# REPORTS ON THE WATER-POWER

OF THE

# REGION TRIBUTARY TO LAKE ONTARIO,

AND OF THE

# NEW YORK STATE CANALS,

BY

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# LETTER OF TRANSMITTAL.

BOSTON, MASS., *July* 9, 1883.

Professor W. P. TROWBRIDGE,

*Columbia College, New York City.*

SIR: I have the honor to submit a report upon the water-power of the region tributary to lake Ontario, based upon investigations carried on under your direction, mainly in the autumn of 1882. It is desired to call attention to the principles observed in the estimates of flow and power, which are fully explained in connection with the report on the region tributary to Long Island sound.

Very respectfully,

DWIGHT PORTER,

*Special Agent.*

# REPORT ON THE WATER-POWER

OF THE

# REGION TRIBUTARY TO LAKE ONTARIO.

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# THE REGION TRIBUTARY TO LAKE ONTARIO.

The principal rivers here to be noticed are the Black, Oswego, and Genesee.(a) These three drain an aggregate area of about 9,370 square miles, and minor streams increase the whole tributary area lying on the south shore of the lake, between the Saint Lawrence and Niagara rivers, to 12,400 square miles. To the southward are the basins of the Susquehanna and Allegheny. Certain tributaries of those rivers and the Genesee have their origin in common in Potter county, Pennsylvania, the drainage from which reaches the Atlantic ocean through such widely-separated channels as the gulf of Saint Lawrence, Chesapeake bay, and the gulf of Mexico. Striking southeasterly from fort Niagara and then southerly, the water-shed line inclosing the district we are considering passes around the head-waters of the Genesee, entering a little way into Pennsylvania, and reaching there its point of farthest removal from the lake, at a distance of about 95 miles. The division of the drainage slopes to the north and south is there effected by the elevated ridges which are thrown out as spurs of the Alleghany mountains. Re-entering New York state the line runs in an irregular course to the southward and eastward of the interior group of lakes; its elevation decreases, it turns to the northward, and east of Oneida lake sinks to an altitude of but 430 feet above ocean-level, forming a most favorable pass, through which the Erie canal crosses from the middle Atlantic slope to the basin of the great lakes. Around the sources of Black river the water-shed traverses the northern wilderness, and finally turning westward to Cape Vincent descends to the lake again.

The country thus included may be described in general as level or gently undulating in the counties bordering upon lake Ontario. To the southward it becomes more rolling, and a series of ridges gradually rising in height stretch down between Cayuga, Seneca, and their companion lakes, and finally become merged in the elevated and broken country forming the principal water-shed, the abrupt slopes of the latter attaining altitudes of from 2,000 to 2,500 feet above sea-level about the head-waters of the Genesee.

In the region inclosed between the summit line and the southern border of lake Ontario the gradual decline in level is accomplished by a succession of terraces, revealing in order the various geological formations from the more recent Devonian down to the older of the Upper Silurian. There is thus a progression downward from the shales and sandstones of the Portage and Chemung groups, in Allegany county, to the Medina sandstone bordering the lake in Monroe, and closely approaching or touching it in Oswego county. Owing to the soft character of many of the formations, changes have gone on which would have been impossible in a region of hard metamorphic rocks. Surface strata have become disintegrated and ground into soil. Tremendous masses have been torn and worn out in past ages by the action of glaciers and water, deep depressions have been formed which are now occupied by lakes, and narrow gorges have been cut for the streams. The latter preserve many high and vertical falls, but descents which were once probably made in single magnificent plunges near the mouths of the rivers have slowly receded, and in an uneven retrograde motion have become distributed up their courses in rapids and minor falls. To the eastward from the lake are found the sandstones, limestones, slates, and shales of the Lower Silurian strata, while still beyond are the granites and gneisses of the Archæan era.

Drift deposits are quite generally scattered over this section, the soil of which is derived in part from that source and in part from the disintegration of the native rocks. The fertility of the soil is great, and sustains a large annual production of the various grains. In those districts less suited to such use, or possessing especial advantages for dairying, wool-growing, and stock-raising, those industries take a prominent position. This region was once heavily clothed with timber, and considerable amounts still remain toward the Pennsylvania boundary, but to the northward the land has generally been cleared and only moderate patches of woods are left. The development of this part of New York state has been warranted by its rich resources, and has been fostered by the establishment of a fine system of water and railroad transportation. Running east and west is the Erie canal, joining the great lakes with the Atlantic seaboard and affording an outlet to numerous connecting routes on the interior lakes and canals. The New York Central and Hudson River railroad through the north, and the New York, Lake Erie, and

a The Niagara river is elsewhere described by Mr. Greenleaf.

Western railroad across the southern portion of the area here described, constitute two great lines between the east and the west, while various feeders and intersecting roads go to make up an extensive network.

Each of the three rivers, the Genesee, Oswego, and Black, possesses a large aggregate amount of water-power; each is already much utilized for manufacturing, and each offers opportunity for a considerable further development; but they differ widely among themselves in several important features. The Genesee has about a third more drainage area than the Black, and half that of the Oswego. Its fall is concentrated in a remarkable manner at Portage and Rochester, but elsewhere in the middle and lower course is only moderate in amount, while the volume is very variable and reaches a low point during the summer and fall. The Oswego is itself comparatively a short stream and its slope is not large, but it embraces within its basin a magnificent group of lakes which serve as storage reservoirs, and which maintain under all ordinary circumstances a very full and uniform discharge. The Black, although draining the smallest extent of country, is not equaled by either of the other main streams in the aggregate of valuable water-power which it offers. Its descent is rapid, both in the upper and lower course; an extensive portion of its basin is underlaid by metamorphic rock; its sources are back among the lakes and woods of the northern wilderness, and it flows with a large and steady volume even during the driest seasons.

In the main portion of the region tributary to lake Ontario on the south and east the average annual rainfall does not probably much, if at all, exceed 35 inches, and there is a range at different points from less than 30 to more than 40 inches. In the more elevated sections, and especially toward the head-waters of the Black river, the precipitation is thought to be greater than in the lower districts, but there are few records of long-continued observations. Regarding the fall of snow, it is stated in Blodgett's *Climatology* that—

> In the basin of lake Ontario, as it is sometimes called—the lower portion, to which Auburn and Rochester are central—there is no regular quantity on the ground in winter, and for half the time, on an average, none remaining. But here and in southern New York there is great inequality, sometimes a winter occurring with very little, and at others immense quantities falling and remaining for several weeks. In extreme cases, of which the winter of 1855–'56 was perhaps the most conspicuous, from 3 to 5 feet in depth have fallen at one time over this basin or low plain, and still more on the highlands east and south.

*Table showing the rainfall and temperature at points in the basin of lake Ontario.(a)*

| Locality. | Elevation. | RAINFALL. | | | | | | TEMPERATURE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Years of record. | Spring. | Summer. | Autumn. | Winter. | Year. | Years of record. | Spring. | Summer. | Autumn. | Winter. | Year. |
| | *Feet.* | | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* |
| Sackett's Harbor | 266 | 7 | 9.20 | 8.59 | 11.58 | 7.36 | 36.73 | 9 | 42.79 | 68.51 | 50.80 | 23.72 | 46.45 |
| Lowville | 847 | 23 | 6.96 | 10.04 | 9.09 | 7.46 | 33.55 | 24 | 42.69 | 65.12 | 45.89 | 21.55 | 43.81 |
| Oswego | 250 | 18 | 9.92 | 10.02 | 11.24 | 9.24 | 40.42 | 18 | 42.10 | 66.94 | 50.47 | 25.87 | 46.35 |
| Syracuse | 407 | 9 | 8.65 | 9.72 | 10.92 | 7.46 | 36.75 | 3 | 43.39 | 68.33 | 49.39 | 26.91 | 47.00 |
| Ithaca | 417 | 19 | 9.05 | 10.13 | 9.52 | 5.84 | 34.54 | 21 | 46.48 | 68.29 | 49.51 | 28.86 | 48.29 |
| Penn Yan | 740 | 30 | 7.09 | 9.28 | 7.45 | 4.49 | 28.31 | 31 | 44.28 | 66.82 | 48.53 | 26.53 | 46.54 |
| Little Genesee | 1,500 | 7 | 7.84 | 10.65 | 9.06 | 8.91 | 36.46 | 5 | 41.43 | 66.46 | 46.45 | 23.39 | 44.43 |
| Rochester | 500 | 45 | 8.05 | 9.12 | 9.27 | 7.21 | 33.65 | 39 | 44.72 | 68.04 | 49.02 | 26.46 | 47.06 |

*a* From Smithsonian records.

## I.—THE BLACK RIVER.

This river is a striking example of the splendid water-power streams which find their sources in the northern wilderness of New York state, and which radiate thence to nearly all points of the compass. Its especial value for power arises from the favorable distribution of its fall, a full and remarkably well-sustained flow, firm bed and banks, an open and accessible valley in or adjacent to sections of valuable agricultural and mineral resources, and convenient facilities for transportation both by land and by water.

The Black river takes its rise in one or two small lakes in the western part of Hamilton county, whence it pursues a southwesterly direction for some 30 miles by general course, passing across Herkimer and into Oneida county; it then turns and runs somewhat west of north through Lewis county, after which the course lies westerly across Jefferson county to Black River bay, at the eastern extremity of lake Ontario. In an air line the extreme lake-source of the river is about 65 miles southeasterly from Watertown. By map measurement the actual length of the river's course, taking account of the bends, is 130 miles, and the drainage area is 1,857 square miles. This area must be regarded, however, as only approximately correct, for the geography of the region about the upper waters is too imperfectly known and portrayed on maps to admit of an accurate determination.

