | 1.80 | 1.70 |
| 3 | 2.60 | 2.30 | 3.40 | 3.40 | 2.70 | 2.40 | 2.00 | 1.90 | 2.50 | 1.60 | 1.70 | 1.60 |
| 4 | 2.30 | 2.30 | 3.40 | 3.25 | 2.70 | 2.40 | 1.85 | 1.90 | 2.10 | 1.60 | 2.10 | 1.60 |
| 5 | 2.30 | 7.90 | 4.80 | 4.30 | 2.60 | 2.25 | 1.80 | 1.90 | 2.10 | 1.50 | 1.80 | 1.60 |
| 6 | 2.20 | 10.75 | 4.10 | 4.20 | 2.60 | 2.20 | 1.80 | 1.80 | 2.00 | 1.50 | 1.70 | 1.60 |
| 7 | 8.30 | 11.70 | 4.30 | 3.80 | 2.60 | 2.20 | 1.80 | 1.70 | 2.00 | 1.80 | 1.60 | 1.60 |
| 8 | 8.00 | 10.20 | 3.70 | 6.20 | 3.30 | 2.15 | 1.90 | 1.70 | 2.60 | 2.40 | 1.60 | 1.60 |
| 9 | 5.10 | 6.20 | 3.20 | 6.90 | 3.80 | 2.10 | 2.00 | 1.80 | 1.90 | 2.10 | 1.60 | 1.60 |
| 10 | 3.30 | 4.20 | 3.10 | 4.80 | 3.10 | 2.10 | 2.00 | 2.00 | 2.30 | 1.80 | 1.60 | 1.70 |
| 11 | 2.80 | 3.50 | 2.90 | 4.00 | 2.90 | 2.50 | 1.90 | 2.20 | 2.60 | 1.80 | 1.60 | 1.60 |
| 12 | 2.85 | 3.10 | 2.90 | 3.70 | 2.80 | 2.50 | 1.90 | 2.40 | 2.10 | 1.70 | 1.60 | 2.80 |
| 13 | 2.70 | 2.80 | 2.80 | 3.50 | 2.70 | 2.40 | 1.80 | 2.20 | 1.80 | 1.70 | 1.60 | 3.30 |
| 14 | 3.10 | 2.50 | 2.60 | 3.40 | 4.30 | 2.90 | 1.80 | 1.90 | 1.80 | 1.70 | 1.60 | 3.60 |
| 15 | 3.60 | 2.60 | 7.55 | 3.30 | 3.40 | 2.60 | 1.80 | 1.80 | 1.80 | 1.70 | 1.60 | 2.60 |
| 16 | 3.30 | 3.10 | 14.05 | 3.15 | 2.90 | 2.35 | 1.80 | 1.80 | 1.70 | 1.70 | 1.60 | 2.20 |
| 17 | 2.95 | 5.80 | 12.00 | 3.20 | 2.70 | 2.20 | 1.80 | 1.80 | 1.70 | 1.70 | 1.60 | 2.10 |
| 18 | 2.80 | 6.60 | 5.70 | 3.10 | 2.60 | 2.05 | 1.80 | 1.80 | 1.55 | 1.70 | 1.50 | 2.00 |
| 19 | 2.70 | 4.80 | 5.30 | 3.10 | 2.55 | 2.05 | 1.80 | 1.80 | 1.50 | 1.70 | 1.50 | 2.20 |
| 20 | 2.60 | 3.90 | 16.85 | 3.00 | 2.55 | 2.05 | 1.80 | 1.70 | 1.80 | 1.70 | 1.50 | 2.10 |
| 21 | 2.50 | 3.40 | 14.20 | 2.90 | 2.50 | 2.00 | 2.10 | 1.70 | 2.00 | 1.70 | 1.50 | 2.10 |
| 22 | 2.40 | 3.30 | 5.70 | 2.85 | 2.40 | 2.00 | 1.80 | 1.60 | 1.90 | 1.70 | 1.50 | 2.10 |
| 23 | 2.40 | 3.10 | 4.40 | 2.80 | 2.40 | 2.00 | 1.80 | 1.60 | 1.70 | 1.70 | 1.70 | 2.00 |
| 24 | 2.20 | 3.10 | 4.40 | 2.80 | 2.50 | 2.00 | 1.70 | 1.60 | 1.70 | 1.60 | 1.70 | 2.70 |
| 25 | 2.40 | 2.90 | 4.00 | 2.80 | 2.50 | 2.00 | 1.80 | 1.60 | 1.60 | 1.60 | 1.70 | 2.70 |
| 26 | 2.40 | 2.80 | 3.70 | 3.50 | 2.40 | 2.00 | 1.90 | 1.60 | 1.60 | 1.60 | 1.90 | 2.70 |
| 27 | 2.40 | 5.99 | 4.55 | 3.85 | 2.35 | 2.00 | 2.50 | 1.50 | 1.60 | 1.60 | 1.80 | 2.40 |
| 28 | 2.30 | 10.40 | 5.50 | 3.30 | 2.35 | 2.15 | 2.70 | 1.60 | 1.60 | 1.60 | 1.70 | 2.10 |
| 29 | 2.30 | ...... | 6.20 | 3.00 | 2.35 | 2.20 | 2.05 | 2.20 | 1.70 | 1.60 | 1.70 | 2.10 |
| 30 | 2.30 | ...... | 5.30 | 2.90 | 2.30 | 2.10 | 2.00 | 2.10 | 1.70 | 1.60 | 1.70 | 2.10 |
| 31 | 2.20 | ...... | 4.40 | ...... | 2.30 | ...... | 2.20 | 1.90 | ...... | 1.80 | ...... | 2.00 |

Catawba River in South Carolina is known as Wateree River. It unites with Congaree River to form the Santee. The United States Weather Bureau has maintained a station at Camden, South Carolina, on Wateree River, 43 miles above its mouth. The gage is a pine timber attached to the central granite pier of the South Carolina and Georgia Extension Railroad bridge. The top of the rail on the bridge is 47.0 feet above zero of gage. The highest water recorded was 31.5 feet, in September, 1886; the lowest, 0.0 feet, in June, 1884. The danger line is at 24 feet. The drainage area at this point, according to the Weather Bureau, is 2,635 square miles.

## BROAD RIVER AT GAFFNEY, SOUTH CAROLINA.

Broad River rises on the eastern slope of the Blue Ridge Mountains, near Hickorynut Gap, in the west-central part of North Carolina, and flowing in a general southeasterly direction unites with Saluda River above Columbia, South Carolina, to form the Congaree. The drainage area comprises about 4,950 square miles, of which 3,550 are in South Carolina and 1,400 in North Carolina, and is partly mapped on the Morganton, Mount Mitchell, and Saluda atlas sheets. The upper part of its basin is rough, broken country largely covered with forests. In South Carolina the topography is flatter and for the greater part the land is under cultivation. Broad River receives a number of important tributaries, but there are no towns of importance along it. There are a number of sites for the possible development of water power along its course, the most important of which are described in the Nineteenth Annual Report, Part IV, page 215. Systematic measurements of the flow have been made at Gaffney, South Carolina, 15 miles below the North Carolina line, and at Alston, 20 miles above Columbia, South Carolina. The station at Gaffney, described in the Eighteenth Annual Report, Part IV, page 65, was established by E. W. Myers July 1, 1896, and was located at the Southern Railway bridge, about 3 miles from Gaffney, South Carolina. This station was maintained until October 25, 1898, when the gage rod was moved to Gaffneys Ferry, 200 yards above the bridge, as described in Water-Supply Paper No. 27, page 27. The bench mark is described in the same paper. The velocity is quite rapid, well distributed all the way across, and the channel is straight for some distance above and below the station. The ferryman, John W. Gaffney, Gaffney, South Carolina, was employed to take charge of the gage. The results of discharge measurements are found as follows: 1896, Eighteenth Annual Report, Part IV, page 66; 1897, Nineteeth Annual Report, Part IV, page 220. The following measurements were made by E. W. Myers during 1899:

February 10, gage height, 3.70 feet; discharge, 4,702 second-feet.
February 22, gage height, 2.25 feet; discharge, 4,497 second-feet.
April 15, gage height, 3.20 feet; discharge, 3,510 second-feet.
June 12, gage height, 2.40 feet; discharge, 2,496 second-feet.
October 4, gage height, 1.70 feet; discharge, 692 second-feet.
October 4, gage height, 1.70 feet; discharge, 662 second-feet.
December 17, gage height, 1.65 feet; discharge, 1,485 second-feet.

*Daily gage height, in feet, of Broad River at Gaffney, South Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.50 | 2.40 | 5.00 | 3.90 | 2.80 | 2.10 | 1.80 | 1.90 | 2.50 | 1.30 | 1.60 | 1.40 |
| 2 | 2.40 | 2.40 | 3.90 | 3.50 | 2.80 | 2.10 | 1.80 | 1.80 | 2.00 | 1.20 | 1.70 | 1.40 |
| 3 | 2.20 | 2.30 | 3.50 | 3.40 | 2.60 | 2.00 | 1.70 | 1.80 | 1.90 | 1.40 | 1.80 | 1.50 |
| 4 | 2.10 | 2.30 | 3.40 | 3.60 | 2.50 | 2.10 | 1.70 | 1.70 | 1.70 | 1.30 | 1.60 | 1.50 |
| 5 | 2.00 | 5.80 | 3.40 | 4.90 | 2.70 | 2.10 | 1.70 | 1.60 | 1.60 | 1.30 | 1.60 | 1.40 |
| 6 | 2.80 | 8.20 | 3.50 | 3.60 | 2.70 | 1.90 | 1.60 | 1.60 | 1.50 | 1.70 | 1.50 | 1.30 |
| 7 | 8.40 | 10.20 | 3.30 | 4.50 | 2.60 | 2.00 | 1.70 | 1.50 | 1.20 | 1.60 | 1.60 | 1.40 |
| 8 | 5.40 | 7.20 | 3.10 | 6.40 | 2.50 | 2.00 | 1.70 | 1.50 | 2.00 | 1.70 | 1.50 | 1.40 |
| 9 | 4.60 | ....... | 3.00 | 4.50 | 2.50 | 2.00 | 1.80 | 1.50 | 2.20 | 1.80 | 1.40 | 1.30 |
| 10 | 3.00 | ....... | 3.00 | 4.00 | 2.40 | 2.00 | 1.80 | 2.00 | 1.90 | 1.80 | 1.50 | 1.30 |
| 11 | 3.10 | ....... | 2.90 | 3.70 | 2.40 | 2.00 | 1.70 | 2.50 | 2.00 | 1.70 | 1.50 | 1.40 |
| 12 | 3.00 | 3.70 | 2.90 | 3.50 | 2.40 | 2.00 | 1.60 | 2.10 | 1.60 | 1.70 | 1.40 | 2.60 |
| 13 | 3.00 | 3.50 | 2.90 | 3.40 | 4.50 | 3.20 | 1.60 | 1.90 | 1.30 | 1.60 | 1.35 | 3.50 |
| 14 | 3.00 | 3.40 | 3.50 | 3.20 | 3.70 | 2.30 | 1.60 | 1.80 | 1.30 | 1.40 | 1.40 | 2.20 |
| 15 | 3.20 | 3.10 | 9.20 | 3.20 | 2.80 | 2.20 | 1.60 | 1.90 | 1.20 | 1.40 | 1.60 | 1.90 |
| 16 | 3.10 | 3.90 | 10.00 | 3.30 | 2.70 | 2.10 | 1.50 | 1.70 | 1.20 | 1.50 | 1.40 | 1.80 |
| 17 | 2.90 | 6.80 | 8.30 | 3.20 | 2.40 | 2.00 | 1.50 | 1.60 | 1.20 | 1.50 | 1.50 | 1.70 |
| 18 | 2.80 | 4.30 | 5.80 | 3.10 | 2.40 | 2.20 | 1.60 | 1.50 | 1.30 | 1.60 | 1.40 | 1.80 |
| 19 | 2.60 | 3.70 | 12.20 | 3.00 | 2.40 | 1.80 | 1.60 | 1.40 | 1.30 | 1.50 | 1.30 | 1.60 |
| 20 | 2.50 | 3.40 | 11.50 | 3.00 | 2.20 | 1.80 | 1.90 | 1.40 | 1.40 | 1.40 | 1.30 | 1.70 |
| 21 | 2.30 | 3.10 | 5.60 | 2.90 | 2.50 | 1.80 | 1.80 | 1.30 | 1.70 | 1.40 | 1.30 | 1.60 |
| 22 | 2.20 | 3.10 | 5.60 | 2.90 | 2.20 | 1.70 | 1.70 | 1.40 | 1.60 | 1.30 | 1.40 | 1.50 |
| 23 | 2.30 | 3.00 | 4.80 | 2.90 | 2.20 | 1.70 | 1.70 | 1.40 | 1.40 | 1.30 | 1.50 | 1.60 |
| 24 | 2.20 | 2.80 | 4.50 | 2.60 | 2.20 | 1.60 | 1.60 | 1.50 | 1.20 | 1.40 | 1.50 | 2.80 |
| 25 | 2.40 | 2.80 | 4.20 | 3.30 | 2.20 | 2.00 | 1.60 | 1.50 | 1.40 | 1.30 | 1.50 | 2.40 |
| 26 | 2.20 | 2.80 | 4.00 | 4.10 | 2.10 | 1.70 | 1.90 | 1.50 | 1.60 | 1.30 | 1.60 | 2.30 |
| 27 | 2.20 | 9.80 | 4.50 | 3.20 | 2.10 | 2.20 | 2.60 | 2.60 | 1.50 | 1.20 | 1.60 | 2.00 |
| 28 | 2.10 | 7.00 | 4.60 | 3.10 | 1.90 | 2.10 | 1.90 | 1.90 | 1.30 | 1.30 | 1.60 | 1.70 |
| 29 | 2.20 | ....... | 5.50 | 2.90 | 2.00 | 2.00 | 1.90 | 2.00 | 1.40 | 1.30 | 1.50 | 1.60 |
| 30 | 2.20 | ....... | 4.00 | 2.80 | 2.20 | 1.80 | 1.80 | 1.90 | 1.70 | 1.40 | 1.50 | 1.60 |
| 31 | 2.30 | ....... | 4.00 | ....... | 2.10 | ....... | 1.80 | 2.30 | ....... | 1.50 | ....... | 1.50 |

## BROAD RIVER AT ALSTON, SOUTH CAROLINA.

This station, described in the Eighteenth Annual Report, Part IV, page 67, was established by E. W. Myers, July 3, 1896, and is located at the Southern Railway bridge near Alston, South Carolina, and 60 miles below the Gaffney station. The length of the wire gage is 42.65 feet. The gage was verified December 19, 1899. The section here is not a good one, being broken by the foundations of an old bridge crossing at the same place as the present one. The bed is flat, muddy, and somewhat shifting. The river is straight for a long distance above and below the station. The current is swift and the velocity fairly uniform across the section. The observer is D. R. Elkin, a farmer of Alston, South Carolina. Records of discharge may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 68; 1897 and 1898, Twentieth Annual Report, Part IV, page 151. The following measurements were made by E. W. Myers in 1899:

February 19, gage height, 10.15 feet; discharge, 28,930 second-feet.
June 14, gage height, 4.33 feet; discharge, 6,289 second-feet.
October 2, gage height, 2.14 feet; discharge, 1,645 second-feet.
December 19, gage height, 2.91 feet; discharge, 3,319 second-feet.

*Daily gage height, in feet, of Broad River at Alston, South Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.42 | 4.78 | 11.50 | 8.83 | 4.30 | 3.32 | 2.77 | 3.10 | 4.50 | 2.20 | 4.47 | 2.90 |
| 2 | 3.88 | 4.60 | 8.00 | 6.74 | 4.10 | 3.30 | 2.74 | 3.00 | 4.45 | 2.12 | 3.10 | 3.16 |
| 3 | 3.90 | 4.30 | 6.54 | 5.51 | 4.09 | 3.20 | 2.50 | 2.55 | 3.55 | 1.97 | 2.87 | 3.14 |
| 4 | 3.43 | 4.30 | 7.42 | 5.30 | 4.00 | 3.10 | 2.76 | 3.08 | 3.65 | 2.20 | 3.88 | 2.80 |
| 5 | 3.35 | 6.90 | 7.42 | 6.10 | 3.99 | 3.10 | 2.53 | 2.50 | 3.00 | 2.34 | 2.74 | 2.66 |
| 6 | 3.47 | 13.00 | 10.51 | 6.10 | 3.99 | 2.80 | 2.63 | 3.00 | 2.90 | 6.28 | 2.62 | 2.82 |
| 7 | 9.50 | 18.00 | 6.20 | 5.61 | 4.11 | 2.90 | 2.60 | 2.80 | 2.78 | 3.52 | 2.37 | 2.70 |
| 8 | 14.00 | 18.50 | 5.53 | 8.33 | 4.20 | 2.89 | 2.62 | 2.10 | 3.45 | 4.18 | 2.64 | 2.65 |
| 9 | 9.40 | 12.90 | 5.11 | 9.00 | 3.98 | 2.90 | 2.73 | 2.80 | 3.43 | 3.22 | 2.58 | 2.71 |
| 10 | 7.10 | 9.50 | 4.90 | 7.14 | 3.82 | 2.88 | 2.90 | 2.35 | 3.52 | 2.90 | 2.51 | 2.66 |
| 11 | 5.78 | 6.78 | 4.79 | 6.13 | 3.63 | 2.89 | 2.60 | 2.75 | 9.30 | 2.86 | 2.50 | 2.53 |
| 12 | 7.20 | 5.80 | 4.71 | 5.88 | 3.69 | 3.40 | 2.48 | 4.50 | 4.40 | 2.68 | 2.56 | 6.48 |
| 13 | 7.35 | 5.40 | 4.42 | 5.40 | 3.70 | 3.10 | 2.43 | 3.34 | 3.60 | 2.58 | 2.78 | 8.13 |
| 14 | 6.71 | 4.86 | 4.59 | 5.20 | 3.88 | 4.28 | 2.30 | 2.80 | 2.81 | 2.60 | 2.23 | 5.13 |
| 15 | 7.51 | 4.54 | 6.28 | 5.03 | 4.68 | 3.70 | 2.34 | 2.55 | 2.62 | 2.58 | 2.50 | 4.42 |
| 16 | 6.10 | 8.33 | 14.40 | 4.90 | 3.98 | 3.35 | 2.33 | 2.55 | 2.60 | 2.43 | 2.60 | 3.70 |
| 17 | 6.20 | 15.30 | 15.39 | 4.87 | 3.62 | 3.00 | 2.24 | 2.55 | 2.40 | 2.21 | 2.57 | 3.34 |
| 18 | 5.32 | 12.69 | 10.50 | 4.65 | 3.52 | 3.40 | 2.09 | 2.23 | 2.30 | 2.52 | 2.58 | 3.07 |
| 19 | 4.70 | 10.10 | 8.00 | 4.69 | 3.40 | 3.10 | 2.28 | 2.20 | 2.35 | 2.54 | 2.51 | 2.91 |
| 20 | 4.33 | 6.84 | 15.30 | 4.68 | 3.45 | 2.92 | 2.10 | 2.00 | 2.60 | 2.49 | 2.43 | 3.22 |
| 21 | 4.11 | 6.23 | 13.94 | 4.54 | 3.30 | 2.84 | 2.83 | 2.15 | 2.63 | 2.57 | 2.29 | 3.08 |
| 22 | 4.00 | 6.52 | 8.94 | 4.41 | 3.40 | 2.82 | 2.52 | 2.14 | 2.60 | 2.42 | 2.52 | 2.90 |
| 23 | 3.82 | 5.61 | 7.00 | 4.30 | 3.43 | 2.79 | 2.30 | 2.40 | 2.50 | 2.20 | 4.71 | 3.60 |
| 24 | 4.10 | 5.11 | 7.12 | 4.40 | 3.88 | 2.73 | 2.17 | 2.30 | 2.39 | 2.15 | 3.61 | 7.32 |
| 25 | 4.20 | 4.61 | 6.40 | 4.13 | 3.72 | 2.51 | 2.40 | 3.40 | 2.30 | 2.45 | 3.10 | 8.20 |
| 26 | 4.55 | 4.62 | 5.90 | 6.61 | 3.32 | 2.60 | 2.95 | 2.35 | 2.08 | 2.40 | 5.54 | 4.44 |
| 27 | 4.00 | 13.72 | 5.80 | 6.64 | 3.30 | 2.70 | 6.25 | 3.55 | 2.60 | 2.39 | 4.25 | 3.00 |
| 28 | 3.80 | 17.98 | 7.30 | 5.30 | 3.30 | 3.78 | 4.72 | 5.55 | 2.35 | 2.41 | 3.50 | 3.76 |
| 29 | 3.90 | ....... | 7.72 | 4.70 | 3.28 | 3.30 | 3.80 | 4.70 | 2.29 | 2.40 | 3.30 | 3.75 |
| 30 | 4.10 | ....... | 7.43 | 4.40 | 3.11 | 2.93 | 2.09 | 4.28 | 2.47 | 2.30 | 3.04 | ....... |
| 31 | 4.50 | ....... | 6.84 | ....... | 3.11 | ....... | 3.15 | 4.50 | ....... | 4.57 | ....... | ....... |

Broad River joins Saluda River at Columbia, South Carolina, to form Congaree River. The United States Weather Bureau has maintained river-height observations at Columbia, South Carolina. The gage rod is painted on the first stone pier from the eastern shore of the Gervais street toll bridge. The bench mark is the track of the South Carolina and Georgia Extension Railroad at the Union Station, and is at an elevation of 102.59 feet above the zero of the gage. The high-water mark is 34.4 feet, and was reached in September, 1852; the lowest, —0.4 foot, on January 20, 1893. The danger line is 15 feet. The drainage area above the station, according to the United States Weather Bureau, is 7,300 square miles.

Santee River is formed by the junction of Wateree and Congaree rivers. The United States Weather Bureau has maintained a gage on Lower Santee River at St. Stephen, South Carolina, 50 miles above its mouth. The gage rod is attached to the downstream side of the central granite pier of the railroad bridge. The top of the rail on this bridge is 31 feet above zero of gage. The high-water mark is 20.2 feet, and was reached on September 18, 1888; the lowest, 1.3 feet, on October 6, 1895. The danger line is at 12 feet. The area drained at this point, according to the United States Weather Bureau, is 13,600 square miles.

### SALUDA RIVER AT WATERLOO, SOUTH CAROLINA.

Saluda River rises in the mountains between North and South Carolina, flows in a southeasterly direction, and unites, near Columbia, South Carolina, with the Broad, to form the Congaree. The drainage area is partly mapped on the Saluda, Pickens, Pisgah, and Abbeville atlas sheets. Measurements have been made on the Saluda to determine the available water power. The station was established by E. W. Myers, August 30, 1896, and is described in the Eighteenth Annual Report, Part IV, page 68. It is 1 mile below the mouth of Reedy River, at the Charleston and Western Carolina Railway bridge, about 3 miles from Coronaca Station, South Carolina. The length of the gage wire is 47.00 feet. The length of the gage was verified December 19, 1899. The river here is straight for several hundred yards above and below the bridge. The flow is probably influenced by dams some miles above. The bed of the stream is of sand and mud and liable to change during high water. The banks are low, the right bank being subject to overflow. The observer is R. N. Cunningham, storekeeper and farmer at Waterloo, South Carolina. The locality is reached by private conveyance from Greenwood, South Carolina. The discharge measurements are made from the railroad bridge. Records of results may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 68; 1897, Nineteenth Annual Report, Part IV, page 221; 1898, Twentieth Annual Report, Part IV, page 153. The following measurements were made by E. W. Myers during 1899:

February 20, gage height, 7.60 feet; discharge, 3,350 second-feet.
June 14, gage height, 5.30 feet; discharge, 1,740 second-feet.
October 1, gage height, 3.65 feet; discharge, 604 second-feet.
December 19, gage height, 4.00 feet; discharge, 995 second-feet.

*Daily gage height, in feet, of Saluda River at Waterloo, South Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.00 | 5.75 | 12.80 | 8.75 | 6.00 | 4.75 | 4.95 | 3.80 | 3.90 | 3.65 | 4.75 | 4.60 |
| 2 | 4.65 | 5.40 | 8.90 | 7.55 | 5.90 | 4.40 | 3.95 | 3.70 | 5.20 | 2.85 | 4.50 | 4.45 |
| 3 | 5.05 | 5.60 | 7.65 | 7.05 | 5.80 | 5.15 | 3.85 | 3.65 | 5.25 | 3.60 | 4.65 | 3.80 |
| 4 | 4.90 | 6.25 | 7.60 | 7.15 | 5.60 | 4.35 | 4.20 | 3.70 | 3.25 | 4.35 | 4.40 | 3.05 |
| 5 | 4.80 | 6.85 | 8.00 | 7.30 | 6.00 | 4.15 | 3.20 | 4.75 | 3.95 | 4.20 | 3.80 | 3.90 |
| 6 | 5.00 | 10.60 | 8.10 | 7.60 | 5.95 | 5.05 | 3.75 | 4.00 | 3.85 | 5.50 | 2.90 | 4.25 |
| 7 | 14.00 | 18.50 | 7.25 | 7.20 | 6.15 | 4.10 | 3.80 | 3.30 | 3.70 | 4.50 | 4.35 | 3.80 |
| 8 | 14.30 | 17.35 | 6.70 | 7.95 | 5.80 | 4.00 | 4.85 | 3.90 | 4.10 | 5.65 | 4.30 | 3.85 |
| 9 | 6.05 | 12.70 | 6.50 | 8.35 | 5.85 | 3.80 | 4.65 | 4.60 | 4.85 | 4.00 | 4.35 | 4.25 |
| 10 | 7.05 | 8.60 | 6.70 | 7.40 | 6.55 | 3.70 | 3.45 | 4.00 | 3.85 | 4.00 | 4.35 | 3.45 |
| 11 | 6.50 | 7.60 | 6.30 | 6.90 | 5.50 | 3.75 | 3.70 | 5.50 | 6.60 | 4.10 | 4.15 | 3.00 |
| 12 | 6.90 | 7.10 | 6.45 | 6.95 | 5.30 | 5.85 | 3.70 | 4.90 | 5.50 | 4.00 | 3.70 | 5.90 |
| 13 | 7.50 | 7.00 | 6.45 | 6.75 | 5.20 | 5.50 | 3.60 | 4.50 | 3.95 | 4.00 | 2.90 | 7.10 |
| 14 | 7.80 | 5.60 | 6.25 | 6.65 | 4.95 | 5.55 | 3.60 | 3.20 | 3.80 | 4.65 | 4.00 | 5.85 |
| 15 | 7.45 | 6.50 | 10.30 | 6.30 | 4.80 | 4.45 | 4.75 | 3.65 | 4.50 | 4.10 | 4.45 | 5.00 |
| 16 | 6.95 | 12.55 | 15.35 | 6.55 | 4.60 | 4.25 | 4.50 | 3.65 | 4.10 | 3.00 | 4.35 | 4.85 |
| 17 | 6.65 | 15.20 | 13.85 | 6.35 | 4.70 | 4.90 | 3.60 | 3.55 | 3.50 | 4.20 | 4.05 | 4.45 |
| 18 | 6.25 | 13.10 | 10.30 | 6.25 | 4.55 | 4.60 | 3.50 | 4.55 | 2.85 | 4.00 | 4.25 | 4.10 |
| 19 | 6.30 | 8.60 | 9.75 | 6.45 | 4.50 | 4.65 | 3.60 | 4.15 | 3.95 | 4.75 | 3.70 | 4.75 |
| 20 | 5.90 | 7.40 | 11.98 | 6.30 | 5.15 | 4.05 | 3.55 | 3.45 | 3.90 | 4.70 | 2.95 | 3.90 |
| 21 | 5.40 | 7.60 | 13.18 | 6.20 | 4.60 | 4.10 | 4.45 | 2.70 | 3.90 | 5.45 | 3.95 | 4.50 |
| 22 | 5.85 | 7.45 | 8.75 | 5.55 | 5.05 | 3.75 | 4.50 | 4.20 | 3.90 | 3.20 | 4.05 | 4.55 |
| 23 | 5.70 | 9.85 | 8.65 | 5.90 | 4.50 | 3.65 | 3.60 | 3.70 | 4.80 | 3.00 | 6.45 | 4.30 |
| 24 | 5.45 | 6.55 | 8.90 | 6.15 | 4.40 | 4.90 | 2.90 | 3.75 | 3.60 | 4.15 | 4.40 | 7.15 |
| 25 | 5.50 | 6.35 | 7.80 | 7.90 | 4.35 | 4.10 | 4.75 | 3.70 | 2.90 | 4.35 | 4.85 | 5.15 |
| 26 | 5.20 | 6.70 | 7.55 | 8.10 | 4.30 | 3.60 | 5.10 | 4.35 | 3.90 | 4.55 | 5.25 | 4.75 |
| 27 | 5.00 | 17.55 | 7.05 | 7.15 | 5.15 | 4.15 | 5.40 | 5.00 | 4.35 | 4.55 | 4.15 | 4.95 |
| 28 | 6.75 | 15.60 | 7.35 | 6.55 | 5.10 | 4.05 | 5.00 | 4.75 | 4.45 | 4.20 | 5.05 | 4.55 |
| 29 | 6.55 | ...... | 7.95 | 6.00 | 3.75 | 4.20 | 5.45 | 4.35 | 3.80 | 3.83 | 5.00 | 4.15 |
| 30 | 4.10 | ...... | 7.25 | 6.10 | 4.15 | 3.80 | 5.40 | 4.80 | 4.00 | 2.95 | 4.15 | 4.75 |
| 31 | 5.30 | ...... | 9.35 | ...... | 4.15 | ...... | 3.80 | 4.40 | ...... | 4.40 | ...... | 4.40 |

## TUGALOO RIVER AT MADISON, SOUTH CAROLINA.

This river is formed by the junction of the Tallulah and Chattooga rivers, which have their sources in the Blue Ridge Mountains. The basin is largely covered with an original growth of oak, and is extremely wild and picturesque. The drainage area is mapped on the following atlas sheets: Nantahala, Dahlonega, Walhalla, and Cowee. There are many beautiful falls in this watershed, the most noted of which are Tallulah Falls, with a drop of 335 feet in four successive leaps, the total fall in 2⅝ miles being 525 feet; and Toccoa Falls, on Toccoa Creek, with a vertical drop of about 190 feet. This latter stream should not be confused with Toccoa River, a tributary of Hiwassee River, and on which a gaging station is maintained at Blue Ridge, Georgia. The gaging station on Tugaloo River was established July 19, 1898, at Cooks Ferry, about one-half a mile from Madison, South Carolina, one mile below the Southern Railway bridge over Tugaloo River and 2 miles above the mouth of Chauga Creek. The gage is a 2 by 4 inch scantling 10 feet long, nailed to a sycamore tree on the right bank at the ferry landing. The bench marks are on the left bank of the river, the first being on a willow tree at the ferry landing, and consisting of three large nails 3.00 feet above zero of gage; the second is on the same tree, being one nail 6.00 feet above zero of gage; the third is a large nail in a sycamore tree at the ferry landing 12.00 feet above the zero of the gage. Discharge measurements are made from a boat held in place by the ferry rope stretched across the river. The results of the measurements are given in the Twentieth Annual Report, Part IV, page 162. The following measurements were made by Max Hall and others in 1899:

April 21, gage height, 4.50 feet; discharge, 2,604 second-feet.
May 22, gage height, 3.20 feet; discharge, 1,687 second-feet.
June 20, gage height, 2.10 feet; discharge, 1,325 second-feet.
September 12, gage height, 1.00 foot; discharge, 734 second-feet.
October 4, gage height, 0.70 foot; discharge, 512 second-feet.

A number of discharge measurements were made on various tributaries of Tugaloo River during the fall of 1899. A measurement of Tallulah River above the falls at the wagon bridge at Tallulah Falls, Georgia, was made October 3, when the discharge was found to be 153 second-feet; a second measurement was made November 25, giving a discharge of 188 second-feet. Two discharge measurements were made on Toccoa Creek, above the falls, $2\frac{1}{2}$ miles from Toccoa, Georgia, on October 4; they were made at different sections on the river, and gave 5.7 and 5.9 second-feet, respectively. Chauga Creek enters the Tugaloo about 2 miles below the gaging station. A measurement was made on this stream at the wagon bridge near its mouth at Madison, South Carolina, on October 4, when the discharge was found to be 99 second-feet.

*Daily gage height, in feet, of Tugaloo River at Madison, South Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.10 | 3.90 | 6.60 | 6.40 | 4.30 | 2.50 | 1.70 | 1.40 | 3.10 | 0.70 | 0.90 | 1.00 |
| 2 | 3.40 | 3.40 | 5.90 | 5.90 | 4.20 | 2.40 | 1.60 | 1.40 | 2.70 | .70 | .80 | 1.10 |
| 3 | 3.30 | 3.50 | 5.80 | 5.70 | 4.10 | 2.40 | 1.60 | 1.30 | 3.30 | .70 | .80 | 1.10 |
| 4 | 3.20 | 7.60 | 5.40 | 5.90 | 4.00 | 2.30 | 1.50 | 1.20 | 1.90 | .70 | .80 | 1.00 |
| 5 | 3.20 | 6.80 | 6.90 | 6.00 | 4.30 | 2.50 | 1.50 | 1.10 | 1.70 | .80 | .80 | .90 |
| 6 | 6.45 | 11.85 | 6.00 | 5.60 | 4.10 | 3.30 | 1.60 | 1.10 | 1.40 | .90 | .70 | .90 |
| 7 | 5.80 | 12.70 | 5.50 | 7.80 | 4.80 | 2.20 | 1.90 | 1.10 | 1.30 | .80 | .70 | .90 |
| 8 | 4.60 | 8.80 | 5.20 | 8.70 | 4.00 | 2.20 | 1.60 | 1.00 | 1.20 | 3.30 | .70 | .80 |
| 9 | 4.20 | 6.80 | 5.20 | 6.80 | 3.80 | 2.10 | 1.60 | 1.00 | 1.20 | 2.50 | .70 | .80 |
| 10 | 3.90 | 5.80 | 4.90 | 6.20 | 3.70 | 2.00 | 1.60 | 1.40 | 1.10 | 1.50 | .70 | .80 |
| 11 | 4.20 | 5.50 | 4.80 | 5.80 | 3.70 | 2.20 | 1.50 | 1.30 | 1.10 | 1.00 | .70 | .90 |
| 12 | 4.10 | 5.30 | 4.70 | 5.50 | 3.60 | 3.90 | 1.40 | 1.00 | 1.00 | .90 | .70 | 12.30 |
| 13 | 3.90 | 8.40 | 4.20 | 5.30 | 3.60 | 5.30 | 1.30 | .90 | .90 | .90 | .70 | 8.45 |
| 14 | 4.00 | 4.40 | 8.05 | 5.20 | 3.40 | 3.50 | 1.30 | 1.00 | .90 | .80 | .70 | 3.10 |
| 15 | 4.50 | 4.50 | 16.15 | 5.00 | 3.30 | 2.80 | 1.30 | 1.00 | .80 | .80 | .70 | 2.50 |
| 16 | 4.00 | 5.60 | 13.80 | 5.10 | 3.20 | 2.40 | 1.20 | 1.00 | .80 | .80 | .70 | 2.00 |
| 17 | 3.90 | 5.60 | 8.40 | 4.90 | 3.20 | 2.50 | 1.20 | 1.20 | .80 | .80 | .70 | 1.80 |
| 18 | 3.70 | 5.00 | 6.90 | 4.80 | 3.10 | 2.40 | 1.20 | 1.00 | .80 | .90 | .70 | 1.60 |
| 19 | 3.40 | 4.80 | 16.15 | 4.80 | 3.20 | 2.20 | 1.10 | .90 | .80 | 1.00 | .70 | 1.60 |
| 20 | 3.40 | 4.60 | 11.60 | 4.60 | 3.00 | 2.10 | 1.20 | .80 | .90 | 1.00 | .70 | 1.90 |
| 21 | 3.30 | 4.50 | 8.40 | 4.50 | 2.90 | 2.00 | 1.20 | .80 | .90 | .90 | .70 | 1.60 |
| 22 | 3.20 | 4.50 | 7.60 | 4.40 | 3.10 | 2.90 | 1.40 | .80 | .80 | .90 | .80 | 1.40 |
| 23 | 3.10 | 4.40 | 8.40 | 4.30 | 3.00 | 2.90 | 1.30 | .90 | .80 | .90 | .90 | 1.30 |
| 24 | 3.20 | 4.30 | 7.30 | 4.20 | 2.80 | 2.80 | 1.70 | .80 | .80 | .80 | 1.10 | 5.00 |
| 25 | 3.40 | 4.10 | 6.80 | 6.80 | 2.70 | 2.00 | 1.40 | .90 | .80 | .80 | .90 | 3.00 |
| 26 | 3.20 | 6.50 | 6.40 | 6.00 | 2.70 | 1.80 | 4.10 | .80 | .90 | .80 | 1.60 | 2.40 |
| 27 | 3.20 | 9.80 | 6.20 | 5.20 | 2.60 | 2.10 | 4.20 | 1.20 | .90 | .80 | 2.60 | 2.00 |
| 28 | 3.10 | 8.10 | 6.10 | 4.80 | 2.60 | 2.10 | 2.40 | 1.00 | .80 | .80 | 1.70 | 1.90 |
| 29 | 3.00 | ....... | 6.80 | 4.60 | 2.60 | 2.00 | 2.90 | .90 | .80 | .90 | 1.30 | 1.80 |
| 30 | 2.90 | ....... | 6.00 | 4.40 | 2.50 | 1.80 | 1.90 | 1.40 | .70 | .90 | 1.10 | 1.60 |
| 31 | 3.10 | ....... | 6.90 | ....... | 2.50 | ....... | 1.60 | 6.50 | ....... | .80 | ....... | 1.40 |

SAVANNAH RIVER AT CALHOUN FALLS, SOUTH CAROLINA.

Savannah River is formed by the junction of Seneca and Tugaloo rivers about 100 miles above Augusta, Georgia. The headwater tributaries have their sources in the Blue Ridge Mountains in North and South Carolina and Georgia, where more than one-fifth of the territory is in original oak forest. The drainage area is partly mapped on the following atlas sheets; Pisgah, Cowee, Dahlonega, Walhalla, Pickens, Abbeville, Elberton, Nantahala, and Carnesville. A large number of fine water powers occur on the tributaries and along the main river, the most noted being at Tallulah Falls on Tallulah River, 335 feet in height, there being a total fall of 525 feet in a distance of $2\frac{2}{3}$ miles. In order to determine the value of these waterpowers, systematic measurements were begun at Calhoun Falls, South Carolina, on August 4, 1896. This station, described in the Eighteenth Annual Report, Part IV, page 73, is at the Seaboard Air Line bridge, across Savannah River, above the mouth of Beaverdam Creek and below Rocky River, and about 3 miles west of the town of Calhoun Falls, South Carolina. The river here is divided into two channels by a large island containing several hundred acres. The east channel is a good section at ordinary stages, but at lowest water the current is very sluggish. The west channel, which is the main river, is obstructed by some very small islands and old cofferdams about the two piers, otherwise the section is a good one. The bed is rocky and constant. The wire gage is on the west channel, center span; its length is 65.40 feet. One bench mark on the top of the iron stringer under the cross-ties near the gage is 54.00 feet above the datum of the gage; the other is on the top of the first pier on east side of west channel, and is 30.85 feet above zero of gage. Zero of gage is 354.5 above sea level. The gage was verified on March 4, 1899. The observer is Peter J. Pfeiffer, a farmer at Calhoun Falls, South Carolina. Records of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 75; 1897, Nineteenth Annual Report, Part IV, page 224; 1898, Twentieth Annual Report, Part IV, page 164. The following measurements were made by B. M. Hall and Max Hall during 1899:

March 4, gage height, 4.77 feet; discharge, 12,076 second-feet.
May 16, gage height, 3.45 feet; discharge, 5,258 second-feet.
September 28, gage height, 2.30 feet; discharge, 2,057 second-feet.
November 10, gage height, 2.25 feet; discharge, 2,039 second-feet.

*Daily gage height, in feet, of Savannah River at Calhoun Falls, South Carolina, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ........ | 6.60 | 4.00 | 3.30 | 3.20 | 3.30 | 3.00 | 2.20 | 2.60 | 2.70 |
| 2 | ........ | 5.00 | 3.90 | 3.20 | 3.00 | 3.10 | 2.90 | 2.10 | 2.50 | 2.80 |
| 3 | ........ | 4.85 | 3.80 | 3.20 | 2.90 | 3.00 | 2.90 | 2.10 | 2.50 | 2.90 |
| 4 | 4.75 | 4.90 | 3.80 | 3.20 | 2.70 | 2.90 | 2.80 | 2.20 | 2.40 | 2.70 |
| 5 | 4.95 | 4.75 | 3.70 | 3.10 | 2.70 | 2.80 | 2.70 | 2.40 | 2.40 | 2.60 |
| 6 | 4.65 | 4.70 | 3.90 | 3.00 | 2.60 | 2.70 | 2.90 | 3.00 | 2.40 | 2.60 |
| 7 | 4.40 | 4.75 | 3.90 | 2.90 | 2.70 | 2.60 | 2.90 | 2.80 | 2.50 | 2.60 |
| 8 | 4.35 | 4.65 | 3.80 | 3.00 | 2.70 | 2.60 | 3.00 | 3.90 | 2.40 | 2.50 |
| 9 | 4.25 | 5.60 | 3.80 | 3.30 | 3.00 | 3.00 | 3.00 | 3.50 | 2.30 | 2.50 |
| 10 | 4.20 | 5.10 | 3.70 | 3.20 | 2.90 | 2.90 | 2.90 | 3.20 | 2.20 | 2.40 |
| 11 | 4.05 | 4.95 | 3.70 | 3.40 | 2.80 | 2.80 | 3.20 | 3.00 | 2.20 | 2.50 |
| 12 | 3.90 | 4.80 | 3.70 | 3.50 | 2.80 | 2.80 | 3.00 | 2.70 | 2.10 | 4.90 |
| 13 | 4.00 | 4.70 | 3.60 | 5.00 | 2.70 | 2.70 | 3.00 | 2.50 | 2.10 | 5.00 |
| 14 | 4.00 | 4.50 | 3.60 | 3.90 | 2.60 | 2.70 | 2.90 | 2.40 | 2.00 | 3.80 |
| 15 | 5.25 | 4.30 | 3.50 | 3.70 | 2.50 | 2.60 | 2.90 | 2.30 | 2.10 | 3.50 |
| 16 | 13.60 | 4.00 | 3.40 | 3.60 | 2.40 | 2.60 | 2.80 | 2.40 | 2.10 | 3.30 |
| 17 | 9.00 | 3.90 | 3.40 | 3.60 | 2.40 | 2.60 | 2.70 | 2.40 | 2.10 | 3.10 |
| 18 | 6.90 | 3.70 | 3.40 | 3.50 | 2.30 | 2.60 | 2.60 | 2.30 | 2.00 | 3.00 |
| 19 | 7.00 | 3.70 | 3.50 | 3.30 | 2.40 | 2.50 | 2.60 | 2.30 | 2.00 | 3.00 |
| 20 | 9.00 | 3.50 | 3.50 | 3.20 | 2.30 | 2.50 | 2.90 | 2.40 | 2.00 | 2.90 |
| 21 | 7.05 | 3.40 | 3.40 | 3.10 | 2.20 | 2.60 | 2.90 | 2.30 | 2.10 | 2.90 |
| 22 | 5.00 | 3.20 | 3.50 | 3.00 | 2.30 | 2.80 | 2.80 | 2.30 | 2.10 | 2.80 |
| 23 | 5.00 | 3.00 | 3.70 | 3.00 | 2.30 | 3.00 | 2.60 | 2.30 | 2.30 | 2.70 |
| 24 | 4.90 | 2.90 | 3.55 | 2.90 | 2.30 | 2.90 | 2.50 | 2.20 | 2.30 | 3.90 |
| 25 | 5.00 | 4.00 | 3.50 | 2.90 | 2.40 | 2.70 | 2.40 | 2.20 | 2.40 | 3.80 |
| 26 | 5.10 | 4.60 | 3.40 | 3.00 | 2.70 | 2.70 | 2.60 | 2.20 | 4.00 | 3.50 |
| 27 | 4.95 | 5.10 | 3.25 | 3.90 | 2.70 | 2.80 | 2.40 | 2.10 | 3.40 | 3.50 |
| 28 | 4.85 | 5.00 | 3.20 | 4.00 | 5.00 | 3.00 | 2.30 | 2.10 | 3.20 | 3.60 |
| 29 | 6.95 | 4.70 | 3.20 | 3.60 | 3.50 | 2.90 | 2.30 | 2.20 | 2.90 | 3.70 |
| 30 | 5.10 | 4.10 | 3.10 | 3.30 | 3.60 | 3.50 | 2.20 | 2.30 | 2.80 | 3.60 |
| 31 | 7.00 | ........ | 3.30 | ........ | 3.40 | 3.20 | ........ | 2.50 | ........ | 2.90 |

## SAVANNAH RIVER AT AUGUSTA, GEORGIA.

Observations of river height have been maintained since 1875 by the city of Augusta, at the city highway bridge. The results have been printed in a volume entitled "Stages of water at river stations," prepared by the United States Weather Bureau. Those for 1875 to 1889 are given in Part III, those for 1890 to 1892 in Part IV, and for 1893 to 1895 in Part V of the above-mentioned publication. The gage consists of a vertical timber fastened to the pier and graduated to feet and inches. Readings are made four times a day by J. M. Youngblood, keeper of the city bridge, usually at 6 a. m., 12 m., 6 p. m., and 9 p. m. The 6. a. m. readings are those used by the Weather Bureau, and are here given, excepting September, October, and November, when the average of all four readings is given, since at that season nearly all of the water passes through the factory wheels above the gage. The channel is straight and without obstructions; the banks are moderately high, but are liable to overflow at the highest floods. Bed is fairly constant. Records of measurement may be found as follows: 1875 to 1891, Fourteenth Annual Report, Part II, page 147; 1891 to 1896, Eighteenth Annual Report, Part IV, page 75; 1897, Nineteenth Annual Report, Part IV, page 227; 1898, Twentieth Annual Report, Part IV, page 165. The following measurements have been made by B. M. Hall and his assistants during 1899:

*Measurements of Savannah River at Augusta, Georgia.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| March 17 | 25.20 | 60,716 | May 29 | 7.60 | 6,271 |
| March 18 | 20.60 | 35,971 | July 1 | 7.22 | 5,391 |
| May 8 | 9.70 | 10,860 | August 3 | 6.68 | 4,226 |
| May 9 | 9.50 | 9,908 | October 10 | 12.48 | 14,613 |

*Daily gage height, in feet, of Savannah River at Augusta, Georgia, for 1899.* (*a*)

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.5 | 12.7 | 28.8 | 19.5 | 9.6 | 7.9 | 7.2 | 7.4 | 13.9 | 5.0 | 6.2 | 7.3 |
| 2 | 10.8 | 13.0 | 21.0 | 18.9 | 9.5 | 8.4 | 6.7 | 6.7 | 10.9 | 5.0 | 6.4 | 6.9 |
| 3 | 10.3 | 14.3 | 16.2 | 15.3 | 9.3 | 7.6 | 6.2 | 6.3 | 9.1 | 5.5 | 6.3 | 5.8 |
| 4 | 9.0 | 15.8 | 14.2 | 13.2 | 9.3 | 7.5 | 6.0 | 6.3 | 8.0 | 5.6 | 5.8 | 7.0 |
| 5 | 8.5 | 14.5 | 13.7 | 12.9 | 9.2 | 7.2 | 6.0 | 6.0 | 7.5 | 5.8 | 5.6 | 8.7 |
| 6 | 8.5 | 20.7 | 16.2 | 13.0 | 9.8 | 7.3 | 6.0 | 5.9 | 6.9 | 11.8 | 5.8 | 6.7 |
| 7 | 12.8 | 28.0 | 15.2 | 12.2 | 10.3 | 7.3 | 5.8 | 5.7 | 6.6 | 9.6 | 5.9 | 6.3 |
| 8 | 22.9 | 31.0 | 13.3 | 12.4 | 10.4 | 7.0 | 6.7 | 5.5 | 7.4 | 10.5 | 5.8 | 6.3 |
| 9 | 19.2 | 29.9 | 12.2 | 15.5 | 9.7 | 7.0 | 7.0 | 5.7 | 7.0 | 14.1 | 5.9 | 6.1 |
| 10 | 14.3 | 22.9 | 11.8 | 14.2 | 9.1 | 6.9 | 8.3 | 6.0 | 7.0 | 12.1 | 5.8 | 6.0 |
| 11 | 12.8 | 18.3 | 11.5 | 12.8 | 8.8 | 7.3 | 7.8 | 5.7 | 8.7 | 8.5 | 5.5 | 5.9 |
| 12 | 17.3 | 14.7 | 11.2 | 12.0 | 8.5 | 6.9 | 6.5 | 8.0 | 9.3 | 7.3 | 5.6 | 5.9 |
| 13 | 17.4 | 13.7 | 11.2 | 11.5 | 8.5 | 7.5 | 6.0 | 8.3 | 8.6 | 6.9 | 5.6 | 6.3 |
| 14 | 15.3 | 12.9 | 11.1 | 11.2 | 8.5 | 9.7 | 6.0 | 6.4 | 6.9 | 6.4 | 5.7 | 10.7 |
| 15 | 15.4 | 12.3 | 11.0 | 11.0 | 8.3 | 9.7 | 6.0 | 6.0 | 6.3 | 6.0 | 6.1 | 14.5 |
| 16 | 14.5 | 14.4 | 18.8 | 10.8 | 8.2 | 8.2 | 6.0 | 5.5 | 5.8 | 6.3 | 5.8 | 10.5 |
| 17 | 17.3 | 25.0 | 25.5 | 10.5 | 8.2 | 8.0 | 5.7 | 5.4 | 5.6 | 6.0 | 5.8 | 8.5 |
| 18 | 16.8 | 24.3 | 21.5 | 10.5 | 8.0 | 8.7 | 5.6 | 5.0 | 5.2 | 6.0 | 5.8 | 7.5 |
| 19 | 13.9 | 19.1 | 17.1 | 10.2 | 8.0 | 7.9 | 5.8 | 5.0 | 5.4 | 6.3 | 5.4 | 7.3 |
| 20 | 11.7 | 15.3 | 20.0 | 10.5 | 7.9 | 7.3 | 5.7 | 5.8 | 5.7 | 6.1 | 5.7 | 7.0 |
| 21 | 10.7 | 13.5 | 22.5 | 10.4 | 7.9 | 7.3 | 5.5 | 4.0 | 6.0 | 6.5 | 5.7 | 6.8 |
| 22 | 10.0 | 14.7 | 17.1 | 10.0 | 7.8 | 7.0 | 5.3 | 4.7 | 6.6 | 6.7 | 5.8 | 6.9 |
| 23 | 9.9 | 14.3 | 15.8 | 9.9 | 7.7 | 6.7 | 5.8 | 5.3 | 6.0 | 6.0 | 5.8 | 7.4 |
| 24 | 11.4 | 13.0 | 15.5 | 9.6 | 8.2 | 6.7 | 5.8 | 4.8 | 5.4 | 6.0 | 7.0 | 9.3 |
| 25 | 11.9 | 11.7 | 15.5 | 10.0 | 8.0 | 6.5 | 5.7 | 5.7 | 5.9 | 5.8 | 8.3 | 13.8 |
| 26 | 10.8 | 11.5 | 13.8 | 11.5 | 7.8 | 6.3 | 6.0 | 5.6 | 5.6 | 5.8 | 9.2 | 12.3 |
| 27 | 10.3 | 17.7 | 14.0 | 13.0 | 7.6 | 6.7 | 7.0 | 7.0 | 5.3 | 5.6 | 11.3 | 9.8 |
| 28 | 10.0 | 29.6 | 13.5 | 11.2 | 7.4 | 7.5 | 11.7 | 13.3 | 5.8 | 5.7 | 9.8 | 8.3 |
| 29 | 11.0 | ...... | 14.0 | 10.3 | 7.4 | 7.7 | 11.6 | 11.3 | 5.8 | 5.6 | 8.4 | 5.0 |
| 30 | 11.2 | ...... | 15.0 | 10.0 | 7.4 | 7.5 | 9.3 | 9.2 | 5.6 | 5.8 | 7.5 | 8.3 |
| 31 | 10.5 | ...... | 13.5 | ...... | 7.3 | ...... | 8.5 | 11.4 | ...... | 5.9 | ...... | 7.7 |

*a* For the months of September, October, and November the figures given are an average of four readings daily—6 a. m., 12 m., 6 p. m., and 8 p. m. For the other months the readings are those taken at 6 a. m.

## BROAD RIVER AT CARLTON, GEORGIA.

Broad River rises in the northeastern part of Georgia and flows in a southeasterly direction, passing between Elbert and Wilkes counties and emptying into Savannah River 8 miles below Calhoun Falls station. The watershed is a rolling country largely covered with timber. Measurements were begun on Broad River at Carlton on May 27, 1897, this station being established by Max Hall. It is located on the bridge of the Seaboard Air Line, 3 miles east of Carlton, Georgia, and 3 miles above the mouth of the South Fork. The iron bridge is 250 feet long and is approached on each side by wooden trestles. The initial point of soundings is the end of the iron bridge at right bank, upstream. The length of the wire gage is 56.30 feet. Bench mark is top of upstream iron girder under cross-tie at 30 feet from initial point and is 51.00 feet above datum. Zero of gage is 384.5 feet above sea level. The gage was last verified April 25, 1899. The channel is straight and the flow uninterrupted except by one pier in the center of the river. The banks are rather low and subject to overflow in time of high water. The bed is fairly constant. The observer is S. P. Power, jr., a farmer at Carlton, Georgia. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 227; 1898, Twentieth Annual Report, Part IV, page 163. The following discharge measurements were made during the year 1899 by Max Hall and assistants:

*Measurements of Broad River at Carlton, Georgia.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| February 28 | 9.05 | 8,281 | June 28 | 2.80 | 1,063 |
| March 1 | 5.28 | 3,205 | September 27 | 2.00 | 514 |
| April 25 | 3.65 | 1,841 | November 11 | 2.05 | 485 |
| May 15 | 2.60 | 919 | December 21 | 2.25 | 591 |

A measurement of Broad River was made June 28 below the junction of South Broad, 3 miles below the station and 4 miles from Carlton, Georgia, which gave a discharge of 1,135 second-feet. On the same date a measurement of South Broad was made at its mouth, when the discharge was found to be 145 second-feet. On September 22 a second measurement of South Broad was made 4 miles above the mouth above Fork Creek and 1.5 of a mile from Carlton, Georgia, and gave 103 second-feet. On November 11 a third measurement of this latter river was made one-half a mile from mouth, below Fork Creek, and 3 miles from Carlton, giving a discharge of 139 second-feet. The drainage area of South Broad River at its mouth is 215 square miles.

*Daily gage height, in feet, of Broad River at Carlton, Georgia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.10 | 3.45 | 5.20 | 5.80 | 3.00 | 2.60 | 2.30 | 2.40 | 3.80 | 1.90 | 2.15 | 2.35 |
| 2 | 2.95 | 3.00 | 4.10 | 4.45 | 3.00 | 2.55 | 2.25 | 2.35 | 3.00 | 1.90 | 2.10 | 2.40 |
| 3 | 2.75 | 3.75 | 3.80 | 3.60 | 2.95 | 2.50 | 2.20 | 2.25 | 2.50 | 1.90 | 2.10 | 2.30 |
| 4 | 2.70 | 3.70 | 3.60 | 3.65 | 2.95 | 2.50 | 2.20 | 2.20 | 2.30 | 1.90 | 2.05 | 2.30 |
| 5 | 2.65 | 4.30 | 3.95 | 3.70 | 3.00 | 2.45 | 2.20 | 2.20 | 2.20 | 2.00 | 2.05 | 2.25 |
| 6 | 4.45 | 7.20 | 4.20 | 3.45 | 3.20 | 2.40 | 2.20 | 2.15 | 2.15 | 2.20 | 2.05 | 2.20 |
| 7 | 6.45 | 13.18 | 3.65 | 3.60 | 3.15 | 2.40 | 2.25 | 2.10 | 2.10 | 2.15 | 2.05 | 2.20 |
| 8 | 6.40 | 10.60 | 3.45 | 4.40 | 3.00 | 2.50 | 2.40 | 2.10 | 2.10 | 4.30 | 2.05 | 2.20 |
| 9 | 3.90 | 5.45 | 3.40 | 4.20 | 2.95 | 2.60 | 2.30 | 2.10 | 2.10 | 3.40 | 2.05 | 2.20 |
| 10 | 3.30 | 4.30 | 3.35 | 3.60 | 2.95 | 2.45 | 2.40 | 2.10 | 2.10 | 2.50 | 2.05 | 2.20 |
| 11 | 3.80 | 3.75 | 3.30 | 3.50 | 2.90 | 2.40 | 2.30 | 2.15 | 2.50 | 2.35 | 2.05 | 2.20 |
| 12 | 4.05 | 3.60 | 3.30 | 3.40 | 2.85 | 2.60 | 2.25 | 2.10 | 2.10 | 2.25 | 2.05 | 3.40 |
| 13 | 3.70 | 3.45 | 3.25 | 3.30 | 2.80 | 3.70 | 2.20 | 2.15 | 2.50 | 2.20 | 2.05 | 3.60 |
| 14 | 3.45 | 3.35 | 3.50 | 3.30 | 2.80 | 3.00 | 2.20 | 2.05 | 2.00 | 2.15 | 2.05 | 2.95 |
| 15 | 3.75 | 3.30 | 4.40 | 3.25 | 2.75 | 2.40 | 2.15 | 2.00 | 2.00 | 2.10 | 2.10 | 2.50 |
| 16 | 3.50 | 4.40 | 13.88 | 3.25 | 2.75 | 2.50 | 2.10 | 1.95 | 1.95 | 2.10 | 2.10 | 2.45 |
| 17 | 3.50 | 5.05 | 11.30 | 3.20 | 2.70 | 2.65 | 2.10 | 1.90 | 1.95 | 2.10 | 2.05 | 2.35 |
| 18 | 3.25 | 4.45 | 4.70 | 3.15 | 2.70 | 2.65 | 2.25 | 1.90 | 1.95 | 2.10 | 2.05 | 2.30 |
| 19 | 3.10 | 3.80 | 4.50 | 3.25 | 2.65 | 2.55 | 2.15 | 1.90 | 1.95 | 2.10 | 2.05 | 2.30 |
| 20 | 3.00 | 3.50 | 8.10 | 3.20 | 2.65 | 2.45 | 2.10 | 1.90 | 2.05 | 2.10 | 2.05 | 2.30 |
| 21 | 2.90 | 3.55 | 5.20 | 3.15 | 2.60 | 2.40 | 2.10 | 2.00 | 2.00 | 2.10 | 2.05 | 2.25 |
| 22 | 2.85 | 3.60 | 4.00 | 3.10 | 2.65 | 2.35 | 2.05 | 1.95 | 2.00 | 2.05 | 2.05 | 2.25 |
| 23 | 2.95 | 3.50 | 4.15 | 3.05 | 2.70 | 2.30 | 2.20 | 2.00 | 2.00 | 2.05 | 3.65 | 2.20 |
| 24 | 3.05 | 3.30 | 4.55 | 3.10 | 2.65 | 2.30 | 2.25 | 1.95 | 1.95 | 2.05 | 3.45 | 4.40 |
| 25 | 3.00 | 3.20 | 3.75 | 3.20 | 2.60 | 2.30 | 2.15 | 2.00 | 1.95 | 2.05 | 2.45 | 4.30 |
| 26 | 2.95 | 3.15 | 3.60 | 3.50 | 2.60 | 3.70 | 2.45 | 2.05 | 1.95 | 2.05 | 3.60 | 3.00 |
| 27 | 2.85 | 15.78 | 3.50 | 3.20 | 2.60 | 3.00 | 6.50 | 3.95 | 2.00 | 2.05 | 3.70 | 2.60 |
| 28 | 2.80 | 11.15 | 3.45 | 3.15 | 2.55 | 2.80 | 5.30 | 2.45 | 1.95 | 2.05 | 2.90 | 2.60 |
| 29 | 2.80 | ...... | 4.20 | 3.10 | 2.55 | 2.80 | 3.50 | 2.10 | 1.95 | 2.05 | 2.55 | 2.60 |
| 30 | 2.75 | ...... | 3.70 | 3.10 | 2.50 | 2.50 | 2.80 | 3.50 | 1.90 | 2.10 | 2.40 | 2.50 |
| 31 | 3.10 | ...... | 5.00 | ...... | 2.70 | ...... | 2.50 | 4.10 | ...... | 2.15 | ...... | 2.45 |

OCONEE RIVER AT DUBLIN, GEORGIA.

Oconee River rises in the northern part of Georgia, near Gainesville, on the southern slope of Chattahoochee Ridge, which separates the headwaters of this stream from the tributaries of Chattahoochee River. It flows in a southeasterly direction and joins the Ocmulgee at the southern border of Montgomery County to form the Altamaha. The watershed is for the most part hilly, and is made up of cultivated ground broken by extensive tracts of forest. A station was maintained for a time at Cary, Georgia, immediately below the mouth of Apalachee River. The rating was evidently affected by the dam several miles below, and for this reason the station was abandoned on March 31, 1898. The results of measurements at this station can be found as follows: 1897, Nineteenth Annual Report, Part IV, page 227; 1898, Twentieth Annual Report, Part IV, page 170. A single discharge measurement was made at this station in 1899 on October 19: Gage height, 2.03 feet; discharge, 898 second-feet.

A station was established by the United States Weather Bureau in 1894, at Dublin, Georgia, about 60 miles above the junction of the Oconee with the Ocmulgee, 45 miles below Milledgeville, and 85 miles below the old Cary station. The station was discontinued on April 30, 1897, but was reestablished by the Georgia geological survey, February 11, 1898. Since October 15, 1898, the station has been maintained by the United States Weather Bureau. The station is located about one-half mile east of Dublin, Georgia. The gage is a vertical rod fastened to the lower side of the middle pier of the Wrightsville and Tennille Railroad bridge. The gage is referred to a secondary gage on a hemlock tree on the right bank, 150 feet above, and to a bench mark on the same tree which consists of three large nails 3.00 feet above the zero of the gage, and a second bench mark on another hemlock tree 100 feet above the first, which consists of three large nails 3.00 feet above datum. The channel is straight and without obstructions except the bridge piers. The current is swift, the banks high and not subject to overflows. Discharge measurements are made from the upper side of the county highway iron bridge, which is about 100 yards above the railroad bridge at which the gage is located. The initial point for soundings is the end of the bridge on right bank of the river. Records of measurement may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 77; 1897, Nineteenth Annual Report, Part IV, page 228; 1898, Twentieth Annual Report, Part IV, page 170. The following measurements were made by B. M. Hall and his assistants during 1899:

February 2, gage height, 8.20 feet; discharge, 9,689 second-feet.
April 28, gage height, 8.00 feet; discharge, 9,033 second-feet.
June 8, gage height, 0.80 foot; discharge, 1,937 second-feet.
September 15, gage height, 0.80 foot; discharge, 1,997 second-feet.
September 15, gage height, 0.50 foot; discharge, 1,903 second-feet.
December 14, gage height, 3.90 feet; discharge, 4,028 second-feet.

A discharge measurement was also made on Oconee River at Milledgeville, Georgia, 45 miles above Dublin, on November 21, 1899, when the discharge was found to be 957 second-feet.

*Daily gage height, in feet, of Oconee River at Dublin, Georgia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.80 | 7.70 | 11.30 | 8.30 | 5.40 | 1.70 | 0.50 | 2.90 | 2.50 | —1.30 | —0.40 | 2.40 |
| 2 | 3.60 | 8.10 | 13.80 | 8.00 | 4.70 | 1.80 | .60 | 2.30 | 2.90 | —1.30 | — .40 | 1.10 |
| 3 | 5.20 | 9.10 | 16.50 | 8.50 | 3.80 | 1.70 | .40 | 2.00 | 2.70 | —1.30 | — .40 | 2.00 |
| 4 | 5.80 | 9.90 | 17.00 | 9.00 | 3.70 | 1.50 | .20 | 1.70 | 2.10 | —1.30 | — .50 | 1.90 |
| 5 | 5.00 | 10.70 | 16.90 | 9.80 | 3.50 | 1.40 | .10 | 1.50 | 1.50 | — .80 | — .50 | 1.70 |
| 6 | 4.70 | 12.70 | 16.20 | 9.50 | 4.10 | 1.20 | .00 | .90 | 1.10 | .50 | — .50 | 1.60 |
| 7 | 5.00 | 13.10 | 14.50 | 9.00 | 5.00 | 1.00 | .20 | .80 | .80 | 2.40 | — .50 | 1.30 |
| 8 | 7.80 | 15.00 | 12.70 | 8.60 | 4.80 | .80 | .40 | .70 | .30 | 5.10 | — .60 | 1.10 |
| 9 | 8.60 | 20.10 | 11.00 | 8.00 | 4.40 | .70 | .00 | .20 | .20 | 7.20 | — .60 | .90 |
| 10 | 10.40 | 22.50 | 9.80 | 7.80 | 3.60 | .60 | —.10 | —.30 | .10 | 8.10 | — .70 | .70 |
| 11 | 12.20 | 21.70 | 8.60 | 7.50 | 3.00 | .50 | —.10 | —.40 | .00 | 8.60 | — .70 | .50 |
| 12 | 14.10 | 18.90 | 7.60 | 7.00 | 2.70 | .40 | —.20 | —.20 | .10 | 6.80 | — .70 | 1.20 |
| 13 | 14.40 | 17.50 | 7.00 | 6.40 | 2.70 | .30 | —.30 | —.10 | .70 | 4.10 | — .80 | 2.60 |
| 14 | 15.30 | 16.80 | 6.80 | 5.60 | 2.40 | .30 | —.40 | —.10 | 1.50 | 1.70 | — .80 | 3.30 |
| 15 | 14.80 | 15.50 | 6.79 | 5.20 | 2.30 | .90 | —.40 | —.20 | .80 | 1.10 | — .10 | 4.10 |
| 16 | 14.50 | 13.70 | 7.30 | 5.00 | 2.10 | 1.20 | —.40 | —.30 | .10 | .60 | .70 | 3.20 |
| 17 | 14.30 | 12.40 | 7.90 | 4.90 | 2.00 | .70 | —.50 | —.50 | — .30 | .50 | .10 | 2.50 |
| 18 | 13.70 | 12.50 | 8.30 | 4.80 | 1.90 | .30 | —.60 | —.60 | — .40 | .50 | .80 | 1.90 |
| 19 | 13.30 | 12.70 | 9.20 | 5.30 | 1.80 | .30 | —.60 | —.70 | — .50 | .50 | .10 | 1.50 |
| 20 | 13.10 | 13.30 | 10.10 | 5.80 | 1.70 | .60 | —.60 | —.80 | — .60 | .40 | — .20 | 1.30 |
| 21 | 12.80 | 13.60 | 10.90 | 5.60 | 1.60 | .90 | —.70 | —.80 | — .70 | .40 | — .30 | 1.20 |
| 22 | 12.60 | 13.00 | 12.60 | 5.50 | 1.50 | .50 | —.70 | —.90 | — .80 | .20 | — .40 | 1.20 |
| 23 | 11.30 | 12.00 | 14.20 | 5.20 | 1.50 | .30 | —.70 | —.70 | — .90 | .00 | — .30 | 1.40 |
| 24 | 8.30 | 10.80 | 13.40 | 5.00 | 1.80 | .20 | —.80 | —.30 | — .90 | — .10 | .10 | 1.40 |
| 25 | 7.80 | 9.80 | 11.90 | 4.80 | 2.10 | .20 | —.80 | —.20 | —1.00 | — .30 | 1.50 | 2.30 |
| 26 | 7.30 | 9.00 | 10.00 | 5.90 | 1.80 | .00 | .30 | 2.50 | —1.00 | — .40 | 1.30 | 5 30 |
| 27 | 7.10 | 9.70 | 9.60 | 7.40 | 1.70 | —.10 | .70 | 3.00 | —1.10 | — .50 | 2.10 | 5.60 |
| 28 | 6.80 | 9.60 | 8.90 | 8.00 | 1.60 | —.20 | .90 | 3.00 | —1.10 | — .60 | 3.20 | 4.60 |
| 29 | 7.00 | ....... | 8.30 | 7.20 | 1.60 | —.20 | 1.80 | 5.10 | —1.10 | — .70 | 4.40 | 3.90 |
| 30 | 7.40 | ....... | 8.10 | 6.10 | 1.60 | .40 | 4.70 | 4.50 | —1.20 | — .70 | 3.30 | 2.80 |
| 31 | 7.60 | ....... | 8.00 | ....... | 1.60 | ....... | 5.00 | 2.90 | ....... | — .30 | ....... | 2.60 |

## YELLOW RIVER AT ALMON, GEORGIA.

This river is an important tributary of the Ocmulgee. Its headwaters are in Gwinnett County, only a short distance from Chattahoochee River. About one-third of the watershed is under cultivation, the ground being well terraced on the hillsides. The drainage area is entirely mapped on the Monroe, Gainesville, Suwanee, and Atlanta atlas sheets of the United States Geological Survey. There are a number of falls along the river capable of development for water power. A gaging station was established at Almon, 3 miles west of Covington, Georgia, September 12, 1897. It was at the low wagon bridge crossing the stream, 600 feet below the Georgia Railroad bridge. Results of measurements at this station may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 230; 1898, Twentieth Annual Report, Part IV, page 170. No current-meter measurements were made during 1898, nor were the gage heights recorded. An attempt was made, however, to ascertain the fluctuations of discharge for comparison with the observations made at Macon. A rating table published on page 229 of the Nineteenth Annual Report, Part IV, was constructed from discharge measurements made during the autumn of 1897. A rating table for 1898 is published in Water-Supply Paper No. 27, of the United States Geological Survey. The application of such a table involves the assumption that the fluctuations at Almon are coincident with those at Macon, and as it is of uncertain accuracy, the old station at Almon has been abandoned and a new station was established May 9, 1899, by B. M. Hall, about 1 mile above the old station. It is intended to maintain this station for six months or more, in order to study the water powers above and below. The gage rod is fastened to a small tree on the left bank below the bridge, and referred to a bench mark on top of the downstream end of floor beam, 90 feet from the initial point of soundings, which is the right-bank end of the hand rail on the downstream side of the bridge. The elevation of bench mark is 20.81 feet above datum. The gage was verified May 9, 1899. The channel is straight, the current swift and not influenced by obstructions except at very low water, when the current is entirely under the west half of the bridge. The banks are high but are overflowed at the highest waters. The bed is rocky and constant. The following measurements were made by B. M. Hall and assistants during 1899:

May 3, gage height 2.97 feet; discharge 481 second-feet.
May 9, gage height 3.16 feet; discharge 561 second-feet.
May 16, gage height 2.30 feet; discharge 364 second-feet.
June 6, gage height 1.80 feet; discharge 235 second-feet.
June 27, gage height 2.42 feet; discharge 427 second-feet.
August 7, gage height 1.40 feet; discharge 218 second-feet.
October 19, gage height 1.70 feet; discharge 200 second-feet.

*Daily gage height, in feet, of Yellow River at Almon, Georgia, for 1899.*

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 1 | | 2.40 | 1.60 | 1.90 | 2.10 | 1.20 | 1.60 | 2.00 |
| 2 | | 2.10 | 1.50 | 1.80 | 2.00 | 1.20 | 1.60 | 2.70 |
| 3 | | 2.00 | 1.40 | 1.70 | 1.80 | 1.20 | 1.50 | 2.50 |
| 4 | | 1.90 | 1.30 | 1.60 | 1.60 | 1.20 | 1.50 | 2.30 |
| 5 | | 1.80 | 1.40 | 1.60 | 1.50 | 1.70 | 1.50 | 2.00 |
| 6 | | 1.80 | 1.50 | 1.40 | 1.50 | 2.00 | 1.50 | 1.90 |
| 7 | | 1.70 | 1.80 | 1.40 | 1.50 | 2.50 | 1.50 | 1.90 |
| 8 | | 1.70 | 1.60 | 1.40 | 1.50 | 4.00 | 1.50 | 1.90 |
| 9 | 3.20 | 1.70 | 1.80 | 1.30 | 1.40 | 2.80 | 1.50 | 1.90 |
| 10 | 2.80 | 1.70 | 1.60 | 1.30 | 1.40 | 2.20 | 1.50 | 1.90 |
| 11 | 2.80 | 1.70 | 1.40 | 1.30 | 2.50 | 1.80 | 1.50 | 1.90 |
| 12 | 2.70 | 2.00 | 1.40 | 1.30 | 2.00 | 1.80 | 1.50 | 4.00 |
| 13 | 2.70 | 2.50 | 1.30 | 1.20 | 1.70 | 1.80 | 1.50 | 3.00 |
| 14 | 2.50 | 2.10 | 1.30 | 1.20 | 1.50 | 1.80 | 1.50 | 2.50 |
| 15 | 2.50 | 1.90 | 1.20 | 1.20 | 1.50 | 1.70 | 1.50 | 2.30 |
| 16 | 2.50 | 1.80 | 1.20 | 1.10 | 1.40 | 1.70 | 1.60 | 2.00 |
| 17 | 2.30 | 1.80 | 1.20 | 1.10 | 1.40 | 1.70 | 1.50 | 2.00 |
| 18 | 2.10 | 1.80 | 1.80 | 1.00 | 1.40 | 1.70 | 1.50 | 2.00 |
| 19 | 2.30 | 1.70 | 1.40 | 1.00 | 1.30 | 1.70 | 1.50 | 2.00 |
| 20 | 2.10 | 1.60 | 1.40 | 1.00 | 1.30 | 2.00 | 1.50 | 2.00 |
| 21 | 2.00 | 1.50 | 1.60 | 1.00 | 1.30 | 1.90 | 1.50 | 2.00 |
| 22 | 2.30 | 1.50 | 1.80 | 1.00 | 1.30 | 1.70 | 1.50 | 2.00 |
| 23 | 2.80 | 1.50 | 2.00 | 1.00 | 1.30 | 1.50 | 2.20 | 2.00 |
| 24 | 2.50 | 1.40 | 1.40 | 1.00 | 1.20 | 1.50 | 2.20 | 5.50 |
| 25 | 2.20 | 1.40 | 1.60 | 1.00 | 1.20 | 1.50 | 1.90 | 4.60 |
| 26 | 2.00 | 3.20 | 2.40 | 3.60 | 1.20 | 1.50 | 4.50 | 3.40 |
| 27 | 2.00 | 2.60 | 5.80 | 3.00 | 1.20 | 1.50 | 4.00 | 2.50 |
| 28 | 2.00 | 2.00 | 5.00 | 2.80 | 1.20 | 1.50 | 3.20 | 2.50 |
| 29 | 1.90 | 2.00 | 3.70 | 2.70 | 1.20 | 1.60 | 2.50 | 2.50 |
| 30 | 1.80 | 1.80 | 2.80 | 2.50 | 1.20 | 1.70 | 2.00 | 2.50 |
| 31 | 3.30 | | 2.00 | 2.30 | | 1.70 | | 2.30 |

## TOWALIGA RIVER AT JULIETTE, GEORGIA.

The drainage basin of this stream occupies a small area in central Georgia, its headwater tributary adjoining those of Flint River on the west, and small creeks draining into the Ocmulgee on the east. The river is a tributary of Ocmulgee River, entering it 25 miles above Macon. The area drained is a rolling country and extensively cultivated. A gaging station was established by B. M. Hall near its mouth, at the Southern Railway bridge, 2½ miles north of Juliette, Georgia, on May 5, 1899, but observations of gage heights were not started until November 2. The rod is 1 by 4 inches and 7 feet long, nailed to the timber crib at base of left bank pier of the iron single-span bridge. Bench mark No. 1 is at top of downstream iron girder under cross-ties at 40 feet from left end of bridge, and is 37.00 feet above gage datum. Bench mark No. 2, top of rail at same point, gage height 38.80 feet. At low stages measurements are made at the wagon bridge a half mile above the railroad bridge. Thomas Pittman, a farmer living one-half mile from the bridge, is the observer. His address is Berner, Georgia. The following measurements were made by B. M. Hall and assistants in 1899:

May 5, gage height 3.15 feet; discharge 581 second-feet.
May 17, gage height 1.80 feet; discharge 255 second-feet.
November 2, gage height 1.20 feet; discharge 167 second-feet.
November 2, gage height 1.20 feet; discharge 163 second-feet.
December 16, gage height 1.90 feet; discharge 184 second-feet.

*Daily gage height, in feet, of Towaliga River at Juliette, Georgia, for 1899.*

| Day. | Nov. | Dec. | Day. | Nov. | Dec. | Day. | Nov. | Dec. | Day. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ....... | 1.70 | 9 | 1.20 | 1.60 | 17 | 1.60 | 1.80 | 25 | 1.20 | 3.80 |
| 2 | 1.20 | 1.65 | 10 | 1.10 | 1.55 | 18 | 1.30 | 1.70 | 26 | 3.35 | 2.50 |
| 3 | 1.20 | 1.65 | 11 | 1.20 | 1.50 | 19 | 1.30 | 1.70 | 27 | 3.20 | 2.10 |
| 4 | 1.10 | 1.75 | 12 | 1.10 | 3.70 | 20 | 1.20 | 1.70 | 28 | 2.20 | 1.10 |
| 5 | 1.10 | 1.75 | 13 | 1.10 | 3.60 | 21 | 1.30 | 1.70 | 29 | 1.95 | 2.00 |
| 6 | 1.10 | 1.65 | 14 | 1.10 | 2.50 | 22 | 1.20 | 1.50 | 30 | 1.80 | 1.90 |
| 7 | 1.10 | 1.55 | 15 | 1.10 | 2.00 | 23 | 1.30 | 1.60 | 31 | ....... | 1.90 |
| 8 | 1.10 | 1.50 | 16 | 1.70 | 1.90 | 24 | 1.20 | 4.00 | | | |

## OCMULGEE RIVER AT MACON, GEORGIA.

The Ocmulgee River rises in the north-central part of Georgia and flows in a southeasterly direction, joining the Oconee south of Mount Vernon to form the Altamaha River, which empties into the Atlantic Ocean. The drainage area has the same general features as that of the Oconee. A station was established by the United States Weather Bureau January 21, 1893, and measurements were begun by the United States Geological Survey in 1895. This station is described in the Eighteenth Annual Report, Part IV, page 79. The wire gage on the Macon, Dublin and Savannah Railroad bridge having been twice stolen in the spring of 1897, the observations were taken on the Weather Bureau gage referred to the same data, which is a vertical rod bolted to the stone pier of the Central Railroad bridge. Bench mark, top of track on Central Railroad bridge, is 54.85 feet above zero of gage. Measurements of discharge are made from the wagon bridge, a short distance above. The channel is straight and without obstructions except two bridge piers. The current is over 1 foot per second at low water; the banks high and not subject to overflow. The bed of the river is soft and changeable. W. T. Bass, a clerk in a store near the gage, was observer for the United States Geological Survey and the Georgia geological survey until June 1, 1899, when the station was resumed by the United States Weather Bureau, in charge of Mr. T. S. Collins, observer. Records of measurement may be found as follows: 1893–96, Eighteenth Annual Report, Part IV, page 82; 1897, Nineteenth Annual Report, Part IV, page 232; 1898, Twentieth Annual Report, Part IV, page 171. The following measurements were made by B. M. Hall and his assistants during 1899:

*Measurements of Ocmulgee River at Macon, Georgia.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| February 1 | 9.72 | 6,302 | June 21 | 1.22 | 1,009 |
| February 3 | 13.75 | 14,954 | August 2 | 1.98 | 1,345 |
| February 3 | 13.75 | 14,781 | September 14 | 1.70 | 1,314 |
| February 3 | 12.81 | 12,687 | September 16 | .80 | 793 |
| April 14 | 4.50 | 2,587 | October 21 | 2.30 | 1,814 |
| April 29 | 5.00 | 3,094 | December 13 | 4.50 | 3,009 |
| June 7 | 1.60 | 1,015 | December 15 | 2.50 | 1,540 |
| June 9 | 1.48 | 983 | | | |

*Daily gage height, in feet, of Ocmulgee River at Macon, Georgia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.42 | 9.60 | 14.72 | 11.30 | 4.05 | 4.40 | 1.50 | 2.50 | 2.60 | 0.30 | 0.80 | 1.70 |
| 2 | 6.60 | 8.41 | 11.14 | 8.71 | 3.80 | 2.80 | 1.50 | 2.10 | 1.80 | .30 | .60 | 1.50 |
| 3 | 5.96 | 13.70 | 9.11 | 7.97 | 3.60 | 2.60 | 1.20 | 1.40 | 2.00 | .30 | .60 | 1.20 |
| 4 | 5.21 | 11.98 | 8.32 | 7.86 | 3.50 | 2.60 | .90 | 1.40 | 1.80 | .40 | .50 | 2.10 |
| 5 | 3.70 | 9.94 | 8.11 | 8.11 | 3.45 | 1.90 | .90 | 1.20 | 1.80 | .50 | .50 | 1.90 |
| 6 | 4.12 | 10.80 | 7.62 | 7.85 | 8.10 | 1.80 | 1.00 | 1.00 | 1.10 | 2.30 | .50 | 1.50 |
| 7 | 15.20 | 15.83 | 6.81 | 6.89 | 6.72 | 1.60 | 1.10 | .80 | .70 | 2.00 | .40 | 1.30 |
| 8 | 12.65 | 13.42 | 6.72 | 6.50 | 5.30 | 1.60 | 1.50 | .70 | .70 | 10.00 | .40 | 1.10 |
| 9 | 10.21 | 12.13 | 6.40 | 5.97 | 3.80 | 1.60 | 2.00 | .60 | .50 | 6.40 | .40 | 1.10 |
| 10 | 9.23 | 10.80 | 6.11 | 5.63 | 3.55 | 1.40 | 1.30 | .50 | .40 | 3.20 | .40 | 1.00 |
| 11 | 12.14 | 9.78 | 5.81 | 5.42 | 3.28 | 1.60 | 1.10 | 2.10 | 2.20 | 2.20 | .40 | 1.10 |
| 12 | 11.87 | 8.21 | 5.74 | 5.01 | 3.10 | 1.50 | .90 | 1.00 | 2.50 | 1.80 | .50 | 3.70 |
| 13 | 9.38 | 7.60 | 5.69 | 4.71 | 2.96 | 2.30 | .80 | 1.20 | 2.20 | 1.30 | .50 | 4.70 |
| 14 | 8.96 | 7.13 | 5.58 | 4.58 | 2.90 | 2.90 | .80 | .80 | 1.70 | 1.00 | .50 | 3.90 |
| 15 | 8.21 | 6.10 | 5.51 | 4.40 | 2.82 | 2.20 | .70 | .70 | .90 | 1.00 | .80 | 2.60 |
| 16 | 9.67 | 12.30 | 8.51 | 5.01 | 2.69 | 1.70 | .60 | .70 | .60 | .90 | .70 | 2.00 |
| 17 | 12.91 | 11.98 | 7.21 | 4.42 | 2.52 | 1.50 | .60 | .60 | .60 | .80 | .70 | 1.80 |
| 18 | 10.87 | 11.12 | 9.38 | 4.33 | 2.45 | 2.30 | .50 | .60 | .50 | .80 | .70 | 1.50 |
| 19 | 9.34 | 9.76 | 12.94 | 10.38 | 2.33 | 1.40 | .70 | .50 | .50 | .80 | .60 | 1.40 |
| 20 | 5.91 | 8.32 | 10.72 | 7.82 | 2.20 | 1.30 | .90 | .40 | .40 | 2.00 | .60 | 1.40 |
| 21 | 5.11 | 8.27 | 9.42 | 5.52 | 2.18 | 1.30 | 1.00 | .40 | .30 | 2.80 | .60 | 1.30 |
| 22 | 5.42 | 8.16 | 8.11 | 4.72 | 2.48 | 1.20 | .80 | *a* .00 | .30 | 3.20 | .50 | 1.30 |
| 23 | 5.10 | 8.10 | 6.42 | 4.61 | 3.67 | 1.00 | 1.30 | 3.30 | .30 | 2.40 | .60 | 1.40 |
| 24 | 5.37 | 7.13 | 8.65 | 5.48 | 3.35 | .90 | 3.20 | 3.10 | .20 | 1.60 | 1.00 | 6.40 |
| 25 | 5.31 | 6.28 | 8.85 | 11.87 | 3.01 | .90 | 2.00 | 2.10 | .20 | 1.20 | 1.40 | 5.90 |
| 26 | 5.01 | 6.13 | 6.93 | 12.41 | 2.40 | 1.20 | 2.00 | 1.20 | .40 | 1.00 | 4.40 | 5.20 |
| 27 | 4.71 | 12.13 | 6.01 | 8.22 | 2.18 | 3.20 | 2.30 | .80 | .40 | .80 | 5.30 | 3.50 |
| 28 | 4.69 | 14.91 | 7.87 | 5.84 | 2.12 | 3.20 | 4.30 | 3.00 | .40 | .70 | 4.20 | 2.60 |
| 29 | 5.03 | ------- | 7.30 | 5.16 | 2.06 | 1.60 | 5.10 | 2.30 | .30 | 1.40 | 3.10 | 2.30 |
| 30 | 4.90 | ------- | 6.91 | 4.71 | 2.03 | 1.70 | 4.20 | 1.80 | .30 | 1.00 | 2.00 | 2.10 |
| 31 | 5.07 | ------- | 6.28 | ------- | 2.15 | ------- | 3.20 | 2.40 | ------- | 1.10 | ------- | 1.60 |

*a* Mud around gage.

## FLINT RIVER, AT ALBANY, GEORGIA.

This river, known to the Indians as the "Thronateeska," rises in the west-central part of Georgia and flowing in a southerly direction cuts through Pine Mountain Range just below Molena. It joins the Chattahoochee to form Apalachicola River. Its drainage area is hilly and rolling on the headwaters and level at the lower end. It is largely cultivated, but most of the ground is well terraced. A station was established at Molena, Georgia, June 7, 1897. Measurements were made during 1897 and 1898, and a rating table constructed by Prof. B. M. Hall. The alternate accumulation and washing out of sediment in an eddy one-half mile below so affected the gage height that it has not been possible to establish a definite relation between them and the discharge measurements, and the station was discontinued June 2, 1898. Records of measurement made at Molena may be found as follows: 1897, Eighteenth Annual Report, Part IV, page 234; 1898, Nineteenth Annual Report, Part IV, page 233. Two measurements were made in 1899 at the Macon and Birmingham bridge, near Woodbury, Georgia, 5 miles below the old Molena station. The gage heights are assumed, based on permanent bench marks. First measurement, January 29, gage height, 0.80 foot; discharge, 590 second-feet. Second measurement, August 29, gage height, 0.57 foot; discharge, 461 second-feet.

The United States Weather Bureau has a gage rod at Reynolds, 80 miles above Albany. It was erected in 1893 by the United States Engineer Corps. The rod is attached to the middle pier of the railroad bridge, 3 miles east of the town. The drainage area above Reynolds is reported to be 2,000 square miles.

A second station has been maintained at Albany, Georgia, by the United States Weather Bureau. The drainage area at this point is, approximately, 5,000 square miles. Mr. J. B. Marbury, the local forecast official at Atlanta, Georgia, furnishes the following information:

The river gage is in two sections. the long section, from 10 to 36 feet, is nailed in two segments to the south face downstream side of the west pier, on the right or Albany side of the river; the short section is nailed to a cypress tree 120 feet down the river from the pier. The top of the pier foundation sill is 8.1 feet above low water. A second gage, reading from zero to 21 feet, is nailed to a cypress tree on the left bank of the river about 100 feet downstream from the point where the south side of Commerce street, if extended, would cross the river. The first bench mark is the top of the wide marble foundation stone of the African Methodist Episcopal Church, corner of Washington and State streets, Albany, Georgia. It is 49.5 feet above zero of gage. A second bench mark is the top of the sill of the old wharf at the foot of Broad street. It is 3 feet above low water. The observer is John E. Clark. No measurements of discharge were made in 1899 at this station.

*Daily gage height, in feet, of Flint River at Albany, Georgia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.70 | 8.30 | 14.30 | 8.30 | 5.40 | 2.40 | 0.50 | 4.30 | 2.50 | 0.40 | 0.60 | 4.10 |
| 2 | 6.50 | 8.70 | 14.30 | 7.80 | 4.80 | 2.40 | .60 | 4.70 | 2.10 | .10 | .70 | 4.30 |
| 3 | 6.40 | 8.90 | 15.10 | 7.00 | 4.40 | 2.20 | .40 | 4.90 | 2.00 | .20 | .70 | 4.50 |
| 4 | 6.40 | 9.20 | 15.90 | 6.70 | 4.20 | 2.00 | .20 | 4.90 | 2.30 | .20 | .70 | 4.50 |
| 5 | 7.30 | 9.60 | 15.90 | 6.40 | 4.10 | 2.00 | .10 | 4.10 | 2.20 | .20 | .70 | 4.50 |
| 6 | 9.20 | 10.80 | 14.30 | 6.90 | 4.00 | 2.00 | .00 | 3.90 | 2.00 | .30 | .70 | 4.20 |
| 7 | 10.00 | 11.60 | 13.00 | 7.50 | 3.80 | 2.00 | .20 | 3.50 | 2.00 | .90 | .60 | 3.90 |
| 8 | 10.00 | 12.30 | 12.10 | 8.00 | 3.30 | 1.90 | .40 | 3.30 | 2.00 | 1.30 | .60 | 3.80 |
| 9 | 9.50 | 13.80 | 11.80 | 7.40 | 3.00 | 1.70 | .00 | 3.00 | 2.10 | 1.60 | .60 | 3.70 |
| 10 | 11.60 | 14.60 | 11.50 | 7.80 | 2.80 | 1.30 | —.10 | 2.60 | 2.10 | 1.90 | .50 | 3.50 |
| 11 | 13.50 | 15.90 | 10.90 | 8.00 | 2.60 | 1.20 | —.10 | 2.60 | 2.00 | 2.40 | .50 | 3.30 |
| 12 | 16.70 | 17.30 | 9.40 | 7.40 | 2.40 | 1.20 | —.20 | 2.30 | 2.10 | 2.40 | .40 | 3.70 |
| 13 | 16.80 | 18.20 | 8.30 | 6.90 | 2.00 | 1.20 | —.30 | 2.20 | 2.20 | 2.40 | .20 | 3.90 |
| 14 | 17.00 | 19.90 | 8.00 | 6.50 | 1.80 | 1.20 | —.40 | 1.80 | 2.20 | 2.70 | .30 | 4.10 |
| 15 | 17.00 | 21.80 | 7.80 | 5.00 | 1.70 | .90 | —.30 | 1.50 | 2.30 | 2.80 | .60 | 4.30 |
| 16 | 17.50 | 19.00 | 8.30 | 5.00 | 1.50 | .70 | —.40 | 1.20 | 2.40 | 2.80 | .70 | 4.30 |
| 17 | 18.00 | 17.60 | 8.90 | 5.00 | 1.30 | .50 | —.50 | 1.00 | 2.50 | 2.90 | .80 | 4.00 |
| 18 | 18.80 | 16.90 | 9.60 | 5.20 | 1.20 | .50 | —.60 | 1.00 | 2.20 | 3.00 | .80 | 3.80 |
| 19 | 17.30 | 15.20 | 10.40 | 5.30 | 1.00 | .40 | —.60 | 1.00 | 2.30 | 3.00 | .90 | 3.60 |
| 20 | 16.90 | 14.60 | 11.30 | 5.50 | .90 | .40 | —.60 | .80 | 1.80 | 2.90 | .80 | 3.30 |
| 21 | 15.30 | 14.30 | 12.80 | 5.50 | .90 | .40 | —.70 | .70 | 1.60 | 3.20 | .80 | 3.10 |
| 22 | 14.10 | 13.90 | 11.90 | 5.50 | .90 | .30 | —.70 | .70 | 1.50 | 3.40 | .90 | 3.40 |
| 23 | 12.30 | 13.20 | 11.60 | 5.50 | 1.00 | .30 | —.70 | .90 | 1.20 | 3.20 | .90 | 3.50 |
| 24 | 11.00 | 13.00 | 11.50 | 5.90 | 2.30 | .60 | —.80 | 1.10 | 1.10 | 2.70 | 1.00 | 3.50 |
| 25 | 10.20 | 12.00 | 11.30 | 6.70 | 3.80 | .80 | —.80 | 1.60 | 1.20 | 2.70 | 1.20 | 3.70 |
| 26 | 9.40 | 11.30 | 10.60 | 6.90 | 4.30 | .90 | —.30 | .50 | 1.30 | 2.50 | 1.50 | 3.90 |
| 27 | 8.70 | 10.20 | 10.00 | 7.00 | 5.40 | .90 | —.70 | .30 | 1.80 | 1.70 | 1.60 | 4.00 |
| 28 | 8.20 | 12.30 | 9.40 | 6.30 | 4.30 | .80 | —.90 | .30 | 1.90 | 1.30 | 1.70 | 4.20 |
| 29 | 7.90 | ....... | 9.20 | 6.00 | 3.80 | .80 | 1.80 | .30 | 1.90 | .90 | 2.20 | 2.50 |
| 30 | 7.90 | ....... | 8.90 | 5.80 | 3.00 | 1.30 | 1.70 | .20 | 1.90 | .70 | 2.60 | 4.90 |
| 31 | 7.90 | ....... | 9.10 | ....... | 2.50 | ....... | 5.00 | .20 | ....... | .50 | ...... | 5.90 |

## CHATTAHOOCHEE RIVER AT OAKDALE, GEORGIA.

This river rises in the northeastern part of Georgia and flows in a southwesterly direction to the boundary line between Georgia and Alabama, when it turns to the southward and forms the dividing line between these States to the southern border of Georgia, where it joins Flint River to form the Apalachicola. Its watershed above the mouth of Chestatee River is mountainous and over 80 per cent in oak forests; from thence to West Point, Georgia, it is narrow and hilly and about 50 per cent is under cultivation. From West Point to Columbus, Georgia, is through a rocky, mountainous, well-wooded country. Below Columbus, Georgia, the river is navigable, but the country is hilly, consisting of extensive high plains traversed by deep narrow valleys. The drainage area above Oakdale is entirely mapped on the following atlas sheets: Marietta, Walhalla, Dahlonega, Ellijay, Suwanee, Gainesville, and Atlanta. A large number of important water-power privileges occur on the tributaries and on the main river. The most important fall occurs near Columbus, where the river descends 120 feet in 4 miles. A fall of 362 feet from West Point to Columbus, a distance of 34 miles, occurs in a number of shoals, separated by stretches of comparatively quiet water. Elaborate surveys of shoals near Atlanta, Georgia—Vining Shoal, 32 feet, and Bull Sluice, 50 feet—have been made by companies with the object of development and electric transmission to Atlanta. Two gaging stations are maintained on the Chattahoochee River, one at Oakdale, about 8 miles northwest of Atlanta, and the other at West Point, Georgia, where the Chattahoochee River reaches the Alabama State line. The station was established at Oakdale by Cyrus C. Babb on October 17, 1895. It is described in the Eighteenth Annual Report, Part IV, page 85. It was located at the Southern Railway bridge, 1 mile above the mouth of Proctor Creek.

On July 30, 1896, the location of the station was changed to Mason & Turners Ferry, 1 mile below Oakdale. The gage at this point, known as the "Oakdale lower gage," is nailed to a tree on the right bank, 100 feet below the ferry, and set 1 foot lower than the gage at the Southern Railway bridge. On June 1, 1899, the lower gage was discontinued and the upper gage resumed and adopted by the United States Weather Bureau, the United States Geological Survey still receiving the records and making current-meter discharge measurements at that point. The gage recently put in and now used is set on the same datum as the old wire gage of the United States Geological Survey, established at that point by Mr. Babb in 1895, and above referred to, but is a vertical, timber, rod, 3.25 inches by 6 inches by 28 feet, bolted with five iron bolts to the east side of the center pier of the Southern Railway bridge. It is well painted and is graduated into feet with brass figures and into tenths with copper nails from −1.5 feet to +26.5 feet, making its total length 28 feet. Its zero point is 753.5 feet above sea level. Bench mark No. 1 is a railroad spike in corner of pier, right bank, 12.39 feet above datum of gage. Bench mark No. 2 is top of downstream iron girder under cross-ties, 23 feet from west end of bridge, and is 54.75 feet above gage datum. The flow is obstructed by rafts, which have to be cleared from the channel occasionally. The channel is straight and the current swift. The banks are subject to overflow. The bed of the stream is constant and the results obtained fairly good. All discharge measurements made in 1899 are referred to the upper gage at the railroad bridge. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 85; 1897, Nineteenth Annual Report, Part IV, page 236; 1898, Twentieth Annual Report, Part IV, page 182. The following measurements were made during 1899 by B. M. Hall and assistants:

*Measurements of Chattahoochee River at Oakdale, Georgia.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| March 11 | 4.35 | 4,397 | September 9 | 1.32 | 1,452 |
| May 1 | 3.80 | 3,452 | October 6 | .67 | 1,150 |
| May 26 | 2.36 | 2,678 | October 17 | .54 | 1,083 |
| June 14 | 3.92 | 4,788 | November 18 | .42 | 988 |

A number of miscellaneous discharge measurements were made on tributaries of Chattahoochee River by B. M. Hall and his assistants during 1899. They are as follows, arranged in geographic order from the headstream down: Three measurements of Soquee River were made at Porter Mills, near Clarksville, Georgia. The first, on May 29, showed a discharge of 342 second-feet; the second, on June 7, gave a discharge of 239 second-feet; the third, on June 10, gave a discharge of 231 second-feet. The measurement of Hazel Creek, below the ford between Demorest and Porter Mills, on June 10, showed a discharge of 63 second-feet. Two measurements were made on Chattahoochee River at Shallow Ford bridge, near Gainesville, Georgia, 5 miles above the mouth of Chestatee River. The first, on June 22, at a gage height of 1.30 feet, showed a discharge of 933 second-feet; the second, on October 10, at a gage height of 0.95 foot, showed a discharge of 613 second-feet. Chestatee River at Newbridge post-office, Georgia, was discharging 354 second-feet on July 19. Chattahoochee River at Barkers Ferry, near Buford, Georgia, was carrying 782 second-feet on November 17. Sweetwater Creek enters the Chattahoochee 10 miles below Oakdale, Georgia. Three measurements of its discharge were made at the Strickland bridge near Austell. The first measurement, on April 19, gage height, 3.20, showed a discharge of 402 second-feet; the second, on June 24, gage height, 1.1 feet, gave a discharge of 242 second-feet. The third measurement, on October 24, gave a discharge of 108 second-feet. The three following measurements were made of Chattahoochee River, between Oakdale and West Point: October 3, at Moodys bridge, on the Owensbyville wagon road, at a gage height of 0.0 feet, the discharge was 1,165 second-feet; on October 4 the river at Franklin, Georgia, about 40 miles above West Point, at a gage height of −0.70 foot, showed a discharge of 1,164 second-feet; on November 4 this river at McGees bridge, about 20 miles above West Point, Georgia, at a gage height of 0.40 foot, was carrying 1,670 second-feet.

Yellow Jacket Creek, at its mouth just above McGees bridge, was discharging 77 second-feet on November 4.

*Daily gage height, in feet, of Chattahoochee River at Oakdale, Georgia, for 1899.*

LOWER GAGE AT MASON & TURNER'S FERRY. (*a*)

| Day. | Jan. | Feb. | Mar. | Apr. | May. | Day. | Jan. | Feb. | Mar. | Apr. | May. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.25 | 5.10 | 9.80 | 13.00 | 4.70 | 17 | 4.75 | 7.25 | 24.25 | 5.25 | 3.60 |
| 2 | 4.75 | 4.50 | 6.85 | 7.75 | 4.45 | 18 | 4.50 | 6.10 | 11.00 | 4.95 | 3.50 |
| 3 | 3.60 | 5.80 | 6.17 | 6.50 | 4.40 | 19 | 4.10 | 5.60 | 10.50 | 5.00 | 3.55 |
| 4 | 3.40 | 4.90 | 5.90 | 7.75 | 4.35 | 20 | 3.90 | 4.90 | 15.00 | 4.95 | 3.50 |
| 5 | 3.10 | 6.50 | 8.10 | 6.50 | 4.50 | 21 | 3.75 | 5.25 | 8.75 | 4.85 | 3.45 |
| 6 | 3.75 | 10.00 | 8.50 | 5.90 | 5.10 | 22 | 3.60 | 5.20 | 7.25 | 4.65 | 5.50 |
| 7 | 6.75 | 16.00 | 6.40 | 6.50 | 4.60 | 23 | 3.90 | 5.00 | 9.50 | 4.75 | 3.60 |
| 8 | 6.10 | 21.50 | 5.90 | 7.75 | 4.35 | 24 | 4.25 | 4.90 | 9.00 | 4.95 | 3.50 |
| 9 | 5.25 | 13.40 | 5.50 | 7.50 | 4.25 | 25 | 4.10 | 4.60 | 6.50 | 7.25 | 3.35 |
| 10 | 4.70 | 9.50 | 5.25 | 7.10 | 4.10 | 26 | 4.25 | 10.23 | 7.10 | 8.00 | 3.25 |
| 11 | 6.30 | 6.40 | 5.10 | 6.80 | 4.00 | 27 | 3.70 | 22.13 | 6.20 | 6.25 | 3.15 |
| 12 | 4.75 | 5.50 | 5.00 | 5.75 | 3.95 | 28 | 3.45 | 18.88 | 6.10 | 5.25 | 3.10 |
| 13 | 4.25 | 4.90 | 4.95 | 5.25 | 3.90 | 29 | 3.25 | ........ | 7.90 | 5.00 | 3.20 |
| 14 | 4.50 | 4.10 | 6.25 | 5.20 | 3.85 | 30 | 3.50 | ........ | 6.45 | 4.80 | 6.10 |
| 15 | 5.50 | 4.60 | 10.00 | 5.10 | 3.80 | 31 | 4.65 | ........ | 12.30 | ........ | 3.40 |
| 16 | 4.90 | 5.60 | 21.50 | 5.00 | 3.70 | | | | | | |

*a* Discontinued May 31.

UPPER GAGE AT SOUTHERN RAILWAY BRIDGE.

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.. | 2.45 | 1.50 | 1.70 | 4.60 | 0.40 | 0.60 | 1.30 | 17... | 2.05 | 0.80 | 0.60 | 0.50 | 0.50 | 0.60 | 1.60 |
| 2.. | 2.40 | 1.40 | 1.40 | 2.70 | .10 | .50 | 1.80 | 18... | 2.05 | 1.00 | .60 | .30 | .60 | .50 | 1.30 |
| 3.. | 2.30 | 1.35 | 1.20 | 2.10 | .10 | .50 | 1.50 | 19... | 2.00 | 1.30 | .50 | .40 | .60 | .50 | 1.10 |
| 4.. | 2.10 | 1.25 | 1.10 | 1.90 | .10 | .50 | 1.40 | 20... | 1.90 | 1.00 | .40 | .40 | .80 | .40 | 1.20 |
| 5.. | 2.05 | 1.20 | 1.10 | 1.60 | .40 | .50 | 1.10 | 21... | 1.75 | 1.35 | .40 | .40 | .90 | .40 | 1.10 |
| 6.. | 2.00 | 1.40 | 1.00 | 1.00 | .60 | .40 | .90 | 22... | 1.70 | 3.80 | .40 | .40 | .70 | .90 | 1.10 |
| 7.. | 2.00 | 1.40 | .90 | .90 | 1.60 | .40 | .80 | 23... | 1.55 | 2.30 | .30 | .30 | .60 | 2.00 | 3.40 |
| 8.. | 2.05 | 1.40 | .80 | .80 | 1.50 | .40 | .80 | 24... | 1.55 | 1.90 | .20 | .30 | .50 | 2.40 | 5.50 |
| 9.. | 2.05 | 1.40 | .70 | .70 | 2.00 | .40 | .80 | 25... | 1.80 | .80 | .10 | .30 | .50 | 1.70 | 4 60 |
| 10.. | 2.10 | 1.30 | .60 | .70 | 1.20 | .40 | .80 | 26... | 2.05 | 2.10 | .20 | .30 | .40 | 3.00 | 3.40 |
| 11.. | 2.15 | 1.30 | .60 | 3.00 | .90 | .40 | .70 | 27... | 2.20 | 2.10 | 5.20 | .20 | .50 | 2.80 | 2.40 |
| 12.. | 2.75 | 1.10 | .50 | 1.10 | .70 | .70 | 2.20 | 28... | 2.00 | 5.90 | 3.40 | .20 | .50 | 2.70 | 2.00 |
| 13.. | 4.80 | 1.10 | .50 | .90 | .70 | .50 | 6.40 | 29... | 1.80 | 3.40 | 1.40 | .20 | .90 | 2.10 | 2.10 |
| 14.. | 4.00 | .90 | .50 | .80 | .70 | .50 | 3.10 | 30... | 1.60 | 3.30 | 3.20 | .20 | .70 | 1.80 | 1.80 |
| 15.. | 2.90 | .80 | .50 | .70 | .60 | .50 | 2.40 | 31... | ...... | 3.20 | 2.80 | ...... | .60 | ...... | 1.70 |
| 16.. | 2.25 | .80 | .60 | .60 | .50 | .60 | 1.80 | | | | | | | | |

## CHATTAHOOCHEE RIVER AT WEST POINT, GEORGIA.

This station was established July 30, 1896, by Max Hall, and is at the highway bridge in West Point, Georgia, about 1,200 feet above the railroad passenger station. A wire gage is suspended from the bridge and referred to four bench marks. First bench mark, downstream end, top of first iron-floor beam from the west bank pier of highway bridge, elevation 24.01 feet above datum; second bench mark, downstream end, top of second iron-floor beam from west bank pier of the highway bridge, elevation 24.19 feet above datum; third bench mark, top of second stone pier, Atlanta and West Point Railroad bridge, 1,000 feet upstream, elevation 24.65 feet; fourth bench mark, notch in large oak tree, east bank of river, 100 feet above wagon bridge, elevation 19.26 feet. The length of the wire gage is 33.46 feet. The gage was last verified March 14, 1899. The channel is straight and without obstructions, except from the piers of the bridge. The flow is sluggish in low stages of water. The banks overflow at high water, but all ordinary stages of water pass through the main channel. The bed of the stream is fairly constant. The observer is C. P. Jennings, a clerk in the Atlanta and West Point freight depot. He is paid by the United States Weather Bureau. The results of measurements at West Point may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 92; 1897, Nineteenth Annual Report, Part IV, page 239; 1898, Twentieth Annual Report, Part IV, page 183. The following measurements were made by B. M. Hall and his assistants during 1899:

March 14, gage height, 5.30 feet; discharge, 8,726 second-feet.
April 24, gage height, 4.72 feet; discharge, 7,144 second-feet.
May 13, gage height, 3.80 feet; discharge, 4,828 second-feet.
June 26, gage height, 3.06 feet; discharge, 3,234 second-feet.
September 12, gage height, 3.10 feet; discharge, 3,689 second-feet.
October 18, gage height, 2.07 feet; discharge, 2,088 second-feet.
December 16, gage height, 3.49 feet; discharge, 4,111 second-feet.

*Daily gage height, in feet, of Chattahoochee River at West Point, Georgia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.30 | 4.50 | 14.50 | 10.00 | 4.30 | 3.60 | 3.00 | 2.50 | 2.40 | 1.10 | 2.10 | 4.40 |
| 2 | 4.35 | 4.65 | 12.70 | 7.70 | 4.20 | 3.30 | 2.80 | 2.30 | 2.00 | 1.30 | 2.10 | 4.30 |
| 3 | 4.20 | 10.20 | 6.50 | 7.00 | 4.10 | 3.20 | 2.70 | 2.80 | 2.90 | 1.30 | 1.90 | 3.40 |
| 4 | 4.10 | 8.30 | 5.80 | 7.15 | 3.90 | 3.10 | 2.50 | 2.80 | 2.40 | 1.10 | 1.90 | 3.40 |
| 5 | 4.00 | 7.20 | 6.40 | 6.70 | 3.80 | 3.00 | 2.40 | 2.70 | 2.10 | 1.40 | 1.90 | 3.40 |
| 6 | 4.00 | 5.80 | 7.00 | 6.40 | 3.75 | 3.00 | 2.40 | 2.80 | 3.00 | 1.50 | 1.90 | 3.20 |
| 7 | 5.50 | 9.10 | 6.10 | 6.90 | 3.75 | 2.90 | 2.40 | 2.80 | 2.90 | 1.80 | 1.90 | 3.10 |
| 8 | 5.75 | 13.30 | 5.60 | 7.30 | 3.70 | 2.80 | 2.80 | 2.70 | 2.00 | 2.40 | 1.90 | 3.10 |
| 9 | 5.50 | 13.00 | 5.20 | 6.80 | 3.80 | 2.80 | 2.90 | 2.40 | 1.90 | 2.70 | 1.90 | 2.90 |
| 10 | 5.60 | 9.05 | 5.00 | 6.30 | 4.00 | 3.00 | 3.00 | 2.30 | 2.90 | 2.60 | 1.90 | 2.60 |
| 11 | 7.00 | 6.30 | 4.90 | 6.00 | 3.80 | 3.10 | 3.20 | 2.10 | 2.50 | 2.30 | 1.90 | 2.40 |
| 12 | 8.80 | 5.90 | 4.85 | 5.40 | 3.70 | 3.20 | 2.50 | 2.20 | 2.10 | 2.30 | 1.90 | 3.50 |
| 13 | 5.90 | 5.20 | 4.90 | 5.15 | 3.65 | 3.80 | 2.30 | 2.30 | 2.40 | 2.10 | 1.90 | 4.00 |
| 14 | 5.40 | 4.75 | 5.00 | 5.10 | 3.65 | 4.00 | 2.30 | 2.40 | 2.60 | 1.90 | 1.90 | 4.60 |
| 15 | 6.00 | 5.00 | 5.10 | 5.05 | 3.65 | 4.10 | 2.30 | 2.09 | 2.80 | 2.40 | 2.10 | 4.10 |
| 16 | 5.20 | 5.20 | 10.50 | 5.00 | 3.60 | 3.60 | 2.10 | 2.50 | 2.40 | 2.50 | 2.20 | 3.60 |
| 17 | 5.00 | 5.10 | 12.30 | 4.95 | 3.60 | 3.10 | 2.30 | 3.00 | 1.60 | 2.30 | 2.20 | 3.10 |
| 18 | 4.90 | 4.60 | 13.50 | 4.90 | 3.50 | 3.00 | 2.30 | 3.20 | 1.60 | 2.30 | 2.10 | 3.00 |
| 19 | 4.75 | 4.30 | 12.10 | 4.80 | 3.20 | 2.90 | 2.50 | 2.90 | 1.60 | 2.60 | 2.10 | 2.80 |
| 20 | 4.50 | 4.00 | 10.75 | 4.60 | 3.10 | 2.80 | 2.70 | 2.40 | 1.50 | 2.90 | 2.10 | 2.80 |
| 21 | 4.20 | 3.75 | 8.20 | 4.45 | 3.10 | 2.80 | 3.00 | 2.60 | 1.70 | 3.30 | 2.10 | 2.80 |
| 22 | 4.10 | 3.60 | 7.50 | 4.60 | 3.05 | 2.60 | 3.60 | 2.90 | 1.90 | 2.40 | 1.90 | 2.80 |
| 23 | 4.05 | 3.60 | 6.90 | 4.65 | 3.05 | 2.50 | 4.20 | 3.00 | 2.30 | 2.40 | 2.00 | 3.20 |
| 24 | 3.90 | 3.50 | 7.20 | 4.70 | 4.80 | 2.70 | 4.70 | 3.20 | 1.10 | 2.30 | 2.20 | 6.00 |
| 25 | 3.60 | 3.50 | 7.00 | 4.80 | 4 10 | 2.90 | 3.60 | 3.50 | 1.20 | 2.50 | 3.00 | 5.70 |
| 26 | 3.60 | 3.50 | 6.50 | 5.60 | 3.80 | 3.40 | 3.00 | 2.00 | 1.20 | 2.10 | 3.10 | 5.60 |
| 27 | 3.50 | 10.70 | 6.20 | 6.05 | 3.10 | 3.50 | 3.20 | 2.50 | 1.20 | 2.00 | 3.40 | 4.10 |
| 28 | 3.65 | 15.20 | 6.15 | 5.10 | 3.40 | 3.20 | 5.90 | 3.10 | 1.30 | 2.10 | 3.20 | 3.60 |
| 29 | 3.75 | ....... | 6.80 | 5.00 | 3.30 | 3.00 | 3.30 | 3.60 | 1.80 | 2.10 | 3.50 | 3.40 |
| 30 | 4.00 | ....... | 6.30 | 4.70 | 3.25 | 3.20 | 2.90 | 2.90 | 1.90 | 2.20 | 4.20 | 3.30 |
| 31 | 4.75 | ....... | 7.15 | ...... | 4.00 | ....... | 2.70 | 2.10 | ....... | 2.10 | ....... | 3.20 |

A station has been maintained by the United States Weather Bureau at Eufaula, Alabama, 80 miles below West Point. The rod is attached to the west side of brick pier of wagon bridge. The top of brick foundation of pier on west bank is 48.5 feet above gage datum. The drainage area above this point is reported to be 6,900 square miles.