The section drained by the upper river in Herkimer and Hamilton counties is described as very rugged and mountainous, with many beautiful lakes scattered over its surface, the latter wooded and covered generally with a

light sandy loam having but little value for cultivation. The population is very sparse, and the entire township of Wilmurt, 16 miles wide and nearly 50 miles long, containing practically all of the Black River basin that lies in Herkimer county, had but 271 inhabitants in 1880. In the southern part of this township are illustrated, though to a less degree than in the upper basins of the Hudson and Raquette rivers, the great capabilities of the Adirondack region for reservoir storage. Within a radius of 5 miles there are a dozen lakes, of various sizes, the most important of which are controlled by state dams and have their waters diverted to the supply of the Erie and Black River canals, mainly the former. Some facts concerning the capacity and cost of these reservoirs are given in the following table:

*State reservoirs in the upper Black River basin.(a)*

| Name of reservoir. | Surface flowage. | Average area for full depth. | Depth. | Capacity. | Supply for 100 days. | Cost. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Acres.* | *Feet.* | *Cubic feet.* | *Cu. ft. per sec.* | *Dollars.* |
| Woodhull reservoir (requires two seasons to fill)... | 1,236 | 1,118 | 18 | 876,550,000 | 101 | 26,529 |
| North Branch reservoir (can be filled twice yearly). | 423 | 277 | 28 | 337,800,000 | 39 | 54,894 |
| South Branch reservoir ..... | 518 | 372 | 26 | 421,190,000 | 49 | ..... |
| Sand Lake reservoir ..... | ..... | 306 | 15 | 200,000,000 | 23 | 34,228 |

*a* Data taken from *Annual Report of the State Engineer and Surveyor*, 1867, and from *Annual Report of the Superintendent of Public Works* for the year ending September 30, 1878.

The storage from the North Branch and South Branch reservoirs descends through the main river, that from Woodhull and Sand Lake reservoirs through Woodhull creek, to Forestport, where there is a state dam below the junction of the two streams. From this point the water is conveyed 10½ miles in a feeder to the summit level of the Black River canal at Boonville, feeding thence northward toward Lyon's Falls, and southward to Rome, where it enters the Erie canal. There is thus directly controlled by the state for canal purposes about 275 square miles of the upper basin of Black river, and its natural drainage is mostly diverted southward during the dry season. So far as concerns the water-power of the river below Forestport this area may therefore be regarded as practically cut off, leaving an effective drainage area above the mouth of the river of only 1,582 square miles. Although for much of the year there is doubtless a considerable waste over the Forestport dam, yet in the dry summer months the storage above that point is scarcely adequate to meet the demands for maintaining canal navigation. In his report for the year ending September 30, 1879, upon the middle division of the New York state canals,(*a*) Mr. Marvin Porter, division engineer, stated that during the preceding season all the reservoirs of the Black River group had been drawn down, and presented several projects for gaining a greater storage in the future, including the construction of a dam 20 feet high at the head of the present pond at Forestport; such a dam would flow 700 acres to an average depth of 7 feet, giving a storage, in addition to the previous supply, of 213,444,000 cubic feet, which could be obtained twice yearly.

All the larger eastern tributaries of the Black river contain within their basins numerous lakes and ponds, and there can be little question that abundant opportunities exist for a substantial increase of the low-season flow of that portion of the main river which is especially available for manufacturing. The only improvements of this character of which any information is at hand are in the case of the Fulton chain, a remarkable series of eight lakes tributary to the north branch of Moose river. It is reported that dams have been erected by the state at the outlets of two of these lakes, but no special knowledge concerning them was gained.

From full-water level in the North Branch reservoir, which is on the upper course of the main stream, to the crest of the Forestport dam, there is a fall of 692 feet in 21.6 miles. Thence to the crest of the Lyon's Falls dam, a distance of 17 miles, there is a further descent of 327¼ feet, followed by an abrupt pitch of about 69 feet in less than 250 feet. The Black River canal, descending to Lyon's Falls from the summit level at Boonville, now enters the river, which changes its character wonderfully and for 42½ miles, to Carthage, is continuous slack-water, only interrupted by two low dams, and navigable. The entire descent in this distance amounts to but 9¼ feet. From a little above Lyon's Falls to Carthage the river increases its gross drainage area from 458 to 1,741 square miles, receiving in the intervening distance most of its important tributaries, including Moose and Beaver rivers and Independence and Otter creeks from the east, with Sugar and Deer rivers from the west.

At Carthage navigation comes to an end, but we reach the most valuable portion of the whole river for power. The volume is large and the descent rapid. From the crest of the Carthage dam to the water-surface of lake Ontario there is a fall of 477 feet, the distance being about 29½ miles. Of this fall 55 feet occurs in 4,000 feet at Carthage, and 122 feet in the 3½ miles within the limits of the city of Watertown. Throughout the section of river now under consideration the bed is almost continuously of solid rock. The banks are to a large extent of the same material and are of good height; in fact, the stream has, for considerable portions of its course between Carthage

*a* See *Annual Report of the State Engineer and Surveyor.*

and the mouth, and especially below Watertown, so cut its way into the rock formations that it runs in a gorge with steep rocky walls, but not in general so deep as to interfere with the development of powers. At Carthage the outcropping ledges are of the primary formation, consisting of granite and gneiss; farther down stream Isle la Motte marble, or Black River limestone, shows in the banks, but it is only about 8 feet thick, and the prevailing rock material is the Trenton limestone.

The country east of the river in Lewis county rises gradually to a plateau, and on the adjacent border of Herkimer county has an elevation of some 1,400 feet above tide. It is frequently traversed by low ridges of gneiss, and possesses a poor, sandy soil. Iron sand is stated to be found along the streams, and magnetic and red specular ores of iron occur interstratified with gneiss on the northeastern border of the county.(*a*) The tributary streams are discolored by organic matter, manganese, and iron, and give to the main river that dark color which fully justifies its name. To the west of the river there is a rise, by successive terraces, to elevated table-lands from 1,500 to 1,700 feet above the sea. The Trenton limestone underlies a very fertile strip of land, from 1 to 3 miles wide, running in a north-and-south direction. Farther west the limestone formation is succeeded as the surface rock by Utica slates and Lorraine shales, which rise some 500 feet higher and are covered by a level summit region containing extensive swamps; the shales are easily decomposed and form a rich soil. Deposits of drift are also scattered throughout this section, and in some localities are very deep. On the north side of the Black river, in the towns of Wilna and Le Ray, Jefferson county, this formation contributes the material of a pine plain, sandy and barren, said to measure 14 miles in length by 4 miles in average width. In the town of Antwerp, which adjoins Wilna on the north, there is an abundance of iron ore. Barley, oats, corn, wheat, and grass are the leading productions of the soil in Jefferson and the western half of Lewis counties, but though fine crops are obtained, and in the vicinity of Watertown a yield of from 25 to 40 bushels of wheat to the acre is not uncommon, dairying is considered more profitable than the raising of grains, and is indeed the principal industry of the people.

Water-power is utilized on the lower river at Carthage, Great Bend, Felt's Mills, Black River, Watertown, between there and Brownville, at the latter place, and at Dexter. Many of the wheels used at the various privileges are old-fashioned and very wasteful, the dams and flumes are often leaky, and thus the best results are not obtained from the water at command. At Watertown and Carthage the available power of the river is especially large, and the manufacturing interests are far more extensive and diverse than at the other localities mentioned; but even there the use of power might be much increased, while it is true of the section of river from Carthage to the mouth, as a whole, that about one-half of the fall is entirely unimproved. Watertown is a fine city of between 10,000 and 11,000 inhabitants; Carthage has a population of 1,900, but the other manufacturing points referred to are unimportant villages, Brownville and Dexter numbering only from 400 to 500 inhabitants each. As we have seen, navigation by slack-water extends from Carthage to Lyon's Falls, and by the Black River canal thence to the Erie canal at Rome. Railway communication is also afforded by the Utica and Black River railroad, which follows down the valley of the river from Boonville to the lake, and by the Rome, Watertown, and Ogdensburg railroad, which crosses at Watertown.

*Table of elevations on Black river and tributaries.*

| Stream and locality. | Distance from mouth of Black river. | Height of water-surface above mean sea-level. | Distance between points. | Fall between points. | Fall per mile between points. | Authority for elevation. |
|---|---|---|---|---|---|---|
| *Beaver river.* | *Miles.* | *Feet.* | *Miles.* | *Feet.* | *Feet.* | |
| Beaver lake (No. 4), in Lewis county | 59.0 | 1,435.97 | 20.0 | 712.27 | 35.61 | Colvin—Adirondack survey. |
| Mouth of Beaver river | 39.0 | 723.70 | | | | Estimated from elevation of Black river at Carthage. |
| *Moose river.* | | | | | | |
| Big Moose lake | | 1,787.00 | | | | Colvin—Adirondack survey. |
| Little Moose lake | | 1,772.00 | | | | Do. |
| Eighth lake, Fulton chain | | 1,803.00 | | 41.00 | | Do. |
| Seventh lake, Fulton chain | | 1,762.00 | | 2.00 | | Do. |
| Sixth lake, Fulton chain | | 1,760.00 | | 69.00 | | Do. |
| Fifth lake, Fulton chain | | 1,691.00 | | 4.00 | | Do. |
| Fourth lake, Fulton chain | | 1,687.00 | | 3.00 | | Do. |
| Third lake, Fulton chain | | | | | | |
| Second lake, Fulton chain | | 1,684.00 | | 0.00 | | Do. |
| First lake, Fulton chain | 102.6 | 1,684.00 | | | | Do. |
| Mouth of Moose river | 72.1 | 801.78 | 30.5 | 882.22 | 28.93 | Estimated from elevation of Black river at lock No. 109, foot of Lyon's falls. |
| *Black river.* | | | | | | |
| South Branch reservoir | | 2,019.00 | | | | 2,019 feet + tide-water, by New York canal profiles. |
| Woodhull reservoir | | 1,854.00 | | | | Colvin—Adirondack survey. |
| Chub lake | | 1,599.00 | | | | 1,599 feet + tide-water, by New York canal profiles. |

*a Gazetteer of New York.*

*Table of elevations on Black river and tributaries*—Continued.

| Stream and locality. | Distance from mouth of Black river. | Height of water-surface above mean sea-level. | Distance between points. | Fall between points. | Fall per mile between points. | Authority for elevation. |
|---|---|---|---|---|---|---|
| *Black river*—Continued. | *Miles.* | *Feet.* | *Miles.* | *Feet.* | *Feet.* | |
| North Branch reservoir | 110.7 | 1,821.00 | | | | Colvin—Adirondack survey. |
| | | | 21.6 | 691.97 | 32.04 | |
| Crest of state dam at Forestport | 89.1 | 1,129.03 | | | | By New York canal profiles 1,126.96 feet + mean tide (here assumed to be mean low tide at Albany). |
| | | | 17.0 | 327.25 | 19.25 | |
| Crest of state dam at Lyon's Falls | 72.1 | 801.78 | | | | Estimated from elevation at foot of falls as given by New York canal profiles. |
| | | | ..... | 69.00 | ..... | |
| Foot of Lyon's falls (smooth water opposite lock No. 109). | 72.1 | 732.78 | | | | Water-surface at lock No. 109 is given by canal profiles as 730.71 feet + mean tide; by Colvin's survey as 738 feet + sea-level. Fall occurs in 250 feet. |
| | | | 42.5 | 9.25 | 0.22 | |
| Crest of state dam at Carthage | 29.6 | 723.53 | | | | *721.46 feet + mean tide, by New York canal profiles.* |
| | | | 0.9 | 55.00 | ..... | |
| Foot of rapids at Carthage | 28.7 | 668.53 | | | | Fall occurs in 4,600 feet. |
| | | | ..... | 4.33 | ..... | |
| Utica and Black River Railroad crossing. | 28.2± | 664.20 | | | | By Utica and Black River Railroad profile rails at crossing are 686.2 feet above mean sea-level. |
| | | | 11.2 | 101.10 | 9.03 | |
| Felt's Mills, crest of dam | 17.0 | 563.10 | | | | By Utica and Black River Railroad profile rails at Felt's Mills station are 616.4 feet above mean sea-level. |
| | | | 6.6 | 70.97 | 10.75 | |
| Watertown, upper city boundary, at head of falls. | 10.4 | 492.13 | | | | Approximate elevation obtained by adding 122 feet to the altitude at the lower city line. By the profile of the Utica and Black River railroad the rails are 511.6 feet above mean sea-level where the road crosses the highway shortly above Huntingtonville, according to which the elevation of the adjacent water-surface would be about 491 feet. |
| | | | 3.5 | 122.00 | 34.86 | |
| Watertown, lower city boundary | 6.9 | 370.13 | | | | F. A. Hinds, civil engineer, gives the elevation as 123.52 feet above the surface of lake Ontario. |
| | | | 6.9 | 123.52 | 17.90 | |
| Mouth of Black river | 0.0 | 246.61 | | | | As stated at the office of the Chief of Engineers, U. S. army, "the mean surface of lake Ontario, from January 1, 1860, to December 31, 1875, is 246.61 feet above mean tide at New York". |

So far as can be learned, there are but few data from which to judge of the discharge of this river. March 22, 1875, the volume was measured at Watertown by Mr. Frank A. Hinds, civil engineer, and found to be 9,946 cubic feet per second; but the stream was then much above its average stage, the flow corresponding to which was assumed, as the mean of estimates by four persons long familiar with the river, at two-thirds the above amount, or 6,630 cubic feet per second. This assumption for the average flow, however, must be far from the truth, for it corresponds to the condition of a rainfall of about 50 inches over the entire tributary drainage area, *all* carried off through the channel of the river, with no allowance whatever for loss from evaporation and other sources.

At the privilege a short distance below Watertown occupied by C. R. Remington for the manufacture of paper, there is a fine new dam, which is tight, and which, acting as a weir, presents a fair opportunity to approximately measure the volume of the river. The roll-way is 650 feet long, with a sharp crest, a vertical face, and a back slope of 3 base to 1 vertical. During the dry summer of 1882 the least depth of water on this dam, measuring from the level surface of the pond, was 6 inches, and November 22 it was 7 inches, 900 horse-power of wheels running at full capacity under a head of 30 feet in each case. Assuming 310 cubic feet per second as used by the wheels, and 720 cubic feet as equivalent to 6 inches on the dam, then the minimum flow during that season may be considered to have been at least 1,030 cubic feet per second.

*Data concerning the discharge of Black river.*

| Locality. | Natural drainage area. | Effective drainage area. (a) | Date, and stage of river. | Approximate discharge. | Discharge per square mile of effective drainage area. | Remarks. |
|---|---|---|---|---|---|---|
| | *Sq. miles.* | *Sq. miles.* | | *Cu. ft. p. sec.* | *Cu. ft. p. sec.* | |
| Carthage | 1,741 | 1,466 | Lowest water in summer of 1882 | 1,070 | 0.73 | 2 feet depth on two weirs of 60 feet each. Waste on dam said to be small, and neglected. |
| Watertown | 1,816 | 1,816 | March 22, 1875, flow estimated to be one-half above average stage. | 9,946 | 5.48 | Measurement by F. A. Hinds, civil engineer. |
| Between Watertown and Brownville. | 1,830 | 1,555 | Lowest water in summer of 1882 | 1,030 | 0.66 | 900 horse-power of wheels running under 30 feet head, and 6 inches of water on dam 650 feet long. |
| Do | ..... | ..... | November 22, 1882, low stage | 1,210 | 0.78 | Same as above, with 7 inches on dam. |

a Deducting, for the dry season, the 275 square miles tributary above Forestport, controlled by the state and having its drainage mainly diverted to the Erie canal.

At Carthage practically all the water used by mills from the upper level passes into the race-ways over two submerged weirs, each 60 feet long and sunk 2 feet below the crest of the dam. At the lowest stage in the summer of 1882 water was barely running over the top of the dam. Neglecting that wastage, and supposing the water in the race-ways drawn down a foot or more below the crests of the weirs, as was stated to be not uncommonly the case in the dry season, so that they are no longer submerged, then the probable discharge of the river appears to have been at least 1,070 cubic feet per second.

On the whole, the low-water flow of the river at Carthage and below, in an ordinarily dry season, may safely be taken at from 1,000 to 1,100 cubic feet per second, average for the twenty-four hours.

Although, taking the year through, Black river is a very steady stream, it is at times visited by large and sudden rises. At Brownville, but a few miles from the mouth, it is said that the effect of a heavy rain in the upper waters is usually felt on the third day, and that the river continues rising about forty-eight hours after the storm is over. Spring freshets generally occur in April, and the river runs lowest from August to November. Difficulty was experienced in ascertaining what effect had been produced upon the stream by the storage said to have been effected in the Fulton chain of lakes. A prominent manufacturer at Watertown was not aware that any especial improvement had been noticeable there, but at Great Bend it was confidently maintained that the dry-season flow had been visibly benefited. Anchor-ice troubles more or less along the stream, and at Watertown has occasionally forced a stoppage of the Remington paper-mills for a few hours. Heavy surface-ice forms in winter; in the lower river 2 feet is the common thickness, but 5½ feet is stated to have been observed one year. At Watertown this ice is well broken up in going over the various falls; at Black River it usually rots in the pond before going out, but there and at other points dangerous runs at times occur, aggravated in some instances by gorges.

*Natural drainage areas of Black river and tributaries.*

| Stream and locality. | Drainage area. | Stream and locality. | Drainage area. |
|---|---|---|---|
| | *Sq. miles.* | | *Sq. miles.* |
| Black river: | | Sugar river | 66 |
| Above mouth of Woodhull creek | 174 | Moose river | 349 |
| At Forestport state dam | 275 | Otter creek | 60 |
| At Lyon's Falls, below Moose river | 807 | Martin's creek | 29 |
| At Carthage | 1,741 | Independence creek | 90 |
| At Watertown | 1,816 | Lowville creek | 34 |
| At mouth | 1,857 | Beaver river | 365 |
| Woodhull creek | 96 | Deer river | 107 |

*Water-powers.*—Above Lyons Falls the river is described as being a succession of rapids, with occasional use of power by saw-mills and tanneries. At the falls there is a fine privilege, which had just been purchased at the time it was visited, with the design of developing it in the spring of 1883. Large manufacturing works were then to be erected, and the balance of the power above their requirements was to be held for disposal to parties who might wish to locate other establishments there. The Utica and Black River railroad has a station near at hand, and water communication is also afforded northward by the river to Carthage, and southward by the Black River canal to the Erie canal at Rome.