## ETOWAH RIVER AT CANTON, GEORGIA.

The headwaters of this stream adjoin those of Chattahoochee River on the east, and the headwater tributaries of Coosawattee River on the west. Its drainage area is on the southern slope of the Blue Ridge Mountains, and it flows westerly into the Gulf drainage. A number of fine water powers occur throughout its length, the one at Cartersville, where it crosses the western fall line, being especially noted. This river joins the Oostanaula at Rome, Georgia, to form Coosa River. Its drainage basin is mapped on the following atlas sheets: Ellijay, Cartersville, and Suwanee. The gaging station was established by the United States Weather Bureau March 12, 1892. It is located at the iron highway bridge over the Etowah River, about 1,000 feet north of and upstream from the Atlanta, Knoxville and Northern Railway station, Canton, Georgia, and about one-half a mile above the mouth of Canton Creek. The bench mark is the top of one of the four pieces of track iron which forms a cap on the left pier, upstream side, and on which the bridge rests, and is at an elevation of 23.30 feet above datum. Up to about 14 feet the river is confined between its banks, but above this stage the river begins to overflow the bottom lands. The reports of discharge measurements are found as follows: 1896, Eighteenth Annual Report, Part IV, page 95; 1897, Nineteenth Annual Report, Part IV, page 242; 1898, Twentieth Annual Report, Part IV, page 189. The following measurements were made by B. M. Hall and his assistants in 1899:

April 27, gage height, 1.92 feet; discharge, 2,087 second-feet.
June 23, gage height, 0.25 foot; discharge, 770 second-feet.
September 27, gage height, —0.19 foot; discharge, 406 second-feet.
November 10, gage height, —0.10 foot; discharge, 420 second-feet.

Long Swamp Creek enters Etowah River 13 miles above Canton, Georgia. On April 21 it was measured at Revis Bridge, near Ballground, Georgia, and showed a discharge of 188 second-feet. Fourmile Creek, a tributary of Long Swamp Creek, was measured April 21 near Ballground, Georgia, and showed a discharge of 20 second-feet. Sharp Mountain Creek enters the Etowah 8½ miles above Canton. On November 10 a measurement of this stream, made by B. M. Hall near Ballground, Georgia, showed a discharge of 34 second-feet.

*Daily gage height, in feet, of Etowah River at Canton, Georgia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.80 | 1.60 | 3.00 | 2.40 | 1.60 | 1.00 | 1.40 | 1.40 | 0.80 | —0.40 | —0.10 | 0.10 |
| 2 | 1.80 | 1.60 | 2.80 | 2.20 | 1.50 | 1.40 | 1.40 | 1.40 | .60 | — .40 | — .10 | .40 |
| 3 | 1.80 | 1.80 | 2.80 | 2.00 | 1.40 | 1.40 | 1.40 | 1.80 | .60 | — .50 | — .10 | .40 |
| 4 | 1.80 | 2.80 | 2.60 | 3.80 | 1.40 | 4.40 | 1.20 | 1.60 | .60 | — .50 | — .10 | .40 |
| 5 | 1.80 | 3.00 | 2.40 | 3.00 | 1.40 | 3.00 | 1.20 | 1.60 | .60 | — .50 | — .10 | .20 |
| 6 | 1.80 | 6.20 | 2.00 | 2.80 | 1.40 | 1.00 | 1.00 | 1.40 | .60 | .00 | — .10 | .20 |
| 7 | 1.60 | 8.00 | 1.80 | 2.80 | 1.40 | 1.00 | 1.40 | 1.20 | .50 | .20 | — .10 | .20 |
| 8 | 1.40 | 4.00 | 1.80 | 4.00 | 1.40 | 1.00 | 1.60 | 1.60 | .50 | .20 | — .10 | .20 |
| 9 | 1.40 | 3.20 | 1.60 | 3.00 | 1.60 | 1.00 | 4.00 | 1.80 | .40 | .20 | — .10 | .20 |
| 10 | 1.40 | 3.00 | 1.50 | 2.80 | 1.60 | 1.00 | 2.00 | 1.60 | .40 | .10 | — .10 | .20 |
| 11 | 1.40 | 2.00 | 1.50 | 2.00 | 1.40 | 1.40 | 1.80 | 1.60 | .40 | .10 | — .10 | .30 |
| 12 | 1.80 | (*a*) | 1.40 | 1.80 | 1.40 | 1.60 | 1.60 | 1.60 | .40 | .10 | — .10 | 2.80 |
| 13 | 1.80 | (*a*) | 1.40 | 1.80 | 1.40 | 1.60 | 1.40 | 1.40 | .40 | .00 | — .10 | .80 |
| 14 | 2.80 | (*a*) | 3.60 | 1.80 | 1.80 | 1.40 | 1.40 | 1.20 | .40 | .00 | — .10 | .30 |
| 15 | 2.60 | 3.00 | 7.00 | 1.80 | 1.80 | 1.40 | 1.80 | 1.20 | .40 | .00 | .00 | .20 |
| 16 | 2.40 | 2.00 | 18.20 | 1.60 | 1.80 | 1.40 | 1.90 | 1.00 | .40 | .00 | .00 | .20 |
| 17 | 2.30 | 2.00 | 18.00 | 1.60 | 1.60 | 1.40 | 1.80 | 1.00 | .30 | .00 | .10 | .20 |
| 18 | 2.30 | 2.00 | 4.00 | 1.60 | 1.60 | 1.40 | 1.80 | .80 | .30 | .00 | .00 | .10 |
| 19 | 2.20 | 2.00 | 4.00 | 1.40 | 1.60 | 1.40 | 1.80 | .80 | .30 | .00 | .00 | .10 |
| 20 | 2.20 | 1.80 | 3.00 | 1.40 | 1.40 | 1.30 | 1.60 | 1.40 | .20 | — .10 | .00 | .10 |
| 21 | 2.00 | 1.80 | 2.00 | 1.40 | 1.40 | 1.30 | 1.60 | 1.40 | .10 | — .10 | .00 | .10 |
| 22 | 1.80 | 1.80 | 2.00 | 1.40 | 1.40 | 1.30 | 1.60 | 1.20 | .00 | — .10 | .00 | .10 |
| 23 | 1.80 | 1.80 | 2.00 | 1.40 | 1.40 | 1.20 | 1.60 | 1.00 | .00 | — .10 | .90 | .80 |
| 24 | 2.00 | 1.60 | 1.80 | 1.80 | 1.40 | 1.20 | 1.40 | 1.00 | .00 | — .10 | .70 | 3.00 |
| 25 | 2.80 | 1.40 | 1.80 | 4.80 | 1.40 | 1.20 | 1.20 | .80 | — .10 | — .10 | .70 | 3.00 |
| 26 | 2.00 | 1.80 | 2.80 | 3.00 | 1.20 | 1.00 | 1.20 | .80 | — .10 | — .10 | 1.10 | 2.00 |
| 27 | 1.80 | 10.00 | 2.00 | 2.80 | 1.20 | 1.00 | 1.20 | 1.40 | — .10 | .00 | .70 | 2.30 |
| 28 | 1.80 | 5.00 | 1.80 | 2.00 | 1.20 | 1.00 | 1.20 | 1.20 | — .20 | .00 | .50 | 1.80 |
| 29 | 1.80 | ....... | 2.80 | 1.80 | 1.20 | 1.00 | 1.20 | 1.00 | — .30 | — .10 | .10 | .60 |
| 30 | 10.00 | ....... | 2.00 | 1.70 | 1.20 | 1.00 | 1.10 | 1.00 | — .30 | — .10 | .10 | .60 |
| 31 | 5.00 | ....... | 2.60 | ....... | 1.00 | ....... | 1.00 | .80 | ....... | — .10 | ....... | .60 |

*a* Gage covered with ice.

## COOSAWATTEE RIVER AT CARTERS, GEORGIA.

This river is formed by the junction of Ellijay and Cartecay rivers at Ellijay, Georgia, and flows in a southwesterly direction, joining the Conasauga to form the Oostanaula. Its drainage area is for the most part mountainous and covered with forest growth. The station was established August 15, 1896, at the iron highway bridge at Carters, Murray County, Georgia, about 20 miles northeast of Calhoun, the most convenient railroad station. It is described in the Eighteenth Annual Report, Part IV, page 96. Carters is the head of navigation, small boats running to Rome, Georgia, and the Coosa River below. It is at the foot of the great shoals made by this stream in cutting through the Cohutta Mountains, the last of which is Carters Shoals, a short distance above the bridge, with a fall of 50 feet. The drainage area above this point is 532 square miles, of which 150 square miles is on the Talking Rock Creek, which enters the river one-half mile above. The basin is mapped on Dalton, Ellijay, Cartersville, and Suwanee atlas sheets. The length of the wire gage is 37.24 feet. The top of the cylindrical iron pier at the right-bank downstream corner of bridge is 30.35 feet above gage datum. The gage was last verified in August, 1898. The current is swift, but is broken by a gravel bar above the section. The bed is gravelly and not apt to change. The banks are high, but occasionally overflow in high water. The observer, H. S. Weems, merchant at Carters, Georgia, gives his services to the Survey without compensation. Records of measurement may be found as follows: 1896 and 1897, Nineteenth Annual Report, Part IV, page 244; 1898, Twentieth Annual Report, Part IV, page 191. The following measurements were made by O. P. Hall and Max Hall in 1899:

January 28, gage height, 2.14 feet; discharge, 868 second-feet.
March 14, gage height, 8.95 feet; discharge, 5,240 second-feet.
March 14, gage height, 7.70 feet; discharge, 4,682 second-feet.
May 26, gage height, 2.35 feet; discharge, 906 second-feet.
June 22, gage height, 1.75 feet; discharge, 653 second-feet.
October 19, gage height, 1.10 feet; discharge, 377 second-feet.

A number of measurements of the tributaries of Coosawattee River have been made during the past season. Ellijay River, at the wagon bridge near Ellijay, Georgia, was measured on October 13, and showed a discharge of 80 second-feet. Talking Rock Creek, which enters Coosawattee River just above Carters Station, was measured twice during the year, the first time on May 26, when the discharge was 144 second-feet, and the second time on June 22, when the discharge was 114 second-feet. April 22 Scared Corn Creek, a tributary of Talking Rock Creek, was discharging 32 second-feet. Sallacoa Creek, which enters Coosawattee River from the south 1 mile above Fields Mill Ferry, was measured on May 20, when the discharge was found to be 103 second-feet. Coosawattee River itself at Fields Mill Ferry, 5½ miles above its junction with the Conasauga, was measured October 14, showing a discharge of 388 second-feet.

*Daily gage height, in feet, of Coosawattee River at Carters, Georgia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.80 | 2.50 | 5.00 | 5.10 | 3.40 | 2.00 | 1.40 | 1.90 | 1.00 | 0.75 | 0.95 | 0.95 |
| 2 | 1.90 | 3.00 | 4.50 | 5.00 | 3.30 | 1.95 | 1.50 | 1.80 | 1.05 | .75 | .90 | 1.30 |
| 3 | 1.90 | 3.50 | 3.50 | 5.20 | 3.20 | 1.95 | 1.40 | 1.80 | 1.00 | .70 | .90 | 1.20 |
| 4 | 2.00 | 15.80 | 3.50 | 6.00 | 3.00 | 1.90 | 1.40 | 1.70 | 1.00 | .65 | .90 | 1.20 |
| 5 | 2.05 | 14.00 | 6.10 | 5.80 | 2.90 | 2.00 | 1.45 | 1.60 | .95 | .65 | .85 | 1.10 |
| 6 | 2.10 | 13.20 | 4.80 | 5.50 | 2.90 | 2.00 | 1.40 | 1.50 | 1.00 | .70 | .85 | 1.00 |
| 7 | 2.00 | 12.50 | 4.50 | 5.50 | 2.80 | 1.90 | 1.30 | 1.45 | .95 | .70 | .80 | 1.10 |
| 8 | 3.00 | 8.00 | 4.00 | 4.80 | 2.70 | 1.90 | 1.30 | 1.50 | .90 | 1.50 | .80 | 1.00 |
| 9 | 2.00 | 6.00 | 3.20 | 4.00 | 2.65 | 1.85 | 1.60 | 1.50 | .90 | 1.20 | .90 | .90 |
| 10 | 2.00 | 6.00 | 3.00 | 3.70 | 2.60 | 1.85 | 1.50 | 1.40 | .90 | 1.00 | .80 | .90 |
| 11 | 2.10 | 5.00 | 3.50 | 3.60 | 2.50 | 1.90 | 1.50 | 1.40 | .95 | .90 | .80 | 1.10 |
| 12 | 2.00 | 4.00 | 3.50 | 3.50 | 2.50 | 3.20 | 1.40 | 1.30 | .90 | .90 | .90 | 7.40 |
| 13 | 1.90 | 4.00 | 4.00 | 3.40 | 2.60 | 3.00 | 1.40 | 1.30 | .90 | .95 | .90 | 5.00 |
| 14 | 1.90 | 4.50 | 4.50 | 3.00 | 2.60 | 2.50 | 1.40 | 1.60 | .90 | .90 | 1.00 | 3.00 |
| 15 | 2.00 | 4.50 | 19.00 | 3.00 | 2.50 | 2.30 | 1.35 | 1.50 | .85 | .90 | .90 | 2.00 |
| 16 | 2.20 | 4.00 | 12.00 | 3.10 | 2.50 | 2.20 | 1.30 | 1.40 | .85 | .90 | .90 | 1.50 |
| 17 | 2.80 | 5.00 | 10.00 | 4.00 | 2.40 | 2.10 | 1.70 | 1.20 | .85 | .90 | 1.00 | 1.30 |
| 18 | 2.60 | 4.70 | 9.00 | 4.00 | 2.30 | 2.00 | 1.50 | 1.20 | .80 | .85 | 1.05 | 1.10 |
| 19 | 2.40 | 3.60 | 7.50 | 3.75 | 2.30 | 1.90 | 1.60 | 1.15 | .85 | .85 | 1.00 | 1.10 |
| 20 | 2.30 | 3.50 | 6.00 | 3.50 | 2.20 | 1.90 | 1.80 | 1.15 | .85 | .90 | 1.10 | 1.20 |
| 21 | 2.10 | 4.00 | 5.00 | 3.40 | 2.20 | 1.80 | 2.20 | 1.10 | .80 | .90 | 1.10 | 1.20 |
| 22 | 2.10 | 3.50 | 8.00 | 3.50 | 2.30 | 1.70 | 3.00 | 1.10 | .80 | .90 | 1.00 | 1.40 |
| 23 | 2.00 | 3.40 | 7.00 | 3.50 | 2.20 | 1.70 | 2.50 | 1.10 | .85 | .85 | .90 | 1.50 |
| 24 | 2.00 | 3.50 | 6.50 | 4.00 | 2.15 | 1.70 | 2.00 | 1.05 | .85 | .85 | 1.00 | 3.00 |
| 25 | 2.50 | 4.00 | 5.00 | 6.00 | 2.15 | 1.60 | 2.00 | 1.05 | .80 | .80 | 1.00 | 2.00 |
| 26 | 2.30 | 5.00 | 5.00 | 5.00 | 2.10 | 1.60 | 3.20 | 1.10 | 80 | .80 | 1.20 | 1.50 |
| 27 | 2.10 | 15.00 | 5.20 | 4.00 | 2.10 | 1.50 | 3.00 | 1.10 | .80 | .75 | 1.10 | 1.30 |
| 28 | 2.10 | 7.00 | 4.80 | 4.00 | 2.05 | 1.50 | 3.00 | 1.05 | .80 | .80 | 1.05 | 1.20 |
| 29 | 2.10 | ....... | 4.50 | 3.70 | 2.05 | 1.40 | 2.20 | 1.15 | .75 | 1.00 | 1.00 | 1.20 |
| 30 | 2.20 | ....... | 4.60 | 3.60 | 2.00 | 1.45 | 1.90 | 1.20 | .80 | 1.00 | 1.00 | 1.10 |
| 31 | 2.40 | ....... | 4.40 | ....... | 2.00 | ....... | 2.00 | 1.10 | ....... | .90 | ....... | 1.10 |

## OOSTANAULA RIVER AT RESACA, GEORGIA.

This river is formed about 3 miles above Resaca by the junction of Coosawattee and Conasauga rivers, the former having a drainage area of 875 and the latter 648 square miles, while there are 4 square miles between the junction and Resaca. This gives a total drainage area of 1,527 square miles, mapped on atlas sheets Cleveland, Ellijay, Dalton, Cartersville, and Suwanee. The station is at the iron railroad bridge of the Western and Atlantic Railroad, in the town of Resaca, Georgia, 1,000 feet from the depot. On July 27, 1896, a discharge measurement was made by Max Hall, and a station established using the Weather Bureau gage. On August 19 a wire gage was established and referred to the same datum. The initial point is the right bank end iron of bridge, downstream side. The length of the wire gage is 43.40 feet. The first bench mark is on the top of capstone of center pier, at an elevation of 36.12 feet; the second is the top of crosstie near center, at an elevation of 40.12 feet. The channel is straight and the current fairly swift. The bed is soft and liable to change; the banks somewhat subject to overflow. The observer is S. M. Barnett, railroad agent at station, who is also the observer for the Weather Bureau. Records of measurement may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 98; 1897, Nineteenth Annual Report, Part IV, page 245; 1898, Twentieth Annual Report, Part IV, page 190. The following measurements were made by Olin P. Hall and Max Hall during 1899:

April 26, gage height, 8.05 feet; discharge, 5,146 second-feet.
May 20, gage height, 4.15 feet; discharge, 1,671 second-feet.
June 9, gage height, 3.10 feet: discharge, 1,171 second-feet.
June 21, gage height, 3.05 feet; discharge, 1,087 second-feet.
October 14, gage height, 1.75 feet; discharge, 644 second-feet.

Three measurements of the discharge of Conasauga River at Fites Ferry, 3½ miles above its mouth, were made during the season. The first, on June 9, gave a discharge of 224 second-feet; second, on June 21, gave a discharge of 258 second-feet, and the third, on October 14, gave a discharge of 122 second-feet.

*Daily gage height, in feet, of Oostanaula River at Resaca, Georgia, for 1899* (*a*).

| Day. | Jan. | Feb. | Mar. | Apr. | Nov. | Dec. | Day. | Jan. | Feb. | Mar. | Apr. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.10 | 11.00 | 16.20 | 13.40 | 1.80 | 2.30 | 17 | 6.10 | 12.10 | 28.60 | 6.20 | 2.00 | 3.30 |
| 2 | 5.00 | 8.80 | 9.60 | 10.30 | 1.70 | 2.50 | 18 | 6.25 | 11.40 | 27.30 | 6.00 | 1.80 | 2.80 |
| 3 | 4.50 | 7.95 | 8.00 | 8.40 | 1.70 | 2.60 | 19 | 5.65 | 10.20 | 26.60 | 6.10 | 1.80 | 2.70 |
| 4 | 4.20 | 16.00 | 7.40 | 8.10 | 1.70 | 2.30 | 20 | 5.10 | 9.55 | 26.20 | 6.00 | 1.80 | 3.50 |
| 5 | 4.10 | 19.90 | 9.30 | 10.20 | 1.70 | 2.20 | 21 | 4.85 | 8.10 | 27.30 | 5.80 | 1.70 | 4.40 |
| 6 | 4.50 | 21.90 | 10.40 | 9.00 | 1.70 | 2.10 | 22 | 4.70 | 8.20 | 25.20 | 5.60 | 1.70 | 3.60 |
| 7 | 7.50 | 25.50 | 9.40 | 8.90 | 1.60 | 2.00 | 23 | 4.50 | 8.65 | 21.10 | 5.40 | 2.30 | 3.30 |
| 8 | 9.35 | 26.50 | 7.50 | 14.30 | 1.60 | 2.00 | 24 | 4.55 | 7.70 | 17.00 | 6.40 | 2.80 | 8.10 |
| 9 | 8.80 | 25.50 | 6.80 | 13.90 | 1.60 | 1.90 | 25 | 5.50 | 6.90 | 11.00 | 8.60 | 2.30 | 8.10 |
| 10 | 6.20 | 22.20 | 6.60 | 12.70 | 1.60 | 2.00 | 26 | 5.30 | 6.40 | 9.00 | 8.70 | 2.70 | 6.00 |
| 11 | 5.85 | 15.80 | 6.40 | 8.90 | 1.60 | 2.10 | 27 | 4.80 | 17.50 | 8.60 | 7.00 | 3.80 | 4.30 |
| 12 | 6.00 | 8.20 | 6.10 | 7.80 | 1.70 | 5.10 | 28 | 4.55 | 20.20 | 7.90 | 6.30 | 3.40 | 3.80 |
| 13 | 5.80 | 7.00 | 6.00 | 7.40 | 1.70 | 8.00 | 29 | 4.40 | ....... | 11.65 | 5.80 | 2.80 | 3.70 |
| 14 | 5.30 | 6.35 | 8.00 | 7.00 | 1.70 | 6.40 | 30 | 4.20 | ....... | 11.40 | 5.50 | 2.50 | 3.50 |
| 15 | 5.50 | 6.70 | 16.00 | 6.80 | 1.60 | 4.00 | 31 | 6.10 | ....... | 11.40 | ....... | ...... | 3.00 |
| 16 | 5.15 | 6.70 | 22.00 | 6.50 | 1.90 | 3.60 | | | | | | | |

*a* No records from May 1 to October 31.

## MEASUREMENTS OF LARGE SPRINGS IN NORTHWEST GEORGIA.

In the basin of Sallacoa Creek, a tributary of Coosawattee River, and in the adjoining basin of Oothkalooga Creek, are a number of large springs which were measured by Olin P. Hall in 1899. On May 30 Dooley Spring, 3 miles south of Fairmount, Georgia, gave a discharge of 0.92 second-foot; Doves Mill Spring, near Cash, Georgia, 16.2 second-feet; Bakers Mill Spring, 5 miles south of Fairmount, Georgia, 3.9 second-feet. June 24 a number of springs in the basin of Sallacoa Creek showed discharges as follows: Colima Spring, near Colima, Georgia, 0.28 second-foot; Arnold Spring, 1 mile south of Colima, 0.38 second-foot; J. R. Byrd's spring, 2½ miles northwest of Fairmount, Georgia, 0.47 second-foot; R. W. Lander's spring, 3 miles east of Pinelog, Georgia, 4.27 second-feet; J. A. Johnson's spring, 2½ miles east of Pinelog, Georgia, 0.48 second-foot; Oakhill Church Spring, 2½ miles east of Pinelog, Georgia, 1.85 second-feet.

The five following springs occur in the basin of Oothkalooga Creek, which enters Oostanaula River 1 mile below Calhoun. On June 26 their discharge was measured and found to be as follows: Hayse

Spring, at Folsom, Georgia, 0.35 second-foot; Cedar Spring, at Mostetters Mill, 1¼ miles west of Folsom, 4.45 second-feet; Trimble Spring, 2 miles north of Adairsville, Georgia, 2.35 second-feet; Gardners Spring, 5 miles north of Adairsville, 0.41 second-foot; Blackwood Spring, 5 miles southeast of Calhoun, Georgia, 1.00 second-foot.

## COOSA RIVER AT ROME, GEORGIA.

Coosa River is formed by the junction of Etowah and Oostanaula rivers at Rome, Georgia. The drainage area is 3,720 square miles. Both of the tributary rivers rise in the northern part of Georgia and flow for the most part through a hilly, broken country, well wooded, about one-fourth of the land being under cultivation. The Coosa River flows in a southwesterly direction into Alabama and joins the Tallapoosa 6 miles above Montgomery, Alabama, to form Alabama River. Measurements of flow are made at Rome and at Riverside, 120 miles farther downstream, and will be made in 1900 at Montgomery and Selma. The measurements at Rome are made on the Oostanaula and Etowah just above their junction. Etowah River is measured at Second avenue bridge and the Oostanaula at Fifth avenue bridge in Rome, and the results added to give the flow of Coosa River. The gage height is taken from the United States Weather Bureau gage at Fifth avenue bridge, on the Oostanaula. There is practically no fall on Oostanaula River from Fifth avenue bridge to the junction, hence the gage is used as Coosa River gage and gives the fluctuations of Coosa River. This gage is a 4 by 6 inch timber, graduated to feet and tenths and fastened to the downstream left-hand corner of the first pier from the left bank. The zero of gage is 575.79 feet above sea level. The United States Weather Bureau has maintained the station here for many years. It is now maintained only as a half-year station, from November 1 to April 30, inclusive, but W. M. Towers, the river observer, kindly reads the gage and furnishes the Survey with monthly reports of the daily gage heights for the entire year without charge. Mr. Towers has kept the records for many years and has predicted floods with great precision. The channel of the Etowah is straight, current swift and unobstructed, but the Oostanaula is rather sluggish and somewhat obstructed by piers. The banks are high, but liable to overflow in times of high water. Records of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 198; 1898, Twentieth Annual Report, Part IV, page 184. The following measurements have been made by Max Hall and others during 1899:

January 25, gage height, 3.80 feet; discharge, 6,540 second-feet.
January 25, gage height, 3.60 feet; discharge, 5,932 second-feet.
May 19, gage height, 2.75 feet; discharge, 4,394 second-feet.
June 16, gage height, 2.40 feet; discharge, 3,352 second-feet.
August 4, gage height, 1.45 feet; discharge, 2,835 second-feet.
October 13, gage height, 0.60 foot; discharge, 1,769 second-feet.

*Daily gage height, in feet, of Coosa River at Rome, Georgia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.00 | 6.90 | 19.70 | 13.20 | 4.00 | 3.00 | 1.70 | 2.20 | 3.40 | 0.40 | 0.7 | 1.1 |
| 2 | 3.40 | 7.80 | 15.00 | 10.60 | 3.70 | 2.60 | 1.50 | 1.90 | 2.00 | .30 | .6 | 1.1 |
| 3 | 3.00 | 6.00 | 8.60 | 7.90 | 3.70 | 2.60 | 1.00 | 1.70 | 1.60 | .30 | .5 | 1.5 |
| 4 | 2.70 | 9.20 | 6.60 | 7.20 | 3.50 | 2.00 | .90 | 1.50 | 1.40 | .30 | .5 | 1.3 |
| 5 | 2.60 | 15.30 | 7.80 | 9.50 | 3.50 | 2.00 | 2.00 | 1.40 | 1.30 | .30 | .4 | 1.1 |
| 6 | 2.60 | 18.20 | 9.00 | 8.20 | 3.50 | 2.00 | 1.90 | 1.50 | 1.30 | .50 | .4 | 1.0 |
| 7 | 3.60 | 27.80 | 8.00 | 8.20 | 3.70 | 2.00 | 1.90 | 1.60 | 1.20 | .70 | .3 | .9 |
| 8 | 5.90 | 24.00 | 6.80 | 15.00 | 3.70 | 1.90 | 3.00 | 1.50 | 1.00 | .70 | .3 | .8 |
| 9 | 5.90 | 22.40 | 5.70 | 13.40 | 3.60 | 1.80 | 2.10 | 1.80 | 1.00 | .80 | .3 | .8 |
| 10 | 4.90 | 21.00 | 5.40 | 11.20 | 3.50 | 1.80 | 1.90 | 1.60 | 1.00 | .60 | .3 | .8 |
| 11 | 4.00 | 19.00 | 5.20 | 9.50 | 3.30 | 1.80 | 2.50 | 1.40 | 2.90 | 1.00 | .3 | .8 |
| 12 | 4.50 | 16.50 | 4.90 | 7.00 | 3.10 | 2.20 | 2.80 | 1.40 | 2.30 | .90 | .3 | 2.8 |
| 13 | 4.00 | 7.00 | 4.50 | 6.40 | 3.10 | 3.80 | 2.00 | 1.20 | 1.50 | .70 | .3 | 6.1 |
| 14 | 3.80 | 5.00 | 6.00 | 5.90 | 3.00 | 4.00 | 1.60 | 1.10 | 1.00 | .70 | .4 | 5.0 |
| 15 | 3.60 | 5.00 | 16.60 | 5.60 | 3.00 | 3.50 | 1.30 | 1.30 | .90 | .60 | .4 | 3.2 |
| 16 | 3.60 | 5.50 | 27.70 | 5.40 | 2.90 | 2.50 | 1.80 | 1.90 | .80 | .60 | .5 | 2.0 |
| 17 | 4.00 | 8.90 | 29.20 | 5.20 | 2.80 | 2.10 | 5.20 | 1.60 | .60 | .60 | .9 | 1.8 |
| 18 | 4.20 | 9.50 | 25.80 | 4.80 | 2.80 | 2.00 | 4.20 | 1.40 | .60 | .60 | .7 | 1.7 |
| 19 | 4.00 | 8.50 | 24.90 | 4.70 | 2.80 | 2.00 | 4.80 | 1.10 | .60 | .60 | .5 | 1.3 |
| 20 | 3.70 | 7.70 | 26.20 | 4.60 | 2.80 | 2.00 | 8.80 | .90 | .70 | .60 | .5 | 1.6 |
| 21 | 3.30 | 6.80 | 24.60 | 4.30 | 2.60 | 1.80 | 12.80 | .90 | .70 | .70 | .5 | 2.0 |
| 22 | 3.20 | 6.90 | 23.00 | 4.10 | 2.60 | 2.20 | 7.90 | .80 | .60 | .70 | .4 | 2.0 |
| 23 | 3.10 | 7.30 | 22.60 | 4.00 | 2.40 | 1.70 | 4.80 | .80 | .60 | .60 | 1.0 | 1.8 |
| 24 | 3.50 | 6.60 | 21.90 | 5.40 | 2.60 | 1.70 | 3.90 | .70 | .50 | .50 | 2.1 | 7.2 |
| 25 | 3.80 | 5.80 | 18.00 | 7.40 | 2.50 | 1.70 | 2.60 | .70 | .50 | .40 | 1.5 | 7.5 |
| 26 | 3.80 | 5.50 | 10.50 | 9.10 | 2.40 | 1.70 | 2.60 | .70 | .50 | .40 | 2.5 | 5.0 |
| 27 | 3.30 | 19.10 | 7.70 | 6.70 | 2.20 | 2.10 | 3.80 | 2.50 | .50 | .40 | 3.0 | 3.5 |
| 28 | 3.00 | 23.40 | 6.80 | 5.50 | 2.20 | 1.90 | 3.00 | 2.50 | .60 | .40 | 2.2 | 3.0 |
| 29 | 3.00 | ------- | 8.80 | 4.80 | 2.00 | 1.90 | 2.40 | 2.50 | .50 | .40 | 1.9 | 3.0 |
| 30 | 2.90 | ------- | 9.30 | 4.20 | 2.00 | 1.80 | 1.40 | 2.00 | .40 | .50 | 1.4 | 3.4 |
| 31 | 4.40 | ------- | 10.20 | ------ | 3.30 | ------ | 1.20 | 2.50 | ------ | .80 | ------- | 2.0 |

## COOSA RIVER AT RIVERSIDE, ALABAMA.

This station, described in the Eighteenth Annual Report, Part IV, page 99, was established September 25, 1896, at the bridge of the Southern Railway across Coosa River near Riverside, Alabama. The drainage area is 6,850 square miles. It is mapped on the Springville, Anniston, Gadsden, Fort Payne, Rome, Tallapoosa, Marietta, Cartersville, Suwanee, Ellijay, Dalton, Cleveland, Ringgold, and Stevenson atlas sheets. The town of Riverside is on the west bank of the river, and the railroad station is 1,000 feet west of the bridge at which the measurements are made. The length of the gage wire is 38.35 feet. The first bench mark is the top capstone on the large circular center pier of turn-span, the elevation of which is 26.80 feet above gage datum; second bench mark is base of rail near same pier, and is 32.80 feet above gage datum. The channel is straight, current swift, but somewhat obstructed by a ledge of rock under water about 300 feet above the station. The observer is J. W. Foster, Riverside, Alabama. The records of measurement may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 101; 1897, Nineteenth Annual Report, Part IV, page 248; 1898, Twentieth Annual Report, Part IV, page 187. The following measurements were made by Max Hall and others during 1899:

April 26, gage height, 9.00 feet; discharge, 29,069 second-feet.
May 3, gage height, 4.05 feet; discharge, 10,592 second-feet.
May 20, gage height, 2.70 feet; discharge, 6,276 second-feet.
June 14, gage height, 2.20 feet; discharge, 5,010 second-feet.

August 26, gage height, 1.42 feet; discharge, 3,791 second-feet.
September 23, gage height, 1.00 foot; discharge, 2,457 second-feet.
November 7, gage height, 0.85 foot; discharge, 2,271 second-feet.
December 9, gage height, 1.20 feet; discharge, 2,727 second-feet.

*Daily gage height, in feet, of Coosa River at Riverside, Alabama, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.80 | 5.90 | 12.10 | 10.30 | 5.00 | 2.70 | 1.70 | 3.95 | 2.30 | 0.90 | 0.95 | 2.60 |
| 2 | 2.75 | 6.30 | 12.20 | 10.20 | 4.50 | 2.80 | 1.70 | 3.00 | 2.40 | .90 | .95 | 2.00 |
| 3 | 2.75 | 7.50 | 12.30 | 10.00 | 4.20 | 2.80 | 1.65 | 2.30 | 2.80 | .90 | .95 | 1.60 |
| 4 | 2.80 | 7.40 | 12.10 | 9.80 | 3.95 | 2.60 | 1.60 | 2.00 | 2.40 | .90 | .95 | 1.50 |
| 5 | 2.80 | 9.10 | 10.10 | 8.90 | 3.80 | 2.30 | 1.50 | 1.90 | 2.10 | .90 | .95 | 1.45 |
| 6 | 3.00 | 12.10 | 9.00 | 8.75 | 3.75 | 2.10 | 1.50 | 1.75 | 2.00 | .90 | .95 | 1.40 |
| 7 | 3.50 | 14.10 | 8.00 | 9.00 | 3.60 | 2.00 | 1.45 | 1.65 | 1.85 | .90 | .95 | 1.35 |
| 8 | 4.30 | 14.30 | 7.50 | 10.00 | 4.00 | 2.00 | 1.40 | 1.50 | 1.40 | .90 | .95 | 1.30 |
| 9 | 4.20 | 14.30 | 7.25 | 12.30 | 3.85 | 1.95 | 1.70 | 1.50 | 1.30 | .95 | .95 | 1.30 |
| 10 | 4.40 | 14.10 | 7.00 | 12.00 | 3.60 | 1.95 | 1.60 | 1.55 | 1.25 | 1.20 | .95 | 1.35 |
| 11 | 5.20 | 13.80 | 6.15 | 11.70 | 3.45 | 1.95 | 1.50 | 1.55 | 1.25 | 1.30 | .95 | 1.40 |
| 12 | 5.90 | 13.00 | 5.20 | 10.00 | 3.30 | 1.95 | 1.50 | 1.60 | 2.20 | 1.40 | .95 | 5.80 |
| 13 | 5.60 | 12.00 | 5.50 | 8.90 | 3.20 | 2.00 | 1.40 | 1.50 | 2.50 | 1.30 | .95 | 8.25 |
| 14 | 5.00 | 10.90 | 7.50 | 7.90 | 3.00 | 2.15 | 1.40 | 1.45 | 2.65 | 1.20 | 1.00 | 8.00 |
| 15 | 4.70 | 8.70 | 8.30 | 6.30 | 3.00 | 2.80 | 1.30 | 1.50 | 2.00 | 1.20 | 1.00 | 6.00 |
| 16 | 4.90 | 7.90 | 16.00 | 5.55 | 2.95 | 3.20 | 1.30 | 1.50 | 1.40 | 1.20 | 1.00 | 4.50 |
| 17 | 5.00 | 7.60 | 17.40 | 5.25 | 2.95 | 2.95 | 1.30 | 1.50 | 1.25 | 1.10 | 1.00 | 3.75 |
| 18 | 4.90 | 7.80 | 17.00 | 5.10 | 2.80 | 2.50 | 1.20 | 1.55 | 1.20 | 1.00 | 1.00 | 3.60 |
| 19 | 4.70 | 8.10 | 16.50 | 5.00 | 2.80 | 2.25 | 1.30 | 1.50 | 1.20 | .95 | 1.00 | 3.40 |
| 20 | 4.60 | 8.20 | 16.30 | 4.80 | 2.75 | 2.00 | 1.50 | 1.45 | 1.10 | .95 | 1.00 | 3.00 |
| 21 | 4.20 | 8.00 | 16.35 | 4.60 | 2.75 | 1.80 | 1.50 | 1.45 | 1.00 | .90 | .95 | 2.85 |
| 22 | 4.00 | 7.65 | 16.20 | 4.30 | 2.70 | 1.70 | 1.90 | 1.35 | .95 | .90 | .95 | 2.75 |
| 23 | 3.90 | 8.00 | 15.90 | 4.75 | 2.70 | 1.70 | 3.20 | 1.30 | 1.00 | .95 | .95 | 3.00 |
| 24 | 3.90 | 8.10 | 15.70 | 5.65 | 2.65 | 1.60 | 4.70 | 1.30 | 1.00 | 1.20 | .95 | 5.40 |
| 25 | 4.00 | 7.30 | 15.50 | 8.90 | 2.60 | 1.75 | 3.60 | 1.30 | 1.00 | 1.15 | 1.00 | 6.40 |
| 26 | 4.25 | 7.00 | 14.90 | 9.00 | 2.50 | 1.60 | 3.20 | 1.60 | 1.00 | 1.00 | 2.15 | 7.10 |
| 27 | 4.15 | 8.30 | 13.25 | 8.90 | 2.45 | 1.60 | 3.00 | 1.20 | .95 | 1.00 | 2.90 | 7.00 |
| 28 | 4.00 | 11.00 | 11.00 | 8.30 | 2.35 | 1.65 | 3.60 | 1.10 | .95 | .95 | 3.00 | 6.60 |
| 29 | 3.90 | ....... | 8.00 | 6.90 | 2.30 | 1.70 | 4.20 | 1.50 | .90 | .95 | 3.00 | 6.00 |
| 30 | 3.75 | ....... | 7.90 | 5.45 | 2.20 | 1.65 | 5.20 | 2.10 | .90 | .90 | 2.75 | 4.85 |
| 31 | 3.70 | ....... | 8.50 | ....... | 2.70 | ....... | 4.75 | 2.10 | ....... | .95 | ....... | 4.00 |

## COOSA RIVER AT LOCKS NOS. 4 AND 5, ALABAMA.

The station at Lock No. 4 is located 3 miles above Riverside, Alabama. Measurements here give the discharge past Riverside except the small quantity, about 1 cubic foot per second, flowing into the Coosa from Blue Spring Branch. The measurements are made from the bridge of the Southern Railway at Riverside. A record has been kept at Lock No. 4 by the United States Engineer Corps. The first section of the vertical gage rod is fastened to the lower end of the cofferdam, 500 feet below the dam on the river. The second section is fastened to a sycamore tree, 150 feet below rod. The zero of rod is 477.30 feet above the Mobile datum. The bench mark is a brass point in a stone post 1,000 feet up the river from lower gage, and is 510.55 feet above Mobile datum.

The station at Lock No. 5 is described in the Eighteenth Annual Report, Part IV, page 101, and is located one-half mile above the Birmingham and Atlantic Railroad crossing and about 20 miles below gaging station at Riverside, Alabama. The gage is vertical in two sections, fastened to the trees immediately above the landing of Collins Ferry. The zero of the gage is 460.37 feet above Mobile datum. Bench mark No. 1, which is on the tree to which one section of the rod is fastened, is 471.80 feet above Mobile datum. Bench mark No. 2 is center of iron plate at top of cylindrical pier, at right bank upstream side of the railroad bridge, and is at an elevation of 493.91 feet Mobile datum. Records of river height are kept by the United States Engineer Corps, and are kindly furnished to the Survey. Measurements of discharge are not made at either of these stations.

*Daily gage height, in feet, of Coosa River, at Lock No. 4, Alabama, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.0 | 7.6 | 14.0 | 11.6 | 5.5 | 2.8 | 1.9 | 4.5 | 2.2 | 0.4 | 0.5 | 2.2 |
| 2 | 3.0 | 7.7 | 14.2 | 11.7 | 5.2 | 2.9 | 1.8 | 3.3 | 2.3 | .4 | .5 | 1.9 |
| 3 | 3.3 | 8.8 | 14.2 | 11.1 | 4.8 | 2.9 | 1.6 | 2.5 | 3.2 | .5 | .6 | 1.4 |
| 4 | 3.5 | 8.6 | 13.5 | 10.6 | 4.6 | 2.6 | 1.5 | 2.0 | 2.5 | .5 | .6 | 1.4 |
| 5 | 3.3 | 10.7 | 11.4 | 9.8 | 4.3 | 2.2 | 1.4 | 1.8 | 1.8 | .5 | .6 | 1.4 |
| 6 | 3.3 | 14.2 | 9.5 | 8.6 | 4.2 | 2.2 | 1.3 | 1.7 | 1.4 | .5 | .6 | 1.4 |
| 7 | 3.9 | 15.9 | 9.2 | 9.8 | 4.1 | 2.7 | 1.3 | 1.7 | 1.3 | .5 | .6 | 1.3 |
| 8 | 5.0 | 16.4 | 8.9 | 12.8 | 4.6 | 2.7 | 1.3 | 1.5 | 1.3 | .5 | .5 | 1.1 |
| 9 | 5.4 | 16.4 | 8.3 | 14.0 | 4.4 | 2.0 | 1.6 | 1.4 | 1.2 | .8 | .5 | 1.0 |
| 10 | 6 0 | 16.1 | 7.3 | 13.9 | 4.3 | 1.9 | 1.8 | 1.5 | 1.0 | 1.1 | .5 | 1.0 |
| 11 | 6.4 | 15.8 | 6.5 | 13.2 | 4.0 | 1.9 | 1.7 | 1.5 | .9 | 1.0 | .5 | 1.0 |
| 12 | 6.6 | 15.5 | 6.1 | 11.6 | 4.0 | 1.9 | 1.5 | 1.6 | 1.0 | 1.0 | .5 | 6.7 |
| 13 | 6.0 | 14.9 | 5.8 | 10.0 | 3.8 | 2.0 | 1.5 | 1.5 | 2.5 | 1.3 | .5 | 9.4 |
| 14 | 5.8 | 13.9 | 8.5 | 8.1 | 3.8 | 2.0 | 1.4 | 1.4 | 2.8 | .8 | .5 | 9.8 |
| 15 | 5.5 | 10.6 | 9.4 | 7.1 | 3.3 | 2.7 | 1.3 | 1.3 | 1.8 | .9 | .5 | 7.4 |
| 16 | 5.1 | 7.5 | 19.7 | 6.6 | 3.3 | 3.7 | 1.3 | 1.4 | 1.3 | .2 | .6 | 5.8 |
| 17 | 5.4 | 7.8 | 20.2 | 6.2 | 3.3 | 2.7 | 1.1 | 1.2 | 1.0 | .3 | .6 | 4.3 |
| 18 | 5.8 | 8.6 | 19.1 | 5.9 | 3.0 | 2.2 | 1.1 | 1.5 | .9 | .3 | .5 | 3.4 |
| 19 | 5.7 | 9.6 | 18.5 | 5.7 | 3.0 | 1.9 | 1.1 | 1.9 | .8 | .4 | .4 | 2.8 |
| 20 | 5.4 | 9.6 | 18.8 | 5.4 | 3.0 | 2.0 | 1.1 | 1.7 | .7 | .4 | .4 | 2.4 |
| 21 | 5.0 | 9.1 | 18.8 | 5.2 | 3.0 | 2.0 | 1.5 | 1.4 | .7 | .4 | .8 | 2.6 |
| 22 | 4.6 | 8.8 | 18.7 | 5.1 | 2.8 | 1.8 | 1.6 | 1.2 | .6 | .4 | .6 | 3.0 |
| 23 | 4.3 | 9.7 | 18.4 | 5.5 | 2.8 | 1.7 | 2.2 | 1.0 | .4 | .4 | .7 | 3.0 |
| 24 | 4.3 | 9.3 | 18.0 | 6.8 | 2.7 | 1.7 | 5.6 | .9 | .3 | .4 | .8 | 5.9 |
| 25 | 4.8 | 8.6 | 17.5 | 10.6 | 2.9 | 1.7 | 5.5 | 1.0 | .3 | .2 | .8 | 7.6 |
| 26 | 4.9 | 7.7 | 17.0 | 10.5 | 3.0 | 1.6 | 3.8 | 1.4 | .4 | .6 | 2.2 | 8.3 |
| 27 | 4.9 | 11.2 | 16.7 | 10.5 | 2.7 | 1.6 | 3.4 | 1.0 | .4 | .6 | 3.1 | 7.8 |
| 28 | 4.6 | 12.9 | 15.2 | 9.8 | 2.7 | 1.5 | 3.4 | 1.0 | .4 | .5 | 3.4 | 6.3 |
| 29 | 4.3 | ....... | 12.7 | 8.0 | 2.7 | 1.8 | 4.1 | 1.5 | .5 | .6 | 3.1 | 5.4 |
| 30 | 4.0 | ....... | 9.5 | 6.0 | 2.4 | 1.8 | 6.3 | 2.1 | .4 | .5 | 2.8 | 4.4 |
| 31 | ....... | ....... | 9.5 | ....... | 3.0 | ....... | 5.3 | 2.3 | ....... | .5 | ....... | 3.8 |

*Daily gage height, in feet, of Coosa River at Lock No. 5, Alabama, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.7 | 3.9 | 10.5 | 8.6 | 3.3 | 1.3 | 0.8 | 2.5 | 1.0 | 0.1 | 0.1 | 1.0 |
| 2 | 1.7 | 4.7 | 10.4 | 8.8 | 2.9 | 1.4 | .7 | 1.7 | 1.1 | .1 | .1 | .8 |
| 3 | 1.7 | 5.7 | 10.4 | 8.1 | 2.7 | 1.5 | .6 | 1.2 | 1.1 | .1 | .1 | .6 |
| 4 | 1.7 | 5.6 | 10.0 | 7.6 | 2.5 | 1.4 | .6 | .9 | 1.0 | .1 | .1 | .5 |
| 5 | 1.7 | 7.1 | 8.9 | 7.4 | 2.3 | 1.2 | .6 | .7 | .8 | .1 | .1 | .5 |
| 6 | 1.6 | 10.1 | 6.7 | 6.7 | 2.2 | 1.0 | .5 | .7 | .6 | .1 | .1 | .5 |
| 7 | 1.9 | 12.1 | 6.4 | 7.6 | 2.1 | .9 | .4 | .7 | .5 | .1 | .1 | .4 |
| 8 | 2.8 | 12.5 | 6.0 | 10.0 | 2.0 | .9 | .5 | .6 | .5 | .1 | .1 | .4 |
| 9 | 3.0 | 12.4 | 5.4 | 11.0 | 2.3 | .9 | .5 | .6 | .4 | .1 | .1 | .4 |
| 10 | 3.3 | 12.0 | 4.7 | 10.5 | 2.2 | .8 | .7 | .6 | .4 | .2 | .1 | .4 |
| 11 | 4.1 | 11.6 | 4.0 | 9.7 | 2.0 | .8 | .7 | .5 | .3 | .3 | .1 | .4 |
| 12 | 4.1 | 11.4 | 3.7 | 8.5 | 2.0 | .9 | .6 | .5 | .3 | .3 | .1 | 4.0 |
| 13 | 3.7 | 10.9 | 4.3 | 7.0 | 1.8 | .9 | .6 | .5 | .3 | .4 | .1 | 5.6 |
| 14 | 3.4 | 10.0 | 6.0 | 5.4 | 1.8 | 1.0 | .5 | .5 | 1.3 | .4 | .1 | 6.2 |
| 15 | 3.2 | 7.8 | 6.7 | 4.6 | 1.7 | 1.3 | .5 | .5 | .8 | .3 | .1 | 5.4 |
| 16 | 3.0 | 4.8 | 14.8 | 4.0 | 1.7 | 1.8 | .4 | .8 | .5 | .2 | .1 | 4.6 |
| 17 | 3.0 | 5.0 | 15.4 | 3.9 | 1.6 | 1.6 | .4 | .5 | .3 | .2 | .1 | 2.4 |
| 18 | 3.3 | 5.6 | 14.5 | 3.6 | 1.5 | 1.3 | .4 | .5 | .3 | .1 | .1 | 1.6 |
| 19 | 3.2 | 6.2 | 14.0 | 3.4 | 1.5 | 1.0 | .4 | .8 | .2 | .1 | .1 | 1.3 |
| 20 | 3.0 | 6.4 | 14.1 | 3.2 | 1.5 | .9 | .3 | .6 | .2 | .1 | .1 | 1.2 |
| 21 | 2.8 | 6.0 | 14.0 | 3.1 | 1.5 | .8 | .5 | .6 | .1 | .1 | .1 | 1.2 |
| 22 | 2.5 | 5.8 | 14.0 | 3.0 | 1.4 | .8 | .8 | .4 | .1 | .1 | .1 | 1.3 |
| 23 | 2.3 | 6.4 | 14.0 | 3.0 | 1.3 | .7 | 1.4 | .4 | .1 | .1 | .1 | 1.4 |
| 24 | 2.3 | 6.1 | 13.5 | 4.0 | 1.3 | .7 | 2.9 | .4 | .1 | .1 | .1 | 2.4 |
| 25 | 2.6 | 5.6 | 13.0 | 7.1 | 1.3 | .7 | 3.0 | .4 | .1 | .1 | .1 | 4.6 |
| 26 | 2.7 | 5.0 | 12.7 | 7.2 | 1.3 | .6 | 2.1 | .4 | .1 | .1 | .8 | 5.3 |
| 27 | 2.7 | 9.5 | 12.4 | 7.2 | 1.3 | .6 | 1.7 | .4 | .1 | .1 | 1.5 | 4.9 |
| 28 | 2.5 | 9.6 | 11.0 | 6.6 | 1.1 | .6 | 1.9 | .3 | .1 | .1 | 1.7 | 3.8 |
| 29 | 2.3 | ....... | 9.5 | 5.3 | 1.1 | .7 | 2.6 | .5 | .1 | .1 | 1.4 | 2.8 |
| 30 | 2.1 | ....... | 7.1 | 4.0 | 1.0 | .9 | 3.8 | 1.0 | .1 | .1 | 1.3 | 2.3 |
| 31 | 2.2 | ....... | 6.9 | ....... | 1.3 | ....... | 3.1 | 1.0 | ....... | .1 | ....... | 1.9 |

## COOSA RIVER AT WETUMPKA, ALABAMA.

This station is located at gage No. 1, 3 miles above Wetumpka, Alabama, and was established November 5, 1889, by the United States Engineer Corps, who have maintained daily gage readings since that date until December 31, 1898, when the station was abandoned. The gage heights here are affected by backwater from Tallapoosa River at high stages of the latter stream, so that the record does not show the true flow of Coosa River. Discharge measurements can not be made at the Wetumpka bridge, as it is located directly over a shoal. Discharge measurements will be made next year at Montgomery, 10 miles below Wetumpka, but below the mouth of Tallapoosa River, and at Selma, 45 miles below Montgomery, at both of which points Weather Bureau stations are maintained.

## TALLAPOOSA RIVER AT MILSTEAD, ALABAMA.

Tallapoosa River rises in the west-central part of Georgia and flows in a southwesterly direction into Alabama, where it joins the Coosa, to form Alabama River, 6 miles above Montgomery, Alabama. Its upper tributaries drain an area between the Chattahoochee and Coosa basins. At Tallassee, Alabama, it crosses the southern fall line. The shoals at this place have a fall of 60 feet, forming an obstruction to navigation. The drainage area is largely wooded, with cultivated fields at short intervals. A gaging station was established at Milstead on August 7, 1897, at the bridge of the Tallassee and Montgomery Railway, about one-fourth of a mile from Milstead, Alabama. The bridge is of iron, two spans of about 155 feet each, with short wooden trestles at each end. The initial point of measurement is the end of iron bridge, left bank, downstream side. The rod of wire gage is fastened to outside of guard rail on downstream side of bridge. The gage was last verified April 18, 1899. The bench mark is top of second cross beam from left-bank pier, downstream end, and is 60.00 feet above datum. The channel is straight at the bridge, and bends above and below. The current is sluggish at low water and obstructed by center pier of bridge. The banks are high, but overflow at extreme high water for several hundred feet on each side. The bed is fairly constant, and all water is confined to the main channel by railroad embankments. The observer is Seth Johnson, a farmer and fruit grower, Milstead, Alabama. Records of discharge measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 250; 1898, Twentieth Annual Report, Part IV, page 193.

The following measurements were made by Max Hall during 1899:

April 17, gage height, 6.34 feet; discharge, 7,444 second-feet.
April 18, gage height, 5.63 feet; discharge, 6,853 second-feet.
May 17, gage height, 2.80 feet; discharge, 3,000 second-feet.
June 26, gage height, 2.05 feet; discharge, 1,847 second-feet.
September 9, gage height, 1.36 feet; discharge, 1,016 second-feet.
November 8, gage height, 1.25 feet; discharge, 972 second-feet.
December 18, gage height, 2.66 feet; discharge, 2,844 second-feet.

Two measurements of Big Sandy Creek, a tributary of Tallapoosa River, were made September 11. The first, near the bridge 4 miles from Dadeville, Alabama, showed a discharge of 79 second-feet and the second, at a point a short distance above the bridge, showed a discharge of 74 second-feet.

*Daily gage height, in feet, of Tallapoosa River at Milstead, Alabama, for 1899.*

| Day | Jan. | Feb | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.00 | 17.00 | 27.00 | 18.00 | 4.30 | 2.40 | 2.80 | 3.00 | 2.40 | 0.70 | 1.50 | 2.40 |
| 2 | 4.60 | 11.60 | 19.00 | 12.20 | 4.00 | 2.90 | 2.30 | 2.70 | 2.30 | .70 | 1.40 | 2.50 |
| 3 | 3.90 | 24.50 | 13.50 | 6.50 | 3.90 | 2.40 | 1.90 | 3.10 | 2.10 | .80 | 1.40 | 2.60 |
| 4 | 3.90 | 20.00 | 9.60 | 6.40 | 3.80 | 2.40 | 1.80 | 3.10 | 2.00 | .90 | 1.30 | 2.60 |
| 5 | 3.90 | 12.90 | 14.20 | 8.50 | 3.70 | 2.30 | 1.60 | 2.50 | 1.80 | 1.00 | 1.30 | 2.90 |
| 6 | 3.80 | 11.90 | 13.20 | 9.70 | 3.60 | 2.20 | 1.50 | 2.30 | 1.60 | 1.40 | 1.20 | 2.20 |
| 7 | 7.40 | 17.50 | 10.10 | 10.30 | 3.50 | 2.10 | 1.50 | 2.20 | 1.60 | 1.40 | 1.20 | 2.00 |
| 8 | 8.00 | 27.00 | 8.60 | 13.00 | 3.60 | 2.00 | 2.00 | 2.00 | 1.40 | 1.30 | 1.20 | 1.90 |
| 9 | 7.10 | 19.00 | 7.70 | 13.00 | 3.50 | 1.90 | 2.20 | 1.80 | 1.40 | 1.30 | 1.20 | 1.80 |
| 10 | 6.40 | 13.80 | 7.20 | 11.20 | 3.40 | 1.70 | 2.00 | 1.60 | 1.30 | 1.30 | 1.20 | 1.90 |
| 11 | 18.50 | 10.00 | 6.80 | 8.40 | 3.30 | 1.90 | 1.80 | 1.50 | 1.20 | 1.40 | 1.30 | 2.00 |
| 12 | 16.80 | 8.30 | 6.60 | 7.00 | 3.20 | 2.00 | 1.70 | 1.70 | 1.20 | 1.40 | 1.30 | 15.20 |
| 13 | 13.00 | 7.40 | 6.50 | 6.50 | 3.10 | 2.00 | 1.50 | 1.60 | 1.20 | 1.30 | 1.30 | 13.20 |
| 14 | 11.60 | 7.00 | 6.40 | 6.20 | 3.10 | 2.70 | 1.40 | 1.60 | 1.10 | 1.30 | 1.30 | 8.20 |
| 15 | 9.40 | 6.10 | 7.20 | 6.00 | 3.00 | 2.70 | 1.30 | 1.50 | 1.00 | 1.20 | 1.30 | 5.00 |
| 16 | 7.80 | 10.40 | 12.20 | 7.10 | 2.90 | 2.60 | 1.30 | 4.00 | 1.00 | 1.10 | 1.30 | 3.70 |
| 17 | 12.70 | 11.50 | 11.00 | 6.60 | 2.80 | 2.10 | 1.20 | 3.90 | 1.00 | 1.20 | 1.60 | 3.00 |
| 18 | 10.00 | 10.60 | 10.20 | 5.60 | 2.70 | 1.90 | 1.10 | 2.20 | 1.00 | 1.10 | 1.50 | 2.60 |
| 19 | 8.00 | 9.30 | 14.80 | 5.50 | 2.60 | 1.80 | 1.60 | 1.90 | 1.10 | 1.20 | 1.50 | 2.50 |
| 20 | 6.50 | 8.30 | 13.90 | 5.40 | 2.50 | 1.80 | 1.40 | 1.70 | 1.00 | 1.30 | 1.50 | 2.70 |
| 21 | 5.70 | 8.30 | 10.40 | 5.20 | 2.60 | 1.70 | 8.40 | 1.50 | .90 | 1.40 | 1.40 | 2.70 |
| 22 | 5.30 | 8.40 | 8.30 | 5.00 | 2.70 | 1.50 | 16.75 | 1.60 | 1.00 | 1.50 | 1.40 | 2.70 |
| 23 | 5.10 | 7.60 | 8.10 | 4.90 | 2.60 | 1.50 | 14.00 | 2.00 | 1.00 | 1.60 | 1.60 | 2.60 |
| 24 | 5.20 | 6.90 | 12.70 | 6.00 | 3.30 | 1.50 | 16.95 | 2.60 | .90 | 1.80 | 1.80 | 9.30 |
| 25 | 5.20 | 6.40 | 8.70 | 10.00 | 4.60 | 1.50 | 7.90 | 1.90 | .90 | 1.50 | 2.20 | 9.40 |
| 26 | 5.10 | 6.30 | 7.30 | 7.50 | 3.30 | 2.00 | 6.70 | 1.80 | .90 | 1.40 | 4.60 | 7.20 |
| 27 | 4.80 | 25.00 | 6.90 | 6.60 | 2.80 | 2.50 | 6.80 | 3.70 | .90 | 1.30 | 6.20 | 5.00 |
| 28 | 4.70 | 37.00 | 6.80 | 5.80 | 2.60 | 2.50 | 8.40 | 2.80 | .80 | 1.20 | 4.80 | 4.00 |
| 29 | 5.10 | ------- | 9.00 | 4.90 | 2.50 | 2.20 | 10.10 | 2.10 | .80 | 1.50 | 3.60 | 3.50 |
| 30 | 5.20 | ------- | 8.90 | 4.60 | 2.60 | 2.70 | 5.40 | 1.90 | .80 | 1.50 | 2.80 | 3.10 |
| 31 | 6.50 | ------- | 13.85 | ------- | 2.50 | ------- | 4.40 | 2.30 | ------- | 1.60 | ------- | 2.90 |

## ALABAMA RIVER AT MONTGOMERY, ALABAMA.

This river is formed by the junction of Coosa and Tallapoosa rivers 6 miles above Montgomery. The basin is described at length under the descriptions of its two tributaries. A gage rod was established by the United States Engineer Corps a number of years ago at the Montgomery wharf, near the Union Passenger Station, at foot of Commerce street. The readings are now taken by the Weather Bureau and are furnished to our Survey. The gage rod is in six sections, as follows: Section 1, from 2 to 10 feet on fender pile at face of wharf, 108 feet from lower end; section 2, from 10 to 15 feet at upper end of pile protection to Louisville and Nashville Railroad bank in corner pile, and the 15-foot mark is 1.1 feet above the top of pile; section 3, 15 to 27 feet on bent in center of drain, on the lower side of Commerce-street sewer; section 4, 27 to 36 feet, on upper side of sewer, third bent; section 5, 36 to 46 feet, same side of sewer, sixth bent; section 6, 46 to 50 feet, same side of sewer, seventh bent. The rods are of pine timber, painted and graduated to feet and tenths. There are also two new sections, 15 to 25 feet and 25 to 37 feet, on trees about 50 yards south of the old gage. The bench mark is northeast corner of stone doorsill, north door of Windsor Hotel, on Commerce street, and is 57.68 feet above zero of gage. This latter datum is 103.7 feet above sea level. The high-water mark for Montgomery is 59.7 feet, and was reached in April, 1886. The danger line is placed at 35 feet. The width of the river at low water is 690 feet. No discharge measurements at this station were made during 1899, but will probably be made in the coming year, and in that case the measurements will be made at the iron bridge of the Louisville and Nashville Railroad, about 3 miles above Montgomery. This bridge is 60.6 feet above low water, with three spans over the river, the center one being a draw or turn span.

*Daily gage height, in feet, of Alabama River at Montgomery, Alabama, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.0 | 13.0 | 35.1 | 20.3 | 9.8 | 3.2 | 2.3 | 9.4 | 3.1 | −0.3 | 0.4 | 3.3 |
| 2 | 5.2 | 14.9 | 35.2 | 21.5 | 8.4 | 3.5 | 2.5 | 7.2 | 2.6 | − .4 | .2 | 2.8 |
| 3 | 5.1 | 19.0 | 33.5 | 21.4 | 7.3 | 3.7 | 2.3 | 6.8 | 2.2 | − .4 | .1 | 2.5 |
| 4 | 5.0 | 23.0 | 30.3 | 19.0 | 6.7 | 3.8 | 2.0 | 5.6 | 2.1 | − .3 | .0 | 2.3 |
| 5 | 4.8 | 23.5 | 27.0 | 17.2 | 6.3 | 3.6 | 1.7 | 4.8 | 2.5 | .2 | .0 | 2.0 |
| 6 | 4.8 | 22.1 | 25.6 | 16.8 | 6.0 | 3.2 | 1.5 | 3.8 | 1.9 | .1 | .0 | 1.7 |
| 7 | 5.3 | 24.8 | 18.7 | 16.4 | 5.8 | 3.0 | 1.2 | 3.4 | 1.7 | .2 | − .1 | 1.5 |
| 8 | 7.4 | 28.9 | 16.1 | 20.3 | 5.6 | 2.8 | 1.2 | 3.2 | 1.3 | .3 | − .1 | 1.4 |
| 9 | 8.5 | 31.6 | 14.3 | 22.3 | 5.8 | 2.6 | 1.3 | 2.9 | .5 | .3 | − .1 | 1.3 |
| 10 | 8.9 | 32.0 | 13.2 | 24.2 | 6.3 | 2.5 | 1.5 | 2.5 | .9 | .2 | − .1 | 1.0 |
| 11 | 11.0 | 31.6 | 12.1 | 24.0 | 6.3 | 2.4 | 1.7 | 2.2 | .9 | .2 | − .1 | 7.5 |
| 12 | 17.5 | 29.7 | 10.9 | 22.1 | 5.7 | 2.3 | 1.7 | 2.0 | .8 | .4 | − .1 | 14.6 |
| 13 | 18.0 | 26.8 | 9.8 | 19.4 | 5.1 | 2.4 | 1.5 | 1.7 | .6 | .6 | − .1 | 15.6 |
| 14 | 16.3 | 24.7 | 13.2 | 17.1 | 5.1 | 2.6 | 1.3 | 1.5 | .5 | .4 | − .1 | 15.5 |
| 15 | 13.9 | 20.6 | 16.0 | 14.1 | 5.0 | 2.8 | 1.1 | 1.4 | 1.3 | .5 | − .1 | 14.6 |
| 16 | 12.7 | 19.2 | 18.3 | 12.0 | 4.8 | 3.3 | 1.0 | 1.3 | 1.8 | .4 | − .1 | 11.4 |
| 17 | 12.4 | 17.6 | 24.9 | 10.4 | 4.4 | 3.4 | .9 | 2.3 | 1.0 | .2 | .0 | 7.5 |
| 18 | 13.0 | 16.5 | 29.0 | 9.8 | 4.3 | 3.5 | .9 | 3.5 | .8 | .1 | .1 | 5.9 |
| 19 | 13.1 | 15.9 | 30.8 | 9.3 | 4.0 | 3.1 | .9 | 2.8 | .5 | .1 | .1 | 4.6 |
| 20 | 10.0 | 15.9 | 31.7 | 9.0 | 3.9 | 2.2 | 1.4 | 1.8 | .4 | .2 | .1 | 4.0 |
| 21 | 8.4 | 16.0 | 32.0 | 8.5 | 3.8 | 1.7 | 1.8 | 1.8 | .0 | .4 | .1 | 3.7 |
| 22 | 7.8 | 15.4 | 32.0 | 8.1 | 3.8 | 1.5 | 4.8 | 1.5 | .0 | .5 | .0 | 3.6 |
| 23 | 7.8 | 14.7 | 31.4 | 8.2 | 3.8 | 1.2 | 9.0 | 1.5 | − .1 | .8 | .4 | 3.5 |
| 24 | 8.9 | 13.5 | 30.0 | 9.4 | 4.9 | 1.2 | 13.7 | 1.8 | − .1 | .4 | .5 | 9.6 |
| 25 | 8.9 | 13.5 | 30.0 | 11.0 | 5.2 | 1.2 | 16.0 | 2.0 | − .1 | .4 | .6 | 10.5 |
| 26 | 9.0 | 13.5 | 28.3 | 14.8 | 5.2 | 1.6 | 11.7 | 1.5 | − .1 | .3 | 1.0 | 11.2 |
| 27 | 9.1 | 24.0 | 27.4 | 16.7 | 4.3 | 1.8 | 8.3 | 1.7 | − .2 | .2 | 3.0 | 12.0 |
| 28 | 9.0 | 33.0 | 26.1 | 16.7 | 3.8 | 2.1 | 9.5 | 2.7 | − .2 | .1 | 4.0 | 10.6 |
| 29 | 8.7 | ....... | 24.9 | 15.8 | 3.5 | 2.3 | 10.4 | 2.8 | − .3 | .1 | 3.8 | 8.6 |
| 30 | 8.7 | ....... | 23.9 | 12.2 | 3.1 | 2.1 | 10.4 | 1.9 | − .3 | .4 | 3.3 | 6.9 |
| 31 | 9.0 | ....... | 19.3 | ....... | 3.0 | ....... | 9.2 | 1.9 | ....... | .4 | ....... | 5.5 |
| Mean | 9.5 | 21.2 | 24.2 | 15.6 | 5.2 | 2.5 | 4.3 | 2.9 | 0.9 | 0.2 | 0.6 | 6.7 |

## ALABAMA RIVER AT SELMA, ALABAMA.

This station is located 45 miles by railroad below Montgomery, and was originally established by the United States Engineer Corps. Readings are now taken by the Weather Bureau. The gage rod is a pine plank painted white with black marks, and is in two sections. Section 1, 3 feet to 23 feet, is fastened to the pile on the lower side of the cofferdam on the draw pier. Section 2, 23 feet to 48 feet, is spiked to the bridge. The bench mark is an iron bolt driven in the face of a rock bluff, 182.3 feet from center of north face of pier and above the bridge, and is 26.05 feet above zero of the gage. The high-water mark is 57 feet, and was reached April 8, 1886. The danger line is placed at 35 feet. The rod is attached to the iron highway bridge, the floor of which is about 60 feet above low water. There is a turn-span at one end. The section is good for measurements, with a width of about 300 feet at low water. No measurements of discharge were made here during 1899.

*Daily gage height, in feet, of Alabama River at Selma, Alabama, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.2 | 10.8 | 35.8 | 23.8 | 13.9 | 4.5 | 2.5 | 11.1 | 3.7 | −1.2 | −0.2 | 4.8 |
| 2 | 6.2 | 17.0 | 36.8 | 24.3 | 11.5 | 4.0 | 2.5 | 9.9 | 4.3 | −1.3 | − .3 | 3.7 |
| 3 | 6.5 | 20.2 | 38.8 | 24.9 | 9.9 | 4.0 | 2.6 | 9.0 | 4.6 | −1.3 | − .5 | 3.0 |
| 4 | 6.2 | 24.0 | 37.7 | 24.1 | 9.8 | 4.0 | 2.6 | 6.7 | 4.8 | −1.3 | − .6 | 3.0 |
| 5 | 6.2 | 26.8 | 35.3 | 22.3 | 8.5 | 3.8 | 2.1 | 6.5 | 4.4 | −1.1 | − .7 | 2.8 |
| 6 | 5.8 | 27.2 | 32.6 | 20.9 | 8.1 | 3.9 | 1.6 | 5.8 | 4.4 | −1.0 | − .7 | 2.8 |
| 7 | 6.6 | 27.2 | 30.5 | 20.0 | 7.5 | 3.8 | 1.6 | 5.3 | 4.1 | −1.6 | − .8 | 1.7 |
| 8 | 8.3 | 29.8 | 27.5 | 19.8 | 7.4 | 3.7 | 1.5 | 4.7 | 3.9 | − .5 | − .8 | 1.7 |
| 9 | 9.7 | 32.2 | 23.4 | 23.3 | 7.3 | 3.3 | 1.4 | 4.5 | 3.6 | − .4 | − .8 | 1.3 |
| 10 | 11.6 | 33.9 | 19.7 | 25.6 | 7.3 | 3.1 | 1.3 | 3.7 | .6 | − .4 | − .9 | 1.3 |
| 11 | 13.9 | 34.4 | 16.9 | 26.9 | 7.5 | 2.8 | 1.3 | 3.5 | .4 | − .5 | − .9 | 1.4 |
| 12 | 14.8 | 33.9 | 15.0 | 26.6 | 7.2 | 2.3 | 1.2 | 3.0 | .3 | − .6 | −1.0 | 4.0 |
| 13 | 21.2 | 32.0 | 13.9 | 25.1 | 6.8 | 2.6 | 1.5 | 2.9 | .3 | − .6 | −1.1 | 10.4 |
| 14 | 21.9 | 30.0 | 16.2 | 22.6 | 6.5 | 2.4 | 1.2 | 2.7 | .2 | − .2 | −1.2 | 16.6 |
| 15 | 19.8 | 28.0 | 16.8 | 19.5 | 6.3 | 2.4 | 1.1 | 2.6 | .2 | − .2 | −1.2 | 17.8 |
| 16 | 18.0 | 26.5 | 19.4 | 16.3 | 6.2 | 2.3 | 1.0 | 2.6 | .1 | − .2 | −1.3 | 16.3 |
| 17 | 17.5 | 26.8 | 21.4 | 14.0 | 6.1 | 2.8 | 1.0 | 2.6 | .6 | − .3 | −1.3 | 13.4 |
| 18 | 17.2 | 24.0 | 27.7 | 13.0 | 5.6 | 3.4 | .7 | 3 6 | 1.3 | − .5 | −1.3 | 9.9 |
| 19 | 17.0 | 22.3 | 31.6 | 12.0 | 5.4 | 3.9 | .6 | 4.1 | 1.0 | − .7 | −1.2 | 8.4 |
| 20 | 15.8 | 19.9 | 33.5 | 11.2 | 5.0 | 3.9 | .6 | 4.3 | .9 | − .6 | −1.0 | 3.8 |
| 21 | 14.2 | 19.9 | 34.7 | 10.5 | 4.8 | 3.1 | 1.0 | 3.6 | .6 | − 7 | −1.0 | 3.8 |
| 22 | 12.6 | 19.5 | 34.8 | 10.4 | 4.5 | 2.8 | 1.6 | 3.5 | − .6 | − .8 | − .6 | 3.4 |
| 23 | 10.2 | 18.8 | 34.2 | 10.2 | 4.4 | 1.6 | 5.5 | 3.4 | − .7 | − .2 | − .6 | 3.4 |
| 24 | 10.3 | 17.8 | 33.4 | 10.1 | 4.8 | 1.4 | 10.7 | 3.1 | − .8 | .0 | − .3 | 3.8 |
| 25 | 9.4 | 17.3 | 31.1 | 12.4 | 5.0 | 1.4 | 14.8 | 3.6 | −1.0 | .0 | .1 | 7.6 |
| 26 | 9.0 | 16.4 | 32.6 | 13.5 | 6.0 | 1.6 | 17.0 | 4.2 | −1.0 | − .5 | .2 | 12.2 |
| 27 | 8.9 | 20.3 | 31.8 | 16.3 | 6.1 | 1.7 | 17.0 | 3.9 | −1.0 | − .5 | .9 | 13.5 |
| 28 | 8.6 | 31.2 | 30.5 | 17.9 | 5.2 | 2.0 | 14.9 | 3.6 | −1.0 | − .6 | 3.2 | 13.7 |
| 29 | 8.6 | ...... | 29.3 | 17.7 | 4.5 | 2.2 | 13.1 | 4.3 | −1.1 | − .6 | 4.6 | 12.3 |
| 30 | 9.0 | ...... | 27.8 | 16.1 | 4.3 | 2.4 | 12.8 | 4.6 | −1.1 | − .6 | 4.8 | 11.4 |
| 31 | 9.6 | ...... | 26.3 | ...... | 4.2 | ...... | 11.9 | 3.8 | ...... | − .4 | ...... | 8.3 |
| Mean | 11.6 | 24.6 | 28.3 | 18.4 | 6.7 | 2.9 | 4.8 | 4.5 | 1.2 | − .6 | − .2 | 7.1 |

## CATAWBA RIVER NEAR BIRMINGHAM, ALABAMA.

A measurement of this river, a tributary of Alabama River, was made by Mr. S. Hill Lea, civil engineer, in June, 1897, at a point 7 miles northeast of Birmingham, Alabama. The stage of the river was considered to be that of average low water. The mean velocity of the current was found to be 2.56 feet per second, and the discharge 817 second-feet.

## BLACK WARRIOR RIVER AT TUSCALOOSA, ALABAMA.

The Black Warrior River rises in the south-central part of Alabama and flows in a southwesterly direction into the Tombigbee, on the southern boundary of Greene County. Tombigbee River flows southward from the junction until it reaches Alabama River, with which it unites to form Mobile River. The drainage area is for the most part flat, open country, much of it being under cultivation. Above Tuscaloosa it is largely in a Carboniferous formation, containing pervious strata, porous shales, and limestone caves, through which considerable water is probably lost. A continuous record of gage height at Tuscaloosa since 1889 has been kept by the United States Engineer Corps. During 1895 and 1896 a number of discharge measurements were also made, from which a rating table was obtained, and since that time measurements of flow have been made regularly by the United State Geological Survey, and computations made of the discharge. This station is described in the Eighteenth Annual Report, Part IV, page 103, and is located about three-fourths of a mile from the business center of Tuscaloosa, Alabama. It is reached by passing down Bridge street to the river, thence down the east bank 1,800 feet to the gage, which consists of an inclined timber 2 by 6 inches, supported on posts and graduated by means of notches placed 1 foot apart vertically. There are two bench marks, one on a willow tree, 10 feet west of gage, and 97.84 feet above Mobile datum; the other on a small hackberry, 30 feet south of the upper end of the gage, and 139.36 feet above Mobile datum. The zero of gage is 87.30 feet above same datum. The discharge measurements are made from the highway bridge above the gage. The channel is straight and unobstructed. The current is sluggish at time of low water; the banks high and rocky and not subject to overflow. The observer is R. C. McCalla, jr., United States assistant engineer. Records of measurement may be found as follows: From 1889 to 1896, Eighteenth Annual Report, Part IV, page 108; 1897, Nineteenth Annual Report, Part IV, page 251; 1898, Twentieth Annual Report, Part IV, page 194. The following measurements were made by B. M. Hall and Prof. George S. Wilkins, of the University of Alabama, in 1899:

*Measurements of Black Warrior River at Tuscaloosa, Alabama.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | Feet. | Sec. feet. | 1899. | Feet. | Sec. feet. |
| February 21 | 19.36 | 12,855 | March 4 | 23.70 | 12,609 |
| February 21 | 19.25 | 12,640 | March 14 | 31.18 | 36,653 |
| February 24 | 22.85 | 16,216 | March 14 | 34.37 | 40,331 |
| February 28 | 39.47 | 48,010 | March 17 | 59.50 | 119,533 |
| March 1 | 35.50 | 24,988 | March 18 | 56.40 | 86,410 |
| March 2 | 30.35 | 18,052 | March 23 | 40.30 | 23,911 |

*Daily gage height, in feet, of Black Warrior River at Tuscaloosa, Alabama, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.40 | 26.10 | 37.70 | 30.30 | 7.90 | 2.00 | 0.10 | 6.50 | 1.20 | −1.50 | −1.03 | 4.83 |
| 2 | 4.50 | 29.50 | 32.00 | 29.20 | 7.00 | 1.50 | .80 | 4.90 | .70 | −1.61 | −1.02 | 3.50 |
| 3 | 4.60 | 27.00 | 27.70 | 24.80 | 6.30 | 1.20 | .30 | 3.40 | .62 | −1.80 | −1.03 | 2.77 |
| 4 | 4.70 | 29.00 | 24.10 | 22.00 | 5.80 | 1.00 | −.70 | 2.70 | .23 | −1.79 | − .99 | 2.03 |
| 5 | 4.70 | 45.50 | 21.00 | 23.20 | 5.30 | 1.00 | −.10 | 2.00 | − .02 | −1.51 | −1.00 | 1.50 |
| 6 | 11.20 | 50.60 | 20.80 | 22.60 | 4.80 | .90 | −.30 | 1.90 | − .17 | −1.48 | −1.02 | 1.22 |
| 7 | 42.50 | 51.40 | 19.50 | 23.30 | 4.40 | 1.00 | −.20 | 1.80 | − .38 | −1.46 | −1.03 | .98 |
| 8 | 49.30 | 51.70 | 16.90 | 33.90 | 4.40 | .80 | −.30 | 1.30 | − .40 | −1.34 | −1.03 | .88 |
| 9 | 46.60 | 48.60 | 14.40 | 34.00 | 7.60 | .40 | −.40 | 1.20 | − .46 | −1.30 | −1.03 | .58 |
| 10 | 40.40 | 43.10 | 12.90 | 30.80 | 6.50 | .40 | −.40 | 1.10 | − .68 | − .96 | −1.01 | .60 |
| 11 | 35.70 | 37.80 | 11.90 | 27.00 | 5.10 | .50 | −.40 | 2.00 | − .73 | − .78 | −1.01 | 2.20 |
| 12 | 31.90 | 32.80 | 11.30 | 23.60 | 4.30 | .50 | −.50 | 1.70 | − .79 | − .72 | − .98 | 23.50 |
| 13 | 28.00 | 28.80 | 10.00 | 20.10 | 4.20 | .50 | −.60 | 1.30 | − .71 | − .70 | − .96 | 39.53 |
| 14 | 25.00 | 25.70 | 28.80 | 17.20 | 4.30 | .50 | −.60 | .90 | − .73 | − .88 | − .98 | 35.71 |
| 15 | 22.20 | 22.90 | 44.50 | 14.90 | 4.70 | .50 | −.70 | .60 | − .78 | − .94 | − .99 | 26.50 |
| 16 | 20.00 | 21.60 | 59.30 | 13.00 | 4.30 | .70 | −.70 | .40 | − .83 | −1.03 | −1.00 | 20.63 |
| 17 | 19.60 | 19.90 | 60.30 | 11.60 | 3.70 | .60 | −.70 | .30 | − .86 | −1.07 | − .97 | 15.21 |
| 18 | 20.10 | 20.10 | 57.70 | 10.50 | 3.30 | .40 | −.70 | .30 | − .88 | −1.12 | − .97 | 10.83 |
| 19 | 18 60 | 20.80 | 52.40 | 9.80 | 2.80 | .30 | −.70 | .60 | − .90 | −1.16 | − .95 | 8.02 |
| 20 | 16.10 | 20.60 | 49.30 | 9.60 | 2.70 | .20 | −.70 | .60 | − .92 | −1.12 | − .95 | 8.09 |
| 21 | 14.00 | 19.60 | 46.80 | 9.50 | 3.70 | .10 | −.60 | .70 | − .94 | −1.10 | − .92 | 9.63 |
| 22 | 12.20 | 18.50 | 41.60 | 8.70 | 3.80 | .40 | −.50 | 1.50 | − .99 | − .84 | − .89 | 10.80 |
| 23 | 11.00 | 22.70 | 36.80 | 8.60 | 3.30 | −.10 | −.20 | 2.60 | −1.03 | − .73 | − .33 | 10.63 |
| 24 | 11.00 | 23.10 | 33.00 | 11.30 | 3.10 | −.10 | +.60 | 2.50 | −1.05 | − .71 | + .17 | 22.01 |
| 25 | 20.30 | 20.90 | 29.50 | 13.60 | 2.70 | −.60 | 4.90 | 2.60 | −1.04 | − .88 | .88 | 29.04 |
| 26 | 29.30 | 18.50 | 26.50 | 13.20 | 2.30 | +.20 | 7.60 | 2.30 | −1.05 | − .94 | 2.60 | 25.91 |
| 27 | 26.20 | 23.50 | 24.20 | 12.60 | 2.00 | .20 | 7.40 | 2.10 | −1.04 | −1.02 | 4.50 | 20.98 |
| 28 | 22 50 | 39.00 | 22.30 | 11.40 | 1.75 | .20 | 7.90 | 1.90 | −1.18 | − .60 | 10.48 | 17.09 |
| 29 | 18.60 | ....... | 21.10 | 10.00 | 1.50 | .20 | 9.50 | 1.60 | −1.28 | − .73 | 9.49 | 15.80 |
| 30 | 15.70 | ....... | 19.30 | 8.90 | 1.60 | .10 | 9.30 | 1.50 | −1.38 | − .96 | 6.67 | 14.62 |
| 31 | 14.80 | ....... | 18.10 | ....... | 2.50 | ....... | 8.50 | 1.10 | ....... | −1.03 | ....... | 12.51 |

The United States Weather Bureau has maintained gage readings at Demopolis, Alabama, on Tombigbee River, at the mouth of the Black Warrior River. The distance to Mobile is 185 miles. The gage rod is on the steamboat landing, and is 225 feet in length. From the bottom of the rod to the top of the bluff the gage is constructed of 2 by 12 inch pine boards set edgewise in a trench cut in the bank and securely fastened, the upper edge faced with three-eighths by 2 inch iron graduated to feet and tenths. At the top of the bluff to a point 5 feet above highest water the gage is marked by rows of copper tacks on a 6 by 8 inch post set firmly in the ground. The bench mark is the top of water table on the north side of the city jail at the western end, and is 68.40 feet above zero of gage and 13.71 feet below top of track of Southern Railway at the freight depot. The highest water was 66 feet, on April 18, 1874; the lowest, 3.9 feet, on October 26 to 30, 1875. The danger line is at 35 feet.

## ALLEGHENY RIVER.

Allegheny River, which with the Monongahela forms the Ohio at Pittsburg, rises in northern Pennsylvania, flows northerly into the State of New York, then again turning southerly flows through western Pennsylvania. The headwaters have an elevation of about 2,250 feet and adjoin those of Genesee River on the north and of the Susquehanna on the east. The total length from the source to the mouth at Pittsburg is about 300 miles, 47 miles of which are in New York State. The catchment basin on the upper waters attains the height of from 2,600 to 2,800 feet above sea level. The principal facts concerning this river have been given in a report by Mr. George M. Lehman, assistant engineer, contained in House Document No. 72, Fifty-fifth Congress, third session. The total area of the watershed as measured from the map of the Pennsylvania geological survey, is 11,400 square miles. The principal tributaries making up this total with their area in square miles are as follows: Conewago Creek, including Chautauqua Lake watershed, 935; Tionesta Creek, 458; French Creek, 1,180; Clarion River, 1,175; Redbank Creek, 526; Mahoning Creek, 397; Kiskiminitas River, 1,846, and Allegheny River above mouth of French Creek, about 5,950. The average fall of the river below Oil City is 2.2 feet per mile, but there are several stretches where for several miles the fall reaches nearly 5 feet per mile. Between Oil City and Tarentum, a distance of 112.6 miles, there are 81 ripples, some of them at very low water having only 0.5 foot depth of water; the depths in quiet water are in many places from 10 to 20 feet. The distance between Oil City and Tarentum, the part of the river surveyed and reported upon in 1897 by the United States Engineer Corps, and where the river is quite winding, is 112.6 miles by river channel and 57 miles by air line. The distance by river channel from Pittsburg to Franklin is 126.4 miles and the railroad distance 124 miles. The following table, furnished by Mr. George M. Lehman, was made in connection with the survey of the river by the United States Engineer Corps in 1897. It shows the heights above low water of 1865 and 1898:

*Height of Allegheny River above low water in 1865 and 1898.*

| Distance from Pittsburg. | Place. | Width between banks. | Flood— 1865. | Flood— 1898. |
|---|---|---|---|---|
| *Miles.* | | *Feet.* | *Feet.* | *Feet.* |
| 134.0 | Oil City | 800 | 22.5 | 12.5 |
| 126.4 | Franklin (French Creek) | 1,050 | 23.2 | 12.0 |
| 110.0 | Kennerdell | 900 | 26.5 | 13.5 |
| 91.6 | Emlenton | 500 | 31.3 | 19.0 |
| 85.0 | Parker (Clarion River) | 1,000 | 26.0 | 16.2 |
| 80.5 | Monterey | 700 | 32.0 | 20.5 |
| 70.7 | East Brady | 700 | 33.0 | 23.5 |
| 65.0 | Redbank Junction (Redbank Creek) | 950 | 24.5 | 18.0 |
| 56.2 | Mahoning (Mahoning Creek) | 1,000 | 28.3 | 23.5 |
| 45.6 | Kittanning | 1,000 | 30.3 | 25.0 |
| 38.2 | Logansport | 750 | 28.0 | 28.0 |
| 28.7 | Freeport (Kiskiminitas River) | 850 | 32.0 | 28.5 |
| 21.6 | Tarentum | 1,500 | 28.5 | 24 0 |
| 0 | Pittsburg | 1,000 | 31.4 | 29.0 |

It is said that the highest flood occurred in 1832, when the water rose to a height of 36 feet at Pittsburg. The flood of 1865 is the highest known, at least for any great extent of river and for which it was possible to get fairly reliable information. The depths show that the rainfall was quite general over the watershed, particularly above Oil City. There is a very gradual and slight increase toward Pittsburg. The flood of 1898 was high on the lower Allegheny; the records show heavy rainfall over the watersheds of tributaries south of Clarion River, and the depths indicate this. The width of river has strong influence in depths, as shown in list.

Other high floods than those mentioned above have occurred at Pittsburg, but they have not all come from Allegheny River. The flood of 1884 backed water for several miles up from the mouth of the Monongahela, the depth recorded being 34.5 feet above low water. The flood of 1889 rose to 31.3 feet, but at points above the vicinity of Pittsburg the heights ranged about halfway between those of the 1865 and 1898 floods. The high water of 1865 is locally known as the "oil flood," because of the fact that many hundred barrels of oil awaiting shipment by steamboat from the Oil City district were carried downstream.

Observations of the discharge of the Allegheny at Pittsburg at the time of the 1898 flood were made by Mr. George M. Lehman on the velocity of drift passing between the bridges. The current averaged 7.7 miles per hour, and the estimated discharge was 290,000 second-feet.

### YOUGHIOGHENY RIVER AT FRIENDSVILLE, MARYLAND.

This river rises in Garrett County, Maryland, and flows in a northwesterly direction into Pennsylvania, where it empties into Monongahela River 15 miles above Pittsburg. Its source is on the western slope of the Allegheny Mountains, at an elevation of about 2,900 feet. The average fall of the stream for 19 miles above its mouth is about 2 feet per mile, but above this point it soon increases to an average fall of nearly 5 feet per mile. The bank height above low water ranges between 15 and 28 feet, and the average width between banks from the mouth to West Newton, Pennsylvania, is 546 feet. The following heights at various points in Pennsylvania of the high water of February, 1897, above low-water stage, was furnished by Mr. George M. Lehman: Whikett, 13 feet; Jacobs Creek, 10 feet; Smithton, 14 feet; Port Royal, 17 feet; Snyder, 16 feet; West Newton, 20 feet; Suterville, 22 feet; Buena Vista, 26.5 feet; Coulterville, 28.5 feet; Boston, 29 feet; McKeesport, 28.5 feet.

A measurement of Youghiogheny River was made October 13, 1892, with surface floats, at Ohio Pyle, Pennsylvania, by Mr. Kenneth Allen, in connection with an investigation of a water supply for the works of the H. C. Frick Coke Company. It was during a period of extreme drought, and the discharge was found to be 106 second-feet. The area of its watershed was approximately obtained from maps of uncertain accuracy, but was called 1,775 square miles.

The station at Friendsville, Maryland, was established by E. G. Paul August 17, 1898. Measurements are made from the iron highway bridge connecting the east and west portions of the village. The wire gage is 20 feet from zero to the end of the weight, and referred to a scale board 14 feet long, graduated to feet and tenths. The channel is straight for several hundred feet above and below the bridge. The bed is rocky and the banks high and not subject to overflow. The observer is J. H. Cuppet, a merchant residing within a short distance of the gage. The results of measurements for 1898 may be found in the Twentieth Annual Report, Part IV, page 199. The following measurements were made by E. G. Paul during 1899:

January 24, gage height, 5.40 feet; discharge, 959 second-feet.
January 25, gage height, 6.35 feet; discharge, 2,050 second-feet.
May 17, gage height, 5.97 feet; discharge, 1,697 second-feet.
June 30, gage height, 5.40 feet; discharge, 944 second-feet.

*Daily gage height, in feet, of Youghiogheny River at Friendsville, Maryland, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.20 | 5.00 | 6.50 | 6.50 | 4.60 | 4.90 | 5.20 | 4.50 | 4.00 | 4.10 | 4.10 | 4.30 |
| 2 | 5.20 | 4.90 | 6.40 | 6.30 | 5.00 | 4.90 | 4.80 | 4.30 | 4.10 | 4.10 | 4.60 | 4.30 |
| 3 | 5.20 | 5.00 | 6.30 | 6.00 | 5.20 | 4.80 | 4.60 | 4.20 | 4.00 | 4.10 | 5.00 | 4.30 |
| 4 | 5.40 | 7.40 | 6.30 | 5.80 | 5.30 | 4.80 | 4.40 | 4.20 | 4.00 | 4.10 | 4.80 | 4.30 |
| 5 | 6.50 | 7.00 | 7.70 | 5.30 | 5.30 | 4.80 | 4.60 | 4.60 | 3.90 | 4.00 | 4.50 | 4.30 |
| 6 | 6.30 | 6.20 | 8.20 | 5.20 | 5.20 | 4.60 | 4.50 | 4.80 | 3.90 | 4.00 | 4.50 | 4.50 |
| 7 | 6.10 | 5.90 | 6.60 | 5.10 | 5.20 | 4.50 | 4.50 | 4.50 | 3.90 | 4.00 | 4.40 | 4.60 |
| 8 | 6.00 | 5.60 | 6.20 | 6.90 | 5.10 | 4.50 | 4.50 | 4.30 | 4.10 | 4.00 | 4.30 | 4.60 |
| 9 | 5.80 | 5.40 | 5.90 | 6.50 | 6.90 | 4.40 | 4.40 | 4.20 | 4.00 | 4.00 | 4.30 | 4.80 |
| 10 | 5.60 | 5.30 | 6.30 | 5.90 | 6.50 | 5.20 | 4.40 | 4.20 | 4.40 | 4.00 | 4.40 | 4.90 |
| 11 | 5.30 | 5.20 | 6.10 | 5.70 | 6.30 | 5.90 | 4.30 | 4.30 | 4.40 | 3.90 | 4.30 | 4.90 |
| 12 | 5.20 | 5.10 | 6.00 | 5.50 | 5.90 | 5.80 | 4.20 | 4.20 | 4.30 | 3.90 | 4.20 | 5.40 |
| 13 | 5.10 | 5.10 | 5.90 | 5.30 | 5.60 | 5.60 | 4.20 | 4.20 | 4.30 | 3.90 | 4.20 | 5.80 |
| 14 | 6.10 | Frozen | 5.70 | 5.20 | 5.60 | 5.60 | 4.30 | 4.20 | 4.20 | 3.90 | 4.20 | 5.50 |
| 15 | 8.00 | do | 5.60 | 5.10 | 5.50 | 5.70 | 4.40 | 4.10 | 4.10 | 3.90 | 4.20 | 5.30 |
| 16 | 7.10 | do | 5.60 | 5.10 | 5.60 | 6.50 | 4.60 | 4.10 | 4.10 | 3.90 | 4.10 | 5.10 |
| 17 | 6.80 | do | 5.70 | 5.00 | 5.70 | 6.20 | 4.60 | 4.10 | 4.00 | 3.90 | 4.10 | 5.10 |
| 18 | 6.50 | do | 5.70 | 5.00 | 8.00 | 5.40 | 4.90 | 4.00 | 4.00 | 3.90 | 4.10 | 5.20 |
| 19 | 6.20 | 5.10 | 5.70 | 5.00 | 9.50 | 5.00 | 4.70 | 4.00 | 4.10 | 3.90 | 4.30 | 5.40 |
| 20 | 5.80 | 5.20 | 5.70 | 4.90 | 7.20 | 4.80 | 4.50 | 4.00 | 4.10 | 3.90 | 4.40 | 5.40 |
| 21 | 5.50 | 5.40 | 6.00 | 4.90 | 6.90 | 4.80 | 4.40 | 4.00 | 4.30 | 3.90 | 4.60 | 5.30 |
| 22 | 5.40 | 6.80 | 6.00 | 4.80 | 6.50 | 4.70 | 4.30 | 4.00 | 4.20 | 3.90 | 4.70 | 5.30 |
| 23 | 5.30 | 7.20 | 6.30 | 4.70 | 6.10 | 4.60 | 4.20 | 4.00 | 4.20 | 3.90 | 4.60 | 5.30 |
| 24 | 5.30 | 6.40 | 6.30 | 4.70 | 5.60 | 4.50 | 4.20 | 4.00 | 4.10 | 3.90 | 4.60 | 5.20 |
| 25 | 6.40 | 5.90 | 6.00 | 4.70 | 5.30 | 5.30 | 4.40 | 4.00 | 4.00 | 3.90 | 4.60 | 5.20 |
| 26 | 6.00 | 6.20 | 5.80 | 4.60 | 5.10 | 5.10 | 4.20 | 4.00 | 4.00 | 3.90 | 4.40 | 5.20 |
| 27 | 5.70 | 7.90 | 5.60 | 4.60 | 4.90 | 5.20 | 4.20 | 4.00 | 4.10 | 3.90 | 4.40 | 5.10 |
| 28 | 5.50 | 7.20 | 6.60 | 4.70 | 4.90 | 5.20 | 4.20 | 4.00 | 4.10 | 4.00 | 4.40 | 5.10 |
| 29 | 5.30 | ........ | 8.00 | 4.70 | 4.80 | 5.40 | 4.40 | 4.10 | 4.10 | 4.00 | 4.40 | 5.10 |
| 30 | 5.10 | ........ | 7.30 | 4.60 | 4.90 | 5.60 | 4.30 | 4.10 | 4.10 | 4.00 | 4.30 | 5.10 |
| 31 | 5.10 | ........ | 6.90 | ....... | 4.90 | ....... | 4.30 | 4.00 | ...... | ....... | ....... | 5.10 |

## CHEAT RIVER AT UNEVA, WEST VIRGINIA.

This river rises in the eastern part of West Virginia, and flows almost due north across the Pennsylvania boundary, entering Monongahela River 3 miles north of the State line. The drainage area is partly mapped on the St. George, Piedmont, Franklin, Beverly, Monterey, and Huntersville atlas sheets. As there is no bridge at a place convenient for making measurements, a cable of 600 feet span was stretched across the stream 6 miles northeast of Morgantown, at Uneva, West Virginia, and observations of heights begun on July 8,

1899. The gage is a post bolted to a rock and graduated to feet and tenths. The initial point of soundings is on the right bank. The channel above and below the station is straight. The current is sluggish. The right bank is low and subject to overflow, but the left bank is high and rocky. The bed of the stream is rocky and constant. The observer is A. F. Blosser, a blacksmith at Uneva, West Virginia. On July 8, 1899, a measurement at this station was made by E. G. Paul, at a gage height of 2.60 feet, and gave a discharge of 1,148 second-feet. A measurement was made of this river during a period of extreme drought at Morris crossroads, Pennsylvania, 1 mile below the West Virginia State line, on October 6, 1892, by Mr. Kenneth Allen, and the discharge found to be 249 second-feet.

*Daily gage height, in feet, of Cheat River at Uneva, West Virginia, for 1899.*

| Day. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | 3.00 | 2.20 | 2.00 | 3.70 | 2.90 | 17 | 3.50 | 2.40 | 2.70 | 1.80 | 2.40 | 3.40 |
| 2 | ...... | 2.80 | 2.00 | 2.00 | 4.00 | 2.80 | 18 | 3.40 | 2.30 | 2.30 | 1.80 | 2.40 | 3.20 |
| 3 | ...... | 2.70 | 2.30 | 1.90 | 3.80 | 2.70 | 19 | 3.00 | 2.20 | 2.20 | 1.70 | 2.50 | 3.00 |
| 4 | ...... | 2.50 | 2.20 | 1.90 | 3.50 | 2.70 | 20 | 2.80 | 2.10 | 2.00 | 1.70 | 3.40 | 4.80 |
| 5 | ...... | 3.40 | 2.20 | 1.90 | 3.30 | 2.60 | 21 | 2.40 | 2.00 | 1.90 | 1.60 | 3.40 | 4.40 |
| 6 | ...... | 3.30 | 2.20 | 1.90 | 3.10 | 2.60 | 22 | 2.40 | 2.00 | 1.90 | 1.60 | 3.20 | 4.10 |
| 7 | ...... | 3.00 | 2.10 | 1.80 | 2.10 | 2.50 | 23 | 2.40 | 1.90 | 2.30 | 1.60 | 3.00 | 3.90 |
| 8 | 2.60 | 2.80 | 2.00 | 1.80 | 2.10 | 2.50 | 24 | 2.30 | 1.90 | 2.20 | 1.60 | 3.00 | 5.20 |
| 9 | 3.00 | 2.70 | 2.00 | 1.80 | 2.80 | 2.50 | 25 | 2.50 | 1.80 | 2.20 | 1.60 | 3.90 | 4.40 |
| 10 | 2.80 | 2.60 | 2.20 | 1.70 | 2.70 | 2.50 | 26 | 2.70 | 1.80 | 2.10 | 1.70 | 3.70 | 3.60 |
| 11 | 2.70 | 2.50 | 4.10 | 1.70 | 2.60 | 2.70 | 27 | 2.80 | 1.80 | 2.30 | 1.70 | 3.50 | 3.20 |
| 12 | 2.50 | 2.40 | 3.80 | 1.70 | 2.90 | 5.50 | 28 | 2.60 | 2.50 | 2.40 | 1.70 | 3.30 | 2.90 |
| 13 | 2.40 | 2.30 | 3.50 | 1.70 | 2.70 | 6.40 | 29 | 2.50 | 2.40 | 2.30 | 1.70 | 3.10 | 2.70 |
| 14 | 2.50 | 2.20 | 3.20 | 1.70 | 2.60 | 4.80 | 30 | 3.50 | 2.30 | 2.20 | 1.70 | 3.10 | 2.60 |
| 15 | 2.80 | 2.20 | 3.00 | 1.70 | 2.60 | 4.20 | 31 | 3.60 | 2.30 | ...... | 1.70 | ...... | ...... |
| 16 | 2.80 | 2.30 | 2.80 | 1.70 | 2.50 | 3.80 | | | | | | | |

The United States Weather Bureau have maintained gage readings on Cheat River at Rowelsburg, West Virginia, 36 miles above its junction with the Monongahela. The river at this point is 270 feet wide. The drainage area above the station is reported to be 890 square miles. The gage rod is on the second pier of the Baltimore and Ohio Railroad bridge. The bench mark of the United States Coast and Geodetic Survey, situated on the center pillar, west end of the bridge, is 26.66 feet above zero of the gage. The highest water was 22 feet, on July 10, 1880; lowest, 0.9 foot, on October 15, 1895. The danger line is at 14 feet.

### NEW RIVER AT RADFORD, VIRGINIA.

This river rises in Watauga, Ashe, and Alleghany counties, North Carolina, and flows in a northwesterly direction into West Virginia, where it meets the Gauley, near Kanawha Falls, to form the Great Kanawha. The drainage area is mapped on the Kanawha Falls, Nicholas, Hinton, Beverly, Monterey, Huntersville, Lewisburg, Raleigh, Christiansburg, Dublin, Pocahontas, Abingdon, Wytheville, Hillsville, Yadkinville, Wilkesboro, and Cranberry topographic sheets. The upper tributaries have a general northeasterly and southwesterly direction, draining the narrow valleys of the greater Appalachian

Valley in Virginia. The basin of New River is for the most part mountainous and wooded, forming one of the most beautiful and picturesque sections in the eastern part of the United States. The river itself is rapid and a part of it almost impassable, even for canoes. Systematic measurements of flow of New River are made at Radford, Montgomery County, Virginia, and at Fayette, West Virginia. The station at Radford is located at the highway bridge close to the Norfolk and Western Railway station. It was established by D. C. Humphreys August 1, 1898. The gage used was erected by the United States Weather Bureau. It consists of a vertical board graduated to feet and tenths, and is attached to the iron framework connecting the pair of iron concrete cylinders which form the first pier from the right bank. The bench mark is the bottom of the lowest horizontal brace connecting the two cylinders, the elevation being 3.88 feet above the zero of the gage. The discharge measurements are made from the upstream side of the bridge. The initial point of soundings is on the right bank of the river 40 feet from the first pier. The bottom is of solid rock and gravel and is smooth and regular. On the left bank there is a steep, rocky bluff. The right bank is low and subject to overflow for about 100 yards, but all the water must pass under the bridge, which is about 85 feet above low water. The observer is A. J. Killinger, bridge tender at Radford, Virginia. The following measurements were made by D. C. Humphreys during 1899:

June 29, gage height, 1.12 feet; discharge, 4,980 second-feet.
August 11, gage height, 0.20 foot; discharge, 2,172 second-feet.

*Daily gage height, in feet, of New River at Radford, Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.00 | 0.70 | 3.00 | 2.40 | 1.40 | 1.10 | 0.80 | 0.00 | 1.00 | 0.30 | 0.40 | —0.30 |
| 2 | 1.10 | .70 | 2.60 | 2.00 | 1.30 | 1.00 | .40 | .00 | 1.00 | .20 | 1.00 | — .30 |
| 3 | 1.00 | 1.70 | 2.00 | 1.90 | 1.30 | .90 | .40 | .00 | 1.00 | .00 | .90 | — .20 |
| 4 | 1.20 | 2.00 | 6.05 | 1.60 | 1.40 | .80 | .30 | .00 | 1.10 | .00 | .60 | — .30 |
| 5 | 1.50 | 3.90 | 10.50 | 2.00 | 1.30 | .70 | .30 | .00 | 1.00 | .00 | .30 | — .10 |
| 6 | 1.80 | 5.70 | 7.00 | 1.90 | 1.00 | .60 | .40 | .00 | .10 | .00 | .20 | — .10 |
| 7 | 4.00 | 5.00 | 5.00 | 1.80 | 1.10 | .40 | .50 | .00 | .00 | .00 | .00 | — .10 |
| 8 | 2.60 | 4.20 | 4.00 | 4.10 | 1.20 | .40 | .40 | .00 | .00 | .20 | .00 | — .10 |
| 9 | 1.80 | 3.10 | 2.90 | 3.80 | 1.90 | .30 | .30 | .00 | .00 | .10 | .00 | — .20 |
| 10 | 1.70 | 3.00 | 2.50 | 2.90 | 1.80 | .30 | .20 | .00 | .00 | .00 | .00 | + .10 |
| 11 | 1.60 | 2.40 | 2.20 | 2.90 | 2.00 | .40 | .30 | .00 | .00 | .00 | .00 | .20 |
| 12 | 1.20 | 2.00 | 2.00 | 1.90 | 1.90 | 1.00 | .30 | .00 | .00 | .00 | .00 | 1.75 |
| 13 | 1.50 | 1.90 | 1.90 | 1.80 | 2.00 | 3.90 | .40 | .00 | .00 | .00 | .00 | 4.20 |
| 14 | 1.40 | 1.30 | 1.70 | 1.70 | 2.10 | 2.60 | .20 | 1.00 | .00 | .00 | .00 | 2.90 |
| 15 | 1.50 | .90 | 3.00 | 1.80 | 1.80 | 2.00 | .10 | .50 | .00 | .00 | .00 | 1.00 |
| 16 | 1.60 | 1.20 | 6.10 | 1.60 | 1.70 | 1.70 | .00 | .40 | .00 | .00 | .00 | .90 |
| 17 | 1.70 | 3.50 | 3.70 | 1.50 | 1.30 | 1.10 | .00 | .20 | .00 | .00 | .20 | .80 |
| 18 | 1.20 | 3.20 | 2.90 | 1.40 | 1.10 | .90 | .00 | .20 | .00 | .00 | .00 | .80 |
| 19 | 1.10 | 3.60 | 7.75 | 1.60 | 1.00 | .80 | .00 | .10 | 1.00 | .00 | .00 | .70 |
| 20 | 1.10 | 2.80 | 7.90 | 1.50 | 1.00 | .90 | .00 | .20 | 1.60 | .00 | .00 | .90 |
| 21 | .90 | 3.00 | 4.00 | 1.40 | .90 | .70 | .10 | .30 | 1.00 | .00 | .00 | 1.00 |
| 22 | .80 | 3.00 | 3.80 | 1.30 | .80 | .60 | .10 | .30 | .90 | .00 | .00 | .90 |
| 23 | 1.00 | 2.90 | 3.00 | 1.30 | 1.10 | .50 | .10 | .20 | .80 | .00 | .00 | .60 |
| 24 | 1.00 | 2.00 | 2.80 | 1.10 | 1.50 | .50 | .00 | .00 | .60 | .00 | .00 | .60 |
| 25 | .90 | 1.90 | 2.60 | 1.00 | 1.40 | .60 | .00 | .00 | .50 | .00 | .00 | .50 |
| 26 | 1.00 | 2.00 | 2.50 | 2.00 | 1.10 | .90 | .00 | .00 | .50 | .00 | .00 | .40 |
| 27 | 1.00 | 4.60 | 2.00 | 2.50 | .80 | 1.20 | 1.00 | .00 | .40 | .00 | .00 | .30 |
| 28 | .90 | 4.00 | 3.10 | 2.00 | .80 | 1.00 | .90 | 1.00 | .30 | .00 | .00 | .30 |
| 29 | 1.00 | ....... | 3.00 | 1.80 | .70 | 1.00 | .80 | 1.10 | .40 | .00 | —.20 | .20 |
| 30 | .80 | ....... | 3.20 | 1.60 | .80 | .90 | .50 | 1.00 | .30 | .10 | —.30 | .20 |
| 31 | .80 | ....... | 2.90 | ....... | .90 | ....... | .40 | 1.00 | ....... | .00 | ....... | .20 |

GREENBRIER RIVER AT ALDERSON, WEST VIRGINIA.

This river rises on the western slope of the Allegheny Mountains, in Pocahontas County, West Virginia, and flows in a southwesterly direction, emptying into New River near Hinton, Summers County, West Virginia. The station was established by C. C. Babb and D. C. Humphreys, at Alderson, West Virginia, 21 miles above Hinton, August 1, 1895. The drainage area at this point is 1,344 square miles, and is mapped on Hinton, Beverly, Monterey, Huntersville, and Lewisburg atlas sheets. Greenbrier River receives many short tributaries from the Allegheny Range, and flows for the most part through a hilly, broken, and mountainous country well covered with forests. The station, described in the Eighteenth Annual Report, Part IV, page 111, is located one-half mile above the mouth of Muddy Creek, on the county bridge at Alderson. The wire gage, length 28.37 feet, is in the third panel of the second span, downstream side, and was last verified on August 12, 1899. This gage is referred to three bench marks: The first, on the upper end of the coping of the first pier from the left bank, 21.75 feet above zero of the gage; the second, on upper end of the bridge seat of the left bank abutment, 21.61 feet above the zero of the gage; the third, on stone foundation of water tank of the Chesapeake and Ohio Railway, 23.48 feet above the zero of the gage. A temporary bench mark has been established on lower end of third floor beam, in second span from left bank. Elevation 22.47 feet above the zero of the gage. The bridge consists of four spans 435 feet long. At ordinary stages the water flows in two channels, there being an island 600 feet long and 75 feet wide between them. The banks are high and not subject to overflow. The bed is of rock and gravel and fairly constant. The observer is W. J. Hancock, clerk in a hardware store, Alderson, West Virginia. Records of measurement can be found as follows: 1895–96, Eigtheenth Annual Report, Part IV, page 113; 1897, Nineteenth Annual Report, Part IV, page 254; 1898, Twentieth Annual Report, Part IV, page 204. The following measurements were made by D. C. Humphreys during 1899:

June 22, gage height, 1.94 feet; discharge, 456 second-feet.
August 12, gage height, 1.36 feet; discharge, 104 second-feet.

*Daily gage height, in feet, of Greenbrier River at Alderson, West Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.80 | 2.63 | 5.75 | 4 13 | 2.42 | 2.75 | 1.78 | 1.48 | 1.30 | 1.48 | 1.37 | 1.52 |
| 2 | 2.75 | 2.90 | 4.95 | 3.68 | 2.40 | 3.15 | 1.75 | 1.43 | 1.40 | 1.42 | 1.48 | 1.50 |
| 3 | 3.08 | 2.38 | 6.10 | 3.35 | 2.77 | 3.20 | 1.73 | 1.43 | 1.38 | 1.42 | 1.58 | 1.45 |
| 4 | 2.75 | 2.27 | 12.98 | 3.13 | 2.60 | 2.90 | 1.72 | 1.33 | 1.35 | 1.42 | 1.58 | 1.45 |
| 5 | 3.52 | 4.58 | 15.38 | 2.90 | 2.55 | 2.65 | 1.67 | 1.48 | 1.45 | 1.40 | 1.60 | 1.45 |
| 6 | 5.35 | 6.21 | 10.95 | 2.83 | 2.52 | 2.47 | 1.61 | 1.35 | 1.42 | 1.40 | 1.68 | 1.45 |
| 7 | 8.60 | 5.80 | 6.45 | 2.75 | 2.66 | 2.34 | 1.58 | 1.22 | 1.37 | 1.40 | 1.62 | 1.45 |
| 8 | 6.00 | 4.50 | 4.90 | 3.00 | 5.38 | 2.25 | 1.61 | 1.35 | 1.47 | 1.40 | 1.58 | 1.42 |
| 9 | 4.60 | 3.68 | 4.15 | 4.75 | 7.30 | 2.47 | 1.63 | 1.35 | 1.55 | 1.33 | 1.53 | 1.40 |
| 10 | 3.90 | 3.10 | 3.90 | 4.10 | 6.30 | 2.27 | 1.62 | 1.34 | 1.47 | 1.38 | 1.48 | 1.40 |
| 11 | 3.50 | 2.70 | 3.75 | 3.58 | 4.60 | 2.25 | 1.64 | 1.34 | 1.50 | 1.35 | 1.48 | 1.40 |
| 12 | 3.20 | 2.65 | 3.75 | 3.42 | 4.30 | 2.68 | 1.60 | 1.36 | 1.50 | 1.34 | 1.48 | 1.48 |
| 13 | 3.03 | 2.75 | 3.60 | 3.23 | 4.58 | 3.30 | 1.58 | 1.38 | 1.47 | 1.34 | 1.45 | 2.20 |
| 14 | 2.98 | 2.75 | 3.43 | 3.15 | 4.80 | 2.90 | 1.60 | 1.32 | 1.42 | 1.37 | 1.43 | 2.40 |
| 15 | 3.90 | 2.80 | 3.60 | 3.05 | 4.35 | 2.83 | 1.58 | 2.30 | 1.38 | 1.36 | 1.43 | 2.45 |
| 16 | 3.28 | 2.70 | 4.05 | 2.95 | 3.83 | 2.75 | 1.56 | 2.00 | 1.40 | 1.35 | 1.43 | 2.20 |
| 17 | 3.95 | 2.60 | 4.10 | 2.85 | 3.45 | 2.52 | 1.52 | 1.72 | 1.38 | 1.35 | 1.40 | 2.00 |
| 18 | 3.70 | 2.68 | 3.75 | 2.80 | 3.15 | 2.37 | 1.52 | 1.60 | 1.32 | 1.26 | 1.40 | 1.75 |
| 19 | 3.48 | 2.80 | 5.05 | 2.75 | 3.05 | 2.23 | 1.55 | 1.38 | 1.40 | 1.26 | 1.38 | 1.73 |
| 20 | 3.23 | 3.10 | 6.35 | 2.70 | 2.92 | 2.20 | 1.58 | 1.40 | 1.47 | 1.30 | 1.38 | 1.76 |
| 21 | 3.00 | 4.40 | 4.95 | 2.60 | 2.88 | 2.15 | 1.55 | 1.35 | 1.48 | 1.30 | 1.42 | 1.85 |
| 22 | 2.92 | 6.75 | 4.20 | 2.50 | 2.68 | 2.03 | 1.63 | 1.42 | 1.42 | 1.27 | 1.38 | 1.75 |
| 23 | 2.90 | 6.60 | 3.85 | 2.45 | 2.58 | 1.89 | 1.60 | 1.36 | 1.65 | 1.22 | 1.38 | 1.73 |
| 24 | 2.80 | 5.25 | 3.70 | 2.40 | 2.52 | 2.10 | 1.54 | 1.37 | 1.70 | 1.32 | 1.38 | 1.78 |
| 25 | 2.85 | 4.28 | 3.50 | 2.37 | 2.42 | 1.95 | 1.55 | 1.30 | 1.60 | 1.28 | 1.40 | 1.73 |
| 26 | 3.30 | 3.80 | 3.35 | 2.60 | 2.33 | 1.92 | 1.50 | 1.30 | 1.58 | 1.25 | 1.40 | 2.13 |
| 27 | 3.15 | 8.63 | 3.22 | 2.88 | 2.27 | 1.87 | 1.54 | 1.28 | 1.55 | 1.25 | 1.36 | 2.02 |
| 28 | 3.05 | 7.60 | 3.17 | 2.72 | 2.20 | 1.90 | 1.50 | 1.25 | 1.53 | 1.25 | 1.40 | 1.80 |
| 29 | 2.97 | ....... | 6.38 | 2.57 | 2.17 | 1.92 | 1.58 | 1.37 | 1.50 | 1.25 | 1.53 | 1.80 |
| 30 | 2.70 | ....... | 5.95 | 2.50 | 2.15 | 1.85 | 1.52 | 1.32 | 1.50 | 1.22 | 1.56 | 1.80 |
| 31 | 2.75 | ....... | 4.65 | ...... | 2.30 | ...... | 1.50 | 1.32 | ....... | 1.32 | ....... | 1.95 |

The United States Weather Bureau has maintained gage readings on New River at Hinton, West Virginia. The drainage area above the station is reported to be 6,020 square miles. The railroad track at the depot is 33.5 feet above zero of gage. The highest water was on September 13, 1878, when it reached 23 feet; lowest, 0.5 foot, date unknown. The danger line is at 14.5 feet.