At the head of the falls the state has a timber dam about 500 feet long, and at the most not over 6 feet high from the bed-rock. The water passing over this dam flows in rapids for less than 200 feet, and then being collected in two narrow clefts in the rock, from 10 to 20 feet wide, one near the east bank and one near the west, plunges suddenly down 50 or 60 feet in a most beautiful fall, and is received into a deep pool below. From the crest of the state dam to the foot of this pitch the horizontal distance does not exceed 250 feet, while the vertical descent was found by measurement at the canal locks to be about 69 feet down to smooth water. The canal passes down the left bank around the falls, and then enters the river again, where it terminates. The banks adjacent to the falls are masses of solid rock, that on the west sufficiently sloping for the convenient location of a mill, but becoming abrupt a couple of hundred feet below; the east bank is rather steep opposite the falls, but a little way down stream has a more gentle descent. The site is a magnificent one naturally for the development of power, and it seems strange that it should not have attracted more attention. In a low stage practically the entire flow of the river is confined within the two narrow fissures in the rock at the top of the falls, and it is a comparatively easy matter to control either or both of the channels, and thus to utilize the whole volume of the river not required for the purposes of navigation. At the same time the sites for mills would be entirely out of reach of freshets and ice. On the west bank a wooden flume runs 60 or 70 feet to a little saw-mill having a single saw, but otherwise there is no evidence of any power ever having been used at the falls.

This privilege is owned by Mr. G. H. P. Gould, of Lyon's Falls. He states the descent from the foot of the state dam to smooth water below the falls as 64½ feet. He has had the volume passing over the dam measured by

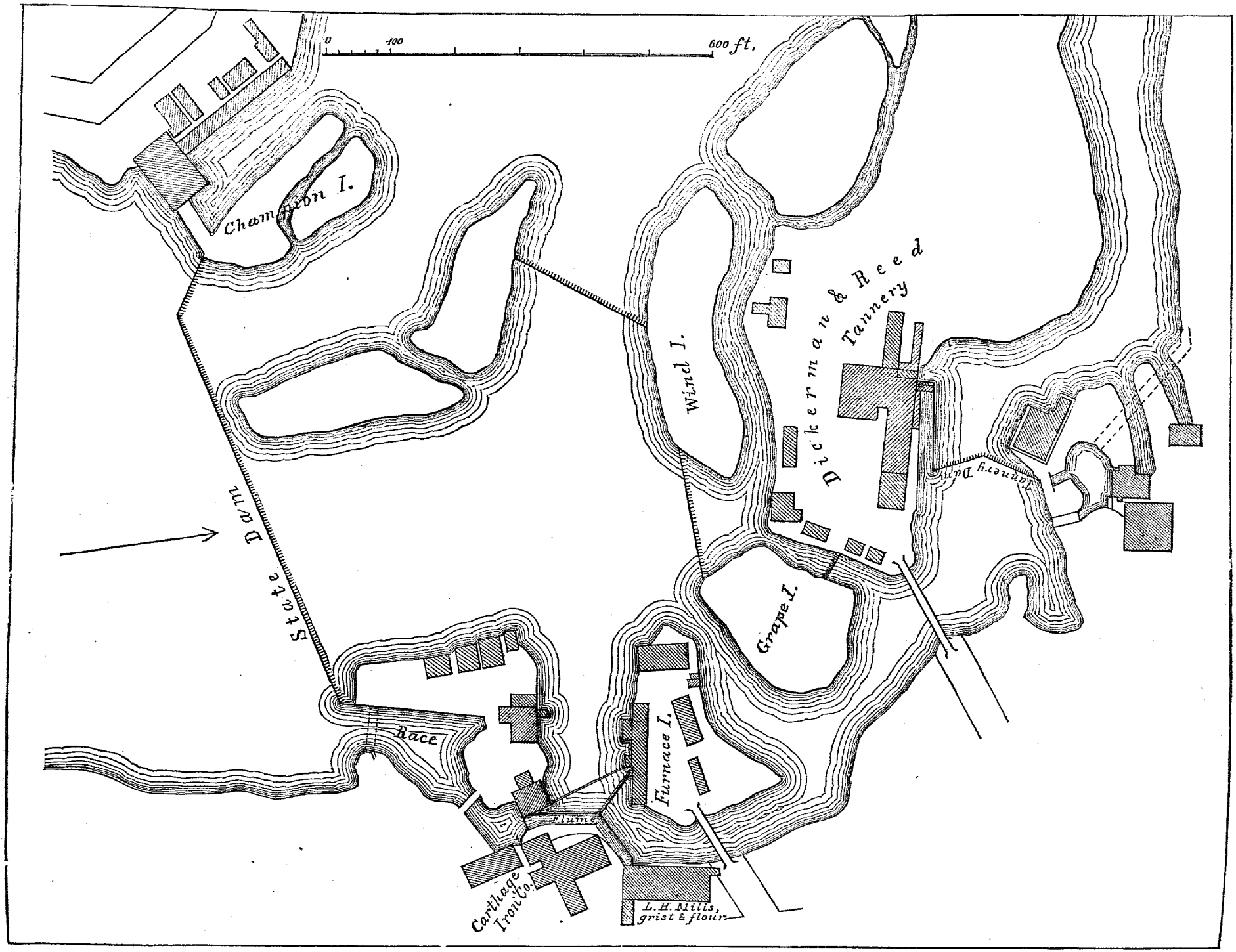


FIG. 1.—The Black river at Carthage.

an engineer, and upon the result obtained bases an estimate of the total available power in a low stage of river, which he puts at 4,000 effective horse-power. In the manner elsewhere explained the theoretical power of the river at this point in various stages may be estimated as below:

*Estimate of power at Lyon's Falls.*

| Stage of river. | Rainfall on basin.(a) | | | | | Natural drainage area. | Flow per second, average for the 24 hours. | Theoretical horse-power. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Spring. | Summer. | Autumn. | Winter. | Year. | | | | | |
| | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Sq. miles.* | *Cubic feet.* | 1 *foot fall.* | 64½ *feet fall.* | 69 *feet fall.* |
| Low water, dry year | 9 | 10 | 12 | 8 | 39 | b 807 | 260 | 29.54 | 1,900 | 2,040 |
| Low water, average year | | | | | | | 360 | 40.90 | 2,640 | 2,820 |
| Available 10 months, average year | | | | | | | 420 | 47.71 | 3,080 | 3,290 |

*a* Roughly estimated; no data for accurate determination. *b* Effective drainage area in dry season, 532 square miles (see page 5).

At Lyon's Falls the valley is open, with a gradual rise to distant high hills. Thence down to Carthage the stream lies in broad flat meadows, with extensive marshes and peat-swamps. The slack-water navigation which exists for the 42½ miles of this interval is maintained for 25 miles, more or less, above Carthage by a dam at that place, and for the remaining distance by two low dams a few miles apart. In low water boats are locked around the ends of these latter, but in high water are run over their crests; no power is used at either. The navigation over this section is small in amount and is mainly for the transportation of lumber.

At Carthage an important amount of manufacturing is sustained by the power which the river affords, and is mainly grouped about the state dam at the head of the falls. The river is there wide, with a bed of solid rock having a considerable dip to the northward, in which direction the stream also runs. Below the dam the channel is divided by a great many islands, varying much in size, low and rocky, and between which the river courses in rapids and falls, with a width between banks amounting in places to 1,000 or 1,500 feet. From the crest of the state dam to the foot of Decatur island, 4,600 feet below, there is a descent of 55 feet.

The dam is a timber structure, resting throughout upon rock; the overflow is about 770 feet long, and not more than 7 feet high at the highest point. As slack-water navigation terminates here, the only canals leading from the pool are those conveying water for power. But in order that the level above the dam shall not become too much reduced by the draughts for the mills, the withdrawals of water from the pool are compelled to be made over weirs, or "drops", as they are called, at either end of the dam, 60 feet in length and 2 feet lower than the crest. The amount of water available for manufacturing at the upper mills is therefore restricted to what will pass over these weirs. But on either side of the river there are numerous concerns employing this water and running very wasteful wheels. In low stages of river they draw down the races and connecting flumes faster than the weirs can supply them, the working head becomes greatly reduced, and much trouble is experienced.

On the east side of the river power is used as follows: An independent flume carries water to a small shingle-mill, while the main race supplies seven different establishments. The principal of these are the works of the Carthage Iron Company, production 15 tons per twenty-four hours when running, but which were shut down in the latter part of November, 1882; and the machine-shop and foundery of Ryther & Pringle, giving employment to 28 hands. The other concerns are of small or moderate size, and comprise two flouring- and grist-mills, one of 4 and one of 3 runs, a saw-mill, a furniture-shop, and a wool-carding shop. The fall obtained is 7 or 8 feet.

By means of four sections of dam extending out from the shore and from one island to another, a second level is formed below and entirely independent of the one just described, and commanding sufficient water to supply, on the main bank, the works of the Empire Steam Pump Manufacturing Company, employing 14 hands, and having a fall of 9 or 10 feet; and, on an island, the tannery of Messrs. Dickerman & Reed, having 6 feet of fall and 250 estimated horse-power of wheels. This latter firm tans from 15,000 to 16,000 hides yearly.

Perhaps a quarter of a mile farther down stream a rude crib-work dam, with a maximum height of not over 5 feet, is extended along from an island some distance parallel to the adjacent east bank, the water being retained next that bank, which is low, by a dike of loose stone with plank facing. The water then enters a wooden flume and runs say 250 feet to the Carthage Pulp Works, where a fall of 9 feet, and 3 wheels with an aggregate of about 120 horse-power, are in use. The production of the mill is 1½ ton per day.

A little farther down, a portion of the flow of the main stream is again confined between the east bank and an island, by means of a dam not more than 80 or 90 feet long running out between them, and on the main bank is Branaugh's tannery, with a fall of 10 or 11 feet, employing 18 hands.

An eighth of a mile below, the islands come to an end, the river has a single broad channel with gravelly rapids for a couple of hundred feet, and is then smooth water. At the foot of the falls the immediate banks are from 10 to 15 feet high, alluvial on the east side, and sandy on the west, though some rock is displayed there.

On the west side of the river the main race from the dam is continued as a wooden flume 7 feet deep and decreasing in width from about 20 to about 8 feet. The head ranges from 9 feet near the dam to 14 feet or more

toward the end of the flume. Power is utilized by a number of small mills and shops, including two saw-mills, a 3-run flouring-mill, a tannery, and shops for the manufacture of tubs and pails, sashes and blinds, and cabinet-ware; the firm of H. D. Farrar & Son employs 14 hands, and turns out an average of about 200 butter-tubs daily.

Succeeding this fall is a privilege on the same side of the river, owned by M. P. Mason. A timber dam 6 or 7 feet high and some 300 feet long runs out to an island, and gives a fall at the mills on the main shore ranging from 7½ to 11 feet, according to position along the race. The power is employed to operate a 2-set hosiery-mill, 2 shops for making map-rollers and duster handles, one of them having a planing-mill in connection; and a shop for the manufacture of sounding-boards and other piano materials. One good site still remains vacant, and another can be made available by prolonging the race a little way, at both of which a moderate amount of permanent power can be realized.

On the levels opening out from either end of the state dam there is no chance for a further use of permanent power. Even now the supply of water is sometimes short in the dry season, and if it were sufficient for the legitimate needs of the mills, yet the lack of definiteness observed in the water-leases would prove, to many, reason enough for not starting a new enterprise. The present manufacturers are said to have priority of right to water in a low stage in the order of their leases. In those leases no definite amounts of water are specified, but each party is allowed a right to whatever amount he needs in his particular business. Thus water enough is granted to supply a grist-mill of a certain number of runs, or a saw-mill, or a cabinet-shop. In practice each mill-owner draws all the water he can get, up to the limit of his wants, and disputes are frequent.

But a privilege established independently below the upper mills has a great advantage. It will receive a certain proportion, according to position, of the tail-water from those mills, and at nearly all times there is also a wastage over the crest of the state dam, the benefit of which will also be gained. There seems to be no opportunity for developing such a privilege adjacent to the east bank; but below Mason's privilege, on the west side, there are fine sites which might easily be improved. Similar chances also exist among the islands out in the stream. Thus at the end of the island on which Dickerman & Reed's tannery is located there are falls with a descent of 10 feet in 200, and several feet more could be obtained by starting a little farther up stream. The powers realized at such sites would of course vary in size according to the fall and the proportion of the river's flow commanded, but probably very little difficulty would be experienced in obtaining them of moderate amount. The current is so rapid among the islands that the freshet-rise is small, amounting to but 2 or 3 feet.

*Estimate of power at Carthage.*

| Stage of river. | RAINFALL ON BASIN. (a) | | | | | Natural drainage area. | Flow per second, average for the 24 hours. | Theoretical horse-power. | | Total effective horse-power of wheels in use. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Spring. | Summer. | Autumn. | Winter. | Year. | | | | | |
| | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Sq. miles.* | *Cubic feet.* | 1 *foot fall.* | 55 *feet fall.* | |
| Low water, dry year | 9 | 10 | 12 | 8 | 39 | b 1,741 | 1,000 | 113.6 | 6,250 | 1,120± |
| Low water, average year | | | | | | | 1,250 | 142.0 | 7,810 | |
| Available 10 months, average year | | | | | | | 1,350 | 153.4 | 8,440 | |

a Roughly estimated; no data for accurate determination.

b Effective drainage area in dry season, 1,466 square miles (see page 5).

From Carthage to Great Bend, 10 miles by river below, there are no dams, though the fall is considerable. Between the former point and Madame De Ferriet's bridge Rawson's dam was formerly located, but was carried out by a spring ice-freshet about 1870. The dam was a log structure 16 feet high, well pinned together, filled in with stone, and part of the way bolted to bed-rock. The power was used in a small saw- and shingle-mill. By a low dam at the head of the rapids, and a flume say 600 feet long, a fine power could be developed here, and the banks are well suited to such improvement.

At Great Bend the river is only 60 or 80 feet wide, with high precipitous banks on the north side, and is controlled by a log dam built on rock and varying in height, but at the highest point measuring about 14 feet, which is also the extreme head obtained at the mill. Two wheels, with an aggregate of 150 or 160 horse-power, are run by the Great Bend Paper Company, manufacturer of hanging-paper, of which it produces an average of 3 tons per day. The company controls the whole privilege, has abundance of water for its own needs, and also a large surplus.

Below Great Bend the river runs quite straight and with a fair amount of fall on toward Felt's Mills, 2¼ miles below. The banks along this section are vertical walls of rock. At Felt's Mills an island forms two channels, across each of which is a dam, the longer section, that across the south channel, being a log structure 13 or 14 feet high above foundation and in the neighborhood of 175 feet long. The north channel is about 175 feet wide at the road bridge, but is not used for power. On the island there is a small saw- and shingle-mill, and C. C. Veber's tannery, at which about 8,000 hides are tanned yearly. Three water-wheels are run under a head of 9 feet. On the south side of the river is B. Felt's grist-mill, 3 runs, fall 8 or 10 feet; and Roberts & Flagg's factory for making ax-helves and other handles. At this establishment four hands are employed usually, and from 10,000 to 12,000

dozen ax-helves, and half that number of other handles, are turned out yearly. Mill creek empties into the flume on that side of the stream, and though it carries but little water in summer, is fed by springs, and keeps the grist-mill race free from ice in winter by the warmth of its waters.

At Black River, 7 miles by road above Watertown, the river is divided by islands into two principal channels. Two islands, one below the other, are joined by a short section of dam, and each island is connected with one of the banks, the whole stream thus being controlled. The principal section of dam is across the right branch, and is a log structure 13 feet high, from 200 to 250 feet in length, and presenting an angle up stream. The bed of the river is solid rock, with a sudden pitch of several feet below the dam. A wooden flume extends from the latter 600 or 800 feet down the right bank and supplies three concerns with water for power, while others are located on the opposite bank and on one of the islands. The fall from the top of the dam to the surface of the pool below is about 16 feet. At this privilege, as at others on the river, water is not economically used, and in low stages there is no waste on the dam. The principal manufacture here is of chairs, in which two firms are engaged; pine is obtained from Canada, and hard wood, mainly beech and maple, from the vicinity of Black River. Poor, Dexter, & Co. manufacture rockers and folding-chairs, using a fall of 10 feet, and two wheels of 30 or 40 horse-power each. They give employment to 25 hands, and turn out 20,000 chairs per year. D. H. Scott & Son employ 10 hands in putting together stock made by the above firm, using a fall of 12 feet, and 40 or 50 horse-power. D. Dexter's Sons also manufacture chairs, their mill having been started in 1839; they employ 35 hands, and their production amounts in value to about $35,000 per year. The firm of J. S. & E. E. Graves makes bent stock and chair-backs, and employs 12 hands. There is also a 4-run flouring-mill here, and a cabinet-shop, blacksmith-shop, and shingle-mill use small powers.

*Estimate of power at Black River.*

| Stage of river. | Natural drainage area. | Flow per second, average for the 24 hours. | Theoretical horse-power. | | Effective horse power of wheels in use. |
|---|---|---|---|---|---|
| | *Sq. miles.* | *Cubic feet.* | *1 foot fall.* | *16 feet fall.* | |
| Low water, dry year | a 1,794 | 1,040 | 118.1 | 1,890 | 265± |
| Low water, average year | | 1,290 | 146.5 | 2,340 | |
| Available 10 months, average year | | 1,390 | 157.9 | 2,530 | |

*a* Effective drainage area in dry season, 1,519 square miles (see page 5).

A short distance below the village there is an unoccupied privilege, formerly in use for a wood-working shop employing a few hands. The dam was about 11 feet high, but in January of 1878 or 1879 an ice-gorge, formed at some point above and coming suddenly down, carried the structure away. The privilege is owned by Messrs. John W. Huntington, of Mexico village, and G. W. Pennock, of Chaumont, and is held for sale. The banks are smooth sloping faces of Isle la Motte marble, on which ordinary freshets rise 8 or 9 feet above low water, and high ones 10 feet. The old dam was located at the top of a pitch of several feet, below which rapids extend to falls to be described. A small wooden building still stands on the left bank.

A little farther down another fall begins, and in 600 or 800 feet there is a descent of about 15 feet, mainly in a single steep pitch in the upper portion. Below this fall, and not more than one-half or three-quarters of a mile from the Black River mills, there are three falls, 300 or 400 feet apart, and covering together a descent of about 15 feet as shown by pocket-level. The river is here from 75 to 125 feet in width, the banks are 15 or 20 feet high and composed of shelving rock, and the site is in every way an excellent one.