## NEW RIVER AT FAYETTE, WEST VIRGINIA.

This station, established by C. C. Babb and D. C. Humphreys July 29, 1895, is described in the Eighteenth Annual Report, Part IV, page 113, and is located just below the mouth of Wolf Creek, on the highway bridge of one span at Fayette, West Virginia. The drainage area is mapped on the Kanawha Falls, Nicholas, Hinton, Beverly, Monterey, Huntersville, Lewisburg, Raleigh, Christiansburg, Dublin, Pocahontas, Abingdon, Wytheville, Hillsville, Yadkinville, Wilkesboro, and Cranberry atlas sheets. The wire gage is on the guard rail on the upper side of the bridge, about the middle of the span, the scale being graduated to feet and tenths. The gage is referred to four bench marks: First, the top of the bottom plate of the lower plate girder at the end of the first panel from the left bank, downstream side, 55.13 feet above the zero of the gage; second, top of lower end of coping on the main pier, right bank, downstream side, 52.13 feet above the zero of the gage; third, bridge seat on the right bank, downstream side, 54.58 feet above the zero of the gage; fourth, west corner of abutment stone by Chesapeake and Ohio Railway station, 58.62 feet above the zero of the gage. The gage was last verified August 14, 1899. The channel is straight above and below the station, the current is swift and without obstructions, except for immense bowlders in the bottom. The banks are high, rocky, and not subject to overflow. The bed is constant in section. The observer is M. W. Brellahan, agent Chesapeake and Ohio Railway, Fayette, West Virginia. Records of measurement may be found as follows: 1895–96, Eighteenth Annual Report, Part IV, page 115; 1897, Nineteenth Annual Report, Part IV, page 156; 1898, Twentieth Annual Report, Part IV, page 203. The following measurements were made by D. C. Humphreys during 1899: June 22, gage height, 3.65 feet; discharge, 5,097 second-feet; August 14, gage height, 1.80 feet; discharge, 2,985 second-feet.

*Daily gage height, in feet, of New River at Fayette, West Virginia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.45 | 4.45 | 9.00 | 8.40 | 6.80 | 6.30 | 3.80 | 2.40 | 2.70 | 0.95 | 1.80 | 0.80 |
| 2 | 4.30 | 5.00 | 11.51 | 8.35 | 6.25 | 6.35 | 3.00 | 2.30 | 1.55 | .80 | 2.00 | .85 |
| 3 | 4.10 | 6.40 | 19.35 | 6.50 | 6.00 | 6.00 | 3.20 | 2.20 | 1.50 | .80 | 1.95 | .80 |
| 4 | 4.10 | 7.25 | 35.08 | 6.10 | 5.85 | 5.50 | 3.05 | 2.40 | 1.90 | .70 | 1.85 | .70 |
| 5 | 4.00 | 14.20 | 29.78 | 5.50 | 5.70 | 4.95 | 2.40 | 2.25 | 2.20 | .60 | 1.80 | .55 |
| 6 | 5.90 | 20.60 | 24.43 | 5.85 | 5.75 | 4.60 | 2.45 | 2.15 | 2.10 | .65 | 1.75 | .50 |
| 7 | 13.00 | 22.80 | 18.78 | 7.50 | 5.65 | 3.15 | 2.25 | 2.00 | 2.00 | .50 | 1.75 | .50 |
| 8 | 10.10 | 17.10 | 14.00 | 8.10 | 7.55 | 3.25 | 2.20 | 1.85 | 1.40 | .50 | 2.40 | .45 |
| 9 | 6.50 | 14.35 | 13.30 | 7.10 | 12.40 | 3.20 | 2.10 | 1.40 | 1.30 | 2.05 | 1.65 | .35 |
| 10 | 5.20 | 10.05 | 10.10 | 7.05 | 12.10 | 3.05 | 2.05 | 1.45 | 1.35 | 2.40 | 1.40 | .80 |
| 11 | 8.10 | 8.30 | 9.50 | 7.15 | 8.10 | 3.05 | 1.95 | 1.35 | 1.45 | 2.35 | 1.20 | 1.00 |
| 12 | 7.50 | 6.50 | 9.00 | 9.80 | 9.95 | 3.00 | 1.90 | 1.30 | 1.40 | 2.65 | 1.20 | 1.00 |
| 13 | 7.40 | 6.10 | 8.20 | 8.00 | 8.25 | 6.85 | 2.05 | 1.35 | 1.30 | 2.60 | 1.15 | 1.70 |
| 14 | 6.45 | 5.30 | 8.00 | 7.55 | 8.90 | 11.60 | 1.85 | 1.40 | 1.30 | 2.60 | 1.10 | 9.50 |
| 15 | 6.15 | 4.50 | 8.40 | 7.00 | 10.70 | 11.75 | 1.45 | 1.50 | 1.25 | 2.45 | 1.10 | 8.30 |
| 16 | 5.80 | 4.30 | 8.25 | 6.75 | 9.50 | 10.30 | 1.35 | 2.10 | 1.20 | 2.40 | 1.05 | 4.60 |
| 17 | 5.50 | 4.45 | 10.50 | 6.65 | 8.00 | 7.05 | 1.30 | 2.70 | 1.15 | 2.30 | 1.05 | 3.25 |
| 18 | 5.05 | 6.50 | 10.10 | 6.00 | 6.60 | 6.00 | 1.40 | 2.15 | 1.20 | 2.15 | 1.00 | 2.95 |
| 19 | 4.75 | 6.85 | 15.00 | 5.55 | 5.95 | 5.30 | 1.35 | 1.45 | 1.20 | 2.10 | 1.00 | 2.80 |
| 20 | 4.35 | 6.20 | 20.00 | 5.55 | 5.65 | 5.05 | 1.40 | 1.40 | 1.15 | 2.10 | 1.00 | 2.85 |
| 21 | 4.10 | 9.40 | 17.60 | 5.50 | 5.20 | 4.35 | 1.80 | 1.30 | 1.10 | 2.05 | .90 | 3.05 |
| 22 | 4.20 | 11.25 | 11.40 | 5.40 | 5.05 | 4.10 | 1.90 | 1.25 | 1.15 | 2.05 | .90 | 3.10 |
| 23 | 5.55 | 10.10 | 8.30 | 5.40 | 5.00 | 3.50 | 1.75 | 1.25 | 1.10 | 2.00 | .90 | 3.15 |
| 24 | 5.40 | 9.50 | 8.00 | 5.30 | 4.85 | 3.20 | 1.50 | 1.10 | 1.05 | 1.85 | .95 | 3.00 |
| 25 | 4.90 | 8.60 | 7.55 | 5.25 | 4.60 | 3.20 | 1.45 | 1.05 | 1.15 | 1.80 | 1.00 | 3.40 |
| 26 | 4.85 | 8.95 | 6.40 | 5.40 | 4.50 | 3.10 | 1.45 | .95 | 1.30 | 1.70 | 1.10 | 3.80 |
| 27 | 4.85 | 20.05 | 11.10 | 8.50 | 4.10 | 3.05 | 1.40 | .90 | 1.20 | 1.70 | 1.10 | 4.10 |
| 28 | 4.60 | 14.65 | 15.00 | 8.70 | 3.90 | 3.30 | 1.30 | .90 | 1.20 | 1.60 | 1.05 | 4.40 |
| 29 | 4.50 | ....... | 18.70 | 7.75 | 3.85 | 4.15 | 3.80 | .85 | 1.20 | 1.65 | 1.00 | 3.05 |
| 30 | 4.60 | ....... | 14.10 | 7.10 | 3.80 | 4.05 | 3.00 | .80 | 1.20 | 1.70 | .85 | 2.90 |
| 31 | 4.50 | ....... | 9.05 | ....... | 4.30 | ....... | 2.25 | 2.60 | ....... | 1.60 | ....... | 2.85 |

## FRENCH BROAD RIVER AT ASHEVILLE, NORTH CAROLINA.

French Broad River rises in the western part of North Carolina, and flows in a general northwesterly direction into Tennessee. It joins Holston River just above Knoxville to form the Tennessee. The watershed is for the most part mountainous and covered with a heavy growth of timber. There are water powers capable of development at a number of places on the French Broad. The drainage area is mapped on the Asheville, Mount Mitchell, Pisgah, and Saluda atlas sheets. Measurements of flow have been made at Asheville, North Carolina. This station, described in the Eighteenth Annual

Report, Part IV, page 116, was established by Cyrus C. Babb in September, 1895, and is located at the Bingham School iron highway bridge, 3 miles west of Asheville, North Carolina, and is reached by an electric car line from Asheville. The Swannanoa River joins the French Broad 3 miles above the station. The zero of the rod of the wire gage is opposite the east edge of the fifth upright, first span from east, upper side. When the gage height is 3.22 feet, water surface is 17.18 feet below top of the lower end of the second floor beam, first span from the east. The gage was last verified on October 27, 1899. The initial point for soundings is on the right bank at the end of the first span of the bridge. Both banks may overflow in very high water. The current is swift, the channel straight, rocky, and reasonably permanent. The observer is J. M. Taylor, a carpenter at Asheville, North Carolina. Records of measurements may be found as follows: 1895–97, Nineteenth Annual Report, Part IV, page 257; 1898, Twentieth Annual Report, Part IV, page 205.

The following measurements were made by E. W. Myers and R. E. Shuford during 1899:

February 25, gage height, 4.30 feet; discharge, 2,810 second-feet.
June 16, gage height, 3.03 feet; discharge, 2,359 second-feet.
September 30, gage height, 1.94 feet; discharge, 714 second-feet.
October 27, gage height, 1.95 feet; discharge, 815 second-feet.
November 30, gage height, 2.12 feet; discharge, 1,043 second-feet.

*Daily gage height, in feet, of French Broad River at Asheville, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.60 | 3.60 | 6.80 | 5.25 | 4.20 | 2.90 | 2.40 | 2.45 | 3.10 | 1.80 | 2.30 | 2.23 |
| 2 | 4.20 | 3.55 | 6.40 | 5.20 | 4.15 | 2.80 | 2.43 | 2.30 | 3.05 | 1.83 | 2.30 | 2.15 |
| 3 | 3.90 | 4.65 | 5.60 | 5.80 | 4.17 | 2.73 | 2.50 | 2.23 | 3.00 | 1.85 | 2.20 | 2.15 |
| 4 | 3.80 | 8.20 | 4.40 | 5.50 | 4.15 | 2.70 | 2.45 | 2.20 | 2.80 | 1.90 | 2.15 | 2.20 |
| 5 | 3.90 | 8.00 | 4.20 | 5.10 | 4.20 | 2.73 | 2.45 | 2.10 | 2.60 | 1.90 | 2.13 | 2.17 |
| 6 | 3.95 | 7.03 | 4.30 | 5.40 | 4.30 | 2.65 | 2.47 | 2.00 | 2.30 | 2.00 | 2.10 | 2.15 |
| 7 | 4.20 | 7.00 | 4.35 | 5.85 | 4.40 | 2.53 | 2.45 | 2.03 | 2.10 | 2.05 | 2.07 | 2.13 |
| 8 | 4.70 | 6.50 | 4.35 | 5.80 | 4.30 | 2.50 | 2.40 | 2.50 | 3.50 | 2.65 | 2.05 | 2.11 |
| 9 | 4.65 | 5.50 | 4.30 | 5.70 | 4.30 | 2.57 | 2.40 | 2.70 | 2.60 | 2.40 | 2.03 | 2.05 |
| 10 | 4.50 | 5.00 | 4.25 | 5.80 | 4.20 | 2.63 | 2.37 | 3.00 | 2.50 | 2.30 | 2.00 | 2.15 |
| 11 | 4.40 | 4.80 | 4.30 | 5.90 | 4.35 | 2.70 | 2.35 | 3.50 | 2.35 | 2.25 | 2.00 | 3.40 |
| 12 | 4.20 | 4.70 | 4.30 | 6.45 | 4.60 | 2.73 | 2.35 | 2.45 | 2.20 | 2.20 | 2.20 | 6.35 |
| 13 | 4.10 | 4.50 | 5.00 | 6.45 | 4.55 | 2.65 | 2.30 | 2.20 | 2.15 | 2.13 | 1.97 | 6.13 |
| 14 | 4.03 | 4.40 | 8.50 | 5.60 | 4.40 | 2.53 | 2.23 | 2.25 | 2.10 | 2.05 | 1.95 | 5.20 |
| 15 | 4.40 | 4.30 | 11.50 | 4.50 | 4.30 | 2.50 | 2.20 | 2.27 | 2.10 | 2.65 | 1.93 | 3.70 |
| 16 | 4.40 | 5.60 | 9.00 | 4.80 | 4.20 | 2.57 | 2.15 | 2.23 | 2.10 | 2.40 | 1.95 | 2.77 |
| 17 | 4.35 | 5.40 | 7.60 | 4.60 | 4.00 | 2.63 | 2.40 | 2.10 | 2.10 | 2.30 | 2.00 | 2.85 |
| 18 | 4.30 | 5.25 | 5.50 | 4.50 | 3.80 | 2.83 | 2.45 | 2.05 | 2.15 | 2.25 | 2.00 | 2.75 |
| 19 | 4.25 | 5.20 | 11.25 | 4.45 | 3.70 | 2.80 | 2.37 | 2.03 | 2.23 | 2.20 | 2.13 | 2.70 |
| 20 | 4.10 | 5.00 | 10.00 | 4.35 | 3.60 | 2.80 | 2.27 | 2.03 | 2.20 | 2.10 | 2.10 | 2.67 |
| 21 | 3.70 | 4.15 | 7.50 | 4.30 | 4.40 | 2.70 | 2.23 | 2.00 | 2.10 | 2.05 | 2.07 | 2.60 |
| 22 | 3.65 | 4.30 | 6.70 | 4.20 | 4.30 | 2.65 | 2.15 | 2.00 | 1.90 | 2.07 | 2.05 | 2.55 |
| 23 | 3.60 | 4.50 | 6.05 | 4.40 | 4.20 | 2.60 | 2.20 | 1.97 | 1.85 | 2.10 | 2.03 | 3.40 |
| 24 | 3.70 | 4.40 | 5.70 | 4.50 | 4.00 | 2.55 | 2.20 | 1.95 | 1.83 | 2.10 | 2.00 | 3.93 |
| 25 | 4.05 | 4.30 | 5.40 | 4.60 | 3.80 | 2.47 | 2.15 | 1.93 | 1.90 | 2.07 | 2.00 | 3.80 |
| 26 | 4.03 | 4.40 | 5.25 | 4.70 | 3.70 | 2.65 | 3.00 | 2.00 | 2.15 | 2.05 | 2.15 | 3.53 |
| 27 | 4.00 | 8.80 | 5.60 | 4.50 | 3.60 | 2.85 | 3.15 | 2.10 | 2.10 | 2.03 | 2.30 | 2.10 |
| 28 | 3.80 | 7.75 | 5.25 | 4.40 | 2.85 | 2.95 | 3.00 | 2.50 | 2.15 | 2.00 | 2.40 | 2.70 |
| 29 | 3.75 | ...... | 5.33 | 4.30 | 2.80 | 2.80 | 2.80 | 2.60 | 1.85 | 2.05 | 2.37 | 2.65 |
| 30 | 3.70 | ...... | 5.40 | 4.25 | 2.75 | 2.50 | 2.50 | 2.80 | 1.80 | 2.13 | 2.35 | 2.60 |
| 31 | 3.65 | ...... | 5.35 | ...... | 3.00 | ...... | 2.43 | 3.85 | ...... | 2.25 | ...... | 2.57 |

## TUCKASEGEE RIVER AT BRYSON, NORTH CAROLINA.

This river rises in the southwestern part of North Carolina, at the base of Tennessee Ridge, which separates Jackson and Transylvania counties. It flows in a northwesterly direction, emptying into the Little Tennessee River at Bushnell, North Carolina. Measurements of discharge are made at Bryson, 2 miles below the mouth of Newton Mill Creek. The drainage area is 609 square miles, largely of a rough and mountainous nature, covered with forest growth, and is mapped on the Cowee, Pisgah, and Mount Guyot atlas sheets. The old station, described in the Eighteenth Annual Report, Part IV, page 116, was located on the Southern Railway bridge about 3 miles above Bryson, North Carolina, and just below Governor Island post-office, and was abandoned March 25, 1897, because the section was poor. A new station was established by A. P. Davis November 7, 1897, at the highway bridge in the town of Bryson, North Carolina. The gage is bolted to the north pier, lower side, and can be read from the bridge. The initial point of sounding is at the south end of upstream hand rail. The channel is straight, but obstructed by the remnants of two old piers. The current is sluggish, the river bed muddy and fairly constant. The observer is H. H. Welch, a carpenter at Bryson, North Carolina. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 117; 1897, Nineteenth Annual Report, Part IV, page 257; 1898, Twentieth Annual Report, Part IV, page 206. The following measurements were made by E. W. Myers and R. E. Shuford in 1899:

*Measurements of Tuckasegee River at Bryson, North Carolina.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Feb. 26 | 7.00 | 19,160 | Oct. 28 | 1.10 | 404 |
| June 17 | 2.00 | 1,216 | Do | 1.10 | 460 |
| June 19 | 1.80 | 712 | Dec. 5 | 1.20 | 479 |
| Sept. 20 | 1.25 | 376 | Dec. 28 | 1.70 | 1,010 |
| Do | 1.25 | 369 | | | |

*Daily gage height, in feet, of Tuckasegee River at Bryson, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.50 | 2.05 | 3.20 | 3.40 | 2.30 | 1.80 | 1.50 | 1.40 | 1.40 | 1.00 | 1.00 | 1.50 |
| 2 | 2.20 | 1.85 | 3.00 | 3.05 | 2.30 | 1.80 | 1.50 | 1.40 | 1.40 | 1.00 | 1.00 | 1.40 |
| 3 | 2.05 | 3.00 | 2.25 | 3.50 | 2.50 | 2.00 | 1.50 | 1.40 | 1.35 | 1.00 | 1.80 | 1.40 |
| 4 | 2.20 | 9.00 | 3.30 | 3.20 | 2.60 | 1.70 | 1.50 | 1.40 | 1.30 | 1.00 | 1.70 | 1.20 |
| 5 | 2.60 | ....... | 3.50 | 3.10 | 2.60 | 1.70 | 1.50 | 1.40 | 1.30 | 1.00 | 1.20 | 1.20 |
| 6 | 3.00 | 7.50 | 3.40 | 3.10 | 3.00 | 1.70 | 1.80 | 1.30 | 1.30 | 1.00 | 1.15 | 1.20 |
| 7 | 2.60 | 7.00 | 3.25 | 3.10 | 3.00 | 1.70 | 1.80 | 1.30 | 1.20 | 1.00 | 1.05 | 1.20 |
| 8 | 2.55 | 5.30 | 3.00 | 3.00 | 2.90 | 1.70 | 1.70 | 1.30 | 1.20 | 2.00 | 1.05 | 1.20 |
| 9 | 2.50 | 3.50 | 2.95 | 3.60 | 2.85 | 1.70 | 1.60 | 1.30 | 1.20 | 1.50 | 1.00 | 1.50 |
| 10 | 2.80 | 3.00 | 2.80 | 3.20 | 2.60 | 1.80 | 1.60 | 1.40 | 1.20 | 1.40 | 1.00 | 1.30 |
| 11 | 2.30 | 3.20 | 2.80 | 3.00 | 2.60 | 1.80 | 1.50 | 1.40 | 1.20 | 1.40 | 1.00 | 1.50 |
| 12 | (*a*) | 3.00 | 2.65 | 3.00 | 2.35 | 3.50 | 1.40 | 1.40 | 1.20 | 1.30 | 1.00 | 6.50 |
| 13 | (*a*) | 2.80 | 2.60 | 2.90 | 2.30 | 2.80 | 1.30 | 1.40 | 1.20 | 1.25 | 1.00 | 2.90 |
| 14 | 2.60 | 2.80 | 3.40 | 2.90 | 2.20 | 2.20 | 1.30 | 1.40 | 1.20 | 1.10 | 1.00 | 2.00 |
| 15 | 2.30 | 2.70 | 9.60 | 2.85 | 2.20 | 2.10 | 1.30 | 1.30 | 1.20 | 1.00 | 1.00 | 1.65 |
| 16 | 2.20 | 2.70 | 6.50 | 2.80 | 2.25 | 2.00 | 1.30 | 1.30 | 1.20 | 1.00 | 1.00 | 1.50 |
| 17 | 2.20 | 2.70 | 4.80 | 2.60 | 2.20 | 2.00 | 1.50 | 1.30 | 1.15 | 1.00 | 1.00 | 1.30 |
| 18 | 2.20 | 2.60 | 4.90 | 2.60 | 2.25 | 2.00 | 1.30 | 1.30 | 1.15 | 1.00 | 1.00 | 1.30 |
| 19 | 2.10 | 2.50 | 11.00 | 2.55 | 2.25 | 1.80 | 1.30 | 1.30 | 1.10 | 1.00 | 1.00 | 1.90 |
| 20 | 2.10 | 2.50 | 5.80 | 2.50 | 2.20 | 1.70 | 1.30 | 1.20 | 1.25 | 2.00 | 1.05 | 1.50 |
| 21 | 2.05 | 2.50 | 4.60 | 2.50 | 2.10 | 1.70 | 1.40 | 1.20 | 1.05 | 1.15 | 1.50 | 1.50 |
| 22 | 2.00 | 2.45 | 4.80 | 2.45 | 2.00 | 1.60 | 1.40 | 1.20 | 1.00 | 1.10 | 1.50 | 1.50 |
| 23 | 2.00 | 2.40 | 4.30 | 2.40 | 2.00 | 1.60 | 1.50 | 1.20 | 1.00 | 1.10 | 1.30 | 1.50 |
| 24 | 2.20 | 2.35 | 3.70 | 3.00 | 2.00 | 1.60 | 1.50 | 1.20 | 1.00 | 1.10 | 1.20 | 1.90 |
| 25 | 2.05 | 2.30 | 3.60 | 2.90 | 2.00 | 1.50 | 1.50 | 1.20 | 1.00 | 1.10 | 1.20 | 1.90 |
| 26 | 2.00 | 3.40 | 3.60 | 2.80 | 1.90 | 1.80 | 1.50 | 1.20 | 1.00 | 1.10 | 1.20 | 1.90 |
| 27 | 2.00 | 7.00 | 4.00 | 2.80 | 1.90 | 1.70 | 1.50 | 1.20 | 1.00 | 1.05 | 1.20 | 1.80 |
| 28 | 1.95 | 3.50 | 3.60 | 2.60 | 1.90 | 1.60 | 2.00 | 1.30 | 1.00 | 1.05 | 1.50 | 1.70 |
| 29 | 1.90 | ....... | 3.50 | 2.50 | 1.80 | 1.60 | 2.00 | 1.35 | 1.00 | 1.05 | 1.45 | 1.70 |
| 30 | 1.80 | ....... | 3.40 | 2.40 | 1.80 | 1.60 | 1.60 | 1.50 | 1.00 | 1.00 | 1.30 | 1.50 |
| 31 | 2.00 | ....... | 4.00 | ....... | 1.80 | ....... | 1.50 | 1.50 | ....... | 1.00 | ....... | 1.50 |

*a* River frozen.

## LITTLE TENNESSEE RIVER AT JUDSON, NORTH CAROLINA.

This river rises in the mountains between North Carolina and Georgia, and flows in a northwesterly direction, emptying into Tennessee River at Lenoir, Tennessee. Measurements of flow are made at Judson, North Carolina, below the mouth of Sawyer Branch. The area drained is 682 square miles, which is largely mountainous and covered with a forest growth. It is mapped on the Nantahala, Cowee, and Walhalla atlas sheets. The station, as described in the Eighteenth Annual Report, Part IV, page 117, was established by E. W. Myers in June, 1896. It is located on the Southern Railway bridge about one-fourth of a mile from Judson, North Carolina. The river is straight for several hundred yards above and below the station; the bottom rocky and very rough on the west side and sandy on the east side. The current is swift and considerably obstructed by two old piers. The section is constant, but not a good one for measurements. The observer is R. C. Sawyer, a farmer at Judson, North Carolina. Records of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 117; 1897, Nineteenth Annual Report, Part IV, page 256; 1898, Twentieth Annual Report, Part IV, page 207. The following measurements were made by E. W. Myers and R. E. Shuford during 1899:

February 27, gage height, 10.25 feet; discharge, 21,880 second-feet.
June 20, gage height, 3.30 feet; discharge, 1,491 second-feet.
September 21, gage height, 2.23 feet; discharge, 339 second-feet.
September 27, gage height, 2.65 feet; discharge, 721 second-feet.
October 29, gage height, 2.84 feet; discharge, 896 second-feet.
December 6, gage height, 2.75 feet; discharge, 758 second-feet.

*Daily gage height, in feet, of Little Tennessee River at Judson, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.52 | 3.56 | 4.82 | 4.78 | 3.78 | 2.38 | 3.14 | 3.70 | 4.32 | 2.48 | 2.48 | 2.72 |
| 2 | 3.59 | 3.59 | 4.39 | 4.50 | 3.76 | 2.47 | 3.40 | 3.68 | 4.21 | 2.46 | 2.49 | 2.72 |
| 3 | 3.59 | 4.98 | 3.98 | 3.99 | 3.80 | 2.40 | 3.33 | 3.68 | 3.17 | 2.46 | 2.40 | 2.70 |
| 4 | 3.57 | 11.38 | 3.74 | 3.82 | 3.92 | 2.37 | 3.30 | 3.64 | 3.80 | 2.45 | 2.41 | 2.70 |
| 5 | 3.58 | 10.58 | 3.72 | 3.81 | 5.68 | 2.38 | 3.27 | 3.62 | 3.81 | 2.42 | 2.72 | 2.70 |
| 6 | 3.52 | 9.72 | 3.64 | 3.80 | 4.93 | 2.34 | 3.28 | 3.58 | 3.70 | 2.39 | 2.74 | 2.58 |
| 7 | 4.23 | 11.40 | 3.64 | 3.78 | 4.80 | 2.31 | 4.42 | 3.47 | 2.91 | 2.39 | 2.69 | 2.59 |
| 8 | 4.23 | 9.58 | 3.68 | 3.72 | 3.91 | 2.30 | 3.90 | 3.28 | 2.46 | 3.71 | 2.68 | 2.52 |
| 9 | 3.98 | 8.56 | 3.67 | 3.72 | 3.90 | 2.29 | 3.18 | 2.71 | 2.33 | 5.58 | 2.64 | 2.50 |
| 10 | 3.92 | 7.51 | 3.61 | 3.70 | 3.82 | 2.29 | 3.10 | 2.70 | 2.32 | 4.31 | 2.64 | 2.62 |
| 11 | 3.84 | 5.32 | 3.61 | 3.68 | 3.71 | 2.27 | 2.90 | 4.98 | 2.32 | 3.72 | 2.63 | 2.62 |
| 12 | 3.84 | 5.32 | 3.62 | 3.69 | 3.70 | 2.91 | 2.71 | 4.57 | 2.28 | 3.20 | 2.62 | 2.60 |
| 13 | 3.80 | 4.58 | 3.64 | 3.49 | 3.68 | 6.71 | 2.71 | 3.38 | 2.27 | 2.58 | 2.62 | 2.70 |
| 14 | 3.71 | 3.72 | 9.55 | 3.48 | 3.60 | 6.70 | 2.70 | 2.92 | 2.25 | 2.51 | 2.62 | 8.40 |
| 15 | 3.70 | 3.71 | 7.42 | 3.46 | 3.62 | 5.82 | 2.68 | 2.88 | 2.25 | 2.50 | 2.64 | 6.50 |
| 16 | 3.69 | 3.70 | 8.93 | 3.48 | 3.80 | 5.40 | 2.69 | 2.88 | 2.24 | 2.50 | 2.63 | 4.51 |
| 17 | 3.68 | 3.68 | 6.81 | 3.52 | 3.82 | 3.58 | 3.48 | 2.64 | 2.22 | 2.48 | 2.58 | 3.92 |
| 18 | 3.69 | 3.68 | 4.58 | 3.52 | 3.71 | 3.41 | 3.30 | 2.63 | 2.25 | 2.49 | 2.59 | 2.94 |
| 19 | 3.69 | 3.72 | 13.00 | 3.51 | 3.74 | 3.40 | 3.10 | 2.60 | 2.28 | 2.52 | 2.57 | 2.94 |
| 20 | 3.69 | 3.74 | 12.00 | 3.48 | 3.78 | 2.56 | 2.93 | 2.60 | 2.28 | 2.52 | 2.57 | 2.90 |
| 21 | 3.66 | 3.74 | 8.55 | 3.49 | 3.52 | 2.58 | 2.84 | 2.48 | 2.23 | 2.57 | 2.49 | 2.53 |
| 22 | 3.68 | 3.70 | 6.54 | 3.61 | 2.90 | 2.47 | 3.91 | 2.42 | 2.20 | 2.60 | 2.54 | 2.52 |
| 23 | 3.67 | 3.69 | 4.88 | 3.60 | 2.80 | 2.75 | 4.28 | 2.41 | 2.21 | 2.60 | 2.70 | 2.41 |
| 24 | 3.67 | 3.68 | 4.32 | 3.72 | 2.50 | 2.70 | 4.20 | 2.41 | 2.21 | 2.50 | 2.71 | 2.40 |
| 25 | 3.69 | 3.60 | 4.28 | 3.72 | 2.47 | 3.15 | 3.90 | 2.40 | 2.26 | 2.50 | 2.77 | 2.42 |
| 26 | 3.58 | 3.65 | 3.92 | 3.70 | 2.46 | 3.10 | 3.90 | 2.39 | 2.65 | 2.50 | 2.89 | 2.42 |
| 27 | 3.52 | 10.25 | 4.78 | 3.78 | 2.30 | 3.00 | 3.91 | 2.38 | 2.50 | 2.50 | 3.42 | 2.43 |
| 28 | 3.59 | 6.72 | 4.74 | 3.74 | 2.31 | 3.31 | 3.88 | 2.37 | 2.41 | 2.60 | 3.50 | 2.41 |
| 29 | 3.58 | ....... | 5.70 | 3.79 | 2.36 | 3.30 | 3.86 | 2.37 | 2.41 | 2.58 | 2.93 | 2.42 |
| 30 | 3.59 | ....... | 5.90 | 3.70 | 3.36 | 3.00 | 3.86 | 2.24 | 2.40 | 2.57 | 2.90 | 2.42 |
| 31 | 3.57 | ....... | 5.60 | ....... | 2.34 | ....... | 3.71 | 2.26 | ....... | 2.57 | ....... | 2.39 |

## HIWASSEE RIVER AT MURPHY, NORTH CAROLINA.

Hiwassee River rises in the northern part of Georgia and flows through the southwestern corner of North Carolina into Tennessee, where it empties into Tennessee River. The watershed is broken and mountainous for the most part and well covered with forest. The area drained is 410 square miles, and is mapped on the Murphy, Nantahala, and Dahlonega atlas sheets. The river is measured at two places, Murphy, North Carolina, and Charleston, Tennessee, 17 miles above its mouth. The station at Murphy, described in the Eighteenth Annual Report, Part IV, page 117, is located on the highway bridge crossing the river at Murphy, North Carolina, one-half mile above Valley River, and was established by E. W. Myers July 26, 1896. The wire gage was last verified on December 29, 1899. The length of the gage is 29.10 feet. The section here is a fairly good one, though somewhat obstructed by the remains of two old piers directly under the present bridge. The course of the stream is straight for several hundred yards above and below the bridge, and the current fairly rapid. The bottom is hard and rocky and not subject to any decided change by high water. The observer is M. L. Brittain, Murphy, North Carolina. The results of measurements may be found as follows: 1896–97, Nineteenth Annual Report, Part IV, page 269; 1898, Twentieth Annual Report, Part IV, page 209. The following measurements were made by E. W. Myers and R. E. Shuford in 1899:

February 28, gage height, 7.50 feet; discharge, 2,150 second-feet.
June 23, gage height, 5.17 feet; discharge, 400 second-feet.
June 23, gage height, 5.30 feet; discharge, 436 second-feet.
September 28, gage height, 4.93 feet; discharge, 304 second-feet.
September 28, gage height, 5.00 feet; discharge, 345 second-feet.
December 7, gage height, 5.10 feet; discharge, 317 second-feet.
December 29, gage height, 5.50 feet; discharge, 613 second-feet.

*Daily gage height, in feet, of Hiwassee River at Murphy, North Carolina, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.80 | 5.60 | 6.90 | 6.80 | 5.85 | 5.30 | ------- | 5.30 | 5.40 | 4.90 | 4.85 | 5.10 |
| 2 | 5.70 | 5.70 | 6.60 | 6.60 | 5.82 | 5.30 | ------- | 5.20 | 5.25 | 4.80 | 4.90 | 5.35 |
| 3 | 5.70 | 5.70 | 6.70 | 6.50 | 5.80 | 5.30 | ------- | 5.20 | 5.50 | 4.85 | 4.90 | 5.10 |
| 4 | 5.65 | 14.00 | 6.32 | 7.20 | 5.80 | 5.25 | ------- | 5.15 | 5.30 | 4.75 | 4.90 | 5.10 |
| 5 | 5.60 | 9.60 | 7.40 | 6.55 | 6.10 | 5.25 | ------- | 5.12 | 5.20 | 4.80 | 4.90 | 5.10 |
| 6 | 5.70 | 9.45 | 6.75 | 6.50 | 5.80 | 5.25 | ------- | 5.20 | 5.10 | 4.90 | 4.90 | 5.02 |
| 7 | 6.30 | 9.90 | 6.50 | 6.55 | 5.85 | 5.10 | ------- | 5.20 | 5.10 | 4.90 | 4.90 | 5.00 |
| 8 | 6.00 | 7.85 | 6.40 | 6.70 | 5.70 | 5.10 | ------- | 5.20 | 5.15 | 5.70 | 4.90 | 5.10 |
| 9 | 5.90 | 7.20 | 6.40 | 6.60 | 5.70 | 5.20 | 5.20 | 5.12 | 5.05 | 5.15 | 4.90 | 5.05 |
| 10 | 5.80 | 6.75 | 6.30 | 6.50 | 5.70 | 5.15 | 5.10 | 5.15 | 5.00 | 5.00 | 4.90 | 5.10 |
| 11 | 5.80 | 6.60 | 6.20 | 6.40 | 5.62 | 5.10 | 5.10 | 5.15 | 5.20 | 5.02 | 4.90 | 5.10 |
| 12 | 5.80 | 6.55 | 6.10 | 6.30 | 5.62 | 5.82 | 5.05 | 5.10 | 5.10 | 5.00 | 4.85 | 9.10 |
| 13 | 5.70 | 6.30 | 6.10 | 6.20 | 5.60 | 5.80 | 5.00 | 5.10 | 5.00 | 4.90 | 4.85 | 6.30 |
| 14 | 5.70 | 6.40 | 6.75 | 6.20 | 5.55 | 5.50 | 5.00 | 5.05 | 5.00 | 4.80 | 4.90 | 5.82 |
| 15 | 5.75 | 6.40 | 10.80 | 6.10 | 5.60 | 5.35 | 5.00 | 5.20 | 5.00 | 5.00 | 4.90 | 5.70 |
| 16 | 5.75 | 6.30 | 8.75 | 6.10 | 5.50 | 5.25 | 5.00 | 5.32 | 4.90 | 5.00 | 4.90 | 5.50 |
| 17 | 5.75 | 6.25 | 7.50 | 6.05 | 5.50 | 5.30 | 5.10 | 5.20 | 5.00 | 5.00 | 4.90 | 5.40 |
| 18 | 5.70 | 6.25 | 7.10 | 6.00 | 5.50 | 5.20 | 5.30 | 5.10 | 5.00 | 4.95 | 4.90 | 5.40 |
| 19 | 5.70 | 6.00 | 18.40 | 6.00 | 5.60 | 5.20 | 5.20 | 5.00 | 5.00 | 5.10 | 4.85 | 5.30 |
| 20 | 5.70 | 6.10 | 8.70 | 6.00 | 5.50 | 5.15 | 5.10 | 5.00 | 5.10 | 5.00 | 4.85 | 5.50 |
| 21 | 5.70 | 6.10 | 7.60 | 6.00 | 5.45 | 5.10 | 5.30 | 5.00 | 5.00 | 5.00 | 4.90 | 5.40 |
| 22 | 5.60 | 6.10 | 7.20 | 5.90 | 5.40 | 5.10 | 5.30 | 5.00 | 5.00 | 4.90 | 4.90 | 5.35 |
| 23 | 5.60 | 6.00 | 8.15 | 5.90 | 5 40 | 5.10 | 5.30 | 5.00 | 5.00 | 4.90 | 5.40 | 5.30 |
| 24 | 5.52 | 5.92 | 7.00 | 5.90 | 5.42 | 4.85 | 5.20 | 5.00 | 5.00 | 4.90 | 5.12 | 6.30 |
| 25 | 5.65 | 6.10 | 6.80 | 6.70 | 5.40 | 4.95 | 5.20 | 5.10 | 5.00 | 4.90 | 5.10 | 5.70 |
| 26 | 5.60 | 6.00 | 6.60 | 6.10 | 5.40 | 5.05 | 6.80 | 5.05 | 5.00 | 4.90 | 5.75 | 5.60 |
| 27 | 5.60 | 9.10 | 6.52 | 6.00 | 5.35 | 5.00 | 5.75 | 5.25 | 5.02 | 4.90 | 5.40 | 5.50 |
| 28 | 5.60 | 7.30 | 6.50 | 6.00 | 5.35 | 5.00 | 5.90 | 5.45 | 5.00 | 5.00 | 5.30 | 5.55 |
| 29 | 5.50 | ------- | 6.90 | 5.90 | 5.32 | 5.00 | ------- | 5.10 | 5.00 | 5.10 | 5.20 | 5.50 |
| 30 | 5.50 | ------- | 6.70 | 5.90 | 5.32 | 5.00 | ------- | 5.10 | 4.88 | 4.90 | 5.10 | 5.35 |
| 31 | 5.90 | ------- | 7.80 | ------- | 5.30 | ------- | ------- | 5.70 | ------- | 5.00 | ------- | 5.40 |

No readings July 1 to 9; gage broken.

## HIWASSEE RIVER AT CHARLESTON, TENNESSEE.

The gaging station on this river is located at the bridge of the Southern Railway 600 feet from the depot in the town of Charleston, Tennessee. It is 17 miles above the mouth of the river and 53 miles above Chattanooga, Tennessee. The drainage area is mapped on the Cleveland, Murphy, Ellijay, Nantahala, Dahlonega, Dalton, Loudon, and Kingston atlas sheets. This station was originally established by the United States Engineer Corps, but is now maintained as a half-year station by the United States Weather Bureau, gage heights being kept from November 1 to April 31, inclusive. The gage rod is fastened to the downstream end of the south pier of the bridge, 125 feet from the shore. It is painted white and marked in feet and tenths. The bench mark is a cross cut in the top surface of the upper corner stone of the pier, and is 35.00 feet above the zero of the gage. The greatest height recorded at this point was on March 31, 1886, when the gage read 32.2 feet. The danger line is placed at 22 feet. The railroad bridge is an iron 3-span bridge, with a total length of 390 feet. There are embankments at each end which confine the water, even at the highest stages, within the banks. The observer is J. M. Bates, Charleston, Tennessee. The following measurements were made by Max Hall in 1899:

May 6, gage height, 3.65 feet; discharge, 6,684 second-feet.
May 25, gage height, 2.05 feet; discharge, 3,730 second-feet.
September 16, gage height, 0.35 foot; discharge, 1,366 second-feet.
October 27, gage height, 0.20 foot; discharge, 1,194 second-feet.

*Daily gage height, in feet, of Hiwassee River at Charleston, Tennessee, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | Nov. | Dec. |
|---|---|---|---|---|---|---|
| 1 | 2.60 | 4.30 | 7.20 | 9.40 | 0.50 | 1.00 |
| 2 | 2.80 | 3.40 | 5.90 | 7.20 | .40 | .80 |
| 3 | 2.40 | 3.10 | 5.30 | 6.10 | .40 | 1.20 |
| 4 | 2.30 | 16.00 | 5.30 | 6.40 | .40 | 1.00 |
| 5 | 2.30 | 21.60 | 7.30 | 7.90 | .40 | .80 |
| 6 | 4.00 | 18.60 | 8.90 | 6.50 | .30 | .70 |
| 7 | 8.30 | 22.40 | 8.10 | 6.30 | .30 | .70 |
| 8 | 6.70 | 20.90 | 7.50 | 11.00 | .30 | .60 |
| 9 | 4.90 | 16.50 | 5.60 | 7.80 | .30 | .60 |
| 10 | 3.90 | 13.50 | 4.50 | 7.10 | .30 | .60 |
| 11 | 3.40 | 8.90 | 4.30 | 6.00 | .30 | .60 |
| 12 | 3.50 | 5.90 | 4.00 | 5.60 | .30 | 3.00 |
| 13 | 3.10 | 5.00 | 3.90 | 5.30 | .30 | 7.00 |
| 14 | 2.90 | 3.70 | 5.70 | 5.00 | .30 | 2.90 |
| 15 | 3.00 | 4.30 | 24.20 | 4.80 | .30 | 2.10 |
| 16 | 2.90 | 4.80 | 27.30 | 4.60 | .50 | 1.80 |
| 17 | 3.20 | 6.90 | 20.00 | 4.40 | .50 | 1.40 |
| 18 | 3.30 | 5.60 | 14.40 | 4.10 | .40 | 1.30 |
| 19 | 3.00 | 5.90 | 24.00 | 4.00 | .40 | 1.30 |
| 20 | 2.80 | 5.30 | 27.60 | 4.00 | .30 | 1.80 |
| 21 | 2.60 | 4.70 | 19.90 | 3.90 | .30 | 2.00 |
| 22 | 2.50 | 4.60 | 16.60 | 3.70 | .30 | 1.50 |
| 23 | 2.40 | 4.60 | 16.00 | 3.50 | .70 | 1.40 |
| 24 | 2.40 | 4.20 | 13.00 | 4.50 | 1.70 | 3.20 |
| 25 | 2.70 | 3.90 | 8.70 | 4.60 | 1.00 | 3.70 |
| 26 | 2.70 | 3.70 | 7.60 | 6.00 | .90 | 2.50 |
| 27 | 2.40 | 7.50 | 7.00 | 4.50 | 1.70 | 2.00 |
| 28 | 2.30 | 11.50 | 7.50 | 4.00 | 1.50 | 1.90 |
| 29 | 2.20 | | 10.60 | 3.70 | 1.20 | 2.00 |
| 30 | 2.20 | | 8.60 | 3.60 | 1.00 | 1.70 |
| 31 | 2.40 | | 8.00 | | | 1.10 |

No readings May 1 to October 31.

A measurement of Hiwassee River at Reliance, Tennessee, was made by Max Hall, October 25, 1899: Gage height, 2.60 feet; discharge, 607 second-feet.

## TOCCOA RIVER AT BLUERIDGE, GEORGIA.

This stream has its source on the northern slopes of the Blue Ridge Mountains, in Georgia, and flows northwesterly into Hiwassee River. The area is covered with a fine growth of oak, hickory, and other hard woods, and is mapped on the Ellijay and Dahlonega atlas sheets. The station, established by B. M. Hall on November 25, 1898, is located at the Morganton bridge, about 4 miles east of the town of Blueridge, Georgia. The gage is a 14-foot rod, in two 7-foot sections, nailed to a tree on the right bank just below the bridge. It is graduated to feet and tenths, and is set to conform to bench marks which were established October 15, 1896, and October 26, 1898. The measurements during 1896 were made at the railroad bridge about 3 miles below, but are referred to the present gage by comparison of the bench marks at the two bridges. The bench mark at Morganton bridge is on the top of the bridge floor, on the downstream side, 50 feet from the initial point, and is 18.00 feet above zero of gage. This bridge is a wooden, queen-post, open bridge, in three spans, with a total length between abutments of 153 feet. The width of the river, including the two piers, at ordinary stages is 143 feet between banks, the three channels being 50, 38, and 33 feet. The observer is M. V. Pressley, a mail carrier who crosses the bridge twice daily, except on Sundays; no readings are had on this day, but figures have been interpolated. The following measurements were made by B. M. Hall and Max Hall during 1899:

April 28, gage height, 3.50 feet; discharge, 1,141 second-feet.
June 16, gage height, 2.70 feet; discharge, 522 second-feet.
September 18, gage height, 1.93 feet; discharge, 242 second-feet.
October 24, gage height, 1.90 feet; discharge, 222 second-feet.

*Daily gage height, in feet, of Toccoa River at Blueridge, Georgia, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.10 | 3.20 | 4.30 | 4.20 | 3.70 | 3.00 | 2.50 | 2.60 | 2.80 | 2.00 | 2.10 | 2.40 |
| 2 | 3.00 | 3.20 | 4.00 | 3.60 | 3.50 | 2.10 | 2.45 | 2.60 | 2.40 | 2.00 | 2.00 | 2.20 |
| 3 | 2.90 | 3.30 | 4.10 | 3.11 | 3.50 | 2.10 | 2.40 | 2.50 | 2.40 | 1.90 | 2.00 | 2.10 |
| 4 | 2.90 | 5.90 | 4.10 | 4.60 | 3.40 | 2.20 | 2.40 | 2.50 | 2.50 | 1.90 | 2.00 | 2.10 |
| 5 | 2.10 | 6.70 | 4.00 | 4.40 | 3.10 | 3.00 | 2.50 | 2.50 | 2.40 | 1.90 | 2.00 | 2.10 |
| 6 | 3.02 | 8.90 | 4.00 | 3.90 | 3.60 | 2.90 | 2.80 | 2.50 | 2.40 | 2.00 | 2.00 | 2.00 |
| 7 | 3.04 | 6.10 | 3.80 | 4.50 | 3.40 | 2.90 | 2.70 | 2.50 | 2.30 | 3.00 | 2.00 | 2.00 |
| 8 | 3.08 | 5.50 | 3.70 | 4.80 | 3.20 | 2.90 | 2.80 | 2.40 | 2.30 | 2.80 | 2.10 | 2.00 |
| 9 | 3.10 | 5.00 | 3.60 | 4.00 | 3.20 | 2.70 | 2.75 | 2.30 | 2.30 | 2.60 | 2.10 | 2.00 |
| 10 | 3.10 | 4.00 | 3.10 | 4.00 | 3.10 | 2.70 | 2.75 | 2.30 | 2.50 | 2.30 | 2.10 | 2.50 |
| 11 | 3.20 | 3.70 | 3.00 | 3.10 | 3.00 | 2.70 | 2.70 | 2.30 | 2.60 | 2.10 | 2.10 | 3.60 |
| 12 | 3.00 | 3.80 | 3.50 | 3.90 | 3.00 | 3.40 | 2.70 | 2.60 | 2.50 | 2.00 | 2.10 | 3.50 |
| 13 | 3.00 | 3.90 | 4.00 | 3.80 | 3.00 | 3.20 | 2.80 | 3.40 | 2.30 | 2.00 | 2.00 | 3.30 |
| 14 | 3.10 | 4.00 | 4.00 | 3.70 | 3.00 | 3.00 | 2.70 | 3.40 | 2.30 | 2.00 | 2.00 | 2.90 |
| 15 | 3.10 | 4.00 | 4.90 | 3.70 | 3.00 | 2.10 | 2.60 | 3.40 | 2.20 | 2.00 | 2.10 | 2.80 |
| 16 | 3.10 | 4.10 | 6.00 | 3.60 | 3.00 | 2.70 | 2.40 | 3.20 | 2.20 | 2.00 | 2.10 | 2.50 |
| 17 | 3.20 | 3.10 | 4.40 | 3.60 | 3.00 | 2.60 | 2.40 | 2.40 | 2.10 | 2.00 | 2.00 | 2.40 |
| 18 | 3.10 | 3.30 | 4.00 | 3.60 | 3.00 | 2.60 | 2.80 | 2.40 | 2.30 | 2.00 | 2.00 | 2.30 |
| 19 | 3.00 | 3.40 | 4.50 | 3.60 | 3.30 | 2.60 | 2.70 | 2.40 | 2.30 | 2.00 | 2.00 | 2.60 |
| 20 | 3.00 | 3.60 | 5.00 | 3.60 | 3.00 | 2.60 | 2.70 | 2.20 | 2.00 | 2.00 | 2.00 | 2.60 |
| 21 | 2.10 | 3.50 | 4.80 | 3.60 | 3.20 | 2.50 | 2.80 | 2.20 | 2.00 | 2.00 | 2.00 | 2.50 |
| 22 | 3.00 | 3.60 | 4.60 | 3.60 | 3.20 | 2.45 | 2.80 | 2.20 | 2.00 | 2.00 | 2.00 | 2.40 |
| 23 | 3.80 | 3.50 | 5.60 | 3.80 | 3.10 | 2.60 | 2.60 | 2.30 | 2.00 | 2.00 | 2.00 | 2.50 |
| 24 | 3.10 | 3.40 | 5.00 | 4.00 | 3.10 | 2.10 | 2.50 | 2.20 | 2.00 | 2.00 | 2.00 | ....... |
| 25 | 3.20 | 3.40 | 4.50 | 5.30 | 3.10 | 2.40 | 2.80 | 2.30 | 2.00 | 2.00 | 2.00 | ....... |
| 26 | 3.10 | 4.00 | 4.20 | 4.10 | 3.10 | 2.70 | 2.80 | 2.20 | 2.00 | 2.00 | 2.30 | ....... |
| 27 | 2.10 | 5.80 | 4.00 | 4.60 | 3.10 | 2.90 | 3.90 | 2.40 | 2.00 | 2.00 | 2.60 | ....... |
| 28 | 2.10 | 4.90 | 4.00 | 3.10 | 3.00 | 2.85 | 3.60 | 2.60 | 2.00 | 2.00 | 2.30 | ....... |
| 29 | 2.09 | ....... | 4.00 | 3.00 | 3.00 | 2.70 | 2.80 | 2.50 | 2.00 | 2.20 | 3.20 | ....... |
| 30 | 2.80 | ....... | 4.00 | 3.30 | 3.10 | 2.60 | 2.80 | 2.60 | 2.00 | 2.40 | 3.10 | ....... |
| 31 | 4.00 | ....... | 4.80 | ....... | 3.11 | ....... | 2.80 | 2.70 | ....... | 2.20 | ....... | ....... |

## TENNESSEE RIVER AT KNOXVILLE, TENNESSEE.

This river is formed by the junction of French Broad and Holston rivers 4 miles above Knoxville. The drainage basin is mapped on Knoxville, Maynardsville, Morristown, Jonesville, Estillville, Bristol, Abingdon, Tazewell, Pocahontas, Greenville, Asheville, Roan Mountain, Cranberry, Mount Guyot, Mount Mitchell, Morganton, Saluda, Pisgah, Cowee, and Wytheville atlas sheets. The station was originally established by the United States Weather Bureau, and was located at the old county highway bridge at Knoxville, which has lately been torn down. The new gage is situated at the Augusta and Knoxville Railroad bridge. The datum of the new gage is 0.6 of a foot higher than that of the old one, so that this amount has to be added to the new readings to make them conform to the old standard. This correction has been applied to the published heights of the Weather Bureau and of this Survey, both in the table of gage heights and in the list of discharge measurements. Measurements of discharge are made at the Cherokee highway bridge 2¼ miles below the gage, as there is at that point a better section for meter measurements. This bridge is a three-span iron bridge, and the width of water surface at low stages under it is 550 feet. The bridge is about 80 feet above low water. The following measurements were made by Max Hall during 1899:

May 4, gage height, 1.90 feet; discharge, 12,810 second-feet.
May 25, gage height, 1.70 feet; discharge, 10,134 second-feet.
September 16, gage height, 0.10 foot; discharge, 3,912 second-feet.
October 26, gage height, —0.60 foot; discharge, 2,728 second-feet.

*Daily gage height, in feet, of Tennessee River at Knoxville, Tennessee, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | (*a*) | 1.20 | 9.20 | 8.00 | 2.30 | 1.50 | 1.20 | 1.00 | 0.80 | —0.10 | —0.20 | 0.30 |
| 2 | (*a*) | 1.20 | 6.80 | 6.60 | 2.20 | 1.10 | .90 | .80 | 1.60 | — .20 | + .40 | .30 |
| 3 | (*a*) | 1.40 | 6.40 | 5.60 | 2.00 | 1.70 | .60 | .70 | 1.40 | — .30 | .50 | .30 |
| 4 | (*a*) | 8.60 | 14.00 | 5.80 | 2.00 | 1.60 | .40 | .60 | .80 | — .30 | .50 | .40 |
| 5 | (*a*) | 16.70 | 14.40 | 8.20 | 2.40 | 1.40 | .20 | .40 | .60 | — .40 | .50 | .30 |
| 6 | (*a*) | 18.70 | 19.20 | 7.60 | 2.60 | 1.20 | .40 | .30 | .40 | — .40 | .40 | .30 |
| 7 | (*a*) | 22.50 | 16.40 | 6.00 | 3.80 | 1.10 | .30 | .20 | .30 | — .50 | .30 | .10 |
| 8 | (*a*) | 22.20 | 9.00 | 5.90 | 4.40 | .90 | .30 | .20 | .30 | — .30 | .10 | .10 |
| 9 | (*a*) | 16.00 | 6.70 | 6.50 | 5.40 | .90 | .40 | .20 | .30 | — .20 | .00 | .00 |
| 10 | (*a*) | 9.40 | 6.10 | 7.30 | 5.20 | 1.10 | .40 | .30 | .30 | — .60 | — .10 | — .10 |
| 11 | (*a*) | 6.00 | 5.10 | 6.20 | 4.40 | 1.20 | .40 | .30 | .40 | + .80 | — .20 | — .20 |
| 12 | (*a*) | 5.00 | 4.60 | 5.20 | 4.60 | 1.40 | .50 | .70 | .70 | .70 | — .20 | .00 |
| 13 | (*a*) | 4.20 | 4.20 | 4.80 | 4.30 | 1.70 | .30 | .80 | .60 | .40 | — .30 | 4.60 |
| 14 | (*a*) | 3.60 | 3.90 | 4.50 | 4.40 | 3.00 | .20 | .80 | .40 | .30 | — .30 | 5.30 |
| 15 | (*a*) | 2.00 | 11.50 | 4.00 | 4.80 | 3.10 | .10 | .60 | .30 | .20 | — .40 | 4.90 |
| 16 | (*a*) | 2.40 | 20.40 | 3.80 | 4.80 | 3.70 | .00 | .60 | .20 | .10 | — .50 | 3.30 |
| 17 | 2.40 | 3.40 | 17.40 | 3.50 | 3.00 | 2.40 | .00 | .50 | .10 | .00 | — .50 | 2.60 |
| 18 | 2.50 | 7.00 | 11.00 | 3.20 | 2.40 | 2.00 | .10 | .30 | .00 | — .10 | — .60 | 1.90 |
| 19 | 2.40 | 6.60 | 18.00 | 2.90 | 2.20 | 1.60 | .20 | .20 | — .10 | — .10 | — .60 | 1.80 |
| 20 | 2.20 | 5.70 | 28.00 | 2.80 | 2.10 | 1.40 | .40 | .10 | .00 | — .20 | — .60 | 1.80 |
| 21 | 2.10 | 4.80 | 25.40 | 2.60 | 1.90 | 1.20 | .40 | .00 | .20 | — .20 | — .70 | 1.60 |
| 22 | 1.80 | 4.30 | 13.60 | 2.50 | 1.80 | 1.00 | .40 | .10 | .50 | — .30 | — .70 | 1.90 |
| 23 | 1.60 | 4.40 | 10.10 | 2.30 | 1.80 | .90 | .30 | .20 | .40 | — .30 | — .70 | 1.80 |
| 24 | 1.50 | 4.40 | 7.80 | 2.20 | 1.70 | .70 | .20 | .30 | .20 | — .40 | — .60 | 2.10 |
| 25 | 1.50 | 3.90 | 7.00 | 2.40 | 1.70 | .80 | .30 | .40 | .00 | — .50 | — .50 | 3.40 |
| 26 | 1.60 | 3.50 | 6.50 | 2.60 | 1.60 | 1.20 | .30 | .40 | .00 | — .50 | — .50 | 3.70 |
| 27 | 1.60 | 5.20 | 7.60 | 3.00 | 1.40 | 1.00 | 1.40 | .50 | .20 | — .60 | — .40 | 3.20 |
| 28 | 1.50 | 9.40 | 9.20 | 2.70 | 1.30 | 1.10 | 1.30 | .60 | .20 | — .60 | — .20 | 2.50 |
| 29 | 1.30 | ...... | 12.20 | 2.60 | 1.20 | 1.60 | 2.10 | .60 | .10 | — .60 | + .20 | 2.20 |
| 30 | 1.20 | ...... | 12.10 | 2.50 | 1.20 | 1.40 | 2.60 | .00 | .00 | — .40 | .30 | 1.70 |
| 31 | 1.20 | ...... | 10.40 | ...... | 1.30 | ...... | 1.40 | .00 | ...... | — .40 | ...... | 1.70 |

*a* January 1 to 16, no readings; gage obstructed by false work of new bridge.

Clinch River, a tributary of Tennessee River, was measured at Clinton, Tennessee, on May 5, at a gage height of 7.55 feet, and showed a discharge of 5,220 second-feet.

## TENNESSEE RIVER AT CHATTANOOGA, TENNESSEE.

This river, after passing Chattanooga, enters Alabama. It then makes a bend to the west and later to the north, returning to Tennessee. Flowing through this State and Kentucky, it empties into the Ohio 50 miles above Cairo. In 1879 a gage was established at Chattanooga, Tennessee, at the foot of Lookout street, just below Chattanooga Island, by the Signal Corps of the United States Army, which has been in charge of the Weather Bureau since July 1, 1891. The drainage area above this station is 21,382 square miles, and is mapped on Morristown, Greenville, Roan Mountain, London, Knoxville, Mount Guyot, Asheville, Murphy, Briceville, Standingstone, Wartburg, Pikeville, Maynardville, Cumberland Gap, Jonesville, Estillville, Bristol, Whitesburg, Grundy, Abingdon, Tazewell, Pocahontas, Wytheville, Cranberry, Morganton, Mount Mitchell, Saluda, Pisgah, Como, Nantahala, Walhalla, Dahlonega, Ellijay, Dalton, Cleveland, Ringgold, Kingston, and Chattanooga atlas sheets. The gage is on an inclined railroad iron for about 20 feet of its lower portion. Above this it is a vertical rod bolted to the rock bluff forming the river bank. The zero of the gage is 630.64 feet above sea level. Measurements are made from the Hamilton County steel highway bridge at the foot of Walnut street, a short distance below the gage. Gage heights are obtained from L. M. Prindell, United States Weather Bureau observer. Records of measurement may be found as follows: 1890 to 1895, Eighteenth Annual Report, Part IV, page 120; 1896–97, Nineteenth Annual Report, Part IV, page 261; 1898, Twentieth Annual Report, Part IV, page 210. The following measurements were made by Max Hall and others during 1899:

May 3, gage height, 6.71 feet; discharge, 37,770 second-feet.
May 26, gage height, 4.76 feet; discharge, 25,526 second-feet.
June 21, gage height, 4.15 feet; discharge, 21,391 second-feet.
September 15, gage height, 1.90 feet; discharge, 10,819 second-feet.
October 27, gage height, 0.80 foot; discharge, 6,566 second-feet.

East Chickamauga Creek, a tributary of the Tennessee, was measured at Anderson upper ford, 3 miles from Ringgold, Georgia, October 26, and gave a discharge of 35 second-feet.

*Daily gage height, in feet, of Tennessee River at Chattanooga, Tennessee, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.75 | 5.70 | 19.25 | 22.80 | 7.60 | 4.15 | 3.45 | 4.20 | 2.20 | 1.20 | 1.10 | 1.70 |
| 2 | 4.95 | 5.65 | 17.60 | 19.50 | 7.10 | 4.25 | 3.30 | 3.55 | 2.35 | 1.10 | 1.10 | 1.70 |
| 3 | 5.30 | 5.60 | 15.15 | 14.90 | 6.70 | 4.40 | 3.05 | 3.05 | 2.80 | 1.05 | 1.05 | 1.70 |
| 4 | 5.80 | 10.70 | 14.15 | 12.95 | 6.30 | 4.85 | 2.80 | 2.75 | 3.05 | .95 | 1.10 | 1.70 |
| 5 | 5.95 | 23.10 | 17.95 | 13.25 | 6.15 | 4.65 | 2.60 | 2.45 | 2.65 | .90 | 1.50 | 1.80 |
| 6 | 7.25 | 30.45 | 24.50 | 14.70 | 7.10 | 4.25 | 2.60 | 2.45 | 2.25 | .80 | 1.50 | 1.70 |
| 7 | 18.80 | 34.30 | 26.55 | 15.70 | 8.50 | 4.05 | 2.65 | 2.40 | 1.95 | .85 | 1.50 | 1.60 |
| 8 | 18.40 | 36.95 | 27.60 | 18.05 | 9.35 | 3.75 | 3.05 | 2.40 | 1.80 | 1.00 | 1.45 | 1.50 |
| 9 | 17.35 | 38.25 | 27.70 | 17.75 | 10.00 | 3.55 | 2.90 | 2.25 | 1.60 | 1.15 | 1.35 | 1.40 |
| 10 | 17.15 | 36.75 | 16.15 | 15.70 | 10.70 | 3.40 | 2.60 | 2.10 | 1.80 | 1.60 | 1.20 | 1.40 |
| 11 | 13.85 | 30.30 | 11.85 | 14.20 | 11.15 | 3.90 | 2.55 | 2.10 | 1.70 | 1.80 | 1.15 | 1.60 |
| 12 | 10.50 | 19.35 | 10.60 | 12.90 | 10.40 | 4.30 | 2.45 | 2.00 | 2.00 | 1.85 | 1.10 | 5.20 |
| 13 | 9.15 | 12.15 | 9.55 | 11.65 | 9.60 | 5.25 | 2.30 | 2.00 | 1.80 | 1.70 | 1.00 | 6.45 |
| 14 | 8.10 | 9.50 | 11.20 | 10.70 | 9.30 | 5.80 | 2.20 | 2.25 | 2.00 | 1.65 | 1.00 | 7.40 |
| 15 | 7.55 | 8.50 | 24.55 | 10.00 | 9.55 | 6.45 | 2.15 | 2.65 | 1.85 | 1.40 | 1.00 | 7.15 |
| 16 | 7.30 | 7.55 | 34.25 | 9.40 | 9.20 | 6.10 | 1.95 | 2.65 | 1.65 | 1.25 | 1.00 | 6.20 |
| 17 | 7.40 | 7.95 | 36.90 | 8.75 | 8.70 | 6.40 | 1.90 | 2.40 | 1.45 | 1.15 | 1.00 | 5.20 |
| 18 | 7.45 | 9.55 | 36.15 | 8.40 | 7.75 | 6.20 | 1.80 | 2.30 | 1.35 | 1.15 | 1.00 | 4.25 |
| 19 | 7.25 | 11.30 | 35.85 | 8.00 | 6.90 | 5.25 | 1.90 | 2.15 | 1.20 | 1.10 | 1.00 | 3.85 |
| 20 | 7.00 | 12.65 | 37.05 | 7.55 | 6.40 | 4.70 | 2.05 | 1.90 | 1.05 | 1.10 | .95 | 4.25 |
| 21 | 6.80 | 11.50 | 39.20 | 7.35 | 5.90 | 4.20 | 2.05 | 1.70 | 1.00 | 1.10 | .85 | 4.40 |
| 22 | 6.45 | 10.65 | 40.00 | 7.05 | 5.60 | 3.75 | 2.40 | 1.60 | 1.05 | 1.10 | .85 | 4.40 |
| 23 | 5.90 | 10.10 | 38.70 | 7.85 | 5.35 | 3.50 | 2.70 | 1.45 | 1.30 | 1.05 | 1.00 | 4.15 |
| 24 | 5.65 | 9.75 | 32.70 | 9.65 | 5.30 | 3.25 | 3.50 | 1.30 | 1.50 | 1.00 | 1.15 | 5.65 |
| 25 | 6.05 | 9.50 | 23.15 | 9.35 | 5.05 | 3.15 | 3.40 | 1.20 | 1.50 | .95 | 1.30 | 6.15 |
| 26 | 6.35 | 9.20 | 16.30 | 10.75 | 4.80 | 3.00 | 3.00 | 1.20 | 1.45 | .85 | 1.70 | 6.30 |
| 27 | 5.85 | 13.20 | 13.65 | 10.30 | 4.65 | 3.25 | 3.05 | 1.20 | 1.30 | .80 | 1.80 | 5.85 |
| 28 | 5.75 | 18.45 | 13.95 | 9.20 | 4.40 | 3.65 | 3.65 | 1.25 | 1.20 | .80 | 1.85 | 5.55 |
| 29 | 5.55 | ....... | 17.30 | 8.35 | 4.30 | 3.50 | 4.25 | 1.50 | 1.25 | .90 | 1.80 | 5.10 |
| 30 | 5.30 | ....... | 21.20 | 7.75 | 4.20 | 3.30 | 4.25 | 1.85 | 1.30 | 1.00 | 1.75 | 4.65 |
| 31 | 5.30 | ....... | 22.80 | ....... | 4.25 | ....... | 5.15 | 1.75 | ....... | 1.05 | ....... | 3.85 |

## OLENTANGY RIVER AT COLUMBUS, OHIO.

This river rises in the north-central part of Ohio and flows in a southerly direction into the Scioto at Columbus. Its watershed is in general flat and for the most part cultivated. Systematic measurements were begun in Columbus on November 22, 1898, when the station at the Fifth avenue bridge was established by H. A. Pressey, Prof. C. N. Brown, and B. H. Flynn. The gagings are made on the upstream side of the bridge, the initial point being on the left bank. A wooden post, graduated to feet and tenths, was driven in the bed of the stream near the bridge as a gage, and referred to a scale cut in the face of the left abutment, from which high-water readings can be taken directly. The observations of river heights are made under the direction of Prof. C. N. Brown, of the Ohio State University. The students in civil engineering have for the last two years studied the rainfall and run-off of the basin of the Olentangy and Scioto rivers. A description of the watershed and the results of observations may be found in the Twentieth Annual Report, Part IV, page 215. The following measurements were made during 1899:

*Measurements of Olentangy River at Columbus, Ohio.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Jan. 5 | 5.71 | 5,335 | Mar. 25 | 3.25 | 1,717 |
| Jan. 15 | 7.90 | 9,236 | Mar. 27 | 3.15 | 1,546 |
| Mar. 15 | 1.87 | 387 | Mar. 31 | 3.67 | 2,221 |
| Mar. 16 | 1.97 | 477 | Apr. 6 | 1.70 | 326 |
| Mar. 20 | 3.58 | 2,356 | Apr. 17 | 1.45 | 180 |
| Mar. 22 | 2.95 | 1,430 | Apr. 22 | 1.33 | 126 |
| Mar. 24 | 4.54 | 3,174 | Sept. 16 | 0.90 | 5 |
| Do | 4.21 | 2,910 | | | |

*Daily gage height, in feet, of Olentangy River at Columbus, Ohio, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.95 | 1.55 | 2.65 | 3.76 | 1.24 | 2.20 | 1.15 | 1.20 | 1.10 | 1.00 | 1.10 | 1.10 |
| 2 | 1.70 | 1.55 | 2.65 | 2.80 | 1.28 | 2.50 | 1.10 | 1.20 | 1.10 | 1.00 | 1.10 | 1.10 |
| 3 | 2.10 | 1.55 | 2.57 | 2.24 | 1.19 | 3.00 | 1.10 | 1.20 | 1.10 | 1.00 | 1.15 | 1.20 |
| 4 | 1.94 | 1.55 | 2.90 | 1.98 | 1.27 | 2.55 | 1.10 | 1.40 | 1.10 | 1.00 | 1.20 | 1.20 |
| 5 | 5.53 | 1.55 | 4.37 | 1.82 | 1.27 | 2.00 | 1.10 | 1.50 | 1.10 | 1.00 | 1.20 | 1.20 |
| 6 | 5.17 | 1.55 | 4.25 | 1.73 | 1.17 | 1.75 | 1.10 | 3.10 | 1.10 | 1.00 | 1.20 | 1.20 |
| 7 | 3.80 | 1.55 | 3.00 | 1.70 | 1.60 | 1.85 | 1.10 | 2.45 | 1.10 | 1.00 | 1.20 | 1.20 |
| 8 | 2.57 | 1.55 | 2.14 | 2.00 | 1.56 | 1.55 | 1.10 | 2.10 | 1.10 | 1.00 | 1.20 | 1.20 |
| 9 | 2.18 | 1.55 | 2.07 | 2.45 | 1.38 | 1.45 | 1.10 | 1.75 | 1.10 | 1.00 | 1.20 | 1.20 |
| 10 | 2.06 | 1.55 | 2.07 | 2.45 | 1.28 | 1.50 | 1.10 | 1.45 | 1 00 | 1.00 | 1.20 | 1.20 |
| 11 | 1.87 | 1.55 | 2.32 | 2.05 | 1.34 | 1.40 | 1.10 | 1.40 | 1.00 | 1.00 | 1.10 | 1.20 |
| 12 | 1.77 | 1.55 | 2.80 | 1.83 | 1.18 | 1.40 | 1.10 | 1.35 | 1.00 | 1.00 | 1.10 | 1.55 |
| 13 | 1.90 | 1.55 | 2.57 | 1.72 | 1.27 | 1.30 | 1.10 | 1.30 | 1.00 | 1.00 | 1.10 | 1.90 |
| 14 | 8.45 | 1.55 | 2.20 | 1.75 | 1.20 | 1.30 | 1.15 | 1.25 | 1.00 | 1.00 | 1.20 | 1.90 |
| 15 | 8.20 | 1.55 | 1.90 | 1.66 | 1.20 | 1.30 | 1.10 | 1.20 | 1.00 | 1.00 | 1.20 | 1.50 |
| 16 | 5.90 | 1.55 | 1.88 | 1.55 | 1.20 | 1.20 | 1.30 | 1.20 | 1.00 | 1.00 | 1.20 | 1.45 |
| 17 | 4.07 | 1.55 | 1.98 | 1.48 | 1.14 | 1.20 | 1.35 | 1.20 | 1.00 | 1.00 | 1.20 | 1.50 |
| 18 | 2.98 | 1.55 | 1.87 | 1.42 | 1.17 | 1.30 | 1.30 | 1.20 | 1.00 | 1.00 | 1.20 | 1.50 |
| 19 | 2.53 | 2.22 | 3.42 | 1.40 | 1.27 | 1.25 | 1.40 | 1.20 | 1.00 | 1.00 | 1.20 | 1.90 |
| 20 | 2.10 | 2.17 | 3.65 | 1.36 | 1.20 | 1.25 | 1.55 | 1.10 | 1.00 | 1.00 | 1.20 | 3.30 |
| 21 | 1.98 | 1.87 | 3.04 | 1.35 | 1.25 | 1.30 | 1.45 | 1.10 | 1.00 | 1.00 | 1.20 | 2.75 |
| 22 | 1.88 | 2.38 | 2.80 | 1.33 | 1.30 | 1.45 | 1.30 | 1.10 | 1.00 | 1.00 | 1.20 | 2.20 |
| 23 | 1.80 | 3.92 | 5.19 | 1.29 | 1.40 | 2.35 | 1 30 | 1.10 | 1.00 | 1.00 | 1.20 | 1.85 |
| 24 | 1.80 | 2.87 | 4.43 | 1.30 | 1.25 | 1.90 | 1.25 | 1.10 | 1.00 | 1.00 | 1.20 | 1.80 |
| 25 | 1.87 | 1.88 | 3.38 | 1.31 | 1.20 | 1.65 | 1.40 | 1.10 | 1.00 | 1.00 | 1.20 | 1.80 |
| 26 | 1.80 | 1.87 | 3.67 | 1.27 | 1.20 | 1.45 | 1.50 | 1.10 | 1.00 | 1.00 | 1.20 | 1.80 |
| 27 | 1.78 | 3.97 | 3.48 | 1.31 | 1.25 | 1.25 | 1.30 | 1.10 | 1.00 | 1.00 | 1.20 | 1.80 |
| 28 | 1.55 | 3.52 | 3.64 | 1.45 | 1.25 | 1.20 | 1.30 | 1.10 | 1.00 | 1.05 | 1.20 | 1.80 |
| 29 | 1.55 | ------- | 3.73 | 1.35 | 1.35 | 1.20 | 1.20 | 1.10 | 1.00 | 1.10 | 1.15 | 1.80 |
| 30 | 1.55 | ------- | 3.12 | 1.30 | 1.60 | 1.20 | 1.20 | 1.10 | 1.00 | 1.10 | 1.10 | 1.80 |
| 31 | 1.87 | ------- | 3.64 | ------- | 1.95 | ------- | 1.20 | 1.10 | ------- | 1.10 | ----- | 1.80 |

## SCIOTO RIVER AT COLUMBUS, OHIO.

This river drains the central portion of the State of Ohio, and flows in a general southerly direction into Ohio River near the city of Portsmouth. Its watershed is flat and highly cultivated above Columbus, while in the southern part it is hilly, with comparatively little cultivation. A description of the watershed and results of measurements may be found in the Twentieth Annual Report, Part IV, page 212. Systematic measurements were begun at Columbus November 22, 1898, when a station was established by H. A. Pressey, Prof. C. N. Brown, and B. H. Flynn. It is located at the Grandview avenue bridge in Columbus. The wire gage is located on the upstream side of the bridge, and is referred to a scale cut in the face of the left abutment, from which high-water readings can be taken directly. The river bed at the station is rocky. The banks are naturally low, but levees have been built on each side in order to prevent overflow; high water seldom reaches the top of the levees, but occasionally they are overflowed. The following measurements were made under the direction of Prof. C. N. Brown during 1899:

*Measurements of Scioto River at Columbus, Ohio.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Jan. 15 | 19.50 | 13,895 | Mar. 27 | 14.05 | 3,379 |
| Jan. 20 | 13.00 | 2,291 | Mar. 29 | 14.56 | 3,894 |
| Mar. 6 | 15.50 | 5,367 | Apr. 5 | 11.76 | 982 |
| Mar. 8 | 13.35 | 2,457 | Apr. 8 | 11.94 | 1,116 |
| Mar. 9 | 12.89 | 1,995 | Apr. 14 | 11.30 | 668 |
| Mar. 17 | 11.61 | 942 | Apr. 16 | 11.02 | 531 |
| Mar. 20 | 14.05 | 3,271 | Apr. 18 | 10.72 | 341 |
| Mar. 22 | 14.30 | 3,905 | Apr. 22 | 9.90 | 236 |
| Mar. 24 | 15.00 | 4,526 | Apr. 26 | 9.80 | 203 |
| Do | 14.57 | 4,050 | Sept. 16 | 9.10 | 23 |
| Mar. 25 | 14.58 | 3,919 | | | |

*Daily gage height, in feet, of Scioto River at Columbus, Ohio, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11.25 | 10.65 | 13.80 | 14.15 | 9.60 | 10.35 | 9.10 | 9.50 | 9.10 | 9.05 | 9.45 | 9.45 |
| 2 | 11.30 | 10.80 | 13.60 | 13.30 | 9.75 | 10.35 | 9.00 | 9.40 | 9.10 | 9.20 | 9.35 | 9.40 |
| 3 | 10.95 | 10.50 | 13.15 | 12.70 | 9.85 | 10.70 | 9.10 | 9.40 | 9.00 | 9.25 | 9.30 | 9.40 |
| 4 | 11.50 | 10.45 | 13.65 | 12.10 | 9.80 | 10.90 | 9.10 | 9.30 | 9.00 | 9.20 | 9.35 | 9.35 |
| 5 | 16.00 | 10.35 | 15.85 | 11.75 | 9.70 | 10.40 | 9.10 | 9.35 | 9.00 | 9.20 | 9.40 | 9.30 |
| 6 | 15.75 | 10.40 | 15.65 | 11.50 | 9.65 | 10.20 | 9.10 | 12.70 | 9.00 | 9.10 | 9.35 | 9.30 |
| 7 | 14.25 | 10.40 | 14.55 | 11.40 | 9.60 | 10.00 | 9.50 | 11.95 | 9.00 | 9.00 | 9.40 | 9.40 |
| 8 | 13.50 | 10.35 | 13.60 | 11.95 | 9.85 | 9.70 | 9.30 | 11.10 | 9.00 | 9.00 | 9.30 | 9.30 |
| 9 | 13.25 | 10.30 | 13.00 | 12.25 | 9.75 | 9.70 | 9.05 | 10.65 | 9.00 | 9.00 | 9.25 | 9.30 |
| 10 | 12.25 | 10.30 | 12.55 | 12.15 | 9.70 | 9.65 | 8.90 | 10.20 | 9.00 | 9.05 | 9.25 | 9.30 |
| 11 | 11.45 | 10.40 | 12.80 | 11.85 | 9.70 | 9.55 | 8.90 | 9.95 | 9.00 | 9.10 | 9.35 | 9.35 |
| 12 | 11.20 | 10.40 | 13.05 | 11.55 | 9.75 | 9.45 | 9.00 | 9.75 | 9.00 | 9.10 | 9.25 | 9.50 |
| 13 | 11.70 | 10.30 | 12.90 | 11.35 | 9.80 | 9.40 | 9.00 | 9.55 | 9.00 | 9.10 | 9.15 | 9.65 |
| 14 | 20.30 | 10.30 | 12.45 | 11.30 | 9.70 | 9.40 | 9.30 | 9.45 | 8.95 | 9.10 | 9.30 | 10.10 |
| 15 | 19.65 | 10.30 | 11.95 | 11.15 | 9.60 | 9.30 | 9.35 | 9.35 | 8.95 | 9.10 | 9.25 | 10.00 |
| 16 | 17.85 | 10.25 | 11.85 | 10.95 | 9.60 | 9.40 | 9.50 | 9.30 | 9.00 | 9.10 | 9.20 | 9.90 |
| 17 | 16.80 | 10.20 | 11.65 | 10.85 | 9.60 | 9.30 | 9.75 | 9.30 | 9.05 | 9.10 | 9.30 | 9.80 |
| 18 | 15.40 | 10.80 | 12.25 | 10.70 | 9.55 | 9.25 | 9.95 | 9.20 | 9.10 | 9.15 | 9.30 | 9.80 |
| 19 | 14.05 | 11.10 | 14.30 | 10.70 | 9.60 | 9.20 | 9.85 | 9.20 | 9.00 | 9.15 | 9.30 | 9.95 |
| 20 | 13.10 | 11.25 | 14.10 | 10.50 | 9.60 | 9.25 | 9.90 | 9.20 | 8.90 | 9.15 | 9.30 | 11.55 |
| 21 | 12.55 | 11.40 | 13.95 | 10.15 | 9.60 | 9.20 | 9.90 | 9.20 | 8.95 | 9.10 | 9.35 | 11.30 |
| 22 | 11.95 | 12.60 | 14.20 | 9.75 | 9.70 | 9.20 | 9.65 | 9.10 | 9.05 | 9.10 | 9.45 | 11.20 |
| 23 | 11.65 | 13.45 | 16.40 | 9.85 | 9.55 | 9.20 | 9.60 | 9.10 | 9.05 | 9.10 | 9.30 | 10.85 |
| 24 | 11.50 | 12.60 | 14.95 | 9.80 | 9.55 | 9.20 | 9.50 | 9.00 | 9.05 | 9.10 | 9.25 | 10.55 |
| 25 | 11.55 | 12.25 | 14.60 | 9.80 | 9.50 | 9.15 | 10.35 | 9.10 | 9.00 | 9.10 | 9.25 | 10.30 |
| 26 | 11.40 | 12.85 | 15.45 | 9.85 | 9.40 | 9.10 | 9.75 | 9.10 | 9.00 | 9.10 | 9.35 | 10.25 |
| 27 | 11.10 | 15.15 | 14.25 | 9.80 | 9.40 | 9.15 | 10.20 | 9.10 | 9.00 | 9.10 | 9.30 | 10.15 |
| 28 | 10.65 | 14.25 | 15.05 | 9.75 | 9.40 | 9.10 | 10.05 | 9.10 | 9.05 | 9.25 | 9.30 | 10.10 |
| 29 | 10.80 | ....... | 14.85 | 9.70 | 9.50 | 9.10 | 9.75 | 9.10 | 9.00 | 9.40 | 9.35 | 10.10 |
| 30 | 11.00 | ....... | 14.00 | 9.70 | 9.50 | 9.10 | 9.70 | 9.10 | 9.00 | 9.40 | 9.30 | 9.95 |
| 31 | 11.05 | ....... | 14.90 | ....... | 9.75 | ....... | 9.65 | 9.10 | ....... | 9.40 | ....... | 9.90 |

## LAKE SUPERIOR OUTFLOW.

In December, 1895, and January, 1896, the United States engineers measured the outflow of Lake Superior under each of the spans of the international bridge.[1] From these and other measurements made at Spry's dock, about a mile below the rapids, the discharge at various stages of the river was computed as shown in the following table:

*Discharge of St. Marys River at various stages.*

| Stage of river. | Discharge. |
|---|---|
| *Feet.* | *Second-feet.* |
| 600.6 | 57,440 |
| 601.2 | 67,310 |
| 602.0 | 81,210 |
| 603.0 | 99,770 |

[1] From report by Alfred Noble, civil engineer, May 25, 1897, in Report on Compensating Works, Michigan Lake Superior Power Company, Sault Ste. Marie, Michigan, September, 1899.

It is proposed to withdraw from St. Marys River about 30,000 second-feet by a canal traversing the city of Sault Ste. Marie, Michigan, pass it through turbines installed below the Government pier and return it to the river. The turbine shafts are to be coupled directly to electric generators which are to develop 40,000 effective horsepower. The section of this canal in rock will be about 200 feet wide and carry 22 feet of flowing water. The available head has been assumed to be 19 feet, and from this a little less than 3 feet is deducted for losses by friction and other causes, leaving an effective head of a trifle over 16 feet, as given by the report of Mr. H. von Schon.

The above-described measurements were made by Mr. E. E. Haskell, assistant engineer, and briefly noted in the annual report of the Chief of Engineers, United States Army, 1896, page 4027. In the next annual report, that for 1897, on pages 4092 to 4104, are details of measurements made by Mr. E. E. Haskell during February and March, 1896. The discharge section was in the reach of river extending from the foot of St. Marys Rapids to the head of Little Rapids. It began at the foot of Spry's dock on the American side of the river and ended at Plummer's dock on the Canadian side. The total water width at this point is 2,483 feet. The river was frozen at the time of making observations, and the section was sounded and current observations made through the ice. At this time the attempt was made to measure low velocities by means of a hydrometric pendulum, but the results obtained with this instrument were not satisfactory. It was found that the friction caused by the ice was practically 31 per cent of that caused by the bottom. The discharges as measured varied from 60,470 to 77,290 second-feet.

In addition to the measurements of the outflow of Lake Superior similar work has been done on the St. Clair and Niagara rivers, results of which are to appear in the annual report of the Chief of Engineers for the year ending June 30, 1900. Investigations of Detroit and St. Lawrence rivers and additional details concerning St. Marys River are being obtained for publication a year later.

## MAUMEE RIVER AT WATERVILLE, OHIO.

Maumee River is formed by the junction of St. Joseph and St. Marys rivers near Fort Wayne, Indiana, and flows in a northeasterly direction through Ohio, emptying into Lake Erie at Toledo. The southern part of the watershed is flat, the northern part being gently rolling and hilly in places. Formerly the hilly section was covered with timber, all of the best of which has been cut, leaving a section of scrub timber, with occasional farms cleared and cultivated. At the station the bed of the stream is rocky and the current sluggish, the fall being only 1.1 feet per mile on an average. Two dams have been built on the Maumee—one at Defiance, to supply water for the Ohio State canals, and one at Grand Rapids for furnishing water power. A station was established on this river by H. A. Pressey and B. H. Flynn November 19, 1898. It is located at the highway bridge near Waterville, the gagings being made on the downstream side of the bridge. Zero of gage is on the left bank, marked by a nail in the guard rail. The wire gage is referred to a bench mark cut in the upstream side of the abutment on the left bank of the river. The elevation is 25.2 feet above gage datum. This is the lowest place on the river at which gagings can be made without being affected by backwater from the lake. The observer is J. E. Harper, station agent at Waterville, Ohio. Two measurements of discharge were made by B. H. Flynn and H. A. Pressey during 1899, as follows: The first, on March 3, at a gage height of 6.18 feet, gave a discharge of 15,490 second-feet; the second, on September 25, at a gage height of 2.15 feet, gave a discharge of 125 second-feet.

*Daily gage height, in feet, of Maumee River at Waterville, Ohio, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.35 | 3.00 | 7.60 | 5.70 | 3.00 | 3.05 | 2.10 | 2.25 | 2.40 | 2.00 | 2.35 | 2.30 |
| 2 | 4.35 | 3.15 | 7.70 | 5.25 | 2.95 | 3.00 | 2.10 | 2.35 | 2.45 | 2.00 | 2.45 | 2.20 |
| 3 | 4.05 | 3.35 | 6.10 | 5.50 | 3.00 | 3.00 | 2.05 | 2.35 | 2.45 | 2.00 | 2.50 | 2.20 |
| 4 | 4.30 | 3.35 | 6.85 | 5.20 | 2.85 | 3.15 | 2.05 | 2.35 | 2.40 | 2.00 | 2.40 | 2.15 |
| 5 | 5.15 | 3.45 | 6.75 | 5.25 | 2.80 | 3.25 | 1.95 | 2.25 | 2.55 | 2.00 | 2.40 | 2.10 |
| 6 | 5.70 | 2.75 | 6.85 | 5.10 | 2.80 | 3.10 | 2.05 | 3.55 | 2.70 | 2.00 | 2.35 | 2.10 |
| 7 | 5.50 | 3.20 | 6.55 | 4.90 | 2.80 | 3.20 | 2.05 | 4.05 | 2.65 | 2.00 | 2.45 | 2.05 |
| 8 | 5.15 | 3.80 | 5.60 | 4.90 | 2.95 | 3.10 | 2.10 | 3.75 | 2.55 | 2.00 | 2.60 | 2.00 |
| 9 | 4.40 | 3.80 | 5.10 | 4.80 | 3.15 | 3.00 | 2.05 | 3.70 | 2.50 | 2.10 | 2.90 | 2.00 |
| 10 | 4.45 | 3.80 | 4.80 | 4.70 | 3.25 | 2.95 | 2.10 | 3.60 | 2.40 | 2.10 | 2.90 | 2.00 |
| 11 | 4.45 | 3.80 | 5.35 | 4.55 | 3.05 | 2.95 | 1.90 | 3.60 | 2.35 | 2.00 | 2.85 | 2.10 |
| 12 | 4.10 | 3.80 | 7.00 | 4.30 | 2.95 | 2.95 | 2.00 | 3.60 | 2.30 | 2.00 | 2.90 | 2.20 |
| 13 | 3.80 | 3.80 | 8.70 | 4.20 | 2.75 | 2.85 | 2.05 | 3.50 | 2.25 | 2.00 | 2.75 | 2.25 |
| 14 | 5.00 | 3.80 | 7.75 | 4.20 | 3.05 | 2.80 | 1.90 | 3.40 | 2.20 | 2.00 | 2.75 | 2.30 |
| 15 | 8.50 | 3.80 | 6.95 | 4.10 | 3.35 | 2.55 | 1.85 | 3.40 | 2.15 | 1.90 | 2.60 | 2.40 |
| 16 | 9.50 | 3.80 | 6.30 | 3.20 | 3.30 | 2.50 | 1.80 | 3.05 | 2.10 | 1.90 | 2.50 | 2.45 |
| 17 | 9.65 | 3.80 | 6.90 | 3.75 | 3.30 | 2.40 | 1.85 | 2.80 | 2.10 | 1.95 | 2.35 | 2.60 |
| 18 | 8.80 | 3.80 | 5.95 | 3.65 | 3.15 | 2.35 | 2.05 | 2.55 | 2.00 | 2.10 | 2.25 | 2.75 |
| 19 | 7.85 | 3.50 | 7.35 | 3.45 | 3.25 | 2.40 | 2.40 | 2.30 | 2.00 | 2.15 | 2.20 | 3.05 |
| 20 | 6.55 | 2.95 | 9.25 | 3.50 | 3.35 | 2.30 | 2.80 | 2.20 | 2.00 | 2.20 | 2.20 | 3.90 |
| 21 | 5.65 | 3.00 | 9.50 | 3.15 | 3.15 | 2.15 | 2.75 | 2.20 | 2.00 | 2.20 | 2.15 | 4.50 |
| 22 | 4.90 | 4.05 | 8.90 | 3.00 | 3.15 | 2.10 | 2.65 | 2.15 | 2.00 | 2.10 | 2.20 | 5.25 |
| 23 | 4.50 | 4.50 | 8.35 | 3.05 | 3.35 | 2.20 | 2.60 | 2.10 | 2.00 | 2.10 | 2.35 | 5.05 |
| 24 | 4.20 | 5.20 | 8.10 | 3.20 | 3.15 | 2.30 | 2.40 | 2.10 | 2.00 | 2.10 | 2.40 | 4.50 |
| 25 | 3.95 | 5.50 | 7.30 | 3.35 | 3.00 | 2.20 | 2.40 | 2.05 | 2.05 | 2.10 | 2.50 | 4.10 |
| 26 | 4.00 | 6.10 | 7.15 | 3.65 | 2.75 | 2.25 | 2.30 | 2.15 | 2.10 | 2.05 | 2.50 | 4.10 |
| 27 | 2.50 | 8.35 | 7.00 | 3.70 | 2.85 | 2.20 | 2.35 | 2.20 | 2.00 | 2.00 | 2.40 | 4.00 |
| 28 | 3.70 | 8.40 | 6.65 | 3.35 | 3.30 | 2.25 | 2.50 | 2.25 | 2.00 | 2.05 | 2.40 | 4.00 |
| 29 | 2.90 | ------- | 6.10 | 3.10 | 3.30 | 2.20 | 2.45 | 2.30 | 2.10 | 2.00 | 2.40 | 4.00 |
| 30 | 3.00 | ------- | 5.75 | 3.10 | 3.05 | 2.15 | 2.40 | 2.25 | 2.10 | 2.10 | 2.30 | 4.00 |
| 31 | 2.70 | ------- | 5.65 | ------- | 3.00 | ------- | 2.35 | 2.35 | ------- | 2.20 | ------- | 4.00 |

## SANDUSKY RIVER AT MEXICO, OHIO.

This river rises in the north-central part of Ohio and flows in a westerly and northerly direction into Sandusky Bay, an arm of Lake Erie. Its watershed is largely used for farming and pasturage, having only an occasional patch of forest. Sixteen dams have been built along its course in order to utilize the water power. Only five of these are now in use, but the flow is more or less obstructed by them all.

Measurements of flow were begun in November, 1898, in connection with the work of the State board of health in their study of the pollution of the Ohio streams and also to obtain information in regard to water power. Two stations have been established on the Sandusky, one at Mexico, 6 miles above Tiffin, and the other at Fremont, about 15 miles from the mouth of the river. The Mexico station was established by H. A. Pressey and B. H. Flynn on November 17, 1898, and is located at the highway bridge near Mexico, about 40 miles above Fremont, Ohio. The wire gage is on the upstream side of the bridge, and is referred to a bench mark cut in the top side of the upstream wing of the right abutment of the bridge. The elevation of the bench mark is 30.00 feet above gage datum. Gagings are made from the downstream side of the bridge, the initial point being on the left bank, marked by a nail in the guard rail. The stream flows through a long stretch of clay banks, with little sand and gravel, and is unobstructed near the point of measurement. At extreme high water the banks are overflowed, and at very low water the measurements are somewhat uncertain, owing to the sluggishness of the stream. The observer is M. L. Estep, of Mexico, Ohio. One measurement of discharge was made by B. H. Flynn in March, 1899, at a gage height of 5.40 feet, which gave a discharge of 1,386 second-feet.

*Daily gage height, in feet, of Sandusky River at Mexico, Ohio, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.00 | 1.90 | 5.60 | 6.40 | 1.50 | 4.10 | 1.10 | 1.40 | 0.60 | 0.60 | 1.10 | 1.20 |
| 2 | 2.90 | 1.90 | 4.30 | 6.00 | 1.40 | 4.10 | 1.00 | 1.30 | .50 | .60 | 1.10 | 1.20 |
| 3 | 2.80 | 1.80 | 4.00 | 4.90 | 1.40 | 3.70 | 1.00 | 1.30 | .60 | .60 | 1.00 | 1.20 |
| 4 | 3.10 | 1.80 | 5.00 | 4.70 | 1.30 | 3.00 | 1.00 | 1.30 | .50 | .60 | 1.20 | 1.20 |
| 5 | 10.20 | 1.70 | 9.40 | 4.20 | 2.40 | 2.40 | .90 | 1.20 | .50 | .60 | 1.20 | 1.30 |
| 6 | 10.80 | 1.70 | 10.80 | 3.40 | 1.90 | 2.00 | .90 | 2.50 | .50 | .50 | 1.10 | 1.60 |
| 7 | 9.80 | 1.70 | 9.20 | 3.00 | 2.20 | 2.00 | .90 | 2.10 | .50 | .50 | 1.10 | 1.40 |
| 8 | 6.10 | 1.60 | 6.30 | 4.80 | 2.00 | 2.50 | .80 | 1.60 | .60 | .50 | 1.10 | 1.30 |
| 9 | 4.00 | 1.60 | 4.50 | 5.80 | 1.80 | 3.00 | .80 | 1.40 | ,60 | .50 | 1.10 | 1.20 |
| 10 | 3.50 | 1.60 | 4.00 | 5.00 | 1.60 | 2.40 | .80 | 1.40 | .60 | .50 | 1.00 | 1.20 |
| 11 | 3.50 | 1.60 | 7.80 | 4.10 | 1.50 | 2.00 | .80 | 1.40 | .60 | .50 | 1.00 | 1.20 |
| 12 | 3.40 | 1.60 | 8.40 | 3.20 | 1.40 | 1.80 | .80 | 1.30 | .60 | .60 | 1.00 | 1.30 |
| 13 | 3.40 | 1.60 | 6.50 | 3.50 | 1.90 | 1.70 | .70 | 1.30 | .50 | .60 | 1.00 | 1.60 |
| 14 | 10.20 | 1.60 | 4.80 | 3.40 | 1.50 | 1.50 | .70 | 1.20 | .50 | .80 | 1.00 | 1.60 |
| 15 | 15.50 | 1.60 | 3.80 | 3.00 | 1.40 | 1.40 | 1.10 | 1.20 | .50 | .80 | 1.10 | 1.80 |
| 16 | 17.00 | 1.50 | 3.70 | 2.50 | 1.30 | 1.30 | 1.50 | 1.00 | .50 | .80 | 1.20 | 1.80 |
| 17 | 15.30 | 1.50 | 3.70 | 2.30 | 1.30 | 1.30 | 1.60 | .90 | .60 | .80 | 1.20 | 1.70 |
| 18 | 10.30 | 1.50 | 3.90 | 2.00 | 2.20 | 1.20 | 1.50 | .90 | .60 | .80 | 1.20 | 1.90 |
| 19 | 6.30 | 1.50 | 11.00 | 2.00 | 4.20 | 1.10 | 1.40 | .90 | .60 | .70 | 1.20 | 2.20 |
| 20 | 4.20 | 1.50 | 11.80 | 1.90 | 3.20 | 1.00 | 1.30 | .80 | .80 | .80 | 1.20 | 3.00 |
| 21 | 3.60 | 1.50 | 9.30 | 1.90 | 2.40 | 1.00 | 1.30 | .80 | .80 | 1.00 | 1.20 | 3.30 |
| 22 | 3.40 | 8.10 | 7.30 | 1.80 | 2.00 | .90 | 1.30 | .80 | .70 | 1.00 | 1.10 | 2.80 |
| 23 | 3.20 | 9.20 | 9.30 | 1.80 | 1.80 | .90 | 1.20 | .80 | .60 | 1.00 | 1.10 | 2.40 |
| 24 | 3.00 | 7.20 | 10.10 | 1.60 | 1.70 | .80 | 1.20 | .80 | .60 | 1.00 | 1.20 | 2.20 |
| 25 | 3.00 | 5.00 | 9.50 | 1.80 | 1.60 | 1.30 | 1.20 | .70 | .60 | 1.00 | 1.20 | 2.20 |
| 26 | 2.90 | 5.40 | 7.40 | 1.80 | 1.60 | 1.20 | 1.20 | .70 | .60 | 1.00 | 1.20 | 2.10 |
| 27 | 2.70 | 9.20 | 6.40 | 1.80 | 1.50 | 1.20 | 1.10 | .70 | .60 | 1.10 | 1.20 | 2.10 |
| 28 | 2.60 | 8.40 | 6.00 | 1.80 | 1.50 | 1.20 | 1.20 | .70 | .60 | 1.10 | 1.30 | 2.00 |
| 29 | 2.40 | ....... | 5.50 | 1.70 | 1.60 | 1.10 | 1.50 | .60 | .60 | 1.20 | 1.20 | 2.00 |
| 30 | 2.20 | ....... | 6.10 | 1.60 | 3.40 | 1.10 | 1.50 | .60 | .60 | 1.20 | 1.20 | 1.80 |
| 31 | 2.00 | ....... | 5.90 | ....... | 4.70 | ....... | 1.40 | .60 | ....... | 1.20 | ....... | 1.60 |

## SANDUSKY RIVER AT FREMONT, OHIO.

This station, established by H. A. Pressey and B. H. Flynn on November 18, 1898, is at the bridge of the Lake Shore Railroad at Fremont, Ohio. The gagings are made from the board walk on the lower cord of the bridge, the initial point being a cross cut on the bottom lateral at the west end of the bridge. The gage is an iron pipe graduated to feet and tenths, located at the waterworks intake, and is referred to a bench mark cut on top of south end of west abutment of bridge. The elevation of bench mark is 20.1 feet above gage datum. The bed is rocky, the banks high and not subject to overflow. During the summer of 1899, owing to the scarcity of water for the waterworks of Fremont, the rubble dam below the station was rebuilt, affecting the flow of the river and gage readings, especially at time of low water. The observer is Charles F. Reiff, superintendent of the waterworks at Fremont, Ohio. A measurement of discharge was made March 2, 1899, by B. H. Flynn: Gage height, 2.32 feet; discharge, 1,784 second-feet.

*Daily gage height, in feet, of Sandusky River at Fremont, Ohio, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.00 | 1.30 | 2.95 | 2.90 | 0.40 | 2.20 | −0.05 | +0.05 | 0.35 | 0.75 | 0.95 | 0.90 |
| 2 | 1.75 | 1.20 | 2.25 | 2.75 | .35 | 2.15 | − .15 | .10 | .40 | .70 | .95 | .90 |
| 3 | 1.70 | 1.20 | 2.05 | 2.45 | .30 | 1.95 | − .25 | .05 | .35 | .75 | 1.05 | .95 |
| 4 | 2.30 | 1.20 | 2.75 | 2.55 | .40 | 1.55 | − .25 | .00 | .40 | .75 | 1.05 | 1.00 |
| 5 | 5.15 | 1.20 | 4.80 | 2.30 | 1.55 | 1.10 | − .15 | .00 | .35 | .75 | 1.05 | .95 |
| 6 | 4.90 | 1.10 | 4.55 | 1 95 | 1.00 | .85 | − .15 | − .10 | .40 | .70 | 1.05 | .95 |
| 7 | 4.40 | 1.10 | 3.75 | 1.80 | .85 | .80 | − .15 | + .55 | .45 | .60 | .95 | .95 |
| 8 | 3.25 | 1.05 | 2.95 | 2.75 | .95 | .75 | − .10 | .25 | .45 | .60 | .90 | .95 |
| 9 | 2.70 | .75 | 2.40 | 2.85 | .75 | 1.40 | − .20 | .10 | .45 | .60 | .90 | .95 |
| 10 | 2.35 | .70 | 2.65 | 2.50 | .65 | 1.30 | − .10 | .00 | .40 | .60 | .90 | .90 |
| 11 | 2.15 | .80 | 4.40 | 2 10 | .50 | 1.00 | + .05 | .00 | .40 | .60 | .90 | 1.00 |
| 12 | 2.15 | .80 | 4.05 | 2.00 | .45 | .75 | − .15 | .00 | .30 | .45 | .95 | 1.00 |
| 13 | 2.50 | .80 | 3.15 | 1.95 | .40 | .55 | − .15 | − .15 | .30 | .50 | .95 | 1.05 |
| 14 | 7.80 | .80 | 2.10 | 1.75 | .40 | .35 | − .20 | − .10 | .30 | .70 | .95 | 1.20 |
| 15 | 8.25 | .80 | 2.10 | 1,50 | .40 | .30 | − .20 | − .10 | .30 | .70 | .90 | 1.20 |
| 16 | 7.40 | .75 | 1.95 | 1.25 | .35 | .20 | + .60 | − .15 | .50 | .75 | .90 | 1.20 |
| 17 | 6.80 | .80 | 1.90 | 1.05 | .40 | .20 | .55 | − .20 | .50 | .85 | .95 | 1.10 |
| 18 | 5.00 | 1.00 | 2.85 | .90 | .85 | .10 | .35 | − .15 | .50 | .85 | .95 | 1.10 |
| 19 | 3.40 | 1.05 | 6.70 | .80 | 1.55 | .10 | .15 | − .20 | .65 | .95 | .95 | 1.50 |
| 20 | 2.90 | 1.55 | 5.05 | .80 | 1.55 | .10 | .10 | − .25 | .60 | .85 | 1.00 | 1.90 |
| 21 | 2.55 | 2.05 | 4.05 | .70 | 1.00 | .00 | .00 | − .25 | .55 | .85 | .95 | 1.90 |
| 22 | 2.25 | 4.25 | 4.00 | .65 | .75 | .00 | .05 | − .25 | .55 | .85 | .95 | 1.70 |
| 23 | 2.20 | 4.00 | 4.65 | .60 | .55 | .09 | − .10 | − .25 | .55 | .85 | .90 | 1.50 |
| 24 | 2.20 | 3.30 | 4.20 | .60 | .45 | − .05 | − .10 | − .25 | .65 | .85 | .95 | 1.40 |
| 25 | 2.30 | 2.50 | 3.80 | 1.15 | .35 | − .05 | + .05 | − .35 | .80 | .85 | .95 | 1.50 |
| 26 | 2.15 | 3.40 | 3.60 | 1.00 | .30 | .00 | − .10 | − .40 | .70 | .85 | .95 | 1.25 |
| 27 | 2.10 | 4.20 | 3.10 | .75 | .35 | − .05 | − .15 | − .30 | .70 | .85 | .95 | 1.10 |
| 28 | 1.65 | 3.60 | 2.85 | .70 | .55 | .00 | − .15 | − .35 | .80 | .95 | .95 | 1.10 |
| 29 | 1.55 | ....... | 2.80 | .60 | 1.20 | − .05 | − .15 | − .25 | .80 | .95 | .95 | 1.10 |
| 30 | 1.45 | ....... | 2.90 | .55 | 2.15 | − .05 | − .15 | − .05 | .70 | .90 | .90 | 1.00 |
| 31 | 1.35 | ....... | 2.85 | ....... | 2.50 | ....... | − .05 | + .20 | ....... | 1.05 | ....... | .95 |

## NIAGARA RIVER BELOW BUFFALO, NEW YORK.

Measurements of Niagara River were made under the direction of the United States Board of Engineers on Deep Waterways, from September, 1897, to September, 1898, the work being in charge of E. E. Haskell, assistant engineer. The results are discussed in a paper prepared by Mr. Clinton B. Stewart, assisting Mr. Haskell, and presented to the Western Society of Engineers in December, 1899.[1] The point of measurement was on the north side of the international bridge, about 3 miles below the head of the river. At this point the total width is 1,806 feet, of which 128.5 feet is taken up by the width of the eight bridge piers. The distance between soundings was about 20 feet. The soundings were made with a 41-pound cast-iron weight attached to a sash chain, in swift and deep water, and with a 25-pound lead in the shallower water. Velocity measurements were made by means of Haskell current meters with high and low pitch wheels. The velocity of the current was determined at points about 80 feet apart and at 0.3 of the total depth. Measurements of velocity near the surface were also taken, with the meter immersed 1 foot, also near the bottom, with the weight just clearing, so that the meter wheel was 1.5 feet above the bottom.

At a water-surface elevation of 567.0 feet above mean tide at New York, the area of cross section was 39,629 square feet. The discharge measurements covered a range of about 2.3 feet in lake level. Taking the elevation of mean level of Lake Erie at 572.78, this being the average at Cleveland for the period 1875 to 1898, the corresponding discharge, when corrected, is placed at 221,500 second-feet. The rate of increase in discharge at this elevation is about 25,000 second-feet per foot rise.

In the results of this investigation published by Mr. Clinton B. Stewart in the Journal of the Western Society of Engineers, the gages showing height of water at the time of measurements were located, one on the American shore and the other on the Canadian shore, each about 2½ miles from the mouth of the river. These were read during the months of July and August, 1898, simultaneously at ten-minute intervals throughout the day. They have been referred to the gage near Buffalo, readings of which were made from 1887 to 1897. The fall from these to the latter is 0.13 foot. No attempt has been made to estimate the daily flow. It is probable that this can be done, as the bed of the river is of rock and not subject to change. The construction of the international bridge about 1870 may have changed the slope conditions slightly, but probably has not influenced the flow by more than a few per cent.

The measurements of the outflow of Lake Erie through Niagara River were continued from September, 1898, by the Corps of Engineers, United States Army, in charge of the survey of northern and northwestern lakes, of which Mr. E. E. Haskell was assistant engineer and Mr. F. C. Shenehon was resident engineer. From the measurements made by these two parties the outflow, by months, for the years 1895 to 1898 has been computed and published.[2] The mean discharge for these thirty-four years is 220,428 second-feet. The following table gives the results, by months, in condensed form:

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[1] Journal of Western Society of Engineers for 1899, pp. 450 to 492.

[2] Regulation of the Level of Lake Erie. Fifty-sixth Congress, first session, H. R. Doc. No. 200, pp. 15 and 16.

*Mean monthly discharge of Niagara River below Buffalo, New York, for years 1865 to 1898, inclusive, in thousands of cubic feet per second.*

| Year. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Mean. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1865 | 205 | 193 | 200 | 216 | 231 | 230 | 229 | 227 | 226 | 219 | 210 | 206 | 216 |
| 1866 | 200 | 197 | 205 | 219 | 225 | 231 | 234 | 228 | 226 | 226 | 220 | 220 | 219 |
| 1867 | 213 | 206 | 215 | 223 | 236 | 244 | 239 | 231 | 221 | 213 | 202 | 197 | 220 |
| 1868 | 192 | 185 | 197 | 216 | 227 | 237 | 236 | 223 | 216 | 206 | 202 | 198 | 211 |
| 1869 | 197 | 196 | 206 | 214 | 227 | 237 | 245 | 242 | 235 | 223 | 212 | 221 | 221 |
| 1870 | 227 | 232 | 227 | 244 | 249 | 249 | 250 | 248 | 241 | 231 | 224 | 221 | 237 |
| 1871 | 216 | 208 | 219 | 231 | 238 | 238 | 238 | 232 | 228 | 212 | 207 | 198 | 222 |
| 1872 | 196 | 191 | 189 | 193 | 203 | 211 | 211 | 210 | 205 | 201 | 194 | 189 | 199 |
| 1873 | 187 | 187 | 189 | 217 | 234 | 236 | 236 | 234 | 224 | 217 | 212 | 221 | 216 |
| 1874 | 231 | 232 | 233 | 237 | 240 | 241 | 242 | 238 | 226 | 215 | 205 | 201 | 228 |
| 1875 | 196 | 192 | 195 | 204 | 215 | 225 | 229 | 228 | 225 | 213 | 209 | 214 | 211 |
| 1876 | 214 | 227 | 244 | 259 | 268 | 272 | 268 | 260 | 255 | 240 | 242 | 233 | 248 |
| 1877 | 223 | 219 | 214 | 224 | 230 | 232 | 239 | 235 | 233 | 223 | 221 | 223 | 226 |
| 1878 | 225 | 228 | 232 | 243 | 250 | 250 | 250 | 243 | 240 | 231 | 226 | 228 | 237 |
| 1879 | 217 | 214 | 214 | 223 | 227 | 229 | 230 | 225 | 216 | 211 | 200 | 206 | 218 |
| 1880 | 218 | 219 | 222 | 226 | 233 | 236 | 238 | 232 | 226 | 215 | 214 | 206 | 224 |
| 1881 | 196 | 199 | 206 | 223 | 233 | 239 | 238 | 230 | 221 | 220 | 215 | 220 | 220 |
| 1882 | 232 | 232 | 244 | 250 | 256 | 260 | 258 | 254 | 247 | 235 | 226 | 214 | 242 |
| 1883 | 212 | 217 | 221 | 224 | 236 | 255 | 261 | 259 | 250 | 242 | 232 | 232 | 237 |
| 1884 | 224 | 231 | 236 | 250 | 258 | 260 | 254 | 250 | 238 | 229 | 217 | 216 | 239 |
| 1885 | 211 | 206 | 203 | 223 | 242 | 256 | 255 | 255 | 251 | 248 | 245 | 243 | 236 |
| 1886 | 244 | 225 | 220 | 243 | 251 | 254 | 253 | 247 | 241 | 235 | 224 | 226 | 239 |
| 1887 | 220 | 230 | 252 | 253 | 258 | 259 | 252 | 243 | 237 | 222 | 215 | 216 | 238 |
| 1888 | 211 | 205 | 207 | 223 | 229 | 232 | 236 | 233 | 222 | 213 | 215 | 212 | 220 |
| 1889 | 212 | 209 | 205 | 213 | 217 | 228 | 233 | 225 | 216 | 206 | 200 | 206 | 214 |
| 1890 | 214 | 221 | 224 | 237 | 246 | 256 | 245 | 234 | 229 | 224 | 223 | 218 | 231 |
| 1891 | 212 | 212 | 223 | 220 | 215 | 219 | 216 | 210 | 206 | 197 | 188 | 189 | 209 |
| 1892 | 190 | 186 | 187 | 198 | 217 | 236 | 239 | 230 | 222 | 209 | 201 | 195 | 209 |
| 1893 | 187 | 189 | 193 | 210 | 230 | 235 | 228 | 220 | 210 | 202 | 194 | 195 | 208 |
| 1894 | 202 | 199 | 200 | 209 | 218 | 225 | 223 | 214 | 210 | 202 | 197 | 195 | 208 |
| 1895 | 188 | 184 | 184 | 189 | 194 | 196 | 193 | 192 | 189 | 180 | 178 | 181 | 187 |
| 1896 | 183 | 181 | 180 | 189 | 198 | 204 | 201 | 206 | 198 | 193 | 186 | 186 | 192 |
| 1897 | 186 | 190 | 198 | 210 | 218 | 220 | 220 | 216 | 210 | 198 | 196 | 195 | 205 |
| 1898 | 196 | 200 | 206 | 220 | 224 | 225 | 219 | 214 | 205 | 201 | 198 | 195 | 209 |

## SENECA RIVER AT BALDWINSVILLE, NEW YORK.

This stream has its source in the lake of the same name in central New York; its general course is northeasterly until its junction with the Oneida River in Onondaga County, where the two form the Oswego River, which flows northwesterly, entering Lake Ontario at the city of Oswego. The station is located at the dam on Seneca River at Baldwinsville, where the drainage area is 3,103 square miles. A head or crest gage is placed at each end of the dam and both are read twice daily. Only one tailrace gage was placed. The elevation of the zeros of the crest gages is 93.99 feet, while the elevation of the zero of the tailrace gage is 84.91 feet, or a difference of 9.08 feet. To obtain the effective heads on the water wheels it is necessary to add to the daily readings of the crest gages 9.08 feet, and subtract the readings of the tailrace gage. Ten mills utilize the flow here developed for power purposes, and to get the entire flow of the river it is necessary to keep a record of the different heads on the wheel gates as well as the amount of opening of each. The records at this point, as well as on various other streams in the State of New York, were begun by Mr. George W. Rafter for the United States Board of Engineers on Deep Waterways. The computations of discharge are quite laborious and have been made as noted in Volume XXVI of the Proceedings of the American Society of Civil Engineers, page 308. The following figures are based on Bazin's experiments. The Oswego Canal is fed from Seneca River, and practically its entire flow should be added to that of the stream to obtain the total yield of the watershed. The discharge of this canal, including both lockage and leakage, was taken as 70 second-feet from June to October, 1899.