The surrounding country in this section has a fertile dark-colored soil, is moderately timbered, and is characterized by long slopes and a generally level appearance. The stream is somewhat divided by islands, and there are three of large size between Black River village and Huntingtonville, a few miles below. From a point a mile or a mile and a half below the former, down to the latter village, there are now and then slight ripples, but the fall is small, and the right bank is low not far above Huntingtonville. At that locality, a small village of scattered houses say 2 miles above Watertown, power was formerly used in a saw-mill and in a scythe and ax factory. A large island of 90 acres divides the river into two channels, both of which were dammed. The main channel is to the left of the island, with a width of perhaps from 200 to 250 feet. The old dam was 11 feet high, but when the state reservoir in the upper waters failed some 14 or 15 years ago, the structure was carried out, together with the adjacent buildings, and a large body of sand was washed off from the bank, leaving a wide shelving surface of rock exposed. There is a rapid in the river opposite, but the site does not appear to be a favorable one for a dam of much height. The privilege is said to be owned by Frederick Emerson, of Watertown.

*Power at Watertown.*—The section of river now to be described is far the most important and valuable in the whole course as regards water-power. The stream has here reached substantially its maximum volume, and in the 3½ miles within the city limits falls over 120 feet,(*a*) measured from the top of the falls at the new pump-works to a

*a* In 1875 a survey was made of this section of Black river for the Watertown Manufacturers' Aid Association, and the fall within the city limits was reported as 111.75 feet. There is reason to believe, however, from measurements which were made with a pocket-level, that the fall between Diamond (or Dramand) island and the new pump-works may have been incorrectly determined, and the entire fall within the city may be estimated to be as much as 122 feet.

point about 5,500 feet below Taggart & Davis' dam. Watertown is admirably situated in the midst of a rich agricultural section, with deposits of the very best of iron-ore near at hand, with a ridge of limestone passing directly through the city and supplying a superior flux for the reduction of ore, with lumber easily to be obtained from the pine forests of Canada and the adjacent counties to the eastward in New York state, and with an abundance of brick and stone immediately accessible. The city itself is the most charming one in this portion of the state, and in 1880 had a population of about 10,700. It is distant 13 miles by rail from Sackett's Harbor, on lake Ontario, and has good facilities of communication with the principal cities of the United States and the coal-fields of Pennsylvania. The distances by railroad from a few prominent points are as follows:

*Rail distances from Watertown.*

| Terminal points. | Distance. | Route. |
|---|---|---|
| | *Miles.* | |
| Watertown to New York | 325 | Via the Rome, Watertown, and Ogdensburg, and New York Central and Hudson River railroads. |
| Do | 330 | Via the Utica and Black River, and New York Central and Hudson River railroads. |
| Watertown to Albany | 182 | Via the Rome, Watertown, and Ogdensburg, and New York Central and Hudson River railroads. |
| Do | 187 | Via the Utica and Black River, and New York Central and Hudson River railroads. |
| Watertown to Buffalo | 225 | Via the Rome, Watertown, and Ogdensburg railroad to Charlotte, and thence through Rochester by the New York Central and Hudson River railroad. |
| Do | 244 | Via the Rome, Watertown, and Ogdensburg railroad to Syracuse, and thence by the New York Central and Hudson River railroad. |
| Watertown to Scranton, Pennsylvania | 234 | Via the Rome, Watertown, and Ogdensburg railroad to Rome, and thence by the Delaware, Lackawanna, and Western railroad. |
| Do | 236 | Via the Rome, Watertown, and Ogdensburg railroad to Syracuse; thence to Binghamton by the Syracuse, Binghamton, and New York railroad, and thence to Scranton by the Delaware, Lackawanna, and Western railroad. |
| Do | 248 | Via the Utica and Black River, and Delaware, Lackawanna, and Western railroads. |

The leading manufactures of the city by water-power are of paper and pulp, spring-wagons, buggies, sewing-machines, force-pumps, vacuum-brakes, steam-engines, and general machinery; water is also pumped for the city supply by power from the river. There are 5 flouring- and grist-mills, one pearl-barley mill, several tanneries, mostly of small size, two small woolen-mills, in addition to which moderate powers are utilized for the manufacture of lamps, furniture, locks, sashes, doors, blinds, cabinet-ware, boots and shoes, and bakers' goods. The first use of the river for power at this point is said to have been made in the year 1802, when a grist-mill was built opposite Beebee's island. In 1808 the manufacture of paper was introduced, and in 1814 that of cotton and woolen goods. Although it is claimed that wool is easily obtained, that the water of Black river is particularly well adapted to cleansing it, and that from Memphis and other shipping points, via Chicago and the great lakes, "cotton can be landed cheaper in Watertown than it can be in New York city",(a) yet enterprises for the manufacture of goods from those materials have hitherto been unfortunate here, no less than seven having been initiated between the years 1814 and 1836, of which none probably have now any existence, and the only present representatives of those branches of industry are two small woolen-yarn mills, with two sets of machinery each. Considering the natural resources and demands of the surrounding region and the opportunities for reaching more distant markets, the location of the city would seem especially suited to the manufacture of pulp and paper, and the more finished articles in wood, leather, and iron—such, for instance, as agricultural and dairying implements, boots and shoes, and machinery.

The 122 feet, more or less, of fall occurring within the limits of Watertown is naturally separated into a number of successive privileges, as follows:

1. Immediately above the upper boundary of the city a large island, which for convenience may be called the Water-works island, divides the river into two branches, which again unite from nearly opposite directions upon the boundary, at the head of a natural barrier of rock which now opposes the passage of the stream and causes abrupt falls of about 14 feet, increased within a short distance by rapids to 16 feet. Above this locality the left bank is low and flat, and a dam at the head of the falls would submerge a considerable tract of good meadow-land; but the privilege has been easily and simply improved by blasting a race-way through the rock on the south shore from the top of the falls to the pump-house, thereby commanding an ample supply of water for the power needed. A heavy masonry bulkhead and wing-walls guard off freshets and ice. Two duplex double-acting plunger-pumps, 18 by 36 inches in size, are run at a speed of 20 revolutions per minute, lifting water 175 feet to a distributing reservoir There are also pumps on each of the lower island privileges, supplying the same reservoir. At the privilege being described two water-wheels, 6 feet 2 inches in diameter, manufactured by R. D. Wood & Co., of Philadelphia, are run under a head of 16 feet. There is at all times a large surplus power at these falls, which probably could be utilized to the best advantage by running a branch race or flume from the present one to some point below the pump-house. The cutting of an independent race, or an extension of the present one, would be through rock, and on that account expensive. There is no other building than the pump-house in the vicinity, on either bank, so that abundance of building-room remains.

a *Attractions and Commercial Advantages of Watertown*, by Hon. Charles R. Skinner (1876).

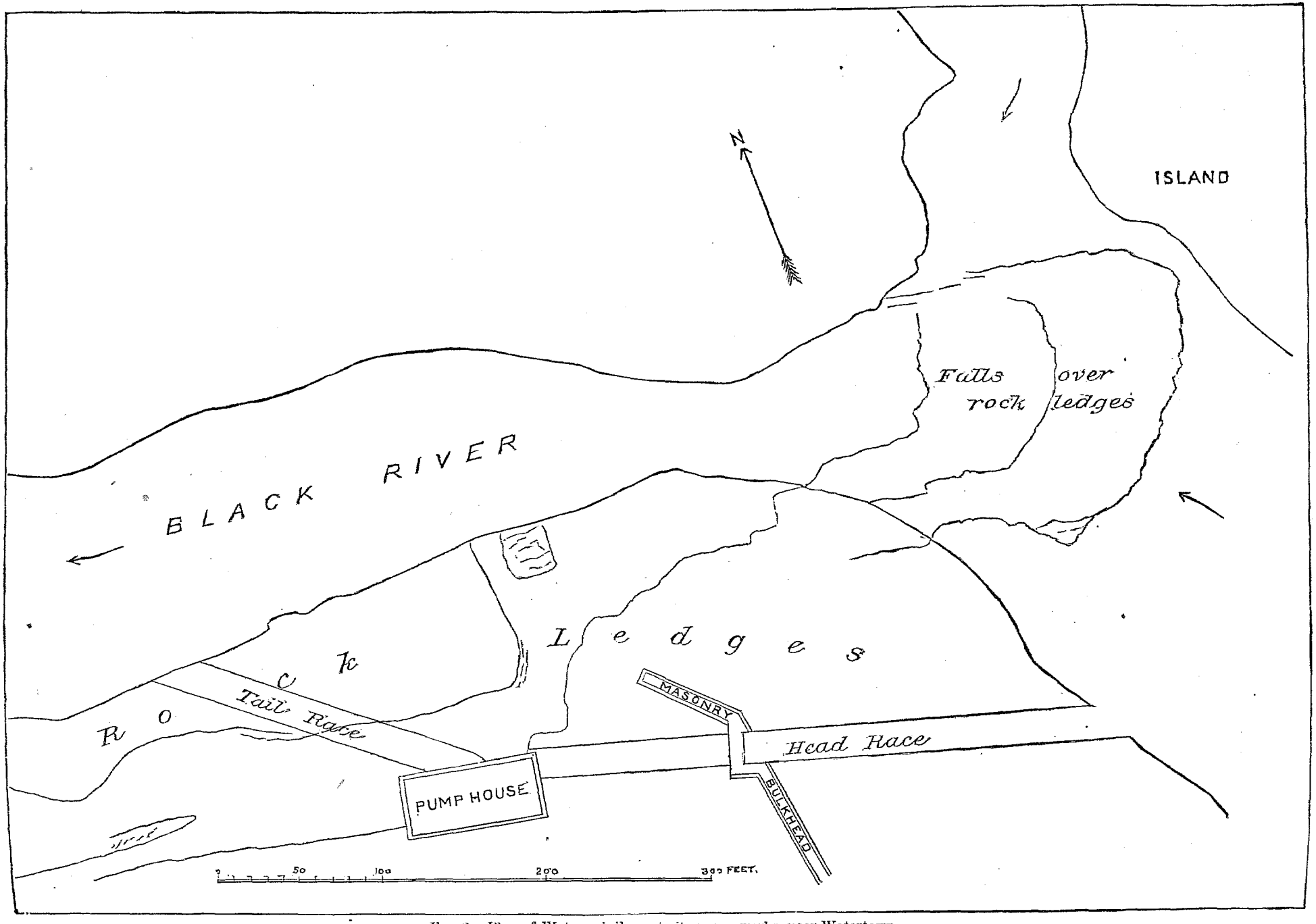


FIG. 2.—Plan of Water-privilege at city pump-works, near Watertown.