*Estimated daily discharge, in second-feet, of Seneca River at Baldwinsville, New York, for 1898.*

| Day. | Nov. | Dec. | Day. | Nov. | Dec. | Day. | Nov. | Dec. | Day. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 2,528 | 10 | | 2,389 | 19 | 3,308 | 2,151 | 28 | 3,119 | 3,449 |
| 2 | | 2,512 | 11 | | 1,872 | 20 | 2,590 | 2,292 | 29 | 2,810 | 3,191 |
| 3 | | 2,609 | 12 | 3,011 | 2,219 | 21 | 3,293 | 2,418 | 30 | 2,801 | 3,326 |
| 4 | | 2,379 | 13 | 2,625 | 2,078 | 22 | 3,174 | 2,927 | 31 | | 3,365 |
| 5 | | 2,889 | 14 | 3,583 | 2,056 | 23 | 3,234 | 3,455 | | | |
| 6 | | 2,715 | 15 | 3,684 | 1,982 | 24 | 3,236 | 3,838 | Mean | 3,142 | 2,689 |
| 7 | | 2,981 | 16 | 3,500 | 2,111 | 25 | 3,257 | 3,661 | | | |
| 8 | | 2,687 | 17 | 3,418 | 2,271 | 26 | 3,245 | 3,630 | | | |
| 9 | | 2,467 | 18 | 3,270 | 1,551 | 27 | 2,452 | 3,368 | | | |

*Estimated daily discharge, in second-feet, of Seneca River at Baldwinsville, New York, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,630 | 1,838 | 3,232 | 4,599 | 3,406 | 2,073 | 1,067 | 585 | 570 | 134 | 1,328 | 1,415 |
| 2 | 2,686 | 1,791 | 3,172 | 4,495 | 3,521 | 1,692 | 156 | 572 | 630 | 658 | 1,386 | 1,454 |
| 3 | 2,454 | 1,953 | 3,352 | 4,606 | 3,230 | 1,132 | 771 | 560 | 112 | 650 | 1,220 | 1,050 |
| 4 | 2,547 | 1,794 | 3,249 | 4,567 | 3,032 | 1,884 | 163 | 540 | 650 | 608 | 1,592 | 1,631 |
| 5 | 2,993 | 1,835 | 3,468 | 4,520 | 3,007 | 2,085 | 1,141 | 532 | 505 | 613 | 1,270 | 1,496 |
| 6 | 3,202 | 1,793 | 3,855 | 4,329 | 2,906 | 2,058 | 1,185 | 70 | 670 | 610 | 1,793 | 1,450 |
| 7 | 2,977 | 1,676 | 4,190 | 4,072 | 2,692 | 1,859 | 1,142 | 621 | 671 | 653 | 1,543 | 1,455 |
| 8 | 2,543 | 1,653 | 3,992 | 4,509 | 2,799 | 1,467 | 825 | 533 | 591 | 70 | 1,462 | 1,330 |
| 9 | 2,779 | 1,293 | 3,943 | 4,394 | 2,842 | 1,713 | 678 | 532 | 623 | 635 | 1,516 | 1,650 |
| 10 | 2,696 | 1,267 | 3,838 | 5,019 | 2,705 | 2,038 | 1,103 | 499 | 158 | 550 | 1,597 | 1,306 |
| 11 | 2,645 | 1,267 | 3,783 | 4,955 | 2,662 | 834 | 1,188 | 475 | 521 | 525 | 1,631 | 1,742 |
| 12 | 2,554 | 1,241 | 3,623 | 5,347 | 2,614 | 1,631 | 1,215 | 491 | 490 | 624 | 1,708 | 1,759 |
| 13 | 2,535 | 1,340 | 3,915 | 5,181 | 2,637 | 1,541 | 1,258 | 74 | 422 | 646 | 1,786 | 1,828 |
| 14 | 2,577 | 1,419 | 3,860 | 5,218 | 2,302 | 1,526 | 1,182 | 339 | 409 | 629 | 1,527 | 1,724 |
| 15 | 2,950 | 1,380 | 3,860 | 5,327 | 2,477 | 1,608 | 1,207 | 575 | 437 | 74 | 1,544 | 1,501 |
| 16 | 3,186 | 1,101 | 3,978 | 4,874 | 2,398 | 1,581 | 174 | 521 | 513 | 787 | 1,545 | 1,533 |
| 17 | 3,628 | 1,226 | 3,872 | 4,939 | 2,534 | 1,797 | 1,226 | 99 | 70 | 765 | 1,599 | 1,565 |
| 18 | 3,708 | 1,502 | 3,678 | 5,033 | 2,355 | 789 | 1,155 | 571 | 514 | 765 | 1,518 | 1,565 |
| 19 | 3,769 | 1,652 | 3,413 | 4,981 | 2,415 | 1,303 | 922 | 545 | 508 | 765 | 1,742 | 1,878 |
| 20 | 3,645 | 1,494 | 3,821 | 4,791 | 2,536 | 569 | 574 | 70 | 623 | 781 | 1,966 | 1,470 |
| 21 | 3,469 | 1,685 | 3,625 | 4,606 | 2,302 | 583 | 712 | 580 | 488 | 834 | 1,712 | 1,960 |
| 22 | 3,272 | 2,056 | 3,563 | 4,620 | 2,576 | 646 | 543 | 596 | 397 | 301 | 1,670 | 2,096 |
| 23 | 3,298 | 2,403 | 3,755 | 4,040 | 2,309 | 756 | 206 | 614 | 177 | 875 | 1,739 | 2,045 |
| 24 | 3,310 | 2,488 | 4,021 | 4,311 | 2,257 | 895 | 656 | 502 | 562 | 798 | 1,757 | 2,050 |
| 25 | 3,209 | 2,646 | 4,091 | 4,026 | 2,334 | 386 | 585 | 548 | 573 | 787 | 1,904 | 2,050 |
| 26 | 3,095 | 2,482 | 4,093 | 3,992 | 2,296 | 668 | 593 | 529 | 561 | 725 | 1,891 | 2,055 |
| 27 | 2,358 | 2,668 | 4,348 | 3,883 | 2,209 | 625 | 613 | 70 | 643 | 794 | 1,879 | 1,978 |
| 28 | 2,093 | 2,584 | 4,278 | 3,975 | 1,962 | 588 | 586 | 555 | 643 | 822 | 1,711 | 2,039 |
| 29 | 1,662 | | 4,776 | 3,853 | 2,045 | 543 | 531 | 522 | 691 | 351 | 1,728 | 2,091 |
| 30 | 2,028 | | 4,702 | 3,216 | 2,066 | 328 | 238 | 395 | | 947 | 1,087 | 2,089 |
| 31 | 1,871 | | 4,782 | | 2,192 | | 467 | 375 | | 971 | | 2,089 |
| Mean | 2,851 | 1,769 | 3,875 | 4,543 | 2,568 | 1,573 | 776 | 455 | 481 | 637 | 1,612 | 1,722 |

## CHITTENANGO CREEK AT BRIDGEPORT, NEW YORK.

This creek rises in Madison County, New York, and flows in a northerly direction between Madison and Onondaga counties into Oneida Lake, the outlet of which is Oneida River, a tributary of Oswego River. The basin of Chittenango Creek is shown on Chittenango atlas sheet of the United States Geological Survey. Observations for the computation of flow of this creek are made at the mill-dam in Bridgeport, New York, a short distance above its mouth. The drainage area at this point is 307 square miles. Three times a day observations are made of the river height above the crest of the dam, head on wheels, and the amount of gate opening. Jefferson Downs, of the flour mill, is the observer. The mill runs three Camden turbines—two of which are 60-inch, and one 54-inch. The dam is of timber, backed with stone. The elevation of the zero of the crest gage is 92.84 feet, while the zero of the tailrace gage is 85.88 feet, the difference between them being 6.96 feet. In computing the flow over the dam the crest is divided into three parts, each of which is considered as a separate weir. The discharge over the dam was first computed from Bazin's experiments, but after July 1, 1899, it was computed from the results of the experiments made at Cornell University. A cross section of the dam and additional facts are given by Mr. Geo. W. Rafter in Volume XXVI of the Proceedings of the American Society of Civil Engineers, page 309.

*Estimated daily discharge, in second-feet, of Chittenango Creek at Bridgeport, New York, for 1898.*

| Day. | Sept. | Oct. | Nov. | Dec. | Day. | Sept. | Oct. | Nov. | Dec. | Day. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | 180 | 562 | 427 | 12 | ...... | 196 | 1,571 | 434 | 23 | 115 | 465 | 593 | 1,293 |
| 2 | ...... | 205 | 559 | 360 | 13 | ...... | 197 | 1,265 | 454 | 24 | 135 | 487 | 569 | 1,401 |
| 3 | ...... | 171 | 434 | 348 | 14 | ...... | 181 | 921 | 442 | 25 | 85 | 472 | 490 | 1,075 |
| 4 | ...... | 172 | 358 | 385 | 15 | ...... | 354 | 790 | 450 | 26 | 142 | 352 | 442 | 857 |
| 5 | ...... | 156 | 379 | 471 | 16 | 82 | 335 | 694 | 472 | 27 | 149 | 867 | 465 | 726 |
| 6 | ...... | 309 | 385 | 414 | 17 | 116 | 299 | 615 | 619 | 28 | 214 | 972 | 523 | 541 |
| 7 | ...... | 235 | 331 | 404 | 18 | 53 | 284 | 500 | 605 | 29 | 154 | 661 | 413 | 480 |
| 8 | ...... | 204 | 359 | 320 | 19 | 119 | 297 | 506 | 678 | 30 | 198 | 565 | 421 | 630 |
| 9 | ...... | 130 | 386 | 261 | 20 | 139 | 320 | 675 | 669 | 31 | ...... | 519 | ...... | 630 |
| 10 | ...... | 165 | 474 | 265 | 21 | 117 | 269 | 728 | 793 | | | | | |
| 11 | ...... | 194 | 1,339 | 465 | 22 | 111 | 463 | 623 | 1,155 | Mean | 129 | 344 | 612 | 597 |

*Estimated daily discharge, in second-feet, of Chittenango Creek at Bridgeport, New York, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 515 | 520 | 632 | 837 | 447 | 426 | 116 | 84 | 81 | 75 | 60 | 113 |
| 2 | 571 | 484 | 473 | 795 | 357 | 346 | 55 | 79 | 49 | 90 | 145 | 127 |
| 3 | 636 | 440 | 385 | 752 | 310 | 234 | 97 | 169 | 45 | 91 | 145 | 143 |
| 4 | 737 | 465 | 520 | 861 | 172 | 105 | 113 | 126 | 133 | 90 | 160 | 159 |
| 5 | 1067 | 385 | 1260 | 866 | 172 | 184 | 132 | 134 | 81 | 80 | 165 | 149 |
| 6 | 1310 | 356 | 1331 | 864 | 157 | 229 | 99 | 70 | 76 | 141 | 228 | 151 |
| 7 | 1282 | 342 | 1475 | 857 | 95 | 229 | 123 | 125 | 74 | 89 | 128 | 166 |
| 8 | 1135 | 465 | 1069 | 1420 | 172 | 244 | 132 | 125 | 96 | 45 | 120 | 179 |
| 9 | 724 | 385 | 860 | 1675 | 172 | 192 | 45 | 134 | 96 | 107 | 108 | 155 |
| 10 | 486 | 385 | 852 | 1369 | 227 | 147 | 89 | 79 | 15 | 117 | 65 | 168 |
| 11 | 473 | 385 | 659 | 1306 | 237 | 70 | 262 | 62 | 71 | 101 | 46 | 181 |
| 12 | 623 | 385 | 565 | 1274 | 172 | 169 | 271 | 44 | 96 | 101 | 35 | 211 |
| 13 | 849 | 538 | 1196 | 1597 | 172 | 192 | 162 | 15 | 92 | 85 | 72 | 326 |
| 14 | 738 | 524 | 1061 | 1737 | 165 | 182 | 169 | 141 | 56 | 72 | 57 | 395 |
| 15 | 1260 | 462 | 970 | 1614 | 180 | 109 | 99 | 125 | 88 | 15 | 65 | 395 |
| 16 | 1280 | 362 | 665 | 1405 | 174 | 184 | 70 | 103 | 79 | 84 | 60 | 374 |
| 17 | 1101 | 449 | 634 | 1339 | 250 | 192 | 101 | 87 | 25 | 30 | 88 | 355 |
| 18 | 632 | 354 | 526 | 1221 | 310 | 70 | 221 | 76 | 89 | 38 | 57 | 466 |
| 19 | 390 | 385 | 565 | 859 | 374 | 152 | 210 | 91 | 74 | 38 | 25 | 706 |
| 20 | 395 | 541 | 736 | 861 | 374 | 84 | 204 | 25 | 96 | 45 | 83 | 588 |
| 21 | 389 | 444 | 766 | 629 | 385 | 92 | 152 | 120 | 117 | 47 | 70 | 298 |
| 22 | 385 | 619 | 962 | 447 | 281 | 100 | 117 | 109 | 39 | 15 | 78 | 304 |
| 23 | 399 | 950 | 1061 | 165 | 265 | 124 | 70 | 96 | 84 | 60 | 100 | 254 |
| 24 | 372 | 1074 | 1345 | 627 | 252 | 134 | 102 | (*a*) | 25 | 68 | 102 | 200 |
| 25 | 311 | 1314 | 1061 | 527 | 197 | 70 | 102 | ...... | 67 | 43 | 110 | 139 |
| 26 | 362 | 1015 | 885 | 456 | 195 | 141 | 122 | ...... | 49 | 57 | 25 | 238 |
| 27 | 308 | 645 | 626 | 331 | 227 | 109 | 110 | ...... | 112 | 48 | 109 | 261 |
| 28 | 332 | 755 | 760 | 279 | 225 | 109 | 88 | ...... | 119 | 25 | 133 | 201 |
| 29 | 385 | ...... | 1075 | 359 | 312 | 84 | 109 | 56 | 96 | 20 | 114 | 249 |
| 30 | 448 | ...... | 1360 | 295 | 333 | 91 | 45 | 96 | 79 | 65 | 105 | 244 |
| 31 | 637 | ...... | 1360 | ...... | 229 | ...... | 141 | 112 | ...... | 65 | ...... | 240 |
| Mean | 662 | 551 | 893 | 921 | 245 | 161 | 123 | 96 | 76 | 64 | 95 | 281 |

*a* Repairing dam; water drawn off August 25 to 28.

## ONEIDA CREEK AT KENWOOD, NEW YORK.

This stream rises in Madison County, New York, and flows in a northwesterly direction, crossing the Erie Canal and emptying into Oneida Lake at its southeastern extremity. It is shown on the Oneida atlas sheet of the United States Geological Survey. The station is located at the silk-mill dam in Kenwood, about 3 miles from Oneida, the drainage area at this point being 59 square miles. One gage gives the height of water above the crest of the dam, and two gages are read at the silk mill, giving the head on wheels. From these readings and from the number of gate openings the quantity of water passing over the dam as well as through the wheels is determined, thus giving the discharge of the creek at this point. The dam is of timber, well constructed, and without leakage. Computations of the flow over it have been made from Bazin's experiments of 1894. The computations for the discharge measurements after July 1, 1899, are based on the coefficients determined at Cornell University. The cross section of the dam is shown in Volume XXVI of the Proceedings of the American Society of Civil Engineers, page 309.

*Estimated daily discharge, in second-feet, of Oneida Creek at Kenwood, New York, for 1899.*

| Day. | May. | June. | July. | Oct. | Nov. | Dec. | Day. | May. | June. | July. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 71 | 46 | 18 | 15 | 144 | 23 | 18 | 68 | 30 | 28 | 25 | 22 | 130 |
| 2 | 60 | 36 | 20 | 21 | 69 | 29 | 19 | 66 | 26 | 26 | 24 | 25 | 97 |
| 3 | 60 | 36 | 20 | 21 | 56 | 25 | 20 | 91 | 31 | 26 | 24 | 28 | 79 |
| 4 | 59 | 35 | 20 | 21 | 66 | 27 | 21 | 80 | 26 | 24 | 25 | 24 | 92 |
| 5 | 54 | 31 | 30 | 21 | 55 | 29 | 22 | 82 | 26 | 25 | ...... | 26 | 80 |
| 6 | 55 | 31 | 34 | 21 | 44 | 29 | 23 | 63 | 31 | 10 | 25 | 24 | 68 |
| 7 | 48 | 31 | 21 | 24 | 40 | 25 | 24 | 54 | 31 | 26 | 25 | 26 | 55 |
| 8 | 53 | 24 | 41 | ...... | 26 | 33 | 25 | 66 | 31 | 21 | 24 | 24 | 70 |
| 9 | 53 | 24 | 40 | 24 | 26 | 41 | 26 | 43 | 31 | 21 | 25 | 25 | 36 |
| 10 | 53 | 24 | 51 | 24 | 24 | 125 | 27 | 43 | 31 | 20 | 24 | 26 | 39 |
| 11 | 54 | 25 | 26 | 21 | 26 | 97 | 28 | 71 | 24 | 21 | 25 | 26 | 27 |
| 12 | 59 | 26 | 24 | 24 | 27 | 70 | 29 | 108 | 24 | 18 | ...... | 26 | 34 |
| 13 | 59 | 26 | 24 | 24 | 28 | 70 | 30 | 76 | 21 | 10 | 29 | 26 | 27 |
| 14 | 48 | 26 | 24 | 24 | 26 | 91 | 31 | 59 | ..... | 21 | 31 | ...... | 34 |
| 15 | 53 | 51 | 21 | ...... | 22 | 82 | | | | | | | |
| 16 | 60 | 41 | 20 | 25 | 26 | 73 | Mean | 62 | 30 | 25 | 24 | 33 | 60 |
| 17 | 61 | 36 | 31 | 25 | 26 | 130 | | | | | | | |

Record not kept for August and September.

## WEST BRANCH OF FISH CREEK AT McCONNELLSVILLE, NEW YORK.

This stream rises in the northern part of Oneida County and flows in a southerly direction to its junction with the East Branch, where it forms the main Fish Creek, which stream flows in a westerly direction, emptying into the east end of Oneida Lake. The lower part of the course of Fish Creek is shown on the Oneida atlas sheet of the United States Geological Survey. The station is located at the Harden dam in McConnellsville. The drainage area at this point is 186.7 square miles. The dam is of timber, with a small leakage. The crest has been so repaired by the Board on Deep Waterways that it is horizontal. The record of gage heights is voluntarily kept by

Frank S. Harden, on a gage showing the height of the river above the crest of the dam and also on one at the end of the tailrace. The flow of this dam is computed from Bazin's experiments, series 170, up to July 1, 1899, and after that date they are based on the experiments made at Cornell University, as noted in Volume XXVI of the Proceedings of the American Society of Civil Engineers, page 310.

*Estimated daily discharge, in second-feet, of West Branch of Fish Creek at McConnellsville, New York, for 1898.*

| Day. | Sept. | Oct. | Nov. | Dec. | Day. | Sept. | Oct. | Nov. | Dec. | Day. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | 137 | 365 | 237 | 12 | ...... | 87 | 997 | 199 | 23 | 57 | 700 | 216 | 317 |
| 2 | ...... | 50 | 319 | 245 | 13 | 100 | 124 | 700 | 186 | 24 | 332 | 750 | 300 | 468 |
| 3 | ...... | 111 | 292 | 217 | 14 | 90 | 134 | 734 | 212 | 25 | 360 | 624 | 329 | 390 |
| 4 | ...... | 121 | 172 | 195 | 15 | 96 | 397 | 434 | 162 | 26 | 197 | 434 | 319 | 285 |
| 5 | ...... | 130 | 155 | 182 | 16 | 47 | 360 | 514 | 157 | 27 | 231 | 1,097 | 255 | 285 |
| 6 | ...... | 137 | 120 | 182 | 17 | 47 | 562 | 365 | 147 | 28 | 181 | 871 | 299 | 225 |
| 7 | ...... | 131 | 146 | 196 | 18 | 50 | 346 | 365 | 120 | 29 | 181 | 686 | 251 | 170 |
| 8 | ...... | 122 | 138 | 182 | 19 | 98 | 227 | 365 | 187 | 30 | 147 | 440 | 172 | 120 |
| 9 | ...... | 65 | 135 | 199 | 20 | 81 | 190 | 370 | 157 | 31 | ...... | 464 | ...... | 120 |
| 10 | ...... | 102 | 557 | 180 | 21 | 57 | 172 | 371 | 190 | | | | | |
| 11 | ...... | 81 | 1,562 | 140 | 22 | 55 | 467 | 220 | 287 | Mean | 134 | 333 | 384 | 210 |

*Estimated daily discharge, in second-feet, of West Branch of Fish Creek at McConnellsville, New York, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | Day. | Jan. | Feb. | Mar. | Apr. | May. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 120 | 228 | 402 | 586 | 273 | 18 | 615 | 133 | 567 | 1644 | 189 |
| 2 | 126 | 183 | 402 | 520 | 313 | 19 | 615 | 120 | 485 | 1434 | 374 |
| 3 | 194 | 183 | 438 | 601 | 243 | 20 | 530 | 183 | 505 | 1174 | 374 |
| 4 | 261 | 172 | 595 | 601 | 184 | 21 | 495 | 198 | 433 | 1085 | 255 |
| 5 | 321 | 120 | 700 | 601 | 184 | 22 | 360 | 258 | 442 | 1045 | 303 |
| 6 | 396 | 212 | 956 | 591 | 184 | 23 | 314 | 338 | 443 | 940 | 244 |
| 7 | 396 | 156 | 856 | 689 | 120 | 24 | 425 | 438 | 442 | 664 | 194 |
| 8 | 285 | 156 | 700 | 1557 | 183 | 25 | 350 | 438 | 442 | 564 | 189 |
| 9 | 352 | 147 | 856 | 2110 | 154 | 26 | 325 | 360 | 360 | 470 | 174 |
| 10 | 422 | 136 | 583 | 1690 | 154 | 27 | 338 | 403 | 552 | 366 | 134 |
| 11 | 502 | 117 | 546 | 1724 | 183 | 28 | 308 | 403 | 599 | 366 | 50 |
| 12 | 587 | 80 | 700 | 2055 | 243 | 29 | 225 | ........ | 599 | 364 | 700 |
| 13 | 873 | 99 | 1178 | 2440 | 194 | 30 | 278 | ........ | 599 | 220 | 455 |
| 14 | 873 | 132 | 1178 | 2920 | 120 | 31 | 278 | ........ | 599 | ........ | 483 |
| 15 | 795 | 94 | 1178 | 3040 | 189 | | | | | | |
| 16 | 787 | 131 | 972 | 2410 | 189 | Mean | 435 | 206 | 615 | 1,206 | 239 |
| 17 | 735 | 148 | 782 | 1720 | 189 | | | | | | |

## EAST BRANCH OF FISH CREEK ABOVE POINT ROCK, NEW YORK.

This stream rises in Lewis County, New York, and flows in a southerly direction into Oneida County, where it joins the West Branch to form the main Fish Creek. The station is located at the sawmill of Fowler W. Willson at Point Rock. The dam is of timber and has considerable leakage. The old sawmill located here is seldom used; whenever the wheels are running, however, record is kept of the length of time and of the amount of gate openings. The profile of crest of dam is somewhat irregular and, in order to facilitate computations, has been divided into five sections, the flow through each of which has been computed separately by Bazin's experiments of 1894. The discharge measurements after July 1, 1899, are based on experiments made at

Cornell University, as noted in Volume XXVI of the Proceedings of the American Society of Civil Engineers, page 310.

*Estimated daily discharge, in second-feet, of East Branch of Fish Creek at Point Rock, New York, for 1898.*

| Day. | Sept. | Oct. | Nov. | Dec. | Day. | Sept. | Oct. | Nov. | Dec. | Day. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | 160 | 340 | 325 | 12 | ...... | 225 | 820 | 360 | 23 | 155 | 1,090 | 370 | 660 |
| 2 | ...... | 100 | 320 | 325 | 13 | ...... | 250 | 485 | 340 | 24 | 690 | 710 | 370 | 745 |
| 3 | ...... | 100 | 250 | 360 | 14 | ...... | 295 | 450 | 385 | 25 | 420 | 460 | 345 | 880 |
| 4 | ...... | 80 | 245 | 340 | 15 | ...... | 600 | 395 | 335 | 26 | 300 | 450 | 325 | 850 |
| 5 | ...... | 210 | 210 | 340 | 16 | ...... | 555 | 370 | 510 | 27 | 265 | 1,245 | 325 | 805 |
| 6 | ...... | 295 | 385 | 340 | 17 | ...... | 350 | 310 | 520 | 28 | 370 | 710 | 340 | 630 |
| 7 | ...... | 240 | 415 | 345 | 18 | ...... | 250 | 340 | 520 | 29 | 300 | 490 | 385 | 490 |
| 8 | ...... | 210 | 350 | 360 | 19 | ...... | 230 | 345 | 570 | 30 | 160 | 400 | 370 | 610 |
| 9 | ...... | 185 | 400 | 370 | 20 | ...... | 310 | 340 | 600 | 31 | ...... | 370 | ...... | 610 |
| 10 | ...... | 185 | 720 | 350 | 21 | ...... | 240 | 310 | 630 | | | | | |
| 11 | ...... | 170 | 1830 | 360 | 22 | 10 | 860 | 265 | 685 | Mean | 296 | 387 | 424 | 501 |

*Estimated daily discharge, in second-feet, of East Branch of Fish Creek at Point Rock, New York, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 565 | 475 | 748 | 970 | 2,745 | 305 | (*a*) | (*a*) | (*a*) | 25 | 650 | 1,200 |
| 2 | 670 | 475 | 810 | 1,040 | 2,260 | 390 | ...... | ...... | ...... | 21 | 650 | 1,230 |
| 3 | 670 | 420 | 810 | 1,090 | 1,950 | 270 | ...... | ...... | ...... | 27 | 665 | 1,180 |
| 4 | 805 | 450 | 815 | 1,150 | 1,340 | 265 | ...... | ...... | ...... | 35 | 660 | 1,160 |
| 5 | 1,190 | 420 | 840 | 1,420 | 930 | 295 | ...... | ...... | ...... | 40 | 635 | 1,120 |
| 6 | 1,280 | 450 | 900 | 1,435 | 750 | 295 | ...... | ...... | ...... | 60 | 680 | 1,120 |
| 7 | 1,280 | 390 | 1,010 | 1,330 | 660 | 260 | ...... | ...... | ...... | 68 | 700 | 1,040 |
| 8 | 1,090 | 370 | 1,010 | 1,220 | 635 | 230 | ...... | ...... | ...... | 80 | 710 | 1,000 |
| 9 | 1,060 | 420 | 770 | 1,150 | 540 | 200 | ...... | ...... | ...... | 100 | 750 | 1,040 |
| 10 | 985 | 390 | 945 | 1,240 | 520 | 160 | ...... | ...... | ...... | 110 | 790 | 1,000 |
| 11 | 930 | 370 | 1,150 | 1,390 | 510 | 150 | ...... | ...... | ...... | 110 | 825 | 1,040 |
| 12 | 900 | 320 | 1,245 | 1,500 | 520 | 165 | ...... | ...... | ...... | 120 | 840 | 1,180 |
| 13 | 1,005 | 440 | 1,200 | 1,600 | 570 | 150 | ...... | ...... | ...... | 115 | 825 | 1,180 |
| 14 | 1,000 | 420 | 1,110 | 1,660 | 520 | 140 | ...... | ...... | ...... | 120 | 840 | 1,040 |
| 15 | 770 | 500 | 1,045 | 1,760 | 580 | 130 | ...... | ...... | ...... | 150 | 880 | 1,000 |
| 16 | 680 | 610 | 985 | 1,870 | 510 | 115 | ...... | ...... | ...... | 130 | 860 | 990 |
| 17 | 610 | 640 | 985 | 1,900 | 500 | 115 | ...... | ...... | ...... | 180 | 860 | 965 |
| 18 | 485 | 740 | 1,090 | 1,900 | 600 | 125 | ...... | ...... | ...... | 190 | 880 | 990 |
| 19 | 550 | 760 | 1,150 | 2,030 | 650 | 150 | ...... | ...... | ...... | 190 | 900 | 1,000 |
| 20 | 510 | 810 | 1,100 | 2,510 | 700 | 170 | ...... | ...... | ...... | 190 | 900 | 990 |
| 21 | 490 | 750 | 1,060 | 3,170 | 635 | 175 | ...... | ...... | ...... | 195 | 840 | 965 |
| 22 | 485 | 780 | 1,045 | 3,550 | 540 | 175 | ...... | ...... | ...... | 220 | 840 | 915 |
| 23 | 425 | 820 | 1,165 | 4,030 | 410 | 170 | ...... | ...... | ...... | 270 | 860 | 915 |
| 24 | 385 | 825 | 1,165 | 4,320 | 415 | 150 | ...... | ...... | ...... | 270 | 900 | 880 |
| 25 | 370 | 900 | 1,235 | 4,650 | 500 | 120 | ...... | ...... | ...... | 285 | 920 | 810 |
| 26 | 350 | 945 | 1,235 | 4,170 | 450 | 105 | ...... | ...... | ...... | 290 | 900 | 960 |
| 27 | 320 | 1,050 | 1,165 | 3,490 | 410 | 95 | ...... | ...... | ...... | 335 | 940 | 960 |
| 28 | 370 | 1,210 | 1,150 | 3,110 | 440 | 100 | ...... | ...... | ...... | 415 | 1,025 | 1,040 |
| 29 | 320 | ...... | 1,130 | 2,790 | 475 | 80 | ...... | ...... | ...... | 510 | 1,080 | 1,045 |
| 30 | 320 | ...... | 1,200 | 2,790 | 450 | 70 | ...... | ...... | ...... | 530 | 1,100 | 1,060 |
| 31 | 340 | ...... | 1,245 | ...... | 400 | ...... | ...... | ...... | ...... | 620 | ...... | 1,060 |
| Mean | 684 | 612 | 1,049 | 2,208 | 745 | 177 | ...... | ...... | ...... | 194 | 830 | 1,035 |

*a* Flow during July, August, and September not computed, owing to fact that all water leaked through the dam.

## OSWEGO RIVER AT FULTON, NEW YORK.

This stream is formed by the junction of Oneida and Seneca rivers in Onondaga County, New York, and flows northwesterly, emptying into Lake Ontario at the city of Oswego. The station is located at the dam at Fulton, 7 miles above Oswego, the catchment area being 4,916 square miles. The dam is well built of stone and brick and has no leakage. At this point four gages are read—one above the dam, one in the tailrace of the Fulton Worsted Mill, one in the headrace and one in the tailrace of the Oswego Falls Pulp and Paper Company's mill. The mills are located at each end of the dam, and both use water from the Oswego River. The dam is 404.6 feet in length, and the crest is practically level. During the low-water stages flashboards are placed on the crest of the dam, and in order to compute the discharge of the river at this point it is necessary to take these flashboards into account, as well as the height of the dam, the head on the various wheels, and the number of openings of the same. The records at this point are not at present available. A cross section of the dam is given in Volume XXVI of the Proceedings of the American Society of Civil Engineers, page 309.

## OSWEGO RIVER AT OSWEGO, NEW YORK.

Another series of records on this stream besides the one at Fulton have been maintained at the high dam between Oswego and Fulton. The water at this point is used in the State canal and by the Oswego Waterworks Company, whose pump house is on the left side of the stream. This station was established April 1, 1897. The following figures of daily gage height were obtained from Mr. Thomas H. Bennett, superintendent of the Oswego Waterworks Company:

*Daily gage height, in feet, of Oswego River at Oswego, New York, for 1897.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.38 | ........ | 5.63 | 6.56 | 8.08 | 8.79 | 8.33 | 8.50 | 7.42 |
| 2 | 3.54 | 4.58 | 5.60 | 6.33 | 8.08 | ........ | 8.38 | 8.29 | 7.42 |
| 3 | 3.71 | 4.65 | 5.60 | 6.42 | ........ | 8.79 | ........ | 8.17 | 7.33 |
| 4 | ........ | 4.73 | 5.60 | ........ | 8.08 | 8.83 | 8.67 | 8.17 | 7.44 |
| 5 | 3.71 | 4.75 | ........ | 6.42 | 8.17 | ........ | 8.46 | 8.25 | ........ |
| 6 | 3.71 | 4.83 | 5.63 | 6.46 | ........ | 8.92 | 8.42 | 8.17 | 7.08 |
| 7 | 3.71 | 4.88 | 5.63 | 6.58 | 8.25 | 8.79 | 8.42 | ........ | 7.17 |
| 8 | 3.75 | ........ | 5.67 | 6.79 | ........ | 8.83 | 8.54 | 8 21 | 7.17 |
| 9 | 3.52 | 4.94 | 5.67 | 6.75 | 8.58 | 8.75 | 8.58 | 8.17 | 6.88 |
| 10 | ........ | 5.00 | 5.67 | 6.79 | 8.50 | 8.83 | ........ | 8.08 | 6.83 |
| 11 | 3.54 | 5.00 | 5.67 | ........ | 8.50 | 8.83 | 8.46 | 8.17 | 6.75 |
| 12 | 3.54 | ........ | ........ | 6.50 | 8.42 | ........ | 8.46 | 8.17 | ........ |
| 13 | 3.54 | 5.04 | 5.67 | 6.83 | 8.50 | 8.42 | 8.54 | 8.25 | 6.79 |
| 14 | 3.71 | 5.08 | 5.75 | 6.96 | 8.44 | 8.29 | 8.33 | 8.25 | 6.83 |
| 15 | 3.71 | ........ | 5.75 | 6.83 | ........ | 8.38 | 8.42 | ........ | 6.50 |
| 16 | 3.75 | 5.04 | 5.77 | 6.75 | 8.58 | 8.33 | 8.38 | 8.04 | 6.54 |
| 17 | ........ | 5.04 | 5.85 | 6.75 | 8.42 | 8.50 | ........ | 7.98 | 6.50 |
| 18 | 3.90 | 5.04 | 5.90 | ........ | 8.42 | 8.54 | 8.79 | 7.92 | 6.50 |
| 19 | 4.00 | 5.17 | ........ | 6.67 | 8.50 | ........ | 8.42 | 7.83 | ........ |
| 20 | 4.08 | 5.25 | 5.96 | 6.71 | 8.50 | 8.67 | 8.25 | 7.83 | 6.50 |
| 21 | 4.13 | 5.25 | 6.17 | 6.67 | 8.54 | 8.63 | ........ | ........ | 6.63 |
| 22 | 4.17 | ........ | 6.17 | 6.75 | ........ | 8.58 | 8.33 | 7.79 | 6.75 |
| 23 | 4.21 | 5.29 | 6.25 | 6.71 | 8.67 | 8.58 | 8.33 | 7.92 | 6.75 |
| 24 | 4.27 | 5.38 | 6.25 | 6.83 | 8.71 | 8.58 | ........ | 7.79 | 7.17 |
| 25 | 4.48 | 5.29 | 6.33 | ........ | 8.71 | 8.42 | 8.38 | 7.79 | 7.33 |
| 26 | 4.48 | 5.38 | ........ | 6.42 | 8.75 | ........ | 8.42 | 7.79 | ........ |
| 27 | 4.48 | 5.42 | 6.25 | 6.33 | 8.75 | 8.50 | 8.46 | 7.46 | 7.08 |
| 28 | 4.48 | 5.42 | 6.38 | 6.33 | 8.75 | 8.21 | 8.42 | ........ | 7.25 |
| 29 | 4.50 | ........ | 6.21 | *a* 8.00 | ........ | 8.54 | 8.50 | 7.17 | 7.46 |
| 30 | 4.67 | 5.46 | 6.31 | 8.13 | 8.79 | 8.46 | 8.50 | 7.17 | 7.17 |
| 31 | ........ | 5.46 | ........ | 8.10 | 8.58 | ........ | ........ | ........ | 7.25 |

*a* 2.01 feet were added to the wall of the dam.

*Daily gage height, in feet, of Oswego River at Oswego, New York, for 1898.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.58 | 6.50 | 5.88 | 6.13 | ------- | 7.00 | 8.29 | 8.33 | 7.83 | ------- | 7.00 | 6.75 |
| 2 | ------- | 6.50 | 5.92 | 6.17 | 6.46 | ------- | 8.29 | 8.33 | 7.83 | 7.83 | 7.00 | 6.75 |
| 3 | 7.42 | 6.50 | 6.00 | ------- | 6.50 | 6.96 | ------- | 8.33 | 7.88 | ------- | 7.00 | ------- |
| 4 | 7.58 | 6.67 | 6.08 | 6.31 | 6.29 | 7.25 | ------- | 8.00 | 8.17 | 7.83 | 7.00 | 6.46 |
| 5 | 7.29 | 6.67 | 6.17 | 6.35 | 6.27 | 7.25 | ------- | 8.17 | 7.92 | 7.88 | ------- | 6.75 |
| 6 | 7.46 | ------- | ------- | 6.44 | 6.25 | 7.25 | ------- | 8.25 | 7.96 | ------- | 7.08 | 6.92 |
| 7 | 7.25 | 6.50 | 6.29 | 6.50 | 6.21 | 7.25 | 7.83 | 8.25 | 7.96 | 7.92 | 7.02 | 6.75 |
| 8 | 7.33 | 6.67 | 6.25 | 6.58 | ------- | 7.50 | ------- | 8.08 | 7.67 | ------- | 7.08 | 6.96 |
| 9 | ------- | 6.63 | 6.25 | 6.67 | 6.21 | 7.50 | ------- | 8.25 | 7.71 | 7.88 | 7.00 | 7.04 |
| 10 | 7.50 | 6.63 | 6.25 | ------- | 6.25 | 7.58 | 8.00 | 8.25 | 7.67 | 7.96 | 6.42 | ------- |
| 11 | 7.50 | 6.63 | 6.21 | 6.71 | 6.33 | 7.58 | 8.00 | 8.33 | 7.83 | 8.00 | 6.38 | 7.00 |
| 12 | 7.33 | 6.17 | 6.13 | 6.83 | ------- | 7.58 | 7.92 | 8.42 | 7.75 | 8.00 | ------- | 7.00 |
| 13 | 6.75 | ------- | ------- | 6.92 | 6.42 | 7.67 | 7.58 | 8.50 | 7.67 | 8.25 | 6.08 | 7.42 |
| 14 | 6.63 | 6.54 | 5.92 | 6.92 | 6.42 | 7.75 | 7.58 | 8.21 | 7.83 | ------- | 6.08 | 7.50 |
| 15 | 6.50 | 6.63 | 5.88 | 7.00 | 6.46 | 7.77 | ------- | 8.42 | 7.92 | ------- | 6.17 | 7.33 |
| 16 | ------- | 6.83 | 5.88 | 7.00 | ------- | ------- | ------- | 8.25 | 7.92 | 7.67 | 6.25 | 7.25 |
| 17 | 6.25 | 6.58 | 5.85 | ------- | ------- | 7.90 | ------- | 8.25 | 7.67 | 7.75 | 6.25 | ------- |
| 18 | 6.54 | 6.00 | 5.88 | 7.10 | 6.71 | 7.90 | ------- | 8.25 | 8.00 | 7.67 | 6.33 | 7.17 |
| 19 | 6.54 | 6.00 | 5.88 | 7.17 | 6.71 | 8.00 | ------- | 8.25 | 8.00 | 7.67 | ------- | 7.25 |
| 20 | 6.54 | ------- | ------- | 6.92 | ------- | 8.00 | ------- | 8.25 | 8.00 | 7.58 | 6.33 | 7.17 |
| 21 | 6.29 | 5.92 | 5.88 | 7.13 | ------- | 8.00 | ------- | 8.33 | 8.00 | 7.58 | 6.33 | 6.75 |
| 22 | 6.21 | 5.92 | 5.83 | 7.17 | ------- | 8.08 | ------- | 8.21 | 8.00 | ------- | 6.25 | 6.50 |
| 23 | ------- | 5.79 | 5.83 | 7.17 | 6.83 | 8.08 | ------- | 8.25 | 8.00 | 7.33 | 6.38 | 6.13 |
| 24 | 5.75 | 5.67 | 5.88 | ------- | ------- | 8.13 | ------- | 8.33 | 7.92 | 7.17 | 6.42 | ------- |
| 25 | 5.75 | 5.67 | 5.88 | 6.50 | ------- | ------- | ------- | 8.27 | 7.88 | 7.17 | 6.42 | 6.08 |
| 26 | 5.88 | 5.67 | 5.92 | 6.38 | 6.92 | ------- | ------- | 7.83 | 8.08 | 7.13 | ------- | 6.08 |
| 27 | 5.83 | ------- | ------- | 6.25 | ------- | ------- | ------- | 7.92 | 7.92 | 7.08 | 6.50 | 6.13 |
| 28 | 6.17 | 5.75 | 6.00 | 6.17 | ------- | 8.21 | ------- | 7.92 | 8.00 | 6.96 | 6.50 | 6.42 |
| 29 | 6.17 | ------- | 6.00 | 6.27 | ------- | 8.27 | ------- | 7.92 | 7.92 | 7.00 | 6.58 | 6.25 |
| 30 | ------- | ------- | 6.04 | 6.29 | ------- | 8.29 | ------- | 7.75 | 7.88 | ------- | 6.58 | 6.25 |
| 31 | 6.83 | ------- | 6.04 | ------- | 6.96 | ------- | ------- | 7.75 | ------- | 7.00 | ------- | ------- |

*Daily gage height, in feet, of Oswego River at Oswego, New York, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.54 | 7.21 | 6.83 | 5.92 | 6.08 | 7.33 | ------- | 8.42 | 8.29 | 8.50 | 7.92 |
| 2 | 6.71 | 7.29 | 6.75 | ------- | 6.08 | 7.33 | 8.00 | 8.33 | ------- | 8.33 | 7.92 |
| 3 | 6.54 | 7.21 | 6.67 | 5.83 | 6.08 | ------- | ------- | 8.33 | 9.00 | 8.33 | 7.75 |
| 4 | 6.29 | ------- | 6.67 | 5.83 | ------- | 7.67 | 8.00 | 8.33 | 8.42 | 8.42 | ------- |
| 5 | ------- | 7.38 | 6.33 | 5.83 | 6.33 | 7.67 | 8.00 | ------- | 8.50 | 8.42 | 7.75 |
| 6 | 6.25 | 7.38 | 8.25 | 5.83 | ------- | 7.83 | 8.17 | 8.33 | 8.58 | 8.42 | 7.67 |
| 7 | 6.46 | 7.42 | 6.25 | 5.92 | 6.83 | 7.83 | 8.33 | 8.33 | 8.33 | ------- | 7.75 |
| 8 | 6.67 | 8.08 | 6.42 | ------- | 6.50 | 8.00 | ------- | 8.50 | 8.50 | ------- | ------- |
| 9 | 7.00 | 8.67 | 6.50 | 5.25 | 6.67 | 8.17 | 8.00 | 8.33 | ------- | 8.50 | ------- |
| 10 | 7.08 | 8.50 | 6.50 | 5.33 | 6.83 | ------- | 8.08 | 8.42 | 7.08 | 8.50 | ------- |
| 11 | 7.00 | ------- | ------- | 5.25 | 6.83 | 8.08 | 8.00 | 8.33 | 8.58 | 8.50 | ------- |
| 12 | 7.00 | 7.75 | 6.33 | 5.17 | ------- | 8.08 | 8.17 | ------- | 9.00 | 8.50 | ------- |
| 13 | 6.75 | 7.75 | 6.33 | 5.17 | ------- | 8.25 | 8.17 | 8.42 | 8.55 | 8.67 | ------- |
| 14 | ------- | 7.58 | 6.42 | 5.21 | 7.08 | 7.50 | 8.33 | 8.50 | 8.33 | 8.58 | ------- |
| 15 | 6.17 | 7.38 | 6.38 | ------- | 7.08 | 7.50 | ------- | 8.42 | 8.75 | ------- | ------- |
| 16 | 6.13 | 7.25 | 6.33 | 5.25 | 7.00 | 7.50 | 8.08 | 8.33 | 10.58 | 8.58 | ------- |
| 17 | 6.13 | 7.33 | 6.38 | 5.25 | 7.00 | ------- | 8.25 | 8.33 | ------- | 8.67 | ------- |
| 18 | 6.25 | ------- | ------- | 5.25 | 7.00 | 7.50 | 8.33 | 9.08 | ------- | 8.42 | ------- |
| 19 | 6.29 | 7.33 | 6.50 | 5.33 | 7.08 | 7.58 | 8.33 | ------- | 8.67 | 8.75 | ------- |
| 20 | 6.25 | 7.21 | 6.50 | 5.25 | ------- | 7.58 | 8.33 | 9.50 | 8.50 | 8.50 | ------- |
| 21 | ------- | 7.17 | 6.46 | 5.50 | 7.08 | 7.67 | 8.42 | 8.50 | 9.17 | ------- | ------- |
| 22 | 6.42 | 7.00 | ------- | ------- | 7.08 | 7.67 | ------- | 8.33 | 8.67 | 8.33 | ------- |
| 23 | 6.42 | 7.00 | 6.33 | 5.54 | 7.08 | 7.83 | 8.33 | 8.42 | ------- | 8.33 | ------- |
| 24 | 6.50 | 7.00 | 6.38 | 5.63 | 7.08 | ------- | 8.33 | 8.50 | 9.33 | 8.33 | ------- |
| 25 | 6.33 | ------- | ------- | 5.75 | 7.25 | 7.67 | 8.42 | 8.42 | 8.50 | 8.42 | ------- |
| 26 | 6.29 | 6.75 | 6.13 | 5.75 | 7.33 | 7.50 | ------- | 8.42 | 8.50 | 8.50 | ------- |
| 27 | 7.42 | 6.79 | 6.13 | 5.79 | ------- | 7.67 | 8.33 | 8.50 | 8.50 | 8.33 | ------- |
| 28 | 7.08 | 6.79 | 6.17 | 5.75 | 7.33 | ------- | 8.42 | 8.50 | 8.50 | ------- | ------- |
| 29 | 7.42 | ------- | 5.83 | ------- | 7.33 | 8.17 | ------- | 8.00 | 8.50 | 8.08 | ------- |
| 30 | 7.25 | ------- | 5.75 | 6.00 | 7.33 | 8.25 | 8.42 | 8.17 | ------- | 8.33 | ------- |
| 31 | 7.25 | ------- | 5.75 | ------- | 7.33 | ------- | 8.42 | 8.33 | ------- | 8.33 | ------- |

## SALMON RIVER AT ORWELL, NEW YORK.

This river rises in Lewis County, New York, and flows in a westerly direction into Lake Ontario, a portion of its course being shown on the Pulaski atlas sheet of the United States Geological Survey. At a point about a mile below Orwell are Salmon Falls, where the river has a vertical descent of about 110 feet, but at present no attempt has been made to utilize it. Observations were made at Orwell, at which locality the river has a drainage area of 190.5 square miles. The gages are at an old wooden dam built to furnish power for a saw-mill. The dam is considerably out of repair and leaks badly. When the station was first established current-meter measurements were made of this leakage, and it was found to be 88 cubic feet per second. The profile of the crest is irregular, and in order to facilitate computation is divided into four parts, each section being computed separately and the sum total taken as the entire flow. The station was abandoned May 31, 1899, on account of the leakage through the dam, which it was difficult to estimate accurately. The results are not at present available for publication.

### BLACK RIVER AT WATERTOWN, NEW YORK.

This river rises in Herkimer County and flows in a northeasterly direction into Black River Bay, an arm of Lake Ontario. A portion of its course is shown on the Watertown atlas sheet of the United States Geological Survey. Observations of the height of water have been made at the dam of the city waterworks of Watertown, located 2 miles above, at Huntingtonville. The station was established on February 22, 1897. The record in the following table has been furnished by Frank A. Hinds, civil engineer. It is the average of two daily readings.

The readings from August 22 to September 16, 1897, do not give reliable data, as the high dam on the opposite channel of the river developed a leak, which gradually increased until it became necessary to open the traps in the dam, letting the water down so that it could be repaired. It is possible that this leak commenced earlier than August 22. The conditions at this point are peculiar, in that the stream flows in two channels with an island between. There is a dam on each channel, the high dam, previously referred to, creating a settling basin for the water supply of the city of Watertown. The other dam, known as the Huntingtonville, on the opposite side of the island, is the one near which the readings given herewith are taken.

In addition to the amount of water which is indicated by the flow over this (the Huntingtonville) dam, there should be added the quantity taken from the other channel above the high dam to supply water for the city of Watertown. There is also constant leakage from seams in the rock underneath the Huntingtonville dam, where the observations are made. This quantity has been variously estimated, but direct measurements have not been made. In the following table the original readings have been diminished by dropping the figure 100; for example, the reading on February 22, 1897, of 103.10 is given below as 3.10. In a few instances this has introduced a minus quantity when the surface dropped below 100, as was the case on October 3, and 8 to 11, 1897.

The crest of the dam is irregular in profile, and for ease of computation is divided into six parts, each of these being considered horizontal.

The discharge of the river was computed by Mr. Robert E. Horton. The results, however, have been revised several times upon the acquisition of new information. Another record of Black River has been kept by the Taggart Company at Felts Mills, about 10 miles above Watertown, covering a somewhat longer period of time than that at Huntingtonville, but the figures are not at present available.

*Daily gage height, in feet, of Black River at Huntingtonville dam, for 1897.*

| Day. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | 3.00 | 4.20 | 5.01 | 3.73 | 2.89 | 3.20 | 1.28 | 0.35 | 2.68 | 4.63 |
| 2 | ...... | ...... | 4.23 | 4.83 | 3.58 | 2.88 | 3.16 | .95 | .37 | 2.84 | 4.40 |
| 3 | ...... | ...... | 4.40 | 4.56 | 3.40 | 2.93 | 3.15 | 1.26 | .02 | 3.21 | 3.57 |
| 4 | ...... | ...... | 4.48 | 4,41 | 3.57 | 2.85 | 3.03 | 1.44 | .10 | 3.50 | 3.45 |
| 5 | ...... | 3.32 | 4.90 | 4.58 | 3.72 | 2.79 | 2.85 | 1.14 | .18 | 3.42 | 3.75 |
| 6 | ...... | 3.58 | 5.03 | 4.49 | 3.65 | 2.71 | 2.79 | 1.55 | .10 | 3.25 | 4.10 |
| 7 | ...... | 3.69 | 5.22 | 4.43 | 3.49 | 2.93 | 2.70 | 1.65 | .03 | 3.20 | 4.26 |
| 8 | ...... | 3.74 | 5.48 | 4.12 | 3.40 | 2.75 | 2.49 | 1.55 | .02 | 3.34 | 4.31 |
| 9 | ...... | 3.80 | 5.60 | 3.83 | 3.30 | 2.73 | 2.64 | 1.49 | .44 | 3.35 | 4.38 |
| 10 | ...... | 3.98 | 5.60 | 3.59 | 4.05 | 2.77 | 2.70 | 1.47 | .63 | 3.56 | 4.40 |
| 11 | ...... | 4.35 | 5.40 | 3.59 | 4.48 | 2.64 | 3.60 | 1.23 | .10 | 4.02 | 4.77 |
| 12 | ...... | 4.43 | 5.05 | 3.45 | 4.54 | 2.67 | 4.63 | .78 | .35 | 4.03 | 4.83 |
| 13 | ...... | 4.58 | 4.75 | 3.47 | 4.43 | 2.82 | 4.74 | .71 | 1.68 | 4.15 | 4.70 |
| 14 | ...... | 4.50 | 4.64 | 3.63 | 4.03 | 2.69 | 4.40 | .80 | 2.92 | 3.92 | 4.60 |
| 15 | ...... | 4.35 | 4.70 | 4.08 | 3.73 | 2.95 | 3.75 | .35 | 3.00 | 3.82 | 4.73 |
| 16 | ...... | 4.20 | 4.88 | 4.23 | 3.55 | 2.99 | 3.42 | .00 | 3.45 | 3.63 | 4.91 |
| 17 | ...... | 4.00 | 5.07 | 4.10 | 3.44 | 2.95 | 3.20 | 1.25 | 2.83 | 3.95 | 5.00 |
| 18 | ...... | 3.90 | 5.15 | 3.95 | 3.31 | 2.90 | 3.30 | 1.40 | 2.98 | 4.23 | 4.96 |
| 19 | ...... | 3.88 | 5.24 | 3.72 | 3.18 | 2.87 | 3.44 | 1.08 | 2.95 | 4.24 | 4.46 |
| 20 | ...... | 4.38 | 5.18 | 3.64 | 3.10 | 2.89 | 3.23 | 1.28 | 2.88 | 3.90 | 3.75 |
| 21 | ...... | 5.20 | 5.24 | 3.46 | 3.33 | 2.90 | 3.03 | 1.18 | 2.83 | 3.60 | 3.68 |
| 22 | 3.10 | 5.10 | 5.16 | 3.51 | 3.53 | 2.85 | 2.91 | 1.33 | 2.80 | 3.73 | 3.68 |
| 23 | 3.10 | 5.48 | 4.95 | 3.65 | 3.39 | 2.76 | 2.89 | 1.38 | 2.79 | 3.57 | 3.66 |
| 24 | 3.50 | 6.48 | 4.82 | 3.44 | 3.23 | 2.70 | 2.74 | 1.25 | 2.60 | 3.35 | 3.50 |
| 25 | 3.25 | 6.10 | 5.13 | 3.47 | 3.07 | 2.60 | 2.63 | 1.25 | 2.88 | 3.25 | 3.43 |
| 26 | 3.75 | 5.70 | 5.53 | 3.90 | 2.99 | 2.90 | 2.66 | 1.30 | 2.77 | 3.74 | 3.47 |
| 27 | ...... | 5.45 | 5.80 | 4.13 | 2.89 | 2.87 | 2.67 | 1.30 | 2.79 | 4.90 | 3.39 |
| 28 | ...... | 4.88 | 6.07 | 4.03 | 2.99 | 2.85 | 2.44 | 1.65 | 2.83 | 5.13 | 3.36 |
| 29 | ...... | 4.48 | 6.01 | 3.92 | 2.89 | 3.00 | 2.34 | 1.58 | 2.75 | 5.28 | 3.32 |
| 30 | ...... | 4.30 | 5.41 | 3.85 | 2.87 | 3.28 | 1.97 | .33 | 2.75 | 4.92 | 3.30 |
| 31 | ...... | 4.30 | ...... | 3.80 | ...... | 3.30 | .63 | ...... | 2.73 | ...... | 3.23 |

*Daily gage height, in feet, of Black River at Huntingtonville dam, for 1898.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.21 | 3.55 | 3.40 | 4.75 | 4.03 | 3.55 | 3.09 | 2.95 | 3.01 | 3.14 | 3.65 | 3.48 |
| 2 | 3.39 | 3.60 | 3.50 | 4.59 | 3.73 | 3.42 | 3.04 | 3.15 | 3.00 | 2.91 | 3.53 | 3.45 |
| 3 | 3.28 | 3.57 | 3.40 | 4.20 | 3.78 | 3.31 | 2.84 | 2.96 | 2.95 | 2.94 | 3.50 | 3.45 |
| 4 | 3.30 | 3.50 | 3.40 | 3.90 | 3.83 | 3.23 | 2.80 | 3.03 | 2.45 | 2.95 | 3.43 | 3.38 |
| 5 | 3.34 | 3.55 | 3.35 | 3.80 | 3.89 | 3.21 | 2.95 | 3.10 | 3.05 | 3.08 | 3.40 | 3.40 |
| 6 | 3.30 | 3.45 | 3.35 | 3.80 | 4.13 | 3.14 | 2.94 | 3.26 | 3.22 | 3.55 | 3.37 | 3.38 |
| 7 | 3.25 | 3.50 | 3.35 | 3.75 | 4.03 | 3.13 | 2.98 | 3.20 | 3.19 | 3.70 | 3.65 | 3.28 |
| 8 | 3.15 | 3.50 | 3.37 | 3.73 | 3.75 | 3.05 | 2.91 | 3.15 | 3.20 | 3.58 | 3.60 | 3.23 |
| 9 | 3.25 | 3.45 | 3.52 | 3.65 | 3.55 | 2.98 | 2.88 | 3.01 | 3.28 | 3.27 | 3.60 | 3.18 |
| 10 | 3.23 | 3.40 | 3.75 | 3.63 | 3.60 | 3.01 | 2.76 | 2.95 | 3.23 | 3.28 | 3.60 | 3.19 |
| 11 | 3.23 | 3.68 | 4.53 | 3.63 | 3.45 | 3.11 | 2.82 | 2.95 | 3.10 | 3.19 | 4.98 | 3.13 |
| 12 | 3.22 | 4.65 | 5.75 | 3.56 | 3.28 | 3.03 | 2.90 | 2.98 | 3.11 | 3.06 | 5.15 | 3.23 |
| 13 | 3.63 | 4.93 | 6.75 | 3.51 | 3.80 | 3.05 | 2.90 | 3.05 | 3.03 | 3.03 | 5.13 | 3.23 |
| 14 | 4.00 | 4.75 | 7.50 | 3.53 | 3.86 | 3.23 | 2.89 | 3.02 | 2.88 | 3.16 | 5.05 | 3.25 |
| 15 | 4.10 | 4.55 | 8.10 | 3.60 | 3.72 | 3.35 | 2.90 | 2.70 | 2.90 | 3.53 | 4.78 | 3.25 |
| 16 | 4.04 | 4.30 | 7.55 | 3.59 | 3.51 | 3.31 | 2.90 | 3.01 | 2.85 | 3.77 | 4.48 | 3.26 |
| 17 | 3.99 | 4.05 | 6.70 | 3.48 | 3.50 | 3.23 | 2.88 | 2.90 | 2.84 | 4.03 | 4.08 | 3.30 |
| 18 | 3.88 | 3.90 | 6.20 | 3.38 | 3.42 | 3.13 | 2.90 | 2.85 | 2.62 | 3.85 | 3.88 | 3.25 |
| 19 | 3.78 | 3.80 | 6.00 | 3.48 | 3.35 | 2.97 | 3.09 | 2.88 | 2.80 | 3.62 | 3.70 | 3.28 |
| 20 | 3.75 | 3.73 | 5.74 | 3.58 | 3.48 | 3.25 | 2.97 | 2.87 | 2.81 | 3.53 | 3.61 | 3.33 |
| 21 | 4.00 | 3.85 | 5.83 | 3.85 | 3.58 | 3.35 | 3.00 | 2.88 | 2.96 | 3.52 | 3.71 | 3.33 |
| 22 | 4.35 | 3.91 | 5.97 | 3.99 | 3.53 | 3.30 | 3.00 | 2.81 | 2.92 | 3.61 | 3.71 | 3.48 |
| 23 | 4.35 | 3.89 | 5.87 | 4.25 | 3.44 | 3.23 | 3.00 | 2.95 | 2.85 | 4.02 | 3.63 | 3.98 |
| 24 | 4.48 | 3.80 | 5.55 | 4.53 | 3.48 | 3.18 | 2.87 | 3.35 | 3.10 | 4.31 | 3.71 | 4.34 |
| 25 | 4.43 | 3.69 | 5.18 | 4.73 | 3.55 | 3.05 | 3.03 | 3.50 | 3.54 | 4.08 | 3.56 | 4.30 |
| 26 | 4.32 | 3.60 | 4.95 | 5.09 | 3.58 | 3.00 | 3.30 | 3.65 | 3.58 | 3.93 | 3.48 | 4.22 |
| 27 | 4.12 | 3.55 | 4.65 | 5.33 | 3.85 | 2.93 | 3.20 | 3.66 | 3.55 | 4.33 | 3.18 | 4.00 |
| 28 | 3.90 | 3.65 | 4.48 | 5.24 | 3.93 | 3.05 | 3.05 | 3.53 | 3.43 | 4.60 | 3.31 | 3.75 |
| 29 | 3.74 | ...... | 4.51 | 4.85 | 3.73 | 3.04 | 3.06 | 3.30 | 3.39 | 4.57 | 3.41 | 3.65 |
| 30 | 3.59 | ...... | 4.75 | 4.40 | 3.69 | 3.03 | 3.03 | 3.10 | 3.25 | 4.25 | 3.50 | 3.83 |
| 31 | 3.60 | ...... | 4.88 | ...... | 3.66 | ...... | 3.12 | 3.08 | ...... | 3.90 | ...... | 4.14 |

*Daily gage height, in feet, of Black River at Huntingtonville dam, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.98 | 3.28 | 3.79 | 3.95 | 6.71 | 3.65 | 3.10 | 2.88 | 2.89 | 2.88 | 3.38 | 2.98 |
| 2 | 3.91 | 3.33 | 3.70 | 3.89 | 6.43 | 3.43 | 2.91 | 2.90 | 3.01 | 2.88 | 3.75 | 2.99 |
| 3 | 3.74 | 3.31 | 3.69 | 3.86 | 6.20 | 3.38 | 2.90 | 2.95 | 2.70 | 3.10 | 3.93 | 3.08 |
| 4 | 3.80 | 3.30 | 3.72 | 3.79 | 5.99 | 3.23 | 2.88 | 2.90 | 2.95 | 3.05 | 3.69 | 3.33 |
| 5 | 5.38 | 3.30 | 3.88 | 3.80 | 5.70 | 3.18 | 3.07 | 2.83 | 2.60 | 2.98 | 3.59 | 3.32 |
| 6 | 5.25 | 3.30 | 4.23 | 3.91 | 5.20 | 3.20 | 3.09 | 2.73 | 2.90 | 2.91 | 3.53 | 3.18 |
| 7 | 5.05 | 3.30 | 4.43 | 4.06 | 4.79 | 3.18 | 3.15 | 2.80 | 2.85 | 2.91 | 3.43 | 3.10 |
| 8 | 5.05 | 3.30 | 4.32 | 4.65 | 4.21 | 3.13 | 3.10 | 2.85 | 2.91 | 2.73 | 3.25 | 3.00 |
| 9 | 4.89 | 3.30 | 4.21 | 4.92 | 3.95 | 3.05 | 2.98 | 2.90 | 2.93 | 2.92 | 3.24 | 2.99 |
| 10 | 4.63 | 3.29 | 4.08 | 4.96 | 3.83 | 3.13 | 3.26 | 2.83 | 2.91 | 2.83 | 3.10 | 2.95 |
| 11 | 4.30 | 3.25 | 3.95 | 5.09 | 3,73 | 3.00 | 3.50 | 2.76 | 3.00 | 2.88 | 3.08 | 3.18 |
| 12 | 4.05 | 3.29 | 4.24 | 5.43 | 3.83 | 3.13 | 3.35 | 2.73 | 2.73 | 2.80 | 2.93 | 4.15 |
| 13 | 3.93 | 3.38 | 4.93 | 5.51 | 3.88 | 3.05 | 3.21 | 2.75 | 3.05 | 2.81 | 3.09 | 4.98 |
| 14 | 3.90 | 3.38 | 4.90 | 5.71 | 3.70 | 3.05 | 3.13 | 2.76 | 2.70 | 2.81 | 2.96 | 4.98 |
| 15 | 4.11 | 3.38 | 4.84 | 5.99 | 3.60 | 2.96 | 3.08 | 2.92 | 2.74 | 2.81 | 3.00 | 4.88 |
| 16 | 4.39 | 3.35 | 4.65 | 6.01 | 3.63 | 3.10 | 2.91 | 2.95 | 2.98 | 2.74 | 3.06 | 4.35 |
| 17 | 4.41 | 3.37 | 4.60 | 6.06 | 3.65 | 3.10 | 2.87 | 2.93 | 2.78 | 2.90 | 3.10 | 3.53 |
| 18 | 4.30 | 3.29 | 4.40 | 6.06 | 3.83 | 3.10 | 2.90 | 3.16 | 3.00 | 2.89 | 3.10 | 3.71 |
| 19 | 4.25 | 3.25 | 4.25 | 6.17 | 3.63 | 3.18 | 3.03 | 2.90 | 2.98 | 2.92 | 2.93 | 4.11 |
| 20 | 3.65 | 3.30 | 4.09 | 6.61 | 3.85 | 3.05 | 2.88 | 2.75 | 2.75 | 2.94 | 2.95 | 4.30 |
| 21 | 3.84 | 3.33 | 4.10 | 7.13 | 4.05 | 3.00 | 2.88 | 2.63 | 2.80 | 2.83 | 3.01 | 4.55 |
| 22 | 3.73 | 3.42 | 4.09 | 7.64 | 4.01 | 3.00 | 2.90 | 2.90 | 2.93 | 2.63 | 2.98 | 4.60 |
| 23 | 3.68 | 3.61 | 4.10 | 7.71 | 3.85 | 3.00 | 2.89 | 2.85 | 2.75 | 2.90 | 2.93 | 4.20 |
| 24 | 3.60 | 3.76 | 4.20 | 7.72 | 3.77 | 3.05 | 3.00 | 2.83 | 2.70 | 2.88 | 2.99 | 4.10 |
| 25 | 3.55 | 3.75 | 4.17 | 7.70 | 3.59 | 3.02 | 3.05 | 3.01 | 2.99 | 2.93 | 2.95 | 4.00 |
| 26 | 3.59 | 3.65 | 4.13 | 7.72 | 3.44 | 3.03 | 2.96 | 2.95 | 2.95 | 2.95 | 2.79 | 3.60 |
| 27 | 3.50 | 3.75 | 4.08 | 7.62 | 3.46 | 3.13 | 2.92 | 2.83 | 2.99 | 2.95 | 2.94 | 3.48 |
| 28 | 3.43 | 3.78 | 3.98 | 7.51 | 3.43 | 3.05 | 2.94 | 2.84 | 2.99 | 2.95 | 2.96 | 3.40 |
| 29 | 3.30 | 4.10 | 3.94 | 7.34 | 3.42 | 2.98 | 2.82 | 2.85 | 2.99 | 2.93 | 2.93 | 3.38 |
| 30 | 3.40 | 4.10 | 4.08 | 7.06 | 3.73 | 3.05 | 2.65 | 2.90 | 3.03 | 3.03 | 2.86 | 3.38 |
| 31 | 3.34 | ------- | 3.97 | ------- | 3.75 | ------- | 2.68 | 2.88 | ------- | 3.28 | ------- | 3.23 |

## ST. LAWRENCE RIVER NEAR MONTREAL, CANADA.

St. Lawrence River receives the outflow of the Great Lakes, and, discharging northeasterly, is joined by Ottawa River near the city of Montreal. About 50 miles below Montreal the river widens into what is known as Lake St. Peter. At the upper end of this lake is the town of Sorel, at which is one of the important gages for recording the height of the stream. The discharge of the river has been measured at a point about 40 miles below Montreal and a mile below the wharf at the town of Lanoraie, this place being chosen because of the excellent form of the channel. The width of the river here is between 3,000 and 3,300 feet, and the depth at low stages about 40 feet. The first measurement was made by Mr. W. J. Sproule, under the direction of the Montreal Flood Commission, by means of rod floats, on November 9 and 13, 1886. At that time the height of water was 11 feet 9 inches on the flats of Lake St. Peter. The area of cross section was 115,298 square feet, and the discharge 311,101 second-feet.[1] The next measurements were made by Prof. C. H. McLeod, of McGill University, Montreal, on November 13 and 14, 1895. At that time the water was 8 feet 9 inches in depth on the flats of Lake St. Peter, the area was 105,432 square feet, and the discharge 215,621 second-feet. The lowest water of that year (1895) occurred in the latter part of October and early in November, the water level being at the time of measurement 7 inches above the lowest

[1] Discharge of the St. Lawrence River, by Prof. C. H. McLeod: Trans. Can. Soc. Civil Engineers, Vol. X, Part I, 1896, p. 129.

point previously recorded. It is estimated that at the lowest stage of that year, which is the lowest on record, the cross section was reduced about 2 per cent, and the discharge was estimated to have been 196,000 second-feet.

On October 23 and 24, 1896, another measurement was made by Professor McLeod, giving an area of cross section of 117,500 square feet and a discharge of 258,500 second-feet. At this date the depth of water on the flats of Lake St. Peter was 10 feet and 7 inches. All depths on these flats have been obtained by reduction from the zero readings taken on the gage at Sorel, the zero of which is said to correspond to 9 feet 6 inches below the level of the flats, and to +0.05 on Steikel's datum, as noted in the Reports of the Public Works Department, Canada, for 1890–91. The height of water at this section is known to be influenced slightly by the tides, but the effect on the discharge has not been investigated.

The discharge of Ottawa River was measured on September 27 and 28, 1899, at a point about 2 miles below the dam at Carillon. The cross section measured 50,000 square feet and the discharge 39,600 second-feet. At the time of the measurement the reading of the gage at Lock No. 1 of Carillon Canal gave 12.0 feet on the lower sill.

## MISSISSIPPI RIVER AT ST. PAUL, MINNESOTA.

Measurements of discharge of the Mississippi River at St. Paul, below the mouth of the Minnesota River, have been made for a number of years by the Engineer Corps of the United States Army. The object of the measurements is the determination of the effect of the reservoirs at the head of the Mississippi River in maintaining deep or navigable water during the periods of drought. Measurements and computations of the amount of water discharged from reservoirs at such seasons are made and comparisons had with the behavior of the river at St. Paul and lower places. Observations of river height are made at the United States Weather Bureau gage located on a wharf near the foot of Jackson street. The zero of this gage is at an elevation of 683.334 feet. The measurements are made from a boat, at a section about halfway between Wabash street bridge and Roberts street bridge, in the city of St. Paul. Every time a series of observations are made two wires are stretched across the river parallel to each other and at a distance of 13 feet apart. Upon the completion of the measurement the wires are reeled up separately on apparatus especially constructed for the purpose, as it is impossible to maintain permanent cables across the river, on account of obstructing navigation. The bridges in the city are too high for satisfactory work. Records of height are maintained by the United States Weather Bureau and are furnished to this office. Results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 267; 1898, Twentieth Annual Report, Part IV, page 230.

*Daily gage height, in feet, of Mississippi River at St. Paul, Minnesota, for 1899.*[1]

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

*a* Estimated.

## WEST GALLATIN RIVER AT SALESVILLE, MONTANA.

This stream has its source in the northwestern corner of Yellowstone National Park and flows in a northerly direction, joining Madison and Gallatin rivers near Threeforks to form the Missouri River. The upper 75 miles of its course is in a canyon the scenery of which rivals many of the noted canyons of Yellowstone National Park. Surveys for a road up this canyon have been made in order to reach the road system that the Government has built in the park, but the plans have not yet been carried out. About 10 miles above Salesville, Montana, the river leaves its canyon and enters the Gallatin Valley, which has an extent, in round numbers, of 1,200 square miles. This area has been noted for a number of years for its fertility; immense crops of hay and cereals are yearly matured here. The land is irrigated from canals taken from the Gallatin River and a number of tributaries, including Middle Creek, Bozeman Creek, and East Gallatin River. On certain bench lands against the sides of the surrounding mountains dry farming is practiced, or, in other words, crops are raised without irrigation. Two gaging stations are maintained on this river, one near Salesville and the other at Logan, near its mouth. The Salesville station, which has been maintained for a number of years, is located at the highway bridge crossing the stream about 5 miles south of Salesville. Kleinschmidt ditch, having a capacity of 75 second-feet but carrying of late years not over 40 second-feet, diverts water from the river above the station. A gage rod was erected in 1895 and

[1] Records kept by United States Weather Bureau.

spiked to a tree; in 1896 a wire gage was placed on the bridge, and the two gages made to read the same. The bench mark is the head of the southwest bolt in the rim of the southeast cylindrical pier, and its elevation is 13.70 feet above gage datum. The observer is Ira T. Williams, of Salesville, Montana. The results of discharge measurements are shown as follows: 1896, Eighteenth Annual Report, Part IV, page 126; 1897, Nineteenth Annual Report, Part IV, page 276; 1898, Twentieth Annual Report, Part IV, page 241. The following measurements were made under the supervision of Samuel Fortier during 1899:

March 21, gage height, 2.90 feet; discharge, 474 second-feet.
April 6, gage height, 2.80 feet; discharge, 766 second-feet.
April 13, gage height, 3.25 feet; discharge, 719 second-feet.
May 1, gage height, 3.40 feet; discharge, 830 second-feet.
May 9, gage height, 4.00 feet; discharge, 1,056 second-feet.
June 10, gage height, 5.35 feet; discharge, 2,607 second-feet.
August 30, gage height, 3.88 feet; discharge, 711 second-feet.

*Daily gage height, in feet, of West Gallatin River at Salesville, Montana, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.10 | 2.70 | | | 3.30 | 4.70 | 7.30 | 4.60 | 3.80 | 3.50 | | |
| 2 | 3.10 | | | 2.80 | 3.20 | 5.10 | 7.30 | 4.50 | 3.80 | 3.50 | | |
| 3 | 3.10 | | | 2.80 | 3.10 | 5.50 | 7.30 | 4.50 | 3.80 | 3.50 | | 3.10 |
| 4 | 3.10 | | | 2.80 | 3.20 | 6.10 | 7.30 | 4.50 | 3.70 | 3.50 | | |
| 5 | 3.10 | 3.10 | 2.90 | 2.80 | 3.30 | 5.65 | 7.20 | 4.50 | 3.70 | 3.50 | 3.50 | |
| 6 | 3.10 | | | 2.80 | 3.40 | 5.00 | 7.20 | 4.40 | 3.70 | 3.50 | | |
| 7 | 3.10 | | | 2.90 | 3.50 | 5.00 | 7.10 | 4.40 | 3.70 | 3.50 | | |
| 8 | 3.10 | | 2.90 | 3.20 | 3.70 | 4.95 | 7.05 | 4.35 | 3.70 | 3.50 | | |
| 9 | 3.10 | | | 3.30 | 3.90 | 5.05 | 7.00 | 4.30 | 3.70 | 3.50 | | |
| 10 | 3.10 | | | 3.30 | 3.90 | 4.30 | 6.95 | 4.30 | 3.70 | 3.50 | | 3.10 |
| 11 | | | | 3.30 | 4.00 | 5.70 | 6.85 | 4.20 | 3.60 | 3.50 | | |
| 12 | | 3.10 | 2.90 | 3.30 | 4.10 | 6.05 | 6.75 | 4.20 | 3.60 | 3.50 | 3.50 | |
| 13 | | | | 3.20 | 4.00 | 6.15 | 6.45 | 4.20 | 3.60 | 3.50 | | |
| 14 | | | | 3.10 | 3.90 | 6.50 | 6.25 | 4.10 | 3.60 | 3.50 | | |
| 15 | 3.04 | | | 3.10 | 3.90 | 6.95 | 5.95 | 4.10 | 3.60 | 3.50 | | |
| 16 | | | | 3.20 | 3.90 | 7.05 | 5.75 | 4.10 | 3.60 | 3.50 | | |
| 17 | | | 2.90 | 3.10 | 3.85 | 7.25 | 5.55 | 4.10 | 3.60 | 3.50 | | 3.40 |
| 18 | | | | 3.00 | 3.80 | 7.60 | 5.40 | 4.10 | 3.60 | 3.50 | | |
| 19 | 3.00 | 3.00 | 2.90 | 3.00 | 3.80 | 8.10 | 5.30 | 4.10 | 3.60 | 3.50 | 3.50 | |
| 20 | | | | 3.00 | 3.80 | 8.55 | 5.30 | 4.10 | 3.60 | 3.50 | | |
| 21 | | | | 3.10 | 3.90 | 8.10 | 5.30 | 4.00 | 3.60 | 3.50 | | |
| 22 | | | | 3.20 | 4.15 | 7.35 | 5.20 | 3.90 | 3.60 | 3.50 | | |
| 23 | | | | 3.30 | 4.30 | 6.70 | 5.10 | 3.90 | 3.60 | 3.50 | | |
| 24 | | | 2.90 | 3.30 | 4.50 | 6.90 | 5.00 | 3.90 | 3.60 | 3.50 | | 3.30 |
| 25 | 2.90 | | | 3.30 | 4.55 | 7.00 | 5.00 | 3.90 | 3.60 | 3.50 | | |
| 26 | | 2.90 | | 3.40 | 4.65 | 7.10 | 4.90 | 3.90 | 3.50 | 3.50 | 3.50 | |
| 27 | | | | 3.50 | 4.55 | 7.20 | 4.85 | 3.90 | 3.50 | 3.50 | | |
| 28 | | | | 3.30 | 4.50 | 7.20 | 4.80 | 3.90 | 3.50 | 3.50 | | |
| 29 | 2.80 | | | 3.30 | 4.60 | 7.20 | 4.70 | 3.80 | 3.50 | | | |
| 30 | | | | 3.30 | 4.65 | 7.30 | 4.70 | 3.80 | 3.50 | | | |
| 31 | | | 2.80 | 3.30 | 4.70 | | 4.60 | 3.80 | | | | |

## MIDDLE CREEK NEAR BOZEMAN, MONTANA.

This creek, a tributary of East Gallatin River, has its source on the northern slope of the Gallatin Range. Although it drains a small area, it is an important stream, on account of its water supply, which is used for irrigation purposes in the vicinity of Bozeman. The gaging station is located 9 miles south of Bozeman and one-eighth of a mile above the old sawmill dam in the creek canyon. Discharge measurements are made from a wire cable placed across the stream in 1898. The gage is about 200 feet below the cable, and consists of a horizontal frame supporting a wire gage. Bench mark No. 1 consists of a spike driven horizontally into a stump 5 feet high about 80 feet east of the gage rod. The middle of this spike is at an elevation of 7.03 feet above gage datum. Bench mark No. 2 consists of an 8-inch bridge spike driven horizontally into a charred stump about 25 feet northeast of the gage, with an elevation of 3.58 feet. Bench mark No. 3 consists of a large rock 93 feet east of the gage, marked "B. M." in black paint, and is 4.84 feet above gage datum. Results of discharge measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 128; 1898, Twentieth Annual Report, Part IV, page 243. The following measurements were made under the direction of Samuel Fortier during 1899:

*Measurements of Middle Creek near Bozeman, Montana.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | Feet. | Sec.-feet. | 1899. | Feet. | Sec.-feet. |
| Mar. 14 | 0.05 | 78 | June 28 | 1.20 | 426 |
| Apr. 4 | .05 | 86 | July 7 | .98 | 440 |
| Apr. 12 | .05 | 79 | July 18 | .80 | 384 |
| May 7 | .10 | 92 | July 26 | .60 | 246 |
| June 16 | .90 | 351 | Aug. 26 | .15 | 77 |

*Daily gage height, in feet, of Middle Creek at Bozeman, Montana, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 0.70 | 1.30 | 0.40 | 0.10 | 0.00 |
| 2 | | | | | | 1.20 | 1.10 | .40 | .10 | .05 |
| 3 | —0.25 | | | | | 1.10 | 1.00 | .40 | .13 | .00 |
| 4 | | | | | | 1.70 | .95 | .40 | .10 | .00 |
| 5 | | | | | | 1.00 | 1.00 | .40 | .10 | .00 |
| 6 | | —0.15 | | | | .80 | 1.00 | .35 | .10 | .00 |
| 7 | | | —0.05 | | 0.20 | .70 | .95 | .40 | .10 | .00 |
| 8 | | | | | .20 | .60 | 1.10 | .35 | .10 | .08 |
| 9 | | | — .10 | | .28 | .70 | 1.00 | .35 | .10 | .00 |
| 10 | | | | | .40 | .85 | 1.20 | .30 | .08 | .00 |
| 11 | | | | | .50 | 1.10 | 1.60 | .30 | .08 | .00 |
| 12 | .00 | | | | .43 | 1.20 | .95 | .30 | .05 | .00 |
| 13 | | | — .08 | | .35 | .90 | .90 | .30 | .05 | .00 |
| 14 | | | — .08 | | .30 | .80 | .85 | .25 | .05 | .00 |
| 15 | | | | | .20 | .80 | .80 | .20 | .05 | .00 |
| 16 | | | | | .23 | 1.10 | .80 | .20 | | .00 |
| 17 | — .10 | | | | .30 | 1.50 | .80 | .20 | .04 | .00 |
| 18 | | | | | .28 | 1.60 | .80 | .20 | .04 | .00 |
| 19 | | | | | .30 | 1.60 | .95 | .20 | .03 | .00 |
| 20 | | | | | .28 | 1.70 | .85 | .20 | .01 | .00 |
| 21 | | | | | .25 | 1.60 | .75 | .15 | .01 | .00 |
| 22 | | | | | .23 | 1.40 | .60 | .15 | .01 | .00 |
| 23 | | — .60 | — .05 | | .30 | 1.60 | .55 | .15 | .01 | .00 |
| 24 | — .10 | | | | .68 | 1.00 | .50 | .15 | .00 | .00 |
| 25 | | | | | .70 | 1.35 | .65 | .15 | .00 | .00 |
| 26 | | | | | .65 | 1.35 | .60 | .15 | .00 | .00 |
| 27 | | | | | .60 | 1.35 | .60 | .10 | .00 | .00 |
| 28 | | — .75 | — .08 | | .70 | 1.15 | .50 | .10 | .00 | .00 |
| 29 | | | | | .70 | 1.50 | .50 | .10 | .00 | .00 |
| 30 | — .10 | | — .05 | | .50 | 1.30 | .45 | .10 | .00 | .00 |
| 31 | | | | | .70 | | .40 | .10 | | .00 |

## GALLATIN RIVER AT LOGAN, MONTANA.

The main Gallatin River is formed by the junction of the East and West Gallatin rivers 5 miles above Logan. The wire gage is located on the east span of the railroad bridge. Bench mark No. 1 is the top of the northeast corner of the iron plate at foot of diagonal end member of truss east end upper side, and is 13.70 feet above datum. Bench mark No. 2 consists of the head of a bridge spike driven vertically into the top of a pile stump, to which the lower end of the old incline gage is fastened; it is 0.162 foot above gage datum. Discharge measurements are made from the cable across the river 300 feet above the railroad bridge, and show the amount of water available after the diversion as above. The section is a good one, the channel being straight for some distance above and below the gaging cable. The results of measurements are published as follows: 1896, Eighteenth Annual Report, Part IV, page 129; 1897, Nineteenth Annual Report, Part IV, page 278; 1898, Twentieth Annual Report, Part IV, page 240. The following measurements were made under the direction of Samuel Fortier during 1899:

March 18, gage height, 1.00 foot; discharge, 580 second-feet.
April 9, gage height, 1.90 feet; discharge, 1,120 second-feet.
April 24, gage height, 1.60 feet; discharge, 1,089 second-feet.
May 22, gage height, 2.20 feet; discharge, 1,786 second-feet.
July 14, gage height, 3.00 feet; discharge, 1,079 second-feet.
July 30, gage height, 1.90 feet; discharge, 760 second-feet.

*Daily gage height, in feet, of Gallatin River at Logan, Montana, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 1.00 | 1.50 | 3.05 | 5.00 | 1.90 | 1.50 | 1.30 | 1.50 | |
| 2 | | 1.00 | 1.50 | 3.10 | 5.00 | 1.80 | 1.50 | 1.30 | 1.50 | |
| 3 | | 1.00 | 1.50 | 3.35 | 4.45 | 1.80 | 1.40 | 1.30 | 1.50 | |
| 4 | | 1.15 | 1.50 | 4.10 | 4.30 | 1.80 | 1.40 | 1.30 | 1.50 | |
| 5 | | 1.05 | 1.50 | 4.05 | 4.05 | 1.80 | 1.40 | 1.30 | | |
| 6 | 1.00 | 1.40 | 1.55 | 3.80 | 3.90 | 1.80 | 1.40 | 1.30 | | 1.50 |
| 7 | 1.20 | 1.80 | 1.60 | 3.45 | 3.75 | 1.80 | 1.40 | 1.30 | | |
| 8 | 1.35 | 1.95 | 1.65 | 3.25 | 3.55 | 1.80 | 1.40 | 1.30 | 1.50 | |
| 9 | 1.45 | 2.65 | 1.85 | 3.10 | 3.50 | 1.80 | 1.40 | 1.30 | | |
| 10 | 1.25 | 3.25 | 2.20 | 3.35 | 3.50 | 1.90 | 1.40 | 1.30 | | |
| 11 | 1.10 | 2.85 | 2.35 | 3.65 | 3.50 | 1.90 | 1.40 | 1.30 | | |
| 12 | 1.00 | 3.10 | 2.45 | 4.25 | 3.30 | 1.90 | 1.40 | 1.30 | | |
| 13 | 1.00 | 2.70 | 2.60 | 4.35 | 3.05 | 1.90 | 1.40 | 1.30 | | 1.60 |
| 14 | 1.00 | 2.40 | 2.75 | 4.05 | 3.00 | 1.90 | 1.40 | 1.30 | | |
| 15 | 1.00 | 1.85 | 2.80 | 3.80 | 2.90 | 1.90 | 1.40 | 1.30 | 1.50 | |
| 16 | 1.00 | 2.15 | 2.75 | 4.00 | 2.80 | 1.80 | 1.40 | 1.30 | | |
| 17 | 1.00 | 2.00 | 2.80 | 4.35 | 2.70 | 1.80 | 1.40 | 1.30 | | |
| 18 | 1.00 | 1.90 | 2.55 | 5.25 | 2.60 | 1.70 | 1.40 | 1.30 | | |
| 19 | 1.00 | 1.80 | 2.00 | 5.65 | 2.60 | 1.70 | 1.40 | 1.30 | | |
| 20 | 1.00 | 1.80 | 1.90 | 5.90 | 2.45 | 1.70 | 1.40 | 1.30 | | 1.60 |
| 21 | 1.10 | 1.50 | 1.90 | 6.25 | 2.40 | 1.70 | 1.40 | 1.30 | | |
| 22 | 1.10 | 1.75 | 2.05 | 5.60 | 2.40 | 1.70 | 1.40 | 1.30 | 1.50 | |
| 23 | 1.10 | 1.70 | 2.15 | 4.90 | 2.35 | 1.65 | 1.30 | 1.50 | | |
| 24 | 1.20 | 1.60 | 2.45 | 4.75 | 2.25 | 1.60 | 1.30 | 1.70 | | |
| 25 | 1.50 | 1.60 | 2.75 | 4.85 | 2.10 | 1.60 | 1.30 | 1.65 | | |
| 26 | 1.35 | 1.60 | 2.90 | 5.20 | 2.00 | 1.60 | 1.30 | 1.60 | | |
| 27 | 1.30 | 1.60 | 2.90 | 5.20 | 1.90 | 1.60 | 1.30 | 1.50 | | |
| 28 | 1.10 | 1.60 | 2.90 | 5.00 | 1.90 | 1.60 | 1.30 | 1.50 | | |
| 29 | 1.00 | 1.60 | 2.90 | 5.10 | 1.90 | 1.55 | 1.30 | 1.50 | 1.60 | (a) |
| 30 | 1.00 | 1.60 | 3.00 | 5.05 | 1.90 | 1.50 | 1.30 | 1.50 | | |
| 31 | 1.00 | | 3.05 | | 1.90 | 1.50 | | 1.50 | | |

January 1 to March 6 river frozen; no readings. *a* Frozen.

A measurement of Bridger Creek, a tributary of East Gallatin River, was made August 3 at the highway bridge at the fish hatchery in the canyon, and showed a discharge of 25 second-feet.

## 1895.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Robert Hay.

A geological reconnoissance of northwestern Wyoming, by George H. Eldridge, 1894; octavo, 72 pp. Bulletin No. 119 of the United States Geological Survey; price, 10 cents.

Contains a description of the geologic structure of portions of the Bighorn Range and Bighorn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 176 pp. Bulletin No. 131 of the United States Geological Survey; price, 15 cents.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in a number of counties in western Nebraska, western Kansas, and eastern Colorado.

## 1896.

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett; and "Preliminary report on the artesian areas of a portion of the Dakotas," by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 230 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey; price, 20 cents.

Gives a description of the geologic conditions of the coastal region from Long Island, N. Y., to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey; price, 25 cents.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

## 1897.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part IV, Hydrography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in South Dakota," by N. H. Darton; and "Reservoirs for irrigation," by J. D. Schuyler.

## 1899.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Part IV, Hydrography, 1899; octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1897," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton; and "Preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

## 1900.

Twentieth Annual Report of the United States Geological Survey, 1898–99, Part IV, Hydrography, 1900; octavo, 660 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell, and "Hydrography of Nicaragua," by A. P. Davis.

## Water-Supply and Irrigation Papers, 1896–1899.

This series of papers is designed to present in pamphlet form the results of stream measurements and of special investigations. A list of these, with other information, is given on the outside (or fourth) page of this cover.

Survey bulletins can be obtained only by prepayment of cost, as noted above. Postage stamps, checks, and drafts can not be accepted. Money should be transmitted by postal money order or express order, made payable to the Director of the United States Geological Survey. Correspondence relating to the publications of the Survey should be addressed to The Director, United States Geological Survey, Washington, D. C.

1. Pumping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phœnix, Arizona, by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A reconnoissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill, 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E. C. Murphy, 1897.
9. Irrigation near Greeley, Colorado, by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Underground waters of southeastern Nebraska, by N. H. Darton, 1898.
13. Irrigation systems in Texas, by W. F. Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15. Operations at river stations, 1897, Part I, 1898.
16. Operations at river stations, 1897, Part II, 1898.
17. Irrigation near Bakersfield, California, by C. E. Grunsky, 1898.
18. Irrigation near Fresno, California, by C. E. Grunsky, 1898.
19. Irrigation near Merced, California, by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of northern Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems of Bighorn Mountains, by Elwood Mead, 1899.
24. Water resources of the State of New York, Part I, by George W. Rafter, 1899.
25. Water resources of the State of New York, Part II, by George W. Rafter, 1899.
26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett, 1899.
27. Operations at river stations, 1898, Part I, 1899.
28. Operations at river stations, 1898, Part II, 1899.
29. Wells and windmills in Nebraska, by Erwin Hinckley Barbour, 1899.
30. Water resources of the Lower Peninsula of Michigan, by Alfred C. Lane, 1899.
31. Lower Michigan mineral waters, by Alfred C. Lane, 1899.
32. Water resources of Puerto Rico, by H. M. Wilson, 1900.
33. Storage of water on Gila River, Arizona, by J. B. Lippincott, 1900.
34. Geology and water resources of southeastern S. Dak., by J. E. Todd, 1900.
35. Operations at river stations, 1899, Part I, 1900.
36. Operations at river stations, 1899, Part II, 1900.
37. Operations at river stations, 1899, Part III, 1900.
38. Operations at river stations, 1899, Part IV, 1900.

In addition to the above, there are, in various stages of preparation, other papers relating to the measurement of streams, the storage of water, the amount available from underground sources, the efficiency of windmills, the cost of pumping, and other details relating to the methods of utilizing the water resources of the country. Provision has been made for printing these by the following clause in the sundry civil act making appropriations for the year 1896–97:

*Provided*, That hereafter the reports of the Geological Survey in relation to the gaging of streams and to the methods of utilizing the water resources may be printed in octavo form, not to exceed 100 pages in length and 5,000 copies in number; 1,000 copies of which shall be for the official use of the Geological Survey, 1,500 copies shall be delivered to the Senate, and 2,500 copies shall be delivered to the House of Representatives, for distribution. (Approved, June 11, 1896; Stat. L., vol. 29, p. 453.)

The maximum number of copies available for the use of the Geological Survey is 1,000. This quantity falls far short of the demand, so that it is impossible to supply all requests. Attempts are made to send these pamphlets to persons who have rendered assistance in their preparation through replies to schedules or who have furnished data. Requests made for a certain paper and stating a reason for asking for it are granted whenever practicable, but it is impossible to comply with general demands, such as to have all of the series sent indiscriminately.

Application for these papers should be made either to members of Congress or to

THE DIRECTOR, UNITED STATES GEOLOGICAL SURVEY, WASHINGTON, D. C.

DEPARTMENT OF THE INTERIOR



# WATER-SUPPLY

AND

# IRRIGATION PAPERS

OF THE

## UNITED STATES GEOLOGICAL SURVEY



## No. 37

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OPERATIONS AT RIVER STATIONS, 1899.—Part III

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

# IRRIGATION REPORTS.

The following list contains the titles and brief descriptions of the principal reports relating to water supply and irrigation prepared by the United States Geological Survey since 1890:

## 1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888-89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

## 1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889-90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 29 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890-91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell; quarto.

No. 35, Irrigation in Arizona; No. 60, Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

## 1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc., of irrigated holdings, the total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps, showing the location and relative extent of the irrigated areas.

## 1893.

Thirteenth Annual Report of the United States Geological Survey, 1891-92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering" and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnaissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 15 plates. Bulletin No. 108 of the United States Geological Survey; price, 15 cents.

Contains a description of the examination of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

## 1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details: then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892-93, in two parts; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.



(Continued on third page of cover.)

DEPARTMENT OF THE INTERIOR

# WATER-SUPPLY

AND

# IRRIGATION PAPERS

OF THE

## UNITED STATES GEOLOGICAL SURVEY

## No. 37

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

# OPERATIONS AT RIVER STATIONS, 1899

A REPORT OF THE

## DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

## PART III

WASHINGTON

GOVERNMENT PRINTING OFFICE

1900

# CONTENTS.

# OPERATIONS AT RIVER STATIONS, 1899.

## PART III.

### MEASUREMENTS AT RIVER STATIONS.[1]

#### MADISON RIVER AT REDBLUFF, MONTANA.

This river has its source in the central portion of the Yellowstone National Park, and flows in a general northerly direction, joining the Jefferson and Gallatin rivers near Threeforks to form the Missouri River. Some distance beyond the western boundary of the park an opening of considerable extent occurs, known as the Upper Madison Valley. Below Meadow Creek the bluffs close in again, and the river is in canyon to below the mouth of Cherry Creek. Beyond this it gradually opens into the lower valley. The country about the head waters of the stream is too high for profitable farming, except for summer stock ranging. Less water can be used for irrigation from this stream than from the other two tributaries of the Missouri, but the fall is admirably adapted for power purposes, and a number of surveys have been made in this connection. The gage rod, which was established May 2, 1897, is located at the ranch of the observer, Mrs. S. A. Black, 3 miles below the Redbluff iron county bridge over the Madison and about 1½ miles below the mouth of Cherry Creek. Discharge measurements are made at the highway bridge above. Cherry Creek enters between the bridge and the gage rod, and it is necessary to measure its discharge whenever a measurement of the main river is made. On June 3 its discharge was 366 second-feet, and on June 29 its discharge was 186 second-feet. Results of measurements are published as follows: 1897, Nineteenth Annual Report, Part IV, page 280; 1898, Twentieth Annual Report, Part IV, page 236. The following discharge measurements, not including Cherry Creek, were made in 1899 under the direction of Samuel Fortier:

June 3, gage height, 2.50 feet; discharge, 4,784 second-feet.
June 30, gage height, 3.30 feet; discharge, 7,616 second-feet.

[1] Continued from Water-Supply and Irrigation Paper No. 36.

*Daily gage height, in feet, of Madison River at Redbluff, Montana, for 1896.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 1.65 | 2.60 | 3.65 | 1.70 | 1.40 | 1.30 | | |
| 2 | | 1.65 | 2.60 | 3.40 | 1.70 | 1.40 | 1.30 | | |
| 3 | | 1.65 | 2.70 | 3.30 | 1.70 | 1.40 | 1.30 | 1.30 | |
| 4 | | 1.65 | 2.70 | 3.20 | 1.65 | 1.40 | 1.30 | | |
| 5 | | 1.65 | 2.80 | 3.10 | 1.60 | 1.40 | 1.30 | | |
| 6 | | 1.65 | 2.70 | 2.90 | 1.70 | 1.40 | 1.30 | | |
| 7 | | 1.65 | 2.80 | 2.85 | 1.80 | 1.40 | 1.30 | | (*a*) |
| 8 | | 1.70 | 2.80 | 2.80 | 1.80 | 1.40 | 1.30 | | |
| 9 | | 1.75 | 2.90 | 2.75 | 1.85 | 1.40 | 1.30 | | |
| 10 | | 1.75 | 3.00 | 2.70 | 1.80 | 1.40 | 1.30 | | |
| 11 | | 1.80 | 3.10 | 2.60 | 1.75 | 1.40 | 1.30 | | |
| 12 | | 1.80 | 3.25 | 2.55 | 1.70 | 1.40 | 1.30 | | |
| 13 | | 1.85 | 3.40 | 2.45 | 1.70 | 1.40 | 1.30 | | |
| 14 | | 1.10 | 3.50 | 2.30 | 1.70 | 1.40 | 1.30 | | |
| 15 | | 1.10 | 3.70 | 2.30 | 1.70 | 1.40 | 1.30 | | (*a*) |
| 16 | 1.60 | 1.95 | 3.90 | 2.10 | 1.60 | 1.40 | 1.30 | 1.30 | |
| 17 | 1.60 | 1.90 | 3.80 | 2.00 | 1.60 | 1.40 | 1.30 | | |
| 18 | 1.60 | 1.10 | 3.70 | 1.90 | 1.55 | 1.40 | 1.30 | | |
| 19 | 1.55 | 1.10 | 3.70 | 1.90 | 1.50 | 1.40 | 1.30 | | |
| 20 | 1.55 | 1.10 | 3.70 | 1.90 | 1.40 | 1.40 | 1.30 | | |
| 21 | 1.60 | 1.10 | 3.60 | 1.95 | 1.40 | 1.40 | 1.30 | | |
| 22 | 1.65 | 1.10 | 3.60 | 2.00 | 1.40 | 1.40 | 1.30 | | |
| 23 | 1.60 | 1.10 | 3.60 | 2.00 | 1.40 | 1.40 | 1.30 | 1.30 | |
| 24 | 1.60 | 1.10 | 3.65 | 1.90 | 1.40 | 1.40 | 1.30 | | |
| 25 | 1.60 | 1.55 | 3.60 | 1.80 | 1.40 | 1.40 | 1.30 | | |
| 26 | 1.55 | 2.10 | 3.60 | 1.80 | 1.40 | 1.40 | 1.30 | | |
| 27 | 1.65 | 2.30 | 3.60 | 1.65 | 1.40 | 1.40 | 1.30 | | |
| 28 | 1.65 | 2.50 | 3.60 | 1.60 | 1.40 | 1.40 | 1.30 | | (*a*) |
| 29 | 1.65 | 2.50 | 3.65 | 1.60 | 1.40 | 1.40 | 1.30 | | |
| 30 | 1.65 | 2.50 | 3.70 | 1.70 | 1.40 | 1.40 | 1.30 | (*a*) | |
| 31 | | 2.60 | | 1.70 | 1.40 | | 1.30 | | |

January 1 to April 15, river frozen; no readings. *a* Ice.

## JEFFERSON RIVER AT SAPPINGTON, MONTANA.

This river is formed by the union of Bighole and Beaverdam rivers near Twin Bridges, Montana. The former stream has its source in the highest parts of the Rocky Mountains, which form the Continental Divide and the State boundary line between Montana and Idaho. The head-water tributary of Beaverdam River is Redrock Creek, rising in in the southwestern part of the State, about 20 miles west of the boundary line of Yellowstone National Park. Jefferson River is one of the main streams that unite at Threeforks to form the Missouri River. This latter name should apply to the Jefferson and its tributary, Redrock Creek, as this is the longest of the three head-water streams of the Missouri. Irrigation is practiced to a limited extent in the upper reaches of the Jefferson, mainly for forage plants. From Twin Bridges downstream to the mouth of the North and South Boulder creeks is an extent of tillable land, which, however, has been little utilized up to the present time. The river is in canyon from Boulder Creek to about Willow Creek, whence the gorge gradually widens out into the Gallatin Valley. The station on this river is located at Sappington, 7 miles above Willow Creek, and was established by Arthur P. Davis November 13, 1894. The wire gage is fastened to the guard rail on the upper side of the Northern Pacific Railway bridge, 1 mile north of the railroad station. Bench mark No. 1 consists of a 6-inch wire nail driven horizontally in the east side of the blocking which forms the south abutment of the railroad bridge and is 6.90 feet above gage datum. Bench mark No. 2 is a 6-inch wire nail in a telegraph pole, about 30 feet south and east of the south abutment of the bridge, and is at an elevation of 7 feet on the gage. Bench mark No. 3 is the head of the northwest bolt fastening the switch standard to the cross-tie, 30 feet east of the bridge. Its elevation is 15.67 feet. On November 3, 1897, the rod was lowered eight-tenths of a foot, the subsequent readings being adjusted to the new datum. Discharge measurements are made from a cable and car erected a short distance above the bridge. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 134; 1897, Nineteenth Annual Report, Part IV, page 281; 1898, Twentieth Annual Report, Part IV, page 238. The following measurements were made during 1899 by Samuel Fortier:

April 10, gage height, 2.70 feet; discharge, 2,891 second-feet.
April 24, gage height, 2.80 feet; discharge, 2,595 second-feet.
May 21, gage height, 4.50 feet; discharge, 6,505 second-feet.
July 13, gage height, 5.40 feet; discharge, 4,847 second-feet.
July 29, gage height, 3.10 feet; discharge, 2,909 second-feet.

*Daily gage height, in feet, of Jefferson River at Sappington, Montana, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 2.70 | 3.00 | 5.80 | 7.60 | 3.10 | 2.30 | 2.10 | 2.90 | 2.60 |
| 2 | | 2.70 | 3.00 | 5.80 | 7.55 | 3.00 | 2.30 | 2.10 | 2.80 | 2.60 |
| 3 | | 2.70 | 2.90 | 6.15 | 7.35 | 3.00 | 2.30 | 2.10 | 2.80 | 2.60 |
| 4 | | 2.70 | 2.85 | 7.00 | 7.20 | 2.90 | 2.30 | 2.10 | 2.80 | 2.60 |
| 5 | | 2.70 | 2.80 | 7.30 | 6.90 | 2.90 | 2.30 | 2.10 | 2.80 | 2.60 |
| 6 | | 2.70 | 3.05 | 7.40 | 6.70 | 2.90 | 2.30 | 2.10 | 2.80 | 2.60 |
| 7 | | 2.70 | 3.20 | 7.00 | 6.50 | 2.90 | 2.30 | 2.10 | 2.80 | 2.60 |
| 8 | | 2.70 | 3.60 | 6.50 | 6.10 | 2.80 | 2.30 | 2.10 | 2.80 | 2.60 |
| 9 | | 2.70 | 4.10 | 6.20 | 5.85 | 2.80 | 2.30 | 2.10 | 2.80 | 2.60 |
| 10 | | 2.70 | 4.55 | 5.95 | 5.65 | 2.80 | 2.30 | 2.10 | 2.80 | 2.60 |
| 11 | | 2.70 | 4.95 | 6.10 | 5.60 | 2.90 | 2.30 | 2.20 | 2.80 | 2.80 |
| 12 | | 2.70 | 5.15 | 6.65 | 5.50 | 3.00 | 2.30 | 2.30 | 2.80 | 2.80 |
| 13 | | 2.70 | 5.35 | 7.40 | 5.40 | 3.00 | 2.30 | 2.30 | 2.80 | 3.00 |
| 14 | | 2.70 | 5.25 | 7.80 | 5.40 | 2.95 | 2.30 | 2.40 | 2.80 | 3.60 |
| 15 | | 2.70 | 4.95 | 8.00 | 5.25 | 2.90 | 2.30 | 2.40 | 2.80 | |
| 16 | | 2.70 | 4.60 | 7.70 | 5.20 | 2.80 | 2.30 | 2.50 | 2.80 | |
| 17 | | 2.70 | 4.25 | 7.30 | 4.85 | 2.80 | 2.30 | 2.50 | 2.80 | |
| 18 | | 3.00 | 4.40 | 7.40 | 4.75 | 2.70 | 2.30 | 2.60 | 2.80 | |
| 19 | | 2.90 | 4.50 | 7.85 | 4.60 | 2.60 | 2.30 | 2.70 | 2.80 | |
| 20 | | 2.85 | 4.60 | 8.50 | 4.45 | 2.60 | 2.30 | 2.70 | 2.80 | |
| 21 | | 2.70 | 4.45 | 9.00 | 4.35 | 2.60 | 2.30 | 2.80 | 2.70 | |
| 22 | | 2.70 | 4.40 | 9.60 | 4.25 | 2.60 | 2.30 | 2.90 | 2.70 | |
| 23 | | 2.70 | 4.40 | 9.65 | 4.05 | 2.60 | 2.30 | 2.90 | 2.60 | |
| 24 | | 2.70 | 4.50 | 9.10 | 3.85 | 2.80 | 2.30 | 2.90 | 2.60 | |
| 25 | | 2.70 | 4.65 | 8.30 | 3.65 | 2.80 | 2.30 | 2.90 | 2.60 | |
| 26 | | 2.80 | 5.35 | 8.00 | 3.45 | 2.80 | 2.20 | 2.90 | 2.60 | |
| 27 | | 3.00 | 5.65 | 8.00 | 3.25 | 2.70 | 2.20 | 2.90 | 2.60 | |
| 28 | | 3.15 | 5.90 | 7.80 | 3.10 | 2.70 | 2.20 | 2.90 | 2.60 | |
| 29 | 2.70 | 3.20 | 5.90 | 7.60 | 3.10 | 2.50 | 2.10 | 2.90 | 2.60 | |
| 30 | 2.70 | 3.10 | 5.80 | 7.70 | 3.10 | 2.50 | 2.10 | 2.90 | 2.60 | |
| 31 | 2.70 | | 5.80 | | 3.10 | 2.40 | | 2.90 | | |

January 1 to March 28, river frozen; no readings.
December 15 to 31, river frozen; no readings.

## MISSOURI RIVER AT TOWNSEND, MONTANA.

This river is formed by the junction of the Jefferson, Madison, and Gallatin rivers at Threeforks, Montana. Observations of gage heights are maintained at Townsend by the Missouri River Commission, and although the section is not an ideal one, it still seems desirable to make occasional discharge measurements as the station is easily accessible and daily gage observations are taken at no expense to this Survey. The gage is located at the wagon bridge about a mile north of the railroad station. The heights given are the means of two daily readings expressed in feet above the St. Louis directrix, which is 412.73 feet above mean gulf level. In the following table, furnished by Charles Keller, first lieutenant, Corps of Engineers, United States Army, the figures 3,300 have been omitted, and it is therefore necessary to add this amount to obtain the elevation of the water surface above the St. Louis datum. Results of measurements are found as follows: 1896, Eighteenth Annual Report, Part IV, page 124; 1897, Nineteenth Annual Report, Part IV, page 283; 1898, Twentieth Annual Report, Part IV, page 244. The following discharge measurements were made during 1899 under the direction of Samuel Fortier:

May 30, gage height, 92.00; discharge, 13,021 second-feet.
June 15, gage height, 93.80 feet; discharge, 29,832 second-feet.
July 21, gage height, 90.90 feet; discharge, 8,842 second-feet.

*Daily gage height, in feet, of Missouri River at Townsend, Montana, for 1899.*

| Day. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ........ | 90.10 | 91.90 | 94.10 | 89.90 | 89.15 | 88.90 | 89.30 | 89.30 |
| 2 | ........ | 89.90 | 92.20 | 94.05 | 89.90 | 89.10 | 88.90 | 89.30 | 89.30 |
| 3 | ........ | 89.80 | 92.40 | 93.95 | 89.85 | 89.10 | 89.00 | 89.30 | 89.30 |
| 4 | 88.40 | 89.80 | 92.85 | 93.60 | 89.80 | 89.10 | 89.00 | 89.30 | 89.10 |
| 5 | 88.50 | 89.80 | 93.35 | 93.35 | 89.70 | 89.10 | 89.05 | 89.35 | 89.00 |
| 6 | 88.80 | 89.80 | 93.50 | 93.05 | 89.70 | 89.10 | 89.00 | 89.35 | 89.05 |
| 7 | 89.30 | 89.90 | 93.30 | 92.80 | 89.70 | 89.05 | 89.00 | 89.35 | 89.10 |
| 8 | 89.80 | 90.30 | 93.10 | 92.60 | 89.75 | 89.00 | 89.00 | 89.35 | 89.10 |
| 9 | 89.90 | 90.60 | 92.60 | 92.55 | 89.80 | 89.00 | 89.00 | 89.35 | 89.10 |
| 10 | 90.20 | 91.05 | 92.30 | 92.45 | 89.95 | 89.00 | 89.10 | 89.35 | 89.10 |
| 11 | 90.40 | 91.25 | 92.45 | 92.35 | 89.95 | 89.00 | 89.10 | 89.35 | a 89.10 |
| 12 | 90.55 | 91.55 | 92.80 | 92.25 | 89.90 | 89.00 | 89.15 | 89.40 | 89.10 |
| 13 | 90.85 | 91.70 | 93.40 | 92.05 | 89.85 | 89.00 | 89.20 | 89.40 | 89.10 |
| 14 | 90.45 | 91.60 | 93.70 | 92.00 | 89.80 | 89.05 | 89.20 | 89.40 | 89.10 |
| 15 | 90.00 | 91.60 | 93.75 | 91.80 | 89.70 | 89.10 | 89.20 | 89.40 | 89.10 |
| 16 | 90.00 | 91.50 | 93.75 | 91.65 | 89.65 | 89.15 | 89.20 | 89.40 | a 89.10 |
| 17 | 90.05 | 91.35 | 93.60 | 91.50 | 89.55 | 89.10 | 89.20 | 89.45 | 89.10 |
| 18 | 89.95 | 91.25 | 93.70 | 91.20 | 89.50 | 89.10 | 89.20 | 89.45 | 89.10 |
| 19 | 89.90 | 91.15 | 94.10 | 91.05 | 89.50 | 89.10 | 89.30 | 89.45 | 89.15 |
| 20 | 89.75 | 91.10 | 94.60 | 90.95 | 89.50 | 89.10 | 89.40 | 89.45 | 89.20 |
| 21 | 89.70 | 91.10 | 95.20 | 90.90 | 89.45 | 89.00 | 89.45 | 89.40 | 89.25 |
| 22 | 89.90 | 91.05 | 95.35 | 90.85 | 89.50 | 89.00 | 89.50 | 89.30 | 89.20 |
| 23 | 90.00 | 91.00 | 95.65 | 90.70 | 89.50 | 89.00 | 89.55 | 89.25 | 89.20 |
| 24 | 89.95 | 91.00 | 95.75 | 90.60 | 89.50 | 89.05 | 89.60 | 89.20 | 89.30 |
| 25 | 89.95 | 91.05 | 95.25 | 90.40 | 89.45 | 89.00 | 89.65 | 89.20 | 89.40 |
| 26 | 90.15 | 91.40 | 94.55 | 90.30 | 89.40 | 89.00 | 89.50 | 89.20 | 89.50 |
| 27 | 90.40 | 91.60 | 94.40 | 90.10 | 89.40 | 89.00 | 89.50 | 89.15 | 89.55 |
| 28 | 90.20 | 92.05 | 94.45 | 90.05 | 89.30 | 88.95 | 89.50 | 89.20 | 89.65 |
| 29 | 90.10 | 92.00 | 94.20 | 90.00 | 89.20 | 88.90 | 89.40 | 89.20 | b 91.70 |
| 30 | 90.10 | 92.00 | 94.20 | 90.00 | 89.20 | 88.90 | 89.40 | 89.25 | 90.90 |
| 31 | ........ | 91.95 | ........ | 89.95 | 89.20 | ........ | 89.40 | ........ | 90.90 |

a Ice readings, December 11 to 16. b Ice gorged December 29.

## MILK RIVER AT HAVRE, MONTANA.

This river rises on the eastern slope of the Rocky Mountains in the extreme northern part of Montana. The head-water tributaries have a general northeasterly direction, crossing the international boundary line into British territory, in which there is a large area drained. The river reenters the United States farther eastward and flows in a general southerly direction to Havre. Its course is thence easterly until it joins the Missouri River near Glasgow, Montana, at the southwestern corner of Fort Peck Indian Reservation. The valley of this river is fertile and well adapted for raising the hardier grains. Development in this direction has been somewhat slow until within the past few years. The area drained by Milk River is to a large extent rolling prairie lands, excellent for grazing purposes and covered with a good growth of grass. The discharge measurements show the amount of water available for the canals, a number of which have recently been taken from the river below Havre, as described in the Eighteenth Annual Report, Part IV, page 286. The present station is located at Havre, Montana, and was established by Cyrus C. Babb, May 15, 1898. The gage rod is an especial form described in Water-Supply Paper No. 27, page 68. Measurements of discharge are made from a car and cable of 200-foot span swung across the river a short distance above the gage. The river is subject to violent floods of short duration, and the bed of the river being composed of gravels and clay is liable to change after each freshet. Results of measurements for 1898 are shown in the Eighteenth Annual Report, Part IV, page 245. The following discharge measurements were made by C. W. Ling in 1899:

*Measurements of Milk River at Havre, Montana.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-ft.* | 1899. | *Feet.* | *Sec.-ft.* |
| Apr. 20 | 3.20 | 1,410 | July 31 | 1.00 | 228 |
| Apr. 28 | 2.20 | 807 | Aug. 3 | 1.10 | 252 |
| May 3 | 1.90 | 732 | Aug. 5 | 1.40 | 379 |
| May 12 | 2.60 | 1,087 | Aug. 11 | .80 | 182 |
| May 16 | 2.50 | 911 | Aug. 16 | .50 | 111 |
| May 22 | 3.50 | 1,657 | Aug. 19 | .40 | 106 |
| May 29 | 3.40 | 1,653 | Aug. 25 | .60 | 137 |
| June 3 | 2.90 | 1,126 | Aug. 28 | .80 | 158 |
| June 10 | 2.80 | 1,209 | Sept. 2 | .60 | 137 |
| June 15 | 2.30 | 661 | Sept. 7 | .30 | 99 |
| June 20 | 2.00 | 586 | Sept. 12 | .20 | 88 |
| June 28 | 1.90 | 588 | Sept. 15 | .30 | 96 |
| July 3 | 1.40 | 353 | Sept. 21 | 1.50 | 360 |
| July 7 | 1.20 | 298 | Sept. 25 | 1.90 | 221 |
| July 11 | 1.25 | 314 | Sept. 30 | 1.50 | 122 |
| July 17 | .80 | 181 | Oct. 16 | 1.40 | 109 |
| July 22 | .60 | 150 | Oct. 24 | 1.70 | 146 |
| July 27 | .70 | 170 | Nov. 6 | 2.40 | 368 |

*Daily gage height, in feet, of Milk River at Havre, Montana, for 1899.*

| Day. | Jan. | Feb. | Apr. | May. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 1 | | | | 2.00 | 0.60 | 1.40 | 1.30 | |
| 2 | 1.40 | | | 1.90 | .60 | 1.30 | 1.30 | |
| 3 | | | | 1.90 | .50 | 1.40 | 1.30 | (*a*) |
| 4 | | 1.80 | | 1.90 | .50 | 1.30 | 1.30 | |
| 5 | | | | 1.90 | .40 | 1.30 | 2.40 | |
| 6 | | | | 2.50 | .40 | 1.20 | 2.40 | |
| 7 | 1.40 | | | 2.60 | .30 | 1.10 | | |
| 8 | | | | 2.60 | .40 | 1.30 | | |
| 9 | 1.40 | | | 2.50 | .40 | 1.30 | | |
| 10 | | | | 2.50 | .30 | 1.30 | | (*a*) |
| 11 | | | | 2.50 | .30 | 1.20 | | |
| 12 | | | | 2.50 | .20 | 1.00 | 2.20 | |
| 13 | | | | 2.55 | .20 | | | |
| 14 | 1.40 | | | 2.60 | .20 | | | |
| 15 | | | | 2.60 | .30 | 1.30 | | |
| 16 | | | 4.60 | 2.60 | .20 | 1.30 | | |
| 17 | | | 4.30 | 2.60 | .40 | 1.20 | | (*a*) |
| 18 | | | 3.90 | 2.70 | 1.50 | 1.10 | | |
| 19 | | 1.90 | 3.40 | 2.70 | 1.60 | 1.10 | 1.10 | |
| 20 | | 2.50 | 3.20 | 2.70 | 1.10 | 1.10 | | |
| 21 | 1.80 | | 3.20 | 2.70 | 1.90 | 1.00 | | |
| 22 | | | 3.05 | 2.95 | 2.00 | 1.20 | | |
| 23 | | | 2.80 | 3.30 | 2.00 | 1.10 | | |
| 24 | 1.80 | | 2.55 | 3.20 | 1.90 | 1.10 | | (*a*) |
| 25 | | | 2.50 | 3.20 | 1.80 | 1.00 | | |
| 26 | | | 2.50 | 2.70 | 1.70 | 1.30 | | |
| 27 | | | 2.40 | 2.80 | 1.60 | 1.30 | 1.90 | |
| 28 | 1.80 | | 2.25 | | 1.40 | 1.40 | | |
| 29 | | | 2.20 | | 1.50 | 1.40 | | |
| 30 | | | 2.00 | | 1.60 | 1.40 | | |
| 31 | | | | | | 1.30 | | |

*a* Frozen.