2. From the above privilege to the head of Diamond (or Dramand) island, a distance of 2,500 feet, there is a fall which is probably not far from 12 feet, increased by 2 feet in the succeeding 2,000 feet to the crest of the upper dam at Sewall's island, or say a total of 12 or 14 feet, entirely unemployed. Below the water-works falls and rapids there begins a stretch of smooth water, succeeded by a descent of about 6 feet in 600 or 800 feet as indicated by pocket-level. There is then a short interval of rapid water, and below it follow an abrupt pitch and rapids, together covering another fall of 6 feet in 600 or 800, and extending nearly to slack-water. Here, as indeed along the entire course of the river through Watertown, the bed and banks are of solid limestone rock, the latter in this vicinity 10 or 15 feet high above low water. The power above Diamond island could very easily be developed by a dam at the main fall near the head of the island, or by a dam in two sections running out from either shore to the island itself. The banks are of good height there, suitable for building, but not yet built upon at all.

3. Eleven hundred feet below the foot of Diamond island is Sewall's island, which again gives rise to two channels; from points near the head and foot of this island sections of dam have been thrown across to the adjacent banks, thus forming two falls opposite the island. From the crest of the upper dam to the crest of the lower, the fall as shown by the survey of 1875 is 15 feet.(*a*) Of the privilege on the north branch the Davis Sewing Machine Company owns one-fourth, the Sewall estate one-fourth, and the Remington Paper Company the balance above that belonging to four vacant lots on the north main bank which together control three-thirteenths of nine-tenths of the flow of the branch, estimated as equivalent to perhaps 100 effective horse-power. Of the privilege on the south branch, the Watertown Paper Company owns one-eighth and the Remington Paper Company the remainder.

On the north main bank of the river the only use of power is at the Remington Paper Company's pulp-mill, where a head of 13½ feet is obtained and 635 horse-power of wheels are run. A wooden flume 11 feet wide and 8 feet deep runs several hundred feet along the bank, past the vacant sites already referred to, on which are a couple of old wooden buildings once used for some kind of manufacturing, but now unoccupied, and one of them in ruins. On the island are the principal works of the Remington Paper Company, manfacturing news printing-paper, of which the production is about 9 tons per day. Including the pulp-mill on the main shore, about 1,000 horse-power of wheels are run, from which full capacity can be realized eight or nine months in the year. There are also the extensive works of the Davis Sewing Machine Company, which, in an article upon the manufactures of Watertown, published in 1876, was stated to employ 175 hands and to have manufactured, in 1875, $300,000 worth of machines; and also the Watertown Paper Company's mill, at which is made the same variety of paper as by the Remington company. The two sections of dam belonging to this privilege have a combined length of roll-way of from 350 to 400 feet, on which the extreme freshet-rise amounts to about 9 feet. Backwater sometimes causes a stoppage of the Remington mills, and also, it is presumed, of the other works, for as much as a week.

4. At the lower privilege at Sewall's island the fall from the crest of the dam to the foot of the island is 13 feet, increasing to 19 feet at the crest of the dam at Beebee's island. The fall actually utilized, however, at the mills does not exceed 12 or 14 feet. The property on the north main bank is owned by the Watertown Spring Wagon Company, but no power is used there and the ground is vacant. On the island side of the adjacent channel a short timber flume conveys water to the large works of the Bagley & Sewall Company, where 150 horse-power of wheels are run under a head of 12 feet. This company has a foundery, and manufactures general iron-work and machinery, and especially force-pumps; it employs 125 hands, and turns out 2,500 tons of cast-iron work yearly. The principal use of power from the lower falls at Sewall's island is from the south channel, on the adjacent main bank, where a long timber flume supplies a number of mills and factories, two or three of which are of very important size. The most prominent among these are the Watertown Spring Wagon Company's works, enjoying a first right to sufficient water for 5,000 spindle-power, and actually using a fall of 14 feet, and 200 horse-power. The business is very extensive, and is conducted in a main building 283 by 55 feet in plan, and a new building 100 by 112 feet, both four stories high. In 1881 this company shipped 4,000 wagons. Power is transferred from the wheel to the main factory by a shaft 175 feet long.

Next in importance is the factory of the H. H. Babcock Buggy Company, using a fall of 12 feet, and probably 125 horse-power. The main building is 250 by 40 feet in size. One hundred hands are employed, and in November, 1882, 8 or 10 buggies were being manufactured per day, the establishment having a capacity for turning out 20 in that time. Farwell & Rhimes' flouring-mill has 3 runs of stone and 10 sets of rollers, with a capacity for grinding a car-load of corn and 150 barrels of flour daily. Besides these larger concerns power is also employed by a 2-run pearl-barley mill and a bakery. Three small tanneries and a wood-working shop were also observed, but they appeared to be doing but little work. With the present mode of development the power on this channel is all utilized, and there is little or no opportunity to obtain reliable power for further manufacturing. In some years there is sufficient water throughout, while in others a scarcity exists for one, and even two months. The flume, ordinarily containing 8 or 10 feet depth of water, is sometimes drawn down by the mills so that toward the foot it does not contain more than 2 feet.

5–6. At Beebee's island, which is 2,300 feet below Sewall's, there are grouped a large number of manufacturing concerns of varying size and importance. Here, as above, there are two channels, separated by the island, and

*a* The Remington company states its fall as 17 feet, possibly gained by the use of brackets on the dam.

the stream is confined within a gorge, with vertical rocky sides. Ledges of rock in the north or main channel form natural falls, at the head of which is a timber dam not over 10 feet high at the highest point, and running out thence on the rocks of the island with a height of only a foot or two for nearly half its length. At the suspension bridge just below the falls this channel has a low-water width of about 90 feet, and a high-water width of probably 135 feet. From the crest of the dam to slack-water a little below the island the descent is 35 feet, which in the north channel is at present uninterrupted by a second dam, but in the south channel is by that means divided into an upper fall of 20 feet, and a lower of 15 feet.

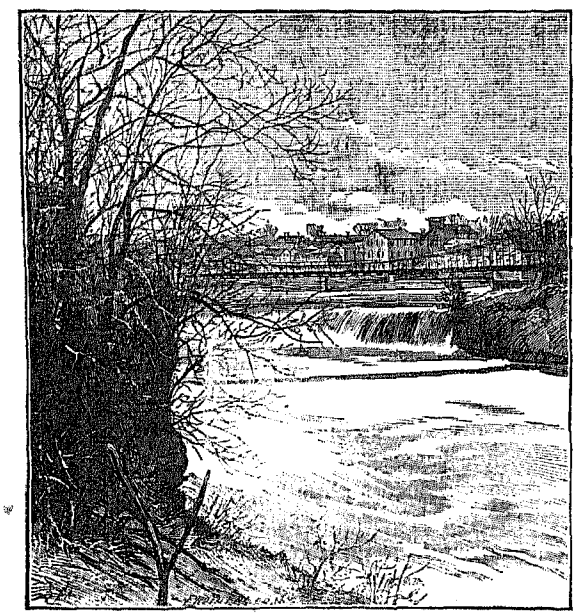

FIG. 3.—Falls at Beebee's island.

On the north main bank water is conveyed three or four hundred feet from the dam, a short distance in a rock cut, and the remainder of the way in a timber flume 8 or 10 feet wide and 5 or 6 feet deep. The principal concerns using power are the Watertown Steam Engine Company, manufacturer of portable and stationary engines, employing a fall of 18 feet and a 100 horse-power wheel from which the power is transferred by a shaft 200 feet long; the Watertown woolen-mills, running 2 sets of machinery on yarns, and Allingham & Co., employing 25 hands in the manufacture of boots and shoes. There is also a 4-run grist-mill, a sash-, door-, and blind-shop, a small furniture-shop, and a small file-shop. With the single exception noted, the falls in use range from 8 to 14 feet with full flume. No other power is used from this channel, but the right is owned by certain parties to build another dam and use the remainder of the fall (presumably 15 feet) as is done in the south channel. It is a valuable privilege, being in the business part of the city and but 1,000 feet from the public square.