## YELLOWSTONE RIVER AT LIVINGSTON, MONTANA.

This river has its source in Yellowstone Lake, in the National Park, and flows in a northerly direction into Montana. Its course is thence easterly to its junction with the Missouri River, near the North Dakota line. Owing to the fact of the numerous springs of the park which contribute to its flow, and also to the fact that the lake acts as a regulator, the discharge when it crosses the Montana line is large for a river of this section of the country. Yellowstone Valley is the largest body of irrigable land in Montana, having a length of about 500 miles. At the present time it is principally utilized as a range for a vast number of cattle and sheep. With its comparatively low altitude of 2,500 feet, the section is well adapted for the future development of irrigation. The gaging station established May 2, 1897, is located at the highway bridge over the Yellowstone River, 5 miles south of Livingston, at the mouth of the canyon. A wire gage is in use. A new bench mark was established in 1899, as follows: The top of the end plate of bridge at upper side of east end, at an elevation of 14.20 feet above zero of gage. The slope of the water surface at gaging station was found to be 0.146 feet in 200 feet on August 29, 1899. The observer is Thomas S. Carter, who lives at the end of the bridge. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 289; 1898, Twentieth

Annual Report, Part IV, page 248. The following measurements of discharge were made under the direction of Samuel Fortier in 1899:

March 10, gage height, 1.00 foot; discharge, 1,702 second-feet.
March 24, gage height, 1.10 feet; discharge, 1,801 second-feet.
April 5, gage height, 1.10 feet; discharge, 1,868 second-feet.
April 14, gage height, 1.40 feet; discharge, 2,629 second-feet.
May 28, gage height, 3.70 feet; discharge, 6,964 second-feet.
June 21, gage height, 8.00 feet; discharge, 22,053 second-feet.
July 20, gage height, 5.30 feet; discharge, 7,283 second-feet.
August 29, gage height, 1.86 feet; discharge, 5,337 second-feet.

*Daily gage height, in feet, of Yellowstone River at Livingston, Montana, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 0.85 | 0.90 | 1.60 | 4.20 | 7.88 | 4.10 | 1.70 | 0.55 | | |
| 2 | | | .85 | .95 | 1.53 | 4.35 | 7.58 | 4.00 | 1.70 | .50 | 0.05 | |
| 3 | | (*a*) | .85 | .95 | 1.43 | 5.03 | 7.30 | 3.90 | 1.70 | .45 | | —0.30 |
| 4 | | | .90 | 1.00 | 1.40 | 5.40 | 7.15 | 3.80 | 1.68 | .43 | .05 | |
| 5 | 0.60 | | .90 | 1.10 | 1.40 | 5.35 | 7.08 | 3.70 | 1.60 | .40 | | |
| 6 | | | .90 | 1.10 | 1.48 | 4.85 | 7.00 | 3.70 | 1.48 | .40 | | |
| 7 | | | .90 | 1.10 | 1.60 | 4.48 | 6.93 | 3.60 | 1.40 | .40 | | |
| 8 | | | .95 | 1.10 | 1.80 | 4.38 | 6.95 | 3.50 | 1.33 | .38 | | |
| 9 | | | 1.00 | 1.13 | 2.25 | 4.35 | 6.95 | 3.50 | 1.30 | .35 | | — .80 |
| 10 | | | 1.00 | 1.30 | 2.73 | 5.00 | 6.75 | 3.63 | 1.28 | .35 | | |
| 11 | | | .80 | 1.30 | 3.00 | 5.50 | 6.65 | 3.35 | 1.20 | .35 | .00 | |
| 12 | .70 | | .85 | 1.30 | 3.30 | 6.20 | 6.55 | 3.25 | 1.15 | .35 | | |
| 13 | | .70 | .90 | 1.50 | 3.40 | 5.60 | 6.20 | 3.10 | 1.15 | .35 | | |
| 14 | | | .85 | 1.43 | 3.10 | 5.28 | 5.93 | 3.03 | 1.15 | .35 | | |
| 15 | | | .80 | 1.25 | 2.90 | 5.20 | 5.75 | 2.98 | 1.15 | .35 | | |
| 16 | | | .85 | 1.38 | 2.75 | 5.63 | 5.65 | 2.83 | 1.10 | .30 | | (*a*) |
| 17 | | .85 | .95 | 1.40 | 2.58 | 6.68 | 5.55 | 2.73 | 1.03 | .30 | | |
| 18 | | | .95 | 1.35 | 2.53 | 7.60 | 5.38 | 2.70 | 1.00 | .30 | — .10 | |
| 19 | | | .93 | 1.28 | 2.70 | 8.05 | 5.30 | 2.65 | .93 | .30 | | |
| 20 | | | .90 | 1.23 | 2.90 | 8.55 | 5.28 | 2.53 | .90 | .40 | | |
| 21 | .90 | | (*a*) | 1.20 | 2.90 | 8.30 | 5.28 | 2.43 | .85 | .35 | | |
| 22 | | | .88 | 1.35 | 2.80 | 7.15 | 5.13 | 2.40 | .83 | .43 | | |
| 23 | | | .93 | 1.50 | 2.75 | 6.73 | 4.85 | 2.35 | .75 | .43 | | — .50 |
| 24 | | .80 | 1.05 | 1.55 | 3.13 | 6.95 | 4.68 | 2.28 | .73 | .40 | | |
| 25 | | | 1.15 | 1.80 | 4.03 | 7.25 | 4.60 | 2.18 | .70 | .35 | — .35 | |
| 26 | .90 | | 1.05 | 2.00 | 4.35 | 7.60 | 4.50 | 2.10 | .70 | .23 | | |
| 27 | | | .78 | 1.95 | 3.95 | 7.60 | 4.48 | 1.98 | .70 | .20 | | |
| 28 | | | .90 | 1.78 | 3.85 | 7.60 | 4.30 | 1.90 | .65 | .18 | | |
| 29 | | | 1.00 | 1.63 | 4.00 | 7.78 | 4.30 | 1.83 | .60 | .15 | | |
| 30 | | | 1.00 | 1.60 | 4.25 | 8.05 | 4.30 | 1.80 | .58 | .15 | | — .80 |
| 31 | | | .90 | | 4.20 | | 4.15 | 1.75 | | .10 | | |

*a* Frozen.

## BIGHORN RIVER AT THERMOPOLIS, WYOMING.

A number of discharge measurements were made on this river at Thermopolis, Wyoming, by A. J. Parshall, during the progress of a survey in that vicinity, which he had undertaken for the State. A bench mark was established on the pile near the ferry, and the gage heights noted are the distance of water surface below this bench mark; they are, therefore, in reverse order to the usual records of water heights. Four measurements were made during 1899, as follows:

July 28, gage height, 8 feet below bench mark; discharge, 4,867 second-feet.
August 7, gage height, 8.38 feet below bench mark; discharge, 4,204 second-feet.
August 16, gage height, 8.98 feet below bench mark; discharge, 2,673 second-feet.
September 14, gage height, 9.74 feet below bench mark; discharge, 1,162 second-feet.

## SHOSHONE RIVER AT LOVELL, WYOMING.

The source of this river is in the high mountain peaks along the eastern border of the Yellowstone National Park. It has a general northeasterly course and enters Bighorn River about 12 miles above the Montana State line. Irrigation is practiced to a limited extent in the upper headwaters, but principally from the small tributaries, as Trout, Rattlesnake, and Cottonwood creeks. Below the junction of the North and South forks a number of large irrigation enterprises have recently been undertaken. A gaging station was established May 23, 1897, at Lovell, Wyoming. The rod is fastened to the landing pier of the ferry on the south side of the river. The channel is straight for some distance above and below the rod, and the cross section at the gaging point has a uniform depth. The bed of the river is stable. The results of measurements are shown as follows: 1897, Nineteenth Annual Report, Part IV, page 292; 1898, Twentieth Annual Report, Part IV, page 249. No discharge measurements were made at this station during 1899.

*Daily gage height, in feet, of Shoshone River at Lovell, Wyoming, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ....... | —.80 | 0.60 | 3.80 | +0.20 | —1.10 | 17 | — .90 | —.40 | 3.00 | 2.60 | — .50 | —1.50 |
| 2 | ....... | —.80 | .60 | 3.60 | + .60 | —1.10 | 18 | — .80 | —.40 | 3.90 | 2.60 | — .50 | —1.50 |
| 3 | ....... | —.70 | 3.00 | 3.40 | — .10 | —1.20 | 19 | — .70 | —.40 | 4.30 | 2.70 | — .60 | —1.50 |
| 4 | ....... | —.70 | .60 | 3.20 | — .30 | —1.20 | 20 | — .60 | +.10 | 4.20 | 2.60 | — .60 | —1.50 |
| 5 | ....... | —.70 | .30 | 3.20 | — .20 | —1.20 | 21 | — .40 | .30 | 4.00 | 2.50 | — .70 | —1.50 |
| 6 | ....... | —.50 | .90 | 3.10 | — .30 | —1.20 | 22 | — .20 | .20 | 2.70 | 2.50 | — .80 | —1.50 |
| 7 | ....... | —.50 | .70 | 3.10 | — .20 | —1.20 | 23 | .00 | .10 | 2.50 | 2.50 | — .90 | —1.50 |
| 8 | ....... | —.40 | .50 | 3.00 | — .30 | —1.30 | 24 | + .70 | .50 | 2.50 | 1.40 | — .90 | —1.50 |
| 9 | ....... | —.20 | .90 | 3.20 | — .30 | —1.30 | 25 | + .60 | .90 | 2.90 | 1.40 | — .90 | —1.50 |
| 10 | ....... | +.20 | 1.30 | 2.90 | — .30 | —1.30 | 26 | — .60 | .70 | 3.50 | 1.00 | —1.00 | —1.50 |
| 11 | ....... | .30 | 2.00 | 2.80 | — .30 | —1.40 | 27 | — .70 | .70 | 3.30 | 1.00 | —1.00 | —1.50 |
| 12 | —0.80 | .30 | 2.80 | 2.70 | — .30 | —1.40 | 28 | — .70 | .80 | 3.40 | 1.40 | —1.00 | —1.50 |
| 13 | — .90 | .20 | 2.00 | 2.80 | — .30 | —1.40 | 29 | — .70 | .70 | 3.70 | 1.30 | —1,00 | —1.50 |
| 14 | — .90 | —.10 | 1.50 | 2.90 | — .30 | —1.40 | 30 | — .70 | .80 | 4.00 | 1.70 | —1.00 | —1.50 |
| 15 | — .80 | —.40 | 1.40 | 2.70 | — .40 | —1.40 | 31 | ....... | .70 | ...... | 1.10 | —1.00 | ....... |
| 16 | — .80 | —.20 | 2.20 | 2.60 | — .40 | —1.40 | | | | | | | |

## CLEAR CREEK AT BUFFALO, WYOMING.

This creek is one of the most important tributaries of Powder River, having its source in the summit of the Bighorn Mountains. The irrigating system diverting water from this stream has been described in detail in earlier reports. The point of measurement is about 4 miles west of Buffalo, Wyoming, at which point is a flume erected in 1889. Of late years this station is not considered as important as formerly, on account of the diversions of water which have taken place within its basin. The earlier discharge measurements established a rating for the measuring flume, and it has not been necessary to make any since. The results of measurements are shown as follows: 1896, Eighteenth Annual Report, Part IV, page 140; 1897, Nineteenth Annual Report, Part IV, page 298; 1898, Twentieth Annual Report, Part IV, page 250. No measurements of discharge were made at this point during 1899.

*Daily gage height, in feet, of Clear Creek at Buffalo, Wyoming, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.30 | | | | 0.60 | 1.13 | 1.80 | 1.35 | 0.50 | 0.48 | 0.50 | |
| 2 | | | | | .50 | 1.18 | 1.53 | 1.27 | .49 | .50 | .45 | |
| 3 | | | | | .50 | 1.63 | 1.47 | 1.18 | .47 | .49 | .43 | 0.45 |
| 4 | | | | 0.30 | .50 | 1.37 | 1.46 | 1.15 | .57 | .50 | .42 | |
| 5 | | 0.25 | 0.25 | | .45 | 1.34 | 1.46 | 1.12 | .57 | .49 | .42 | |
| 6 | | | | | .52 | 1.24 | 1.45 | 1.03 | .58 | .49 | .48 | |
| 7 | | | | | .73 | 1.20 | 1.40 | .94 | .57 | .50 | .47 | |
| 8 | .33 | | | | .52 | 1.15 | 1.43 | .81 | .57 | .50 | .48 | |
| 9 | | | | | .54 | 1.14 | 1.41 | .70 | .56 | .57 | .49 | |
| 10 | | | | | .67 | 1.11 | 1.42 | .73 | .56 | .56 | .47 | .40 |
| 11 | | | | | .58 | 1.26 | 1.39 | .69 | .50 | .56 | .48 | |
| 12 | | | .30 | .40 | .64 | 1.34 | 1.33 | .64 | .50 | .57 | .47 | |
| 13 | | | | | .70 | 1.39 | 1.39 | .60 | .50 | .59 | .49 | |
| 14 | | | | | .60 | 1.26 | 1.37 | .59 | .50 | .58 | .50 | |
| 15 | .30 | | | | .69 | 1.23 | 1.39 | .59 | .60 | .59 | .47 | |
| 16 | | | | | .70 | 1.23 | 1.35 | .58 | .50 | .60 | .48 | |
| 17 | | | | | .69 | 1.40 | 1.20 | .56 | .48 | .60 | .48 | .40 |
| 18 | | | | | .70 | 2.15 | 1.20 | .57 | .62 | .60 | .49 | |
| 19 | | .25 | | .60 | .77 | 2.43 | 1.25 | .53 | .61 | .59 | .49 | |
| 20 | | | | | 1.17 | 2.42 | 1.21 | .54 | .61 | .58 | | |
| 21 | | | | | 1.20 | 2.45 | 1.23 | .58 | .60 | .56 | | |
| 22 | | | | | .90 | 1.75 | 1.23 | .57 | .58 | .53 | | |
| 23 | | | | | .90 | 1.45 | 1.44 | .55 | .52 | .57 | | |
| 24 | | | | | 1.10 | 1.46 | 1.75 | .53 | .54 | .55 | | .40 |
| 25 | | | | | 1.24 | 1.89 | 1.73 | .52 | .51 | .44 | | |
| 26 | | .25 | | | 1.20 | 2.07 | 1.73 | .50 | .50 | .42 | .45 | |
| 27 | | | | | 1.13 | 1.73 | 1.70 | .50 | .51 | .49 | | |
| 28 | | | | | 1.12 | 1.64 | 1.70 | .49 | .50 | .48 | | |
| 29 | | | | | 1.12 | 1.72 | 1.58 | .48 | .49 | .47 | | .40 |
| 30 | | | | .63 | 1.21 | 1.87 | 1.42 | .49 | .49 | .39 | | |
| 31 | | | | | 1.14 | | 1.42 | .49 | | .48 | | |

## MINNECHADUSA RIVER AT VALENTINE, NEBRASKA.

This stream rises in South Dakota, flows into Nebraska, and empties into Niobrara River near Valentine. Measurements have been made at the times when the regular river station on Niobrara River at Fort Niobrara has been visited. The results are of value as showing the flow available for milling purposes, there being little, if any, opportunity for irrigation. Measurements were made by Glenn E. Smith at a point 1 mile above the town. The channel at this point is straight, and the water moves with moderate velocity. The banks are high and the bed sandy. Most of the measurements were made by wading. Results for 1899 are as follows:

January 27, 26.2 second-feet; February 21, 45.0 second-feet; March 15, 25.7 second-feet; April 26, 32.6 second-feet; May 11, 35.6 second-feet; June 23, 23.0 second-feet; August 12, 19.0 second-feet; September 13, 23.5 second-feet; September 26, 26.5 second-feet; October 20, 30.0 second-feet.

## NIOBRARA RIVER AT FORT NIOBRARA, NEBRASKA.

This river rises in eastern Wyoming and flows across the State line into Nebraska, continuing along the northern side of that State near the boundary of South Dakota until it enters the Missouri River at the northeastern corner of Nebraska. A gaging station was established by O. V. P. Stout on July 22, 1897, three-fourths of a mile southwesterly from Fort Niobrara and above the mouth of Minnechadusa River. It was afterwards discontinued, but was resumed on April 26, 1899, when a rod was located 195 feet downstream from the wagon bridge near Fort Niobrara. The rod is solidly bedded on cross-ties and well fastened with bridge spikes. It is a new 3 by 4 inch oak rod 10 feet long, and is placed on the left bank of the stream. Bench mark No. 1 is the top of a large spike driven in the top of a 2 by 4 inch timber which is set 4 feet in the ground and 12 feet west of the rod, and is 5.63 feet above gage datum. Bench mark No. 2 is the top of the short cap at shoe of truss at west end of the bridge, downstream side, and is 9.98 feet above the zero of the gage. Bench mark No. 3 is the top of the plate of the center pier of the bridge, downstream side, and is 10.03 feet above gage datum. Thomas Dillon, mail carrier between Valentine and Fort Niobrara, is the observer. The results of measurement are shown as follows: 1897, Nineteenth Annual Report, Part IV, page 300; 1898, Twentieth Annual Report, Part IV, page 255. The following discharge measurements were made by Glenn E. Smith during 1899:

*Measurements of Niobrara River at Fort Niobrara, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Second-ft.* | 1899. | *Feet.* | *Second-ft.* |
| Jan. 27 | Frozen. | 623 | July 16 | 1.52 | 788 |
| Mar. 15 | Frozen. | 726 | Aug. 13 | 1.30 | 718 |
| Mar. 15 | Frozen. | *a* 650 | Aug. 30 | 1.35 | 700 |
| Apr. 25 | 1.15 | 952 | Sept. 13 | 1.15 | 695 |
| May 11 | 1.18 | 867 | Sept. 26 | 1.05 | 732 |
| May 26 | 1.44 | 1,031 | Oct. 7 | 1.15 | 776 |
| June 23 | 1.24 | 733 | Oct. 20 | 0.80 | 849 |

*a* Measurement made at point 5 miles south of Valentine.

*Daily gage height, in feet, of Niobrara River at Fort Niobrara, Nebraska, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | 1.13 | 1.31 | 1.21 | 1.31 | 1.24 | 17 | ...... | 1.12 | 1.41 | 1.51 | 1.41 | 1.24 |
| 2 | ...... | 1.11 | 1.31 | 1.41 | 1.34 | 1.24 | 18 | ...... | 1.14 | 1.41 | 1.44 | 1.44 | 1.21 |
| 3 | ...... | 1.12 | 1.34 | 1.34 | 1.51 | 1.31 | 19 | ...... | 1.21 | 1.34 | 1.41 | 1.41 | 1.14 |
| 4 | ...... | 1.12 | 1.31 | 1.23 | 1.41 | 1.31 | 20 | ...... | 1.22 | 1.24 | 1.41 | 1.34 | 1.14 |
| 5 | ...... | 1.14 | 1.31 | 1.24 | 1.34 | 1.24 | 21 | ...... | 1.23 | 1.23 | 1.41 | 1.32 | 1.24 |
| 6 | ...... | 1.21 | 1.21 | 1.34 | 1.34 | 1.21 | 22 | ...... | 1.24 | 1.23 | 1.31 | 1.34 | 1.21 |
| 7 | ...... | 1.13 | 1.14 | 1.41 | 1.31 | 1.21 | 23 | ...... | 1.34 | 1.22 | 1.31 | 1.34 | 1.11 |
| 8 | ...... | 1.24 | 1.12 | 1.41 | 1.31 | 1.21 | 24 | ...... | 1.44 | 1.22 | 1.31 | 1.34 | 1.11 |
| 9 | ...... | 1.31 | 1.12 | 1.41 | 1.41 | 1.24 | 25 | ...... | 1.34 | 1.51 | 1.24 | 1.24 | 1.14 |
| 10 | ...... | 1.14 | 1.12 | 1.42 | 1.34 | 1.21 | 26 | 1.14 | 1.44 | 1.21 | 1.21 | 1.24 | 1.12 |
| 11 | ...... | 1.14 | 1.24 | 1.44 | 1.31 | 1.21 | 27 | 1.14 | 1.41 | 1.31 | 1.24 | 1.24 | 1.14 |
| 12 | ...... | 1.14 | 1.44 | 1.44 | 1.34 | 1.14 | 28 | 1.21 | 1.42 | 1.34 | 1.24 | 1.24 | 1.11 |
| 13 | ...... | 1.14 | 1.34 | 1.51 | 1.41 | 1.14 | 29 | 1.21 | 1.41 | 1.34 | 1.31 | 1.31 | 1.11 |
| 14 | ...... | 1.14 | 1.21 | 1.42 | 1.21 | 1.14 | 30 | 1.13 | 1.42 | 1.41 | 1.31 | 1.31 | 1.11 |
| 15 | ...... | 1.14 | 1.21 | 1.51 | 1.31 | 1.24 | 31 | ...... | 1.31 | ...... | 1.31 | 1.21 | ...... |
| 16 | ...... | 1.11 | 1.24 | 1.54 | 1.41 | 1.21 | | | | | | | |

## LARAMIE RIVER AT WOODS LANDING, WYOMING.

This river, a tributary of the North Platte River, entering it at Fort Laramie, Wyoming, has its source in the mountains of northern Colorado, adjoining the head waters of the Cache la Poudre on the west.

Irrigation is practiced on a small scale in Colorado, but principally for hay ranches, as the elevation is too great for diversified farming. One important diversion—that of the Sky-line canal—takes water from the Laramie, carrying it across the divide and into Cache la Poudre drainage. This diversion is working a hardship to the Wyoming appropriators below, as many in this State have prior rights to Sky-line canal, but owing to the present water laws the Wyoming rancher has no redress through the courts. Laramie River, on crossing the Wyoming line, soon leaves its canyon and enters the Laramie Plains, which are extensively irrigated from the main stream and from the various tributaries, notably from Little Laramie River, whose low-water flow is now entirely used. Lower down on its course the river passes through another canyon, to enter finally the plain of the Lower Laramie, which extends from the eastern edge of the Laramie Hills to the mouth of the river. A notable diversion in this section of the country is that of the Wyoming Development Company, taking water from Laramie River about 27 miles southwest of Wheatland. This canal system is more fully described in the Nineteenth Annual Report, Part IV, page 303. Two gaging stations are maintained on the river, one at Woods Landing, a short distance after the river appears in Wyoming, and the other at Uva, near its mouth. The former station is 26 miles from Laramie, Wyoming, and is reached by stage. Measurements of discharge are made from the wagon bridge which spans the river at this point.

The gage rod is fastened to a perpendicular post set firmly in the bed of the stream and braced at the top to adjacent trees, and is about 400 feet above the bridge. The bench mark is a nail in a notch on a cottonwood tree 1 foot in diameter, 6 feet from the rod, and is on a level with the 7-foot mark on the rod. The measurements here show the amount of water available for the use of the irrigators below. The bottom of the stream is composed of large granite bowlders, which renders the shape and slope of the channel practically unchangeable, but adds an element of uncertainty to the gaging results, owing to the difficulty of determining the correct cross section. Results of measurements are published as follows: 1896, Eighteenth Annual Report, Part IV, page 147; 1897, Nineteenth Annual Report, Part IV, page 302; 1898, Twentieth Annual Report, Part IV, page 274. The following measurements of discharge were made by A. J. Parshall in 1899:

May 26, gage height, 3.30 feet; discharge, 2,598 second-feet.
June 8, gage height, 3.10 feet; discharge, 2,319 second-feet.
June 21, gage height, 4.40 feet; discharge, 4,145 second-feet.
July 6, gage height, 2.80 feet; discharge, 2,194 second-feet.

*Daily gage height, in feet, of Laramie River at Woods Landing, Wyoming, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | ...... | 2.00 | 2.00 | 1.20 | 3.15 | 3.75 | 1.40 | 0.80 | 0.40 | ...... | ...... |
| 2 | ...... | ...... | ...... | 2.00 | 1.10 | 3.25 | 3.65 | 1.40 | 0.75 | 0.40 | ...... | ...... |
| 3 | 2.00 | 2.00 | ...... | 2.00 | 1.00 | 3.25 | 3.50 | 1.55 | 0.75 | 0.40 | ...... | ...... |
| 4 | ...... | ...... | ...... | 2.00 | 1.00 | 3.15 | 3.50 | 1.70 | 0.70 | 0.40 | ...... | ...... |
| 5 | ...... | ...... | ...... | 2.00 | 1.00 | 2.95 | 3.10 | 1.75 | 0.60 | 0.50 | ...... | ...... |
| 6 | ...... | ...... | ...... | 2.00 | 1.20 | 3.05 | 2.80 | 1.70 | 0.60 | 0.50 | ...... | ...... |
| 7 | ...... | ...... | ...... | 2.00 | 1.30 | 3.00 | 2.70 | 1.60 | 0.60 | 0.65 | 0.60 | 0.90 |
| 8 | ...... | ...... | 2.00 | 2.00 | 1.40 | 3.00 | 2.60 | 1.50 | 0.50 | 0.75 | ...... | ...... |
| 9 | ...... | ...... | ...... | 2.00 | 1.50 | 3.00 | 2.45 | 1.40 | 0.50 | 0.80 | ...... | ...... |
| 10 | 2.10 | 2.00 | ...... | 2.00 | 1.60 | 3.05 | 2.35 | 1.35 | 0.50 | 0.85 | ...... | ...... |
| 11 | ...... | ...... | ...... | 2.00 | 1.75 | 3.45 | 2.50 | 1.20 | 0.55 | 0.80 | ...... | ...... |
| 12 | ...... | ...... | ...... | 2.00 | 1.95 | 3.80 | 2.65 | 1.10 | 0.50 | 0.80 | ...... | ...... |
| 13 | ...... | ...... | ...... | 2.00 | 2.30 | 4.30 | 2.65 | 1.10 | 0.50 | 0.70 | ...... | ...... |
| 14 | ...... | ...... | ...... | 2.00 | 2.55 | 4.35 | 2.55 | 1.03 | 0.50 | 0.70 | 0.70 | 1.10 |
| 15 | ...... | ...... | 2.00 | 2.00 | 2.60 | 3.75 | 2.45 | 1.00 | 0.60 | 0.70 | ...... | ...... |
| 16 | ...... | ...... | ...... | 2.00 | 2.65 | 3.50 | 2.30 | 1.00 | 0.65 | 0.70 | ...... | ...... |
| 17 | 2.00 | 2.00 | ...... | 1.90 | 2.55 | 3.75 | 2.20 | 0.90 | 0.60 | 0.70 | ...... | ...... |
| 18 | ...... | ...... | ...... | 1.90 | 2.45 | 3.85 | 2.05 | 0.90 | 0.60 | 0.70 | ...... | ...... |
| 19 | ...... | ...... | ...... | 1.80 | 2.60 | 3.95 | 2.00 | 0.90 | 0.60 | 0.60 | ...... | ...... |
| 20 | ...... | ...... | ...... | 1.80 | 2.65 | 4.15 | 1.85 | 0.90 | 0.60 | 0.70 | ...... | ...... |
| 21 | ...... | ...... | ...... | 1.70 | 2.75 | 4.25 | 1.80 | 0.85 | 0.50 | 0.75 | 0.70 | 1.00 |
| 22 | ...... | ...... | 2.00 | 1.70 | 2.85 | 4.45 | 1.85 | 0.80 | 0.50 | 0.70 | ...... | ...... |
| 23 | ...... | ...... | ...... | 1.60 | 2.95 | 4.50 | 1.80 | 0.80 | 0.50 | 0.70 | ...... | ...... |
| 24 | 2.00 | ...... | ...... | 1.50 | 3.10 | 4.40 | 1.80 | 0.80 | 0.50 | 0.60 | ...... | ...... |
| 25 | ...... | 2.00 | ...... | 1.50 | 3.20 | 4.65 | 1.75 | 0.78 | 0.50 | 0.60 | ...... | ...... |
| 26 | ...... | ...... | ...... | 1.40 | 3.20 | 4.55 | 1.75 | 0.75 | 0.40 | 0.60 | ...... | ...... |
| 27 | ...... | ...... | ...... | 1.40 | 3.10 | 4.40 | 1.75 | 0.70 | 0.40 | 0.60 | ...... | ...... |
| 28 | ...... | ...... | ...... | 1.30 | 3.25 | 4.15 | 1.90 | 0.60 | 0.40 | 0.60 | 0.80 | 1.20 |
| 29 | ...... | ...... | ...... | 1.20 | 3.35 | 4.05 | 1.75 | 0.60 | 0.40 | 8.60 | ...... | ...... |
| 30 | ...... | ...... | ...... | 1.15 | 3.30 | 3.90 | 1.60 | 0.75 | 0.50 | 0.60 | ...... | ...... |
| 31 | ...... | ...... | ...... | ...... | 3.05 | ...... | 1.45 | 0.90 | ...... | 0.60 | ...... | ...... |

## LARAMIE RIVER AT UVA, WYOMING.

This station is located 18 miles, by wagon road, from the mouth of the river at Fort Laramie, and the results obtained show practically the amount of water passing out of the State from this drainage area. The rod is fastened to the railroad bridge of the Cheyenne Northern Railway, a half mile from the town of Uva, while discharge measurements are made from the wagon bridge 1,000 feet below. The bench mark is a spike head on the south side of a pile on the east end of railroad bridge, and is 11.95 feet above zero of gage. The bed of the river is sandy and liable to change during high water. The results of measurements are shown as follows: 1896, Eighteenth Annual Report, Part IV, page 149; 1897, Nineteenth Annual Report, Part IV, page 302; 1898, Twentieth Annual Report, Part IV, page 176. The following measurements of discharge were made by A. J. Parshall in 1899:

April 25, gage height, 3 feet; discharge, 863 second-feet.
May 6, gage height, 2.80 feet; discharge, 530 second-feet.
May 30, gage height, 4.40 feet; discharge, 2,022 second-feet.
June 13, gage height, 4.50 feet; discharge, 2,144 second-feet.
June 26, gage height, 5.80 feet; discharge, 3,472 second-feet.
July 13, gage height, 3.95 feet; discharge, 1,607 second-feet.

*Daily gage height, in feet, of Laramie River at Uva, Wyoming, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.80 | 1.40 | 1.50 | 1.50 | 3.00 | 4.60 | 5.30 | 2.20 | 1.20 | 0.90 | | |
| 2 | | | | 1.50 | 2.90 | 4.70 | 5.30 | 2.20 | 1.20 | 0.90 | | 1.50 |
| 3 | | | | 1.40 | 2.90 | 4.80 | 5.00 | 2.20 | 1.20 | 0.90 | | |
| 4 | | | | 1.40 | 2.80 | 4.80 | 4.90 | 2.10 | 1.20 | 0.90 | 1.60 | |
| 5 | | | | 1.50 | 2.80 | 4.80 | 5.00 | 2.10 | 1.20 | 0.90 | | |
| 6 | | | | 1.60 | 2.80 | 4.80 | 5.10 | 2.10 | 1.20 | 0.90 | | |
| 7 | | | 1.50 | 1.80 | 2.80 | 4.70 | 4.90 | 2.00 | 1.20 | 0.90 | | |
| 8 | 1.00 | 1.40 | | 1.80 | 2.60 | 4.60 | 4.70 | 2.00 | 1.20 | 0.90 | | |
| 9 | | | | 2.00 | 2.40 | 4.20 | 4.70 | 2.00 | 1.60 | 1.00 | | 1.40 |
| 10 | | | | 3.00 | 2.20 | 4.10 | 4.60 | 2.00 | 1.50 | 1.10 | | |
| 11 | | | | 3.40 | 2.00 | 4.10 | 4.40 | 2.00 | 1.40 | 1.20 | 1.40 | |
| 12 | | | | 5.60 | 1.90 | 4.20 | 4.20 | 1.90 | 1.30 | 1.20 | | |
| 13 | | | | 5.10 | 1.90 | 4.30 | 4.20 | 1.90 | 1.10 | 1.20 | | |
| 14 | | | 1.60 | 5.40 | 1.80 | 4.30 | 4.10 | 1.90 | 1.10 | 1.30 | | |
| 15 | 1.00 | 1.50 | | 4.80 | 1.80 | 4.80 | 4.00 | 1.90 | 1.10 | 1.30 | | |
| 16 | | | | 4.40 | 2.55 | 5.00 | 4.00 | 2.00 | 1.10 | 1.30 | | 2.00 |
| 17 | | | | 4.30 | 3.40 | 5.50 | 4.00 | 2.00 | 1.00 | 1.30 | | |
| 18 | | | | 4.20 | 3.40 | 5.50 | 3.80 | 2.00 | 1.00 | 1.30 | 1.50 | |
| 19 | | | | 3.20 | 3.30 | 5.60 | 3.60 | 2.00 | 1.00 | 1.30 | | |
| 20 | | | | 3.60 | 4.80 | 5.60 | 3.50 | 1.90 | 1.00 | 1.40 | | |
| 21 | | | 1.60 | 3.00 | 4.80 | 5.60 | 3.30 | 1.90 | 1.00 | 1.40 | | |
| 22 | 1.40 | 1.50 | | 3.00 | 4.50 | 5.50 | 3.10 | 1.80 | 1.00 | 1.40 | | |
| 23 | | | | 3.30 | 4.40 | 5.50 | 3.00 | 1.70 | 1.00 | 1.40 | | 1.60 |
| 24 | | | | 3.20 | 4.60 | 5.60 | 2.90 | 1.60 | 1.00 | 1.40 | | |
| 25 | | | | 3.00 | 4.80 | 5.60 | 2.80 | 1.50 | 1.00 | 1.50 | 1.50 | |
| 26 | | | | 3.00 | 4.90 | 5.80 | 2.60 | 1.40 | 1.00 | 1.50 | | |
| 27 | | | | 3.10 | 4.80 | 6.00 | 2.60 | 1.40 | 0.90 | 1.60 | | |
| 28 | | 1.50 | 1.50 | 3.00 | 4.60 | 5.90 | 2.50 | 1.40 | 0.90 | 1.60 | | |
| 29 | 1.80 | | | 3.00 | 4.50 | 5.80 | 2.40 | 1.40 | 0.90 | | | |
| 30 | | | | 3.00 | 4.40 | 5.70 | 2.40 | 1.30 | 0.90 | | | 1.90 |
| 31 | | | | | 4.40 | | 2.30 | 1.30 | | | | |

## NORTH PLATTE RIVER AT ORIN JUNCTION, WYOMING.

This river has its source in the mountains of North Park in northern Colorado. The general elevation of the park is 8,000 feet, and it is surrounded by mountains which attain an elevation of 12,000 feet. Irrigation is practiced to a considerable extent from small ditches, which are used almost entirely, however, in flooding native grass lands for forage purposes. The river passes through a short, narrow canyon on entering Wyoming, and thence flows northerly through the upper Platte Valley, which extends from the State line down to Fort Steel. The river thence continues northerly, receiving a number of important tributaries, notably Sweetwater River, in the basin of which considerable irrigation is practiced. The only station maintained in this State on this stream at present is at Orin Junction, at the bridge of the Cheyenne Northern Railway. The rod is attached to the mid-channel pier of the railroad bridge, and is connected with the following bench marks: The spike on top of the cap on the set of piles nearest the water at the east end of the bridge is 11.52 feet above gage datum. The bed of the stream is composed of heavy gravel and sand, the cross section being quite uniform. Measurements at this point are not altogether satisfactory, on account of the occurrence of bridge piers, which interfere with the uniform flow to a considerable extent. Results of measurements are found as follows: 1896, Eighteenth Annual Report, Part IV, page 153; 1897, Nineteenth Annual Report, Part IV, page 307; 1898, Twentieth Annual Report, Part IV, page 266. The following discharge measurements were made during 1899 by A. J. Parshall:

April 24, gage height, 4.26 feet; discharge, 5,239 second-feet.
May 5, gage height, 3.70 feet; discharge, 4,115 second-feet.
May 19, gage height, 5.70 feet; discharge 13,422 second-feet.
June 12, gage height, 5.85 feet; discharge, 14,746 second-feet.
June 26, gage height, 6.85 feet; discharge, 20,855 second-feet.
July 12, gage height, 5.67 feet; discharge, 10,784 second-feet.
September 2, gage height, 1 foot; discharge, 239 second-feet.

*Daily gage height, in feet, of North Platte River at Orin Junction, Wyoming, for 1899.*

| Day. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | Ice. | ...... | 4.45 | 6.10 | 6.40 | 3.00 | 1.00 | ...... | 1.60 | ...... |
| 2 | ...... | ...... | ...... | 4.25 | 5.95 | ...... | 2.93 | .98 | 1.00 | ...... | ...... |
| 3 | ...... | ...... | ...... | 4.00 | 5.75 | 6.40 | 2.83 | ...... | 1.00 | ...... | ...... |
| 4 | 4.55 | 3.00 | ...... | 3.85 | ...... | 6.30 | 2.73 | .95 | 1.00 | ...... | ...... |
| 5 | ...... | ...... | ...... | 3.70 | 6.15 | 6.20 | 2.55 | .95 | 1.00 | ...... | ...... |
| 6 | ...... | ...... | ...... | 3.65 | 6.20 | 6.15 | ...... | .95 | .98 | ...... | ...... |
| 7 | ...... | ...... | ...... | ...... | 6.20 | 5.95 | 2.58 | .95 | .93 | ...... | ...... |
| 8 | ...... | ...... | ...... | 3.35 | 6.15 | 5.75 | 2.75 | .95 | ...... | 1.40 | Ice. |
| 9 | ...... | ...... | ...... | 3.45 | 5.95 | ...... | 2.73 | .95 | 1.00 | ...... | ...... |
| 10 | ...... | ...... | 2.65 | 3.85 | 5.75 | 5.35 | 2.70 | ...... | 1.08 | ...... | ...... |
| 11 | 4.45 | Ice. | 2.85 | 4.15 | ...... | 5.15 | 2.63 | .90 | 1.25 | ...... | ...... |
| 12 | ...... | ...... | 3.95 | 4.30 | 5.95 | 4.98 | 2.45 | .90 | 1.18 | ...... | ...... |
| 13 | ...... | ...... | 5.05 | 4.50 | 6.10 | 4.88 | ...... | .90 | 1.05 | ...... | ...... |
| 14 | ...... | ...... | 5.45 | ...... | 6.50 | 4.83 | 2.08 | .90 | 1.05 | ...... | ...... |
| 15 | ...... | ...... | 5.30 | 5.45 | 6.75 | 4.95 | 2.03 | .95 | ...... | 1.30 | Ice. |
| 16 | ...... | ...... | ...... | 5.75 | 6.80 | ...... | 1.93 | 1.60 | 1.20 | ...... | ...... |
| 17 | ...... | ...... | 5.05 | 5.85 | 6.80 | 4.75 | 1.83 | ...... | 1.35 | ...... | ...... |
| 18 | 5.10 | Ice. | 4.80 | 5.95 | ...... | 4.68 | 1.73 | 1.40 | 1.63 | ...... | ...... |
| 19 | ...... | ...... | 4.70 | 6.05 | 6.35 | 4.45 | 1.60 | 1.30 | 1.70 | ...... | ...... |
| 20 | ...... | ...... | 4.45 | 6.20 | 6.30 | 4.20 | ...... | 1.65 | 1.70 | ...... | ...... |
| 21 | ...... | ...... | 4.10 | ...... | 6.55 | 4.08 | 1.60 | 1.58 | 1.63 | ...... | ...... |
| 22 | ...... | ...... | 3.85 | 6.30 | 6.85 | 3.85 | 1.60 | 1.48 | ...... | 1.30 | Ice. |
| 23 | ...... | ...... | ...... | 6.20 | 6.95 | ...... | 1.53 | 1.38 | 1.50 | ...... | ...... |
| 24 | ...... | ...... | 4.05 | 6.00 | 7.15 | 3.73 | 1.43 | ...... | 1.50 | ...... | ...... |
| 25 | ...... | 4.00 | 4.30 | 5.75 | ...... | 3.63 | 1.33 | 1.23 | 1.58 | ...... | ...... |
| 26 | ...... | ...... | 4.90 | 5.55 | 6.85 | 3.60 | 1.23 | 1.20 | 1.73 | ...... | ...... |
| 27 | ...... | ...... | 5.70 | 5.35 | 6.65 | 3.45 | ...... | 1.00 | 1.75 | ...... | ...... |
| 28 | 5.15 | ...... | 5.70 | ...... | 6.45 | 3.28 | 1.03 | 1.00 | 1.83 | ...... | ...... |
| 29 | ...... | ...... | 5.65 | 5.75 | 6.40 | 3.05 | 1.00 | 1.00 | ...... | 1.25 | Ice. |
| 30 | ...... | ...... | ...... | 6.05 | 6.40 | ...... | 1.00 | 1.00 | 1.73 | ...... | Ice. |
| 31 | ...... | ...... | ...... | 6.10 | ...... | 3.00 | 1.00 | ...... | 1.60 | ...... | ...... |

## NORTH PLATTE RIVER AT GERING, NEBRASKA.

This river does not receive any tributaries of importance after passing into Nebraska. A number of canals divert water between the State line and North Platte, at the junction of the North and South Platte rivers, and because of the nonincrease of the flow from important tributaries the water is constantly being reduced. A gaging station was established at Gering, Nebraska, May 29, 1897, and is located at the highway bridge at this point. The rod is fastened to one of the bridge piles. The bench mark is the head of a nail on top of the west end of the first cap at the south end of the bridge, and is 6.61 feet above gage datum. The results of discharge measurements are shown as follows: 1897, Nineteenth Annual Report, Part IV, page 308; 1898, Twentieth Annual Report, Part IV, page 267. The following discharge measurements were made by R. H. Willis during 1899:

*Measurements of North Platte River at Gering, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Apr. 10 | 1.48 | 3,464 | July 6 | 3.09 | 15,996 |
| Apr. 21 | 2.10 | 9,776 | July 11 | 2.75 | 12,808 |
| May 2 | 2.35 | 11,096 | July 18 | 2.38 | 11,232 |
| May 16 | 2.10 | 8,575 | July 26 | 1.90 | 6,198 |
| May 26 | 2.90 | 12,942 | Aug. 10 | 1.48 | 3,677 |
| June 6 | 2.70 | 13,799 | Aug. 18 | 1.40 | 2,658 |
| June 14 | 2.90 | 14,176 | Aug. 24 | 1.18 | 2,150 |
| June 20 | 3.00 | 18,227 | Sept. 21 | 1.05 | 860 |
| June 26 | 3.55 | 23,473 | Sept. 30 | .95 | 957 |

*Daily gage height, in feet, of North Platte River at Gering, Nebraska, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | | 2.35 | 2.70 | 3.20 | 1.65 | 1.05 | 0.93 |
| 2 | | 2.37 | 2.71 | 3.15 | 1.70 | 1.02 | .95 |
| 3 | | 2.35 | 2.66 | 3.10 | 1.75 | 1.00 | .95 |
| 4 | | 2.10 | 2.61 | 3.07 | 1.70 | 1.02 | .96 |
| 5 | | 2.00 | 2.60 | 3.10 | 1.58 | 1.04 | .95 |
| 6 | | 1.95 | 2.72 | 3.05 | 1.55 | 1.01 | .95 |
| 7 | | 1.80 | 3.10 | 3.00 | 1.51 | 1.01 | .96 |
| 8 | | 1.75 | 3.00 | 2.95 | 1.47 | 1.00 | .96 |
| 9 | | 1.73 | 2.83 | 2.87 | 1.48 | 1.00 | .96 |
| 10 | 1.48 | 1.70 | 2.73 | 2.70 | 1.53 | 1.00 | .97 |
| 11 | 1.41 | 1.68 | 2.69 | 2.75 | 1.47 | 1.00 | 1.06 |
| 12 | 1.53 | 1.64 | 2.68 | 2.68 | 1.50 | 1.00 | 1.07 |
| 13 | 1.85 | 1.82 | 2.80 | 2.55 | 1.48 | 1.00 | 1.07 |
| 14 | 2.22 | 1.93 | 2.90 | 2.46 | 1.37 | .95 | 1.06 |
| 15 | 2.42 | 2.00 | 3.00 | 2.45 | 1.35 | .95 | 1.07 |
| 16 | 2.51 | 2.25 | 3.20 | 2.44 | 1.43 | 1.00 | 1.04 |
| 17 | 2.58 | 2.40 | 3.25 | 2.42 | 1.40 | .98 | 1.10 |
| 18 | 2.38 | 2.60 | 3.15 | 2.37 | 1.37 | 1.00 | 1.02 |
| 19 | 2.43 | 2.76 | 3.00 | 2.30 | 1.36 | 1.00 | 1.16 |
| 20 | 2.20 | 2.80 | 2.95 | 2.25 | 1.32 | 1.06 | 1.20 |
| 21 | 2.21 | 2.85 | 3.00 | 2.13 | 1.26 | 1.06 | 1.23 |
| 22 | 2.08 | 2.87 | 3.05 | 2.05 | 1.23 | .98 | 1.25 |
| 23 | 1.92 | 2.87 | 3.20 | 2.00 | 1.23 | 1.03 | 1.27 |
| 24 | 1.90 | 3.10 | 3.27 | 2.00 | 1.20 | 1.03 | 1.23 |
| 25 | 1.88 | 2.85 | 3.50 | 1.95 | 1.20 | .98 | 1.23 |
| 26 | 1.93 | 2.65 | 3.55 | 1.90 | 1.10 | .98 | 1.23 |
| 27 | 2.12 | 2.43 | 3.50 | 1.85 | 1.10 | 1.00 | 1.27 |
| 28 | 2.40 | 2.41 | 3.30 | 1.81 | 1.10 | .98 | 1.30 |
| 29 | 2.39 | 2.43 | 3.27 | 1.77 | 1.13 | .91 | 1.30 |
| 30 | 2.37 | 2.52 | 3.25 | 1.67 | 1.10 | .90 | 1.30 |
| 31 | | 2.70 | | 1.67 | 1.07 | | 1.30 |

Closed for winter October 31.

## NORTH PLATTE RIVER AT CAMP CLARKE, NEBRASKA.

A third gaging station on this river is located at the bridge at Camp Clarke, Nebraska, and was established on June 27, 1896. The rod consists of an oak timber 2 by 4 inches, 10 feet long, fastened to cross-ties which are bedded in the bank of the river. Bench mark No. 1 consists of a spike driven horizontally in the northeast side of the downstream pile of the bent at the north end of the first truss span, on the south end of the bridge, and is 7.55 feet above gage datum. Bench mark No. 2 is a point on the southeast corner of the window sill at the front of the store, and is 9.74 feet above the zero of the gage. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 154; 1897, Nineteenth

Annual Report, Part IV, page 308; 1898, Twentieth Annual Report, Part IV, page 268. The following discharge measurements were made by R. H. Willis in 1899:

*Measurements of North Platte River at Camp Clarke, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Apr. 11 | 2.57 | 2,823 | July 20 | 3.97 | 9,855 |
| Apr. 22 | 3.45 | 8,625 | July 29 | 3.09 | 4,747 |
| May 3 | 3.41 | 7,982 | Aug. 5 | 2.90 | 4,187 |
| May 17 | 3.52 | 9,646 | Aug. 12 | 2.92 | 3,272 |
| May 27 | 3.90 | 13,492 | Aug. 19 | 2.67 | 2,359 |
| June 8 | 4.42 | 15,607 | Aug. 29 | 2.46 | 1,492 |
| June 17 | 4.45 | 18,237 | Sept. 5 | 2.13 | 965 |
| June 24 | 5.05 | 18,330 | Sept. 14 | 2.05 | 758 |
| June 28 | 5.00 | 22,903 | Sept. 23 | 2.03 | 794 |
| July 8 | 4.76 | 18,705 | Sept. 29 | 2.10 | 863 |
| July 13 | 4.25 | 12,268 | Oct. 19 | 2.15 | 1,110 |

*Daily gage height, in feet, of North Platte River at Camp Clarke, Nebraska, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | ........ | 3.68 | 4.12 | 4.81 | 2.88 | 2.28 | 2.28 |
| 2 | ........ | 3.73 | 4.18 | 4.83 | 2.98 | 2.22 | 2.27 |
| 3 | ........ | 3.30 | 4.12 | 4.85 | 3.10 | 2.06 | 2.23 |
| 4 | ........ | 3.13 | 4.10 | 4.88 | 3.03 | 2.03 | 2.22 |
| 5 | 2.55 | 3.34 | 4.09 | 4.80 | 2.88 | 2.11 | 2.21 |
| 6 | 2.60 | 3.30 | 4.22 | 4.87 | 2.88 | 2.16 | 2.19 |
| 7 | 2.62 | 2.80 | 4.40 | 4.83 | 2.90 | 2.00 | 2.30 |
| 8 | 2.67 | 2.80 | 4.35 | 4.82 | 2.84 | 2.10 | 2.20 |
| 9 | 2.68 | 2.74 | 4.25 | 4.70 | 2.75 | 2.12 | 2.28 |
| 10 | 2.58 | 2.80 | 4.21 | 4.50 | 2.85 | 2.16 | 2.25 |
| 11 | 2.55 | 2.73 | 4.02 | 4.45 | 2.95 | 2.11 | 2.28 |
| 12 | 2.54 | 2.87 | 3.97 | 4.40 | 2.91 | 2.02 | 2.22 |
| 13 | 2.86 | 2.99 | 4.02 | 4.25 | 3.08 | 2.03 | 2.29 |
| 14 | 3.26 | 3.02 | 4.08 | 4.14 | 2.81 | 2.15 | 2.28 |
| 15 | 3.76 | 3.19 | 4.22 | 4.20 | 2.74 | 2.13 | 2.34 |
| 16 | 3.70 | 3.40 | 4.45 | (*a*) | 2.84 | 2.15 | 2.25 |
| 17 | 3.58 | 3.61 | 4.48 | (*a*) | 2.82 | 2.17 | 2.30 |
| 18 | 3.58 | 3.74 | 4.25 | (*a*) | 2.77 | 2.18 | 2.25 |
| 19 | 3.60 | 3.87 | 4.10 | 4.00 | 2.70 | 2.21 | 2.22 |
| 20 | 3.65 | 4.06 | (*f*) | 3.93 | 2.68 | 2.23 | 2.25 |
| 21 | 3.50 | 4.19 | (*f*) | 3.80 | 2.60 | 2.21 | 2.40 |
| 22 | 3.43 | 4.32 | 4.80 | 3.75 | 2.62 | 2.19 | ........ |
| 23 | 3.15 | 4.23 | 4.95 | 3.65 | 2.58 | 2.22 | ........ |
| 24 | 3.08 | 4.19 | 5.08 | 3.50 | 2.55 | 2.40 | ........ |
| 25 | 3.05 | 4.30 | 5.30 | 3.48 | 2.58 | 2.30 | ........ |
| 26 | 3.05 | 4.03 | 5.35 | 3.32 | 2.48 | 2.23 | ........ |
| 27 | 3.20 | 3.85 | 5.20 | 3.20 | 2.47 | 2.20 | ........ |
| 28 | 3.55 | 3.75 | 5.00 | 3.20 | 2.48 | 2.30 | ........ |
| 29 | 3.65 | 3.80 | 4.85 | 3.07 | 2.47 | 2.22 | ........ |
| 30 | 3.75 | 3.92 | 4.85 | 2.93 | 2.35 | 2.25 | ........ |
| 31 | ........ | 4.03 | ........ | 3.04 | 2.34 | ........ | ........ |

Discontinued October 31. *a* Bridge out. *f* Rod out.

## NORTH PLATTE RIVER AT NORTH PLATTE, NEBRASKA.

The lowest gaging station on this river is located at the wagon bridge at North Platte, Nebraska, and was established in 1894. It is 3.5 miles above the junction of the South Platte River. The bridge is a long, low, pile bridge, having 93 spans of approximately 20 feet each, crossing the main channel of the river. North of this is another bridge crossing a slough, through which no water passes, however, except in time of flood. The gage rod is at the railroad bridge 2 miles below the wagon bridge. The zero is 12 feet below the top and immediately under the east rail of the track. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 158; 1897, Nineteenth Annual Report, Part IV, page 309; 1898, Twentieth Annual Report, Part IV, page 269. The following discharge measurements were made by Glenn E. Smith and Charles P. Ross during 1899:

*Measurements of North Platte River at North Platte, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Apr. 19 | 3.30 | 9,111 | July 17 | 3.30 | 10,351 |
| May 6 | 3.00 | 8,239 | Aug. 8 | 2.50 | 4,637 |
| May 22 | 3.80 | 12,962 | Aug. 28 | 1.85 | 2,013 |
| June 6 | 3.60 | 13,310 | Sept. 15 | 1.55 | 976 |
| June 15 | 3.60 | 11,330 | Oct. 4 | 1.70 | 713 |
| June 19 | 4.20 | 16,257 | | | |

*Daily gage height, in feet, of North Platte River at North Platte, Nebraska, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.70 | 3.00 | 3.00 | 2.30 | 3.50 | 3.55 | 4.10 | 2.60 | 1.90 | 1.55 | 1.90 | 2.10 |
| 2 | 2.70 | 3.00 | 3.00 | 2.10 | 3.50 | 3.70 | 4.20 | 2.70 | 1.80 | 1.50 | 2.00 | 2.10 |
| 3 | 2.70 | 3.00 | 3.00 | 2.80 | 3.40 | 3.80 | 4.15 | 2.70 | 1.80 | 1.60 | 2.00 | 2.05 |
| 4 | 2.70 | 3.00 | 3.00 | 2.70 | 3.25 | 3.80 | 4.10 | 2.80 | 1.80 | 1.70 | 2.05 | 2.05 |
| 5 | 2.70 | 3.00 | 3.00 | 2.60 | 3.15 | 3.70 | 4.10 | 2.80 | 1.65 | 1.70 | 2.10 | 2.30 |
| 6 | 2.70 | 3.00 | 3.00 | 2.80 | 3.00 | 3.60 | 4.10 | 2.70 | 1.65 | 1.70 | 2.15 | 2.50 |
| 7 | 2.70 | 3.00 | 3.00 | 2.85 | 3.00 | 3.65 | 4.00 | 2.65 | 1.70 | 1.70 | 2.10 | 2.50 |
| 8 | 2.70 | 3.00 | 3.00 | 2.55 | 3.25 | 3.80 | 4.00 | 2.50 | 1.70 | 1.60 | 2.10 | 2.50 |
| 9 | 2.70 | 3.00 | 3.00 | 2.50 | 3.15 | 3.90 | 4.00 | 2.50 | 1.60 | 1.60 | 2.10 | 2.40 |
| 10 | 2.70 | 3.00 | 3.10 | 2.50 | 2.80 | 3.90 | 4.00 | 2.40 | 1.55 | 1.60 | 2.10 | 2.40 |
| 11 | 2.70 | 3.00 | 3.10 | 2.50 | 2.75 | 3.85 | 3.90 | 2.30 | 1.60 | 1.60 | 2.10 | 2.40 |
| 12 | 2.70 | 3.00 | 3.10 | 2.60 | 2.60 | 3.75 | 3.65 | 2.30 | 1.60 | 1.70 | 2.10 | 2.40 |
| 13 | 2.70 | 3.00 | 3.10 | 2.65 | 2.60 | 3.65 | 3.60 | 2.35 | 1.60 | 1.70 | 2.00 | 2.40 |
| 14 | 2.70 | 3.00 | 3.10 | 2.50 | 2.50 | 3.55 | 3.60 | 2.50 | 1.60 | 1.65 | 2.00 | 2.40 |
| 15 | 2.70 | 3.00 | 3.10 | 2.45 | 2.60 | 3.60 | 3.55 | 2.50 | 1.55 | 1.80 | 2.05 | 2.40 |
| 16 | 2.70 | 3.00 | 3.10 | 2.50 | 2.65 | 3.70 | 3.40 | 2.40 | 1.50 | 1.80 | 2.10 | 2.40 |
| 17 | 2.70 | 3.00 | 3.00 | 3.25 | 2 85 | 3.95 | 3.30 | 2.35 | 1.50 | 1.80 | 2.05 | 2.40 |
| 18 | 2.70 | 3.00 | 2.80 | 3.30 | 3.05 | 4.00 | 3.20 | 2.40 | 1.50 | 1.80 | 2.00 | 2.40 |
| 19 | 2.80 | 3.00 | 2.80 | 3.35 | 3.05 | 4.20 | 3.25 | 2.30 | 1.50 | 1.80 | 2.10 | 2.40 |
| 20 | 2.80 | 3.00 | 2.80 | 3.40 | 3.40 | 4.15 | 3.30 | 2.30 | 1.50 | 1.80 | 2.10 | 2.40 |
| 21 | 2.80 | 3.00 | 2.50 | 3.30 | 3.60 | 3.95 | 3.30 | 2.30 | 1.60 | 1.80 | 2.20 | 2.40 |
| 22 | 2.90 | 3.00 | 2.80 | 3.10 | 3.75 | 3.85 | 3.20 | 2.00 | 1.60 | 1.80 | 2.20 | 2.40 |
| 23 | 2.80 | 3.00 | 2.80 | 3.10 | 3.75 | 3.90 | 3.15 | 2.00 | 1.50 | 1.80 | 2.10 | 2.40 |
| 24 | 2.80 | 3.00 | 3.05 | 3.10 | 3.80 | 3.85 | 3.00 | 1.90 | 1.50 | 1.80 | 2.10 | 2.45 |
| 25 | 3.00 | 3.00 | 2.90 | 3.00 | 3.70 | 4.15 | 2.95 | 1.90 | 1.50 | 1.80 | 2.10 | 2.55 |
| 26 | 3.00 | 3.00 | 2.60 | 2.90 | 3.80 | 4.30 | 2.80 | 1.90 | 1.60 | 1.90 | 2.10 | 2.70 |
| 27 | 3.00 | 3.00 | 2.60 | 3.00 | 3.85 | 4.45 | 2.80 | 1.90 | 1.60 | 2.00 | 2.10 | 2.70 |
| 28 | 3.00 | 3.00 | 2.55 | 3.00 | 3.85 | 4.40 | 2.85 | 1.85 | 1.55 | 2.00 | 2.20 | 2.70 |
| 29 | 3.00 | ....... | 2.50 | 3.00 | 3.75 | 4.30 | 2.70 | 1.75 | 1.60 | 2.00 | 2.10 | 2.70 |
| 30 | 3.00 | ....... | 2.55 | 3.10 | 3.50 | 4.25 | 2.70 | 1.65 | 1.60 | 2.00 | 2.10 | 2.70 |
| 31 | 3.00 | ....... | 2.60 | ...... | 3.50 | ...... | 2.55 | 1.75 | ...... | 1.95 | ....... | 2.65 |

## SOUTH PLATTE RIVER.

The headwater tributaries of this stream have their sources in the high mountain peaks surrounding the basin known as South Park. The average elevation of the valley is 8,000 feet, while the peaks attain an elevation of 13,000 feet. Considerable irrigation is practiced on a small scale, but principally for forage crops, as on account of the high altitude only the hardier products can be raised. The streams have a general northerly direction, and upon issuing from the mountainous area the water is quickly appropriated by the large irrigation enterprises serving land on both sides of the South Platte River in the vicinity of Denver. A number of smaller streams rising on the eastern slope of the Rocky Mountains drain easterly into the South Platte River. The principal tributaries are—in order downstream—Bear Creek, Clear Creek, South Boulder Creek, Boulder Creek, St. Vrain Creek, Big Thompson Creek, and Cache la Poudre River. Gaging stations have been maintained on them also as well as one at Lake Cheesman on the South Fork of South Platte, and one on Goose Creek, which also contributes to the supply of the proposed reservoir. The next one downstream on the main river is at Platte Canyon, the third one at Denver, and the lower one at Orchard, Colorado. Besides the measurements of discharge at regular stations a number of others have been made in this basin during 1899, as follows: April 14 a measurement of the High-line ditch in the South Platte, at a gage height of 1.20 feet, showed a discharge of 98 second-feet. On July 28 the same canal was measured twice, the first time at a gage height of 3.25 feet, showing a discharge of 432 second-feet; the second time at a gage height of 3 feet, with a discharge of 375 second-feet. On the same day also the South Platte River was discharging over the High-line dam, at a gage height of 0.50 foot, 73 second-feet. September 14, South Platte River, at Julesburg, was carrying 2 second-feet. October 4 the river at the dam of the High-line canal, at a gage height of 0.13 foot, was discharging 12 second-feet.

A notable storage proposition on which work was prosecuted during the past season is that of the dam of Lake Cheesman, which is located on the South Fork of South Platte River, below the mouth of Goose Creek. The dam, which is partially completed, will be 215 feet high. Its length at its base is only 20 feet and at the top it will be 520 feet. The abutments are solid granite. The main tunnel for diverting the flow during the course of the construction of the dam is now completed, and work is now progressing on two subsidiary tunnels. The dam is to be rock filled and steel plate faced. The capacity of the reservoir is about 90,000 acre-feet. The object of this enterprise is to develop electric power to be used in the city of Denver, and also to furnish a water supply for the same city.

### GOOSE CREEK AT LAKE CHEESMAN, COLORADO.

The station on this creek, a tributary of South Platte River, was established August 1, 1899, by J. A. Runner, assistant engineer of the Denver Union Water Company. It was desired to obtain the flow of the South Fork of South Platte River at this point, where the construction of the Cheesman dam has been begun, the discharge of Goose Creek being added to the South Fork of South Platte to give the total flow at this point. The station is maintained by the Denver Union Water Company. All discharge measurements for 1899 have been made by means of floats. This station is to be considered simply as temporary, as it will be necessary to move it farther upstream when water is stored in the reservoir. The following discharge measurements were made by J. A. Runner during 1899:

September 8, gage height, 0.95 foot; discharge, 24 second-feet.
October 8, gage height, 0.84 foot; discharge, 10 second-feet.
November 19, gage height, 0.72 foot; discharge, 8 second-feet.
December 3, gage height, 0.76 foot; discharge, 9 second-feet.

*Daily gage height, in feet, of Goose Creek at Lake Cheesman, Colorado, for 1899.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.25 | 0.97 | 0.85 | ........ | 0.80 | 17 | 1.04 | .90 | .86 | ........ | ........ |
| 2 | 1.20 | .95 | .85 | ........ | ........ | 18 | 1.00 | .89 | .86 | .85 | .74 |
| 3 | 1.30 | *a* .95 | .85 | ........ | .76 | 19 | .98 | .88 | .87 | ........ | ........ |
| 4 | 1.32 | *a* .95 | .85 | 0.85 | ........ | 20 | .96 | .88 | .87 | ........ | .80 |
| 5 | 1.35 | *a* .95 | .86 | ........ | .74 | 21 | .96 | .88 | .88 | .84 | ........ |
| 6 | 1.15 | *a* .95 | .85 | .86 | ........ | 22 | .95 | .88 | .88 | ........ | ........ |
| 7 | 1.25 | *a* .95 | .85 | ........ | ........ | 23 | .94 | *a* .88 | .88 | ........ | ........ |
| 8 | 1.25 | .95 | .84 | .87 | ........ | 24 | .93 | *a* .88 | ........ | .82 | ........ |
| 9 | 1.10 | .94 | .84 | .87 | ........ | 25 | .93 | *a* .88 | ........ | ........ | ........ |
| 10 | 1.09 | .94 | .85 | ........ | .72 | 26 | .92 | .87 | ........ | .80 | ........ |
| 11 | 1.06 | .92 | .85 | .87 | ........ | 27 | .91 | .87 | ........ | ........ | ........ |
| 12 | 1.05 | .90 | .85 | ........ | .73 | 28 | .90 | .86 | ........ | ........ | ........ |
| 13 | 1.05 | .89 | .85 | ........ | ........ | 29 | .91 | .86 | ........ | .80 | ........ |
| 14 | 1.05 | .88 | .85 | .86 | .74 | 30 | .93 | .85 | ........ | ........ | ........ |
| 15 | 1.04 | .89 | .85 | ........ | ........ | 31 | .96 | ........ | ........ | ........ | ........ |
| 16 | 1.04 | .90 | .85 | .85 | .73 | | | | | | |

*a* Estimated.

## SOUTH FORK OF SOUTH PLATTE RIVER AT LAKE CHEESMAN, COLORADO.

This station was established July 31, 1899, and has been maintained since that time by the Denver Union Water Company, J. A. Runner, assistant engineer, making the discharge measurements. It is located above the mouth of Goose Creek, and is maintained in order to determine the flow available for Lake Cheesman. The discharge here should be added to the discharge of Goose Creek, as the dam for this reservoir is located below the mouth of the latter tributary. It will be necessary in this case, as in the preceding one, to move the station upstream when water has been stored in the reservoir, so the station can be considered merely as a temporary one. It is the intention that both the inflow and the discharge from the reservoir shall be accurately measured after the storage has begun. The following measurements of discharge were made by J. A. Runner by means of floats in 1899:

July 31, gage height, 3.62 feet; discharge, 806 second-feet.
September 8, gage height, 1.45 feet; discharge, 184 second-feet.
October 3, gage height, 1.23 feet; discharge, 95 second-feet.
November 19, gage height, 1.30 feet; discharge, 107 second-feet.
December 3, gage height, 1.24 feet; discharge, 97 second-feet.

*Daily gage height, in feet, of South Platte River at Lake Cheesman, Colorado, for 1899.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.55 | 1.51 | 1.23 | -------- | 1.26 | 17 | 1.72 | 1.34 | 1.30 | -------- | -------- |
| 2 | 2.20 | 1.50 | 1.23 | -------- | -------- | 18 | 1.72 | 1.36 | 1.20 | 1.28 | 1.02 |
| 3 | 2.60 | (*a*) | 1.23 | -------- | 1.24 | 19 | 1.67 | 1.37 | 1.20 | 1.30 | -------- |
| 4 | 3.70 | (*a*) | 1.24 | 1.20 | -------- | 20 | 1.60 | 1.36 | 1.28 | -------- | 1.10 |
| 5 | 3.55 | (*a*) | 1.26 | -------- | 1.14 | 21 | 1.57 | 1.37 | 1.30 | -------- | -------- |
| 6 | 3.10 | (*a*) | 1.05 | 1.43 | -------- | 22 | 1.56 | 1.38 | 1.28 | 1.24 | -------- |
| 7 | 2.50 | (*a*) | .88 | -------- | -------- | 23 | 1.54 | (*a*) | 1.27 | -------- | 1.20 |
| 8 | 2.60 | 1.45 | .86 | 1.45 | -------- | 24 | 1.53 | (*a*) | -------- | 1.29 | -------- |
| 9 | 2.35 | 1.45 | .85 | 1.41 | -------- | 25 | 1.50 | (*a*) | -------- | -------- | -------- |
| 10 | 2.15 | 1.44 | .80 | -------- | .92 | 26 | 1.50 | (*a*) | -------- | .98 | -------- |
| 11 | 1.98 | 1.42 | .80 | 1.41 | -------- | 27 | 1.48 | 1.28 | -------- | -------- | -------- |
| 12 | 1.95 | 1.40 | .80 | -------- | .90 | 28 | 1.46 | 1.27 | -------- | -------- | -------- |
| 13 | 1.92 | 1.38 | .90 | -------- | -------- | 29 | 1.44 | 1.26 | -------- | 1.30 | -------- |
| 14 | 1.87 | 1.33 | 1.10 | 1.40 | .92 | 30 | 1.43 | 1.23 | -------- | -------- | -------- |
| 15 | 1.79 | 1.32 | 1.40 | -------- | -------- | 31 | 1.48 | -------- | -------- | -------- | -------- |
| 16 | 1.70 | 1.33 | 1.40 | 1.20 | 1.00 | | | | | | |

*a* No readings.

## SOUTH PLATTE RIVER AT PLATTE CANYON, COLORADO.

This station has been maintained for sometime by the Denver Union Water Company, but cooperation with this Survey was not begun until April 1, 1899. The station is located at a point about 2 miles above Platte Canyon railway station, on the Colorado and Southern Railroad. The rod is an inclined 2 by 6 timber on the right-hand side of the stream, marked with brass nails. The bench mark is a point chiseled in a circle just south of the Denver Union Water Company's pipe line, and 15 feet south of the zero point of soundings on the bridge. It is on a granite rock and is 10 feet above gage datum. Measurements of discharge are made from the footbridge constructed by the Denver Union Water Company. The channel of the stream is rocky, and at first it was considered that it was not liable to material change; but during a freshet of considerable size erosion took place, making necessary a change in the rating table. This station gives the total discharge of the river at Platte Canyon before any water is taken out for irrigation or any other purposes excepting that taken out by the Denver Union Water Company at a point about 1 mile above the station. The observer, G. E. Carleton, Littleton, Colorado, is superintendent of the filtering plant belonging to the Denver Union Water Company. He furnishes gage readings to the United States Weather Bureau at Denver, where they are published each day. The following discharge measurements were made under the direction of A. L. Fellows during 1899:

April 14, 1899, gage height, 1.8 feet; discharge, 559 second-feet.
May 8, 1899, gage height, 1.5 feet; discharge, 500 second-feet.
June 10, 1899, gage height, 2.9 feet; discharge, 1,127 second-feet.
July 28, 1899, gage height, 1.8 feet; discharge, 633 second-feet.
October 4, 1899, gage height, 0.1 feet; discharge, 146 second-feet.

*Daily gage height, in feet, of South Platte River at Platte Canyon, Colorado, for 1899.*

| Day. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.50 | 1.40 | 2.50 | 3.20 | 2.50 | 0.90 | 0.10 | 0.40 | —0.10 |
| 2 | .50 | 1.50 | 2.50 | 3.80 | 2.20 | .90 | .00 | .30 | — .40 |
| 3 | .55 | 1.50 | 2.50 | 4.10 | 2.60 | .90 | .00 | .40 | — .40 |
| 4 | .60 | 1.20 | 2.60 | 4.10 | 3.30 | .80 | .00 | .40 | —1.10 |
| 5 | .60 | 1.10 | 2.40 | 3.90 | 3.30 | .70 | .10 | .40 | 1.80 |
| 6 | .50 | 1.10 | 2.40 | 3.60 | 2.90 | .60 | .10 | .40 | — .60 |
| 7 | .60 | 1.20 | 2.50 | 3.40 | 2.70 | .60 | .10 | .30 | .60 |
| 8 | .60 | 1.50 | 2.80 | 3.40 | 2.50 | .60 | —.20 | .40 | — .70 |
| 9 | .70 | 1.90 | 3.00 | 3.30 | 2.30 | .60 | —.30 | .40 | — .30 |
| 10 | .70 | 2.10 | 2.90 | 3.10 | 2.00 | .60 | —.30 | .30 | — .40 |
| 11 | .80 | 2.20 | 3.00 | 2.80 | 1.80 | .60 | —.20 | .30 | — .20 |
| 12 | 1.20 | 2.30 | 3.20 | 2.70 | 1.60 | .50 | —.20 | .30 | .10 |
| 13 | 1.50 | 2.50 | 3.30 | 2.70 | 1.60 | .50 | —.10 | .30 | .30 |
| 14 | 1.80 | 2.60 | 3.50 | 3.00 | 1.60 | .50 | —.10 | .30 | .00 |
| 15 | 1.90 | 2.60 | 3.40 | 3.00 | 1.50 | .50 | .20 | .20 | .30 |
| 16 | 1.70 | 2.70 | 3.50 | 3.00 | 1.40 | .50 | .20 | .30 | .60 |
| 17 | 1.80 | 2.60 | 3.50 | 3.20 | 1.40 | .50 | .30 | .10 | .70 |
| 18 | 2.00 | 2.60 | 3.50 | 3.30 | 1.30 | .50 | .40 | .10 | .50 |
| 19 | 1.80 | 2.50 | 3.50 | 3.10 | 1.20 | .50 | .40 | .00 | .50 |
| 20 | 1.70 | 2.50 | 4.65 | 3.00 | 1.10 | .50 | .30 | —.20 | .50 |
| 21 | 1.40 | 2.40 | 4.20 | 2.60 | 1.00 | .40 | .30 | .10 | .60 |
| 22 | 1.40 | 2.30 | 4.20 | 2.40 | 1.00 | —.10 | .30 | .00 | .60 |
| 23 | 1.50 | 2.30 | 3.90 | 2.20 | .90 | +.20 | .20 | .20 | .60 |
| 24 | 1.60 | 2.40 | 3.60 | 2.10 | .80 | .50 | .20 | .20 | .60 |
| 25 | 1.80 | 2.40 | 3.60 | 2.00 | .80 | .20 | .30 | —.20 | .50 |
| 26 | 2.10 | 2.50 | 3.70 | 1.90 | .70 | .30 | .30 | —.40 | .40 |
| 27 | 1.90 | 2.50 | 3.60 | 1.90 | .70 | .20 | .30 | —.60 | .20 |
| 28 | 1.90 | 2.50 | 3.40 | 1.80 | .70 | .20 | .30 | —.30 | .30 |
| 29 | 1.70 | 2.50 | 3.30 | 2.20 | .70 | .10 | .30 | .10 | .30 |
| 30 | 1.60 | 2.50 | 3.20 | 2.80 | .70 | .10 | .30 | —.10 | .30 |
| 31 | ........ | 2.50 | ........ | 3.10 | 1.10 | ........ | .30 | ........ | .40 |

## SOUTH PLATTE RIVER AT DENVER, COLORADO.

The gaging station at this point, established July 15, 1895, is located at the Fifteenth street bridge in the city of Denver, immediately below the mouth of Cherry Creek. The rod at present used is fastened to a post in the left bank of the river and graduated to vertical feet and tenths. The bench mark is a cross on top of east abutment of the Fifteenth street bridge on the north corner, and is 15.15 feet above gage datum. The river is confined between slag embankments, and the bed, although sandy and shifting, did not materially change during 1899. Mr. W. J. Southland, water commissioner of Colorado Irrigation District No. 2, cooperated with this survey in furnishing the gage readings, which are also transmitted to the United States Weather Bureau, and published each day in the Denver daily papers. The station is an important one, and it is fortunate that it can so easily be reached and discharge measurements made without great expense. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 165; 1897, Nineteenth Annual Report, Part IV, page 313; 1898, Twentieth Annual Report, Part IV, page 279. The following measurements of discharge were made by A. L. Fellows in 1899:

April 12, gage height, 6.0 feet; discharge, 422 second-feet.
May 11, gage height, 6.03 feet; discharge, 355 second-feet.
June 12, gage height, 6.2 feet; discharge, 764 second-feet.
July 27, gage height, 5.32 feet; discharge, 213 second-feet.
August 4, gage height, 6.93 feet; discharge, 1,200 second-feet.
September 6, gage height, 5.95 feet: discharge, 288 second-feet.
October 5, gage height, 5.1 feet; discharge, 100 second-feet.

*Daily gage height, in feet, of South Platte River at Denver, Colorado, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.80 | 4.80 | 6.10 | 6.10 | 5.85 | 5.90 | 6.30 | 6.20 | 6.00 | 5.20 | 5.15 | 5.55 |
| 2 | 4.70 | 4.80 | 6.00 | 6.05 | 5.85 | 5.90 | 6.65 | 5.95 | 5.95 | 5.20 | 5.25 | 5.65 |
| 3 | 4.80 | 4.80 | 6.00 | 6.00 | 5.75 | 6.10 | 6.95 | 5.90 | 6.00 | 5.15 | 5.35 | 5.15 |
| 4 | 4.90 | 4.80 | 5.90 | 5.95 | 5.75 | 5.90 | 7.10 | 7.00 | 6.00 | 5.10 | 5.40 | 5.25 |
| 5 | 4.90 | 4.90 | 5.90 | 5.90 | 5.80 | 6.00 | 7.00 | 7.20 | 5.90 | 5.10 | 5.30 | 5.35 |
| 6 | 4.80 | 4.90 | 5.80 | 5.80 | 5.95 | 5.95 | 6.60 | 6.95 | 5.85 | 5.10 | 5.25 | 5.50 |
| 7 | 4.90 | 4.80 | 5.80 | 5.75 | 5.85 | 6.30 | 6.45 | 6.75 | 5.80 | 5.05 | 5.35 | 5.50 |
| 8 | 4.90 | 4.70 | 5.70 | 5.80 | 5.75 | 6.50 | 6.40 | 6.60 | 5.80 | 4.90 | 5.40 | 5.15 |
| 9 | 4.80 | 4.80 | 5.60 | 5.90 | 5.75 | 6.50 | 6.40 | 6.45 | 5.80 | 4.90 | 5.25 | 5.15 |
| 10 | 4.70 | 4.90 | 5.50 | 6.05 | 6.05 | 6.45 | 6.35 | 6.30 | 5.80 | 5.00 | 5.20 | 5.30 |
| 11 | 4.80 | 4.80 | 5.60 | 6.15 | 6.05 | 6.25 | 6.15 | 6.20 | 5.75 | 5.00 | 5.40 | 5.05 |
| 12 | 4.80 | 4.90 | 5.70 | 6.10 | 6.10 | 6.25 | 6.00 | 6.20 | 5.75 | 5.00 | 5.70 | 5.15 |
| 13 | 4.90 | 5.10 | 5.60 | 6.15 | 6.25 | 6.45 | 5.95 | 6.00 | 5.70 | 5.10 | 5.60 | 5.15 |
| 14 | 5.00 | 5.20 | 5.80 | 6.20 | 6.25 | 6.50 | 6.40 | 6.00 | 5.65 | 5.20 | 5.50 | 5.05 |
| 15 | 4.90 | 5.30 | 5.80 | 6.25 | 6.35 | 6.65 | 6.25 | 6.00 | 5.70 | 5.20 | 5.55 | 5.20 |
| 16 | 4.90 | 5.30 | 5.90 | 6.30 | 6.30 | 6.60 | 6.30 | 5.90 | 5.75 | 5.25 | 5.45 | 5.30 |
| 17 | 4.80 | 5.40 | 6.00 | 6.20 | 6.25 | 6.65 | 6.40 | 5.65 | 5.80 | 5.15 | 5.55 | 5.25 |
| 18 | 4.90 | 5.70 | 6.10 | 6.35 | 6.20 | 6.65 | 6.45 | 5.65 | 5.75 | 5.05 | 5.35 | 5.30 |
| 19 | 4.80 | 6.30 | 6.15 | 6.25 | 6.08 | 6.65 | 6.60 | 5.55 | 5.75 | 5.15 | 5.45 | 5.35 |
| 20 | 4.80 | 6.20 | 6.25 | 6.05 | 6.08 | 6.85 | 6.30 | 5.65 | 5.80 | 5.20 | 5.70 | 5.25 |
| 21 | 4.80 | 6.00 | 6.30 | 5.95 | 6.00 | 7.10 | 6.20 | 6.05 | 5.70 | 5.10 | 5.65 | 5.25 |
| 22 | 4.70 | 5.90 | 6.20 | 5.95 | 5.90 | 7.00 | 6.00 | 6.02 | 5.65 | 5.15 | 5.75 | 5.25 |
| 23 | 4.80 | 5.70 | 6.05 | 5.95 | 5.80 | 6.90 | 5.90 | 5.98 | 5.60 | 5.25 | 5.70 | 5.30 |
| 24 | 4.70 | 5.60 | 6.00 | 6.00 | 5.88 | 6.90 | 5.80 | 5.92 | 5.30 | 5.30 | 5.70 | 5.35 |
| 25 | 4.80 | 5.50 | 5.90 | 5.95 | 5.89 | 6.80 | 5.70 | 5.85 | 5.60 | 5.20 | 5.60 | 5.40 |
| 26 | 4.90 | 5.60 | 5.95 | 6.10 | 5.85 | 6.70 | 5.60 | 5.75 | 5.60 | 5.20 | 5.65 | 5.40 |
| 27 | 4.80 | 5.80 | 6.05 | 6.15 | 5.88 | 6.65 | 5.50 | 5.65 | 5.60 | 5.30 | 5.65 | 5.25 |
| 28 | 4.70 | 6.20 | 6.10 | 6.05 | 5.95 | 6.55 | 5.30 | 5.75 | 5.65 | 5.25 | 5.70 | 5.30 |
| 29 | 4.80 | ...... | 6.20 | 5.95 | 6.30 | 6.40 | 5.20 | 5.80 | 5.50 | 5.15 | 5.60 | 5.40 |
| 30 | 4.80 | ...... | 6.15 | 5.90 | 5.95 | 6.30 | 5.90 | 5.90 | 5.20 | 5.25 | 5.50 | 5.30 |
| 31 | 4.80 | ...... | 6.10 | ...... | 5.85 | ...... | 6.10 | 6.00 | ...... | 5.15 | ...... | 5.40 |

## SOUTH PLATTE RIVER AT ORCHARD, COLORADO.

This station, on the lower South Platte River, is located one-fourth of a mile southwest of Orchard, Colorado. The gage is vertical and is fastened to a pile of the wagon bridge. The gage rod is not referred to any satisfactory bench mark, and consequently when the pile to which the rod was nailed was raised a number of tenths by ice about March 17, it was necessary that a new rating table be made for observations after that date. The left bank is high and the right low and liable to overflow. The bed of the stream is sandy and shifting, although the section did not materially change during 1899. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 166; 1897, Nineteenth Annual Report, Part IV, page 315; 1898, Twentieth Annual Report, Part IV, page 293. The following measurements of discharge were made under the direction of A. L. Fellows in 1899:

April 14, gage height, 3.2 feet; discharge, 1,258 second-feet.
May 27, gage height, 2.3 feet; discharge, 158 second-feet.
September 12, gage height, 2.05 feet; discharge, 57 second-feet.
November 3, gage height, 2.80 feet; discharge, 614 second-feet.

*Daily gage height, in feet, of South Platte River at Orchard, Colorado, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.50 | 4.40 | 5.00 | 3.20 | 3.20 | 2.10 | 3.40 | 2.80 | 2.00 | 2.30 | 2.80 | 3.00 |
| 2 | 4.50 | 4.40 | 5.00 | 3.20 | 3.20 | 2.10 | 3.45 | 2.75 | 2.00 | 2.30 | 2.80 | 3.00 |
| 3 | 4.50 | 4.40 | 5.00 | 3.20 | 3.10 | 2.10 | 3.70 | 2.70 | 1.90 | 2.30 | 2.80 | 3.00 |
| 4 | 4.50 | 4.40 | 5.00 | 3.20 | 3.10 | 2.10 | 3.90 | 2.70 | 1.90 | 2.30 | 2.80 | 3.00 |
| 5 | 4.50 | 4.40 | 5.00 | 3.20 | 3.10 | 2.00 | 4.20 | 2.90 | 1.90 | 2.30 | 2.80 | 3.00 |
| 6 | 4.50 | 4.40 | 5.00 | 3.20 | 3.00 | 2.00 | 4.00 | 4.20 | 1.90 | 2.30 | 2.80 | 3.00 |
| 7 | 4.50 | 4.40 | 4.90 | 3.20 | 3.00 | 2.00 | 3.80 | 4.20 | 1.90 | 2.30 | 2.80 | 3.00 |
| 8 | 4.40 | 4.40 | 4.80 | 3.20 | 3.00 | 2.00 | 3.90 | 4.00 | 1.90 | 2.30 | 2.80 | 3.00 |
| 9 | 4.40 | 4.40 | 4.50 | 3.20 | 3.00 | 1.90 | 4.20 | 3.80 | 1.90 | 2.30 | 2.85 | 3.00 |
| 10 | 4.40 | 4.40 | 4.50 | 3.20 | 2.80 | 1.90 | 4.00 | 3.70 | 1.90 | 2.35 | 2.85 | 3.00 |
| 11 | 4.40 | 4.40 | 4.50 | 3.20 | 2.80 | 1.90 | 3.50 | 3.40 | 1.90 | 2.40 | 2.90 | 3.00 |
| 12 | 4.40 | 4.40 | 4.50 | 3.20 | 2.80 | 1.85 | 3.20 | 3.20 | 1.90 | 2.50 | 2.90 | 3.00 |
| 13 | 4.40 | 4.45 | 4.50 | 3.20 | 2.50 | 1.90 | 3.00 | 3.20 | 1.90 | 2.60 | 2.90 | 3.20 |
| 14 | 4.40 | 4.50 | 4.50 | 3.20 | 2.50 | 3.00 | 3.10 | 3.20 | 1.90 | 2.70 | 2.90 | 3.20 |
| 15 | 4.40 | 4.60 | 4.00 | 3.20 | 2.50 | 3.20 | 3.20 | 2.70 | 1.90 | 2.80 | 2.90 | 3.20 |
| 16 | 4.40 | 4.70 | 4.00 | 3.20 | 2.50 | 3.20 | 3.50 | 2.65 | 1.90 | 2.80 | 2.90 | 3.20 |
| 17 | 4.40 | 4.75 | 4.00 | 3.20 | 2.50 | 3.20 | 3.80 | 2.60 | 1.90 | 2.80 | 2.95 | 3.20 |
| 18 | 4.40 | 4.80 | 3.50 | 3.25 | 2.30 | 3.20 | 3.90 | 2.50 | 1.90 | 2.80 | 2.98 | 3.20 |
| 19 | 4.40 | 4.80 | 3.20 | 3.30 | 2.30 | 3.20 | 4.00 | 2.40 | 1.90 | 2.80 | 3.00 | 3.30 |
| 20 | 4.40 | 5.00 | 3.20 | 3.30 | 2.20 | 3.20 | 3.70 | 2.40 | 1.95 | 2.80 | 3.00 | 3.40 |
| 21 | 4.40 | 5.00 | 3.20 | 3.30 | 2.20 | 3.90 | 3.60 | 2.35 | 1.95 | 2.80 | 3.00 | 3.60 |
| 22 | 4.40 | 5.00 | 3.20 | 3.30 | 2.20 | 4.40 | 3.30 | 2.30 | 2.00 | 2.80 | 3.00 | 3.70 |
| 23 | 4.40 | 5.00 | 3.20 | 3.30 | 2.20 | 4.50 | 3.20 | 2.30 | 2.00 | 2.80 | 3.00 | 3.80 |
| 24 | 4.40 | 5.00 | 3.20 | 3.30 | 2.20 | 4.60 | 3.00 | 2.20 | 2.10 | 2.80 | 3.00 | 3.90 |
| 25 | 4.40 | 5.00 | 3.20 | 3.30 | 2.20 | 4.20 | 2.90 | 2.15 | 2.10 | 2.80 | 3.00 | 3.90 |
| 26 | 4.40 | 5.00 | 3.20 | 3.30 | 2.20 | 4.10 | 2.85 | 2.10 | 2.20 | 2.80 | 3,00 | 3.90 |
| 27 | 4.40 | 5.00 | 3.20 | 3.30 | 2.20 | 4.00 | 2.70 | 2.00 | 2.20 | 2.80 | 3.00 | 4.00 |
| 28 | 4.40 | 5.00 | 3.20 | 3.30 | 2.20 | 3.90 | 2.60 | 2.00 | 2.20 | 2.80 | 3.00 | 4.00 |
| 29 | 4.40 | ....... | 3.20 | 3.30 | 2.20 | 3.70 | 2.60 | 2.00 | 2.30 | 2.80 | 3.00 | 4.00 |
| 30 | 4.40 | ....... | 3.20 | 3.30 | 2.20 | 3.60 | 2.50 | 2.00 | 2.30 | 2.80 | 3.00 | 4.00 |
| 31 | 4.40 | ....... | 3.20 | ....... | 2.20 | ....... | 2.80 | 2.00 | ....... | 2.80 | ....... | 4.00 |

The water diversions from this stream in Colorado are so extensive that during the summer season a comparatively insignificant flow reaches Nebraska. Measurements of the South Platte were made near its junction with the North Platte. On April 19, 1899, Glenn E. Smith made a measurement from the wagon bridge south of the town of North Platte, and found the total width to be 1,296 feet, while the discharge was 883 second-feet; on May 6 the discharge was 866 second-feet, and on May 22, 88 second-feet. At this time the water was flowing in a number of small channels scattered across the sandy bed. On June 6 the channel was dry.

## BEAR CREEK AT MORRISON, COLORADO.

This stream, a tributary of the South Platte, drains a portion of the eastern slope of the Rocky Mountains and enters the main stream 8 miles above Denver. The station is located in the upper part of the town of Morrison. The present station was established April 16, 1899, by John E. Field, State engineer, and is located about a quarter of a mile above the railway station. The gage rod consists of a 2 by 4 timber placed vertically and marked in feet and tenths, and is fastened to the upper side of the dam which diverts water into the mains of the Denver Union Water Company. At the height of 4 feet on the gage rod water begins to flow over the spillway, making a marked difference in the rating curve. The bench mark consists of the top of a granite bowlder about 100 feet above the rod and on the left-hand side of the stream, and is 10.33 feet above gage datum. The station was maintained during the year through cooperation with the Denver Union Water Company. Previous results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 167; 1897, Nineteenth Annual Report, Part IV, page 317; 1898, Twentieth Annual Report, Part IV, page 284. The following discharge measurements were made under the direction of A. L. Fellows during 1899:

April 15, gage height, 3.80 feet; discharge, 64 second-feet.
May 9, gage height, 4.25 feet; discharge, 99 second-feet.
June 16, gage height, 4.25 feet; discharge, 107 second-feet.
August 5, gage height, 4.98 feet; discharge, 192 second-feet.
November 14, gage height, 1.35 feet; discharge, 13 second-feet.

*Daily gage height, in feet, of Bear Creek at Morrison, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | ---------- | 4.05 | 4.05 | 4.15 | 4.10 | 3.35 | 2.00 |
| 2 | ---------- | 4.10 | 4.05 | 4.40 | 4.15 | 3.35 | 1.90 |
| 3 | ---------- | 3.20 | 3.95 | 4.45 | 5.25 | 3.25 | 1.90 |
| 4 | ---------- | 3.25 | 3.85 | 4.45 | 5.80 | 3.25 | 1.90 |
| 5 | ---------- | 3.55 | 3.55 | 4.20 | 5.20 | 3.15 | 1.80 |
| 6 | ---------- | 3.65 | 3.90 | 4.05 | 5.05 | 2.95 | 1.80 |
| 7 | ---------- | 3.90 | 4.20 | 4.20 | 4.90 | 2.80 | 1.80 |
| 8 | ---------- | 4.15 | 4.15 | 4.20 | 4.75 | 2.65 | 1.80 |
| 9 | ---------- | 4.20 | 4.30 | 4.05 | 4.65 | 2.65 | 1.80 |
| 10 | ---------- | 4.20 | 4.15 | 3.75 | 4.65 | 2.55 | 2.20 |
| 11 | ---------- | 4.40 | 4.15 | 3.65 | 4.55 | 2.70 | 2.10 |
| 12 | ---------- | 4.55 | 4.20 | 3.65 | 4.55 | 2.75 | 2.10 |
| 13 | ---------- | 4.60 | 4.30 | 4.10 | 4.45 | 2.70 | 2.00 |
| 14 | ---------- | 4.70 | 4.25 | 4.25 | 4.35 | 2.65 | 2.00 |
| 15 | ---------- | 4.70 | 4.15 | 4.30 | 4.25 | 2.60 | 2.05 |
| 16 | 4.20 | 4.65 | 4.15 | 4.30 | 4.15 | 2.70 | 2.00 |
| 17 | 4.20 | 4.60 | 4.15 | 4.50 | 4.20 | 2.75 | 1.95 |
| 18 | 4.15 | 4.50 | 4.15 | 4.10 | 3.95 | 2.65 | 1.90 |
| 19 | 4.15 | 4.45 | 4.25 | 4.00 | 3.75 | 2.60 | 1.80 |
| 20 | 3.95 | 4.45 | 4.30 | 4.00 | 3.65 | 2.45 | 1.80 |
| 21 | 3.75 | 4.25 | 4.25 | 3.95 | 3.45 | 2.45 | 1.70 |
| 22 | 4.00 | 4.25 | 4.25 | 3.90 | 3.35 | 2.35 | ---------- |
| 23 | 4.05 | 4.25 | 4.15 | 3.85 | 3.25 | 2.25 | ---------- |
| 24 | 4.20 | 4.25 | 4.15 | 3.75 | 3.15 | 2.20 | ---------- |
| 25 | 4.20 | 4.25 | 4.30 | 3.65 | 3.05 | 2.20 | ---------- |
| 26 | 4.10 | 4.25 | 4.15 | 3.75 | 3.05 | 2.15 | ---------- |
| 27 | 4.10 | 4.25 | 4.15 | 3.75 | 2.95 | 2.10 | ---------- |
| 28 | 4.00 | 4.25 | 4.05 | 3.75 | 2.75 | 2.10 | ---------- |
| 29 | 3.85 | 4.15 | 4.05 | 4.25 | 2.55 | 2.05 | ---------- |
| 30 | 3.65 | 4.15 | 4.20 | 4.15 | 2.45 | 2.00 | ---------- |
| 31 | ---------- | 4.15 | ---------- | 3.90 | 3.35 | ---------- | ---------- |

Closed for the winter October 21.

## CLEAR CREEK AT FORKSCREEK, COLORADO.

This stream rises on the eastern slope of the Rocky Mountains almost due west of Denver, and flows in an easterly direction, entering the South Platte River 6 miles below the center of the city of Denver. The small summer flow of this stream is completely utilized for irrigation purposes. The gaging station, established by John E. Field, State engineer, March 29, 1899, is located at the railway station at Forkscreek, on the Colorado and Southern Railway, in Clear Creek Canyon, just below the junction of the North and South forks. The gage consists of a weight fastened to a wire running over a pulley fastened to a rock at the railway station. Bench mark No. 1 is a point on the timber to which the pulley is attached, and is 13.58 feet above gage datum. Bench mark No. 2 is a granite point 49.5 feet east of the first bench mark, and is 15.46 feet above gage datum. The channel is rocky and not liable to serious change. The walls are high and not liable to overflow. On April 20 measurements of the North and

South forks were made separately and gave 43 second-feet and 101 second-feet, respectively. The following discharge measurements were made under the direction of A. L. Fellows during 1899:

March 29, gage height, 1.50 feet; discharge, 52 second-feet.
April 20, gage height, 2.10 feet; discharge, 155 second-feet.
May 10, gage height, 2.75 feet; discharge, 365 second-feet.
June 7, gage height, 3.70 feet; discharge, 779 second-feet.
August 12, gage height, 3.08 feet; discharge, 449 second-feet.
November 15, gage height, 1.70 feet; discharge, 67 second-feet.

*Daily gage height, in feet, of Clear Creek at Forkscreek, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.65 | 2.55 | (a) | 4.45 | 3.35 | 2.60 | 2.10 | 2.10 | 1.40 |
| 2 | 1.75 | 2.50 | (a) | 4.40 | 3.39 | 2.75 | 2.10 | 2.05 | 1.40 |
| 3 | 1.65 | 2.50 | (a) | 4.30 | 3.35 | 2.60 | 2.10 | 2.00 | ........ |
| 4 | 1.65 | 2.25 | (a) | 4.05 | 3.40 | 2.60 | 2.00 | 2.00 | ........ |
| 5 | 1.70 | 2.35 | (a) | 4.00 | 3.55 | 2.60 | 2.00 | 1.90 | ........ |
| 6 | 1.55 | 2.40 | (a) | 4.05 | 3.35 | 2.50 | 2.00 | 1.85 | ........ |
| 7 | 1.75 | 2.45 | 3.70 | 4.00 | 3.30 | 2.40 | 2.00 | 1.75 | ........ |
| 8 | 1.70 | 2.45 | 3.75 | 4.00 | 3.30 | 2.40 | 2.00 | 1.75 | ........ |
| 9 | 1.85 | 2.60 | 3.80 | 3.95 | 3.25 | 2.30 | 2.00 | 1.80 | ........ |
| 10 | 1.95 | 2.85 | 3.80 | 3.90 | 3.15 | 2.30 | 2.00 | 1.80 | ........ |
| 11 | 2.20 | 3.10 | 3.90 | 3.75 | 3.10 | 2.30 | 2.00 | 1.80 | ........ |
| 12 | 2.20 | 3.50 | 4.15 | 3.70 | 3.05 | 2.30 | 2.00 | 1.80 | ........ |
| 13 | 2.05 | 3.75 | 4.30 | 3.70 | 3.00 | 2.30 | 2.10 | 1.80 | ........ |
| 14 | 2.15 | 4.00 | 4.40 | 3.70 | 3.00 | 2.30 | 2.05 | 1.80 | ........ |
| 15 | 2.20 | 4.10 | 4.20 | 3.70 | 3.00 | 2.30 | 2.10 | 1.70 | ........ |
| 16 | 2.30 | 4.25 | 4.25 | 3.70 | 3.00 | 2.30 | 2.10 | 1.70 | ........ |
| 17 | 2.30 | 4.20 | 4.30 | 3.70 | 2.95 | 2.30 | 2.10 | 1.70 | ........ |
| 18 | 2.30 | 4.35 | 4.45 | 3.60 | 2.90 | 2.30 | 2.10 | 1.65 | ........ |
| 19 | 2.15 | 4.45 | 4.65 | 3.50 | 2.85 | 2.20 | 2.10 | 1.60 | ........ |
| 20 | 2.10 | (a) | 4.70 | 3.50 | 2.80 | 2.20 | 2.00 | 1.55 | ........ |
| 21 | 2.20 | (a) | 4.75 | 3.50 | 2.75 | 2.20 | 2.00 | 1.50 | ........ |
| 22 | 2.20 | (a) | 4.70 | 3.50 | 2.70 | 2.20 | 2.00 | 1.55 | ........ |
| 23 | 2.45 | (a) | 4.40 | 3.50 | 2.70 | 2.20 | 2.00 | 1.65 | ........ |
| 24 | 2.50 | (a) | 4.40 | 3.40 | 2.70 | 2.20 | 2.00 | 1.50 | ........ |
| 25 | 2.75 | (a) | 4.25 | 3.40 | 2.70 | 2.20 | 2.00 | 1.40 | ........ |
| 26 | 2.90 | (a) | 4.25 | 3.40 | 2.70 | 2.20 | 2.05 | 1.40 | ........ |
| 27 | 2.80 | (a) | 4.15 | 3.40 | 2.70 | 2.20 | 2.10 | 1.40 | ........ |
| 28 | 2.80 | (a) | 4.10 | 3.40 | 2.60 | 2.10 | 2.00 | 1.40 | ........ |
| 29 | 2.30 | (a) | 4.10 | 3.45 | 2.60 | 2.10 | 2.00 | 1.40 | ........ |
| 30 | 2.45 | (a) | 4.25 | 3.40 | 2.60 | 2.10 | 2.00 | 1.40 | ........ |
| 31 | ........ | (a) | ........ | 3.40 | 2.60 | ........ | 2.05 | ........ | ........ |

*a* Gage broken; no reading.

## SOUTH BOULDER CREEK AT MARSHALL, COLORADO.

This stream, the next one of importance entering below Clear Creek, is measured at a point about 3 miles west of Marshall, Colorado. The gage is an inclined 2 by 6 inch timber fastened to a tree and stakes driven into the ground. The bench mark is a stone 15 feet west of the gage, marked with black paint, and is 6.99 feet above gage datum. The gage was verified August 10, 1899. Two ditches divert water at points above the station, viz, the South Boulder and Coal Creek ditch and the Community ditch, and their discharge must be added to the discharge as found at the station to determine the total run-off of the basin. May 6 South Boulder and Coal Creek ditch, at a gage height of 0.7 foot, was discharging 7 second-feet, and on the same date Community ditch, at a gage height of 2.25 feet, was carrying 35 second-feet. C. E. Barber, Langford, Colorado, is the observer. Measurements are usually made by wading, but a footbridge near by can be used in high water. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 169; 1897, Nineteenth Annual Report, Part IV, page 318; 1898, Twentieth Annual Report, Part IV, page 287. The following discharge measurements were made under the direction of A. L. Fellows in 1899:

April 22, gage height, 1.70 feet; discharge, 115 second-feet.
May 6, gage height, 1.55 feet; discharge, 96 second-feet.
June 15, gage height, 2.80 feet; discharge, 451 second-feet.
August 10, gage height, 1.60 feet; discharge, 109 second-feet.
October 10, gage height, 0.70 foot; discharge, 7 second-feet.

*Daily gage height, in feet, of South Boulder Creek at Marshall, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.90 | 1.80 | 2.50 | 2.65 | 1.65 | 1.30 | 17 | 1.75 | 2.65 | 2.85 | 2.15 | 1.40 | 1.10 |
| 2 | 1.00 | 1.80 | 2.55 | 2.65 | 1.55 | 1.30 | 18 | 1.75 | 2.60 | 2.90 | 2.10 | 1.40 | 1.10 |
| 3 | .95 | 1.65 | 2.50 | 2.55 | 1.65 | 1.30 | 19 | 1.80 | 2.65 | 2.95 | 2.10 | 1.40 | 1.10 |
| 4 | 1.00 | 1.65 | 2.35 | 2.45 | 1.85 | 1.25 | 20 | 1.80 | 2.65 | 3.00 | 2.00 | 1.35 | 1.00 |
| 5 | .95 | 1.60 | 2.30 | 2.45 | 2.00 | 1.20 | 21 | 1.80 | 2.50 | 3.00 | 2.05 | 1.30 | 1.05 |
| 6 | 1.00 | 1.60 | 2.35 | 2.40 | 1.90 | 1.20 | 22 | 1.85 | 2.45 | 3.00 | 2.00 | 1.30 | .90 |
| 7 | .95 | 1.65 | 2.45 | 2.35 | 1.80 | 1.20 | 23 | 1.80 | 2.35 | 2.85 | 2.00 | 1.35 | .90 |
| 8 | 1.00 | 1.70 | 2.55 | 2.30 | 1.85 | 1.20 | 24 | 1.95 | 2.30 | 2.80 | 1.95 | 1.30 | .90 |
| 9 | 1.05 | 1.90 | 2.60 | 2.25 | 1.70 | 1.20 | 25 | 2.10 | 2.40 | 2.70 | 1.90 | 1.30 | .90 |
| 10 | 1.15 | 2.25 | 2.70 | 2.30 | 1.60 | 1.10 | 26 | 2.15 | 2.55 | 2.65 | 1.85 | 1.30 | .90 |
| 11 | 1.25 | 2.25 | 2.65 | 2.30 | 1.60 | 1.00 | 27 | 2.25 | 2.60 | 2.65 | 1.85 | 1.30 | .90 |
| 12 | 1.40 | 2.35 | 2.80 | 2.25 | 1.60 | 1.00 | 28 | 2.20 | 2.55 | 2.55 | 1.80 | 1.25 | .90 |
| 13 | 1.60 | 2.35 | 2.90 | 2.50 | 1.50 | 1.00 | 29 | 2.15 | 2.50 | 2.55 | 1.70 | 1.20 | .90 |
| 14 | 1.65 | 2.55 | 2.95 | 2.35 | 1.50 | 1.00 | 30 | 1.90 | 2.55 | 2.60 | 1.60 | 1.30 | .90 |
| 15 | 1.75 | 2.60 | 2.90 | 2.45 | 1.40 | 1.00 | 31 | ------ | 2.55 | ------ | 1.55 | 1.30 | -------- |
| 16 | 1.80 | 2.70 | 2.85 | 2.25 | 1.50 | 1.05 | | | | | | | |

Closed for the winter September 30.

*Daily gage height, in feet, of South Boulder and Coal Creek ditch, Colorado, for 1899.*

| Day. | May. | June. | July. | Aug. | Day. | May. | June. | July. | Aug. | Day. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ------ | 1.35 | 1.50 | 1.20 | 12 | ------ | 1.50 | 1.30 | 1.00 | 23 | 1.10 | 1.50 | 1.20 | -------- |
| 2 | ------ | 1.30 | 1.50 | 1.20 | 13 | ------ | 1.50 | 1.30 | 1.00 | 24 | 1.10 | 1.50 | 1.20 | -------- |
| 3 | ------ | 1.40 | 1.50 | 1.20 | 14 | ------ | 1.50 | 1.30 | 1.00 | 25 | 1.10 | 1.50 | 1.20 | -------- |
| 4 | ------ | 1.40 | 1.50 | 1.20 | 15 | ------ | 1.50 | (*a*) | .90 | 26 | 1.10 | 1.50 | 1.20 | -------- |
| 5 | ------ | 1.40 | 1.50 | 1.20 | 16 | ------ | 1.50 | (*a*) | .90 | 27 | 1.10 | 1.50 | 1.20 | -------- |
| 6 | ------ | 1.50 | 1.40 | 1.20 | 17 | ------ | 1.50 | 1.30 | .80 | 28 | 1.10 | 1.50 | 1.20 | -------- |
| 7 | ------ | 1.50 | 1.40 | 1.20 | 18 | ------ | 1.50 | 1.30 | .80 | 29 | 1.10 | 1.50 | 1.20 | -------- |
| 8 | ------ | 1.50 | 1.30 | 1.00 | 19 | ------ | 1.50 | 1.20 | .80 | 30 | 1.30 | 1.50 | 1.20 | -------- |
| 9 | ------ | 1.50 | 1.30 | 1.00 | 20 | ------ | 1.50 | 1.20 | -------- | 31 | 1.30 | ------ | 1.20 | -------- |
| 10 | ------ | 1.50 | 1.30 | 1.00 | 21 | 0.90 | 1.50 | 1.20 | -------- | | | | | |
| 11 | ------ | 1.50 | 1.30 | 1.00 | 22 | .90 | 1.50 | 1.20 | -------- | | | | | |

*a* Dry.

*Daily gage height, in feet, of Community ditch, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Day. | Apr. | May. | June. | July. | Day. | Apr. | May. | June. | July. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ------ | 2.10 | 2.20 | 2.20 | 12 | ------ | 2.20 | 2.20 | 2.10 | 23 | 1.50 | 2.20 | 2.20 | ------- |
| 2 | ------ | 2.10 | 2.30 | 2.20 | 13 | ------ | 2.20 | 2.20 | 2.10 | 24 | 1.70 | 2.20 | 2.20 | ------- |
| 3 | ------ | 2.10 | 2.30 | 2.20 | 14 | ------ | 2.20 | 2.20 | 2.10 | 25 | 1.80 | 2.20 | 2.20 | ------- |
| 4 | ------ | 2.20 | 2.30 | 2.20 | 15 | ------ | 2.20 | 2.20 | -------- | 26 | 1.80 | 2.20 | 2.20 | ------- |
| 5 | ------ | 2.20 | 2.30 | 2.20 | 16 | ------ | 2.20 | 2.20 | -------- | 27 | 1.90 | 2.20 | 2.20 | ------- |
| 6 | ------ | 2.20 | 2.20 | 2.20 | 17 | ------ | 2.20 | 2.20 | 1.25 | 28 | 1.90 | 2.20 | 2.20 | ------- |
| 7 | ------ | 2.20 | 2.20 | 2.20 | 18 | ------ | 2.20 | 2.20 | 1.30 | 29 | 2.10 | 2.20 | 2.20 | ------- |
| 8 | ------ | 2.20 | (*a*) | 2.20 | 19 | ------ | 2.20 | 2.20 | 1.20 | 30 | 2.10 | 2.20 | 2.20 | ------- |
| 9 | ------ | 2.20 | 2.20 | 2.10 | 20 | ------ | 2.10 | 2.20 | 1.20 | 31 | ------ | 2.20 | ------ | ------- |
| 10 | ------ | 2.20 | 2.20 | 2.10 | 21 | ------ | 2.10 | 2.20 | 1.20 | | | | | |
| 11 | ------ | 2.20 | 2.20 | 2.10 | 22 | ------ | 2.20 | 2.20 | 1.20 | | | | | |

*a* Dry.

## BOULDER CREEK AT BOULDER, COLORADO.

The next drainage of importance entering the South Platte from the west is Boulder Creek, an important tributary, furnishing water for a number of irrigation ditches. The station is located about 1½ miles above the town of Boulder, Colorado. The gage rod is inclined and spiked to stakes driven into the ground. The bench mark is the top of a large stone 22 feet west of the gage, and is 5.72 feet above gage datum. Both banks are high and rocky, and not liable to overflow. Two small irrigating ditches take water from the stream above the station, but the amount thus diverted will probably not exceed 5 or 6 second-feet. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 171; 1897, Nineteenth Annual Report, Part IV, page 319; 1898, Twentieth Annual Report, Part IV, page 286. The following discharge measurements were made under the direction of A. L. Fellows in 1899:

April 21, gage height, 1 foot; discharge, 84 second-feet.
May 6, gage height, 1.20 feet; discharge, 134 second-feet.
June 15, gage height, 2.50 feet; discharge, 642 second-feet.
August 10, gage height, 1.70 feet; discharge, 276 second-feet.
October 10, gage height, 0.50 foot; discharge, 36 second-feet.

*Daily gage height, in feet, of Boulder Creek at Boulder, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.32 | 1.55 | 2.15 | 2.90 | 1.92 | 1.52 | 0.48 | 0.48 |
| 2 | .30 | 1.52 | 2.12 | 2.92 | 1.98 | 1.50 | .48 | .45 |
| 3 | .38 | 1.40 | 2.12 | 2.85 | 2.22 | 1.45 | .48 | .48 |
| 4 | .45 | 1.38 | 2.00 | 2.85 | 2.45 | 1.38 | .48 | .48 |
| 5 | .35 | 1.30 | 1.98 | 2.78 | 2.18 | 1.22 | .45 | .42 |
| 6 | .32 | 1.20 | 2.05 | 2.70 | 2.02 | 1.12 | .48 | .40 |
| 7 | .42 | 1.22 | 2.12 | 2.65 | 1.88 | 1.05 | .42 | .38 |
| 8 | .42 | 1.28 | 2.18 | 2.58 | 1.82 | .95 | .45 | .38 |
| 9 | .48 | 1.35 | 2.28 | 2.48 | 1.78 | .98 | .50 | .35 |
| 10 | .55 | 1.45 | 2.45 | 2.50 | 1.70 | .95 | .55 | .35 |
| 11 | .92 | 1.60 | 2.48 | 2.42 | 1.65 | .92 | .58 | .30 |
| 12 | 1.00 | 1.70 | 2.62 | 2.40 | 1.68 | .90 | .60 | .30 |
| 13 | 1.05 | 1.90 | 2.65 | 2.48 | 1.62 | .88 | .65 | .35 |
| 14 | 1.10 | 2.00 | 2.68 | 2.45 | 1.52 | .95 | .65 | .38 |
| 15 | 1.10 | 2.12 | 2.62 | 2.48 | 1.60 | .98 | .60 | .42 |
| 16 | 1.25 | 2.15 | 2.58 | 2.40 | 1.65 | .92 | .58 | .42 |
| 17 | 1.20 | 2.12 | 2.60 | 2.30 | 1.55 | .88 | .58 | .40 |
| 18 | 1.22 | 2.08 | 2.75 | 2.28 | 1.52 | .82 | .52 | .35 |
| 19 | 1.15 | 2.12 | 2.85 | 2.18 | 1.45 | .78 | .55 | .30 |
| 20 | 1.10 | 2.15 | 2.85 | 2.12 | 1.38 | .72 | .50 | .30 |
| 21 | 1.12 | 2.10 | 2.90 | 2.10 | 1.38 | .72 | .48 | .28 |
| 22 | 1.20 | 2.08 | 2.88 | 2.05 | 1.32 | .62 | .50 | .28 |
| 23 | 1.25 | 2.10 | 2.90 | 2.02 | 1.32 | .60 | .52 | .25 |
| 24 | 1.48 | 2.05 | 2.85 | 1.90 | 1.28 | .58 | .55 | .25 |
| 25 | 1.62 | 2.08 | 2.85 | 1.92 | 1.20 | .58 | .60 | .22 |
| 26 | 1.68 | 2.18 | 2.85 | 2.00 | 1.15 | .55 | .55 | .22 |
| 27 | 1.65 | 2.12 | 2.78 | 2.05 | 1.22 | .58 | .50 | .25 |
| 28 | 1.60 | 2.12 | 2.70 | 2.10 | 1.45 | .55 | .48 | .22 |
| 29 | 1.55 | 2.15 | 2.72 | 2.20 | 1.25 | .50 | .48 | .18 |
| 30 | 1.58 | 2.15 | 2.82 | 2.10 | 1.50 | .50 | .48 | .18 |
| 31 | | 2.12 | | 1.90 | 1.55 | | .50 | |

## ST. VRAIN CREEK AT LYONS, COLORADO.

The gaging station on this drainage is located one-half mile southeast of Lyons, Colorado, below the intersections of the North and South forks of St. Vrain Creek. The gage is inclined and fastened to a post driven into the ground. Both banks are low and liable to overflow. The bed of the stream is composed of gravel. On May 5 a new gage rod was established having the same reading as the old one, and connected with a bench mark 150 feet north of the rod. The elevation of the bench mark is 6.51 feet above gage datum. Supply ditch diverts water above the station, and its discharge should be added to that of the river to obtain the total run-off in the basin. On May 5 at the rating flume, it was discharging, at a gage height of 0.65 foot, 35 second-feet. The observer is Miss Bessie Sites, who reads the gage on the creek, as well as that of the ditch. The results of measurements are found as follows: 1896, Eighteenth Annual Report, Part IV, page 173; 1897, Nineteenth Annual Report, Part IV, page 320; 1898; Twentieth Annual Report, Part IV, page 285. The following discharge measurements were made under the direction of A. L. Fellows in 1899:

April 18, gage height, 3 feet; discharge, 217 second-feet.
May 5, gage height, 2.75 feet; discharge, 137 second-feet.
June 14, gage height, 4.15 feet; discharge, 825 second-feet.
August 9, gage height, 3.20 feet; discharge, 263 second-feet.
October 7, gage height, 2.10 feet; discharge, 37 second-feet.

*Daily gage height, in feet, of St. Vrain Creek at Lyons, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.05 | 2.90 | 3.35 | 4.40 | 3.45 | 2.65 | 2.05 | 2.00 |
| 2 | 2.15 | 2.90 | 3.55 | 4.40 | 3.45 | 2.65 | 2.05 | 2.00 |
| 3 | 2.25 | 2.70 | 3.45 | 4.30 | 3.60 | 2.60 | 2.05 | 2.00 |
| 4 | 2.25 | 2.55 | 3.45 | 4.30 | 4.05 | 2.55 | 1.95 | 2.00 |
| 5 | 2.20 | 2.65 | 3.45 | 4.30 | 4.05 | 2.55 | 1.95 | 2.00 |
| 6 | 2.25 | 2.90 | 3.40 | 4.15 | 3.85 | 2.55 | 1.95 | 2.00 |
| 7 | 2.30 | 3.00 | 3.50 | 4.00 | 3.75 | 2.55 | 1.95 | 1.95 |
| 8 | 2.25 | 2.90 | 3.50 | 4.05 | 3.70 | 2.65 | 1.95 | 1.90 |
| 9 | 2.35 | 3.00 | 3.55 | 4.15 | 3.65 | 2.65 | 2.05 | 1.90 |
| 10 | 2.70 | 3.10 | 3.50 | 4.05 | 3.55 | 2.65 | 2.05 | 1.90 |
| 11 | 2.75 | 3.15 | 3.75 | 4.05 | 3.50 | 2.65 | 2.15 | 1.90 |
| 12 | 2.80 | 3.35 | 4.05 | 3.95 | 3.40 | 2.55 | 2.18 | 1.95 |
| 13 | 3.00 | 3.30 | 4.00 | 4.00 | 3.20 | 2.55 | 2.15 | 2.00 |
| 14 | 3.05 | 3.40 | 4.25 | 4.10 | 3.05 | 2.55 | 2.25 | 2.00 |
| 15 | 3.00 | 3.40 | 4.10 | 4.00 | 2.95 | 2.55 | 2.25 | 2.00 |
| 16 | 2.90 | 3.35 | 4.15 | 3.90 | 2.90 | 2,45 | 2.25 | 2.00 |
| 17 | 3.10 | 3.30 | 4.30 | 3.65 | 2.90 | 2.45 | 2.22 | 2.10 |
| 18 | 3.10 | 3.30 | 4.50 | 3.65 | 2.95 | 2.35 | 2.22 | 2.05 |
| 19 | 3.20 | 3.30 | 4.55 | 3.65 | 2.80 | 2.35 | 2.15 | 2.00 |
| 20 | 3.15 | 3.35 | 4.65 | 3.65 | 2.90 | 2.25 | 2.15 | 2.00 |
| 21 | 3.15 | 3.25 | 4.55 | 3.65 | 2.90 | 2.30 | 2.15 | 2.00 |
| 22 | 3.20 | 3.20 | 4.55 | 3.65 | 2.90 | 2.22 | 2.15 | 2.00 |
| 23 | 3.40 | 3.25 | 4.30 | 3.65 | 2.80 | 2.25 | 2.25 | 2.00 |
| 24 | 3.65 | 3.25 | 4.25 | 3.55 | 2.80 | 2.25 | 2.25 | 1.95 |
| 25 | 3.65 | 3.05 | 4.25 | 3.60 | 2.70 | 2.20 | 2.25 | 1.95 |
| 26 | 3.55 | 3.10 | 4.30 | 3.55 | 2.60 | 2.18 | 2.15 | 1.95 |
| 27 | 3.65 | 3.40 | 4.25 | 3.55 | 2.60 | 2.18 | 2.15 | 1.90 |
| 28 | 3.45 | 3.40 | 4.25 | 3.60 | 2.55 | 2.15 | 2.05 | 1.90 |
| 29 | 3.30 | 3.30 | 4.35 | 3.70 | 2.65 | 2.12 | 2.05 | 1.90 |
| 30 | 3.15 | 3.40 | 4.30 | 3.45 | 2.65 | 2.05 | 2.15 | 1.90 |
| 31 | .......... | 3.30 | .......... | 3.45 | 2.55 | .......... | 2.15 | (a) |

*a* Closed for the winter November 30.

*Daily gage height, in feet, of Supply ditch at Lyons, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.10 | 0.90 | 0.70 | 1.40 | 0.90 | 0.58 | 0.15 | 0.10 |
| 2 | .10 | .80 | .70 | 1.40 | .90 | .52 | .15 | .10 |
| 3 | .10 | .70 | .70 | 1.40 | .85 | .55 | .15 | .10 |
| 4 | .10 | .70 | .70 | 1.40 | .80 | .50 | .15 | .10 |
| 5 | .10 | .70 | .60 | 1.40 | .80 | .52 | .10 | .10 |
| 6 | .10 | .70 | .50 | 1.30 | .80 | .37 | .10 | .10 |
| 7 | .10 | .70 | .50 | 1.30 | .80 | .20 | .10 | .10 |
| 8 | .10 | .70 | .50 | 1.30 | .80 | .40 | .10 | .10 |
| 9 | .10 | .70 | .55 | 1.30 | .80 | .40 | .10 | .10 |
| 10 | .25 | .70 | .60 | 1.30 | .80 | .20 | .10 | .10 |
| 11 | .40 | .70 | .95 | 1.30 | .80 | .20 | .20 | .10 |
| 12 | .40 | .95 | 1.20 | 1.25 | .80 | .20 | .20 | .10 |
| 13 | .40 | .80 | 1.30 | 1.20 | .85 | .28 | .20 | .10 |
| 14 | .40 | .80 | 1.30 | 1.20 | .70 | .22 | .15 | .10 |
| 15 | .45 | .80 | 1.40 | 1.20 | .70 | .20 | .10 | .10 |
| 16 | .50 | .80 | 1.40 | 1.20 | .70 | .20 | .10 | .10 |
| 17 | .50 | .90 | 1.40 | 1.20 | .70 | .20 | .10 | .10 |
| 18 | .10 | 1.00 | 1.40 | 1.20 | .70 | .20 | .10 | .10 |
| 19 | .10 | 1.00 | 1.40 | 1.20 | .70 | .30 | .10 | .10 |
| 20 | .10 | 1.00 | 1.40 | 1.20 | .70 | .20 | .10 | .10 |
| 21 | .10 | 1.00 | 1.40 | 1.05 | .50 | .20 | .10 | .10 |
| 22 | .10 | 1.00 | 1.40 | .90 | .50 | .20 | .10 | .10 |
| 23 | .10 | 1.00 | 1.40 | .90 | .50 | .18 | .10 | .10 |
| 24 | .10 | .70 | 1.40 | .90 | .50 | .18 | .10 | .10 |
| 25 | .10 | .40 | 1.40 | .90 | .50 | .12 | .15 | .10 |
| 26 | .10 | .60 | 1.40 | .90 | .50 | .10 | .15 | .10 |
| 27 | .10 | .80 | 1.40 | .90 | .50 | .10 | .15 | .10 |
| 28 | .10 | .80 | 1.40 | .90 | .20 | .10 | .15 | .10 |
| 29 | .10 | .75 | 1.40 | .90 | .20 | .15 | .10 | .10 |
| 30 | .50 | .70 | 1.40 | .90 | .50 | .15 | .10 | .10 |
| 31 | ---------- | .70 | ---------- | .90 | .60 | ---------- | .10 | ---------- |

## BIG THOMPSON CREEK AT ARKINS, COLORADO.

This stream drains the country immediately south of the headwaters of Cache la Poudre River, and enters the South Platte 8 miles from Greeley. The location of the station was changed April 1, 1899, from its original position to a point 2 miles above, so that the head of the Home Supply ditch is now below the gaging station, while that of the Handy ditch is still above. It is necessary to include the discharge of this latter canal to give the total run-off of the stream. The present location of the station is at a wagon bridge upon the ranch of Mr. John Chasteen. The gage rod consists of a 2 by 4 inch timber spiked to the downstream side of the bridge on the right-hand side of the river. The bench mark is 25 feet south of the gage and is 9.35 feet above the zero. Handy ditch, which heads one-half mile above the station, was measured twice during the year, the first time, on April 17, at a gage height 0.6 foot, the discharge was 41 second-feet; June 13, at a gage height of 2.30 feet, the discharge was 182 second-feet. The observer is Ed. Chasteen, who records the heights of the canal as well as at the main gaging station. The results of measurements are found as follows: 1896, Eighteenth Annual Report, Part IV, page 175; 1897, Nineteenth Annual Report, Part IV, page 322; 1898, Twentieth Annual Report, Part IV, page 288. The following discharge measurements were made under the direction of A. L. Fellows in 1899:

April 17, gage height, 0.90 foot; discharge, 143 second-feet.
May 4, gage height, 0.97 foot; discharge, 173 second-feet.
June 13, gage height, 2.55 feet; discharge, 941 second-feet.
August 8, gage height, 1.73 feet; discharge, 406 second-feet.
October 6, gage height, 0.50 foot; discharge, 34 second-feet.

*Daily gage height, in feet, of Big Thompson Creek at Arkins, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | 0.30 | 1.00 | 1.90 | 2.75 | 1.80 | 0.90 | (a) |
| 2 | .40 | .95 | 2.00 | 2.70 | 1.80 | .90 | (a) |
| 3 | .35 | .90 | 1.90 | 2.60 | 1.80 | .85 | (a) |
| 4 | .45 | .90 | 1.85 | 2.65 | 2.15 | .80 | (a) |
| 5 | .45 | .90 | 1.90 | 2.50 | 1.90 | .90 | (a) |
| 6 | .50 | .90 | 1.90 | 2.40 | 1.80 | .85 | (a) |
| 7 | .55 | .90 | 1.90 | 2.40 | 1.75 | .80 | (a) |
| 8 | .35 | 1.00 | 2.00 | 2.30 | 1.70 | .80 | 0.50 |
| 9 | .20 | 1.00 | 2.10 | 2.30 | 1.60 | .80 | .50 |
| 10 | .35 | 1.00 | 2.15 | 2.25 | 1.55 | .80 | .60 |
| 11 | .55 | 1.05 | 2.25 | 2.20 | 1.45 | .80 | .70 |
| 12 | .65 | 1.10 | 2.30 | 2.15 | 1.40 | .80 | .80 |
| 13 | .75 | 1.25 | 2.45 | 2.75 | 1.30 | .70 | .80 |
| 14 | .90 | 1.55 | 2.60 | 2.15 | 1.30 | .70 | .60 |
| 15 | .90 | 1.60 | 2.65 | 2.15 | 1.30 | .70 | .60 |
| 16 | .95 | 1.65 | 2.75 | 2.25 | 1.25 | .70 | .60 |
| 17 | .95 | 1.50 | 2.80 | 1.95 | 1.20 | .70 | .60 |
| 18 | .95 | 1.40 | 2.80 | 1.75 | 1.15 | .80 | .60 |
| 19 | 1.00 | 1.40 | 2.90 | 2.00 | 1.20 | .70 | .60 |
| 20 | 1.10 | 1.45 | 3.15 | 2.00 | 1.10 | .70 | .60 |
| 21 | 1.00 | 1.60 | 3.15 | 1.90 | 1.10 | .60 | .60 |
| 22 | 1.15 | 1.40 | 2.90 | 2.00 | 1.05 | .60 | .60 |
| 23 | 1.20 | 1.60 | 2.65 | 2.00 | 1.00 | .60 | .60 |
| 24 | 1.35 | 1.75 | 2.50 | 2.05 | 1.05 | .60 | .60 |
| 25 | 1.30 | 1.85 | 2.60 | 1.90 | 1.00 | .65 | .60 |
| 26 | 1.45 | 1.85 | 2.65 | 1.85 | 1.00 | .55 | .60 |
| 27 | 1.50 | 2.00 | 2.55 | 1.95 | .90 | .50 | .60 |
| 28 | 1.45 | 2.00 | 2.70 | 1.90 | .95 | .50 | .60 |
| 29 | 1.25 | 1.90 | 2.80 | 1.90 | .90 | .50 | .60 |
| 30 | 1.10 | 1.90 | 2.75 | 1.90 | .90 | .50 | .60 |
| 31 | ---------- | 2.00 | ---------- | 1.80 | .90 | ---------- | .60 |

*a* No readings; closed for the winter October 31.

*Daily gage height, in feet, of Handy ditch on Big Thompson Creek, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ---- | 0.30 | 0.95 | 2.30 | 0.75 | 0.30 | 17 | ------ | 1.10 | 2.20 | 1.92 | 0.70 | (a) |
| 2 | ------ | .30 | .95 | 2.30 | .75 | .30 | 18 | ------ | 2.00 | 2.20 | 1.55 | .70 | (a) |
| 3 | ------ | .30 | .72 | 2.30 | .75 | .30 | 19 | ------ | 2.00 | 2.30 | 1.55 | .70 | (a) |
| 4 | ------ | .55 | .60 | 2.30 | 1.12 | .30 | 20 | ------ | 1.15 | 2.30 | 1.15 | .70 | (a) |
| 5 | ------ | .80 | .60 | 2.30 | 1.55 | .30 | 21 | ------ | 1.15 | 2.30 | .75 | .70 | .30 |
| 6 | ------ | .78 | .70 | 2.30 | 1.15 | .30 | 22 | ------ | .75 | 2.30 | .75 | .70 | .30 |
| 7 | ------ | .75 | .75 | 2.30 | 1.55 | .30 | 23 | ------ | .75 | 2.30 | .75 | .70 | .30 |
| 8 | ------ | .75 | .78 | 2.30 | 1.30 | .30 | 24 | ------ | .75 | 2.25 | .75 | .70 | .50 |
| 9 | ------ | .75 | 1.10 | 2.30 | 1.02 | .30 | 25 | 0.30 | .75 | 2.30 | .75 | .50 | .40 |
| 10 | ------ | .75 | 1.55 | 2.30 | .75 | .30 | 26 | .30 | .75 | 2.30 | .75 | .30 | .30 |
| 11 | ------ | .75 | 2.00 | 2.30 | .70 | .30 | 27 | .30 | .98 | 2.30 | 1.12 | .30 | .30 |
| 12 | ------ | .75 | 2.00 | 1.95 | .70 | .30 | 28 | .30 | .98 | 2.30 | 1.50 | .30 | .30 |
| 13 | ------ | .75 | 2.10 | 1.95 | .70 | .30 | 29 | .30 | .98 | 2.30 | 1.50 | .30 | .30 |
| 14 | ------ | 2.20 | 2.20 | 2.30 | .70 | .30 | 30 | .30 | .75 | 2.30 | 1.50 | .30 | .30 |
| 15 | ------ | 2.20 | 2.20 | 2.30 | .70 | .65 | 31 | ------ | .75 | ------ | 1.13 | .30 | ------ |
| 16 | ------ | 1.60 | 2.20 | 2.30 | .70 | 1.00 | | | | | | | |

*a* Dry.

## CACHE LA POUDRE RIVER AT FORT COLLINS, COLORADO.

This stream drains an area of considerable size in northern Colorado, its headwater tributaries joining those of Laramie on the west. As given in the description of this latter stream, the Sky-line Canal diverts water from the Laramie River into Cache la Poudre River, and measurements of discharge in the latter basin include some of the Laramie waters. The station was established in 1884, at a point about 15 miles above Fort Collins, by Prof. L. G. Carpenter, of the Colorado State Agricultural College, and the work has been carried on under his immediate direction. The record is probably the longest and among the best of any of the small streams of the West. The daily discharge for 1893 and 1894 will be found in Bulletin No. 131, page 30. The following table shows the daily discharge through the irrigating season of the river from 1895 to 1899, inclusive:

*Daily discharge, in second-feet, of Cache la Poudre River at Fort Collins, Colorado.*

1895.

| Day. | May. | June. | July. | Aug. | Sept. | Day. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 1,800 | 1,690 | 796 | 357 | 17 | 1,100 | | 1,030 | 417 | 180 |
| 2 | | 1,920 | 1,510 | 805 | 339 | 18 | 1,100 | | 996 | 389 | 174 |
| 3 | | 3,200 | 1,430 | 846 | 300 | 19 | 1,350 | | 950 | 380 | 180 |
| 4 | | 2,800 | 1,410 | 666 | 283 | 20 | | | 942 | 406 | 188 |
| 5 | | 2,500 | 1,368 | 612 | 264 | 21 | | | 996 | 398 | 200 |
| 6 | | 2,660 | 1,240 | 588 | 247 | 22 | | | 1,076 | 375 | 216 |
| 7 | | 2,750 | 1,210 | 565 | 238 | 23 | 1,300 | | 1,086 | 404 | 216 |
| 8 | | 2,940 | 1,100 | 541 | 229 | 24 | 1,274 | | 899 | 415 | 208 |
| 9 | | 3,130 | 1,035 | 67[illegible] | 212 | 25 | 1,325 | | 867 | 381 | |
| 10 | | 3,450 | 1,114 | 652 | 192 | 26 | 1,404 | | 800 | 378 | |
| 11 | | 3,100 | 1,200 | 558 | 196 | 27 | 1,512 | 1,740 | 768 | 312 | |
| 12 | | 2,500 | 1,682 | 512 | 194 | 28 | 2,060 | 1,920 | 722 | 326 | |
| 13 | | | 1,602 | 471 | 192 | 29 | 1,668 | 1,830 | 707 | 343 | |
| 14 | | | 1,352 | 487 | 192 | 30 | 1,500 | 1,715 | 722 | 349 | |
| 15 | 1,680 | | 1,220 | 480 | 188 | 31 | 1,400 | | | 378 | |
| 16 | | | 1,142 | 447 | 184 | | | | | | |

1896.

| Day. | June. | July. | Aug. | Sept. | Day. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 531 | 364 | 322 | 17 | 981 | 617 | 320 | 255 |
| 2 | | 538 | 322 | 283 | 18 | 942 | 602 | 192 | 251 |
| 3 | | 512 | 288 | 308 | 19 | 882 | 468 | 320 | 280 |
| 4 | | 487 | 269 | 298 | 20 | 878 | 403 | 294 | 294 |
| 5 | | 468 | 284 | 288 | 21 | 841 | 364 | 283 | 285 |
| 6 | | 456 | 269 | 260 | 22 | 780 | 348 | 422 | 255 |
| 7 | | 432 | 260 | 233 | 23 | 753 | 362 | 517 | |
| 8 | | 507 | 238 | 208 | 24 | 753 | 495 | 390 | |
| 9 | | 480 | 216 | 268 | 25 | 760 | 453 | 302 | |
| 10 | | 409 | 196 | 370 | 26 | 745 | 498 | 269 | |
| 11 | | 386 | 173 | 411 | 27 | 707 | 589 | 251 | |
| 12 | | 381 | 173 | 361 | 28 | 634 | 468 | 242 | |
| 13 | | 381 | 169 | 346 | 29 | 612 | 456 | 266 | |
| 14 | | 395 | 166 | 307 | 30 | 559 | 415 | 288 | |
| 15 | | 394 | 162 | 278 | 31 | | 392 | 358 | |
| 16 | | 499 | 158 | 264 | | | | | |

*Daily discharge, in second-feet, of Cache la Poudre River at Fort Collins, Colorado*—Continued.

1897.

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | | 862 | 3,013 | 994 | 466 | | *a* 121 |
| 2 | | 964 | 2,378 | 910 | 437 | | |
| 3 | | 978 | 1,903 | 1,051 | | 203 | |
| 4 | | 1,171 | 1,681 | 945 | | | |
| 5 | | 1,189 | 1,601 | 792 | | | |
| 6 | | 1,268 | 1,485 | 769 | *a* 420 | | |
| 7 | | 1,425 | 1,406 | 797 | | | |
| 8 | | 1,517 | 1,451 | 848 | | | |
| 9 | | 1,486 | 1,961 | 1,048 | | | |
| 10 | | 1,474 | 2,191 | 1,039 | | 186 | |
| 11 | | | 2,173 | 971 | | | |
| 12 | | | 2,232 | 837 | | | |
| 13 | | | 2,402 | 797 | *a* 339 | | |
| 14 | | | 2,074 | 772 | | | |
| 15 | | | 2,328 | 1,028 | | | |
| 16 | | | 2,451 | 907 | | | |
| 17 | | | 1,698 | 828 | | | |
| 18 | | 2,236 | 1,381 | 791 | | | |
| 19 | | 2,298 | 1,449 | 816 | | | |
| 20 | | 2,857 | 1,533 | 738 | *a* 314 | | |
| 21 | | 3,106 | 1,548 | 626 | | | |
| 22 | | 2,654 | | 558 | | | |
| 23 | | 2,987 | 1,463 | 520 | | | |
| 24 | | 3,155 | 1,303 | 650 | | 142 | |
| 25 | | 2,981 | 1,339 | 546 | | | |
| 26 | | 2,822 | 1,468 | 478 | | | |
| 27 | 667 | 2,998 | 1,278 | 449 | *a* 248 | | |
| 28 | 810 | 2,461 | 1,105 | 441 | | | |
| 29 | | 2,505 | 1,086 | 418 | | | |
| 30 | 704 | 2,468 | 1,043 | 404 | | | |
| 31 | | 2,658 | | 455 | | | |

*a* Average for week.

1898.

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | | 307 | 1,148 | 812 | 211 | | *a* 35 |
| 2 | | 271 | 1,410 | 792 | 201 | | |
| 3 | | 267 | 1,636 | 704 | 180 | *a* 112 | |
| 4 | | 243 | 1,481 | 645 | 177 | | |
| 5 | | 244 | 1,210 | 586 | 186 | | |
| 6 | | 206 | 1,035 | 576 | 206 | | |
| 7 | | 219 | 1,131 | 554 | 258 | | |
| 8 | | 251 | 1,192 | 523 | 220 | | *a* 50 |
| 9 | | 297 | 1,267 | 555 | 176 | | |
| 10 | | 337 | 1,247 | 592 | | *a* 97 | |
| 11 | | | 1,379 | 580 | | | |
| 12 | | | 1,364 | 686 | | | |
| 13 | | | 1,383 | 893 | *a* 139 | | |
| 14 | | | 1,612 | 658 | | | |
| 15 | | | 1,411 | 571 | | | *a* 66 |
| 16 | | | 1,605 | 521 | | | |
| 17 | | | 1,658 | 486 | | *a* 60 | |
| 18 | | 806 | 1,629 | 437 | | | |
| 19 | | 756 | 1,650 | 396 | | | |
| 20 | | 755 | 1,432 | 332 | *a* 133 | | |
| 21 | | 664 | 1,414 | 319 | | | |
| 22 | | 629 | | 297 | | | *a* 84 |
| 23 | | 702 | 1,349 | 288 | | | |
| 24 | | 837 | 1,358 | 287 | | *a* 43 | |
| 25 | | 1,308 | 1,273 | 296 | | | |
| 26 | | 1,175 | 1,109 | 283 | | | |
| 27 | 294 | 1,050 | 951 | 267 | *a* 115 | | |
| 28 | 308 | 1,280 | 905 | 240 | | | |
| 29 | | 1,130 | 842 | 212 | | | |
| 30 | 316 | 1,115 | 824 | 211 | | | |
| 31 | | 1,265 | | 210 | | | |

*a* Average for week.

*Daily discharge, in second-feet, of Cache la Poudre River at Fort Collins, Colorado*—Continued.

1899.

| Day. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|
| 1 | | 1,848 | 2,710 | 767 | 358 | 116 |
| 2 | | 1,924 | 2,544 | 765 | 351 | 112 |
| 3 | | 1,839 | 2,459 | 782 | 365 | 104 |
| 4 | | 1,631 | 2,415 | 972 | 335 | 100 |
| 5 | | 1,472 | 2,102 | 974 | 324 | 95 |
| 6 | | 1,579 | 2,242 | 848 | 302 | 93 |
| 7 | | 1,786 | 2,136 | 813 | 290 | 92 |
| 8 | | 1,912 | 1,678 | 760 | 280 | 104 |
| 9 | | 2,010 | 1,577 | 797 | 263 | 111 |
| 10 | 636 | 2,168 | 1,482 | 735 | 231 | 125 |
| 11 | 684 | 2,490 | 1,303 | 668 | 213 | |
| 12 | 929 | 3,103 | 1,703 | 629 | 201 | |
| 13 | 1,144 | 3,619 | 1,643 | 592 | 196 | |
| 14 | 1,348 | 2,831 | 1,477 | 555 | 199 | |
| 15 | 1,404 | 2,702 | 1,446 | 504 | 202 | |
| 16 | 1,452 | 2,822 | 1,355 | 682 | 220 | |
| 17 | 1,453 | 2,981 | 1,161 | 533 | 220 | |
| 18 | 1,492 | 3,040 | 1,081 | 469 | 200 | 98 |
| 19 | 1,663 | 3,556 | 974 | 431 | 183 | 128 |
| 20 | 1,809 | 3,865 | 985 | 399 | 162 | 160 |
| 21 | 1,573 | 3,968 | 974 | 381 | 125 | 165 |
| 22 | 1,380 | 3,343 | 972 | 344 | 125 | 110 |
| 23 | 1,310 | 2,945 | 987 | 307 | 125 | 110 |
| 24 | 1,351 | 2,933 | 960 | 301 | 125 | 110 |
| 25 | 1,521 | 2,663 | 947 | 286 | 125 | |
| 26 | 1,911 | 2,953 | 841 | 286 | 123 | |
| 27 | 2,001 | 2,943 | 955 | 281 | 141 | |
| 28 | 1,936 | 2,734 | 928 | 328 | 141 | |
| 29 | 1,803 | 2,691 | 918 | 322 | 126 | |
| 30 | 2,015 | 2,606 | 897 | 331 | 120 | |
| 31 | 1,881 | | 809 | 423 | | |

## NORTH LOUP RIVER AT ST. PAUL, NEBRASKA.

This stream has its source among the sand hills in the western portion of Cherry County, Nebraska, and drains the country midway between the Niobrara River on the north and Middle Loup River on the south. It has a general southeasterly direction, joining the Middle Loup at St. Paul to form the main Loup River, which enters Platte River near Columbus, Nebraska. Calamus River is a tributary of the North Loup River, entering it near Burwell, Nebraska. The measurement of its discharge at the bridge 1 mile above the mouth and 2 miles north of Burwell, on May 16, 1899, by Glenn E. Smith, showed a discharge of 372 second-feet; North Loup River, on May 16, from a bridge one-fourth of a mile above Burwell, below the mouth of Calamus River, was carrying 984 second-feet. The gaging station on North Loup River, established in 1895, is located at the wagon bridge 4 miles north of St. Paul. Measurements at this station were not made in 1898, but the station was resumed April 18, 1899, when a new rod was located 200 feet downstream from the line of the hand rail on the wagon bridge. It is a 2 by 3 inch timber, 16 feet long, situated on the left bank of the river, at an angle of 30°. The bench mark is the standard iron pipe, with brass cap, of the United States Geological Survey. It is set with the top 5 inches above the ground, and 102 feet northwest of the gage rod, and is at an elevation of 5.57 feet above gage datum. The zero of the old rod was 6.54 feet below same bench; so that 0.97 foot should be added to all gage heights after April 18, 1899, to make them comparable with the previous records. The bed of the river is sandy and is liable to change during floods. James Stout, jr., a farmer living about a quarter of a mile from the rod, is the observer. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 176; 1897, Nineteenth Annual Report, Part IV, page 329; 1898, no report. The following discharge measurements were made by Glenn E. Smith during 1899:

*Measurements of North Loup River at St. Paul, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec. feet.* | 1899. | *Feet.* | *Sec. feet.* |
| Apr. 18 | 1.81 | 1,678 | Aug. 8 | 1.70 | 1,026 |
| May 5 | 1.77 | 1,138 | Aug. 23 | 1.47 | 920 |
| May 18 | 1.65 | 877 | Sept. 7 | 1.70 | 917 |
| June 7 | 1.58 | 1,024 | Sept. 19 | 1.50 | 796 |
| June 27 | 3.40 | 7,690 | Sept. 30 | 1.47 | 776 |
| July 20 | 1.35 | 811 | | | |

*Daily gage height, in feet, of North Loup River at St. Paul, Nebraska, for 1899. a*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | | 1.85 | 1.68 | 1.95 | 1.34 | 1.61 | 1.52 |
| 2 | | 1.85 | 1.65 | 1.83 | 1.37 | 1.68 | 1.58 |
| 3 | | 1.83 | 1.66 | 1.75 | 1.38 | 1.73 | 1.55 |
| 4 | | 1.80 | 1.62 | 1.68 | 1.89 | 1.57 | 1.55 |
| 5 | | 1.80 | 1.61 | 1.68 | 2.20 | 1.62 | 1.57 |
| 6 | | 1.75 | 1.60 | 1.59 | 2.08 | 1.70 | 1.52 |
| 7 | | 2.30 | 1.55 | 1.55 | 2.05 | 1.95 | 1.50 |
| 8 | | 2.32 | 1.57 | 1.55 | 2.01 | 1.98 | 1.50 |
| 9 | | 2.07 | 1.56 | 1.56 | 1.88 | 1.85 | 1.60 |
| 10 | | 2.00 | 1.52 | 1.57 | 1.80 | 1.80 | 1.63 |
| 11 | | 1.95 | 1.55 | 1.63 | 1.92 | 1.72 | 1.58 |
| 12 | | 1.83 | 1.53 | 1.53 | 1.74 | 1.68 | 1.53 |
| 13 | | 1.72 | 1.47 | 1.49 | 1.92 | 1.65 | 1.57 |
| 14 | | 1.72 | 1.42 | 1.45 | 1.86 | 1.62 | 1.55 |
| 15 | | 1.68 | 1.41 | 2.12 | 1.65 | 1.60 | 2.08 |
| 16 | | 1.71 | 1.45 | 2.27 | 1.65 | 1.63 | 2.03 |
| 17 | | 1.73 | 1.48 | 2.03 | 1.57 | 1.53 | 1.97 |
| 18 | 1.81 | 1.70 | 1.50 | 1.92 | 1.48 | 1.55 | 1.69 |
| 19 | 1.77 | 1.64 | 1.50 | 1.75 | 1.55 | 1.50 | 1.65 |
| 20 | 1.82 | 1.68 | 1.50 | 1.35 | 1.57 | 1.50 | 1.65 |
| 21 | 1.73 | 2.30 | 1.47 | 1.37 | 1.62 | 1.50 | 1.60 |
| 22 | 1.75 | 2.08 | 1.50 | 1.28 | 1.58 | 1.51 | 1.58 |
| 23 | 1.72 | 1.93 | 1.53 | 1.30 | 1.57 | 1.50 | 1.60 |
| 24 | 1.80 | 1.90 | 2.30 | 1.28 | 1.54 | 1.55 | 1.60 |
| 25 | 1.83 | 1.87 | 2.00 | 1.28 | 1.54 | 1.52 | 1.62 |
| 26 | 1.78 | 1.85 | 1.80 | 1.33 | 1.55 | 1.50 | 1.60 |
| 27 | 3.20 | 1.78 | 3.30 | 1.32 | 1.57 | 1.52 | 1.65 |
| 28 | 2.78 | 1.75 | 2.54 | 1.25 | 1.53 | 1.55 | 1.63 |
| 29 | 2.43 | 1.77 | 2.12 | 1.22 | 1.54 | 1.55 | 1.58 |
| 30 | 1.87 | 1.73 | 2.03 | 1.33 | 1.57 | 1.58 | 1.57 |
| 31 | | 1.73 | | 1.35 | 1.59 | | 1.58 |

*a* Closed for winter October 31.

## MIDDLE LOUP RIVER AT ST. PAUL, NEBRASKA.

This river also has its source in the sand hills of Cherry County, and flows in a general southeasterly direction, joining the North Loup River at St. Paul. Oak Creek is a small stream draining the area east of Loup City and flowing southeasterly into the Middle Loup.

It was measured by Glenn E. Smith, on May 19, 1899, at a point above the backwater from the dam, at which time it showed a discharge of 5 second-feet. The original station was established May 5, 1895, by Glenn E. Smith, but was discontinued during 1898. It was reestablished, however, on April 18, 1899, and is located at the highway and railway bridge about 1 mile south of St. Paul. The rod is located on the right bank of the stream, 130 feet downstream from the line of hand rail of bridge and consists of an oak rod 2 by 3 inches, 16 feet long, set at an angle of 30 degrees. On account of a change in the channel of the river, which threatened to leave the gage rod dry, a second rod was set on the north side on June 7, 1899. The new rod is 2 by 4 inches, hard pine, 12 feet long, set at an angle of 30 degrees, and 200 feet downstream from the bridge. The gage datum is the same for both rods. The observer is instructed to read the rod adjacent to the main channel, on whichever side it may be, and the hydrographer is expected to read both rods. The bench mark is the regulation 4-foot iron post of the United States Geological Survey, and is located 60 feet southeast of the gage rod and 100 feet from the line of the downstream hand rail of the bridge. It is 7.54 feet above gage datum. The zero of the original rod was 7.35 feet below the same bench mark, so that 0.19 foot should be subtracted from all gage heights after April 18, 1899, to make them comparable with the previous records. The observer is A. C. Snyder, a farmer living about one-half mile from the station. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 181; 1897, Nineteenth Annual Report, Part IV, page 330; 1898, no report. The following measurements were made by Glenn E. Smith and Adna Dobson during 1899:

*Measurements of Middle Loup River at St. Paul, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec. feet.* | 1899. | *Feet.* | *Sec. feet.* |
| Apr. 18 | 2.10 | 988 | Aug. 7 | 2.68 | 1,612 |
| May 4 | 1.84 | 964 | Aug. 23 | 2.20 | 1,113 |
| May 18 | 1.70 | 1,186 | Sept. 7 | 2.25 | 983 |
| June 7 | 2.30 | 920 | Sept. 19 | 2.40 | 1,112 |
| June 27 | 4.20 | 14,631 | Sept. 30 | 2.25 | 989 |
| July 20 | 2.18 | 888 | | | |

*Daily gage height, in feet, of Middle Loup River at St. Paul, Nebraska, for 1899. (a)*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | ........ | 1.76 | 1.59 | 2.00 | 2.24 | 2.29 | 2.24 |
| 2 | ........ | 1.80 | 1.41 | 1.87 | 2.12 | 2.29 | 2.20 |
| 3 | ........ | 1.79 | 1.40 | 1.90 | 2.16 | 2.33 | 2.35 |
| 4 | ........ | 1.81 | 1.62 | 1.90 | 3.10 | 2.19 | 2.34 |
| 5 | ........ | 1.95 | 1.53 | 2.12 | 2.74 | 2.16 | 2.37 |
| 6 | ........ | 1.82 | 1.44 | 2.78 | 2.70 | 2.21 | 2.40 |
| 7 | ........ | 1.90 | 1.54 | 3.17 | 2.65 | 2.18 | 2.37 |
| 8 | ........ | 2.08 | 1.29 | 2.71 | 2.57 | 2.28 | 2.34 |
| 9 | ........ | 1.93 | 1.32 | 2.42 | 2.66 | 2.32 | 2.36 |
| 10 | ........ | 1.87 | 1.25 | 2.16 | 2.25 | 2.34 | 2.36 |
| 11 | ........ | 1.81 | 1.24 | 2.12 | 2.20 | 2.34 | 2.34 |
| 12 | ........ | 1.78 | 1.20 | 2.09 | 2.18 | 2.32 | 2.37 |
| 13 | ........ | 1.75 | 1.33 | 2.18 | 2.13 | 2.28 | 2.36 |
| 14 | ........ | 1.75 | 1.32 | 3.10 | 2.25 | 2.25 | 2.40 |
| 15 | ........ | 1.60 | 1.31 | 2.65 | 2.39 | 2.30 | 2.39 |
| 16 | ........ | 1.62 | 1.32 | 2.55 | 2.36 | 2.30 | 2.49 |
| 17 | ........ | 1.62 | 1.30 | 2.36 | 2.31 | 2.40 | 2.47 |
| 18 | 2.10 | 1.72 | 1.28 | 2.20 | 2.30 | 2.38 | 2.49 |
| 19 | 2.09 | 1.66 | 1.19 | 2.12 | 2.27 | 2.36 | 2.42 |
| 20 | 2.12 | 1.70 | 1.15 | 2.12 | 2.21 | 2.30 | 2.40 |
| 21 | 2.09 | 1.80 | 1.32 | 2.09 | 2.20 | 2.30 | 2.41 |
| 22 | 2.10 | 2.15 | 1.34 | 2.11 | 2.15 | 2.30 | 2.42 |
| 23 | 2.00 | 2.05 | 1.29 | 2.12 | 2.20 | 2.30 | 2.41 |
| 24 | 2.00 | 1.70 | 1.29 | 2.15 | 2.20 | 2.27 | 2.40 |
| 25 | 2.03 | 1.68 | 2.34 | 2.06 | 2.15 | 2.26 | 2.45 |
| 26 | 2.60 | 1.60 | 4.17 | 2.02 | 2.19 | 2.24 | 2.42 |
| 27 | 2.12 | 1.83 | 3.51 | 2.06 | 2.16 | 2.27 | 2.45 |
| 28 | 2.39 | 1.92 | 3.30 | 2.30 | 2.12 | 2.26 | 2.44 |
| 29 | 2.00 | 1.66 | 2.84 | 2.20 | 2.10 | 2.24 | 2.47 |
| 30 | 1.74 | 1.49 | 2.35 | 2.10 | 2.13 | 2.22 | 2.49 |
| 31 | ........ | 1.84 | ........ | 2.42 | 2.21 | ........ | 2.49 |

*a* Closed for winter October 31.

## LOUP RIVER AT COLUMBUS, NEBRASKA.

This river is formed by the junction of the North Loup and Middle Loup rivers at St. Paul, Nebraska, and 60 miles below St. Paul enters the Platte River near Columbus, Nebraska. Cedar River is a tributary of Loup River, and flows southeasterly, emptying into Loup River at Fullerton, 30 miles below St. Paul. At Ericson, Nebraska, a large dam has been built for the purpose of turning Cedar Creek into a canal to be used for irrigation. The dam backs the water for about one-half a mile, forming a pond 1,000 feet in width in some places. May 17, 1899, Glenn E. Smith measured the river 500 feet below the above dam, and below the race of a small mill near by, and found a discharge of 113 second-feet; at the same time the mill race was carrying 10 second-feet, and the Cedar Valley irrigation canal 20 second-feet—this latter being measured about 1,000 feet below the head gates. On the same day a measurement was made by wading, at a point 2 miles from Ericson and above the backwater from the dam, and gave a discharge in Cedar River of 107 second-feet. A tributary known as Dry Cedar enters near this point—there being seldom any discharge from it except during the rainy season. Near the mouth of this tributary are several small springs, not large enough, however, to give a continuous discharge. They were found to be flowing on May 17, at a point about 1 mile north of Ericson, 5 second-feet, while 5 miles above the channel was dry. The gaging station on the Loup River is located near the iron bridge of the Union Pacific Railway just west of Columbus, Nebraska, and only a short distance above the mouth of the river. The gage rod is 150 feet from the bridge, and is of oak, fastened to a pile which forms part of the training works above the bridge. The bench mark is the regulation 4-foot iron post of the United States Geological Survey, placed 72 feet east of the rod, and is 13.27 feet above gage datum. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 182; 1897, Nineteenth Annual Report, Part IV, page 332; 1898, Twentieth Annual Report, Part IV, page 294. The following measurements of discharge were made by Glenn E. Smith during 1899:

*Measurements of Loup River at Columbus, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899—Continued. | *Feet.* | *Sec.-feet.* |
| Jan. 22 | Frozen. | 2,726 | July 9 | 5.40 | 3,435 |
| Apr. 9 | 4.95 | 3,004 | July 23 | 4.25 | 1,792 |
| Apr. 23 | 5.00 | 2,699 | Aug. 6 | 4.93 | 3,251 |
| May 7 | 5.05 | 3,057 | Aug. 20 | 4.61 | 2,267 |
| May 23 | 5.54 | 4,073 | Sept. 3 | 4.40 | 1,902 |
| June 4 | 4.86 | 2,628 | Sept. 17 | 4.40 | 1,840 |
| June 18 | 4.75 | 1,921 | Oct. 5 | 4.60 | 2,402 |
| June 29 | 5.80 | 7,728 | Oct. 15 | 4.80 | 1,983 |

*Daily gage height, in feet, of Loup River at Columbus, Nebraska, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | ... | 5.30 | ... | 5.50 | 4.30 | 4.80 | 4.40 |
| 2 | 5.40 | 4.95 | 5.00 | ... | 4.25 | 4.85 | 4.40 |
| 3 | 5.60 | 4.60 | ... | 5.90 | 4.20 | 4.80 | 4.40 |
| 4 | 5.80 | 4.70 | 4.80 | ... | 4.25 | 4.80 | 4.40 |
| 5 | 5.70 | 4.90 | ... | 5.70 | 4.55 | 4.70 | 4.45 |
| 6 | 5.00 | 4.95 | 5.40 | ... | 4.93 | 4.60 | 4.40 |
| 7 | 4.90 | 5.05 | ... | 5.60 | 4.90 | 4.55 | 4.40 |
| 8 | 5.00 | 4.95 | ... | ... | 4.80 | 4.50 | 4.40 |
| 9 | 4.95 | 5.15 | ... | ... | 4.85 | 4.80 | 4.40 |
| 10 | 4.90 | 5.00 | ... | 4.40 | 4.80 | 4.70 | 4.40 |
| 11 | 5.00 | 4.95 | 5.40 | ... | 4.70 | 4.60 | 4.40 |
| 12 | 4.90 | 4.80 | ... | 4.00 | 4.85 | 4.50 | 4.40 |
| 13 | 4.80 | 4.85 | ... | 4.20 | 4.20 | 4.45 | 4.40 |
| 14 | 4.90 | 4.97 | ... | 4.21 | 4.10 | 4.40 | 4.50 |
| 15 | 5.10 | 5.30 | ... | 4.20 | 4.50 | 4.40 | 4.80 |
| 16 | 5.20 | 5.15 | 4.80 | 4.10 | 4.20 | 4.40 | 4.70 |
| 17 | 5.15 | 5.14 | ... | 4.20 | 4.40 | 4.40 | 4.75 |
| 18 | 5.10 | 4.95 | 4.70 | 4.15 | 4.40 | 4.40 | 4.70 |
| 19 | 5.00 | 5.00 | ... | 4.00 | 4.50 | 4.40 | 4.60 |
| 20 | 4.90 | 5.05 | ... | 3.98 | 4.61 | 4.40 | 4.50 |
| 21 | 4.90 | 5.40 | 4.95 | 4.00 | 4.80 | 4.40 | 4.50 |
| 22 | 4.90 | 5.80 | ... | 4.10 | 4.70 | 4.40 | 4.70 |
| 23 | 5.00 | 5.54 | ... | 4.25 | 4.75 | 4.40 | 4.60 |
| 24 | 4.90 | 5.40 | 5.10 | 4.20 | 4.80 | 4.40 | 4.60 |
| 25 | 4.85 | ... | ... | 4.21 | 4.81 | 4.40 | 4.55 |
| 26 | 4.90 | ... | ... | 4.20 | 4.80 | 4.40 | 4.55 |
| 27 | 5.00 | ... | 5.90 | 4.20 | 4.81 | 4.40 | 4.50 |
| 28 | 5.40 | ... | ... | 4.22 | 4.80 | 4.40 | 4.55 |
| 29 | 5.60 | 5.40 | 5.80 | 4.23 | 4.70 | 4.40 | 4.60 |
| 30 | 5.80 | ... | ... | 4.50 | 4.60 | 4.40 | 4.65 |
| 31 | ... | ... | ... | 4.40 | 4.70 | ... | 4.65 |

## PLATTE RIVER AT COLUMBUS, NEBRASKA.

Lower Platte River is a sandy stream, the bed shifting during the high stages, through which considerable water is lost during the summer season. On September 8 there were only 20 second-feet flowing in the middle channel at the bridge of the Burlington and Missouri Railroad near Central City, Nebraska, this point being 20 miles below Grand Island and 40 miles above Columbus. On September 19, Glenn E. Smith reports that the stream was dry at this point. Mr. Adna Dobson reports the river dry at Grand Island on September 30. The gaging station at Columbus was established in 1895, and is located on the left bank of the main channel of the river, 75 feet above the Meridian bridge south of Columbus. It is about 4 miles above the mouth of the Loup River. The gage consists of an inclined oak timber fastened to cross-ties which are bedded in the bank of the river. The channel is straight both above and below the gage. The bench mark is a standard 4-foot iron post of the United States Geological Survey, and is located 44.5 feet east of the gage, 60 feet north of the north end of the north bridge truss, and 10 feet west of a cottonwood tree 6 inches in diameter. Its elevation is 7.06 feet above gage datum. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 190; 1897, Nineteenth Annual Report, Part IV, page 334; 1898, Twentieth Annual Report, Part IV, page 295. The following discharge measurements were made by Glenn E. Smith and Adna Dobson during 1899:

*Measurements of Platte River at Columbus, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Jan. 22 | | Dry. | July 9 | 4.61 | 17,032 |
| Feb. 19 | | 55 | July 23 | 3.84 | 8,694 |
| Apr. 9 | 3.50 | 6,736 | Aug. 6 | 4.00 | 9,450 |
| Apr. 23 | 3.94 | 8,210 | Aug. 20 | 2.80 | 3,338 |
| May 7 | 4.14 | 10,121 | Sept. 3 | .90 | 93 |
| May 23 | 3.81 | 7,878 | Sept. 17 | | 15 |
| June 4 | 4.01 | 9,294 | Oct. 5 | | Dry. |
| June 18 | 4.00 | 9,279 | Oct. 15 | | 8 |
| June 29 | 4.82 | 18,631 | | | |

*Daily gage height, in feet, of Platte River at Columbus, Nebraska, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|
| 1 | ---------- | 3.90 | 4.30 | 5.10 | 3.70 | 1.20 |
| 2 | .00 | 3.73 | 4.10 | 4.90 | 3.65 | 1.10 |
| 3 | .00 | 3.80 | 4.00 | 4.80 | 3.60 | .90 |
| 4 | 4.00 | 3.85 | 4.01 | 4.85 | 3.68 | .85 |
| 5 | 4.80 | 3.93 | 3.40 | 4.95 | 3.88 | .80 |
| 6 | 4.50 | 4.00 | 3.70 | 4.98 | 4.00 | .70 |
| 7 | 4.40 | 4.14 | 4.00 | 4.97 | 3.90 | .65 |
| 8 | 3.70 | 3.96 | 3.81 | 4.98 | 3.96 | .60 |
| 9 | 3.45 | 4.00 | 3.65 | 4.61 | 3.94 | .50 |
| 10 | 3.50 | 3.94 | 3.64 | 4.63 | 3.90 | ---------- |
| 11 | 3.55 | 3.87 | 4.50 | 4.62 | 3.80 | ---------- |
| 12 | 3.60 | 3.80 | 4.60 | 4.60 | 4.00 | ---------- |
| 13 | 3.65 | 3.73 | 4.80 | 4.58 | 3.50 | ---------- |
| 14 | 3.20 | 3.68 | 4.95 | 4.56 | 3.40 | ---------- |
| 15 | 3.10 | 3.60 | 4.98 | 4.50 | 3.30 | ---------- |
| 16 | 3.00 | 3.63 | 4.99 | 4.50 | 2.90 | ---------- |
| 17 | 3.10 | 3.41 | 4.98 | 4.40 | 2.95 | ---------- |
| 18 | 3.20 | 3.36 | 4.00 | 4.23 | 2.85 | ---------- |
| 19 | 3.60 | 3.21 | 4.00 | 4.11 | 2.81 | ---------- |
| 20 | 3.80 | 3.30 | 4.00 | 4.10 | 2.80 | ---------- |
| 21 | 4.00 | 3.91 | 4.20 | 4.00 | 2.81 | ---------- |
| 22 | 3.90 | 4.10 | 4.40 | 3.90 | 2.80 | ---------- |
| 23 | 3.94 | 3.81 | 4.50 | 3.83 | 2.75 | ---------- |
| 24 | 3.50 | 4.50 | 4.63 | 3.80 | 2.70 | ---------- |
| 25 | 3.93 | 4.70 | 4.40 | 3.70 | 2.60 | ---------- |
| 26 | 4.50 | 4.90 | 4.43 | 3.72 | 2.55 | ---------- |
| 27 | 3.90 | 5.05 | 4.50 | 3.74 | 2.40 | ---------- |
| 28 | 3.83 | 4.83 | 4.75 | 3.80 | 2.00 | ---------- |
| 29 | 3.90 | 4.70 | 4.85 | 3.90 | 1.60 | ---------- |
| 30 | 3.93 | 4.60 | 5.15 | 3.92 | 1.50 | ---------- |
| 31 | ---------- | 4.51 | ---------- | 3.85 | 1.35 | ---------- |

June 18-20, gage washed out; gage heights estimated. September 10-October 28, sand bar; no readings. Closed for the winter September 9.

## ELKHORN RIVER AT NORFOLK, NEBRASKA.

This river rises in the sand hills in Rock County, Nebraska, and flows in a general southeasterly direction, entering the Platte River about 30 miles above its mouth. Two gaging stations are maintained on this river, one at Norfolk, Nebraska, and the other at Arlington, Nebraska. The station at the former place is at the Thirteenth street bridge, 2 miles south of Norfolk and above the mouth of the North Fork of Elkhorn River. The gage consists of an inclined oak timber fastened to cross-ties, which are firmly bedded in the bank of the river. The bench mark is a standard 4-foot iron pipe of the United States Geological Survey, 35 feet west and 7 feet north of the top of gage and 15.5 feet west of an ash tree. Its elevation is 10.70 feet above gage datum. The bed of the river is composed of sand and mud. A number of measurements of the North Fork were made and are given below. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 191; 1897, Nineteenth Annual Report, Part IV, page 335; 1898, Twentieth Annual Report, Part IV, page 296. The following measurements were made by Glenn E. Smith during 1899:

Elkhorn River:

January 26, gage height, frozen; discharge, 272 second-feet.
April 27, gage height, 1.94; discharge. 505 second-feet.
May 10, gage height, 2.01 feet; discharge, 572 second-feet.

Elkhorn River—Continued.

May 25, gage height, 2.72 feet; discharge, 830 second-feet.

July 7, gage height, 1.70 feet; discharge, 427 second-feet.

August 17, gage height, 1.30 feet; discharge, 274 second-feet.

September 25, gage height, 1.12 feet; discharge, 184 second-feet.

North Fork of Elkhorn River:

February 20, discharge, 119 second-feet.

April 27, discharge, 122 second-feet.

May 25, discharge, 414 second-feet.

August 17, discharge, 81 second-feet.

September 25, discharge, 85 second-feet.

*Daily gage height, in feet, of Elkhorn River at Norfolk, Nebraska, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | | 1.94 | 2.07 | 2.45 | 1.20 | 0.97 | 1.13 |
| 2 | | 2.24 | 2.03 | 2.20 | 1.23 | .97 | 1.19 |
| 3 | | 2.30 | 1.93 | 1.97 | 1.27 | .76 | 1.23 |
| 4 | | 3.20 | 1.85 | 1.66 | 1.32 | .70 | 1.26 |
| 5 | | 2.41 | 1.85 | 1.76 | 1.33 | .67 | 1.22 |
| 6 | | 2.31 | 1.87 | 1.74 | 1.33 | 1.06 | 1.23 |
| 7 | 1.90 | 2.24 | 2.45 | 1.68 | 1.36 | 1.08 | 1.22 |
| 8 | 1.87 | 2.16 | 2.22 | 1.71 | 1.35 | 1.12 | 1.27 |
| 9 | 1.90 | 2.06 | 1.92 | 1.67 | 1.45 | 1.15 | 1.28 |
| 10 | 1.93 | 2.00 | 1.82 | 1.73 | 1.27 | 1.13 | 1.25 |
| 11 | 2.00 | 1.92 | 1.75 | 1.73 | 1.28 | 1.13 | 1.20 |
| 12 | 2.01 | 1.83 | 1.74 | 1.78 | 1.48 | 1.10 | 1.20 |
| 13 | 2.05 | 1.78 | 1.64 | 1.69 | 1.48 | 1.06 | 1.29 |
| 14 | 2.05 | 1.73 | 1.63 | 1.65 | 1.33 | 1.02 | 1.27 |
| 15 | 2.03 | 1.77 | 1.64 | 1.56 | 1.34 | 1.06 | 1.33 |
| 16 | 1.98 | 1.77 | 1.65 | 1.51 | 1.33 | 1.11 | 1.30 |
| 17 | 1.98 | 1.74 | 1.60 | 1.48 | 1.38 | 1.09 | 1.32 |
| 18 | 1.97 | 1.70 | 1.53 | 1.45 | 1.26 | 1.11 | 1.31 |
| 19 | 1.99 | 1.80 | 1.57 | 1.43 | 1.25 | 1.04 | 1.32 |
| 20 | 1.90 | 3.50 | 1.57 | 1.45 | 1.23 | 1.03 | 1.34 |
| 21 | 1.97 | 3.58 | 1.57 | 1.38 | 1.25 | 1.02 | 1.33 |
| 22 | 1.89 | 3.34 | 1.53 | 1.34 | 1.23 | 1.03 | 1.33 |
| 23 | 1.85 | 2.63 | 1.45 | 1.26 | 1.17 | 1.04 | 1.33 |
| 24 | 1.84 | 2.65 | 1.55 | 1.21 | 1.17 | 1.17 | 1.31 |
| 25 | 1.84 | 2.75 | 2.07 | 1.23 | 1.14 | 1.11 | 1.36 |
| 26 | 1.87 | 2.80 | 1.75 | 1.23 | 1.13 | 1.10 | 1.31 |
| 27 | 1.93 | 2.85 | 2.65 | 1.24 | 1.12 | 1.12 | 1.34 |
| 28 | 1.95 | 2.75 | 3.75 | 1.24 | .97 | 1.12 | 1.34 |
| 29 | 1.89 | 2.35 | 3.40 | 1.24 | .95 | 1.13 | 1.31 |
| 30 | 1.73 | 2.20 | 3.02 | 1.21 | .99 | 1.12 | 1.32 |
| 31 | | 2.07 | | 1.22 | .97 | | 1.30 |

Closed for winter October 31.

## ELKHORN RIVER AT ARLINGTON, NEBRASKA.

The station at Arlington, Nebraska, was established by Glenn E. Smith April 28, 1899, and is located at the wagon bridge 1 mile west of the town of Arlington. The original rod was fastened to cross-ties, which are solidly bedded in the river bank. It consisted of a new oak stake 3 by 4 inches and 12 feet long. It was placed 200 feet downstream from the bridge on the west bank of the river. Bench mark No. 1 is a large spike driven in a pile 50 feet upstream from the rod, and is 6.36 feet above gage datum. Bench mark No. 2 is a large spike driven in a piling 20 feet back and 10 feet upstream from the rod, and is 9.12 feet above gage datum. Bench mark No. 3 is a vertical spike driven into a small leaning tree 5 feet downstream from the rod, and is 7.43 feet above gage datum. On May 10 the rod was washed out; on May

29 it was replaced by an oak rod 2 by 6 inches and 16 feet long. This rod was placed on the same bank as the first rod, but was set 25 feet farther upstream. The gage datum was not changed. S. P. Hammang, a farmer living about 300 yards from the gage rod, is the observer. The following discharge measurements were made by Glenn E. Smith during 1899:

*Measurements of Elkhorn River at Arlington, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Feb. 4 | | 337 | July 8 | 2.23 | 1,016 |
| Feb. 17 | | 269 | Aug. 9 | 1.72 | 732 |
| Apr. 28 | 1.78 | 794 | Aug. 18 | 1.40 | 606 |
| May 9 | 3.90 | 1,779 | Sept. 15 | .82 | 344 |
| May 24 | | 1,626 | Sept. 24 | .75 | 340 |
| May 29 | 4.24 | 2,462 | Oct. 13 | .90 | 351 |
| June 22 | 2.70 | 1,199 | | | |

*Daily gage height, in feet, of Elkhorn River at Arlington, Nebraska, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | | 1.84 | 3.81 | 2.68 | 1.32 | 0.87 | 0.68 |
| 2 | | 2.07 | 3.65 | 2.68 | 1.25 | .89 | .69 |
| 3 | | 1.86 | 3.63 | 3.19 | 1.17 | .76 | .68 |
| 4 | | 1.96 | 3.50 | 2.97 | 1.36 | .73 | .67 |
| 5 | | 2.30 | 3.41 | 2.81 | 1.50 | .70 | .68 |
| 6 | | 3.00 | 3.42 | 2.66 | 1.40 | .72 | .73 |
| 7 | | 4.37 | 3.54 | 2.38 | 1.56 | .74 | .74 |
| 8 | | 3.96 | 2.87 | 2.23 | 2.00 | .75 | .78 |
| 9 | | 3.91 | 2.58 | 2.23 | 1.70 | .74 | .79 |
| 10 | | (*a*) | 2.38 | 2.12 | 1.57 | .79 | .82 |
| 11 | | (*a*) | 2.35 | 2.13 | 1.66 | .80 | .86 |
| 12 | | (*a*) | 2.40 | 2.02 | 1.40 | .82 | .88 |
| 13 | | (*a*) | 5.35 | 2.10 | 1.41 | .81 | .90 |
| 14 | | (*a*) | 4.94 | 1.94 | 1.35 | .84 | .92 |
| 15 | | (*a*) | 4.55 | 1.86 | 1.42 | .79 | .93 |
| 16 | | (*a*) | 4.12 | 1.83 | 1.49 | .75 | .94 |
| 17 | | (*a*) | 4.30 | 1.76 | 1.48 | .74 | .92 |
| 18 | | (*a*) | 4.48 | 1.68 | 1.39 | .73 | .91 |
| 19 | | (*a*) | 3.67 | 1.64 | 1.27 | .73 | .92 |
| 20 | | (*a*) | 3.16 | 1.63 | 1.24 | .65 | .96 |
| 21 | | (*a*) | 2.67 | 1.57 | 1.09 | .66 | .98 |
| 22 | | (*a*) | 2.76 | 1.50 | 1.10 | .69 | 1.02 |
| 23 | | (*a*) | 2.75 | 1.55 | 1.09 | .72 | 1.04 |
| 24 | | (*a*) | 2.65 | 1.36 | 1.21 | .75 | 1.10 |
| 25 | | (*a*) | 2.51 | 1.30 | 1.23 | .76 | 1.12 |
| 26 | | (*a*) | 2.21 | 1.27 | 1.03 | .70 | 1.11 |
| 27 | | (*a*) | 2.32 | 1.27 | 1.02 | .69 | 1.12 |
| 28 | 1.78 | (*a*) | 2.19 | 1.25 | 1.07 | .66 | 1.13 |
| 29 | 1.76 | 4.24 | 2.32 | 1.26 | 1.03 | .64 | 1.12 |
| 30 | 1.81 | 4.15 | 2.64 | 1.20 | 1.01 | .63 | 1.13 |
| 31 | | 4.17 | | 1.22 | .85 | | 1.11 |

Closed for winter October 31. *a* Rod washed out.

## REPUBLICAN RIVER AT SUPERIOR, NEBRASKA.

This river rises in the northeastern part of Colorado, and after entering Nebraska it flows in a general easterly direction along the southern boundary of the State to 98° west longitude, where it bends into Kansas, and thence flows southeasterly until it joins the Smoky Hill River at Junction to form the Kansas River. All of the tributaries of the Kansas River have their sources in the Great Plains region, none drawing their supply from a mountain area. They are also different from ordinary streams, in that the rainfall is less at the headwaters, gradually increasing downstream. Two gaging stations are maintained on Republican River, one at Superior, Nebraska, just before it enters Kansas, and the other at Junction, Kansas. The former station was established June 20, 1896, about one mile west from Superior, Nebraska. The old gage rod was first placed just above the river highway bridge, which is itself 75 yards above the dam which diverts water into the mill race. In the spring of 1898 two other gages were located and have been exclusively used during the last season. The first gage was placed in the river a few feet upstream from the crest of the dam the zero being at same elevation as the crest, the second is in the mill race, where it is crossed by a wagon bridge about 50 yards below its head. Discharge measurements of the river are made from the highway bridge, thus determining at once the discharge through the mill race and from the dam. The discharge from the mill race was measured in order that it might be deducted from the total discharge of the river to give the amount passing over the dam. The bench mark for the river gage is a standard 4-foot iron post of the United States Geological Survey, and is situated 83 feet north of the upstream cylinder of the north pier of the bridge, and 1 foot inside of a wire fence. Its elevation is 4.92 feet above datum of gage at dam. The gage of the mill race reads 2 feet higher than that of the river gage, so that its zero is 6.92 feet below the same bench mark. During 1899 Glenn E. Smith made an examination of a portion of the upper Republican River. On September 6, at Oxford, Nebraska, the river channel was dry and was reported to have been in this condition for ten days. At Orleans, about 12 miles below, there was an estimated discharge of 0.3 second-feet—this small amount coming from Sappa River, which enters at this point. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 201; 1897, Nineteenth Annual Report, Part IV, page 339; 1898, Twentieth Annual Report, Part IV, page 317. The following discharge measurements were made by Glenn E. Smith during 1899:

*Measurements of Republican River at Superior, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Foot.* | *Sec.-feet.* | 1899. | *Foot.* | *Sec.-feet.* |
| January 24 | Frozen. | 463 | June 26 | 0.42 | 204 |
| February 14 | Frozen. | 131 | July 6 | .90 | 732 |
| April 10 | 0.98 | 738 | July 26 | .23 | 135 |
| May 1 | .75 | 382 | August 11 | .40 | 215 |
| May 13 | .61 | 442 | September 6 | | 0 |
| June 2 | .51 | 291 | September 29 | | 0 |
| June 16 | .63 | 439 | October 17 | | 0 |

*Measurements of mill race at Superior, Nebraska.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| April 10 | 2.98 | 49 | July 6 | 2.80 | 56 |
| May 1 | 3.00 | 0 | August 11 | 2.70 | 56 |
| May 13 | 3.10 | 47 | September 6 | 2.60 | 50 |
| June 2 | 2.60 | 55 | September 29 | 1.20 | 25 |
| June 16 | 3.50 | 53 | October 17 | 1.50 | 50 |
| June 26 | 3.40 | 59 | | | |

No water was passing over the dam, and all was in the mill race on September 6 and 29 and October 17. The figures which are noted as gage heights in the mill race during 1899 are, in fact, measurements of the center depth at the gaging section. As expected, this has proved to be a better basis for the computation of areas of cross section there than the gage height observed in previous years.

*Daily gage height, in feet, of Republican River at Superior, Nebraska, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|
| 1 | | 0.97 | 0.74 | 0.45 | 1.05 | 0.91 | 0.12 | (*a*) |
| 2 | | 1.00 | .70 | .51 | .90 | .95 | .09 | (*a*) |
| 3 | | .95 | .73 | .60 | .80 | .82 | .20 | (*a*) |
| 4 | | .94 | 1.18 | .60 | .80 | .68 | (*a*) | (*a*) |
| 5 | | 1.00 | .68 | .47 | .79 | .60 | (*a*) | (*a*) |
| 6 | | .98 | .64 | .45 | .90 | .45 | (*a*) | (*a*) |
| 7 | | 1.04 | .50 | .47 | .93 | .52 | (*a*) | (*a*) |
| 8 | | .97 | .61 | .45 | .89 | .42 | (*a*) | (*a*) |
| 9 | | 1.00 | .68 | .40 | .63 | .41 | (*a*) | (*a*) |
| 10 | | .97 | .63 | .40 | .51 | .41 | (*a*) | (*a*) |
| 11 | | .94 | .63 | .41 | .45 | .40 | (*a*) | (*a*) |
| 12 | | .89 | .60 | .35 | .42 | .41 | (*a*) | (*a*) |
| 13 | | .90 | .61 | .33 | .52 | .50 | (*a*) | (*a*) |
| 14 | | .90 | .67 | .70 | .47 | .60 | (*a*) | (*a*) |
| 15 | | .88 | .63 | .53 | .42 | .44 | (*a*) | (*a*) |
| 16 | | .74 | .69 | .63 | .45 | .39 | (*a*) | (*a*) |
| 17 | | .83 | .65 | .42 | .45 | .62 | (*a*) | (*a*) |
| 18 | | .83 | .64 | .41 | .46 | .52 | (*a*) | (*a*) |
| 19 | 1.13 | .82 | .65 | .12 | .39 | .42 | (*a*) | (*a*) |
| 20 | .94 | .77 | .93 | .35 | .40 | .41 | (*a*) | (*a*) |
| 21 | .89 | .82 | 1.50 | .35 | .49 | .27 | 1.25 | (*a*) |
| 22 | .99 | .73 | 1.02 | .32 | .42 | .35 | (*a*) | (*a*) |
| 23 | .99 | .63 | .80 | .60 | .35 | .31 | (*a*) | (*a*) |
| 24 | .96 | .75 | .74 | .63 | .20 | .20 | (*a*) | (*a*) |
| 25 | .92 | .70 | .70 | .39 | .26 | .30 | (*a*) | (*a*) |
| 26 | .94 | .73 | .80 | .42 | .26 | .45 | (*a*) | (*a*) |
| 27 | .93 | .75 | .73 | 2.60 | .25 | .72 | (*a*) | (*a*) |
| 28 | .95 | .75 | .66 | 2.05 | .26 | .33 | (*a*) | (*a*) |
| 29 | .92 | .79 | .65 | 1.31 | 1.22 | .21 | (*a*) | (*a*) |
| 30 | .91 | .70 | .63 | 1.22 | .69 | .33 | (*a*) | (*a*) |
| 31 | .96 | | .54 | | .45 | .20 | | (*a*) |

*a* September 4 to 20, 22 to 30, no water flowing over dam. Closed for winter October 31.

*Daily gage height, in feet, of mill race at Superior, Nebraska, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|
| 1 | | 2.98 | 2.84 | 2.54 | 2.15 | 3.05 | 2.86 | 1.15 |
| 2 | | 3.08 | 2.90 | 2.06 | 1.80 | 2.85 | 2.12 | 1.53 |
| 3 | | 3.03 | 2.93 | 2.65 | 2.18 | 2.38 | 2.79 | 1.10 |
| 4 | | 2.98 | 3.42 | 2.67 | 2.30 | 1.94 | 2.19 | 1.60 |
| 5 | | 3.02 | 2.61 | 2.50 | 2.34 | 1.86 | 2.00 | 1.20 |
| 6 | | 2.97 | 2.61 | 2.49 | 2.40 | 2.05 | 2.06 | 1.15 |
| 7 | | 3.04 | 2.15 | 2.59 | 2.42 | 2.87 | 1.41 | 1.28 |
| 8 | | 2.98 | 3.00 | 2.48 | 2.54 | 2.64 | 1.63 | 1.87 |
| 9 | | 3.04 | 3.10 | 2.41 | 2.01 | 2.78 | 1.56 | 2.79 |
| 10 | | 2.99 | 3.04 | 2.46 | 2.22 | 2.80 | 1.84 | 1.45 |
| 11 | | 2.92 | 3.01 | 2.69 | 2.38 | 2.07 | 3.62 | 2.15 |
| 12 | | 2.89 | 3.06 | 3.20 | 2.25 | 2.70 | 3.44 | 1.12 |
| 13 | | 2.90 | 3.10 | 3.22 | 2.94 | 2.90 | 2.88 | 1.70 |
| 14 | | 2.89 | 3.25 | 3.52 | 2.84 | 3.00 | 3.54 | 1.30 |
| 15 | | 2.77 | 3.19 | 3.35 | 2.80 | 2.78 | 3.88 | 1.78 |
| 16 | | 2.47 | 3.20 | 3.50 | 2.86 | 2.76 | 3.74 | 3.40 |
| 17 | | 2.97 | 3.12 | 3.38 | 3.08 | 2.95 | 3.79 | 2.30 |
| 18 | | 2.84 | 3.15 | 3.27 | 3.26 | 2.78 | 3.65 | 3.10 |
| 19 | 3.13 | 2.82 | 3.36 | 2.56 | 2.95 | 2.68 | 3.53 | 2.74 |
| 20 | 2.88 | 2.77 | 3.95 | 3.20 | 2.90 | 2.75 | 3.56 | 2.27 |
| 21 | 2.84 | 2.83 | 4.38 | 3.21 | 3.03 | 2.35 | 3.94 | 2.75 |
| 22 | 2.94 | 2.73 | 3.15 | 2.95 | 3.04 | 2.60 | 3.70 | 1.72 |
| 23 | 2.93 | 2.51 | 2.97 | 3.35 | 2.93 | 2.48 | 3.50 | 3.01 |
| 24 | 2.90 | 2.70 | 2.77 | 3.52 | 2.81 | 2.56 | 3.80 | 1.86 |
| 25 | 2.81 | 2.75 | 2.73 | 2.43 | 2.60 | 2.60 | 3.43 | 4.02 |
| 26 | 2.94 | 2.78 | 2.82 | 3.12 | 2.80 | 2.66 | 3.81 | 3.78 |
| 27 | 2.90 | 2.83 | 2.78 | 5.69 | 2.70 | 3.00 | 2.17 | 3.63 |
| 28 | 2.90 | 2.85 | 2.66 | 4.51 | 2.71 | 3.20 | 2.83 | 3.43 |
| 29 | 2.95 | 2.80 | 2.83 | 2.45 | 3.80 | 3.10 | 1.20 | 3.92 |
| 30 | 2.95 | 2.75 | 2.83 | 2.45 | 2.93 | 2.86 | 1.10 | 3.82 |
| 31 | 2.96 | | 2.73 | | 3.43 | 2.90 | | 3.33 |

## REPUBLICAN RIVER AT JUNCTION, KANSAS.

The gaging station at this point, established by Arthur P. Davis April 26, 1895, is located at the wagon bridge at the north end of Washington street just above the mouth of the river. The gage consists of two oak timbers bolted to a post and to a cottonwood tree. One bench mark consists of a 60-penny spike driven into the base of the abutment of the bridge at an elevation of 10.67 feet on the rod; the second bench mark is the top of a stone in the base of the bridge abutment 18 feet south of the gage and at an elevation of 14.51 feet above gage datum. The right bank is high, but the left is low and may overflow in high water. The bed of the stream is sandy and liable to change. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 205; 1897, Nineteenth Annual Report, Part IV, page 339; 1898, Twentieth Annual Report, Part IV, page 318. The following discharge measurements were made by W. G. Russell in 1899:

April 19, gage height, 3.90 feet; discharge, 737 second-feet.
May 26, gage height, 4.20 feet; discharge, 1,029 second-feet.
June 7, gage height, 4.40 feet; discharge, 1,224 second-feet.
June 15, gage height, 3.80 feet; discharge, 936 second-feet.
October 19, gage height, 2.55 feet; discharge, 85 second-feet.

*Daily gage height, in feet, of Republican River at Junction, Kansas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.40 | 4.15 | 4.00 | 4.20 | 3.65 | 3.70 | 5.90 | 4.10 | 3.10 | 2.65 | 2.65 | 2.80 |
| 2 | 3.45 | 4.15 | 4.15 | 4.20 | 3.90 | 4.25 | 5.90 | 4.55 | 3.05 | 2.70 | 2.85 | 2.90 |
| 3 | 3.75 | 4.20 | 4.35 | 4.20 | 4.25 | 6.95 | 5.20 | 5.45 | 3.00 | 2.75 | 2.90 | 3.20 |
| 4 | 4.00 | 4.05 | 4.50 | 4.15 | 4.10 | 10.00 | 5.70 | 4.85 | 3.10 | 2.60 | 2.95 | 3.50 |
| 5 | 3.95 | 3.75 | 4.80 | 4.15 | 3.85 | 7.25 | 6.05 | 4.70 | 2.85 | 2.60 | 2.80 | 3.00 |
| 6 | 3.95 | 3.70 | 4.85 | 4.20 | 3.70 | 5.20 | 4.90 | 4.40 | 2.80 | 2.85 | 2.60 | 3.80 |
| 7 | 3.80 | 3.60 | 4.85 | 4.15 | 3.65 | 4.60 | 6.00 | 4.25 | 2.85 | 3.25 | 2.60 | 3.80 |
| 8 | 3.65 | 3.65 | 4.80 | 4.20 | 3.90 | 6.10 | 6.20 | 4.00 | 2.90 | 2.80 | 2.70 | 3.20 |
| 9 | 3.50 | 3.50 | 4.70 | 4.20 | 5.45 | 8.80 | 5.90 | 3.80 | 2.90 | 2.75 | 2.80 | 3.00 |
| 10 | 3.65 | 3.50 | 4.65 | 4.20 | 5.35 | 7.25 | 5.60 | 3.65 | 2.80 | 2.70 | 2.80 | 3.20 |
| 11 | 3.85 | 3.50 | 4.80 | 4.20 | 4.10 | 5.40 | 5.00 | 3.55 | 2.70 | 2.55 | 2.50 | 3.30 |
| 12 | 3.90 | 3.50 | 4.90 | 4.15 | 4.05 | 4.40 | 4 90 | 3.60 | 2.65 | 2.55 | 2.50 | 3.50 |
| 13 | 3.95 | 3.55 | 5.15 | 4.10 | 3.80 | 4.25 | 4.40 | 4.50 | 2.65 | 2.70 | 2.60 | 3.20 |
| 14 | 3.90 | 3.60 | 4.90 | 4.00 | 3.75 | 4.00 | 4.10 | 4.45 | 2.70 | 2.70 | 2.40 | 3.50 |
| 15 | 3.85 | 3.65 | 5.25 | 4.05 | 3.60 | 3.80 | 4.15 | 4.20 | 2.60 | 2.65 | 2.60 | 3.20 |
| 16 | 3.70 | 3.70 | 5.20 | 4.00 | 3.60 | 3.65 | 3.90 | 3.80 | 2.70 | 2.50 | 2.40 | 3.30 |
| 17 | 3.60 | 4.05 | 5.40 | 4.00 | 3.60 | 3.60 | 3.70 | 4.05 | 2.70 | 2.50 | 2.60 | 3.30 |
| 18 | 3.40 | 3.90 | 5.35 | 4.00 | 3.50 | 3.50 | 3.70 | 3.80 | 2.55 | 2.60 | 2.80 | 3.20 |
| 19 | 3.50 | 3.90 | 4.90 | 3.90 | 3.40 | 3.75 | 3.85 | 3.60 | 2.60 | 2.55 | 3.20 | 3.20 |
| 20 | 3.70 | 3.95 | 4.90 | 3.95 | 4.35 | 3.60 | 3.70 | 3.40 | 2.70 | 2 50 | 2.80 | 3.10 |
| 21 | 3.85 | 4.00 | 4.85 | 3.80 | 6.00 | 3.55 | 3.60 | 3.40 | 2.70 | 2.60 | 2.70 | 3.40 |
| 22 | 3.85 | 3.95 | 4.50 | 3.80 | 6.40 | 3.35 | 3.55 | 3.30 | 2.65 | 3.25 | 2.60 | 3.60 |
| 23 | 3.70 | 4.05 | 4.50 | 3.80 | 6.15 | 4.35 | 3.50 | 3.35 | 2.65 | 3.10 | 2.80 | 3.50 |
| 24 | 3.65 | 4.15 | 4.10 | 3.80 | 4.70 | 4.30 | 3.55 | 3.40 | 2.60 | 3.35 | 2.90 | 3.50 |
| 25 | 3.65 | 3.90 | 4.10 | 3.80 | 4.55 | 4.75 | 3.30 | 3.30 | 2.70 | 4.20 | 2.90 | 3.60 |
| 26 | 3.70 | 3.85 | 4.20 | 3.75 | 4.20 | 4.15 | 3.30 | 3.00 | 2.60 | 4.05 | 2.70 | 3.40 |
| 27 | 3.70 | 4.05 | 4.15 | 3.60 | 8.20 | 4.10 | 3.20 | 3.55 | 2.65 | 4.35 | 2.60 | 3.40 |
| 28 | 3.75 | 3.95 | 4.10 | 3.70 | 6.15 | 4.10 | 3.20 | 3.10 | 2.80 | 4.05 | 2.70 | 3.60 |
| 29 | 3.80 | ------- | 4.10 | 3.70 | 4.55 | 4.80 | 3.20 | 3.10 | 2.90 | 3.55 | 2.90 | 3.90 |
| 30 | 3.85 | ------- | 4.20 | 3.75 | 4.00 | 6.70 | 3.25 | 3.25 | 2.65 | 3.20 | 2.90 | 3.80 |
| 31 | 4.00 | ------- | 4.20 | ------- | 3.95 | ------- | 3.35 | 3.05 | ------- | 2.20 | ------- | 3.40 |

SOLOMON RIVER AT NILES, KANSAS.

This river, one of the principal tributaries of Smoky Hill River, rises in western Kansas, and flows in a general easterly direction, entering the Smoky Hill River near Solomon, Kansas. The station at Niles was established May 5, 1897, and is located at a bridge one-half mile west of the town and 7 miles above the mouth of the river. The rod of the wire gage is spiked to the floor of the bridge. The bench mark is the upper of three nails driven into a cottonwood tree 18 inches in diameter, on the north side of the river and 25 feet east of the bridge, at an elevation of 24.96 feet above gage datum. The channel is straight for about 100 feet above and below the section. The current is sluggish; the right bank is high, and the left bank overflows only at very high stages. The bed of the stream is muddy. The discharge measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 342; 1898, Twentieth Annual Report, Part IV, page 214. The following discharge measurements were made by W. G. Russell during 1899:

April 20, gage height, 4.90 feet; discharge, 120 second-feet.
May 27, gage height, 5.10 feet; discharge, 129 second-feet.
May 29, gage height, 11.65 feet; discharge, 1,529 second-feet.
June 16, gage height, 13.60 feet; discharge, 2,270 second-feet.

*Daily gage height, in feet, of Solomon River at Niles, Kansas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ------- | 5.70 | 5.35 | 5.20 | 4.75 | 5.30 | 18.75 | 6.40 | 5.10 | 4.40 | 5.00 | 4.40 |
| 2 | 5.30 | 5.65 | 5.30 | 5.25 | 4.65 | 5.10 | 11.85 | 10.75 | 5.00 | 5.10 | 4.80 | 4.90 |
| 3 | ------- | 5.65 | 5.30 | 5.30 | 5.75 | 8.35 | 8.90 | 10.00 | 5.10 | 4.70 | 4.70 | 4.60 |
| 4 | 5.20 | 5.65 | 5.30 | 5.25 | 5.35 | 20.00 | 9.65 | 8.25 | 5.10 | 4.45 | 4.80 | 4.40 |
| 5 | 5.20 | 5.70 | 5.25 | 5.25 | 4.90 | 23.60 | 8.90 | 6.80 | 4.95 | 4.30 | 4.90 | 4.40 |
| 6 | ------- | 5.65 | 5.40 | 5.25 | 4.90 | 16.70 | 8.30 | 6.20 | 4.85 | 4.40 | 5.00 | 4.90 |
| 7 | 5.10 | 5.65 | 5.25 | 5.25 | 4.85 | 8.30 | 9.70 | 5.80 | 5.05 | 4.45 | ------- | 4.70 |
| 8 | 5.30 | 5.65 | 5.45 | 5.35 | 5.10 | 16.80 | 8.60 | 5.65 | 4.95 | 4.45 | 4.30 | 4.60 |
| 9 | ------- | 5.55 | 5.65 | 5.20 | 6.00 | 21.50 | 7.45 | 5.55 | 4.90 | 4.30 | 4.80 | 4.70 |
| 10 | 5.20 | 5.60 | 5.45 | 5.25 | 5.65 | 21.35 | 6.85 | 5.30 | 4.85 | 4.40 | 4.60 | 4.70 |
| 11 | ------- | 5.65 | 5.55 | 5.20 | 6.35 | 15.60 | 6.75 | 5.35 | 4.85 | 4.60 | 4.20 | 4.90 |
| 12 | 5.20 | 5.45 | 5.45 | 5.30 | 6.55 | 10.00 | 6.60 | 5.30 | 4.70 | 4.40 | 4.80 | 4.70 |
| 13 | ------- | 5.45 | 5.15 | 5.15 | 6.00 | 8.75 | 7.25 | 5.40 | 4.60 | 4.20 | 4.40 | 4.90 |
| 14 | ------- | 5.45 | 5.95 | 5.10 | 5.65 | 7.65 | 10.60 | 5.25 | 4.50 | 4.35 | 4.40 | 4.80 |
| 15 | 5.30 | 5.50 | 6.50 | 5.00 | 5.15 | 9.80 | 7.65 | 5.25 | 4.60 | 4.35 | 4.50 | 5.00 |
| 16 | ------- | 5.55 | 6.25 | 5.15 | 5.00 | 13.25 | 6.40 | 5.35 | 4.50 | 4.35 | 5.00 | 5.10 |
| 17 | 5.20 | 5.40 | 6.25 | 5.05 | 5.05 | 10.10 | 6.15 | 6.15 | 4.50 | 4.15 | 4.50 | 5.00 |
| 18 | ------- | 5.45 | 5.95 | 4.95 | 5.00 | 7.15 | 6.40 | 6.55 | 4.50 | 4.15 | 4.40 | 4.90 |
| 19 | 6.40 | 5.35 | 5.70 | 5.00 | 4.80 | 6.55 | 6.80 | 6.30 | 4.45 | 4.15 | 4.30 | 5.10 |
| 20 | ------- | 5.45 | 5.55 | 5.05 | 5.00 | 6.35 | 6.40 | 6.30 | 4.40 | 4.10 | 4.50 | 5.00 |
| 21 | ------- | 5.40 | 5.50 | 4.85 | 5.10 | 6.15 | 6.40 | 5.90 | 4.45 | 4.20 | 4.40 | 5.10 |
| 22 | 6.10 | 5.45 | 5.55 | 4.85 | 5.45 | 5.85 | 6.05 | 5.60 | 4.70 | 4.30 | 4.90 | 4.90 |
| 23 | 5.75 | 5.35 | 5.25 | 4.90 | 5.30 | 7.15 | 5.85 | 5.50 | 4.55 | 4.30 | 4.50 | 5.00 |
| 24 | 5.50 | 5.25 | 5.25 | 4.95 | 5.35 | 8.15 | 5.65 | 5.20 | 4.45 | 4.20 | 4.50 | 4.70 |
| 25 | 5.25 | 5.40 | 5.35 | 4.80 | 5.20 | 12.45 | 5.65 | 5.15 | 4.45 | 4.55 | 4.70 | 4.80 |
| 26 | 5.65 | 5.35 | 5.25 | 4.90 | 5.10 | 12.90 | 5.70 | 5.20 | 4.40 | 4.60 | 4.50 | 4.90 |
| 27 | 5.50 | 5.45 | 5.15 | 4.85 | 8.50 | 11.85 | 5.40 | 5.10 | 4.55 | 10.25 | 4.70 | 4.70 |
| 28 | 5.70 | 5.30 | 5.25 | 4.80 | 14.45 | 11.50 | 5.35 | 5.10 | 4.40 | 8.15 | 4.60 | 4.60 |
| 29 | 5.75 | ------- | 5.30 | 4.70 | 11.95 | 14.60 | 5.40 | 5.05 | 4.30 | 6.15 | 4.80 | 4.70 |
| 30 | 5.65 | ------- | 5.25 | 4.80 | 7.15 | 18.60 | 5.55 | 4.85 | 4.45 | 5.30 | 4.70 | 4.60 |
| 31 | 5.60 | ------- | 5.05 | ------- | 5.80 | ------- | 5.25 | 4.90 | ------- | 5.00 | ------- | 4.70 |

## SALINE RIVER AT SALINA, KANSAS.

This river and the Solomon are the two principal tributaries of Smoky Hill River. They are of a similar type to the other tributaries of Kansas River, as they are sand-hill streams. Saline River joins Smoky Hill River a short distance below Salina and 9 miles, by railroad, above the mouth of Solomon River. The station, established May 4, 1897, is located at a bridge 4.5 miles northeast of Salina, near the mouth of the river. The rod of the wire gage is spiked to the floor of the bridge. Bench mark No. 1 is a nail in an elm tree 2 feet in diameter on the north side of the river and 6 feet west of the bridge. Its elevation is 22.90 feet above gage datum. Bench mark No. 2 is six nails driven into a 16-inch box-elder tree on the north side of the river and 35 feet east of the bridge. Its elevation is 22.90 feet above gage datum. The channel is straight for a little distance above and below the station. Both banks are high and not liable to overflow. The bed of the stream is sand and mud. The results of measurements may be found as follows: 1897, Ninteenth Annual Report, Part IV, page 346; 1898, Twentieth Annual Report, Part IV, page 316. The following discharge measurements for 1899 were made by W. G. Russell:

April 21, gage height, 2.90 feet; discharge, 26 second-feet.
May 27, gage height, 4.20 feet; discharge, 90 second-feet.
May 29, gage height, 12.65 feet; discharge, 1,007 second-feet.
May 30, gage height, 9.30 feet; discharge, 524 second-feet.
June 16, gage height, 8.60 feet; discharge, 560 second-feet.

*Daily gage height, in feet, of Saline River at Salina, Kansas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | 3.35 | 2.90 | 4.55 | 8.95 | 4.25 | 3.55 | 3.20 | 4.80 | 3.60 |
| 2 | 3.90 | 3.30 | 3.50 | 3.35 | 2.90 | 4.00 | 7.85 | 4.35 | 3.90 | 3.05 | 4.90 | 3.40 |
| 3 | | | | 3.35 | 3.70 | 9.95 | 6.95 | 4.55 | 3.75 | 3.10 | 4.10 | 3.60 |
| 4 | 3.80 | 3.20 | | 3.25 | 3.70 | 23.95 | 6.50 | 4.50 | 3.60 | 3.30 | 3.90 | 3.80 |
| 5 | | | 4.05 | 3.25 | 2.95 | 21.30 | 6.25 | 4.35 | 3.50 | 3.25 | 3.70 | 3.80 |
| 6 | | | 3.95 | 3.20 | 2.90 | 17.50 | 6.05 | 4.25 | 3.35 | 3.10 | 3.70 | 3.60 |
| 7 | 3.40 | 3.20 | 4.00 | 3.45 | 3.10 | 10.50 | 6.65 | 4.00 | 3.30 | 3.05 | 3.60 | 3.60 |
| 8 | | | 3.75 | 3.40 | 3.05 | 11.40 | 7.20 | 3.90 | 3.30 | 3.15 | 3.50 | 3.60 |
| 9 | 3.60 | 3.20 | 3.50 | 3.35 | 3.00 | 21.70 | 7.05 | 3.85 | 3.35 | 3.00 | 3.50 | 3.60 |
| 10 | | 3.30 | 3.80 | 3.35 | 2.80 | 27.15 | 6.15 | 3.80 | 3.35 | 3.00 | 3.50 | 3.60 |
| 11 | 3.70 | 3.30 | 3.75 | 3.30 | 2.70 | 23.50 | 7.55 | 3.80 | 3.25 | 3.00 | 3.50 | 3.80 |
| 12 | | | 3.65 | 3.35 | 2.60 | 21.20 | 10.05 | 3.80 | 3.20 | 3.20 | 3.40 | 3.60 |
| 13 | | | 4.10 | 3.10 | 2.70 | 15.10 | 8.60 | 4.15 | 3.30 | 3.10 | 3.60 | 3.60 |
| 14 | 3.80 | 3.10 | 3.70 | 3.30 | 3.00 | 8.40 | 6.45 | 4.10 | 3.25 | 3.05 | 3.60 | 3.70 |
| 15 | | | 3.70 | 3.25 | 2.95 | 7.25 | 6.15 | 3.95 | 3.30 | 3.05 | 3.50 | 3.80 |
| 16 | | 3.20 | 3.95 | 3.15 | 2.85 | 8.85 | 6.00 | 3.80 | 3.40 | 3.15 | 3.50 | 3.60 |
| 17 | 3.50 | | 3.75 | 3.15 | 2.90 | 13.45 | 6.20 | 3.75 | 3.55 | 3.05 | 3.60 | 3.90 |
| 18 | | 3.10 | 3.65 | 2.95 | 2.85 | 9.95 | 5.50 | 4.05 | 3.55 | 3.00 | 3.50 | 3.90 |
| 19 | 3.50 | | 3.65 | 3.00 | 2.75 | 7.25 | 5.30 | 4.05 | 3.35 | 3.10 | 3.60 | 3.80 |
| 20 | | | 3.35 | 3.00 | 2.85 | 5.80 | 5.15 | 3.85 | 3.35 | 3.05 | 3.50 | 3.70 |
| 21 | 3.70 | 3.30 | 3.35 | 2.80 | 2.75 | 5.35 | 4.95 | 3.70 | 3.35 | 3.10 | 3.60 | 3.60 |
| 22 | | | 3.45 | 3.00 | 4.35 | 5.10 | 4.85 | 3.65 | 3.25 | 3.20 | 3.60 | 3.70 |
| 23 | 3.20 | 3.40 | 3.15 | 3.10 | 11.35 | 5.40 | 4.65 | 3.55 | 3.25 | 3.10 | 3.60 | 3.60 |
| 24 | | | 3.25 | 3.10 | 9.40 | 7.50 | 4.60 | 3.60 | 3.35 | 3.05 | 3.70 | 3.40 |
| 25 | | 3.40 | 3.30 | 3.05 | 5.70 | 12.35 | 4.55 | 3.55 | 3.20 | 3.45 | 3.60 | 3.60 |
| 26 | 3.30 | | 3.30 | 3.10 | 4.75 | 15.30 | 4.45 | 3.60 | 3.15 | 4.00 | 3.60 | 3.80 |
| 27 | | | 3.35 | 3.05 | 4.20 | 17.70 | 4.35 | 3.55 | 3.25 | 3.65 | 3.70 | 3.60 |
| 28 | 3.30 | 3.90 | 3.10 | 2.90 | 6.85 | 19.65 | 4.35 | 3.50 | 3.25 | 3.35 | 3.50 | 3.60 |
| 29 | | | 3.15 | 2.85 | 12.60 | 20.05 | 4.30 | 3.30 | 3.30 | 7.30 | 3.60 | 3.60 |
| 30 | | | 3.20 | 2.95 | 8.15 | 14.25 | 4.35 | 3.25 | 3.25 | 6.60 | 3.80 | 3.60 |
| 31 | 3.30 | | 3.50 | | 5.20 | | 4.35 | 3.25 | | 5.50 | | 3.50 |

SMOKY HILL RIVER AT ELLSWORTH, KANSAS.

This river rises in eastern Colorado, and flows easterly, joining the Republican River at Junction to form the Kansas River. The gaging station, established April 17, 1895, is located at the highway bridge on Douglass avenue, Ellsworth, Kansas. The gage is an inclined ash timber spiked to a post driven in the bed of the river and bolted to an iron post on the bridge pier. The bench mark is a nail driven in the base of a large box-elder tree near the southeast corner of the bridge, 90 feet from the gage, and its elevation is 13.07 feet above the zero of the gage. A slope gage is spiked to the Saint Louis and San Francisco Railroad bridge 2,536 feet upstream, and is referred to the same datum. The channel is nearly straight above and below the gage, and the bed is sandy and shifting. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 214; 1897, Nineteenth Annual Report, Part IV, page 347; 1898, Twentieth Annual Report, Part IV, page 315. Measurements for 1899 were made by W. G. Russell, as follows:

March 20, gage height, 1.25 feet; discharge, 35 second-feet.
June 6, gage height, 2.07 feet; discharge, 184 second-feet.
June 26, gage height, 1.95 feet; discharge, 189 second-feet.
July 7, gage height, 4.75 feet; discharge, 1,675 second-feet.
July 8, gage height, 13 feet; discharge, 10,986 second-feet.
July 8, gage height, 10.95 feet; discharge, 7,348 second-feet.

*Daily gage height, in feet, of Smoky Hill River at Ellsworth, Kansas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 1.20 | 1.17 | 0.98 | 0.88 | 1.58 | 2.25 | 1.40 | 1.13 | 1.30 | 1.20 |
| 2 | | | 1.40 | 1.17 | .95 | .90 | 1.38 | 2.13 | 1.33 | 1.10 | 1.30 | 1.20 |
| 3 | 1.40 | | 1.50 | 1.10 | .90 | 5.00 | 2.33 | 2.05 | 1.33 | 1.30 | 1.25 | 1.15 |
| 4 | | 1.30 | 1.45 | 1.13 | .93 | 3.25 | 2.33 | 1.98 | 1.33 | 1.10 | 1.25 | 1.15 |
| 5 | 1.40 | | 1.30 | 1.17 | .95 | 1.98 | 2.00 | 1.95 | 1.30 | 1.10 | 1.25 | 1.15 |
| 6 | | | 1.20 | 1.23 | .98 | 3.20 | 1.83 | 1.88 | 1.28 | 1.30 | 1.20 | 1.10 |
| 7 | 1.50 | 1.30 | 1.30 | 1.20 | .98 | 4.10 | 8.60 | 1.80 | 1.20 | 1.50 | 1.20 | 1.10 |
| 8 | | | 1.20 | 1.17 | 1.00 | 3.00 | 11.35 | 1.73 | 1.28 | 1.50 | 1.25 | 1.15 |
| 9 | | | 1.38 | 1.15 | .95 | 7.70 | 6.00 | 1.73 | 1.38 | 1.30 | 1.25 | 1.15 |
| 10 | 1.50 | | 1.35 | 1.17 | .93 | 5.70 | 5.10 | 1.73 | 1.50 | 1.30 | 1.25 | 1.20 |
| 11 | | 1.30 | 1.30 | 1.17 | .93 | 3.45 | 4.58 | 1.68 | 1.38 | 1.30 | 1.25 | 1.20 |
| 12 | 1.50 | | 1.35 | 1.17 | .93 | 2.80 | 3.80 | 1.60 | 1.35 | 1.10 | 1.20 | 1.15 |
| 13 | 1.40 | 1.50 | 1.40 | 1.23 | 1.00 | 2.20 | 3.33 | 1.95 | 1.50 | 1.10 | 1.20 | 1.15 |
| 14 | 1.05 | | 1.43 | 1.17 | .95 | 2.00 | 2.85 | 1.78 | 1.50 | 1.50 | 1.20 | 1.20 |
| 15 | 1.20 | 1.50 | 1.45 | 1.20 | .98 | 1.90 | 2.70 | 1.68 | 1.48 | 1.50 | 1.15 | 1.20 |
| 16 | 1.30 | | 1.35 | 1.17 | .95 | 1.75 | 2.60 | 1.63 | 1.45 | 1.10 | 1.15 | 1.20 |
| 17 | 1.10 | 1.50 | 1.38 | 1.10 | .90 | 1.60 | 2.70 | 1.60 | 1.48 | 1.10 | 1.15 | 1.25 |
| 18 | 1.30 | | 1.30 | 1.08 | .95 | 1.60 | 2.40 | 1.55 | 1.40 | 1.50 | 1.10 | (a) |
| 19 | 1.40 | 1.50 | 1.28 | 1.08 | .90 | 1.53 | 2.28 | 1.50 | 1.33 | 1.50 | 1.15 | 1.25 |
| 20 | 1.25 | 1.50 | 1.28 | 1.08 | 1.00 | 1.50 | 2.23 | 1.43 | 1.30 | 1.05 | 1.15 | (a) |
| 21 | 1.35 | 1.55 | 1.23 | 1.03 | .95 | 1.45 | 2.18 | 1.40 | 1.28 | 1.05 | 1.20 | (a) |
| 22 | 1.35 | 1.45 | 1.23 | 1.03 | .93 | 1.40 | 2.23 | 1.40 | 1.23 | 1.25 | 1.25 | 1.20 |
| 23 | 1.35 | 1.45 | 1.13 | 1.05 | .95 | 3.15 | 2.23 | 1.33 | 1.23 | 1.25 | 1.20 | 1.20 |
| 24 | 1.20 | 1.40 | 1.17 | 1.03 | 1.03 | 2.85 | 2.20 | 1.30 | 1.20 | 1.30 | 1.20 | 1.20 |
| 25 | 1.15 | 1.40 | 1.15 | 1.03 | 1.10 | 2.25 | 2.13 | 1.35 | 1.20 | 1.40 | 1.25 | 1.15 |
| 26 | 1.30 | 1.40 | 1.17 | 1.03 | 1.13 | 2.15 | 2.10 | 3.85 | 1.15 | 1.75 | 1.25 | 1.20 |
| 27 | 1.20 | 1.40 | 1.15 | 1.00 | 1.08 | 1.90 | 2.05 | 2.75 | 1.15 | 1.58 | 1.20 | 1.20 |
| 28 | 1.30 | 1.45 | 1.15 | 1.00 | .98 | 2.00 | 2.35 | 2.35 | 1.13 | 1.50 | 1.20 | (a) |
| 29 | 1.30 | | 1.10 | 1.00 | .90 | 1.95 | 2.90 | 1.65 | 1.10 | 1.45 | 1.20 | 1.20 |
| 30 | 1.30 | | 1.20 | .98 | .93 | 1.80 | 2.45 | 1.50 | 1.10 | 1.45 | 1.20 | 1.25 |
| 31 | | | 1.17 | | .88 | | 2.30 | 1.43 | | 1.35 | | 1.20 |

*a* Frozen.

## BLUE RIVER AT MANHATTAN, KANSAS.

This stream is one of the principal tributaries of Kansas River, and drains a part of southeastern Nebraska and northeastern Kansas. It enters Kansas River at Manhattan. Its tributaries extend almost to the Platte River. The drainage basin receives a copious rainfall, and therefore the run-off is considerably larger than from the more western tributaries of Kansas River. The gaging station, established April 12, 1895, is at the county bridge 4 miles north of Manhattan. The gage rod consists of three sections, the lower being an ash stick driven into the bottom of the river and bolted to an overhanging cottonwood tree 30 feet east of the bridge. The other two sections of the rod are bolted to the south bridge pier. The bench mark is a cross cut in the capstone of the south bridge pier immediately above the upper gage, and is 32.135 feet above gage datum. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 218; 1897, Nineteenth Annual Report, Part IV, page 348; 1898, Twentieth Annual Report, Part IV, page 319. The following discharge measurements were made by W. G. Russell during 1899:

April 20, gage height, 4.60 feet; discharge, 767 second-feet.
May 23, gage height, 13.70 feet; discharge, 8,952 second-feet.
June 8, gage height, 16.60 feet; discharge, 20,237 second-feet.
June 9, gage height, 18.30 feet; discharge, 19,529 second-feet.
June 10, gage height, 15.60 feet; discharge, 13,616 second-feet.
October 18, gage height, 3.70 feet; discharge, 366 second-feet.

*Daily gage height, in feet, of Blue River at Manhattan, Kansas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.50 | 4.80 | 4.65 | 4.95 | 4.88 | 5.70 | 6.85 | 7.05 | 4.20 | 3.80 | 4.25 | 4.00 |
| 2 | 4.40 | 4.70 | 4.65 | 4.85 | 5.45 | 5.95 | 6.25 | 5.90 | 4.15 | 3.80 | 4.25 | 3.95 |
| 3 | 4.40 | 4.60 | 4.95 | 4.75 | 5.35 | 12.85 | 6.85 | 5.25 | 4.30 | 3.80 | 4.15 | 4.05 |
| 4 | 4.40 | 4.70 | 5.75 | 4.85 | 6.05 | 23.00 | 6.35 | 4.90 | 4.25 | 3.80 | 4.05 | 4.10 |
| 5 | 4.40 | 4.85 | 5.80 | 4.90 | 5.90 | 12.65 | 5.85 | 5.15 | 4.15 | 3.80 | 4.00 | 3.95 |
| 6 | 4.50 | 4.90 | 5.70 | 5.15 | 5.10 | 8.40 | 8.35 | 6.75 | 4.00 | 3.80 | 4.00 | 4.00 |
| 7 | 4.45 | 4.80 | 5.60 | 5.45 | 4.75 | 7.60 | 10.65 | 6.00 | 4.05 | 3.80 | 4.15 | 3.95 |
| 8 | 4.45 | 4.75 | 6.00 | 5.65 | 5.10 | 13.95 | 14.25 | 5.20 | 4.05 | 3.85 | 4.10 | 3.90 |
| 9 | 4.45 | 4.70 | 6.05 | 5.65 | 5.95 | 18.25 | 12.90 | 5.00 | 4.20 | 3.80 | 4.10 | 4.00 |
| 10 | 4.45 | 4.80 | 6.10 | 5.45 | 10.55 | 15.80 | 10.60 | 4.70 | 4.30 | 3.75 | 4.10 | 4.15 |
| 11 | 4.60 | 4.85 | 7.40 | 5.30 | 10.25 | 11.25 | 9.00 | 4.70 | 4.10 | 3.85 | 4.10 | 4.20 |
| 12 | 4.75 | 4.90 | 7.35 | 5.15 | 6.40 | 8.75 | 8.35 | 4.65 | 4.05 | 3.80 | 4.10 | 4.30 |
| 13 | 4.75 | 4.80 | 6.40 | 5.00 | 5.80 | 8.05 | 7.40 | 7.00 | 3.90 | 3.80 | 4.05 | 3.95 |
| 14 | 4.65 | 4.80 | 6.00 | 5.00 | 5.40 | 7.20 | 7.25 | 11.45 | 3.95 | 3.80 | 4.05 | 3.75 |
| 15 | 4.55 | 4.90 | 9.00 | 4.95 | 5.00 | 6.83 | 6.55 | 9.25 | 3.95 | 8.80 | 3.95 | 4.55 |
| 16 | 4.50 | 4.60 | 12.20 | 4.85 | 5.00 | 6.50 | 6.60 | 9.20 | 4.00 | 3.95 | 4.05 | 4.30 |
| 17 | 4.50 | 4.65 | 9.95 | 4.75 | 5.05 | 6.60 | 6.60 | 8.15 | 4.00 | 3.80 | 4.20 | 4.45 |
| 18 | 4.50 | 4.60 | 8.35 | 4.75 | 4.80 | 6.75 | 6.10 | 7.00 | 3.75 | 3.80 | 4.20 | 4.20 |
| 19 | 4.40 | 4.65 | 7.25 | 4.70 | 4.30 | 6.90 | 5.75 | 6.10 | 3.75 | 3.80 | 4.20 | 4.10 |
| 20 | 4.40 | 4.75 | 6.60 | 4.58 | 13.10 | 6.95 | 5.60 | 5.60 | 3.90 | 3.80 | 4.15 | 3.90 |
| 21 | 4.45 | 4.70 | 6.25 | 4.53 | 21.55 | 6.70 | 5.50 | 5.30 | 3.95 | 3.75 | 4.00 | 4.10 |
| 22 | 4.50 | 4.75 | 6.15 | 4.48 | 22.85 | 6.55 | 5.25 | 4.90 | 3.90 | 3.95 | 4.00 | 4.10 |
| 23 | 4.50 | 4.90 | 5.90 | 4.50 | 13.50 | 6.25 | 5.15 | 4.80 | 3.90 | 3.45 | 3.95 | 4.15 |
| 24 | 4.50 | 5.25 | 5.55 | 4.50 | 9.40 | 6.15 | 5.10 | 4.80 | 3.90 | 3.80 | 3.90 | 4.05 |
| 25 | 4.40 | 5.20 | 5.40 | 4.50 | 8.30 | 6.35 | 4.95 | 4.50 | 3.90 | 3.90 | 4.05 | 4.15 |
| 26 | 4.40 | 5.20 | 5.25 | 4.43 | 9.10 | 6.40 | 4.90 | 4.20 | 3.80 | 7.05 | 4.10 | 3.95 |
| 27 | 4.50 | 5.10 | 5.25 | 4.45 | 9.65 | 6.30 | 4.85 | 3.50 | 3.90 | 6.80 | 4.05 | 3.90 |
| 28 | 4.50 | 4.95 | 5.20 | 5.63 | 7.25 | 7.35 | 5.05 | 4.50 | 3.80 | 5.65 | 4.05 | 3.85 |
| 29 | 4.80 | ........ | 5.05 | 5.70 | 6.45 | 6.45 | 6.90 | 4.45 | 3.80 | 4.95 | 4.05 | 3.70 |
| 30 | 4.85 | ........ | 5.05 | 5.20 | 6.00 | 6.45 | 12.00 | 4.35 | 3.80 | 4.70 | 4.05 | 3.70 |
| 31 | 4.90 | ........ | 5.00 | ........ | 6.10 | ........ | 8.25 | 4.40 | ........ | 4.40 | ........ | 4.05 |

## KANSAS RIVER AT LECOMPTON, KANSAS.

This river, formed by the junction of Republican and Smoky Hill rivers at Junction, Kansas, flows in a general easterly direction into Missouri River at Kansas City. The gaging station at Lecompton was established April 16, 1899, and is located at the new carriage bridge recently built across the river.

The following discharge measurements were made by E. C. Murphy and W. G. Russell during 1899:

*Measurements of Kansas River at Lecompton, Kansas.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Apr. 7 | 3.40 | 2,935 | June 5 | 9.90 | 21,762 |
| Apr. 15 | 3.35 | 2,747 | June 12 | 6.60 | 11,549 |
| Apr. 21 | 3.15 | 2,251 | June 16 | 3.52 | 4,326 |
| Apr. 29 | 5.90 | 8,744 | July 17 | 6.30 | 10,500 |
| May 11 | 6.35 | 10,859 | July 28 | 3.95 | 3,349 |
| May 25 | 11.20 | 34,213 | Oct. 10 | 2.00 | 1,889 |

*Daily gage height, in feet, of Kansas River at Lecompton, Kansas, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ........ | 3.40 | 4.50 | 5.45 | 5.55 | 2.60 | 2.00 | 2.90 | 2.10 |
| 2 | ........ | 3.35 | 4.15 | 6.25 | 4.45 | 2.60 | 2.00 | 2.80 | 2.10 |
| 3 | ........ | 3.20 | 4.00 | 6.20 | 4.15 | 2.60 | 2.00 | 2.70 | 2.10 |
| 4 | ........ | 3.20 | 7.10 | 6.00 | 3.95 | 2.60 | 2.00 | 2.60 | 2.10 |
| 5 | ........ | 3.20 | 9.50 | 5.90 | 3.85 | 2.50 | 2.00 | 2.50 | 2.10 |
| 6 | ........ | 3.20 | 8.90 | 5.75 | 4.85 | 2.50 | 2.00 | 2.50 | 2.05 |
| 7 | ........ | 3.40 | 7.90 | 9.05 | 4.50 | 2.40 | 2.00 | 2.40 | 2.00 |
| 8 | ........ | 3.40 | 7.25 | 11.00 | 4.40 | 2.40 | 2.00 | 2.40 | 2.00 |
| 9 | ........ | 3.40 | 9.25 | 8.85 | 4.30 | 2.30 | 2.00 | 2.40 | 2.00 |
| 10 | ........ | 3.55 | 10.00 | 8.50 | 3.90 | 2.30 | 2.00 | 2.30 | 2.00 |
| 11 | ........ | 5.80 | 9.00 | 7.80 | 3.50 | 2.30 | 2.00 | 2.30 | 2.15 |
| 12 | ........ | 6.15 | 7.80 | 6.70 | 3.50 | 2.30 | 2.00 | 2.30 | 2.25 |
| 13 | ........ | 5.25 | 7.30 | 6.20 | 3.50 | 2.30 | 1.90 | 2.30 | 2.45 |
| 14 | ........ | 4.45 | 6.90 | 5.90 | 4.00 | 2.30 | 1.90 | 2.30 | 2.65 |
| 15 | ........ | 3.95 | 6.65 | 6.40 | 5.40 | 2.20 | 1.90 | 2.30 | 2.90 |
| 16 | 3.50 | 3.65 | 6.55 | 6.60 | 5.50 | 2.20 | 1.90 | 2.30 | 3.00 |
| 17 | 3.40 | 3.50 | 6.10 | 6.25 | 5.10 | 2.20 | 1.90 | 2.30 | 3.00 |
| 18 | 3.30 | 3.35 | 5.30 | 5.85 | 4.75 | 2.20 | 1.90 | 2.20 | 2.90 |
| 19 | 3.20 | 3.30 | 5.00 | 5.30 | 4.40 | 2.20 | 1.90 | 2.20 | 2.90 |
| 20 | 4.70 | 3.35 | 4.95 | 4.80 | 4.15 | 2.20 | 1.90 | 2.20 | 2.80 |
| 21 | 3.40 | 8.00 | 4.85 | 4.45 | 3.80 | 2.20 | 1.90 | 2.20 | 2.70 |
| 22 | 3.40 | (*a*) | 4.65 | 4.25 | 3.55 | 2.10 | 1.90 | 2.20 | 2.65 |
| 23 | 3.40 | (*a*) | 4.50 | 4.05 | 3.45 | 2.10 | 1.90 | 2.20 | 2.60 |
| 24 | 3.40 | 7.50 | 4.50 | 3.85 | 3.25 | 2.10 | 1.90 | 2.20 | 2.60 |
| 25 | 3.30 | 6.15 | 4.80 | 3.70 | 3.05 | 2.10 | 1.90 | 2.20 | 2.60 |
| 26 | 3.20 | 5.65 | 4.90 | 3.60 | 2.90 | 2.10 | 1.90 | 2.20 | 2.50 |
| 27 | 3.20 | 5.10 | 5.05 | 3.60 | 2.90 | 2.00 | 2.05 | 2.20 | 2.50 |
| 28 | 3.20 | 5.90 | 5.35 | 3.50 | 2.90 | 2.00 | 2.45 | 2.10 | 2.45 |
| 29 | 3.20 | 6.45 | 5.55 | 3.45 | 2.80 | 2.00 | 2.75 | 2.10 | 2.40 |
| 30 | 3.20 | 5.10 | 5.70 | 5.15 | 2.80 | 2.00 | 3.00 | 2.10 | 2.40 |
| 31 | ........ | 4.75 | ........ | 5.30 | 2.70 | ........ | 3.00 | ........ | 2.40 |

*a* Water over gage.

## KANSAS RIVER AT LAWRENCE, KANSAS.

The station at this point, 11 miles below the Lecompton station, was established in July, 1895, and is located at the wagon bridge at Lawrence, Kansas. The gage was fastened to the south pier of the bridge, about 50 feet up the river from the crest of the dam. Owing to the impossibility of accurately rating this station, no measurements of discharge were made here during 1899, but gage readings were maintained until November 4, when the station was discontinued. The Lecompton station was established to take the place of this one. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 220; 1897, Nineteenth Annual Report, Part IV, page 350; 1898, Twentieth Annual Report, Part IV, page 322.

*Daily gage height, in feet, of Kansas River at Lawrence, Kansas, for 1899*

[Sign — indicates that water is below zero of gage.]

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.50 | —1.75 | .80 | 1.20 | 1.20 | 2.00 | 2.35 | 2.85 | 0.60 | 0.10 | 0.80 |
| 2 | .60 | — .50 | 1.10 | 1.20 | 1.00 | 1.90 | 2.70 | 1.95 | .60 | .15 | .75 |
| 3 | .60 | .00 | .90 | 1.20 | 1.00 | 2.10 | 2.95 | 1.65 | .60 | .20 | .75 |
| 4 | .80 | .10 | 1.05 | 1.20 | .85 | 2.70 | 2.80 | 1.55 | .60 | .20 | .65 |
| 5 | .90 | .00 | 2.00 | 1.25 | .85 | 5.60 | 2.65 | 1.40 | .60 | .20 | ....... |
| 6 | .70 | .40 | 1.80 | 1.35 | .90 | 5.50 | 2.55 | 1.50 | .55 | .20 | ....... |
| 7 | .65 | — .70 | .70 | 1.60 | 1.20 | 3.75 | 4.50 | 1.80 | .50 | .20 | ....... |
| 8 | .80 | — .60 | .90 | 1.60 | 1.10 | 3.50 | 6.55 | 1.90 | .50 | .20 | ....... |
| 9 | .60 | .00 | 1.05 | 1.80 | 1.00 | 4.60 | 4.80 | 1.50 | .50 | .10 | ....... |
| 10 | .50 | — .50 | 1.30 | 1.75 | 1.20 | 6.20 | 4.50 | 1.40 | .50 | .00 | ....... |
| 11 | .45 | — .80 | 1.30 | 1.60 | 2.90 | 6.30 | 3.55 | 1.30 | .50 | .00 | ....... |
| 12 | .50 | — .20 | 2.80 | 1.45 | 2.80 | 5.40 | 3.00 | 1.25 | .50 | .00 | ....... |
| 13 | .50 | — .60 | 2.90 | 1.40 | 2.60 | 4.10 | 2.55 | 1.10 | .50 | —.10 | ....... |
| 14 | .50 | —1.20 | 2.80 | 1.25 | 1.80 | 3.80 | 2.65 | 1.35 | .40 | —.20 | ....... |
| 15 | .50 | —1.20 | 2.60 | 1.10 | 1.45 | 3.50 | 2.75 | 1.90 | .40 | —.20 | ....... |
| 16 | .45 | —1.40 | 3.70 | 1.00 | 1.20 | 3.10 | 3.00 | 2.65 | .35 | —.30 | ....... |
| 17 | .40 | — .15 | 3.60 | 1.00 | 1.00 | 2.80 | 3.00 | 2.25 | .40 | —.20 | ....... |
| 18 | .40 | .00 | 3.50 | .90 | 1.00 | 2.15 | 2.70 | 2.05 | .40 | —.20 | ....... |
| 19 | .40 | .50 | 2.80 | .80 | 1.00 | 2.00 | 2.25 | 1.70 | .35 | —.20 | ....... |
| 20 | .55 | .50 | 2.10 | 2.70 | 1.00 | 2.00 | 1.95 | 1.50 | .30 | —.20 | ....... |
| 21 | .75 | .55 | 1.80 | 1.35 | 3.40 | 1.95 | 1.80 | 1.35 | .30 | —.20 | ....... |
| 22 | .80 | .35 | 1.80 | 1.00 | 5.65 | 1.85 | 1.60 | 1.15 | .30 | —.30 | ....... |
| 23 | .75 | .00 | 1 55 | 1.00 | 5.80 | 1.70 | 1.60 | 1.00 | .30 | —.30 | ....... |
| 24 | .75 | — .20 | 1.50 | 1.00 | 4.80 | 1.90 | 1.50 | 1.00 | .30 | —.30 | ....... |
| 25 | .70 | .00 | 1.40 | 1.00 | 3.10 | 2.00 | 1.40 | .85 | .30 | —.35 | ....... |
| 26 | .80 | .50 | 1.40 | 1.00 | 2.50 | 2.00 | 1.40 | .85 | .20 | —.35 | ....... |
| 27 | .65 | .70 | 1.40 | 1.00 | 2.10 | 2.10 | 1.25 | .80 | .10 | —.30 | ....... |
| 28 | .35 | .80 | 1.35 | 1.00 | 2.70 | 2.40 | 1.15 | .80 | .05 | —.35 | ....... |
| 29 | .60 | ....... | 1.20 | 1.00 | 3.10 | 2.40 | 1.10 | .80 | .00 | +.80 | ....... |
| 30 | .40 | ....... | 1.20 | 1.40 | 2.60 | 2.40 | 1.80 | .75 | .00 | .85 | ....... |
| 31 | .60 | ....... | 1.20 | ....... | 1.90 | ....... | 2.35 | .65 | ....... | .85 | ....... |

Station discontinued October 31.

## ARKANSAS RIVER.

The source of this river is in the vicinity of Tennessee Pass, in the central portion of Colorado. It flows southerly for about 70 miles, then easterly for 50 miles to Canyon, receiving a number of tributaries from the mountainous area on either side, which tends to increase the discharge of the river. At Canyon it suddenly emerges from the Rocky Mountain front and thence flows in an easterly direction, traversing the Great Plains of eastern Colorado, in which section most of the water is diverted for irrigation. After crossing the Kansas line it continues eastward for about 200 miles until the center of the State is reached, when it suddenly bends to the southward and passes into Indian Territory, and from thence into the State of Arkansas, finally entering the Mississippi River about 25 miles above Greenville, Mississippi. Throughout the mountainous area above Canyon the discharge increases, but as soon as the river emerges onto the Great Plains the water is gradually diverted by means of canals, so that by the time the Kansas line is reached the river is usually dry during the summer stages. In its mountainous course the river makes a descent from 10,000 feet at Leadville to 5,300 feet at Canyon, a distance of 120 miles.

During the last year two notable examples of engineering construction have been practically completed in this basin. The first one is the Twin Lakes reservoir, in which a dam 30 feet in height, of solid masonry, has been completed in a cut below the outlet of the lower lake of Twin Lakes, which is one source of supply of the Arkansas. This is designed to store water for a canal 130 miles below, which heads a few miles below Pueblo. The ditch has been cleaned out during the last season, and it is stated that $2,000,000 are being spent on a sugar-beet factory receiving water from it.

Twelve miles north of Lamar, Colorado, are a series of depressions in the plains, separated by ridges. Five of these have been connected by ditches, making the continuous reservoir system of The Great Plains Water Company. Their total available capacity is 194,562 acre-feet. It is the intention to fill them from the Arkansas River during the winter and high-water seasons by means of a supply ditch, which is now completed. This ditch is about 90 miles long and heads immediately above La Junta. Its capacity at the head is 2,000 second-feet. A number of gaging stations have been maintained in this drainage basin, and they are described in order down stream:

### LAKE CREEK AT TWIN LAKES, COLORADO.

This creek enters the Arkansas a short distance above Granite, Colorado. The station was established June 21, 1899, by Mr. O. O. McReynolds, chief engineer of the Colorado Land and Water Company, which has been at work on the reservoir of Twin Lakes during the last year. It was at first contemplated that measurements should be made showing the discharge into the upper lake, between the two lakes, and below the lower lake, but owing to difficulties encountered only a few measurements were made at the two upper points. On July 17 the discharge entering the upper lake, at a gage height of 2.80 feet, was found to be 273 second-feet; on October 12, at the same point, with a gage height of 1.9 feet, the discharge was 27 second-feet. Three measurements of discharge were made at a point between the two lakes: June 21, at a gage height of 3.60 feet, the discharge was found to be 1,007 second-feet; July 17, at a gage height of 1.90 feet, the discharge was 374 second-feet; October 12, gage height, 1.4 feet; discharge, 42 second-feet. A number of discharge measurements at the lower station were made, sufficient for the construction of a rating table covering the period from June 21 to July 20, but after that date the surface of the lakes was raised and lowered periodically through the operations of a placer company which had constructed a dam below the lower lake. The following measurements of discharge were made by A. L. Fellows and O. O. McReynolds during 1899:

June 21, gage height, 3.80 feet; discharge, 1,208 second-feet.
June 27, gage height, 3.20 feet; discharge, 696 second-feet.
July 17, gage height, 2.55 feet; discharge, 391 second-feet.
July 24, gage height, 2.50 feet; discharge, 344 second-feet.
August 14, gage height, 2.50 feet; discharge, 183 second-feet.
October 13, gage height ———; discharge, 22 second-feet.

*Daily gage height, in feet, of Lake Creek at Twin Lakes, Colorado. for 1899.*

| Day. | June. | July. | Aug. | Sept. | Day. | June. | July. | Aug. | Sept. | Day. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | 3.10 | 2.72 | 2.15 | 12 | ...... | 2.65 | 2.60 | ........ | 23 | 3.65 | 2.50 | 2.30 | ........ |
| 2 | ...... | 3.15 | 2.72 | 2.10 | 13 | ...... | 2.75 | 2.55 | ........ | 24 | 3.50 | 2.52 | 2.30 | ........ |
| 3 | ...... | 3.10 | 2.78 | 2.10 | 14 | ...... | 2.65 | 2.50 | ........ | 25 | 3.40 | 2.50 | 2.25 | ........ |
| 4 | ...... | 3.05 | 2.88 | 2.10 | 15 | ...... | 2.55 | 2.48 | ........ | 26 | 3.30 | 2.45 | 2.25 | ........ |
| 5 | ...... | 2.95 | 2.95 | 2.05 | 16 | ...... | 2.50 | 2.45 | ........ | 27 | 3.20 | 2.48 | 2.22 | ........ |
| 6 | ...... | 2.95 | 2.98 | 2.05 | 17 | ...... | 2.50 | 2.45 | ........ | 28 | 3.10 | 2.55 | 2.20 | ........ |
| 7 | ...... | 2.90 | 2.90 | 2.05 | 18 | ...... | 2.50 | 2.45 | ........ | 29 | 3.10 | 2.65 | 2.15 | ........ |
| 8 | ...... | 2.85 | 2.88 | 2.05 | 19 | ...... | 2.50 | 2.40 | ........ | 30 | 3.10 | 2.70 | 2.15 | ........ |
| 9 | ...... | 2.80 | 2.85 | 2.00 | 20 | ...... | 2.50 | 2.40 | ........ | 31 | ...... | 2.70 | 2.15 | ........ |
| 10 | ...... | 2.75 | 2.75 | 2.00 | 21 | 3.80 | 2.55 | 2.40 | ........ | | | | | |
| 11 | ...... | 2.70 | 2.65 | 2.00 | 22 | 3.70 | 2.55 | 2.35 | ........ | | | | | |

## ARKANSAS RIVER AT GRANITE, COLORADO.

This station is located at the wagon bridge, 250 feet from the railroad station at Granite, Colorado. The gage is a vertical 2 by 6 inch plank spiked to the upper end of the center pier of the bridge. The banks are low and liable to overflow; the bed is rocky, and the current swift. It will be impossible to construct a rating table for this station from the measurements obtained in 1899. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 354; 1898, Twentieth Annual Report, Part IV, page 330. The following discharge measurements were made by A. L. Fellows during 1899:

May 25, gage height, 5 feet; discharge, 1,476 second-feet.
July 15, gage height, 2.80 feet; discharge, 1,178 second-feet.
October 14, gage height, 1.60 feet; discharge, 130 second-feet.

*Daily gage height, in feet, of Arkansas River at Granite, Colorado, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|
| 1 | .......... | 3.15 | 3.90 | 5.80 | 3.90 | 2.40 | 2.00 |
| 2 | .......... | 3.25 | 3.80 | 5.75 | 3.90 | 2.40 | 2.00 |
| 3 | .......... | 3.25 | 3.80 | 5.25 | 3.90 | 2.40 | 2.00 |
| 4 | .......... | 2.25 | 3.80 | 4.80 | 3.80 | 2.60 | 2.00 |
| 5 | .......... | 3.20 | 3.80 | 4.50 | 3.50 | 2.60 | 2.00 |
| 6 | .......... | 3.20 | 3.80 | 4.60 | 3.50 | 2.60 | 2.00 |
| 7 | .......... | 3.20 | 3.90 | 4.85 | 3.45 | 2.60 | 2.00 |
| 8 | .......... | 3.15 | 3.95 | 5.00 | 3.40 | 2.60 | 2.00 |
| 9 | .......... | 3.25 | 4.05 | 5.00 | 3.40 | 2.60 | 2.00 |
| 10 | .......... | 3.35 | 4.20 | 5.00 | 3.40 | 2.40 | 2.00 |
| 11 | .......... | 3.45 | 4.35 | 5.40 | 3.35 | 2.40 | .......... |
| 12 | .......... | 3.45 | 4.60 | 6.70 | 3.30 | 2.40 | .......... |
| 13 | .......... | 3.50 | 4.95 | 6.95 | 3.00 | 2.40 | .......... |
| 14 | .......... | 3.50 | 5.40 | 6.90 | 3.00 | 2.40 | .......... |
| 15 | .......... | 3.50 | 5.80 | 6.40 | 2.80 | 2.40 | .......... |
| 16 | .......... | 3.50 | 5.80 | 6.00 | 2.80 | 2.00 | .......... |
| 17 | .......... | 3.50 | 5.80 | 5.85 | 2.80 | 2.00 | .......... |
| 18 | .......... | 3.50 | 5.90 | 5.75 | 2.80 | 2.00 | .......... |
| 19 | .......... | 3.50 | 5.90 | 5.85 | 2.80 | 2.00 | .......... |
| 20 | .......... | 3.50 | 5.75 | 5.85 | 2.80 | 2.00 | .......... |
| 21 | .......... | 3.50 | 5.65 | 5.70 | 2.80 | 2.00 | .......... |
| 22 | .......... | 3.55 | 5.00 | 5.65 | 2.80 | 2.00 | .......... |
| 23 | 3.30 | 3.65 | 4.80 | 5.00 | 2.80 | 2.00 | .......... |
| 24 | 3.15 | 3.65 | 4.95 | 4.85 | 2.80 | 2.00 | .......... |
| 25 | 3.20 | 3.75 | 5.00 | 4.60 | 2.80 | 2.00 | .......... |
| 26 | 3.25 | 3.95 | 5.35 | 4.40 | 2.80 | 2.00 | .......... |
| 27 | 3.25 | 4.00 | 5.65 | 4.00 | 2.60 | 2.00 | .......... |
| 28 | 3.25 | 4.00 | 5.75 | 3.90 | 2.60 | 2.00 | .......... |
| 29 | 3.20 | 3.90 | 5.60 | 3.90 | 2.60 | 2.00 | .......... |
| 30 | 3.10 | 3.90 | 5.90 | 3.90 | 2.60 | 2.00 | .......... |
| 31 | 3.15 | .......... | 6.00 | .......... | 2.60 | 2.00 | .......... |

## ARKANSAS RIVER AT SALIDA, COLORADO.

This station was established April 11, 1895, and is located at the suspension bridge at Salida, Colorado. The gage consists of a vertical timber bolted to the abutment of the bridge; the banks are high and do not overflow; the bed of the stream consists of sand and gravel. Large bowlders interfere to a considerable extent with the accuracy of the results. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 224; 1897, Nineteenth Annual Report, Part IV, page 355; 1898, Twentieth Annual Report, Part IV, page 331. The following discharge measurements were made by A. L. Fellows during 1899:

April 26, gage height, 1.72 feet; discharge, 686 second-feet.
May 25, gage height, 3.10 feet; discharge, 1,999 second-feet.
July 14, gage height, 2.40 feet; discharge, 1,801 second-feet.
November 8, gage height, 0.80 feet; disharge, 317 second-feet.

*Daily gage height, in feet, of Arkansas River at Salida, Colorado, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|
| 1 | | 0.80 | 1.30 | 3.25 | 3.20 | 1.60 | 0.80 |
| 2 | | .80 | 1.35 | 3.35 | 3.20 | 1.60 | .80 |
| 3 | | .80 | 1.25 | 3.10 | 3.20 | 1.70 | .80 |
| 4 | | .80 | 1.20 | 2.85 | 3.20 | 2.40 | .70 |
| 5 | | .85 | 1.25 | 2.65 | 3.10 | 2.10 | .70 |
| 6 | | .80 | 1.40 | 2.60 | 3.20 | 2.15 | .60 |
| 7 | | .80 | 1.50 | 2.85 | 3.05 | 1.85 | .60 |
| 8 | | .80 | 1.65 | 2.90 | 2.90 | 1.65 | .55 |
| 9 | | .85 | 1.95 | 3.05 | 2.50 | 1.45 | .50 |
| 10 | | .95 | 2.05 | 3.20 | 2.45 | 1.40 | .50 |
| 11 | | 1.00 | 2.10 | 3.50 | 2.40 | 1.35 | .50 |
| 12 | | 1.02 | 2.25 | 3.60 | 2.35 | 1.15 | .50 |
| 13 | | 1.10 | 2.45 | 3.70 | 2.65 | 1.20 | .75 |
| 14 | | 1.00 | 2.70 | 4.60 | 2.35 | 1.20 | .90 |
| 15 | | 1.05 | 2.85 | 4.30 | 2.45 | 1.20 | 1.00 |
| 16 | | 1.20 | 2.90 | 4.85 | 2.40 | 1.20 | 1.00 |
| 17 | | 1.20 | 2.90 | 5.00 | 2.80 | 1.10 | .80 |
| 18 | | 1.10 | 2.95 | 4.85 | 2.50 | 1.10 | .70 |
| 19 | | 1.15 | 3.00 | 4.95 | 2.40 | 1.05 | .65 |
| 20 | | .95 | 3.00 | 5.10 | 2.30 | 1.00 | .55 |
| 21 | | .90 | 2.80 | 5.00 | 2.00 | 1.00 | .50 |
| 22 | 0.80 | .95 | 2.60 | 4.50 | 1.85 | .90 | .50 |
| 23 | .80 | 1.10 | 2.45 | 4.20 | 1.80 | .80 | .50 |
| 24 | .80 | 1.20 | 2.50 | 4.20 | 1.85 | .80 | .50 |
| 25 | .80 | 1.30 | 2.75 | 4.10 | 1.65 | .80 | .50 |
| 26 | .90 | 1.55 | 2.95 | 3.85 | 1.60 | .70 | .50 |
| 27 | .70 | 1.60 | 3.10 | 3.50 | 1.65 | .70 | .40 |
| 28 | .70 | 1.65 | 3.10 | 3.20 | 1.55 | .70 | .40 |
| 29 | .70 | 1.50 | 3.10 | 3.20 | 1.40 | .70 | .40 |
| 30 | .70 | 1.40 | 3.20 | 3.20 | 1.50 | .70 | .40 |
| 31 | .70 | | 3.25 | | 1.60 | .90 | |

Closed for the winter September 30.

## ARKANSAS RIVER AT CANYON, COLORADO.

This station, established in 1889, is located at the Hot Springs Hotel, 1½ miles west of Canyon and about 500 yards below the mouth of Grape Creek. The gage rod is placed on the left bank of the river, just below the suspension foot bridge, and consists of an inclined 4 by 4 inch timber bolted to posts set in the ground. The station is an important one, as it is located at the mouth of the canyon and above most of the canal diversions. The only two ditches taking water above the gaging station are the North and South Side ditches, which were each measured three times during 1899, as follows: On April 27, August 18, and November 7. North Side ditch, on the first date, was carrying 55 second-feet, and the South Side ditch 48 second-feet; on the second date North Side ditch was discharging 35 second-feet and the South Side ditch 43 second-feet; at the third measurement of discharge the North Side ditch showed 28 second-feet and the South Side 36 second-feet. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 226; 1897, Nineteenth Annual Report, Part IV, page 356; 1898, Twentieth Annual Report, Part IV, page 331. The discharge measurements were made by A. L. Fellows for 1899, as follows:

April 27, gage height, 3.20 feet; discharge, 611 second-feet.
May 26, gage height, 4.55 feet; discharge, 2,189 second-feet.
July 7, gage height, 4.50 feet; discharge, 2,651 second-feet.
August 18, gage height, 2.90 feet; discharge, 553 second-feet.
November 7, gage height, 2.55 feet; discharge, 306 second-feet.

*Daily gage height, in feet, of Arkansas River at Canyon, Colorado, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | 2.80 | 3.25 | 5.00 | 5.00 | 3.60 | 2.60 | | | |
| 2 | | | | 2.80 | 3.10 | 5.05 | 5.30 | 3.50 | 2.50 | | | *a*2.70 |
| 3 | | | | 2.80 | 3.05 | 5.00 | 5.00 | 3.50 | 2.50 | | | |
| 4 | | 2.60 | 3.40 | 2.80 | 2.90 | 4.75 | 4.85 | 4.10 | 2.50 | *a*2.20 | *a*2.60 | |
| 5 | | | | 2.80 | 2.90 | 4.50 | 4.75 | 4.45 | 2.40 | | | |
| 6 | 2.60 | | | 2.80 | 2.90 | 4.45 | 4.60 | 3.65 | 2.40 | | | |
| 7 | | | | 2.70 | 3.00 | 4.65 | 4.55 | 3.50 | 2.30 | | | |
| 8 | | | | 2.70 | 3.15 | 4.70 | 4.40 | 3.50 | 2.30 | | | |
| 9 | | | | 2.70 | 3.35 | 4.75 | 4.30 | 3.40 | 2.30 | | | *a*2.70 |
| 10 | | | | 2.75 | 3.55 | 4.85 | 4.20 | 3.30 | 2.30 | | | |
| 11 | | 2.50 | 3.00 | 2.80 | 3.65 | 5.05 | 4.10 | 3.10 | 2.20 | *a*2.40 | *a*2.80 | |
| 12 | | | | 3.00 | 3.90 | 5.45 | 4.05 | 3.00 | 2.20 | | | |
| 13 | | | | 3.00 | 4.25 | 5.85 | 4.45 | 3.00 | 2.20 | | | |
| 14 | 2.60 | | | 3.05 | 4.50 | 6.00 | 4.25 | 3.00 | 2.20 | | | |
| 15 | | | | 3.00 | 4.70 | 5.95 | 4.25 | 2.90 | 2.30 | | | |
| 16 | | | | 3.05 | 4.80 | 5.95 | 4.40 | 2.80 | 2.30 | | | *a*2.50 |
| 17 | | | | 3.00 | 4.85 | 5.95 | 4.10 | 2.95 | 2.60 | | | |
| 18 | | 2.10 | 2.70 | 3.00 | 4.65 | 6.05 | 4.05 | 2.90 | 2.50 | | *a*2.90 | |
| 19 | | | | 2.95 | 4.75 | 6.10 | 4.50 | 2.85 | 2.40 | | | |
| 20 | | | | 3.00 | 4.80 | 6.10 | 4.10 | 2.80 | 2.40 | *a*2.40 | | |
| 21 | 2.60 | | | 2.75 | 4.65 | 6.05 | 3.90 | 2.70 | 2.30 | | | |
| 22 | | | | 2.70 | 4.40 | 5.95 | 3.80 | 2.70 | 2.30 | | | |
| 23 | | | | 2.75 | 4.20 | 5.75 | 3.70 | 2.60 | 2.30 | | | *a*2.50 |
| 24 | | | | 2.90 | 4.15 | 5.60 | 3.70 | 2.60 | 2.30 | | | |
| 25 | | 3.00 | 2.70 | 3.05 | 4.50 | 5.50 | 3.60 | 2.50 | 2.30 | | *a*3.00 | |
| 26 | | | | 3.20 | 4.60 | 5.30 | 3.50 | 2.50 | 2.30 | | | |
| 27 | | | | 3.30 | 4.80 | 5.25 | 3.50 | 2.50 | 2.20 | | | |
| 28 | 2.60 | | | 3.35 | 4.80 | 5.00 | 3.60 | 2.50 | 2.20 | *a*2.50 | | |
| 29 | | | | 3.40 | 4.80 | 5.05 | 3.55 | 2.50 | 2.20 | | | |
| 30 | | | | 3.25 | 4.90 | 4.95 | 3.65 | 2.40 | 2.20 | | | *a*2.80 |
| 31 | | | | | 5.00 | | 3.60 | 2.50 | | | | |

*a* Average for week.

## ARKANSAS RIVER AT PUEBLO, COLORADO.

This station was established in September, 1894, and is at present located at Main street bridge in the city of Pueblo. The gage is a 2 by 6 inch plank bolted to the masonry wall at the south end of the bridge. The bench mark consists of a point on the stone coping at the south end of the bridge, and is 17.30 feet above gage datum.

Gage readings are furnished by the city engineer of Pueblo. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 230; 1897, Nineteenth Annual Report, Part IV, page 357; 1898, Twentieth Annual Report, Part IV, page 336. The following discharge measurements for 1899 were made under the direction of A. L. Fellows:

*Measurements of Arkansas River at Pueblo, Colorado.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec.-feet.* | 1899. | *Feet.* | *Sec.-feet.* |
| Apr. 27 | 0.8 | 695 | Aug. 5 | 1.46 | 1,938 |
| May 26 | 2.2 | 2,221 | Aug. 14 | 1.20 | 1,496 |
| June 3 | 2.55 | 2,856 | Sept. 10 | —0.5 | 180 |
| June 17 | 3.60 | 4,565 | Sept. 18 | —0.10 | 388 |
| July 1 | 2.22 | 2,959 | Oct. 6 | —0.20 | 331 |
| July 8 | 1.61 | 2,098 | Nov. 7 | 0.05 | 411 |
| Aug. 1 | 0.72 | 1,199 | | | |

*Daily gage height, in feet, of Arkansas River at Pueblo, Colorado, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.40 | 0.36 | 0.59 | 0.49 | 0.75 | 2.50 | 2.10 | *c*1.00 | —0.23 | (*b*) | 0.05 | —0.10 |
| 2 | .35 | .52 | .75 | .45 | .80 | 2.50 | 2.10 | .80 | — .22 | —0.35 | .02 | — .12 |
| 3 | .30 | .57 | .59 | .50 | .80 | 2.50 | 2.40 | .90 | (*b*) | — .30 | .07 | (*b*) |
| 4 | .55 | .62 | .68 | .44 | .60 | 2.20 | 2.10 | 1.15 | — .20 | — .31 | .04 | — .10 |
| 5 | .55 | .60 | .60 | .40 | .55 | 1.90 | 1.90 | 1.55 | — .25 | — .26 | (*b*) | — .30 |
| 6 | .58 | .62 | .51 | .47 | .50 | 1.70 | 1.80 | (*b*) | — .35 | — .20 | .00 | — .25 |
| 7 | .43 | .60 | .62 | .47 | .55 | 2.00 | 2.20 | 1.10 | — .38 | — .30 | .05 | — .30 |
| 8 | .43 | .62 | .63 | .47 | .65 | 2.10 | 1.60 | .97 | — .40 | (*b*) | .00 | — .18 |
| 9 | .45 | .60 | .59 | .34 | .65 | 2.20 | 1.50 | .85 | — .32 | — .28 | — .02 | — .20 |
| 10 | .47 | .58 | .61 | .30 | .75 | 2.30 | 1.40 | .60 | (*b*) | — .32 | .01 | (*b*) |
| 11 | .39 | .75 | .47 | .29 | .85 | 2.40 | 1.20 | .30 | — .50 | — .30 | — .01 | — .15 |
| 12 | .37 | .72 | .45 | .29 | 1.30 | 2.80 | 1.80 | .35 | — .48 | — .33 | (*b*) | — .28 |
| 13 | .45 | .70 | .40 | .40 | 1.70 | 3.30 | 2.00 | (*b*) | — .60 | — .25 | .00 | — .05 |
| 14 | .48 | .70 | .27 | .40 | 2.00 | 3.30 | 1.90 | *d*1.90 | — .55 | — .20 | — .02 | .00 |
| 15 | .49 | 1.05 | .20 | .45 | 2.15 | 3.60 | 1.90 | .40 | — .50 | (*b*) | — .01 | — .08 |
| 16 | .49 | 1.05 | .18 | .50 | 2.25 | 3.70 | 1.65 | .27 | — .38 | — .15 | — .05 | — .25 |
| 17 | .50 | 1.19 | .69 | .50 | 2.25 | 3.60 | 1.50 | .25 | (*b*) | — .30 | — .12 | (*b*) |
| 18 | .50 | .95 | .40 | .50 | 2.35 | 3.50 | 1.80 | .10 | — .05 | — .25 | — .15 | — .05 |
| 19 | .50 | .85 | .40 | .45 | 2.25 | 3.60 | 2.00 | .07 | — .20 | — .28 | (*b*) | — .12 |
| 20 | .50 | .72 | .22 | .40 | 2.45 | 3.80 | 1.50 | (*b*) | — .18 | — .25 | — .13 | (*e*) |
| 21 | .47 | .70 | .30 | .50 | 2.25 | 3.70 | *a*1.30 | — .05 | — .15 | — .20 | — .15 | — .28 |
| 22 | .50 | .70 | .25 | .20 | 2.05 | 3.70 | 1.10 | — .20 | — .25 | (*b*) | — .16 | (*e*) |
| 23 | .55 | .70 | .20 | .20 | 1.75 | 3.30 | 1.10 | — .10 | — .30 | — .05 | — .18 | (*e*) |
| 24 | .52 | .45 | .35 | .20 | 1.65 | 2.90 | 1.10 | — .15 | (*b*) | — .11 | — .10 | (*b*) |
| 25 | .45 | .67 | .35 | .40 | 2.05 | 2.80 | .90 | — .30 | — .35 | — .15 | — .08 | (*b*) |
| 26 | .40 | .65 | .45 | .45 | 2.28 | 2.60 | .80 | — .35 | — .39 | — .03 | (*b*) | .05 |
| 27 | .30 | .50 | .45 | .70 | 2.50 | 2.60 | 1.10 | (*b*) | — .40 | — .00 | — .20 | — .05 |
| 28 | .37 | .59 | .31 | .78 | 2.55 | 2.20 | 1.00 | — .33 | — .42 | .02 | — .22 | — .08 |
| 29 | .37 | ....... | .36 | .90 | 2.45 | 2.20 | .80 | — .35 | — .45 | (*b*) | — .20 | — .10 |
| 30 | .37 | ....... | .33 | .80 | 2.50 | 2.30 | 1.10 | — .45 | — .45 | .06 | (*b*) | — .05 |
| 31 | .35 | ....... | .40 | ....... | 2.50 | ....... | .90 | — .40 | ....... | .03 | ....... | (*b*) |

*a* New rating table from June 21.
*b* No record.
*c* Gage heights after July 31 are from city engineer's records.
*d* August 19, storm in Pueblo; water rose to 7 feet in night.
*e* Ice gorge; discard readings.

ARKANSAS RIVER AT NEPESTA, COLORADO.

This station, established September 8, 1897, is located 1,000 feet north of Nepesta, Colorado, at a wagon bridge. The gage consists of a vertical timber securely fastened to the upstream cylinder of bridge, on the left side of the river. The channel above and below the station is straight for several hundred feet, while the bed is sandy and shifting, and the results, therefore, are not altogether satisfactory for the purpose of making a rating table. This station is maintained by The Great Plains Water Company. The results of discharge measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 358; 1898, Twentieth Annual Report, Part IV, page 337. The following discharge measurements were made under the direction of A. L. Fellows in 1899:

May 29, gage height, 4.60 feet; discharge, 1,810 second-feet.
June 7, gage height, 4.63 feet; discharge, 1,636 second-feet.
August 3, gage height, 4 feet; discharge, 610 second-feet.
August 25, gage height, 3.10 feet; discharge, 215 second-feet.
October 2, gage height, 3.12 feet; discharge, 213 second-feet.

*Daily gage height, in feet, of Arkansas River at Nepesta, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 3.50 | 4.80 | 5.50 | 4.10 | 3.40 | 3.00 | 5.20 | 3.10 |
| 2 | | 3.60 | 4.70 | 5.30 | 4.00 | 3.10 | 3.00 | 3.70 | 3.10 |
| 3 | | 3.50 | 4.80 | 5.70 | 4.20 | 3.10 | 3.00 | 3.70 | (*b*) |
| 4 | | 3.50 | 4.50 | 5.50 | 4.90 | 3.10 | 3.10 | 3.50 | |
| 5 | | 3.40 | 4.30 | 5.20 | 5.80 | 3.00 | 3.20 | 3.20 | |
| 6 | | 3.30 | 4.30 | 5.10 | 5.50 | 3.00 | 3.20 | 3.30 | |
| 7 | | 3.40 | 4.70 | 5.00 | 5.10 | 3.00 | 3.20 | 3.50 | |
| 8 | | 3.50 | 4.70 | 5.20 | 4.20 | 3.00 | 3.20 | 3.50 | |
| 9 | | 3 50 | 4.70 | 4.90 | 4.20 | 3.00 | 3.10 | 3.50 | |
| 10 | | 3.70 | 4.80 | 4.90 | 3.90 | 2.80 | 3.10 | 3.40 | |
| 11 | | 3.70 | 5.00 | 4.50 | 3.60 | 3.00 | 2.90 | 3.50 | |
| 12 | | 3.90 | 5.30 | 4.70 | 3.40 | 2.90 | 3.00 | 3.60 | |
| 13 | | 4.50 | 5.20 | 4.20 | 3.20 | 2.80 | 3.10 | 3.50 | |
| 14 | | 4.60 | 5.10 | 5.10 | *a*7.50 | 2.80 | 3.30 | 3.50 | |
| 15 | | 4.60 | 5.30 | 5.80 | 4.40 | 3.00 | 3.10 | 3.30 | |
| 16 | | 4.60 | 5.50 | 6.00 | 3.50 | 3.40 | 3.00 | 3.30 | |
| 17 | | 4.50 | 5.50 | 5.90 | 3.40 | 3.10 | 3.10 | 3.20 | |
| 18 | | 4.60 | 5.40 | 5.50 | 3.10 | 3.30 | 3.20 | 3.30 | |
| 19 | | 4.40 | 5.50 | 5.40 | 2.90 | 3.20 | 3.10 | 3.20 | |
| 20 | | 4.50 | 5.60 | 5.20 | 3.40 | 3.10 | 3.10 | 3.20 | |
| 21 | 3.50 | 4.50 | 5.80 | 4.90 | 3.20 | 3.10 | 3.20 | 3.10 | |
| 22 | 3.40 | 4.50 | 5.70 | 4.70 | 3.30 | 3.10 | 3.20 | 3.10 | |
| 23 | 3.00 | 4.50 | 5.70 | 5.00 | 2.90 | 3.00 | 3.30 | 3.20 | |
| 24 | 3.20 | 4.40 | 5.50 | 5.80 | 3.00 | 3.00 | 3.30 | 3.20 | |
| 25 | 3.20 | 4.50 | 5.30 | 4.00 | 3.10 | 3.10 | 3.30 | 3.30 | |
| 26 | 3.30 | 4.70 | 5.20 | 4.00 | 3.00 | 3.00 | 3.40 | 3.10 | |
| 27 | 3.50 | 4.80 | 5.10 | 4.00 | 3.20 | 3.00 | 3.40 | 3.10 | |
| 28 | 3.50 | 4.80 | 5.10 | 5.00 | 3.20 | 2.90 | 3.50 | 3.00 | |
| 29 | 3.40 | 4.60 | 5.00 | 7.00 | 3.10 | 2.80 | 3.40 | 3.00 | |
| 30 | 3.40 | 4.60 | 5.10 | 4.90 | 3.00 | 2.90 | 3.40 | 3.00 | |
| 31 | | 4.90 | | 4.90 | 3.00 | | 3.50 | | |

*a* Flood at Pueblo. *b* Records discontinued December 2.

## ARKANSAS RIVER AT ROCKYFORD, COLORADO.

This station is located 2 miles northeast of Rockyford, Colorado, and was established May 3, 1897. The gage consists of a vertical timber fastened to the abutment of the wagon bridge on the left side of the stream. Both banks are low, but not liable to overflow, excepting at very high water. The bed is sandy and shifting. S. W. Cressy, commissioner of Colorado irrigation district No. 17, is the voluntary observer. On October 16 Rockyford ditch near by was measured at the rating flume, at a gage height of 1.13 feet, and gave a discharge of 41 second-feet. The results of measurements may be found as follows: 1898, Twentieth Annual Report, Part IV, page 338. The measurements for 1899, made by A. L. Fellows, are as follows:

May 30, gage height, 1.88 feet; discharge, 1,042 second-feet.
October 16, gage height, 0.88 foot; discharge, 136 second-feet.

*Daily gage height, in feet, of Arkansas River at Rockyford, Colorado, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 1.34 | 1.10 | 2.12 | 2.10 | 1.82 | 0.81 | 0.68 | 1.70 | 0.80 |
| 2 | | 1.30 | 1.15 | 2.10 | 2.20 | 1.45 | .97 | .52 | 1.90 | .80 |
| 3 | | 1.32 | 1.30 | 2.08 | 2.35 | 1.19 | .95 | .50 | 1.25 | .80 |
| 4 | | 1.31 | 1.05 | 2.01 | 3.10 | 1.45 | .74 | .65 | 1.18 | .80 |
| 5 | | 1.25 | .90 | 1.89 | 2.28 | 4.40 | .83 | .72 | 1.18 | .88 |
| 6 | | 1.12 | .90 | 1.62 | 2.10 | 2.85 | .90 | .74 | 1.00 | 1.00 |
| 7 | | 1.02 | .89 | 1.91 | 2.00 | 2.85 | .90 | .72 | 1.03 | 1.00 |
| 8 | | 1.02 | .90 | 2.10 | 2.58 | 2.20 | .88 | .79 | 1.04 | .95 |
| 9 | | 1.10 | .89 | 2.40 | 2.05 | 1.78 | .76 | .79 | 1.05 | *a*1.00 |
| 10 | | 1.05 | .92 | 2.05 | 1.85 | 1.59 | .70 | .75 | 1.08 | |
| 11 | | 1.00 | 1.28 | 1.98 | 1.78 | 1.34 | .72 | .74 | 1.05 | |
| 12 | | .99 | 1.35 | 2.15 | 1.65 | 1.20 | .74 | .65 | 1.09 | |
| 13 | 1.35 | .95 | 1.43 | 2.20 | 1.48 | 1.11 | .76 | .68 | 1.12 | |
| 14 | 1.30 | .95 | 1.63 | 2.20 | 3.40 | 2.25 | .78 | .80 | 1.14 | |
| 15 | 1.28 | .95 | 1.81 | 2.50 | 3.30 | 2.25 | .82 | .89 | 1.16 | |
| 16 | 1.25 | | 1.79 | 2.60 | 3.20 | 1.48 | .87 | .88 | 1.03 | |
| 17 | 1.10 | 1.20 | 1.80 | 2.70 | 3.85 | 1.27 | 1.02 | .85 | 1.00 | |
| 18 | 1.05 | 1.20 | 1.80 | 2.75 | 2.40 | 1.18 | 1.01 | .86 | .85 | |
| 19 | 1.00 | 1.22 | 1.91 | 2.65 | 3.00 | 1.10 | 1.12 | .92 | .75 | |
| 20 | 1.00 | 1.16 | 1.75 | 2.80 | 2.80 | 1.07 | 1.25 | .94 | | |
| 21 | .97 | 1.10 | 1.85 | 2.85 | 2.40 | 1.19 | 1.00 | .95 | 1.20 | |
| 22 | .93 | 1.16 | 2.05 | 2.85 | 2.15 | 1.17 | 1.00 | | 1.00 | |
| 23 | .90 | 1.17 | 1.95 | 2.98 | 1.95 | 1.08 | .98 | | .98 | |
| 24 | 1.10 | 1.02 | 1.90 | 2.72 | 1.88 | .95 | 1.00 | 1.00 | 1.00 | |
| 25 | 1.15 | .90 | 1.80 | 2.68 | 2.01 | .80 | .94 | 1.00 | .95 | |
| 26 | .90 | .90 | 1.95 | 2.50 | 1.48 | .75 | .90 | 1.01 | .92 | |
| 27 | .90 | .95 | 2.02 | 2.30 | 1.25 | .88 | .80 | 1.02 | .91 | |
| 28 | 1.27 | .97 | 2.05 | 2.20 | 1.12 | .88 | .82 | 1.06 | .91 | |
| 29 | 1.25 | .95 | 2.08 | 2.05 | 3.20 | .90 | .84 | 1.09 | .94 | |
| 30 | 1.20 | 1.10 | 1.90 | 1.92 | 2.45 | .90 | .72 | 1.13 | .82 | |
| 31 | 1.38 | | 1.85 | | 2.92 | .80 | | 1.10 | | |

*a* Readings discontinued December 9.

## ARKANSAS RIVER AT LA JUNTA, COLORADO.

This station is situated at the head of the Fort Lyons canal, measurements being taken of the water in the rating flume of the canal, of that in its wasteway, and of that passing over the dam at the head of the canal. The station is maintained by The Great Plains Water Company. On May 30, at gage height of 3.90 feet, the discharge of the canal was 772 second-feet, and 22 second-feet was in the wasteway. October 17 the canal was carrying, at a gage height of 1.89 feet, a discharge of 159 second-feet, with 44 second-feet in the wasteway. Continuous records of gage heights were not kept throughout the year. Three measurements of discharge were made by A. L. Fellows of the amount of water passing over the dam, for the purpose of securing a rating table for the form of weir of which the Fort Lyons dam is typical. The first, on May 30, at a gage height of 0.05 foot, gave a discharge of 246 second-feet. The second, on June 13, with a gage height of 0.47 foot, showed a discharge of 857 second-feet, and the last measurement, on June 20, with a gage height of 0.67 foot, gave a discharge of 1,181 second-feet.

## PURGATORY RIVER AT TRINIDAD, COLORADO.

This stream is one of the principal tributaries entering the Arkansas River from the south; it rises in northern New Mexico and flows in a general northeasterly direction across the plains, entering the main stream a short distance below Las Animas. The rod is attached to the downstream side of the cylindrical pier of the Las Animas street bridge in the city of Trinidad, and has been maintained for a number of years. Owing, however, to the unsatisfactory condition of the river at this locality, the station was discontinued July 31, 1899. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 232; 1897, Nineteenth Annual Report, Part IV, page 359; 1898, Twentieth Annual Report, Part IV, page 341. Two measurements of discharge were made in 1899 by A. L. Fellows. The first one, on April 28, at a gage height of 3.60 feet, gave a discharge of 52 second-feet; one on July 12, at a gage height of 3.30 feet, showed a discharge of 4 second-feet.

*Daily gage height, in feet, of Purgatory River at Trinidad, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Day. | Apr. | May. | June. | July. | Day. | Apr. | May. | June. | July. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.. | 3.50 | 3.95 | 3.70 | 3.40 | 12... | 3.50 | 3.80 | 3.60 | 3.85 | 23... | 3.75 | 3.75 | 3.60 | 4.15 |
| 2.. | 3.50 | 3.85 | 3.70 | 3.75 | 13... | 3.50 | 3.80 | 3.55 | 4.65 | 24... | 3.80 | 3.60 | 3.70 | 3.65 |
| 3.. | 3.50 | 3.75 | 3.70 | 3.95 | 14... | 3.55 | 3.80 | 3.50 | 4.80 | 25... | 3.80 | 3.60 | 3.55 | 3.60 |
| 4.. | 3.50 | 3.70 | 3.70 | 3.75 | 15... | 3.60 | 3.85 | 3.55 | 4.70 | 26... | 3.85 | 3.60 | 3.40 | 3.50 |
| 5.. | 3.50 | 3.80 | 3.70 | 3.60 | 16... | 3.70 | 4.00 | 4.20 | 4.15 | 27... | 3.90 | 3.60 | 3.40 | 3.50 |
| 6.. | 3.50 | 3.70 | 3.55 | 3.50 | 17... | 3.70 | 4.00 | 4.00 | 3.95 | 28... | 3.90 | 3.60 | 3.30 | 4.75 |
| 7.. | 3.50 | 3.70 | 3.50 | 3.55 | 18... | 3.80 | 3.90 | 3.90 | 4.25 | 29... | 3.90 | 3.60 | 3.30 | 4.90 |
| 8.. | 3.50 | 3.65 | 3.50 | 3.70 | 19... | 3.85 | 3.85 | 3.75 | 4.05 | 30... | 3.95 | 3.60 | 3.30 | 4.20 |
| 9.. | 3.50 | 3.80 | 3.55 | 3.60 | 20... | 3.90 | 3.90 | 3.60 | 3.85 | 31... | ...... | 3.70 | ...... | 3.85 |
| 10.. | 3.50 | 3.80 | 3.60 | 3.50 | 21... | 3.95 | 3.90 | 3.60 | 3.70 | | | | | |
| 11.. | 3.50 | 3.80 | 3.50 | 3.40 | 22... | 3.75 | 3.95 | 3.55 | 3.60 | | | | | |

## ARKANSAS RIVER AT AMITY CANAL HEAD GATES, COLORADO.

This station is located at the head of Amity canal, 7 miles west of Lamar, Colorado, and is maintained by the Amity Canal Company. The observations here are not as satisfactory as they might be for determining the total flow of the river. The following measurements were made by A. L. Fellows on the canal and wasteway: May 31, the canal, at a gage height of 2.63 feet, was discharging 249 second-feet, while there were 129 second-feet in the wasteway; on June 18 the amount of water in the wasteway, at a gage height of 2.15 feet, was 114 second-feet. No measurements of the main river were made during 1899.

The Arkansas River at the head of the Colorado and Kansas canal, 12 miles west of Lamar, was measured September 8, 1899, and at a gage height of 0.20 feet on the dam was discharging 16 second-feet.

*Daily gage height, in feet, of Arkansas River at Amity canal head gates, Colorado, for 1899.*

| Day. | Jan | Feb. | Mar. | Apr. | May. | Day. | Jan. | Feb. | Mar. | Apr. | May. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.50 | 1.40 | 5.60 | 2.10 | 0.40 | 17 | 1.80 | 2.00 | 4.50 | 1.50 | 2.10 |
| 2 | 1.50 | 1.40 | 5.80 | 1.90 | .30 | 18 | 1.80 | 2.00 | 2.50 | 1.50 | 2.10 |
| 3 | 1.80 | 1.40 | 5.60 | 1.90 | .10 | 19 | 1.80 | 2.40 | 2.50 | 1.50 | 2.70 |
| 4 | 1.80 | 1.40 | 5.80 | 1.80 | .10 | 20 | 2.00 | 2.40 | 2.30 | 1.70 | 2.20 |
| 5 | 2.00 | 1.40 | 5.80 | 1.80 | .10 | 21 | 2.20 | 2.60 | 2.20 | 1.60 | 2.60 |
| 6 | 2.00 | 1.40 | 5.00 | 1.70 | 1.30 | 22 | 2.80 | 2.80 | 2.10 | 1.60 | 2.00 |
| 7 | 2.00 | 1.40 | 4.80 | 1.90 | .60 | 23 | 2.60 | 2.80 | 2.00 | 1.20 | 1.80 |
| 8 | 2.00 | 1.40 | 4.80 | 1.80 | .30 | 24 | 2.40 | 2.80 | 2.00 | 1.10 | 3.30 |
| 9 | 2.00 | 1.40 | 4.80 | 1.90 | .40 | 25 | 2.40 | 2.60 | 1.90 | 1.10 | 3.10 |
| 10 | 2.00 | 1.40 | 4.80 | 2.00 | .20 | 26 | 2.40 | 2.60 | 2.00 | .90 | 3.30 |
| 11 | 2.00 | 1.40 | 4.80 | 2.20 | .20 | 27 | 2.40 | 2.60 | 1.80 | .80 | 3.10 |
| 12 | 1.80 | 1.60 | 4.80 | 2.20 | .20 | 28 | 2.70 | 2.60 | 2.50 | .50 | 3.90 |
| 13 | 1.80 | 1.60 | 4.00 | 2.20 | .20 | 29 | 2.60 | ....... | 2.10 | .30 | 4.00 |
| 14 | 1.80 | 1.80 | 4.00 | 2.10 | .60 | 30 | 2.20 | ....... | 2.40 | .30 | 3.90 |
| 15 | 1.80 | 1.80 | 4.60 | 1.80 | 1.20 | 31 | 1.90 | ....... | 2.00 | ....... | 3.30 |
| 16 | 1.80 | 2.00 | 4.60 | 1.60 | 1.80 | | | | | | |

## ARKANSAS RIVER AT GRANADA, COLORADO.

This station was established July 24, 1898, and is located at the head gates of the Buffalo Creek canal, 2 miles northeast of Granada. There is an earth dam across the river at this point, with a footbridge over it, from which measurements were to have been attempted, but, owing to an occasional breaking of the dam during high stages of the river, none have been made since the station was established. The gage is vertical, well painted, and nailed to the head gates of the canal.

*Daily gage height, in feet, of Arkansas River at Granada, Colorado, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.40 | 1.40 | 2.40 | 0.30 | 0.40 | 0.60 | 0.60 | 2.20 | 0.60 | 0.80 | 1.00 | 0.80 |
| 2 | .40 | 1.40 | 2.40 | .30 | .60 | .40 | .60 | 1.80 | .60 | .80 | 1.20 | .80 |
| 3 | .50 | 1.40 | 2.40 | .30 | .80 | .40 | .80 | 1.00 | .60 | .80 | 3.00 | .80 |
| 4 | .40 | 1.60 | 2.40 | .30 | 1.00 | .80 | .80 | .80 | .60 | .80 | 2.00 | .80 |
| 5 | .40 | 1.60 | 2.40 | .30 | 1.00 | .60 | 3.00 | 1.40 | .60 | .80 | 1.00 | 1.00 |
| 6 | .40 | 1.60 | 2.00 | .30 | 1.00 | .80 | 2.60 | 5.40 | .60 | .80 | 1.00 | 1.00 |
| 7 | .40 | 1.60 | 1.60 | .30 | .80 | .80 | 1.00 | 3.60 | .60 | .80 | 1.00 | 1.20 |
| 8 | 1.00 | 1.60 | 1.60 | .30 | .60 | .80 | .80 | 2.50 | 70 | .80 | .80 | 1.20 |
| 9 | 1.00 | 1.60 | 1.40 | .30 | .60 | 1.00 | .80 | 1.90 | 1.00 | .80 | .80 | 1.40 |
| 10 | 1.00 | 1.60 | 1.40 | .30 | .60 | 1.00 | 2.00 | 1.60 | 1.00 | .80 | .80 | 1.50 |
| 11 | 1.00 | 1.60 | 1.40 | .30 | .80 | 1.00 | 1.60 | 1.00 | 1.00 | .80 | .80 | 1.50 |
| 12 | 1.00 | 1.60 | 1.40 | .30 | .80 | 1.20 | 1.00 | .60 | .80 | .80 | .80 | 1.50 |
| 13 | 1.40 | 1.60 | 1.40 | .20 | .50 | .80 | 2.00 | .60 | .60 | .80 | .80 | 2.00 |
| 14 | 1.40 | 1.80 | 1.40 | .30 | .50 | .60 | 3.50 | .60 | .60 | .80 | .80 | 2.00 |
| 15 | 1.40 | 1.80 | 1.40 | .80 | .50 | 1.20 | 4.00 | .60 | .60 | .80 | .80 | 2.00 |
| 16 | 1.40 | 1.80 | 1.40 | .80 | .60 | 1.40 | 3.80 | 2.00 | .60 | .80 | .80 | 2.50 |
| 17 | 1.40 | 1.80 | 1.40 | .80 | .60 | 1.00 | 4.00 | 1.50 | .60 | .80 | .80 | 2.50 |
| 18 | 1.00 | 1.80 | 1.40 | .60 | .60 | 1.00 | 4.60 | 1.00 | .60 | .80 | .80 | 2.50 |
| 19 | 1.00 | 2.00 | .80 | .60 | .80 | 2.40 | 3.60 | .80 | .60 | .80 | .80 | 2.50 |
| 20 | 1.00 | 2.00 | .60 | .80 | .80 | .60 | 5.00 | .80 | .60 | .80 | .86 | 2.50 |
| 21 | 1.60 | 2.00 | .60 | .60 | .60 | .60 | 2.80 | .80 | .80 | .80 | .80 | 2.50 |
| 22 | 1.60 | 2.00 | .60 | .80 | .60 | 1.20 | 2.00 | .60 | .80 | .80 | .80 | 2.50 |
| 23 | 1.80 | 2.00 | .60 | .60 | .60 | 2.00 | 1.60 | .60 | .80 | .80 | 2.20 | 3.00 |
| 24 | 1.40 | 2.00 | .30 | .60 | .60 | 3.00 | 1.00 | .60 | .80 | .80 | 1.10 | 3.00 |
| 25 | 1.40 | 2.40 | .30 | .40 | .60 | 2.20 | .80 | .70 | .80 | .80 | .80 | 3.00 |
| 26 | 1.40 | 2.40 | .30 | .60 | .80 | 2.30 | .80 | .80 | .80 | .80 | .80 | 3.00 |
| 27 | 1.40 | 2.40 | .30 | .60 | .60 | 2.30 | .80 | .60 | .80 | .80 | .80 | 3.00 |
| 28 | 1.60 | 2.40 | .30 | .60 | .60 | 1.40 | .80 | .60 | .80 | .80 | .80 | 3.00 |
| 29 | 1.60 | ....... | .50 | .60 | .80 | 1.00 | 3.00 | .60 | .80 | .80 | .80 | 3.00 |
| 30 | 1.80 | ....... | .50 | .60 | 1.00 | .80 | 1.60 | .60 | .80 | .80 | .80 | 3.00 |
| 31 | 1.40 | ....... | .40 | ....... | 1.20 | ....... | 2.80 | .60 | ....... | .80 | ....... | 3.60 |

## ARKANSAS RIVER AT HUTCHINSON, KANSAS.

The Arkansas River, after crossing the Kansas and Colorado State line, is not systematically measured until Hutchinson, in about the center of the State, is reached. The station here was established May 13, 1895, and is located at the wagon bridge at the south end of Main street. The gage consists of an oak timber spiked to a pile a few feet above the bridge. Bench mark No. 1 is the upper crosspiece of the pier guard, with an elevation of 8.35 feet above zero of the gage. Bench mark No. 2 is the top of the iron doorsill of the first brick building next to the river, and its elevation is 8.12 feet above gage datum. The channel is straight for some distance above and below the bridge; the bed is sandy and very shifting. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 233; 1897, Nineteenth Annual Report, Part IV, page 361; 1898, Twentieth Annual Report, Part IV, page 343. Discharge measurements for 1899 were made by W. G. Russell, as follows:

May 2, gage height, 1.45 feet; discharge, 63 second-feet.
June 13, gage height, 3.95 feet; discharge, 2,790 second-feet.
June 14, gage height, 3.85 feet; discharge, 2,772 second-feet.
October 17, gage height, 1.20 feet; discharge, 30 second-feet.

*Daily gage height, in feet, of Arkansas River at Hutchinson, Kansas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.80 | 2.00 | 2.15 | 2.20 | 1.50 | 1.40 | 2.10 | 2.95 | 1.60 | 1.30 | 1.70 | 1.70 |
| 2 | 1.90 | ....... | 2.50 | 2.20 | 1.55 | 1.35 | 2.10 | 2.80 | 1.50 | 1.20 | 1.70 | 1.70 |
| 3 | 1.95 | ....... | 2.95 | 2.20 | 1.60 | 1.50 | 2.20 | 2.75 | 1.50 | 1.20 | 1.65 | 1.70 |
| 4 | 2.00 | 2.00 | 2.85 | 2.15 | 1.65 | 2.30 | 2.20 | 2.65 | 1.50 | 1.20 | 1.55 | 1.70 |
| 5 | 2.00 | (*a*) | 2.90 | 2.15 | 1.60 | 2.15 | 2.15 | 2.60 | 1.50 | 1.20 | 1.50 | 1.70 |
| 6 | 2.00 | (*a*) | 3.15 | 2.20 | 1.60 | 2.00 | 2.10 | 2.55 | 1.50 | 1.20 | 1.50 | 1.70 |
| 7 | 1.90 | (*a*) | 3.20 | 2.20 | 1.50 | 2.00 | 2.20 | 2.55 | 1.50 | 1.20 | 1.50 | 1.70 |
| 8 | 1.90 | (*a*) | 3.25 | 2.20 | 1.50 | 2.65 | 2.20 | 2.60 | 1.50 | 1.20 | 1.50 | 1.70 |
| 9 | 2.00 | (*a*) | 3.00 | 2.20 | 1.50 | 3.10 | 2.05 | 2.55 | 1.50 | 1.20 | 1.50 | 1.70 |
| 10 | 2.00 | (*a*) | 2.90 | 2.15 | 1.60 | 3.30 | 2.00 | 2.80 | 1.55 | 1.20 | 1.50 | 1.70 |
| 11 | 1.70 | (*a*) | 3.05 | 2.05 | 1.55 | 3.35 | 2.00 | 4.15 | 1.50 | 1.20 | 1.50 | 1.70 |
| 12 | 1.70 | (*a*) | 2.85 | 2.00 | 1.50 | 4.35 | 1.95 | 3.80 | 1.50 | 1.20 | 1.50 | 1.80 |
| 13 | 1.70 | (*a*) | 2.80 | 2.00 | 1.45 | 3.90 | 1.90 | 3.65 | 1.40 | 1.20 | 1.50 | 1.90 |
| 14 | 1.70 | (*a*) | 2.90 | 1.90 | 1.40 | 3.80 | 1.90 | 3.60 | 1.40 | 1.20 | 1.50 | 1.90 |
| 15 | 1.70 | (*a*) | 2.90 | 1.85 | 1.40 | 3.65 | 1.90 | 3.35 | 1.40 | 1.20 | 1.50 | 1.90 |
| 16 | 1.80 | (*a*) | 2.65 | 1.80 | 1.40 | 3.30 | 1.85 | 3.05 | 1.45 | 1.20 | 1.50 | 2.00 |
| 17 | 1.80 | 2.30 | 2.60 | 1.80 | 1.40 | 2.90 | 1.80 | 2.75 | 1.50 | 1.20 | 1.50 | 2.00 |
| 18 | 2.10 | 2.30 | 2.60 | 1.80 | 1.40 | 2.65 | 1.80 | 2.55 | 1.50 | 1.20 | 1.50 | 2.00 |
| 19 | 2.10 | 2.15 | 2.50 | 1.70 | 1.40 | 2.45 | 1.80 | 2.50 | 1.40 | 1.20 | 1.50 | 2.00 |
| 20 | 2.10 | 2.05 | 2.50 | 1.70 | 1.40 | 2.40 | 1.80 | 2.35 | 1.40 | 1.20 | 1.50 | 2.00 |
| 21 | 2.00 | 2.10 | 2.50 | 1.70 | 1.40 | 2.25 | 1.95 | 2.20 | 1.40 | 1.20 | 1.50 | 2.00 |
| 22 | 2.00 | 2.25 | 2.50 | 1.65 | 1.50 | 2.20 | 3.95 | 2.20 | 1.40 | 1.20 | 1.60 | 2.00 |
| 23 | 2.00 | 2.30 | 2.45 | 1.60 | 1.50 | 2.30 | 4.55 | 2.15 | 1.40 | 1.20 | 1.70 | 2.00 |
| 24 | 2.10 | 2.30 | 2.40 | 1.60 | 1.55 | 2.30 | 4.35 | 2.00 | 1.30 | 1.20 | 1.70 | 2.00 |
| 25 | 2.00 | 2.30 | 2.35 | 1.60 | 1.50 | 2.35 | 4.45 | 1.90 | 1.30 | 1.50 | 1.70 | 2.00 |
| 26 | 2.00 | 2.30 | 2.30 | 1.60 | 1.40 | 2.40 | 4.05 | 1.90 | 1.30 | 1.75 | 1.70 | 1.90 |
| 27 | 2.10 | 2.25 | 2.45 | 1.60 | 1.40 | 2.40 | 3.70 | 1.80 | 1.30 | 1.80 | 1.70 | 1.80 |
| 28 | 2.10 | 2.15 | 2.35 | 1.55 | 1.40 | 2.40 | 3.35 | 1.75 | 1.30 | 1.80 | 1.70 | 1.80 |
| 29 | ....... | ....... | 2.20 | 1.50 | 1.40 | 2.30 | 3.25 | 1.70 | 1.30 | 1.80 | 1.70 | 1.80 |
| 30 | 2.00 | ....... | 2.20 | 1.50 | 1.40 | 2.15 | 3.20 | 1.65 | 1.30 | 1.80 | 1.70 | 1.80 |
| 31 | ....... | ....... | 2.25 | ....... | 1.30 | ....... | 3.20 | 1.60 | ....... | 1.80 | ....... | 1.80 |

*a* Frozen.

## VERDIGRIS RIVER AT LIBERTY, KANSAS.

This river rises in the southeastern corner of Chase County, Kansas, and has a general southerly direction, passing out of the State near Coffeyville into Indian Territory. It enters Arkansas River 1 mile above the mouth of Grand, or Neosho, River near Fort Gibson.

It is essentially a surface run-off stream; its water is muddy, the fall flood large, the summer flow small, and the fluctuations in height rapid. There are a number of fine water powers located on the main stream and its various tributaries, and many of them were utilized several years ago. In the years 1880 to 1890 it is said that there were eleven dams on the Verdigris River, but at the present time not more than three or four are utilized. The drainage area is mapped on the Independence, Fredonia, Emporia, Eureka, Sedan, Eldorado, Cottonwood Falls, Parkerville, Newton, and Abilene atlas sheets. The station was established in August, 1895, and is located at a wagon bridge about 250 feet below McTaggart's mill dam, about 3 miles southwest of the town of Liberty, Kansas. The gage is a vertical timber fastened to the floor of the mill. Bench mark No. 1 is the heads of three large nails in the flume, and is at an elevation of 12.46 feet above the zero of the gage. Bench mark No. 2 is the head of a spike in the root of a cottonwood tree 40 feet south of the gage, and is at an elevation of 10.98 feet above gage datum. The bed is rocky, composed of gravel and subject to very little change. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 235; 1897, Nineteenth Annual Report, Part IV, page 369; 1898, Twentieth Annual Report, Part IV, page 344. The following discharge measurements were made by E. C. Murphy and W. G. Russell during 1899:

May 19, gage height, 3.03 feet; discharge, 311 second-feet.
June 10, gage height, 21.30 feet; discharge, 16,906 second-feet.
July 6, gage height, 21.50 feet; discharge, 16,505 second-feet.
October 11, gage height, 1.70 feet; discharge, 17 second-feet.

*Daily gage height, in feet, of Verdigris River at Liberty, Kansas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.80 | 2.80 | 4.10 | 4.10 | 3.65 | 6.75 | 2.80 | 4.50 | 2.00 | 1.70 | 1.90 | 1.90 |
| 2 | 3.70 | 2.70 | 3.80 | 4.10 | 3.75 | 5.15 | 2.80 | 4.20 | 2.00 | 1.70 | 1.90 | 1.90 |
| 3 | 3.20 | 2.70 | 3.60 | 3.80 | 4.05 | 3.70 | 2.75 | 3.60 | 2.00 | 1.70 | 1.90 | 1.90 |
| 4 | 3.00 | 2.70 | 3.50 | 3.60 | 7.35 | 5.55 | 12.40 | 3.15 | 2.00 | 1.70 | 1.90 | 1.90 |
| 5 | 3.30 | 2.70 | 3.50 | 3.40 | 6.75 | 6.35 | 15.40 | 3.05 | 2.00 | 1.70 | 1.90 | 1.90 |
| 6 | 3.30 | 2.70 | 3.40 | 3.60 | 4.70 | 8.60 | 15.95 | 2.80 | 2.00 | 1.70 | 1.90 | 1.90 |
| 7 | 3.20 | 2.70 | 3.30 | 3.80 | 4.85 | 9.35 | 8.55 | 2.75 | 2.00 | 1.70 | 1.80 | 1.90 |
| 8 | 3.20 | 2.60 | 3.20 | 4.10 | 5.05 | 5.80 | 26.90 | 2.60 | 2.00 | 1.70 | 1.80 | 1.90 |
| 9 | 3.20 | 2.60 | 3.10 | 4.00 | 4.65 | 10.35 | 30.45 | 2.60 | 2.00 | 1.70 | 1.80 | 1.90 |
| 10 | 3.10 | 2.60 | 3.20 | 3.80 | 4.45 | 21.45 | 19.75 | 2.50 | 2.00 | 1.70 | 1.80 | 1.90 |
| 11 | 3.10 | 2.60 | 3.20 | 3.70 | 4.15 | 24.05 | 8.75 | 2.50 | 2.00 | 1.70 | 1.80 | 1.90 |
| 12 | 3.10 | 2.60 | 7.10 | 3.60 | 4.00 | 24.75 | 4.90 | 2.50 | 2.00 | 1.70 | 1.80 | 2.00 |
| 13 | 3.30 | 2.50 | 6.30 | 3.50 | 3.85 | 19.10 | 4.55 | 2.40 | 2.00 | 1.70 | 1.80 | 2.00 |
| 14 | 3.20 | 2.50 | 6.00 | 4.30 | 3.65 | 9.15 | 4.25 | 2.75 | 2.00 | 1.70 | 1.80 | 2.00 |
| 15 | 3.10 | 2.50 | 5.60 | 3.70 | 3.45 | 5.75 | 4.20 | 5.55 | 2.00 | 1.70 | 1.80 | 2.00 |
| 16 | 3.20 | 2.50 | 5.90 | 3.30 | 3.20 | 7.50 | 4.25 | 3.40 | 2.00 | 1.70 | 1.80 | 2.00 |
| 17 | 3.10 | 2.40 | 5.00 | 3.30 | 3.20 | 5.65 | 6.40 | 2.90 | 2.00 | 1.70 | 1.80 | 2.00 |
| 18 | 3.20 | 2.40 | 4.80 | 3.70 | 3.00 | 4.80 | 7.65 | 2.65 | 2.00 | 1.70 | 1.80 | 2.00 |
| 19 | 3.10 | 2.40 | 4.90 | 3.85 | 3.00 | 4.40 | 7.05 | 2.45 | 1.90 | 1.70 | 1.80 | 2.00 |
| 20 | 3.00 | 2.40 | 5.80 | 7.15 | 6.60 | 4.05 | 7.20 | 2.40 | 1.90 | 1.60 | 1.90 | 1.90 |
| 21 | 3.00 | 3.10 | 4.80 | 6.45 | 10.20 | 3.85 | 7.65 | 2.30 | 1.90 | 1.60 | 1.90 | 1.90 |
| 22 | 3.00 | 3.20 | 4.60 | 8.45 | 5.10 | 3.60 | 7.70 | 2.30 | 1.90 | 1.60 | 1.90 | 1.90 |
| 23 | 2.90 | 3.10 | 4.10 | 11.20 | 6.70 | 3.40 | 6.40 | 2.30 | 1.90 | 1.60 | 1.90 | 2.00 |
| 24 | 2.90 | 3.00 | 3.90 | 6.50 | 14.65 | 3.25 | 4.75 | 2.20 | 1.90 | 1.60 | 1.90 | 2.00 |
| 25 | 2.90 | 3.10 | 3.80 | 5.30 | 9.65 | 3.20 | 4.10 | 2.20 | 1.90 | 1.60 | 1.90 | 2.00 |
| 26 | 3.00 | 6.60 | 3.70 | 4.70 | 4.80 | 3.35 | 3.85 | 2.20 | 1.80 | 1.90 | 1.90 | 2.00 |
| 27 | 3.00 | 6.00 | 3.50 | 4.45 | 4.40 | 3.20 | 3.65 | 2.10 | 1.80 | 2.00 | 1.90 | 2.00 |
| 28 | 3.00 | 4.50 | 3.50 | 4.25 | 4.00 | 3.05 | 3.45 | 2.10 | 1.80 | 2.00 | 1.90 | 2.10 |
| 29 | 3.00 | ------- | 3.40 | 4.35 | 4.00 | 3.00 | 3.15 | 2.00 | 1.70 | 2.00 | 1.90 | 2.10 |
| 30 | 3.00 | ------- | 3.70 | 3.80 | 3.70 | 2.85 | 3.10 | 2.00 | 1.70 | 2.00 | 1.90 | 2.10 |
| 31 | 2.90 | ------- | 4.10 | ------- | 3.45 | ------- | 3.85 | 2.00 | ------- | 2.00 | ------- | 2.10 |

## NEOSHO RIVER AT IOLA, KANSAS.

This river drains a long, narrow strip in southeastern Kansas, extending into Indian Territory. The upper part of the basin has a general east-west direction, draining the area immediately south of Kansas River and north of the headwaters of Verdigris River. The general direction of the river bends gradually southward between Emporia and Iola, and that direction is maintained for the rest of its course. Neosho River in Indian Territory is known as Grand River. During the last season two gaging stations were maintained in the basin—one at Iola, the other at Fort Gibson, near the mouth. The former station was established in July, 1895, and is located at the highway bridge 1 mile west of the city of Iola, Kansas. The gage is fastened to the head gates of the flume about 90 feet above the bridge. The bench mark is the heads of three large nails driven into the crosspiece of the flume, and is 13.30 feet above the datum of the gage. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 238; 1897, Nineteenth Annual Report, Part IV, page 362; 1898, Twentieth Annual Report, Part IV, page 346. The following discharge measurements were made by E. C. Murphy and W. G. Russell during 1899:

May 18, gage height, 2.70 feet; discharge, 242 second-feet.
June 9, gage height, 18 feet; discharge, 27,959 second-feet.
July 5, gage height, 8.20 feet; discharge, 6,313 second-feet.
July 8, gage height, 16.70 feet; discharge, 25,849 second-feet.
October 11, gage height, 2.30 feet; discharge, 316 second-feet.

*Daily gage height, in feet, of Neosho River at Iola, Kansas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.00 | 2.70 | 3.60 | 3.85 | 3.10 | 4.50 | 2.80 | 2.80 | 2.70 | 2.30 | 2.00 | 2.00 |
| 2 | 2.90 | 2.60 | 3.55 | 3.70 | 3.10 | 5.20 | 2.80 | 2.70 | 2.70 | 2.30 | 2.00 | 2.00 |
| 3 | 2.90 | 2.60 | 3.60 | 3.70 | 3.00 | 4.45 | 3.00 | 2.70 | 2.60 | 2.30 | 2.00 | 2.00 |
| 4 | 2.80 | 2.60 | 3.60 | 4.20 | 3.10 | 4.80 | 12.50 | 2.70 | 2.60 | 2.30 | 2.00 | 2.00 |
| 5 | 2.80 | 2.60 | 3.65 | 4.40 | 3.10 | 6.30 | 8.90 | 2.60 | 2.60 | 2.30 | 2.00 | 2.00 |
| 6 | 2.80 | 2.60 | 3.70 | 4.00 | 3.00 | 7.95 | 5.80 | 2.50 | 2.50 | 2.30 | 2.00 | 2.00 |
| 7 | 2.80 | 2.60 | 3.70 | 3.85 | 3.10 | 6.60 | 14.00 | 2.60 | 2.50 | 2.30 | 2.00 | 2.00 |
| 8 | 2.70 | 2.60 | 3.60 | 3.60 | 3.10 | 5.55 | 16.50 | 3.05 | 2.45 | 2.30 | 2.00 | 2.00 |
| 9 | 2.70 | 2.60 | 3.50 | 3.60 | 3.10 | 17.03 | 9.80 | 2.90 | 2.40 | 2.25 | 2.00 | 2.00 |
| 10 | 2.80 | 2.50 | 3.50 | 3.50 | 3.15 | 15.70 | 6.60 | 2.80 | 2.40 | 2.20 | 2.00 | 2.00 |
| 11 | 2.80 | 2.50 | 4.90 | 3.50 | 3.30 | 11.40 | 4.50 | 2.70 | 2.40 | 2.20 | 2.00 | 2.00 |
| 12 | 2.80 | 2.50 | 11.05 | 3.40 | 3.50 | 11.50 | 3.75 | 2.60 | 2.40 | 2.20 | 2.00 | 2.10 |
| 13 | 2.90 | 2.50 | 6.05 | 3.40 | 3.40 | 9.20 | 3.25 | 2.50 | 2.40 | 2.20 | 2.00 | 2.10 |
| 14 | 2.90 | 2.60 | 5.45 | 3.40 | 3.40 | 5.60 | 3.00 | 2.50 | 2.40 | 2.20 | 2.00 | 2.10 |
| 15 | 2.90 | 2.70 | 5.00 | 3.40 | 3.25 | 4.75 | 3.65 | 2.50 | 2.40 | 2.20 | 2.00 | 2.10 |
| 16 | 2.90 | 2.80 | 4.50 | 3.30 | 3.00 | 4.40 | 4.65 | 2.55 | 2.40 | 2.20 | 2.00 | 2.10 |
| 17 | 2.90 | 2.90 | 4.85 | 3.20 | 2.90 | 4.20 | 4.80 | 3.30 | 2.40 | 2.10 | 2.00 | 2.20 |
| 18 | 2.90 | 2.95 | 7.55 | 3.20 | 2.85 | 4.10 | 4.10 | 3.00 | 2.40 | 2.10 | 2.00 | 2.20 |
| 19 | 2.80 | 3.10 | 5.85 | 3.10 | 2.85 | 4.05 | 3.60 | 2.80 | 2.40 | 2.10 | 2.00 | 2.20 |
| 20 | 2.80 | 3.15 | 5.40 | 4.50 | 2.90 | 3.85 | 3.95 | 2.80 | 2.40 | 2.10 | 2.00 | 2.20 |
| 21 | 2.80 | 3.20 | 5.15 | 4.05 | 2.90 | 3.70 | 5.35 | 2.60 | 2.40 | 2.10 | 2.00 | 2.20 |
| 22 | 2.80 | 3.30 | 4.65 | 3.80 | 2.90 | 3.60 | 6.40 | 2.60 | 2.40 | 2.10 | 2.00 | 2.20 |
| 23 | 2.80 | 3.40 | 4.10 | 3.75 | 4.65 | 3.50 | 3.50 | 2.60 | 2.40 | 2.10 | 2.00 | 2.10 |
| 24 | 2.80 | 3.60 | 3.85 | 3.60 | 6.60 | 3.25 | 3.35 | 2.50 | 2.40 | 2.10 | 2.00 | 2.10 |
| 25 | 2.80 | 3.95 | 3.65 | 3.50 | 4.90 | 3.15 | 3.05 | 2.50 | 2.40 | 2.00 | 2.00 | 2.10 |
| 26 | 2.80 | 5.95 | 3.55 | 3.40 | 6.95 | 3.10 | 3.00 | 2.60 | 2.40 | 2.00 | 2.00 | 2.10 |
| 27 | 2.80 | 4.70 | 3.70 | 3.30 | 6.55 | 3.05 | 2.85 | 2.60 | 2.49 | 2.00 | 2.00 | 2.10 |
| 28 | 2.70 | 3.90 | 3.90 | 3.20 | 4.45 | 3.00 | 2.80 | 2.60 | 2.40 | 2.00 | 2.00 | 2.10 |
| 29 | 2.70 | ------- | 4.20 | 3.10 | 3.85 | 2.90 | 2.70 | 2.85 | 2.40 | 2.00 | 2.00 | 2.10 |
| 30 | 2.70 | ------- | 4.20 | 3.10 | 3.70 | 2.80 | 2.70 | 2.85 | 2.40 | 2.00 | 2.00 | 2.10 |
| 31 | 2.70 | ------- | 3.95 | ------- | 3.25 | ------- | 2.70 | 2.75 | ------- | 2.00 | ------- | 2.10 |

## GRAND RIVER AT FORT GIBSON, INDIAN TERRITORY.

In its lower course through Indian Territory Neosho River is known as Grand River. The station was established by W. G. Russell, May 16, 1899, at the railroad bridge one-half mile north of the station at Fort Gibson and 3 miles above the mouth of the river. The rod is spiked to the ties of the bridge. The initial point for soundings is the left end of the bridge. The channel is straight for some distance both above and below the station. The right bank is liable to overflow, while the left is not, being high and rocky. The bed of the stream is sandy and shifting at the right side and toward the center. W. Blackwell, railroad pump man, is the observer. Two measurements of discharge were made here by W. G. Russell during 1899. The first one was on May 16, at a gage height of 15.00 feet, and showed a discharge of 19,823 second-feet; the second measurement was on October 12, with a gage height of 9.20 feet, and gave a discharge of 1,070 second-feet.

*Daily gage height, in feet, of Grand River at Fort Gibson, Indian Territory, for 1899.*

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 1 | | 13.80 | 12.80 | 15.20 | 10.90 | 10.00 | 10.00 | 11.90 |
| 2 | | 13.80 | 13.00 | 15.00 | 10.90 | 10.00 | 10.00 | 11.80 |
| 3 | | 13.80 | 13.00 | 14.80 | 10.40 | 10.00 | 10.00 | 11.60 |
| 4 | | 14.70 | 13.20 | 14.90 | 10.20 | 10.00 | 10.00 | 11.40 |
| 5 | | 13.60 | 13.70 | 14.40 | 10.20 | 10.00 | 10.00 | 11.10 |
| 6 | | 13.00 | 14.00 | 14.20 | 10.10 | 10.00 | 10.00 | 11.00 |
| 7 | | 12.90 | 14.60 | 14.00 | 10.00 | 10.00 | 10.00 | 10.80 |
| 8 | | 16.20 | 14.70 | 13.90 | 10.00 | 9.90 | 10.00 | 10.50 |
| 9 | | 16.00 | 14.80 | 13.70 | 10.00 | 9.90 | 10.00 | 10.40 |
| 10 | | 16.30 | 14.90 | 13.30 | 10.00 | 9.80 | 10.00 | 10.40 |
| 11 | | 15.20 | 15.00 | 13.20 | 10.00 | 9.70 | 10.00 | 10.20 |
| 12 | | 17.20 | 15.40 | 13.00 | 10.00 | 9.20 | 10.00 | 10.00 |
| 13 | | 19.00 | 15.90 | 13.00 | 10.00 | 9.20 | 10.00 | 10.00 |
| 14 | | 19.80 | 16.00 | 12.90 | 10.00 | 9.10 | 10.00 | 10.00 |
| 15 | | 19.60 | 16.80 | 12.90 | 10.00 | 9.10 | 10.00 | 10.00 |
| 16 | 15.00 | 17.60 | 17.00 | 12.80 | 10.00 | 9.10 | 10.00 | 10.00 |
| 17 | 15.00 | 16.60 | 17.60 | 12.70 | 9.90 | 9.00 | 10.00 | 10.00 |
| 18 | 13.60 | 15.60 | 17.90 | 12.60 | 9.80 | 9.00 | 10.00 | 10.00 |
| 19 | 13.50 | 14.50 | 17.90 | 12.60 | 9.70 | 9.00 | 10.20 | 10.00 |
| 20 | 13.40 | 14.00 | 17.60 | 12.40 | 9.70 | 9.00 | 10.40 | 10.00 |
| 21 | 13.30 | 14.00 | 17.40 | 12.20 | 9.70 | 9.00 | 10.60 | 10.00 |
| 22 | 14.30 | 14.00 | 17.40 | 12.10 | 9.60 | 9.10 | 11.00 | 10.00 |
| 23 | 14.70 | 13.80 | 17.00 | 12.00 | 9.60 | 9.10 | 11.20 | 10.00 |
| 24 | 15.60 | 13.80 | 17.00 | 12.00 | 9.70 | 9.10 | 11.50 | 10.00 |
| 25 | 15.10 | 13.10 | 16.80 | 11.90 | 9.80 | 9.20 | 11.80 | 10.10 |
| 26 | 14.80 | 13.00 | 16.60 | 11.80 | 9.80 | 9.20 | 12.00 | 10.20 |
| 27 | 14.80 | 13.00 | 16.00 | 11.80 | 9.80 | 9.50 | 12.00 | 10.30 |
| 28 | 14.80 | 13.00 | 16.00 | 11.60 | 9.90 | 9.50 | 12.00 | 10.40 |
| 29 | 14.80 | 13.00 | 15.80 | 11.40 | 9.90 | 9.60 | 12.00 | 10.40 |
| 30 | 13.80 | 13.00 | 15.60 | 11.20 | 9.90 | 9.70 | 11.90 | 10.50 |
| 31 | 13.80 | | 15.40 | 11.00 | | 9.80 | | 10.60 |

## NORTH FORK OF CANADIAN RIVER AT OKLAHOMA, OKLAHOMA.

This stream rises in the extreme northeast corner of the panhandle of Texas. Its general course across Oklahoma and Indian Territory is southeasterly, emptying into the main Canadian River 45 miles above its mouth. The basin is a long, narrow area located between Cimarron River on the north and the main Canadian River on the south. Two gaging stations are maintained on the river, one at Oklahoma, Oklahoma, and the other at Eufaula, Indian Territory. The former station was established by W. G. Russell May 19, 1899, and is located at the highway bridge, east of the Atchison, Topeka and Santa Fe Railroad bridge, one-half mile south of the town. The right bank is high, but the left is low and liable to overflow. H. E. Smith, a farmer living near by, is the observer. Two measurements of discharge were made by W. G. Russell during 1899, as follows: The first, on May 19, at a gage height of 5.50 feet, gave a discharge of 395 second-feet; the second, on October 15, at a gage height of 2.80 feet, showed a discharge of 22 second-feet.

*Daily gage height, in feet, of North Fork of Canadian River at Oklahoma, Oklahoma, for 1899.*

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 1 | ........ | 6.10 | 5.10 | 9.30 | 3.30 | 3.10 | 3.40 | 5.50 |
| 2 | ........ | 5.90 | 5.00 | 8.60 | 3.20 | 3.10 | 3.30 | 5.50 |
| 3 | ........ | 5.70 | 4.90 | 8.00 | 3.30 | 3.00 | 3.10 | 5.40 |
| 4 | ........ | 5.60 | 4.80 | 7.60 | 3.20 | 3.00 | 3.10 | 5.30 |
| 5 | ........ | 6.20 | 4.70 | 7.10 | 3.20 | 2.90 | 3.30 | 5.20 |
| 6 | ........ | 6.50 | 4.60 | 6.90 | 3.20 | 2.90 | 3.50 | 5.10 |
| 7 | ........ | 6.20 | 4.50 | 6.20 | 3.20 | 2.90 | 3.60 | 5.00 |
| 8 | ........ | 6.90 | 4.50 | 5.90 | 3.20 | 2.90 | 3.60 | 4.10 |
| 9 | ........ | 6.20 | 4.30 | 5.60 | 3.10 | 2.90 | 3.70 | 5.20 |
| 10 | ........ | 5.90 | 4.30 | 5.40 | 3.30 | 2.90 | 3.70 | 5.10 |
| 11 | ........ | 6 50 | 4.50 | 5.30 | 3.20 | 2.90 | 3.70 | 4.90 |
| 12 | ........ | 8.00 | 5.00 | 5.20 | 3.10 | 2.80 | 3.80 | 4.80 |
| 13 | ........ | 9.30 | 5.20 | 5.00 | 3.10 | 2 80 | 3.90 | 4.70 |
| 14 | ........ | 7.80 | 5.10 | 4.90 | 3.00 | 2.80 | 4.00 | 4.60 |
| 15 | ........ | 8.00 | 4.60 | 4.80 | 3.00 | 2.80 | 4.20 | 4.50 |
| 16 | ........ | 11.10 | 4.50 | 4.70 | 3.00 | 2.80 | 4.60 | 4.40 |
| 17 | ........ | 11.00 | 4.40 | 4.60 | 3.00 | 2.80 | 5.00 | 4.40 |
| 18 | ........ | 9.40 | 6.00 | 4.40 | 3.10 | 2.80 | 5.20 | 4.40 |
| 19 | 5.50 | 8.80 | 4.50 | 4.30 | 3.00 | 2.70 | 6.00 | 4.30 |
| 20 | 5.40 | 8.00 | 4.30 | 4.30 | 3.00 | 2.70 | 12.10 | 4.30 |
| 21 | 5.30 | 7.80 | 4.30 | 4.20 | 3.00 | 2.70 | 13.60 | 4.60 |
| 22 | 5.20 | 7.20 | 5.00 | 4.10 | 3.00 | 2.70 | 13.50 | 4.60 |
| 23 | 5.20 | 7.00 | 4.80 | 4.00 | 3.00 | 2.60 | 12.60 | 4.50 |
| 24 | 5.10 | 6.80 | 6.00 | 3.11 | 3.60 | 2.60 | 7.90 | 4.40 |
| 25 | 5.60 | 6.50 | 6.30 | 3.10 | 3.60 | 2.90 | 6.00 | 4.30 |
| 26 | 5.70 | 6.10 | 7.50 | 3.90 | 3.50 | 3.00 | 5.90 | 4.30 |
| 27 | 6.40 | 5.90 | 7.60 | 3.80 | 3.40 | 3.50 | 5.80 | 4.20 |
| 28 | 6.40 | 5.70 | 8.50 | 3.70 | 3.30 | 4.00 | 5.70 | 4.20 |
| 29 | 6.20 | 5.50 | 9.60 | 3.60 | 3.30 | 3.00 | 5.60 | 4.10 |
| 30 | 5.80 | 5.30 | 10.20 | 3.50 | 3.30 | 4.00 | 5.60 | 4.10 |
| 31 | 6.20 | ........ | 10.30 | 3.40 | ........ | 3.70 | ........ | 4.20 |

## NORTH FORK OF CANADIAN RIVER AT EUFAULA, INDIAN TERRITORY.

This station was established by W. G. Russell May 17, 1899, and is located at the railroad bridge of the Missouri, Kansas and Texas Railroad, 5 miles above the mouth of the river and 2 miles north of the town of Eufaula. The channel is straight for some distance both above and below the station. The right bank is high, but the left bank is low and liable to overflow. The bed of the stream is sandy and shifting. H. Erwin, railroad pump man, is the observer. Two measurements of discharge were made during 1899 by W. G. Russell: The first, on May 17, with a gage height of 24.00 feet, gave a discharge of 19,072 second-feet; the second, on October 13, with a gage height of 9.50 feet, gave a discharge of 154 second-feet.

*Daily gage height, in feet, of North Fork of Canadian River at Eufaula, Indian Territory, for 1899.*

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 1 | ---------- | 12.00 | 11.60 | 12.00 | 10.50 | 10.00 | 10.00 | 11.50 |
| 2 | ---------- | 12.00 | 11.60 | 11.60 | 10.50 | 9.80 | 9.80 | 11.50 |
| 3 | ---------- | 11.60 | 11.50 | 11.60 | 10.50 | 9.80 | 9.70 | 11.50 |
| 4 | ---------- | 11.60 | 11.00 | 11.50 | 10.50 | 9.60 | 9.50 | 11.50 |
| 5 | ---------- | 11.60 | 11.00 | 12.00 | 10.30 | 9.50 | 9.50 | 11.50 |
| 6 | ---------- | 10.00 | 10.60 | 12.00 | 10.40 | 9.50 | 9.50 | 11.50 |
| 7 | ---------- | 10.50 | 10.50 | 12.00 | 10.40 | 9.50 | 9.50 | 11.50 |
| 8 | ---------- | 11.50 | 10.60 | 12.00 | 10.30 | 9.50 | 9.40 | 11.50 |
| 9 | ---------- | 11.60 | 10.60 | 11.60 | 10.00 | 9.50 | 9.40 | 11.50 |
| 10 | ---------- | 12.00 | 10.60 | 11.60 | 10.00 | 9.50 | 9.40 | 11.50 |
| 11 | ---------- | 14.00 | 11.00 | 11.50 | 10.00 | 9.50 | 9.30 | 11.50 |
| 12 | ---------- | 14.00 | 11.60 | 11.50 | 10.00 | 9.50 | 9.40 | 11.50 |
| 13 | ---------- | 13.00 | 12.00 | 11.50 | 10.00 | 9.50 | 9.40 | 11.40 |
| 14 | ---------- | 11.00 | 12.50 | 11.50 | 10.00 | 9.50 | 9.40 | 11.40 |
| 15 | ---------- | 12.00 | 12.50 | 11.50 | 10.00 | 9.50 | 9.30 | 10.40 |
| 16 | ---------- | 13.00 | 11.50 | 11.40 | 10.00 | 9.40 | 9.20 | 10.40 |
| 17 | 24.00 | 14.00 | 11.00 | 11.00 | 10.00 | 9.40 | 9.20 | 10.30 |
| 18 | 23.60 | 15.00 | 10.60 | 11.00 | 10.00 | 9.50 | 9.20 | 10.50 |
| 19 | 23.00 | 17.00 | 11.00 | 11.00 | 10.00 | 9.50 | 9.20 | 11.00 |
| 20 | 22.50 | 20.00 | 12.60 | 11.00 | 10.00 | 9.40 | 9.20 | 11.00 |
| 21 | 21.30 | 20.00 | 13.00 | 11.00 | 10.00 | 9.40 | 9.50 | 11.00 |
| 22 | 20.50 | 19.00 | 13.00 | 11.00 | 10.00 | 9.30 | 9.60 | 11.40 |
| 23 | 19.90 | 16.00 | 14.00 | 10.80 | 10.00 | 9.20 | 10.50 | 11.50 |
| 24 | 20.50 | 13.00 | 16.00 | 10.80 | 10.00 | 9.20 | 10.70 | 11.50 |
| 25 | 19.60 | 12.50 | 18.00 | 10.80 | 10.00 | 9.30 | 12.00 | 11.50 |
| 26 | 18.60 | 12.00 | 11.50 | 10.80 | 10.00 | 9.30 | 12.50 | 11.50 |
| 27 | 18.00 | 11.50 | 11.00 | 10.80 | 10.00 | 9.60 | 12.50 | 11.30 |
| 28 | 17.60 | 11.50 | 11.00 | 10.70 | 10.00 | 10.20 | 12.50 | 11.00 |
| 29 | 15.00 | 11.00 | 12.00 | 10.70 | 10.00 | 10.00 | 12.30 | 10.00 |
| 30 | 12.50 | 11.50 | 12.00 | 10.60 | 10.00 | 10.00 | 12.30 | 10.00 |
| 31 | 12.00 | ---------- | 12.00 | 10.60 | ---------- | 10.00 | ---------- | 9.60 |

## WASHITA RIVER AT PAULS VALLEY, INDIAN TERRITORY.

This river rises in the eastern edge of the Texas Panhandle, immediately south of Canadian River. Its general direction is southeasterly through Oklahoma Territory, and then into Indian Territory, emptying into Red River about 11 miles above the crossing of the Missouri, Kansas and Texas Railroad. The gaging station was established by W. G. Russell on May 20, 1899, and is located at the highway bridge, 2 miles east of the town of Pauls Valley, Indian Territory. The channel is straight for some distance above and below the station; the right bank is low and liable to overflow, but the left bank is high. The bed of the stream is sandy and shifting. Two measurements of discharge were made at this point by W. G. Russell in 1899: The first, on May 20, with a gage height of 8.50 feet, gave a discharge of 684 second-feet; the second, made on October 15, at a gage height of 4.60 feet, gave a discharge of 96 second-feet.

*Daily gage height, in feet, of Washita River at Pauls Valley, Indian Territory, for 1899.*

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 1 | | 7.60 | 7.30 | 12.80 | 5.40 | 5.10 | 6.00 | 8.50 |
| 2 | | 6.80 | 7.20 | 9.90 | 5.40 | 5.00 | 5.80 | 8.00 |
| 3 | | 6.50 | 7.00 | 8 90 | 5.30 | 4.90 | 5.50 | 7.80 |
| 4 | | 6.50 | 7.00 | 8 20 | 5.10 | 4.80 | 5.40 | 7.60 |
| 5 | | 6.20 | 7.00 | 7.80 | 5.00 | 4.80 | 5.30 | 7.50 |
| 6 | | 6.40 | 6.90 | 7.70 | 5.00 | 4.70 | 5.20 | 7.40 |
| 7 | | 7.30 | 6.80 | 7.70 | 5.00 | 4.70 | 5.10 | 7.00 |
| 8 | | 8.80 | 8.30 | 7.60 | 4.90 | 4.70 | 5.00 | 6.80 |
| 9 | | 7.70 | 9.50 | 7.20 | 5.90 | 4.70 | 4.90 | 7.00 |
| 10 | | 7.50 | 8.50 | 7.00 | 4.90 | 4.70 | 4.80 | 7.40 |
| 11 | | 9.40 | 7.70 | 7.80 | 4.90 | 4.70 | 4.80 | 7.40 |
| 12 | | 8.80 | 7.00 | 6.80 | 4.90 | 4.70 | 4.80 | 7.50 |
| 13 | | 9.00 | 6.90 | 6.70 | 4.90 | 4.60 | 4.80 | 7.50 |
| 14 | | 9.50 | 9.00 | 6.60 | 4.90 | 4.50 | 4.80 | 7.50 |
| 15 | | 10.70 | 9.10 | 6.50 | 4.90 | 4.60 | 4.70 | 8.60 |
| 16 | | 11.50 | 8.50 | 6.30 | 4.90 | 4.60 | 4.70 | 8.00 |
| 17 | | 12.70 | 8.00 | 6.10 | 5.00 | 4.60 | 4.80 | 7.40 |
| 18 | | 16.20 | 7.50 | 6.00 | 5.20 | 4.60 | 7.00 | 7.50 |
| 19 | | 15.70 | 8.90 | 6.00 | 5.70 | 4.50 | 14.55 | 7.20 |
| 20 | 8.50 | 13.70 | 8.00 | 5.90 | 5.50 | 4.50 | 20.70 | 7.00 |
| 21 | 7.90 | 12.20 | 7.50 | 5.80 | 5.40 | 4.50 | 20.70 | 6.80 |
| 22 | 7.80 | 11.40 | 8.90 | 5.70 | 5.20 | 4.50 | 19.80 | 6.50 |
| 23 | 7.40 | 10.50 | 9.00 | 5.70 | 5.20 | 4.50 | 19.05 | 6.60 |
| 24 | 7.40 | 9.10 | 9.50 | 5.80 | 5.00 | 4.50 | 15.75 | 6.50 |
| 25 | 7.20 | 8.20 | 9.30 | 5.70 | 6.00 | 4.70 | 14.25 | 6.40 |
| 26 | 7.00 | 8.00 | 9.40 | 5.70 | 5.70 | 5.00 | 15.60 | 6.30 |
| 27 | 6.90 | 7.80 | 8.30 | 5.50 | 5.50 | 6.00 | 16.50 | 6.60 |
| 28 | 6.80 | 7.30 | 7.80 | 5.50 | 5.30 | 7.50 | 13.90 | 6.50 |
| 29 | 6 80 | 7.50 | 9.80 | 5.50 | 5.30 | 6.50 | 11.30 | 6.50 |
| 30 | 7.00 | 7.80 | 12.70 | 5.40 | 5.20 | 6.40 | 9.00 | 6.40 |
| 31 | 7.70 | | 14.00 | 5.40 | | 6.30 | | 6.00 |

## TRINITY RIVER AT DALLAS, TEXAS.

This river rises in Montague and Cooke counties, in northern Texas, the headwater streams draining the area within a few miles of Red River on the north. The general course of Trinity River is southeasterly, and it empties into the Gulf of Mexico at Galveston. The entire basin is located in Texas. The station, established October 1, 1898, is located at Turtle Creek pump house, 3 miles north of the court-house in Dallas. The height of the water is indicated by a pointer which slides up and down in the well of the pump house. This well is connected with the river by a pipe. Measurements of discharge are made by wading. The channel is practically straight above and below the point of measurement. The right bank is high, the left bank low and liable to overflow. The bed of the stream is of gravel and shifting. There was no discharge of the river from June 22 to October 30. Three discharge measurements were made during 1899 by Thomas U. Taylor, as follows: The first one, on June 20, at a gage height of 57 feet, gave a discharge of 269 second-feet; June 22, a gage height of 53.30 feet gave a discharge of 0 second-feet; the third measurement was on December 29, at a gage height of 56.60 feet, and gave a discharge of 336 second-feet.

*Daily gage height, in feet, of Trinity River at Dallas, Texas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 55.50 | 55.25 | 55.50 | 54.20 | 57.45 | 55.50 | 64.60 | 56.20 | 52.65 | 50.35 | 60.25 | 59.75 |
| 2 | 55.40 | 54.90 | 55.85 | 54.20 | 56.85 | 55.40 | 63.25 | 55.75 | 52.25 | 50.35 | 60.45 | 56.70 |
| 3 | 55.40 | 54.55 | 55.80 | 54.20 | 56.60 | 55.30 | 58.60 | 55.45 | 51.80 | 50.00 | 60.55 | 56.45 |
| 4 | 55.40 | 54.40 | 55.45 | 54.20 | 56.30 | 55.20 | 59.05 | 55.20 | 51.40 | 50.25 | 58.80 | 56.25 |
| 5 | 55.30 | 54.60 | 55.45 | 54.30 | 55.85 | 55.20 | 63.20 | 55.20 | 51.05 | 49.95 | 57.30 | 56.05 |
| 6 | 55.25 | 54.95 | 55.00 | 54.80 | 55.70 | 55.15 | 73.35 | 54.95 | 50.25 | 50.20 | 56.05 | 56.00 |
| 7 | 55.15 | 54.85 | 54.40 | 54.65 | 57.10 | 55.00 | 69.60 | 54.80 | 51.15 | 50.20 | 55.70 | 56.00 |
| 8 | 55.30 | 54.65 | 54.65 | 54.50 | 57.50 | 55.00 | 59.45 | 54.80 | 51.05 | 50.25 | 55.55 | 56.00 |
| 9 | 55.65 | 54.65 | 54.45 | 54.50 | 58.75 | 54.95 | 57.25 | 54.75 | 50.80 | 50.25 | 55.40 | 56.05 |
| 10 | 55.55 | 54.80 | 53.95 | 54.50 | 61.10 | 55.60 | 56.75 | 54.65 | 49.80 | 50.30 | 55.30 | 56.20 |
| 11 | 55.75 | 54.40 | 53.90 | 54.70 | 59.00 | 56.45 | 56.55 | 54.55 | 51.05 | 50.35 | 55.15 | 56.35 |
| 12 | 55.65 | 54.25 | 53.90 | 54.95 | 59.75 | 61.70 | 56.30 | 54.75 | 51.20 | 50.30 | 54.95 | 57.75 |
| 13 | 56.30 | 54.45 | 54.10 | 55.00 | 58.05 | 62.55 | 56.20 | 54.60 | 51.15 | 49.75 | 54.95 | 59.80 |
| 14 | 59.10 | 54.55 | 54.55 | 54.65 | 57.55 | 58.75 | 56.45 | 54.50 | 51.00 | 50.25 | 54.95 | 61.20 |
| 15 | 58.15 | 54.95 | 54.35 | 54.95 | 57.70 | 57.95 | 56.05 | 54.40 | 51.15 | 50.30 | 54.95 | 61.80 |
| 16 | 57.50 | 54.45 | 54.10 | 55.80 | 57.70 | 57.65 | 55.70 | 54.35 | 50.95 | 50.30 | 55.00 | 60.60 |
| 17 | 56.85 | 54.80 | 54.00 | 56.70 | 57.75 | 59.65 | 55.40 | 54.35 | 51.35 | 50.05 | 54.60 | 58.85 |
| 18 | 56.45 | 54.55 | 54.65 | 57.10 | 58.00 | 61.10 | 55.30 | 54.40 | 51.40 | 50.00 | 54.25 | 57.55 |
| 19 | 56.05 | 54.90 | 54.40 | 56.60 | 57.80 | 58.25 | 55.45 | 54.20 | 50.35 | 50.00 | 54.05 | 56.85 |
| 20 | 55.70 | 54.45 | 54.00 | 56.30 | 56.95 | 57.20 | 55.80 | 53.75 | 50.65 | 50.00 | 58.20 | 56.50 |
| 21 | 55.55 | 54.30 | 53.95 | 55.90 | 56.80 | 58.20 | 55.30 | 53.40 | 51.30 | 49.90 | 67.30 | 56.50 |
| 22 | 55.45 | 54.75 | 54.25 | 55.65 | 56.80 | 58.40 | 58.25 | 53.05 | 51.30 | 49.80 | 71.05 | 57.30 |
| 23 | 55.50 | 54.40 | 54.10 | 55.50 | 56.80 | 58.55 | 57.50 | 52.75 | 51.40 | 49.80 | 65.45 | 57.70 |
| 24 | 55.55 | 54.05 | 54.05 | 55.55 | 57.00 | 58.60 | 57.30 | 52.40 | 51.10 | 49.80 | 62.75 | 58.40 |
| 25 | 55.40 | 54.50 | 54.15 | 55.60 | 57.95 | 57.90 | 56.65 | 52.00 | 50.38 | 49.80 | 64.20 | 57.35 |
| 26 | 55.15 | 54.40 | 54.20 | 57.30 | 58.00 | 56.95 | 56.20 | 51.55 | 49.80 | 49.80 | 68.10 | 57.15 |
| 27 | 55.00 | 54.20 | 54.25 | 58.30 | 58.00 | 56.40 | 55.80 | 51.85 | 50.25 | 49.80 | 71.90 | 57.25 |
| 28 | 55.20 | 54.05 | 54.45 | 58.55 | 57.60 | 56.00 | 57.10 | 52.00 | 50.15 | 49.95 | 74.55 | 56.80 |
| 29 | 55.30 | ...... | 54.30 | 58.55 | 56.85 | 55.90 | 56.45 | 52.15 | 50.00 | 50.15 | 76.00 | 56.55 |
| 30 | 55.25 | ...... | 54.25 | 58.00 | 55.85 | 59.20 | 55.85 | 52.35 | 50.10 | 53.10 | 74.45 | 56.40 |
| 31 | 55.30 | ...... | 54.20 | ...... | 55.65 | ...... | 56.10 | 52.50 | ...... | 59.30 | ...... | ...... |

## BRAZOS RIVER AT WACO, TEXAS.

This river has its source in the Staked Plains region of western Texas, and has a general southeasterly course, emptying into the Gulf of Mexico south of the mouth of Trinity River. Its drainage basin is entirely within the State of Texas. The gaging station, established by T. U. Taylor September 14, 1898, is located at the Austin street bridge, northwest of Waco. The gage is inclined, the channel straight, and the banks high. The bed of the stream is of shifting sand. Measurements of discharge have been made under the suspension bridge above the railroad bridge. Under the former, at low water, is a sand bar, which does not, however, affect the reliability of the measurements, as there are then two distinct channels. Three measurements of discharge were made in 1899 by Thomas U. Taylor: The first, on June 19, at a gage height of 18.50 feet, showed a discharge of 58,700 second-feet; the measurement of June 26, at a gage height of 6.90 feet, gave a discharge of 4,430 second-feet; while the third measurement, on December 30, at a gage height of 4.90 feet, showed a discharge of 2,085 second-feet.

*Daily gage height, in feet, of Brazos River at Waco, Texas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.70 | 2.30 | 2.20 | 1.80 | 2.10 | 6.00 | *a*15.00 | 5.30 | 2.45 | 1.10 | 7.10 | 5.30 |
| 2 | 2.65 | 2.35 | 2.25 | 1.90 | 2.05 | 5.45 | 17.00 | 5.00 | 2.40 | 1.10 | 6.65 | 4.90 |
| 3 | 2.60 | 2.40 | 2.20 | 1.90 | 2.00 | 4.75 | 12.45 | 4.90 | 2.30 | 1.10 | 6.10 | 4.45 |
| 4 | 2.50 | 2.40 | 2.20 | 1.90 | 2.40 | 4.25 | 11.25 | 4.70 | 2.40 | 2.00 | 5.65 | 4.20 |
| 5 | 2.50 | 2.40 | 2.15 | 1.90 | 2.70 | 4.00 | 14.85 | 4.20 | 2.30 | 2.00 | 5.30 | 4.05 |
| 6 | 2.50 | 2.35 | 2.10 | 2.20 | 2.70 | 3.70 | 12.60 | 3.95 | 2.30 | 2.00 | 5.00 | 3.95 |
| 7 | 2.60 | 2.40 | 2.10 | 2.10 | 2.60 | 3.85 | 12.20 | 3.75 | 2.30 | 2.00 | 4.75 | 3.85 |
| 8 | 2.50 | 2.25 | 2.00 | 2.10 | 2.60 | 7.40 | 10.10 | 3.60 | 2.30 | 1.90 | 4.35 | 3.85 |
| 9 | 2.50 | 2.25 | 2.20 | 2.10 | 2.55 | 10.30 | 9.00 | 3.60 | 2.20 | 1.90 | 4.10 | 3.95 |
| 10 | 2.50 | 2.40 | 2.05 | 2.10 | 3.15 | 9.45 | 8.40 | 3.50 | 2.20 | 1.95 | 3.85 | 4.25 |
| 11 | 2.50 | 2.40 | 2.00 | 2.05 | 5.10 | 7.95 | 8.35 | 3.40 | 2.15 | 1.95 | 3.70 | 6.45 |
| 12 | 2.50 | 2.30 | 1.95 | 1.95 | 5.25 | 7.40 | 7.50 | 3.30 | 2.10 | 1.90 | 3.60 | 9.75 |
| 13 | 2.50 | 2.30 | 1.90 | 1.80 | 5.75 | 7.10 | 6.95 | 3.20 | 2.10 | 1.90 | 3.50 | 8.60 |
| 14 | 2.50 | 2.30 | 2.00 | 1.90 | 4.70 | 6.60 | 6.50 | 3.15 | 2.10 | 1.90 | 3.40 | 7.55 |
| 15 | 2.60 | 2.30 | 2.00 | 5.90 | 4.05 | 6.30 | 6.25 | 3.10 | 2.10 | 1.90 | 3.30 | 6.70 |
| 16 | 2.45 | 2.30 | 2.00 | 2.75 | 4.20 | 6.60 | 5.90 | 3.00 | 2.05 | 1.90 | 3.20 | 6.00 |
| 17 | 2.40 | 2.40 | 2.00 | 2.55 | 4.30 | 10.00 | 5.70 | 3.00 | 2.10 | 1.90 | 3.15 | 5.80 |
| 18 | 2.40 | 2.40 | 2.00 | 2.60 | 6.20 | 6.55 | 5.65 | 2.95 | 2.15 | 1.90 | 3.10 | 5.70 |
| 19 | 2.45 | 2.40 | 2.10 | 2.45 | 5.55 | 18.50 | 5.40 | 2.90 | 2.10 | 1.90 | 3.30 | 5.15 |
| 20 | 2.50 | 2.35 | 1.95 | 2.40 | 4.80 | 20.70 | 5.20 | 2.80 | 2.10 | 1.90 | 5.90 | 4.95 |
| 21 | 2.50 | 2.30 | 1.90 | 2.35 | 4.20 | 18.05 | 5.15 | 2.80 | 2.30 | 1.90 | 19.85 | 5.85 |
| 22 | 2.55 | 2.30 | 1.90 | 2.30 | 4.10 | 10.25 | 5.00 | 2.70 | 2.65 | 1.90 | 21.85 | 9.40 |
| 23 | 2.40 | 2.30 | 1.80 | 2.30 | 3.75 | 9.10 | 5.30 | 2.70 | 2.45 | 1.90 | 11.85 | 6.55 |
| 24 | 2.50 | 2.30 | 1.90 | 2.20 | 4.50 | 8.20 | 9.95 | 2.70 | 2.40 | 1.90 | 8.90 | 6.20 |
| 25 | 2.50 | 2.30 | 1.80 | 2.20 | 6.40 | 7.35 | 9.00 | 2.60 | 2.30 | 1.95 | 8.40 | 6.10 |
| 26 | 2.40 | 2.30 | 1.90 | 2.15 | 5.85 | 6.85 | 8.30 | 2.55 | 2.40 | 2.25 | 7.25 | 5.75 |
| 27 | 2.40 | 2.30 | 1.90 | 2.20 | 5.45 | 6.30 | 7.25 | 2.50 | 2.40 | 2.55 | 6.70 | 5.50 |
| 28 | 2.40 | 2.20 | 1.90 | 2.20 | 5.05 | 6.10 | 6.60 | 2.50 | 2.35 | 2.50 | 6.20 | 5.05 |
| 29 | 2.35 | ....... | 1.85 | 2.10 | 5.00 | *a*9.00 | 6.10 | 2.50 | 2.20 | 9.15 | 5.60 | 4.95 |
| 30 | 2.40 | ...... | 1.80 | 2.05 | 7.25 | *a*12.00 | 5.90 | 2.50 | ....... | 11.00 | 5.45 | 4.85 |
| 31 | 2.30 | ....... | 1.80 | ....... | 6.50 | ....... | 5.70 | 2.50 | ....... | 8.30 | ....... | 4.70 |

*a* Estimated.

## BRAZOS RIVER AT LEWIS, TEXAS.

This station, established by Thomas U. Taylor February 22, 1898, is at the International and Great Northern Railroad bridge about 1¼ miles southwest of the town of Lewis, Texas, and about 75 miles below the station at Waco. After the establishment of the Waco station the one at Lewis was not of much importance, and was discontinued February 25, 1899. No measurements of discharge were made here during 1899.

*Daily gage height, in feet, of Brazos River at Lewis, Texas, for 1899.*

| Day. | Jan. | Feb. | Day. | Jan. | Feb. | Day. | Jan. | Feb. | Day. | Jan. | Feb. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.40 | 4.30 | 9 | 4.50 | 4.20 | 17 | 4.60 | 4.20 | 25 | 4.30 | 4.20 |
| 2 | 4.40 | 4.25 | 10 | 4.60 | 4.20 | 18 | 4.45 | 4.20 | 26 | 4.25 | ........ |
| 3 | 4.35 | 4.20 | 11 | 4.80 | 4.20 | 19 | 4.40 | 4.20 | 27 | 4.20 | ........ |
| 4 | 4.30 | 4.20 | 12 | 5.15 | 4.20 | 20 | 4.40 | 4.20 | 28 | 4.15 | ........ |
| 5 | 4.40 | 4.20 | 13 | 5.45 | 4.20 | 21 | 4.40 | 4.20 | 29 | 4.05 | ........ |
| 6 | 4.70 | 4.10 | 14 | 6.25 | 4.20 | 22 | 4.35 | 4.20 | 30 | 4.15 | ........ |
| 7 | 4.55 | 4.15 | 15 | 5.10 | 4.20 | 23 | 4.25 | 4.20 | 31 | 4.20 | ........ |
| 8 | 4.50 | 4.20 | 16 | 4.85 | 4.20 | 24 | 4.20 | 4.20 | | | |

Station discontinued February 25.

## COLORADO RIVER AT AUSTIN, TEXAS.

This river drains a large area in central Texas. It rises in the extreme western portion of the State, within a few miles of the western boundary of New Mexico, and flows in a general southeasterly direction, emptying into the Gulf of Mexico in Matagorda County. Its head-water tributaries drain the country immediately south of the Brazos River. Llano Creek is a tributary of Colorado River and empties into it 85 miles above Austin. On March 14, 1899, this stream was measured one-half mile west of the station at Llano, Texas, and showed a discharge of 76 second-feet; a second measurement was made below on this creek, 200 yards above its junction with the Colorado River at Kingsland, on the same date, which also showed a discharge of 76 second-feet. On March 13 the main Colorado River, at a short distance below the wagon bridge near Marble Falls, Texas, showed a discharge of 197 second-feet. The river was also measured four times at the head of Lake McDonald, about 20 miles above Austin. On January 31 it showed a discharge of 210 second-feet; on October 3 the discharge was 134 second-feet; on October 4 the discharge was also 134 second-feet; and on the same date, at another section near by, the discharge was 136 second-feet. On March 15 two measurements were made at the power house at the Austin dam. The first measurement was in the fore bay, and showed a discharge of 206 second-feet; immediately afterwards the tailrace was measured and showed a discharge of 233 second-feet. The station maintained during 1899 is located at the Congress avenue bridge, south of the city of Austin. The gage rod is a vertical timber attached to a bath house near by. The bench mark is on the first flange above the cribwork of the north pier of the highway bridge, and is 4.78 feet above the zero of the gage. The following measurements of discharge were made by Thomas U. Taylor during 1899:

March 17, gage height, 1.70 feet; discharge, 267 second-feet.
March 31, gage height, 1.50 feet; discharge, 170 second-feet.
November 10, gage height, 1.71 feet; discharge, 476 second-feet.
November 16, gage height, 1.50 feet; discharge, 386 second-feet.
November 28, gage height, 2.36 feet; discharge, 1,156 second-feet.
December 5, gage height, 2.02 feet; discharge, 686 second-feet.

*Daily gage height, in feet, of Colorado River at Austin, Texas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.90 | 2.00 | 1.85 | 1.45 | 2.05 | 3.60 | 3.85 | 3.10 | 1.45 | 1.05 | 2.80 | 2.65 |
| 2 | 1.85 | 1.95 | 1.85 | 1.45 | 2.05 | 3.20 | 3.35 | 2.45 | 1.45 | 1.05 | 2.35 | 2.50 |
| 3 | 1.85 | 1.90 | 1.75 | 1.45 | 2.00 | 2.95 | 3.55 | 2.30 | 1.45 | .90 | 2.10 | 2.50 |
| 4 | 1.95 | 2.05 | 1.85 | 1.45 | 2.10 | 3.55 | 3.50 | 1.95 | 1.45 | .85 | 2.10 | 2.20 |
| 5 | 1.95 | 1.95 | 1.85 | 1.55 | 2.00 | 3.15 | 3.65 | 1.80 | 1.45 | .90 | 1.95 | 2.05 |
| 6 | 1.95 | 1.90 | 1.85 | 1.50 | 2.05 | 2.85 | 3.45 | 1.70 | 1.40 | .90 | 1.95 | 2.05 |
| 7 | 1.85 | 1.90 | 1.90 | 1.50 | 1.95 | 11.35 | 3.15 | 1.75 | 1.40 | .85 | 2.00 | 2.05 |
| 8 | 1.95 | 1.85 | 1.80 | 1.45 | 1.85 | 21.05 | 2.95 | 1.75 | 1.40 | .80 | 1.90 | 2.40 |
| 9 | 1.95 | 1.90 | 1.85 | 1.45 | 1.95 | 17.60 | 3.60 | 1.65 | 1.40 | .85 | 1.80 | 2.75 |
| 10 | 1.95 | 1.90 | 1.80 | 1.45 | 2.00 | 14.75 | 3.25 | 1.65 | 1.35 | .90 | 1.75 | 3.45 |
| 11 | 1.95 | 1.90 | 1.75 | 1.45 | 2.00 | 9.00 | 3.00 | 1.65 | 1.35 | .90 | 1.70 | 6.40 |
| 12 | 2.05 | 2.10 | 1.75 | 1.45 | 4.10 | 5.30 | 2.80 | 1.55 | 1.35 | .90 | 1.65 | 5.35 |
| 13 | 1.95 | 1.95 | 1.75 | 1.50 | 7.95 | 4.45 | 2.65 | 1.55 | 1.35 | .90 | 1.60 | 4.30 |
| 14 | 1.90 | 1.80 | 1.75 | 1.55 | 7.10 | 4.10 | 2.50 | 1.55 | 1.35 | .90 | 1.65 | 3.70 |
| 15 | 1.85 | 1.75 | 1.80 | 1.50 | 5.30 | 3.60 | 2.30 | 1.55 | 1.35 | .90 | 1.60 | 3.35 |
| 16 | 1.90 | 1.80 | 1.80 | 1.50 | 4.55 | 3.75 | 2.15 | 1.55 | 1.35 | .90 | 1.55 | 3.05 |
| 17 | 1.90 | 1.85 | 1.75 | 1.55 | 3.85 | 4.40 | 2.05 | 1.55 | 1.35 | .85 | 1.50 | 2.85 |
| 18 | 1.95 | 1.80 | 1.75 | 1.65 | 3.40 | 5.90 | 2.00 | 1.55 | 1.35 | .95 | 1.45 | 2.70 |
| 19 | 1.95 | 1.75 | 1.75 | 1.80 | 3.20 | 6.60 | 2.00 | 1.55 | 1.30 | 1.45 | 1.75 | 2.60 |
| 20 | 1.90 | 1.75 | 1.70 | 1.90 | 3.00 | 6.15 | 2.00 | 1.65 | 1.30 | .95 | 2.00 | 2.65 |
| 21 | 1.90 | 1.75 | 1.65 | 3.95 | 2.75 | 4.90 | 1.90 | 1.55 | 1.25 | .90 | 5.35 | 2.75 |
| 22 | 1.90 | 1.75 | 1.65 | 3.80 | 2.45 | 6.00 | 1.85 | 1.55 | 1.25 | .90 | 6.35 | 2.90 |
| 23 | 1.90 | 1.85 | 1.60 | 3.45 | 4.20 | 5.15 | 1.80 | 1.55 | 1.15 | .90 | 4.55 | 4.05 |
| 24 | 1.90 | 1.90 | 1.60 | 3.05 | 4.05 | 4.15 | 1.80 | 1.55 | 1.15 | 1.40 | 5.65 | 3.90 |
| 25 | 1.95 | 1.85 | 1.60 | 2.85 | 4.75 | 3.75 | 1.75 | 1.55 | 1.10 | 1.35 | 3.00 | 3.40 |
| 26 | 1.90 | 1.85 | 1.60 | 2.65 | 4.50 | 3.45 | 2.35 | 1.55 | 1.15 | 1.45 | 2.65 | 3.05 |
| 27 | 1.90 | 1.85 | 1.60 | 2.55 | 5.05 | 3.15 | 2.45 | 1.55 | 1.15 | 1.55 | 2.55 | 2.85 |
| 28 | 1.90 | 1.75 | 1.60 | 2.45 | 4.85 | 2.95 | 2.20 | 1.55 | 1.15 | 2.30 | 2.35 | 2.75 |
| 29 | 1.90 | ....... | 1.55 | 2.35 | 4.10 | 2.85 | 3.30 | 1.55 | 1.15 | 3.35 | 2.35 | 2.70 |
| 30 | 1.90 | ....... | 1.45 | 2.25 | 3.70 | 2.75 | 4.25 | 1.55 | 1.05 | 2.90 | 2.95 | 2.55 |
| 31 | 1.95 | ....... | 1.50 | ....... | 3.35 | ....... | 3.60 | 1.55 | ....... | 3.10 | ....... | ....... |

## GUADALUPE RIVER AT NEW BRAUNFELS, TEXAS.

This river drains a small area in central Texas. Its source is in Kerr County, and it has a general southeasterly direction, emptying into the Gulf of Mexico in Calhoun County. At New Braunfels it receives Comal River, which is the principal source of supply for the upper Guadalupe. Comal River is simply the outlet of a series of large springs near New Braunfels and is only about 3 miles long. These springs maintain a very constant flow throughout the entire year. Comal River is described in Bulletin 140, page 84. The gaging station at New Braunfels is about 1 mile east of the town, near the highway bridge, and below the International and Great Northern Railroad bridge, and was established March 13, 1898. It is located below the mouth of Comal River, and hence includes the flood waters of the main Guadalupe besides the very equable discharge of Comal River. Two measurements of discharge were made by Thomas U. Taylor during 1899: The first, on March 16, with a gage height of 1.80, showed a total discharge of the two channels of 358 second-feet; the second one, on December 23, with a gage height of 2.70 feet, gave a discharge of 797 second-feet.

*Daily gage height, in feet, of Guadalupe River at New Braunfels, Texas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.90 | 3.65 | 2.00 | 1.80 | 1.70 | 2.40 | 2.00 |
| 2 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.90 | 2.65 | 2.00 | 1.80 | 1.70 | 2.30 | 2.00 |
| 3 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.85 | 2.45 | 1.90 | 1.80 | 1.70 | 2.05 | 2.00 |
| 4 | 1.80 | 1.80 | 1.80 | 1.80 | 2.15 | 1.80 | 2.35 | 1.90 | 1.80 | 1.70 | 2.00 | 1.90 |
| 5 | 1.80 | 1.80 | 1.80 | 1.85 | 2.05 | 1.80 | 2.60 | 1.90 | 1.80 | 1.70 | 2.00 | 1.90 |
| 6 | 1.80 | 1.80 | 1.80 | 1.90 | 1.85 | 3.85 | 2.60 | 1.90 | 1.80 | 1.70 | 2.00 | 1.90 |
| 7 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 3.25 | 2.50 | 1.90 | 1.80 | 1.70 | 1.90 | 1.95 |
| 8 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 16.00 | 2.45 | 1.90 | 1.80 | 1.70 | 1.90 | 2.65 |
| 9 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 8.00 | 2.30 | 1.85 | 1.80 | 1.70 | 1.90 | 2.60 |
| 10 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 4.20 | 2.30 | 1.80 | 1.80 | 1.70 | 1.90 | 2.30 |
| 11 | 1.80 | 1.80 | 1.80 | 1.80 | 2.65 | 3.55 | 2.25 | 1.80 | 1.80 | 1.70 | 1.90 | 2.20 |
| 12 | 1.80 | 1.80 | 1.80 | 1.80 | 2.10 | 3.10 | 2.20 | 1.80 | 1.80 | 1.70 | 1.90 | 2.20 |
| 13 | 1.80 | 1.80 | 1.80 | 1.80 | 1.95 | 3.45 | 2.10 | 1.80 | 1.80 | 1.70 | 1.60 | 2.10 |
| 14 | 1.80 | 1.80 | 1.80 | 1.80 | 1.90 | 3.00 | 2.10 | 1.80 | 1.80 | 1.70 | 1.90 | 2.10 |
| 15 | 1.80 | 1.80 | 1.80 | 1.85 | 1.90 | 2.75 | 2.10 | 1.80 | 1.80 | 1.70 | 1.90 | 2.00 |
| 16 | 1.80 | 1.80 | 1.80 | 1.85 | 1.90 | 2.55 | 2.10 | 1.80 | 1.80 | 1.70 | 1.90 | 2.00 |
| 17 | 1.80 | 1.80 | 1.80 | 1.80 | 1.90 | 4.45 | 2.00 | 1.80 | 1.80 | 1.70 | 1.80 | 2.00 |
| 18 | 1.80 | 1.80 | 1.80 | 1.80 | 1.90 | 3.05 | 2.00 | 1.80 | 1.80 | 1.70 | 1.80 | 2.10 |
| 19 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 3.15 | 2.00 | 1.80 | 1.80 | 1.70 | 1.90 | 2.25 |
| 20 | 1.80 | 1.80 | 1.80 | 1.95 | 1.80 | 2.85 | 1.90 | 1.80 | 1.80 | 1.70 | 2.15 | 2.40 |
| 21 | 1.80 | 1.80 | 1.80 | 2.45 | 1.80 | 2.60 | 1.90 | 1.80 | 1.80 | 1.90 | 2.10 | 2.65 |
| 22 | 1.80 | 1.80 | 1.80 | 2.20 | 1.80 | 2.50 | 1.90 | 1.80 | 1.80 | 2.00 | 2.10 | 2.80 |
| 23 | 1.80 | 1.80 | 1.80 | 2.00 | 4.20 | 2.45 | 1.90 | 1.80 | 1.80 | 2.00 | 2.30 | 2.70 |
| 24 | 1.80 | 1.80 | 1.80 | 2.00 | 2.90 | 2.40 | 1.90 | 1.80 | 1.80 | 2.00 | 2.30 | 2.55 |
| 25 | 1.80 | 1.80 | 1.80 | 2.00 | 2.50 | 2.40 | 2.00 | 1.80 | 1.80 | 2.00 | 2.30 | 2.40 |
| 26 | 1.80 | 1.80 | 1.80 | 2.00 | 2.30 | 2.30 | 2.00 | 1.80 | 1.75 | 2.00 | 2.10 | 2.30 |
| 27 | 1.80 | 1.80 | 1.80 | 1.90 | 2.05 | 2.20 | 2.00 | 1.80 | 1.70 | 2.15 | 2.10 | 2.30 |
| 28 | 1.80 | 1.80 | 1.80 | 1.80 | 2.00 | 2.20 | 4.50 | 1.80 | 1.70 | 6.15 | 2.00 | 2.20 |
| 29 | 1.80 | ....... | 1.80 | 1.80 | 2.00 | 2.15 | 2.35 | 1.80 | 1.70 | 3.30 | 2.00 | 2.20 |
| 30 | 1.80 | ....... | 1.80 | 1.80 | 2.00 | 2.10 | 2.20 | 1.80 | 1.70 | 2.70 | 2.00 | 2.20 |
| 31 | 1.80 | ....... | 1.80 | ....... | 1.90 | ....... | 2.00 | 1.80 | ....... | 2.45 | ....... | ....... |

## LEONA RIVER AT UVALDE, TEXAS.

In former years there was located in the southern suburbs of Uvalde a large spring with constant flow, known as "Leona spring." This spring was dry but once between 1870 and 1893, viz, in 1885. It soon revived, however, and continued flowing up to 1893, when the discharge stopped, and no water has issued from it since that date. The water in the wells in the vicinity in 1884 was 25 feet below the surface of the ground, but in 1899 the level was about 50 feet below the surface. A pumping station was located on the banks of Leona River, near Leona spring, in 1893, but after one or two years the river failed to such an extent that the entire pumping plant was moved to within 150 yards of the court-house at Uvalde. At the new station a 15 by 15 foot pit was excavated 24 feet deep, and the pumps were placed at the bottom of this pit, and then a well 4 by 7 feet square was sunk from this level to a depth of 16 feet, out of which the water was pumped into a standpipe. The water at first rose in this well to within 35 feet of the ground surface. In December, 1897, it was noticed that the supply was failing, and this continued until May, 1898, when a second pit, 10 by 10 feet, and 9 feet deep, was excavated on the southwest side of the first pit, and the well was also lowered until its bottom was 63 feet below the ground surface; when the pumps were finally lowered, their new position was 33 feet below the surface. In January, 1899, it was found necessary to sink three small drill wells in the bottom of the main pump well to a depth of

30 to 35 feet, reaching a total depth of 98 feet from the surface of the ground.

Leona River, in 1895, was found by Mr. Cyrus C. Babb to be dry under the railroad bridge, but at the crossing 1½ miles south of the town a discharge of 11 second-feet was found. The river ceased flowing at this crossing in January, 1898. About June 15, 1899, heavy rains fell over Uvalde and Kinney counties, raising the Leona River to a flowing depth of 6 to 8 feet. Notwithstanding this, on June 28, 1899, when visited by Thomas U. Taylor, the river was dry at the crossing above referred to. The bed of the stream was followed to the head of the upper irrigation ditch about 4 miles below the town of Uvalde, but no flowing water was found. The only irrigation along Leona River in 1899 was done through the agency of a steam pump 10 or 12 miles below Uvalde.

### LAS MORAS SPRING, NEAR BRACKETTVILLE, TEXAS.

This spring is located at Fort Clark, near Brackettville, 10 miles distant from Spofford, on the Southern Pacific Railroad. The discharge from this spring was measured by Prof. Thomas U. Taylor on June 30, 1899, when 60 second-feet was found. A measurement on December 24, 1895, near the same point, by Cyrus C. Babb, showed a discharge of 21 second-feet.

### SAN FELIPE SPRINGS, NEAR DEL RIO, TEXAS.

San Felipe Creek has its source in four large springs, the upper one being 2 miles above the railroad bridge near Del Rio, the others being within about 200 yards of the bridge. On June 29, 1899, the creek was measured by Prof. Thomas U. Taylor, at a point about 200 yards below the railroad bridge, and a discharge of 84 second-feet was found. Madre ditch diverts water from one of these springs above the point of measurement, and on June 29 its discharge was found to be 29 second-feet. Previous measurements at this locality will be found in Bulletin 140, page 85.

### RIO GRANDE AT DEL NORTE, COLORADO.

This river has its source in the Continental Divide in southern Colorado. Its general course is easterly through its mountainous collecting area until San Luis Park is reached, when it gradually takes a southeasterly course, and then just before crossing the State line into New Mexico it bends southward and continues this general course throughout New Mexico. The station is located about 2 miles above the town of Del Norte, Colorado, well above most of the irrigation ditches which divert water from this river. The gage consists of an inclined 2 by 6 inch plank fastened to a post driven into the right bank of the river. Bench mark No. 1 is a large nail in the root of a tree 15 feet northeast of the end of the cable on the left bank of the river and is 7.54 feet above gage datum. Bench mark No. 2 is a large nail in the root of a tree 25 feet northwest of the end of the inclined gage, and is also 7.54 feet above gage datum. While the banks are not high, the river has never been known to overflow. The current is swift; the bed is composed of small stone, and has not materially changed during the last year. Discharge measurements are made from a box suspended from a five-eighths inch wire cable fastened to trees on each side of the river. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 247; 1897, Nineteenth Annual Report, Part IV, page 383; 1898, Twentieth Annual Report, Part IV, page 360. The following discharge measurements were made by A. L. Fellows during 1899:

April 25, gage height, 2.42 feet; discharge, 1,004 second-feet.
May 24, gage height, 2.92 feet; discharge, 1,480 second-feet.
June 29, gage height, 2.10 feet; discharge, 734 second-feet.
August 21, gage height, 1.58 feet; discharge, 387 second-feet.

*Daily gage height, in feet, of Rio Grande at Del Norte, Colorado, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | 1.62 | 1.90 | 2.94 | 2.00 | 2.24 | 1.46 | | | |
| 2 | | | | | | | | | | | | 1.96 |
| 3 | | | | 1.48 | 1.82 | 2.62 | 2.12 | 2.20 | 1.50 | | | |
| 4 | | 2.64 | 2.82 | | | | | | | | 1.64 | |
| 5 | | | | 1.40 | 1.86 | 2.44 | 1.98 | 2.64 | 1.48 | | | |
| 6 | | | | | | | | | | | | |
| 7 | 2.76 | | | 1.40 | 1.96 | 2.50 | 2.12 | 2.42 | 1.40 | 1.50 | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | 1.52 | 2.16 | 2.68 | 1.94 | 2.12 | 1.40 | | | 2.00 |
| 10 | | | | | | | | | | | | |
| 11 | | 2.60 | 2.66 | 1.70 | 3.62 | 2.82 | 1.90 | 2.00 | 1.40 | | 1.60 | |
| 12 | | | | | | | | | | | | |
| 13 | | | | 1.84 | 3.54 | 2.90 | 1.80 | 1.84 | 1.38 | | | |
| 14 | 2.74 | | | | | | | | | 1.90 | | |
| 15 | | | | 1.92 | 3.20 | 2.62 | 1.86 | 1.76 | 2.12 | | | |
| 16 | | | | | | | | | | | | 2.30 |
| 17 | | | | 2.04 | 3.18 | 2.50 | 1.86 | 1.82 | 1.86 | | | |
| 18 | | 2.46 | 2.04 | | | | | | | | 1.62 | |
| 19 | | | | 2.10 | 3.14 | 2.38 | 2.74 | 1.70 | 1.64 | | | |
| 20 | | | | | | | | | | | | |
| 21 | 2.68 | | | 2.14 | 3.02 | 2.32 | 2.14 | 1.60 | 1.58 | 1.80 | | |
| 22 | | | | | | | | | | | | |
| 23 | | | | 2.30 | 2.84 | 2.20 | 2.02 | 1.60 | 1.52 | | | 2.04 |
| 24 | | | | | | | | | | | | |
| 25 | | 2.48 | 1.96 | 2.46 | 3.04 | 2.10 | 1.84 | 1.54 | 1.48 | | 2.04 | |
| 26 | | | | | | | | | | | | |
| 27 | | | | 2.28 | 2.96 | 2.48 | 1.84 | 1.50 | 1.44 | | | |
| 28 | 2.84 | | | | | | | | | 1.72 | | |
| 29 | | | | 2.24 | 2.84 | 2.10 | 2.00 | 1.48 | 1.42 | | | |
| 30 | | | | | | | | | 1.42 | | | 2.12 |
| 31 | | | 1.64 | | 2.90 | | 2.24 | 1.42 | | | | |

## CONEJOS RIVER AT LOS MOGOTES, COLORADO.

This stream rises on the eastern slope of the mountain range which forms the western line of Conejos County, in southern Colorado. It flows southeasterly, and then bending at the town of Conejos flows in a general northeasterly direction, entering the Rio Grande below the mouth of Trinchera Creek. The gage rod, established by A. L. Fellows August 25, 1899, was at first located at a wagon bridge 10 miles above the town of Conejos, but owing to the fact that it was destroyed at this point, it was later moved to a point about 500 yards below. It is here attached to the pier projecting into the river near the house occupied by Gustav Timm, a ranchman who has acted as observer. The channel is fairly good, being of gravel and not particularly liable to either change or overflow. Owing to the removal of the gage it will not be possible to make a rating table for 1899. Two measurements of discharge were made at this point in 1899 by A. L. Fellows: The first, on August 25, at a gage height of 1.00 foot, showed a discharge of 76 second-feet; the second measurement, on November 28, at a gage height of 2.20 feet, showed a discharge of 70 second-feet.

*Daily gage height, in feet, of Conejos River at Los Mogotes, Colorado, for 1899.*

| Day. | Sept. | Oct. | Nov. | Day. | Sept. | Oct. | Nov. | Day. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .95 | 1.02 | 1.15 | 12 | .98 | 1.20 | 1.57 | 23 | 1.18 | 1.30 | 1.50 |
| 2 | .92 | 1.05 | 1.12 | 13 | .95 | 1.38 | 1.57 | 24 | 1.15 | 1.28 | 1.48 |
| 3 | .92 | 1.10 | 1.12 | 14 | .98 | 1.32 | 1.57 | 25 | 1.10 | 1.25 | 1.40 |
| 4 | .92 | 1.12 | 1.10 | 15 | 2.00 | 1.25 | 1.57 | 26 | 1.05 | 1.25 | 1.55 |
| 5 | .90 | 1.10 | [a]1.55 | 16 | 1.75 | 1.22 | 1.65 | 27 | 1.05 | 1.15 | 1.90 |
| 6 | .90 | 1.07 | 1.57 | 17 | 1.65 | 1.25 | 1.70 | 28 | 1.05 | 1.20 | 2.20 |
| 7 | .87 | 1.07 | 1.57 | 18 | 1.50 | 1.28 | 1.70 | 29 | 1.05 | 1.18 | 2.10 |
| 8 | .87 | 1.05 | 1.57 | 19 | 1.30 | 1.25 | 1.70 | 30 | 1.05 | 1.15 | 1.60 |
| 9 | 1.02 | 1.05 | 1.57 | 20 | 1.22 | 1.20 | 1.60 | 31 | ........ | 1.15 | ........ |
| 10 | 1.05 | 1.02 | 1.57 | 21 | 1.22 | 1.30 | 1.58 | | | | |
| 11 | 1.00 | 1.00 | 1.57 | 22 | 1.20 | 1.32 | 1.55 | | | | |

[a] Gage moved to a point near house of Gustav Timm.

### RIO GRANDE AT CENICERO, COLORADO.

The Rio Grande for a number of years has been dry during the summer after passing through San Luis Park, due to the diversion of water above. On August 20 the river 6 miles below Alamosa, Colorado, was carrying 17 second-feet, and on the 23d of the same month, at a point one-half mile above Alamosa, the discharge was found to be 10 second-feet. Just before it crosses the State line into New Mexico it enters the canyon, and in order to obtain the amount of water passing out of the State, a station was located on June 28, 1899, by A. L. Fellows, at the State bridge across the Rio Grande, at a point about 4 miles west of Eastdale, Colorado. The station is favorably located for the purpose, the cross section being fairly uniform, the channel regular and not liable to overflow. The gage consists of two rods, one for low stages, fastened to a rock near the shore; the upper section is fastened to the lower side of the middle pier of the bridge. The observer is Roman Mondragon. The following measurements of discharge were made by A. L. Fellows in 1899:

June 28, gage height, 0.90 foot; discharge, 20 second-feet.
August 24, gage height, 1 foot; discharge, 31 second-feet.
November 28, gage height, 1.80 feet; discharge, 297 second-feet.

*Daily gage height, in feet, of Rio Grande at Cenicero, Colorado, for 1899.*

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | ---------- | 0.78 | 1.00 | 1.00 | 1.30 | 1.50 | 1.80 |
| 2 | ---------- | .90 | 1.00 | 1.00 | 1.30 | 1.50 | 1.80 |
| 3 | ---------- | .88 | .90 | 1.00 | 1.20 | 1.60 | 1.80 |
| 4 | ---------- | .90 | .90 | 1.00 | 1.40 | 1.60 | 1.70 |
| 5 | ---------- | 1.00 | 1.40 | 1.00 | 1.30 | 1.60 | 1.60 |
| 6 | ---------- | .90 | 1.40 | 1.00 | 1.20 | 1.60 | 1.50 |
| 7 | ---------- | .90 | 1.30 | 1.00 | 1.20 | 1.60 | 1.60 |
| 8 | ---------- | .90 | 1.40 | 1.00 | 1.20 | 1.70 | 1.60 |
| 9 | ---------- | .90 | 1.40 | 1.00 | 1.30 | 1.70 | 1.70 |
| 10 | ---------- | .85 | 1.30 | 1.00 | 1.30 | 1.80 | 1.60 |
| 11 | ---------- | .80 | 1.30 | 1.00 | 1.40 | 1.70 | 1.60 |
| 12 | ---------- | .80 | 1.30 | 1.00 | 1.30 | 1.70 | 1.70 |
| 13 | ---------- | .85 | 1.30 | 1.10 | 1.30 | 1.70 | 1.70 |
| 14 | ---------- | .90 | 1.20 | 1.10 | 1.20 | 1.80 | 1.80 |
| 15 | ---------- | 1.00 | 1.10 | 1.60 | 1.30 | 1.80 | 1.90 |
| 16 | ---------- | 1.00 | 1.00 | 2.10 | 1.30 | 1.70 | 2.00 |
| 17 | ---------- | 1.00 | 1.00 | 2.00 | 1.40 | 1.70 | 2.00 |
| 18 | ---------- | .98 | 1.00 | 1.40 | 1.40 | 1.70 | 2.00 |
| 19 | ---------- | 1.00 | 1.00 | 1.50 | 1.40 | 1.70 | 2.00 |
| 20 | ---------- | 1.00 | .90 | 1.50 | 1.40 | 1.70 | 2.00 |
| 21 | ---------- | 1.02 | .90 | 1.50 | 1.40 | 1.70 | 2.00 |
| 22 | ---------- | 1.08 | 1.00 | 1.40 | 1.40 | 1.80 | 2.00 |
| 23 | ---------- | 1.50 | 1.00 | 1.40 | 1.40 | 1.80 | 2.00 |
| 24 | ---------- | 1.50 | 1.00 | 1.40 | 1.40 | 1.80 | 2.00 |
| 25 | ---------- | 1.35 | .95 | 1.30 | 1.50 | 1.80 | 2.00 |
| 26 | ---------- | 1.30 | .90 | 1.30 | 1.50 | 1.80 | 2.00 |
| 27 | ---------- | 1.20 | .90 | 1.30 | 1.50 | 1.80 | 2.00 |
| 28 | 0.90 | 1.10 | 1.00 | 1.30 | 1.50 | 1.80 | 2.00 |
| 29 | .90 | 1.10 | 1.00 | 1.30 | 1.50 | 1.80 | 2.00 |
| 30 | .80 | 1.10 | 1.00 | 1.30 | 1.50 | 1.80 | 2.00 |
| 31 | ---------- | 1.00 | 1.00 | ---------- | 1.50 | ---------- | 2.00 |

## RIO GRANDE AT EMBUDO, NEW MEXICO.

Rio Grande enters the canyon some distance above where it crosses the New Mexico and Colorado line, and continues southward for some distance below Embudo. It receives a number of important tributaries from either side through this section of its course, which contribute to its discharge; and although in recent years the river is dry in the vicinity of Alamosa, Colorado, there is a constant flow at Embudo, New Mexico. The station at this point, established in 1889, is located about 300 feet east of the railroad station at Embudo. The gage is inclined, and consists of a timber fastened to posts driven into the bank of the river. Bench mark No. 1 is a rock near the end of the cable, left bank, marked "B. M." with white paint, and is 20.66 feet above gage datum. Bench mark No. 2 is a rock 100 feet above the cable, left bank, similarly marked, and is 18.79 feet above gage datum. Bench mark No. 3 is a notch cut in the southeastern corner of the station, 2 feet above the platform, and is 30.48 feet above gage datum. The left bank is steep, and the right has a gentle slope. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 251; 1897, Nineteenth Annual Report, Part IV, page 385; 1889 to 1898, Twentieth Annual Report, Part IV, page 366. The following measurements of discharge were made by P. E. Harroun during 1899:

April 7, gage height, 8.20 feet; discharge, 710 second-feet.
April 20, gage height, 9.50 feet; discharge, 1,627 second-feet.
May 4, gage height, 8.60 feet; discharge, 967 second-feet.
May 30, gage height, 8.10 feet; discharge, 745 second-feet.
September 4, gage height, 7 feet; discharge, 183 second-feet.
October 27, gage height, 7.58 feet; discharge, 412 second-feet.

*Daily gage height, in feet, of Rio Grande at Embudo, New Mexico, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.50 | 7.60 | 7.70 | 8.40 | 9.20 | 7.90 | 7.20 | 7.20 | 7.00 | 7.30 | 7.60 | 7.85 |
| 2 | 7.60 | 7.60 | 7.70 | 8.30 | 9.00 | 7.85 | 7.20 | 7.25 | 7.00 | 7.30 | 7.60 | 7.85 |
| 3 | 7.60 | 7.60 | 7.80 | 8.30 | 8.80 | 7.80 | 7.15 | 7.20 | 7.00 | 7.35 | 7.60 | 7.80 |
| 4 | 7.60 | 7.70 | 7.80 | 8.30 | 8.60 | 7.80 | 7.10 | 7.20 | 7.00 | 7.40 | 7.60 | 7.80 |
| 5 | 7.60 | 7.70 | 7.85 | 8.20 | 8.45 | 7.80 | 7.10 | 7.30 | 7.00 | 7.40 | 7.65 | 8.00 |
| 6 | 7.70 | 7.70 | 7.90 | 8.20 | 8.25 | 7.60 | 7.10 | 7.25 | 7.00 | 7.40 | 7.70 | 7.85 |
| 7 | 7.85 | 7.70 | 8.00 | 8.20 | 8.20 | 7.35 | 7.10 | 7.20 | 7.00 | 7.40 | 7.75 | 7.70 |
| 8 | 7.90 | 7.80 | 8.05 | 8.10 | 8.20 | 7.00 | 7.10 | 7.20 | 7.10 | 7.40 | 7.80 | 7.70 |
| 9 | 7.90 | 7.80 | 8.15 | 8.10 | 8.20 | 6.90 | 7.10 | 7.20 | 7.10 | 7.40 | 7.80 | 7.80 |
| 10 | 7.90 | 7.85 | 8.20 | 8.10 | 8.20 | 6.85 | 7.10 | 7.30 | 7.10 | 7.40 | 7.80 | 8.00 |
| 11 | 7.90 | 7.90 | 8.20 | 8.10 | 8.20 | 6.70 | 7.05 | 7.25 | 7.10 | 7.40 | 7.80 | 7.60 |
| 12 | 7.90 | 7.80 | 8.25 | 8.20 | 8.30 | 6.60 | 7.00 | 7.20 | 7.10 | 7.40 | 7.80 | 7.60 |
| 13 | 7.90 | 7.90 | 8.30 | 8.50 | 8.65 | 6.70 | 7.00 | 7.20 | 7.15 | 7.40 | 7.80 | 7.60 |
| 14 | 7.80 | 7.80 | 8.35 | 8.65 | 8.80 | 6.95 | 7.10 | 7.20 | 7.20 | 7.40 | 7.80 | 7.70 |
| 15 | 7.80 | 7.80 | 8.50 | 8.80 | 9.00 | 7.00 | 7.25 | 7.25 | *a* 7.30 | 7.50 | 7.85 | 7.60 |
| 16 | 7.70 | 7.80 | 8.65 | 8.80 | 9.10 | 7.00 | 7.40 | 7.30 | 8.15 | 7.50 | 7.90 | 7.60 |
| 17 | 7.70 | 7.80 | 8.70 | 8.85 | 9.20 | 7.00 | 7.60 | 7.30 | 7.90 | 7.50 | 7.90 | 7.70 |
| 18 | 7.70 | 7.70 | 8.70 | 9.05 | 9.20 | 7.00 | 7.60 | 7.15 | 7.85 | 7.50 | 7.90 | 7.70 |
| 19 | 7.70 | 7.70 | 8.70 | 9.35 | 9.15 | 7.00 | 8.10 | 7.10 | 7.80 | 7.50 | 7.90 | 7.70 |
| 20 | 7.70 | 7.70 | 8.65 | 9.35 | 9.00 | 7.00 | 7.90 | 7.10 | 7.65 | 7.50 | 7.90 | 7.70 |
| 21 | 7.70 | 7.70 | 8.60 | 9.30 | 9.00 | 7.00 | 7.60 | 7.10 | 7.60 | 7.50 | 7.95 | 7.70 |
| 22 | 7.70 | 7.70 | 8.45 | 9.25 | 8.80 | 7.00 | 7.60 | 7.10 | 7.50 | 7.50 | 8.00 | 7.70 |
| 23 | 7.70 | 7.70 | 8.40 | 9.20 | 8.75 | 7.00 | 7.55 | 7.00 | 7.50 | 7.50 | 8.00 | 7.70 |
| 24 | 7.70 | 7.70 | 8.30 | 9.20 | 8.50 | 7.10 | 7.50 | 7.00 | 7.50 | 7.50 | 8.00 | 7.70 |
| 25 | 7.60 | 7.70 | 8.30 | 9.30 | 8.20 | 7.10 | 7.45 | 7.00 | 7.40 | 7.50 | 8.10 | 7.70 |
| 26 | 7.60 | 7.70 | 8.30 | 9.40 | 8.20 | 7.10 | 7.35 | 7.00 | 7.40 | 7.50 | 8.10 | 7.70 |
| 27 | 7.60 | 7.70 | 8.30 | 9.40 | 8.10 | 7.00 | 7.20 | 7.00 | 7.30 | 7.50 | 8.00 | 7.70 |
| 28 | 7.60 | 7.70 | 8.35 | 9.30 | 8.10 | 7.15 | 7.15 | 7.00 | 7.30 | 7.50 | 8.00 | 7.70 |
| 29 | 7.60 | ....... | 8.40 | 9.20 | 8.10 | 7.20 | 7.10 | 7.00 | 7.30 | 7.60 | 7.90 | 7.70 |
| 30 | 7.60 | ....... | 8.35 | 9.20 | 8.00 | 7.20 | 7.10 | 7.00 | 7.30 | 7.60 | 7.90 | 7.70 |
| 31 | 7.60 | ....... | 8.40 | ....... | 8.00 | ....... | 7.20 | 7.00 | ....... | 7.60 | ....... | 7.70 |

*a* Began to rise at 4.30 p. m.; maximum, 8.3 feet, at 6 p. m.

## RIO GRANDE AT RIO GRANDE, NEW MEXICO.

Three miles below Embudo the river emerges into Espanola Valley, through which it continues for a few miles and then enters White Rock Canyon, flowing through that canyon for 30 miles. At the lower end of this canyon the river emerges into Albuquerque Valley, and so continues down to about Socorro. This valley averages from 1 to 3 miles in width, and has been irrigated for a great many years by the Mexican settlers. Their primitive methods of irrigation are very wasteful of the waters, so that the duty of water in this section, about 17 acres per second-foot, is not as high as it might be. During the last few years, however, a number of important and modern irrigation systems have been planned and built in the vicinity of Albuquerque. The gaging station, established February 3, 1895, is located about one-fourth of a mile above the railroad station of Rio Grande, New Mexico, and at the head of White Rock Canyon. The gage is inclined, and consists of timbers fastened to piles and wired to a solid rock. The bench mark is the top of the bowlder to which the upper portion of the gage is fastened, and is 17.815 feet above gage datum. Measurements are made from a car suspended from a cable above the rod. The bed of the stream is rocky and is confined between high banks. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 254; 1897, Nineteenth Annual Report, Part IV, page 386; 1898, Twentieth Annual Report, Part IV, page 370. Three measurements of discharge were made at this point by P. E. Harroun during 1899: The first one, on April 6, at a gage height of 5.90 feet, gave a discharge of 978 second-feet; the second, on September 2, at a gage height of 3.70 feet, gave a discharge of 110 second-feet; the third measurement, October 24, at a gage height of 5.15 feet, gave a discharge of 482 second-feet.

*Daily gage height, in feet, of Rio Grande at Rio Grande, New Mexico, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.65 | 5.40 | 5.65 | 6.20 | 7.15 | 5.60 | 4.20 | 5.00 | 3.60 | 4.70 | 5.30 | 5.65 |
| 2 | 4.65 | 5.35 | 6.00 | 6.20 | 7.15 | 5.55 | 4.20 | 4.80 | 3.60 | 4.70 | 5.25 | 5.60 |
| 3 | 4.65 | 5.35 | 5.90 | 6.05 | 6.95 | 5.45 | 4.30 | 4.70 | 3.60 | 4.70 | 5.30 | 5.60 |
| 4 | 4.75 | 5.15 | 5.80 | 6.15 | 6.75 | 5.45 | 4.30 | 6.75 | 3.65 | 4.85 | 5.40 | 5.60 |
| 5 | 4.85 | 5.30 | 5.80 | 6.10 | 6.60 | 5.45 | 4.10 | 5.50 | 3.60 | 5.10 | 5.40 | 5.35 |
| 6 | 4.75 | 5.20 | 5.85 | 5.90 | 6.50 | 5.35 | 4.00 | 5.00 | 3.60 | 5.05 | 5.45 | 5.00 |
| 7 | 4.85 | 5.30 | 5.85 | 5.85 | 6.45 | 5.25 | 4.00 | 6.35 | 3.55 | 5.05 | 5.50 | 5.25 |
| 8 | 4.95 | 5.30 | 5.90 | 6.05 | 6.35 | 5.20 | 3.90 | 5.45 | 4.00 | 5.00 | 5.55 | 5.40 |
| 9 | 5.10 | 5.45 | 6.15 | 5.95 | 6.35 | 5.05 | 4.40 | 5.45 | 4.25 | 4.95 | 5.55 | 5.65 |
| 10 | 5.00 | 5.45 | 6.05 | 6.05 | 6.30 | 5.40 | 4.20 | 4.80 | 4.75 | 4.90 | 5.55 | 5.45 |
| 11 | 4.95 | 5.45 | 6.25 | 6.30 | 6.30 | 5.10 | 4.20 | 4.75 | 4.95 | 4.85 | 5.60 | 5.25 |
| 12 | 5.00 | 5.35 | 6.25 | 6.45 | 6.45 | 5.05 | 4.20 | 4.65 | 4.35 | 4.85 | 5.55 | 5.15 |
| 13 | 4.95 | 5.20 | 6.20 | 6.65 | 6.40 | 5.00 | 4.00 | 4.60 | 4.30 | 4.85 | 5.55 | 5.40 |
| 14 | 5.00 | 5.75 | 6.20 | 6.95 | 6.65 | 4.90 | 4.40 | 4.55 | 4.30 | 4.80 | 5.55 | 5.40 |
| 15 | 5.05 | 5.50 | 6.25 | 7.30 | 7.15 | 4.85 | 4.55 | 4.40 | *a*9.30 | 4.80 | 5.90 | 5.15 |
| 16 | 5.05 | 5.40 | 5.85 | 7.20 | 7.35 | 4.60 | 5.00 | 4.35 | 9.40 | 5.00 | 5.70 | 4.85 |
| 17 | 5.00 | 5.50 | 6.15 | 7.65 | 7.40 | 4.65 | 5.05 | 4.30 | 6.55 | 5.00 | 5.75 | 5.10 |
| 18 | 5.00 | 5.45 | 6.40 | 8.15 | 7.15 | 4.50 | 7.80 | 4.15 | 5.85 | 5.05 | 5.70 | 5.40 |
| 19 | 5.00 | 5.50 | 6.30 | 8.30 | 6.90 | 4.45 | 6.80 | 4.20 | 5.45 | 4.95 | 5.70 | 5.65 |
| 20 | 5.05 | 5.45 | 6.35 | 8.30 | 6.75 | 4.40 | 6.30 | 4.15 | 5.25 | 5.05 | 5.70 | 5.55 |
| 21 | 5.05 | 5.50 | 6.30 | 7.95 | 6.75 | 4.30 | 5.70 | 4.10 | 5.15 | 5.10 | 5.70 | 5.40 |
| 22 | 5.00 | 5.50 | 6.25 | 7.70 | 6.75 | 4.20 | 5.30 | 4.00 | 5.25 | 5.15 | 5.70 | 5.30 |
| 23 | 5.00 | 5.50 | 6.20 | 7.75 | 6.40 | 4.20 | 5.30 | 3.90 | 5.00 | 5.15 | 5.80 | 5.45 |
| 24 | 5.00 | 5.55 | 6.15 | 7.85 | 6.25 | 4.30 | 5.15 | 3.75 | 5.05 | 5.15 | 5.80 | 5.50 |
| 25 | 5.05 | 5.80 | 6.20 | 7.90 | 6.10 | 4.40 | 5.25 | 3.85 | 4.95 | 5.20 | 5.80 | 5.45 |
| 26 | 5.10 | 5.50 | 6.45 | 8.05 | 6.10 | 4.65 | 5.20 | 3.80 | 4.85 | 5.20 | 5.75 | 5.45 |
| 27 | 5.20 | 5.50 | 6.65 | 7.95 | 5.95 | 4.50 | 5.30 | 3.70 | 4.85 | 5.30 | 5.75 | 5.40 |
| 28 | 5.25 | 5.65 | 6.60 | 7.75 | 6.00 | 4.40 | 5.35 | 3.75 | 4.75 | 5.30 | 5.75 | 5.40 |
| 29 | 5.25 | ....... | 6.55 | 7.50 | 5.85 | 4.20 | 5.00 | 3.70 | 4.75 | 5.30 | 5.70 | 5.45 |
| 30 | 5.35 | ....... | 6.45 | 7.15 | 5.80 | 4.35 | 5.05 | 3.60 | 4.65 | 5.25 | 5.70 | 5.50 |
| 31 | 5.40 | ....... | 6.40 | ....... | 5.70 | ....... | 6.05 | 3.60 | ....... | 5.25 | ....... | 5.65 |

*a* 10 at 7 a. m.

## RIO GRANDE AT SAN MARCIAL, NEW MEXICO.

The fifth gaging station on the main stream, continuing downward, is at San Marcial. It was established January 29, 1895, and is located at the railroad bridge one-half mile south of the town. The wire gage is attached to the guard rail of the bridge, south span, lower side. Bench mark No. 1 is the top of the capstone on which the bridge truss rests, and is at an elevation of 15 feet above gage datum; bench mark No. 2 is the top of the extension of the pier to which the old vertical gage was fastened, and is at an elevation of 13 feet above gage datum. The channel is sandy and shifting. A number of bridge piers interfere with the current to a certain extent, but not with the observed gage heights or discharge measurements. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 257; 1897, Nineteenth Annual Report, Part IV, page 387; 1898, Twentieth Annual Report, Part IV, page 371. The following discharge measurements were made by P. E. Harroun during 1899:

*Measurements of Rio Grande at San Marcial, New Mexico.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Sec. feet.* | 1899. | *Feet.* | *Sec. feet.* |
| Apr. 3 | 7.30 | 715 | May 17 | 6.50 | 199 |
| Apr. 19 | 7.30 | 660 | Sept. 22 | 5.30 | 112 |
| Apr. 25 | 7.70 | 1,609 | Oct. 12 | 4.40 | 6 |
| May 2 | 7.60 | 1,403 | Dec. 17 | 6.20 | 263 |

*Daily gage height, in feet, of Rio Grande at San Marcial, New Mexico, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.95 | 6.90 | 6.70 | 7.00 | 7.70 | 6.00 | ...... | 6.00 | ...... | ...... | 5.00 | 6.50 |
| 2 | 6.75 | 6.65 | 6.70 | 7.15 | 7.65 | 5.80 | ...... | 5.80 | ...... | ...... | 5.00 | 6.50 |
| 3 | 6.50 | 6.70 | 6.60 | 7.30 | 7.50 | 5.70 | ...... | 5.60 | ...... | ...... | 5.10 | 6.50 |
| 4 | 6.60 | 6.70 | 6.50 | 7.10 | 7.40 | 5.60 | ...... | 5.40 | ...... | ...... | 5.10 | 6.55 |
| 5 | 6.55 | 6.60 | 6.50 | 7.00 | 7.40 | 5.40 | ...... | 5.65 | ...... | ...... | 5.20 | 6.55 |
| 6 | 6.60 | 6.50 | 6.70 | 6.90 | 7.30 | 5.25 | ...... | 6.80 | ...... | ...... | 5.20 | 6.55 |
| 7 | 6.60 | 5.10 | 6.70 | 7.20 | 7.20 | 5.00 | ...... | 7.15 | ...... | ...... | 5.30 | 6.55 |
| 8 | 6.75 | 4.50 | 6.50 | 7.00 | 7.20 | ...... | ...... | 7.55 | ...... | ...... | 5.30 | 6.60 |
| 9 | 6.55 | 4.50 | 6.80 | 6.90 | 7.20 | ...... | ...... | 6.95 | 5.35 | ...... | 5.40 | 6.60 |
| 10 | 6.50 | 6.95 | 6.50 | 6.80 | 7.10 | ...... | ...... | 6.40 | 5.65 | ...... | 5.40 | 6.45 |
| 11 | 6.60 | 6.60 | 6.50 | 6.70 | 7.00 | ...... | ...... | 6.10 | 5.00 | ...... | 5.50 | 6.60 |
| 12 | 7.00 | 6.70 | 6.50 | 6.50 | 6.80 | ...... | ...... | 5.70 | 5.15 | ...... | 5.50 | 6.55 |
| 13 | 6.70 | 5.90 | 6.60 | 6.40 | 6.70 | ...... | ...... | 5.30 | 5.50 | 4.50 | 5.60 | 6.55 |
| 14 | 7.00 | 7.20 | 7.00 | 6.30 | 6.60 | ...... | ...... | ...... | 5.05 | 4.50 | 5.60 | 6.55 |
| 15 | 6.90 | 6.70 | 7.10 | 6.15 | 6.50 | ...... | 3.60 | ...... | ...... | 4.50 | 5.70 | 6.60 |
| 16 | 6.85 | 6.70 | 7.00 | 6.00 | 6.40 | ...... | 3.60 | ...... | ...... | 4.50 | 5.70 | 6.60 |
| 17 | 6.70 | 6.95 | 6.90 | 6.05 | 6.50 | ...... | 3.60 | ...... | ...... | 4.50 | 5.80 | 6.05 |
| 18 | 6.55 | 6.80 | 6.90 | 6.90 | 6.60 | ...... | 3.60 | ...... | ...... | 4.50 | 5.80 | 6.40 |
| 19 | 6.55 | 6.80 | 6.80 | 7.35 | 6.70 | ...... | 9.05 | ...... | 7.25 | 4.50 | 5.90 | 6.50 |
| 20 | 6.55 | 6.80 | 6.50 | 7.80 | 7.45 | ...... | 9.25 | ...... | 6.05 | 4.50 | 6.00 | 6.45 |
| 21 | 6.60 | 6.80 | 6.40 | 7.95 | 7.40 | ...... | 7.60 | ...... | 5.50 | 4.50 | 6.00 | 6.55 |
| 22 | 6.50 | 6.80 | 6.40 | 7.95 | 7.30 | ...... | 6.75 | ...... | 5.15 | 4.50 | 6.10 | 6.55 |
| 23 | 6.60 | 6.80 | 6.40 | 7.80 | 7.30 | ...... | 6.25 | ...... | 5.00 | 4.50 | 6.20 | 6.60 |
| 24 | 6.70 | 6.70 | 6.40 | 7.70 | 7.20 | ...... | 6.15 | ...... | 5.00 | 4.60 | 6.20 | 6.65 |
| 25 | 6.70 | 6.80 | 6.40 | 7.70 | 7.00 | ...... | 7.60 | ...... | ...... | 4.60 | 6.30 | 6.70 |
| 26 | 6.60 | 6.80 | 6.30 | 7.70 | 6.95 | ...... | 7.50 | ...... | ...... | 4.70 | 6.30 | 6.65 |
| 27 | 6.60 | 6.80 | 6.30 | 7.70 | 6.80 | ...... | 6.55 | ...... | ...... | 4.70 | 6.40 | 6.65 |
| 28 | 6.60 | 6.80 | 6.50 | 7.70 | 6.65 | ...... | 6.30 | ...... | ...... | 4.80 | 6.40 | 6.65 |
| 29 | 6.60 | ...... | 6.70 | 7.80 | 6.55 | ...... | 6.20 | ...... | ...... | 4.80 | 6.50 | 6.75 |
| 30 | 6.60 | ...... | 6.85 | 7.70 | 6.30 | ...... | 6.25 | ...... | ...... | 4.90 | 6.50 | 6.85 |
| 31 | 6.65 | ...... | 7.00 | ...... | 6.20 | ...... | 6.20 | ...... | ...... | 4.90 | ...... | 6.80 |

June 8 to July 14, inclusive, no flow in river.
August 14 to September 8, inclusive, no flow in river.
September 15 to 18, inclusive, September 25 to October 22, inclusive, no flow in river.

## RIO GRANDE AT EL PASO, TEXAS.

This is an important station, and measurements have been made here for a long period. During the last three years the work has been carried on under the direction of W. W. Follett, consulting engineer International (Water) Boundary Commission. This commission has had charge of the investigation looking toward the building of an international dam at El Paso. The present station is located at Courchesne's limekiln, 4 miles north of El Paso, Texas. The river heights are measured at the masonry pump foundation pier, 150 feet above the kiln. The top of the downstream chisel draft is assumed to be at a gage height of 15 feet, and the distance to the water surface below is measured with a carefully graduated rod. The left bank of the river is formed by the loose rock fill of the Atchison, Topeka and Santa Fe Railroad embankments; and will not overflow; the right bank, however, is made ground and is liable to overflow at high stages. Owing to the shifting character of the bed of the stream, it has been necessary to make a large number of discharge measurements at this point in order to obtain an accurate idea of the discharge. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 259; 1897, Nineteenth Annual Report, Part IV, page 390; 1898, Twentieth Annual Report, Part IV, page 312. There were 32 discharge measurements made by T. M. Courchesne during 1899, as follows:

*Measurements of Rio Grande at El Paso, Texas.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1899. | *Feet.* | *Second-ft.* | 1899. | *Feet.* | *Second-ft.* |
| Jan. 4 | 6.40 | 290 | Mar. 16 | 5.70 | 86 |
| Jan. 9 | 6.10 | 226 | Mar. 18 | 5.60 | 69 |
| Jan. 12 | 6.00 | 173 | Mar. 20 | 5.70 | 78 |
| Jan. 14 | 5.90 | 126 | Mar. 22 | 5.80 | 93 |
| Jan. 16 | 5.90 | 126 | Mar. 25 | 5.60 | 66 |
| Jan. 18 | 6.40 | 244 | Apr. 11 | 5.50 | 48 |
| Jan. 21 | 6,30 | 249 | Apr. 14 | 5.20 | 31 |
| Jan. 23 | 6.10 | 181 | May 8 | 6.90 | 336 |
| Jan. 26 | 6.40 | 261 | Dec. 14 | 5.40 | 94 |
| Jan. 28 | 6.20 | 187 | Dec. 16 | 5.30 | 70 |
| Jan. 31 | 6.10 | 188 | Dec. 18 | 5.10 | 48 |
| Feb. 2 | 6.10 | 167 | Dec. 20 | 5.10 | 47 |
| Feb. 4 | 6.00 | 147 | Dec. 23 | 5.20 | 56 |
| Mar. 8 | 6.30 | 216 | Dec. 26 | 5.30 | 72 |
| Mar. 11 | 6.00 | 144 | Dec. 28 | 5.50 | 101 |
| Mar. 13 | 5.80 | 112 | Dec. 30 | 5.40 | 104 |

*Daily gage height, in feet, of Rio Grande at El Paso, Texas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.15 | 6.10 | 6.25 | 6.05 | 7.45 | (a) | (a) | 5.70 | (a) |
| 2 | 6.20 | 6.10 | 6.15 | 5.50 | 7.60 | (a) | (a) | 5.00 | (a) |
| 3 | 6.40 | 6.00 | 6.20 | 5.05 | 7.50 | (a) | (a) | 5.00 | (a) |
| 4 | 6.40 | 6.00 | 6.15 | 5.05 | 7.40 | (a) | (a) | 4.90 | (a) |
| 5 | 6.25 | 5.90 | 6.20 | 5.05 | 7.30 | (a) | (a) | 4.85 | 4.30 |
| 6 | 6.15 | 6.25 | 6.20 | 5.00 | 7.10 | (a) | (a) | 4.65 | 4.40 |
| 7 | 6.10 | 6.50 | 6.25 | 4.95 | 6.85 | (a) | (a) | 4.45 | 4.50 |
| 8 | 6.10 | 6.30 | 6.30 | 5.10 | 6.85 | (a) | (a) | 4.15 | 4.50 |
| 9 | 6.10 | 6.40 | 6.20 | 5.25 | 6.55 | (a) | (a) | ---------- | 4.50 |
| 10 | 6.10 | 6.40 | 6.10 | 5.40 | 6.30 | (a) | (a) | ---------- | 4.50 |
| 11 | 6.00 | 6.40 | 6.00 | 5.50 | 6.00 | (a) | (a) | ---------- | 4.50 |
| 12 | 6.00 | 6.30 | 5.90 | 5.40 | 5.85 | (a) | (a) | ---------- | 4.75 |
| 13 | 5.90 | 5.90 | 5.80 | 5.25 | 5.65 | (a) | (a) | ---------- | 5.10 |
| 14 | 5.90 | 6.20 | 5.80 | 5.20 | 5.70 | (a) | (a) | ---------- | 5.40 |
| 15 | 5.90 | 6.00 | 5.75 | 5.10 | 5.55 | (a) | (a) | ---------- | 5.40 |
| 16 | 5.90 | 6.00 | 5.70 | 5.10 | 5.40 | (a) | (a) | ---------- | 5.30 |
| 17 | 6.20 | 6.00 | 5.65 | 5.10 | 5.50 | (a) | (a) | ---------- | 5.20 |
| 18 | 6.40 | 6.05 | 5.60 | 4.90 | 5.15 | (a) | 4.45 | ---------- | 5.10 |
| 19 | 6.40 | 6.20 | 5.60 | 4.90 | 4.95 | (a) | 5.35 | ---------- | 5.10 |
| 20 | 6.40 | 6.10 | 5.70 | 4.90 | 4.85 | (a) | 6.60 | ---------- | 5.10 |
| 21 | 6.30 | 6.20 | 5.80 | 4.95 | 4.80 | (a) | 7.90 | ---------- | 5.10 |
| 22 | 6.30 | 6.50 | 5.80 | 5.00 | 4.70 | (a) | 9.05 | ---------- | 5.15 |
| 23 | 6.10 | 6.55 | 5.65 | 5.35 | 4.60 | (a) | 9.05 | ---------- | 5.20 |
| 24 | 6.20 | 6.35 | 5.60 | 7.45 | 4.60 | (a) | 8.40 | ---------- | 5.20 |
| 25 | 6.25 | 6.30 | 5.60 | 7.60 | 4.60 | (a) | 8.20 | ---------- | 5.20 |
| 26 | 6.35 | 6.30 | 5.45 | 7.50 | 4.60 | (a) | 7.85 | ---------- | 5.30 |
| 27 | 6.30 | 6.25 | 5.45 | 7.30 | 4.60 | (a) | 7.55 | ---------- | 5.25 |
| 28 | 6.20 | 6.20 | 5.50 | 7.20 | 4.60 | (a) | 6.90 | ---------- | 5.40 |
| 29 | 6.20 | ---------- | 5.40 | 7.30 | 4.60 | (a) | 6.70 | ---------- | 5.50 |
| 30 | 6.10 | ---------- | 5.40 | 7.30 | 4.55 | (a) | 6.65 | ---------- | 5.40 |
| 31 | 6.10 | ---------- | 5.75 | ---------- | 4.50 | (a) | 6.35 | ---------- | 5.40 |

*a* Not flowing from June 1 to July 17 and from August 9 to November 30.

## PECOS RIVER AT PECOS, TEXAS.

This stream rises on the eastern slope of the Santa Fe Range in northern New Mexico. Its course is first southerly, through a typical mountainous and canyon country, until it reaches Fort Sumner, when the character of the topography changes. The river then takes a more southerly course and the country then changes from a rolling to an almost flat area. A number of large irrigation enterprises have been completed within the last few years and now irrigate large areas in the vicinity of Roswell and Eddy, New Mexico, and even extend down into Texas. The summer flow of the river is largely dependent upon numerous springs, which occur in the limestone country in the vicinity of Roswell and below. Owing to the numerous diversions for irrigating purposes, however, the river would be dry in the summer where it crosses into Texas were it not for the waters which are gradually returning to the river through seepage. This water, unfortunately, is impregnated to a considerable extent with alkali, which renders it undesirable for irrigating purposes. The station on this river was established January 1, 1898, and is located at a point 6 miles above the town of Pecos, Texas, at the flume of the Margueretta canal. This canal diverts water from the river 3 miles above this point on the west side, and then the water is carried over to the east side by means of a flume, where it is used below. The bench mark of the gage is the top of north pier at west side of flume, and its elevation is 20.7 feet above gage datum. The channel at this point is nearly straight, the water sluggish, the banks high, and the bottom sandy and shifting. One measurement of the discharge in the flume was made on June 22, when it was found to be 85 second-feet. Two measurements were made on the main river by Prof. Thomas U. Taylor in 1899, as follows: June 22, at a gage height of 0.70 foot, the discharge was 21 second-feet; the second measurement, on December 28, at a gage height of 2.90 feet, gave a discharge of 345 second-feet.

In the vicinity of Fort Stockton, Pecos County, Texas, occur a series of springs which contribute to the discharge of Comanche Creek, a tributary of Pecos River. On June 23, 1899, their discharge was measured by Prof. Thomas U. Taylor at the ford one-half mile east of the court-house, and the discharge was found to be 66 second-feet.

*Daily gage height, in feet, of Pecos River at Pecos, Texas, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.80 | 3.00 | 2.80 | 1.00 | 1.00 | 0.45 | 0.75 | 5.35 | 1.30 | 1.25 | 1.30 | 3.00 |
| 2 | 2.80 | 3.00 | 2.70 | 1.00 | 1.00 | .45 | .90 | 4.80 | 1.30 | 1.20 | 1.30 | 3.00 |
| 3 | 2.60 | 3.00 | 2.60 | 1.00 | 1.00 | .40 | .70 | 3.75 | 1.30 | 1.20 | 1.30 | 2.95 |
| 4 | 2.60 | 2.95 | 2.50 | 1.00 | 1.00 | .40 | .80 | 3.65 | 1.25 | 1.85 | 1.30 | 2.90 |
| 5 | 2.60 | 2.80 | 2.50 | 1.00 | 1.00 | .40 | .80 | 3.45 | 1.20 | 1.60 | 1.35 | 2.90 |
| 6 | 2.55 | 2.65 | 2.75 | 1.00 | 1.00 | .40 | .80 | 2.65 | 1.20 | 1.50 | 1.40 | 2.90 |
| 7 | 2.50 | 2.45 | 2.65 | 1.00 | 1.00 | .40 | .80 | 2.15 | 1.20 | 1.50 | 1.40 | 3.00 |
| 8 | 2.50 | 2.40 | 2.55 | 1.00 | 1.00 | .40 | 1.50 | 2.05 | 1.20 | 1.45 | 1.40 | 3.05 |
| 9 | 2.50 | 2.70 | 2.35 | 1.00 | 1.55 | .40 | 3.75 | 1.90 | 1.30 | 1.35 | 1.45 | 3.00 |
| 10 | 2.50 | 3.00 | 2.10 | 1.00 | 1.50 | .40 | 2.20 | 1.75 | 1.50 | 1.30 | 1.45 | 3.10 |
| 11 | 3.10 | 3.00 | 1.80 | .95 | 1.00 | 1.75 | 1.60 | 1.70 | 2.40 | 1.30 | 1.50 | 3.00 |
| 12 | 3.10 | 2.90 | 1.45 | .90 | 1.00 | 1.00 | 1.35 | 1.80 | 1.85 | 1.20 | 1.40 | 2.90 |
| 13 | 3.10 | 2.85 | 1.35 | .90 | 1.00 | .60 | 1.15 | 2.20 | 3.00 | 1.20 | 1.40 | 3.00 |
| 14 | 3.00 | 3.00 | 1.30 | .90 | 1.00 | .60 | 1.00 | 2.15 | 2.40 | 1.20 | 1.40 | 3.00 |
| 15 | 3.00 | 3.00 | 1.20 | 1.10 | .95 | .60 | .85 | 2.05 | 1.80 | 1.20 | 1.40 | 3.00 |
| 16 | 3.00 | 3.00 | 1.20 | 3.50 | .90 | 1.60 | 1.15 | 2.00 | 1.65 | 1.35 | 1.40 | 3.00 |
| 17 | 3.00 | 2.90 | 1.10 | 2.75 | .70 | 2.30 | .80 | 2.00 | 1.35 | 1.10 | 1.30 | 3.00 |
| 18 | 3.00 | 2.80 | 1.10 | 1.95 | .50 | 1.15 | 4.35 | 1.95 | 1.30 | 1.10 | 1.30 | 3.10 |
| 19 | 3.00 | 2.70 | 1.10 | 1.60 | .50 | .85 | 1.95 | 1.50 | 1.30 | 1.10 | 2.65 | 3.10 |
| 20 | 3.00 | 2.70 | 1.10 | 1.45 | .50 | .70 | 3.00 | 1.40 | 1.40 | 1.00 | 4.40 | 3.10 |
| 21 | 3.00 | 2.70 | 1.20 | 1.35 | .50 | .70 | 3.00 | 1.30 | 1.60 | 1.00 | 3.30 | 3.20 |
| 22 | 3.00 | 2.70 | 1.15 | 1.30 | .50 | .70 | 2.65 | 1.40 | 2.60 | 1.00 | 2.60 | 3.30 |
| 23 | 3.00 | 2.70 | 1.10 | 1.30 | .50 | .70 | 3.05 | 1.40 | 2.65 | 1.10 | 2.25 | 3.05 |
| 24 | 2.95 | 2.60 | 1.10 | 1.15 | .50 | .70 | 4.25 | 1.40 | 2.45 | 1.10 | 2.05 | 3.25 |
| 25 | 2.90 | 2.50 | 1.10 | 1.10 | .50 | .70 | 5.00 | 1.40 | 2.00 | 1.10 | 2.00 | 3.80 |
| 26 | 3.05 | 2.75 | 1.30 | 1.10 | .50 | .70 | 5.55 | 1.40 | 1.80 | 1.10 | 2.00 | 3.15 |
| 27 | 3.00 | 2.70 | 1.10 | 1.10 | .50 | .70 | 5.60 | 1.40 | 1.50 | 1.20 | 2.00 | 3.05 |
| 28 | 3.00 | 2.70 | 1.00 | 1.10 | .50 | .70 | 5.50 | 1.30 | 1.45 | 1.20 | 2.55 | 3.00 |
| 29 | 3.05 | ....... | 1.00 | 1.00 | .50 | .70 | 5.50 | 1.30 | 1.40 | 1.20 | 2.50 | 2.90 |
| 30 | 3.00 | ....... | 1.00 | 1.00 | .50 | .70 | 5.50 | 1.30 | 1.35 | 1.20 | 2.45 | 2.90 |
| 31 | 3.00 | ....... | 1.00 | ....... | .50 | ....... | 5.50 | 1.30 | ....... | 1.30 | ....... | 2.95 |

## GREEN RIVER AT GREENRIVER, WYOMING.

This river has its source in the Wind River and Gros Ventre mountains in western Wyoming; it flows southerly, receiving a number of important tributaries from either side, and after crossing the State line flows through Utah. In this State its principal tributaries are Yampa and White rivers from the east and Duchesne River from the west. Sixty miles below the crossing of the Rio Grande Western Railway in Utah, Green River joins the Grand River to form the Colorado. Two gaging stations have been maintained on the main river, one at Greenriver, Wyoming, at the crossing of the Union Pacific Railroad, and the other at Blake, Utah, at the crossing of the Rio Grande Western Railway. The former station, established May 2, 1895, is located at the pump house of the Union Pacific Railroad Company. The rod is fastened to a pile near the east end of the bridge. The bench mark consists of a cross on the third step from the bottom on the south end of the east abutment, and is 12.48 feet above gage datum. The rod was last verified with the bench mark August 30, 1899. As the section under the railroad bridge is poor, discharge measurements are made from the iron highway bridge about one-half mile below. The average annual discharge of Green River at this point having been determined for the last five years, and as the water supply is far greater than the demand by irrigators, observations will be discontinued in the spring and attention given to the more important tributaries of the river. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 275; 1897, Nineteenth Annual Report, Part IV, page 395; 1898, Twentieth Annual Report, Part IV, page 380. The following discharge measurements were made by A. J. Parshall during 1889:

April 19, gage height, 1.35 feet; discharge, 1,595 second-feet.
May 13, gage height, 2.20 feet; discharge, 2,661 second-feet.
May 25, gage height, 2.55 feet; discharge, 3,422 second-feet.
June 7, gage height, 3.80 feet; discharge, 8,234 second-feet.
June 20, gage height, 5.30 feet; discharge, 15,305 second-feet.
July 5, gage height, 6.25 feet; discharge, 18,372 second-feet.
August 30, gage height, 2.10 feet; discharge, 1,632 second-feet.

*Daily gage height, in feet, of Green River at Greenriver, Wyoming, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 1.80 | 1.90 | 1.00 | 1.78 | 3.20 | 6.38 | 3.88 | 2.05 | 1.45 | 1.60 | 1.20 |
| 2 | | | | .70 | 1.58 | 3.25 | 6.43 | 3.78 | 2.05 | 1.45 | | |
| 3 | 1.50 | | | .95 | 1.50 | 3.35 | 6.50 | 3.70 | 1.95 | 1.45 | 1.60 | 1.20 |
| 4 | | | | 1.10 | 1.43 | 3.48 | 6.43 | 3.68 | 1.90 | 1.40 | | |
| 5 | | | | .90 | 1.33 | 3.55 | 6.13 | 3.65 | 1.90 | 1.40 | 1.60 | 1.40 |
| 6 | | | | .80 | 1.30 | 4.00 | 5.85 | 3.65 | 1.90 | 1.40 | | |
| 7 | | | | .90 | 1.33 | 3.95 | 5.75 | 3.58 | 1.90 | 1.40 | 1.55 | 1.45 |
| 8 | | 1.80 | 1.70 | .85 | 1.50 | 3.70 | 5.73 | 3.53 | 1.85 | 1.45 | | |
| 9 | 1.60 | | | .95 | 1.50 | 3.45 | 5.65 | 3.50 | 1.85 | 1.45 | 1.55 | 1.45 |
| 10 | | | | .90 | 1.63 | 3.38 | 5.60 | 3.45 | 1.80 | 1.45 | | |
| 11 | | | | 1.30 | 1.95 | 3.43 | 5.53 | 3.40 | 1.78 | 1.48 | 1.50 | 1.45 |
| 12 | | | | 1.35 | 2.15 | 3.73 | 5.45 | 3.40 | 1.73 | 1.50 | | |
| 13 | 1.60 | | | 1.50 | 2.28 | 4.13 | 5.45 | 3.35 | 1.78 | 1.55 | 1.50 | 1.45 |
| 14 | | | | 1.50 | 2.55 | 4.68 | 5.48 | 3.23 | 1.85 | 1.58 | | |
| 15 | | 1.90 | 1.30 | 1.60 | 2.58 | 4.73 | 5.53 | 3.13 | 1.80 | 1.60 | 1.50 | 1.45 |
| 16 | | | | 1.50 | 2.80 | 4.35 | 5.45 | 3.00 | 1.75 | 1.60 | | |
| 17 | | | | 1.40 | 2.78 | 4.30 | 5.38 | 2.95 | 1.75 | 1.60 | 1.50 | 1.40 |
| 18 | | | | 1.40 | 2.65 | 4.50 | 5.23 | 2.93 | 1.75 | 1.60 | | |
| 19 | 1.60 | | | 1.35 | 2.63 | 4.93 | 4.95 | 2.83 | 1.73 | 1.63 | 1.45 | 1.40 |
| 20 | | | | 1.35 | 2.50 | 5.40 | 4.73 | 2.68 | 1.70 | 1.65 | | |
| 21 | | | | 1.30 | 2.80 | 5.80 | 4.63 | 2.60 | 1.65 | 1.68 | 1.40 | 1.45 |
| 22 | | 1.90 | 1.30 | 1.25 | 2.78 | 6.18 | 4.50 | 2.55 | 1.65 | 1.70 | | |
| 23 | | | | 1.35 | 2.73 | 6.50 | 4.45 | 2.53 | 1.60 | 1.70 | 1.30 | 1.45 |
| 24 | | | | 1.45 | 2.58 | 6.63 | 4.40 | 2.50 | 1.60 | 1.70 | | |
| 25 | 1.70 | | | 1.65 | 2.55 | 6.30 | 4.33 | 2.45 | 1.60 | 1.65 | 1.25 | 1.50 |
| 26 | | | | 2.00 | 2.78 | 6.05 | 4.18 | 2.40 | 1.55 | 1.65 | | |
| 27 | 1.70 | | | 1.95 | 3.08 | 5.98 | 4.03 | 2.38 | 1.55 | 1.63 | 1.25 | 1.55 |
| 28 | | 1.90 | | 1.90 | 3.18 | 6.03 | 3.98 | 2.30 | 1.50 | 1.60 | | |
| 29 | | | 1.70 | 1.90 | 3.20 | 6.10 | 3.95 | 2.23 | 1.50 | 1.60 | 1.25 | 1.55 |
| 30 | 1.55 | | | 1.83 | 3.25 | 6.28 | 3.95 | 2.10 | 1.45 | 1.60 | | 1.60 |
| 31 | | | | | 3.20 | | 3.95 | 2.05 | | 1.60 | | |

## BLACK FORK AT GRANGER, WYOMING.

This tributary of Green River rises in the extreme southwestern corner of Wyoming, and flows in a general northwesterly direction until after its junction with Hams Fork, when it turns southeasterly and joins Green River 20 miles below Greenriver station, Wyoming. Considerable irrigation is practiced on its head-water streams, almost wholly for forage crops, as the elevation is too high for diversified farming. The general industry of the country is stock raising, the herds being ranged on the hillside during the summer, and during the winter fed the hay raised by irrigation. The station on this river was established April 28, 1897, and is located below the mouth of Hams Fork and about a quarter of a mile below Granger. The rod consists of a horizontal timber fastened to two upright posts set firmly in the bank of the river. One end of the timber to which the wire gage is fastened projects out over the water. The bench mark is a rail spike in an old tie 25 feet west of inside post of gage, marked "B. M." in black paint, and is at an elevation of 8.74 feet above gage datum. The rod was last verified with the bench mark August 30, 1899. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 393; 1898, Twentieth Annual Report, Part IV, page 382. The following discharge measurements were made by A. J. Parshall during 1899:

April 19, gage height, 1.85 feet; discharge, 769 second-feet.
May 13, gage height, 3.30 feet; discharge, 2,229 second-feet.
May 25, gage height, 3.60 feet; discharge, 2,535 second-feet.
June 7, gage height, 5.10 feet; discharge, 4,776 second-feet.
June 20, gage height, 5.70 feet; discharge, 5,567 second-feet.
July 5, gage height, 3.90 feet; discharge, 2,674 second-feet.
August 30, gage height, 0.20 foot; discharge, 101 second-feet.

*Daily gage height, in feet, of Black Fork at Granger, Wyoming, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 2.20 | | 1.80 | 3.90 | 4.40 | 1.50 | 0.80 | 0.30 | | |
| 2 | 1.80 | | | 2.90 | 2.20 | 3.90 | 4.50 | 1.40 | .80 | .30 | | 1.30 |
| 3 | | | | 2.90 | 2.65 | 3.90 | 4.60 | 1.40 | .80 | .30 | | |
| 4 | | 2.10 | | 2.90 | 1.60 | 4.20 | 4.30 | 1.40 | .70 | .30 | 0.80 | |
| 5 | | | | 2.95 | 1.70 | 4.30 | 3.90 | 1.40 | .65 | .35 | | |
| 6 | | | | 3.20 | 1.60 | 4.50 | 3.80 | 1.40 | .60 | .40 | | |
| 7 | | | | 3.25 | 1.70 | 5.05 | 3.60 | 1.40 | .60 | .50 | | |
| 8 | | | 2.30 | 1.80 | 1.90 | 5.40 | 3.50 | 1.60 | .60 | .50 | | |
| 9 | 1.60 | | | 1.80 | 2.00 | 5.20 | 3.30 | 1.50 | .60 | .50 | | 1.00 |
| 10 | | | | 1.60 | 2.20 | 4.90 | 3.10 | 1.50 | .60 | .50 | | |
| 11 | | 2.10 | | 1.40 | 2.65 | 4.85 | 3.10 | 1.50 | .50 | .50 | .80 | |
| 12 | | | | 1.60 | 2.75 | 5.10 | 3.00 | 1.50 | .50 | .60 | | |
| 13 | | | | 1.65 | 3.35 | 5.50 | 3.20 | 1.25 | .50 | .60 | | |
| 14 | | | | 1.60 | 3.80 | 6.05 | 3.20 | 1.20 | .50 | .70 | | |
| 15 | | | 2.50 | 1.70 | 4.20 | 6.05 | 3.20 | 1.20 | .50 | .70 | | |
| 16 | 1.70 | | | 1.80 | 4.50 | 5.60 | 3.10 | 1.20 | .50 | .70 | | 1.00 |
| 17 | | | | 1.75 | 4.50 | 5.50 | 3.20 | 1.10 | .40 | .70 | | |
| 18 | | 2.20 | | 1.60 | 4.10 | 5.40 | 2.90 | 1.10 | .40 | .70 | .90 | |
| 19 | | | | 1.85 | 3.80 | 5.50 | 2.55 | 1.00 | .45 | .70 | | |
| 20 | | | | 2.10 | 3.90 | 5.70 | 2.30 | 1.00 | .50 | .80 | | |
| 21 | | | | 1.50 | 4.00 | 5.90 | 2.20 | .95 | .50 | .70 | | |
| 22 | 1.90 | | 2.70 | 1.50 | 3.80 | 6.25 | 2.05 | .90 | .50 | .70 | | |
| 23 | | | | 1.60 | 3.80 | 6.00 | 2.00 | .90 | .50 | .80 | | 1.50 |
| 24 | | | | 1.85 | 3.30 | 5.50 | 1.90 | .80 | .50 | .80 | | |
| 25 | | 2.30 | | 1.80 | 3.60 | 5.30 | 1.90 | .70 | .40 | .80 | .90 | |
| 26 | | | | 2.00 | 4.10 | 5.00 | 1.80 | .70 | .40 | .80 | | |
| 27 | | | | 2.20 | 4.20 | 4.70 | 1.80 | .70 | .30 | .80 | | |
| 28 | 1.90 | | | 2.00 | 4.30 | 4.60 | 1.80 | .70 | .30 | .70 | | |
| 29 | | | 3.80 | 1.80 | 4.30 | 4.40 | 1.80 | .70 | .30 | .70 | | |
| 30 | | | | 1.80 | 3.90 | 4.30 | 1.70 | .70 | .30 | .75 | | 1.30 |
| 31 | | | | | 3.90 | | 1.50 | .70 | | .80 | | |

## UINTA RIVER NEAR WHITEROCKS, UTAH.

Uinta River has its source on the southern slope of the Uinta Mountains in northeastern Utah, and flows in a general southeasterly direction, emptying into Duchesne River about 15 miles above its mouth. Its drainage area is included within the Uinta Indian Reservation. During the fall of 1899 an investigation of the water supply of the Uinta Indian Reservation was begun by Cyrus C. Babb, and in this connection a number of gaging stations were established. Uinta River emerges from its canyon about 10 miles northwest of the Indian agency at Whiterocks, and at this point a gaging station was established September 16, 1899. The gage rod is a 2 by 4 inch timber, 12 feet long, bolted to two trees on the left bank of the stream. The bench mark is a nail in an aspen tree 125 feet north of the rod, and its elevation is 8.93 feet above gage datum. Discharge measurements are made by car and cable. The bed of the stream is very rocky and strewn with large bowlders, and the station is not altogether satisfactory, on account of the roughness of the channel. During high water the velocity undoubtedly will be great, owing to the rapid fall of the water. A few hundred yards above the station an important tributary comes in from the east. At the present location a second channel has to be measured, but it will never carry a large volume of water. Farther down the stream a number of larger channels are formed, so that it is difficult to obtain a satisfactory station. Daily records of gage heights were not maintained at this point, but frequent measurements of discharge were made by Cyrus C. Babb and C. T. Prall during 1899, as follows:

*Measurements of Uinta River near Whiterocks, Utah.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| September 16 | 1.15 | 191 | November 25 | 1.00 | 119 |
| September 28 | 1.00 | 142 | December 4 | 1.00 | 136 |
| October 6 | 1.00 | 159 | December 11 | .97 | 136 |
| October 18 | 1.10 | 165 | December 18 | 1.00 | 124 |
| November 2 | 1.00 | 141 | December 28 | (*a*) | 86 |

*a* Ice.

## WHITEROCKS RIVER NEAR WHITEROCKS, UTAH.

This stream drains the country immediately east of the head waters of Uinta River. It has its source in the peaks of the Uinta Mountains, which attain elevations of over 13,000 feet. The general course of the river is southerly, and it joins the main Uinta through numerous channels between Whiterocks and Fort Duchesne. A gaging station was established in the canyon of this river about 10 miles above the United States Indian agency at Whiterocks on September 15, 1899, by Cyrus C. Babb, in connection with the investigation of a water supp y for the Uinta Indian Reservation. The gage rod consists of a 2 by 4 inch by 12 foot timber bolted to the triple trunk of a tree on the left bank of the stream. The bench mark is a nail in a burnt tree 50 feet east of the rod, and is at an elevation of 10.12 feet above gage datum. Discharge measurements are made from a car and cable 200 feet above the gage rod. The bed of this river is very rocky, is strewn with large bowlders, and although permanent in character is not altogether satisfactory because of the fact that it is impossible to obtain accurate soundings. Daily gage heights were not read at this point, owing to its distance from any reliable observer. The following discharge measurements were made by C. C. Babb and C. T. Prall during 1899:

*Measurements of Whiterocks River near Whiterocks, Utah.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| September 15 | .......... | 93 | November 27 | 1.05 | 66 |
| September 29 | 1.00 | 58 | December 5 | 1.10 | 71 |
| October 7 | 1.00 | 75 | December 12 | .95 | 59 |
| October 17 | 1.10 | 85 | December 19 | .95 | 56 |
| November 1 | 1.00 | 65 | December 29 | (*a*) | 66 |

*a* Ice.

## UINTA RIVER AT FORT DUCHESNE, UTAH.

This river, on its emergence from its canyon, spreads out in numerous channels over its flood plain until a short distance above Fort Duchesne, where its waters are collected in one channel. Whiterocks River enters some distance above this point. A number of canals for the use of the Indians divert water between Fort Duchesne and the agency. On the east side are a number of small ditches, which in the aggregate take considerable water; but the amount is difficult to estimate. On the east side are two principal ditches, known as Canal No. 1 and Bench ditch. The former was measured on October 14, 1899, and was then carrying 16 second-feet; its maximum capacity is about double this quantity. Bench ditch, near its head, on the same day, was discharging 49 second-feet; its maximum capacity is somewhere in the neighborhood of 75 second-feet. This station was established September 14, 1899, in connection with the investigation of the water supply for the Uinta Indian Reservation, and is located at the highway bridge at the fort. The permanent rod was established November 8, 1899, and is nailed to the southern end of the east crib of the new bridge. The bench mark is a nail in the southeast crib in the first header above the bottom, and is at an elevation of 4,910.13 feet. The elevation of the zero of the rod is 4,907.20 feet. Daily gage readings were not obtained at this place. The following measurements of discharge were made by Cyrus C. Babb and C. T. Prall during 1899:

*Measurements of Uinta River at Fort Duchesne, Utah.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| September 14 | .......... | 86 | December 1 | 2.55 | 120 |
| September 26 | 2.30 | 71 | December 8 | 2.43 | 112 |
| October 27 | 2.40 | 83 | December 13 | 2.40 | 107 |
| November 3 | 2.50 | 102 | December 21 | 2.35 | 102 |
| November 18 | 2.57 | 120 | December 27 | 2.59 | 131 |

## UINTA RIVER AT OURAY SCHOOL.

This river, after leaving Fort Duchesne, receives as its principal tributary Dry Gulch Creek, which enters from the west. The natural flow of this tributary occurs only during flood stages, but for several years there has been a constant stream in it, being the waste water from the Indians' ditches above, principally from Canal No. 1 and Bench ditch. The station was established November 8, 1899, and is located at the highway bridge over the river near the Ouray School. The rod is nailed to the east end of the south crib of the wagon bridge. Bench mark No. 1 is the head of a nail in the extreme northeast corner of the bridge floor, and is at an elevation of 4,745.97 feet above sea; bench mark No. 2 is a nail in the flagstaff of the school, with an elevation of 4,760 feet. The elevation of the zero of the rod is 4,737.36 feet. During low water measurements are made, by wading, at a section 200 feet below the bridge, and at high stages they are made from the bridge itself. The section is a good one, although the center pier of the bridge will interfere somewhat with the accuracy of the results when measurements are taken there. The following measurements of discharge were made by Cyrus C. Babb and C. T. Prall during 1899:

November 15, gage height, 0.53 foot; discharge, 124 second-feet.
November 20, gage height, 0.56 foot; discharge, 124 second-feet.
December 2, gage height, 0.49 foot; discharge, 120 second-feet.
December 9, gage height, 0.50 foot; discharge, 115 second-feet.
December 16, gage height, 0.45 foot; discharge, 103 second-feet.

*Daily gage height, in feet, of Uinta River at Ouray School, Utah, for 1899.*

| Day. | Nov. | Dec. | Day. | Nov. | Dec. | Day. | Nov. | Dec. | Day. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.51 | 9 | | .52 | 17 | 0.68 | | 25 | 0.46 | |
| 2 | | .50 | 10 | | | 18 | .64 | | 26 | .51 | |
| 3 | | .30 | 11 | | | 19 | .60 | | 27 | .46 | |
| 4 | | .18 | 12 | 0.57 | | 20 | .58 | | 28 | .61 | |
| 5 | | .40 | 13 | .55 | | 21 | .55 | | 29 | .58 | |
| 6 | | .40 | 14 | .58 | | 22 | .50 | | 30 | .50 | |
| 7 | | | 15 | .57 | | 23 | .59 | | 31 | | |
| 8 | | .60 | 16 | .99 | | 24 | .52 | | | | |

## DUCHESNE RIVER AT PRICE ROAD BRIDGE, UTAH.

This stream has its source in the high peaks of the Uinta and Wasatch mountains, and flows in a general easterly direction, emptying into Green River 3 miles above the mouth of White River. Practically the entire drainage basin is included within the Uinta Indian Reservation. Strawberry Creek is an important tributary of the Duchesne and includes within its basin a tract of very fine grazing land, known as Strawberry Valley. The area is of a rolling character in contrast to the basin of the upper Duchesne, which is distinctly mountainous. A number of measurements were made of the tributaries of Duchesne

River in the fall of 1899, in connection with the water-supply investigations for the Uinta Indian Reservation. In Strawberry Valley a number of small tributaries, averaging about one second-foot each, contribute to the supply of the river. In September, 1899, Currant Creek was discharging 20 second-feet at the crossing of the Provo and Fort Duchesne road. Red Creek, farther to the east, was at the same date carrying 8 second-feet. Strawberry Creek 4 miles above its mouth was measured on September 10 and found to be carrying 134 second-feet. Duchesne River immediately above Strawberry Creek was carrying on the same day 302 second-feet. Lake Creek is an important tributary of Duchesne River from the north. At the bridge near its mouth it was found to be carrying 128 second-feet on September 11. The station on Duchesne River was established October 26, 1899, and is located 3 miles below the mouth of Lake Creek at the highway bridge on the stage road from Price to Fort Duchesne. The permanent gage rod was placed November 16, 1899, and is nailed to the east side of the center pier. Bench mark No. 1 is a wire nail in a log close to the rod, and is opposite the 7-foot mark. Bench mark No. 2 is a wire nail on the west side of the crib, with an elevation of 5.48 feet above gage datum. The section at this point is very good, with a moderate velocity of water. There is one pier in the center of the stream which does not materially affect the accuracy of the results at low water, but presumably will to a certain extent during the flood season. The following measurements of discharge were made by Cyrus C. Babb and C. T. Prall during 1899:

October 26, gage height, 5.48 feet; discharge, 403 second-feet.
November 16, gage height, 5.50 feet; discharge, 436 second-feet.
November 29, gage height, 5.38 feet; discharge, 360 second-feet.
December 7, gage height, 5.50 feet; discharge, 386 second feet.
December 14, gage height, 5.10 feet; discharge, 309 second-feet.

*Daily gage height, in feet, of Duchesne River at Price road bridge, Utah, for 1899.*

| Day. | Dec. | Day. | Dec. | Day. | Dec. | Day. | Dec. | Day. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ........ | 8 | 5.52 | 14 | 5.00 | 20 | 5.40 | 26 | 5.94 |
| 2 | ........ | 9 | 5.52 | 15 | 5.05 | 21 | 5.35 | 27 | 5.98 |
| 3 | 5.32 | 10 | 5.04 | 16 | 5.06 | 22 | 5.45 | 28 | 6.00 |
| 4 | 5.32 | 11 | 5.04 | 17 | 5.15 | 23 | 5.65 | 29 | 6.00 |
| 5 | 5.36 | 12 | 5.00 | 18 | 5.40 | 24 | 5.75 | 30 | 6.00 |
| 6 | 5.20 | 13 | 5.00 | 19 | 5.40 | 25 | 5.92 | 31 | ........ |
| 7 | 5.52 | | | | | | | | |

GREEN RIVER AT BLAKE, UTAH.

This river, in the lower portion of its course, drains a rough and broken country in eastern Utah not susceptible of irrigation and hardly adapted to grazing purposes. It is in canyon most of its way below the Rio Grande Western Railway and is very inaccessible. About 60 miles below the railroad crossing it receives the waters of Grand River, and the two streams form Colorado River. The station located at Blake, Utah, was established October 21, 1894. The rod of the wire gage is nailed to the guard rail on the lower side of the railroad bridge. The elevation of the top of the pier, to which the old vertical rod is attached, is 22 feet above gage datum. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 278; 1897, Nineteenth Annual Report, Part IV, page 398; 1898, Twentieth Annual Report, Part IV, page 387. One measurement of discharge was made during 1899 by J. S. Baker, on June 28, when, at a gage height of 10.19 feet, a discharge of 52,378 second-feet was found.

*Daily gage height, in feet, of Green River at Blake, Utah, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.80 | 2.10 | 2.00 | 3.55 | 5.85 | 7.15 | 9.55 | 5.40 | 3.25 | 2.50 |
| 2 | 1.80 | 2.10 | 2.00 | 3.50 | 5.65 | 7.25 | 9.35 | 5.15 | 3.20 | 2.40 |
| 3 | 1.80 | 2.20 | 2.10 | 3.50 | 5.55 | 7.35 | 9.15 | 5.20 | 3.20 | 2.40 |
| 4 | 1.80 | 2.20 | 2.10 | 3.50 | 5.25 | 7.45 | 8.95 | 6.60 | 3.20 | 2.40 |
| 5 | 1.80 | 2.10 | 2.20 | 3.40 | 5.05 | 7.55 | 8.75 | 6.55 | 3.20 | 2.40 |
| 6 | 1.80 | 2.10 | 2.20 | 3.40 | 4.85 | 7.65 | 8.55 | 6.40 | 3.10 | 2.40 |
| 7 | 1.80 | 2.10 | 2.20 | 3.40 | 4.95 | 7.75 | 8.40 | 6.30 | 3.10 | 2.40 |
| 8 | 1.80 | 2.10 | 2.20 | 3.30 | 5.15 | 7.85 | 8.30 | 6.15 | 3.10 | 2.40 |
| 9 | 1.80 | 2.10 | 2.20 | 3.30 | 5.50 | 8.05 | 8.20 | 6.00 | 3.10 | 2.40 |
| 10 | 1.80 | 2.10 | 2.30 | 3.20 | 5.90 | 8.20 | 8.10 | 5.85 | 3.00 | 2.40 |
| 11 | 1.80 | 2.10 | 2.30 | 3.20 | 6.15 | 8.30 | 8.00 | 5.65 | 3.00 | 2.40 |
| 12 | 1.80 | 2.10 | 2.30 | 3.30 | 6.35 | 8.40 | 7.90 | 5.45 | 3.00 | 2.40 |
| 13 | 1.90 | 2.10 | 2.30 | 3.30 | 6.55 | 8.50 | 7.80 | 5.25 | 2.90 | 2.40 |
| 14 | 1.90 | 2.00 | 2.30 | 3.30 | 6.65 | 8.50 | 7.70 | 5.20 | 2.85 | 2.40 |
| 15 | 1.90 | 2.00 | 2.35 | 3.40 | 6.95 | 8.65 | 7.60 | 5.10 | 2.80 | ........ |
| 16 | 1.90 | 2.00 | 2.40 | 3.50 | 7.30 | 8.90 | 7.50 | 5.00 | 2.80 | ........ |
| 17 | 1.90 | 2.00 | 2.40 | 3.60 | 7.55 | 9.20 | 7.40 | 4.95 | 2.80 | ........ |
| 18 | 1.90 | 2.10 | 2.40 | 3.75 | 7.75 | 9.15 | 7.30 | 4.85 | 2.70 | ........ |
| 19 | 2.00 | 2.10 | 2.50 | 3.95 | 7.75 | 9.10 | 7.15 | 4.75 | 2.70 | ........ |
| 20 | 2.00 | 2.10 | 2.60 | 4.15 | 7.65 | 9.40 | 7.00 | 4.65 | 2.65 | ........ |
| 21 | 2.00 | 2.00 | 2.70 | 4.35 | 7.60 | 9.50 | 6.85 | 4.55 | 2.60 | ........ |
| 22 | 2.00 | 2.00 | 2.85 | 4.55 | 7.60 | 9.75 | 6.65 | 4.45 | 2.60 | ........ |
| 23 | 2.00 | 2.00 | 3.05 | 4.75 | 7.50 | 9.90 | 6.45 | 4.25 | 2.55 | ........ |
| 24 | 2.00 | 2.00 | 3.25 | 4.95 | 7.50 | 10.00 | 6.25 | 4.05 | 2.50 | ........ |
| 25 | 2.10 | 2.00 | 3.45 | 5.05 | 7.40 | 10.05 | 6.05 | 3.85 | 2.50 | ........ |
| 26 | 2.10 | 2.00 | 3.65 | 5.25 | 7.25 | 10.25 | 5.90 | 3.65 | 2.50 | ........ |
| 27 | 2.20 | 2.00 | 3.85 | 5.45 | 7.05 | 10.30 | 5.75 | 3.50 | 2.50 | ........ |
| 28 | 2.20 | 2.00 | 4.05 | 5.65 | 6.90 | 10.15 | 5.60 | 3.50 | 2.50 | ........ |
| 29 | 2.20 | ........ | 4.25 | 5.85 | 6.95 | 9.95 | 5.50 | 3.45 | 2.50 | ........ |
| 30 | 2.20 | ........ | 4.10 | 6.00 | 7.05 | 9.75 | 5.50 | 3.40 | 2.50 | ........ |
| 31 | 2.20 | ........ | 3.75 | ........ | 7.10 | ........ | 5.45 | 3.30 | ........ | ........ |

Station discontinued November 15.

## GRAND RIVER AT GLENWOOD SPRINGS, COLORADO.

This river has its source on the western slope of the Continental Divide in north-central Colorado, near the head waters of North Platte, South Platte, and Arkansas rivers. It flows in a general southwesterly direction, passing out of the State into Utah, where it joins the Green River to form the Colorado. Little irrigation is practiced along the main stream, owing to the comparatively small area of land that can be utilized for that purpose. Two stations were maintained on this river during 1899, one at Glenwood Springs and the other at Grand Junction, Colorado. The former station was established by A. L. Fellows May 12, 1899, at the request of the Denver and Rio Grande

Railroad Company, and is located at the railroad bridge one-fourth of a mile west of the railroad station, and above the mouth of Roaring Fork. A wire gage is here used. Discharge measurements are made at the wagon bridge opposite Colorado Hotel in the town. The channel is good, composed of gravel and rock, and not liable to great changes. The banks are not subject to overflow. Gage readings were taken only during the high-water season, having been discontinued July 17, but the station will probably be resumed in 1900, when continuous measurements will be made. Roaring Fork was measured twice during the year, the first time on June 17, when, during the flood stage, the discharge was found to be 11,258 second-feet; the second time on November 17, when a discharge of 457 second-feet was found. Three measurements at the gaging station were made by A. L. Fellows in 1899. The first, on May 12, at a gage height of 6.05 feet, showed a discharge of 17,577 second-feet; the second, on June 17, at a gage height of 10.22 feet, showed a discharge of 29,187 second-feet; the third, on November 17, at a gage height of 2.75 feet, gave a discharge of 1,084 second-feet.

*Daily gage height, in feet, of Grand River at Glenwood Springs, Colorado, for 1899.*

| Day. | May. | June. | July. | Day. | May. | June. | July. | Day. | May. | June. | July. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ........ | 7.50 | 6.90 | 12 | 6.05 | 9.35 | 5.90 | 23 | 6.20 | 9.70 | ........ |
| 2 | ........ | 7.40 | 7.10 | 13 | 6.80 | 10.05 | 5.60 | 24 | 6.30 | 9.30 | ........ |
| 3 | ........ | 7.35 | 7.00 | 14 | 7.50 | 10.40 | 5.30 | 25 | 6.65 | 8.80 | ........ |
| 4 | ........ | 7.20 | 7.00 | 15 | 7.85 | 10.30 | 5.00 | 26 | 7.15 | 8.50 | ........ |
| 5 | ........ | 6.65 | 6.80 | 16 | 8.15 | 10.10 | 4.90 | 27 | 7.65 | 8.40 | ........ |
| 6 | ........ | 6.45 | 6.70 | 17 | 7.75 | 10.10 | 4.70 | 28 | 7.70 | 8.20 | ........ |
| 7 | ........ | 6.40 | 6.50 | 18 | 7.65 | 10.20 | ........ | 29 | 7.45 | 7.20 | ........ |
| 8 | ........ | 6.60 | 6.40 | 19 | 7.80 | 10.60 | ........ | 30 | 7.50 | 7.00 | ........ |
| 9 | ........ | 7.60 | 6.40 | 20 | 8.00 | 10.65 | ........ | 31 | 7.60 | ........ | ........ |
| 10 | ........ | 7.85 | 6.20 | 21 | 7.50 | 10.60 | ........ | | | | |
| 11 | ........ | 8.25 | 6.10 | 22 | 6.75 | 10.40 | ........ | | | | |

Station discontinued July 18.

## GRAND RIVER AT GRAND JUNCTION, COLORADO.

The station at this point, established October 18, 1894, is located at the wagon bridge across Grand River, near the pump house of the city waterworks at Grand Junction and a short distance above the mouth of Gunnison River. The river at this point discharges through two channels, and a separate record of each is maintained, with separate discharge measurements. The water in the right-hand channel does not run during the entire year, and in 1899 there was a discharge in it extending only from May 10 to July 15, inclusive. Gage rod No. 1, in the right-hand channel, consists of a 4 by 6 inch timber bolted to the bridge abutment on the right-hand side of the right channel. The bench mark is the top of the bridge abutment and is 12 feet above gage datum. The horizontal wire gage No. 2 is fastened to the upper side of the bridge over the left channel. The bench mark is a cross on iron post of bridge at 592-foot mark on right abutment, and is 31 feet above gage datum. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 261; 1897, Nineteenth Annual Report, Part IV, page 401; 1898, Twentieth Annual Report, Part IV, page 389. Only two measurements of discharge were made during the year on the right channel, and these by A. L. Fellows. The first, on May 13, with a gage height of 3.15 feet, gave a discharge of 2,758 second-feet; the second, on June 18, with a gage height of 5.55 feet, showed a discharge of 8,954 second-feet. During 1899 the following measurements of discharge on the left channel were made by A. L. Fellows:

April 15, gage height, 4.70 feet; discharge, 2,946 second-feet.
May 13, gage height, 10 feet; discharge, 20,395 second-feet.
June 18, gage height, 11.55 feet; discharge, 30,000 second-feet.
September 19, gage height, 4.20 feet; discharge, 1,989 second-feet.
November 18, gage height, 3.90 feet; discharge, 1,916 second-feet.

*Daily gage height, in feet, of Grand River at Grand Junction, Colorado, for 1899.*

[Rod No. 1.]

| Day. | May. | June. | July. | Day. | May. | June. | July. | Day. | May. | June. | July. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1... | ........ | 3.90 | 3.90 | 12.... | 1.95 | 4.85 | 0.90 | 23.... | 2.70 | 5.80 | ........ |
| 2... | ........ | 3.95 | 4.00 | 13.... | 3.05 | 5.45 | .95 | 24.... | 2.60 | 5.20 | ........ |
| 3... | ........ | 3.80 | 4.10 | 14.... | 3.55 | 5.80 | .80 | 25.... | 2.95 | 4.85 | ........ |
| 4... | ........ | 3.40 | 3.90 | 15.... | 4.00 | 5.90 | .20 | 26.... | 3.35 | 4.70 | ........ |
| 5... | ........ | 3.05 | 3.40 | 16.... | 4.30 | 5.85 | ........ | 27.... | 3.85 | 4.50 | ........ |
| 6... | ........ | 2.95 | 2.90 | 17.... | 4.45 | 5.75 | ........ | 28.... | 4.10 | 4.10 | ........ |
| 7... | ........ | 2.95 | 2.65 | 18.... | 4.10 | 5.70 | ........ | 29.... | 3.85 | 4.00 | ........ |
| 8... | ........ | 3.25 | 2.25 | 19.... | 4.20 | 5.90 | ........ | 30.... | 3.80 | 3.95 | ........ |
| 9... | ........ | 3.45 | 1.90 | 20.... | 4.20 | 6.10 | ........ | 31.... | 3.95 | ........ | ........ |
| 10... | 0.40 | 3.90 | 1.50 | 21.... | 4.15 | 6.45 | ........ | | | | |
| 11... | .90 | 4.35 | 1.20 | 22.... | 3.50 | 6.10 | ........ | | | | |

Water was running in this channel only during the time when records are given.

*Daily gage height, in feet, of Grand River at Grand Junction, Colorado, for 1899.*

[Rod No. 2.]

| Day. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ...... | 3.80 | 3.40 | 6.75 | 10.50 | 10.30 | 6.50 | 4.45 | ...... | ...... | ........ |
| 2 | ...... | 3.80 | 3.45 | 6.45 | 10.55 | 10.50 | 6.50 | 4.65 | ...... | ...... | ........ |
| 3 | ...... | 3.80 | 3.55 | 6.30 | 10.45 | 10.50 | 6.40 | 4.60 | 3.80 | ...... | ........ |
| 4 | ...... | 3.40 | 3.60 | 6.05 | 10.00 | 10.35 | 7.35 | 4.45 | ...... | ...... | ........ |
| 5 | ...... | ...... | 3.60 | 5.80 | 9.50 | 9.90 | 7.00 | 4.35 | ...... | ...... | ........ |
| 6 | ...... | ...... | 3.60 | 5.75 | 9.35 | 9.70 | 6.85 | 4.30 | ...... | ...... | ........ |
| 7 | ...... | ...... | 3.60 | 6.00 | 9.30 | 9.55 | 6.65 | 4.20 | ...... | ...... | ........ |
| 8 | ...... | 3.60 | 3.60 | 6.40 | 9.55 | 9.30 | 6.45 | 4.20 | ...... | ...... | ........ |
| 9 | ...... | ...... | 3.60 | 6.95 | 9.85 | 9.05 | 6.20 | 4.15 | ...... | ...... | ........ |
| 10 | ...... | ...... | 3.70 | 7.50 | 10.30 | 8.85 | 5.90 | 4.10 | 3.90 | 3.90 | ........ |
| 11 | ...... | 3.60 | 3.75 | 8.15 | 10.45 | 8.70 | 5.75 | 4.10 | ...... | ...... | ........ |
| 12 | ...... | ...... | 3.85 | 8.95 | 10.70 | 8.55 | 5.65 | 4.10 | ...... | ...... | 3.70 *a* |
| 13 | ...... | ...... | 4.05 | 9.75 | 11.20 | 8.65 | 5.55 | 4.05 | ...... | ...... | ........ |
| 14 | ...... | ...... | 4.40 | 10.25 | 11.60 | 8.55 | 5.45 | 3.95 | ...... | ...... | ........ |
| 15 | ...... | 3.40 | 4.60 | 10.65 | 11.70 | 8.40 | 5.40 | 4.10 | ...... | 3.90 | ........ |
| 16 | ...... | ...... | 4.65 | 10.85 | 11.65 | 8.35 | 5.35 | 4.35 | ...... | ...... | ........ |
| 17 | ...... | ...... | 4.90 | 10.80 | 11.65 | 8.15 | 5.25 | 4.30 | ...... | ...... | ........ |
| 18 | ...... | 3.50 | 5.20 | 10.70 | 11.60 | 7.85 | 5.20 | 4.30 | ...... | ...... | ........ |
| 19 | ...... | ...... | 5.45 | 10.80 | 11.80 | 7.65 | 5.15 | 4.20 | 4.40 | ...... | ........ |
| 20 | ...... | ...... | 5.55 | 10.80 | 11.90 | 7.45 | 4.95 | 4.15 | ...... | ...... | ........ |
| 21 | ...... | ...... | 5.35 | 10.60 | 11.95 | 7.35 | 4.85 | 4.10 | ...... | ...... | ........ |
| 22 | 4.10 | 3.80 | 5.15 | 10.05 | 11.80 | 7.25 | 4.75 | 4.05 | ...... | 3.90 | ........ |
| 23 | 4.10 | ...... | 5.35 | 9.50 | 11.55 | 7.15 | 4.65 | 3,95 | ...... | ...... | ........ |
| 24 | 4.10 | ...... | 5.95 | 9.55 | 11.15 | 7.05 | 4.55 | 3.90 | ...... | ...... | ........ |
| 25 | 4.00 | 4.10 | 6.55 | 9.95 | 10.90 | 6.95 | 4.50 | 3.90 | ...... | ...... | ........ |
| 26 | ...... | ...... | 7.00 | 10.45 | 10.80 | 6.85 | 4.45 | 3.90 | ...... | ...... | ........ |
| 27 | ...... | ...... | 7.55 | 10.75 | 10.65 | 6.65 | 4.40 | 3.95 | 4.00 | ...... | ........ |
| 28 | ...... | ...... | 7.70 | 10.70 | 10.45 | 6.60 | 4.30 | 3.90 | ...... | ...... | ........ |
| 29 | ...... | 3.70 | 7.25 | 10.45 | 10.40 | 6.55 | 4.30 | 3.90 | ...... | 3.90 | ........ |
| 30 | ...... | ...... | 7.10 | 10.40 | 10.35 | 6.50 | 4.30 | 3.90 | ...... | ...... | ........ |
| 31 | ...... | ...... | ...... | 10.60 | ........ | 6.50 | 4.30 | ...... | ...... | ...... | ........ |

*a* River frozen.

## UNCOMPAHGRE RIVER AT FORT CRAWFORD, COLORADO.

This river has its source in Ouray County, in the high peaks in southwestern Colorado, and flows in a general northwesterly direction, entering Gunnison River at Delta. The upper portion of its drainage basin is mountainous, but proceeding downstream the character changes to a more rolling country, and irrigation is possible along the valleys and adjacent mesas. In the vicinity of Montrose a number of canals divert nearly all of the low water flow, and recourse must be had to storage for the further irrigation of the country. The station established June 25, 1895, is located about one-half mile east of the depot at Fort Crawford, at a wagon bridge, and is about 8 miles above Montrose. The gage consists of an inclined timber bolted to the bridge trestle on the right-hand side of the stream. The bench mark is a spike driven into the base of a cottonwood post near by, and is 9.18 feet above gage datum. The channel has been changing a great deal, and a new location for the station will probably be found during the next season. On September 20 a measurement of this river was made at Montrose, at a gage height of 0.40 foot, which gave a discharge of 15 second-feet. On November 20, at a gage height of 0.45 foot, at the same point, the discharge was 15 second-feet. A measurement of Montrose canal at its head gate was made September 21, at a gage height of 0.67 foot, and showed a discharge of 30 second-feet. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 266; 1897, Nineteenth Annual Report, Part IV, page 402; 1898, Twentieth Annual Report, Part IV, page 391. The following measurements of discharge were made by A. L. Fellows during 1899:

April 16, gage height, 4.50 feet; discharge, 328 second-feet.
May 15, gage height, 5.22 feet; discharge, 747 second-feet.
June 19, gage height, 5.18 feet; discharge, 773 second-feet.
September 21, gage height, 3.65 feet; discharge, 69 second-feet.
November 20, gage height, 3.70 feet; discharge, 79 second-feet.

*Daily gage height, in feet, of Uncompahgre River at Fort Crawford, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.... | ...... | 4.35 | 5.05 | 4.70 | 4.00 | 3.00 | 17..... | 4.55 | 5.35 | 5.35 | 4.35 | 3.85 | 3.70 |
| 2.... | 3.80 | 4.45 | 5.05 | 4.70 | 4.15 | 3.00 | 18..... | 4.60 | 5.45 | 5.35 | 4.45 | 3.85 | 3.60 |
| 3.... | 3.85 | 4.35 | 4.80 | 4.55 | 4.80 | 2.95 | 19..... | 4.55 | 5.30 | 5.30 | 4.45 | 3.80 | 3.70 |
| 4.... | 3.80 | 4.35 | 4.40 | 4.25 | 4.65 | 2.95 | 20..... | 4.45 | 4.95 | 5.25 | 4.35 | 3.80 | 3.75 |
| 5.... | 3.88 | 4.30 | 4.35 | 4.35 | 4.55 | 2.80 | 21..... | 4.35 | 4.90 | 5.10 | 4.35 | 3.75 | 3.75 |
| 6.... | 3.82 | 4.40 | 5.05 | 4.25 | 4.30 | 2.80 | 22..... | 4.40 | 4.80 | 5.05 | 4.25 | 3.70 | 3.60 |
| 7.... | 3.80 | 4.35 | 5.05 | 4.20 | 3.90 | 2.80 | 23..... | 4.60 | 4.80 | 4.95 | 4.05 | 3.70 | 3.50 |
| 8.... | 3.85 | 4.30 | 5.00 | 4.10 | 3.95 | 2.80 | 24..... | 4.58 | 4.65 | 4.80 | 4.10 | 3.35 | 3.50 |
| 9.... | 3.95 | 4.35 | 5.15 | 4.25 | 3.80 | 2.80 | 25..... | 4.75 | 4.95 | 4.80 | 4.10 | 3.85 | 3.55 |
| 10.... | 4.25 | 4.40 | 5.45 | 4.20 | 3.90 | 2.75 | 26..... | 4.70 | 5.00 | 5.00 | 4.20 | 3.85 | 3.55 |
| 11.... | 4.15 | 4.70 | 5.40 | 4.35 | 4.00 | 2.80 | 27..... | 4.68 | 5.10 | 4.90 | 4.35 | 3.60 | 3.50 |
| 12.... | 4.25 | 4.65 | 5.45 | 4.45 | 4.00 | 2.85 | 28..... | 4.55 | 5.10 | 4.85 | 4.00 | 3.45 | 3.50 |
| 13.... | 4.30 | 4.90 | 5.85 | 4.50 | 3.95 | 2.90 | 29..... | 4.45 | 5.10 | 4.85 | 4.10 | 3.40 | 3.45 |
| 14.... | 4.35 | 5.10 | 5.75 | 4.50 | 3.95 | 3.85 | 30..... | 4.30 | 5.35 | 4.70 | 4.15 | 3.30 | 3.45 |
| 15.... | 4.40 | 5.15 | 5.85 | 4.35 | 3.95 | 3.95 | 31..... | ...... | 5.35 | ...... | 4.05 | 3.20 | ........ |
| 16.... | 4.55 | 5.25 | 5.55 | 4.40 | 3.85 | 3.70 | | | | | | | |

Closed for the winter September 30.

## GUNNISON RIVER AT GRAND JUNCTION, COLORADO.

This river, the principal tributary of Grand River, has its source on the western slope of the Continental Divide in south-central Colorado, and flows in a general westerly direction into Grand River at Grand Junction. There were two gaging stations maintained within its basin during the last season, one at Fort Crawford, on the Uncompahgre, and the other at Grand Junction, at the mouth of Gunnison River. This latter station was established in May, 1897, and is located at the iron highway bridge one and one-half miles from the town of Grand Junction. The gage is vertical and consists of a timber bolted to the stone pier of the bridge. The bench mark is the top of the capstone of the bridge pier, and is 17.60 feet above gage datum. The measurements here are not satisfactory, owing to the fact that at high stages of Grand River the water backs up the mouth of the Gunnison considerably above the point where the gage rod upon the latter is located, thus affecting the gage readings so seriously that no satisfactory rating table can be made for this point. The station will not be resumed the coming year. Results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page

405; 1898, Twentieth Annual Report, Part IV, page 390. The following measurements of discharge were made by A. L. Fellows during 1899:

April 15, gage height, 3.50 feet; discharge, 3,002 second-feet.
May 13, gage height, 7 feet; discharge, 14,280 second-feet.
June 18, gage height, 7.15 feet; discharge, 12,769 second-feet.
September 19, gage height, 2.20 feet; discharge, 1,061 second-feet.
November 18, gage height, 2 feet; discharge, 968 second-feet.

*Daily gage height, in feet, of Gunnison River at Grand Junction, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.... | 2.00 | 4.60 | 6.60 | 5.60 | 3.00 | 1.80 | 17..... | 3.90 | 7.30 | 7.20 | 3.80 | 2.70 | 1.80 |
| 2.... | 2.10 | 4.50 | 6.50 | 5.40 | 4.30 | 1.90 | 18..... | 4.20 | 7.00 | 7.10 | 3.80 | 2.60 | 1.90 |
| 3.... | 2.00 | 4.40 | 6.40 | 5.60 | 3.10 | 1.80 | 19..... | 4.30 | 7.10 | 7.20 | 3.70 | 2.60 | 2.10 |
| 4.... | 2.00 | 4.00 | 6.00 | 5.60 | 3.80 | 1.90 | 20..... | 4.50 | 7.30 | 7.30 | 3.90 | 2.50 | 2.00 |
| 5.... | 2.00 | 4.00 | 5.60 | 5.40 | 4.00 | 1.90 | 21..... | 4.20 | 7.00 | 7.20 | 3.80 | 2.40 | 1.80 |
| 6.... | 2.00 | 4.00 | 5.50 | 5.00 | 3.60 | 1.90 | 22..... | 3.90 | 6.50 | 7.10 | 3.70 | 2.40 | 1.60 |
| 7.... | 2.10 | 4.10 | 5.50 | 4.90 | 3.40 | 2.00 | 23..... | 4.20 | 5.80 | 6.80 | 3.60 | 2.20 | 1.60 |
| 8.... | 2.10 | 4.30 | 5.80 | 4.20 | 3.30 | 1.90 | 24..... | 4.70 | 5.90 | 6.50 | 3.50 | 2.10 | 1.60 |
| 9.... | 2.20 | 4.80 | 5.90 | 4.20 | 3.20 | 1.60 | 25..... | 5.00 | 6.20 | 6.40 | 3.30 | 2.00 | 1.60 |
| 10.... | 2.30 | 5.20 | 6.00 | 4.10 | 3.20 | 1.50 | 26..... | 5.40 | 6.40 | 6.40 | 3.20 | 1.80 | 1.50 |
| 11.... | 2.60 | 5.80 | 6.50 | 4.00 | 3.00 | 1.50 | 27..... | 5.70 | 6.50 | 6.50 | 3.00 | 1.80 | 1.40 |
| 12.... | 2.80 | 6.30 | 6.90 | 3.90 | 2.70 | 1.40 | 28..... | 5.60 | 6.70 | 6.10 | 3.30 | 1.80 | 1.40 |
| 13.... | 3.00 | 6.60 | 7.30 | 3.90 | 2.70 | 1.40 | 29..... | 5.40 | 6.50 | 5.80 | 3.60 | 1.80 | 1.40 |
| 14.... | 3.40 | 7.20 | 7.50 | 4.00 | 2.70 | 1.60 | 30..... | 5.00 | 6.40 | 5.70 | 3.30 | 1.80 | 1.30 |
| 15.... | 3.60 | 7.40 | 7.50 | 4.00 | 2.70 | 1.80 | 31..... | ...... | 6.60 | ...... | 3.20 | 2.10 | ........ |
| 16.... | 3.70 | 7.50 | 7.40 | 3.90 | 2.70 | 1.80 | | | | | | | |

Station discontinued September 30.

[Continued in Water-Supply and Irrigation Paper No. 38.]

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## 1895.

Sixteenth Annual Report of the United States Geological Survey, 1894-95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Robert Hay.

A geological reconnaissance of northwestern Wyoming, by George H. Eldridge, 1894; octavo, 72 pp. Bulletin No. 119 of the United States Geological Survey; price, 10 cents.

Contains a description of the geologic structure of portions of the Bighorn Range and Bighorn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 176 pp. Bulletin No. 131 of the United States Geological Survey; price, 15 cents.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in a number of counties in western Nebraska, western Kansas, and eastern Colorado.

## 1896.

Seventeenth Annual Report of the United States Geological Survey, 1895-96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett, and "Preliminary report on the artesian areas of a portion of the Dakotas,' by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 230 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey; price, 20 cents.

Gives a description of the geologic conditions of the coastal region from Long Island, N. Y., to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey; price, 25 cents.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

## 1897.

Eighteenth Annual Report of the United States Geological Survey, 1896-97, Part IV, Hydrography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in South Dakota," by N. H. Darton, and "Reservoirs for irrigation," by J. D. Schuyler.

## 1899.

Nineteenth Annual Report of the United States Geological Survey, 1897-98, Part IV, Hydrography, 1899; octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1897," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton, and "Preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

## 1900.

Twentieth Annual Report of the United States Geological Survey, 1898-99, Part IV, Hydrography, 1900; octavo, 660 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell, and "Hydrography of Nicaragua," by A. P. Davis.

### Water-Supply and Irrigation Papers, 1896-1900.

This series of papers is designed to present in pamphlet form the results of stream measurements and of special investigations. A list of these, with other information, is given on the outside (or fourth) page of this cover.

Survey bulletins can be obtained only by prepayment of cost, as noted above. Postage stamps, checks, and drafts can not be accepted. Money should be transmitted by postal money order or express order, made payable to the Director of the United States Geological Survey. Correspondence relating to the publications of the Survey should be addressed to **The Director, United States Geological Survey, Washington, D. C.**

## WATER-SUPPLY AND IRRIGATION PAPERS.

1. Pumping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phœnix, Arizona, by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A recónnaissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill, 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E. C. Murphy, 1897.
9. Irrigation near Greeley, Colorado, by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Underground waters of southeastern Nebraska, by N. H. Darton, 1898.
13. Irrigation systems in Texas, by W. F. Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15. Operations at river stations, 1897, Part I, 1898.
16. Operations at river stations, 1897, Part II, 1898.
17. Irrigation near Bakersfield, California, by C. E. Grunsky, 1898.
18. Irrigation near Fresno, California, by C. E. Grunsky, 1898.
19. Irrigation near Merced, California, by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of northern Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems of Bighorn Mountains, by Elwood Mead, 1899.
24. Water resources of the State of New York, Part I, by George W. Rafter, 1899.
25. Water resources of the State of New York, Part II, by George W. Rafter, 1899.
26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett 1899.
27. Operations at river stations, 1898, Part I, 1899.
28. Operations at river stations, 1898, Part II, 1899.
29. Wells and windmills in Nebraska, by Erwin Hinckley Barbour, 1899.
30. Water resources of the Lower Peninsula of Michigan, by Alfred C. Lane, 1899.
31. Lower Michigan mineral waters, by Alfred C. Lane, 1899.
32. Water resources of Puerto Rico, by H. M. Wilson, 1900.
33. Storage of water on Gila River, Arizona, by J. B. Lippincott, 1900.
34. Geology and water resources of southeastern S. Dak., by J. E. Todd, 1900.
35. Operations at river stations, 1899, Part I, 1900.
36. Operations at river stations, 1899, Part II, 1900.
37. Operations at river stations, 1899, Part III, 1900.
38. Operations at river stations, 1899, Part IV, 1900.
39. Operations at river stations, 1899, Part V, 1900.

In addition to the above, there are in various stages of preparation other papers relating to the measurement of streams, the storage of water, the amount available from underground sources, the efficiency of windmills, the cost of pumping, and other details relating to the methods of utilizing the water resources of the country. Provision has been made for printing these by the following clause in the sundry civil act making appropriations for the year 1896–97:

*Provided*, That hereafter the reports of the Geological Survey in relation to the gaging of streams and to the methods of utilizing the water resources may be printed in octavo form, not to exceed 100 pages in length and 5,000 copies in number; 1,000 copies of which shall be for the official use of the Geological Survey, 1,500 copies shall be delivered to the Senate, and 2,500 copies shall be delivered to the House of Representatives, for distribution. [Approved June 11, 1896; Stat. L., vol. 29, p. 453.]

The maximum number of copies available for the use of the Geological Survey is 1,000. This quantity falls far short of the demand, so that it is impossible to supply all requests. Attempts are made to send these pamphlets to persons who have rendered assistance in their preparation through replies to schedules or who have furnished data. Requests made for a certain paper and stating a reason for asking for it are granted whenever practicable, but it is impossible to comply with general demands, such as to have all of the series sent indiscriminately.

Application for these papers should be made either to Members of Congress or to THE DIRECTOR, UNITED STATES GEOLOGICAL SURVEY, WASHINGTON, D. C.