On the south side of the island there is at the head of the falls a heavy masonry bulkhead and wall, shutting off from the channel and flume below all water except that allowed to pass through the gates. This wall is about 275 feet long, 6 feet wide on top, and rises 12 feet above the water in the pond, opposing an effectual barrier to freshets and ice. Water is admitted through six gates, each opening about 5 feet wide in the clear, into a timber flume having at the bulkhead a width of about 45 feet and a depth of 8 feet. Power is utilized on the south main bank by Knowlton Brothers, manufacturers of glazed medium papers, production 3 tons per day, and employing at least 300 horse-power of wheels under heads ranging from 11 to 15 feet; at I. A. Graves & Co.'s flouring-mill, having 5 runs of stone, a full line of rollers, and using a fall of 16 feet, with about 250 horse-power of wheels; by the Hitchcock Lamp Company, employing 60 hands; and by several other establishments of small size, comprising a cabinet-shop, a machine-shop, a sash-, door-, and blind-shop, and a shop for filing saws. On the island side of this upper fall there is an old ax factory, now unoccupied; G. Lord's foundery and machine-shop and manufactory of agricultural implements, using 12 feet of fall and employing 15 or 20 hands; a sash-, door-, and blind-shop, and a city water-works pump.

The tail-water from these various mills is discharged into the south channel, along which they are located, and which is mainly taken up with the head-race or flume, and passing under the latter is collected in a small basin constituting a second level and formed by a second dam. There are rapids below the dam, and the mills are not placed so as thoroughly to utilize the fall. From this level are supplied the Eames Vacuum Brake Company, having two 100 horse-power wheels working under a head of 12 feet, and one wheel of 50 horse-power under a head of 26 feet, combining both falls; also a furniture factory, a 6-run flouring- and grist-mill, and a planing-mill.

7. Three thousand feet below Beebee's island, but yet within the city limits, there is still another power in use. The dam is a crib-work structure with rollway 280 feet long, and is 14 feet high. The timbers are 6 by 10 inches in cross-section and the back-slope is 30 feet long. The dam was built in 1879, at a cost stated to have been $3,000. Wooden flumes extend down each bank from the dam, and supply, on the north side, the mill of Taggart Brothers, manufacturers of news-paper and of flour-bags. Poplar and spruce are here ground for wood-pulp, while rope is used for bagging-material. The works have a capacity of 5 tons of finished product per day, use about 800 horse-power, and give employment to 50 men. On the opposite bank of the river there are a 3-run flouring- and grist-mill, J. S. Robinson's 2-set yarn-mill, and A. M. Farwell's tannery. Probably these three concerns do not together use more than 120 horse-power, leaving a large amount unemployed, for which there is suitable and abundant building-room. The fall on this privilege is stated to be 14 feet, which, according to Hinds' survey, covers the descent from the crest of the dam to the railroad bridge, 1,200 feet below.

8. From the railroad bridge to the lower boundary of the city, 4,300 feet down stream, there is a further fall of 8¾ feet, entirely unimproved.

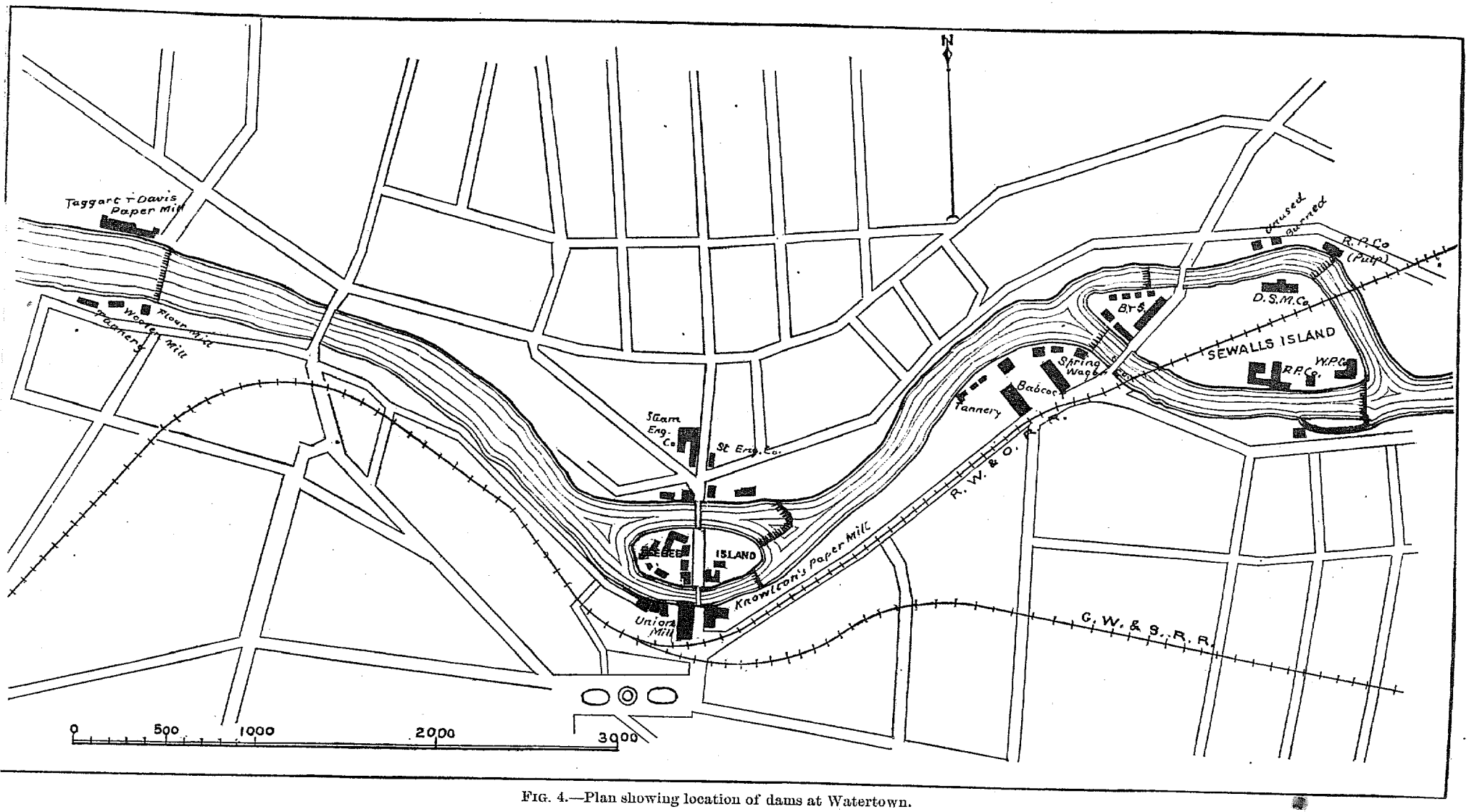


FIG. 4.—Plan showing location of dams at Watertown.

Each fall or section of the river, in its course through Watertown, has now been described. It is impossible to say just how much power still remains unemployed and available for manufacturing, or how much would be available if the mills now running were all supplied with the best machinery and with economical wheels; if they were so located as to employ all the water at each privilege under the full head, instead of under various lesser falls as is now the case; and if the water were used without leakage at dams, in flumes, and in pen-stocks. An estimate will be presented, however, of the total power of the river here, accompanied by a statement, based on the returns of the census enumerators, of the power of wheels in use, from which some idea can perhaps be formed of the amount still idle. To recapitulate, it may be said, in brief, that at the Water-works privilege there is a fall of 16 feet and an important amount of surplus power; that thence to Diamond island there is say 12 feet of fall entirely unimproved; opposite the upper end of Sewall's island a fall of from 15 to 17 feet, the power of which is thoroughly utilized in low stages of river, although on the north main bank there are several vacant sites, together entitled to about 20 per cent. of the flow in the adjacent channel; opposite the lower end of Sewall's island an immediate fall of 12 or 14 feet, increasing to 19 feet beyond, though only the first-mentioned amount is actually employed (at this privilege the power in the south channel is thoroughly utilized, but there is a considerable surplus in the north channel, probably several hundred effective horse-power); opposite Beebee's island a descent of about 35 feet, in two falls, with 15 feet of this in the north channel unimproved and constituting a very valuable privilege; 3,000 feet down stream a fall of 14 feet, largely improved, but still offering surplus power on the south bank; and thence to the western boundary of the city an unimproved fall of 8¾ feet.

The undeveloped falls are sufficient in themselves to warrant a large increase in the already extensive manufacturing of this flourishing city, but at the older and more thoroughly utilized privileges, such as those at Beebee's island and opposite the foot of Sewall's island, the rights to water are in a peculiar and very unattractive position. The occupancy of these privileges dates far back in the century, and by the original owners rights were deeded in the most vague and indefinite manner possible. It was assumed that the power of Black river was equal to all demands, and almost no limitations were placed in the deeds conveying it. Thus, on the south upper level at Beebee's island, power was granted "sufficient for a machine-shop", "sufficient for a cast-iron business", and so on. The deed to the Knowltons, paper manufacturers, was so comprehensive that according to a literal reading they could claim the entire flow of the river. By the deeds the various grantees were holden for certain proportions of the dam, as regards expense of maintenance, and this was carried so far that at length it was found that they were together responsible for *four-thirds* of a dam. By mutual concessions serious disputes have been avoided, but it is plain that the claims to water exist here on a very unsatisfactory basis.

Again, at the south lower privilege opposite Sewall's island, occupied by the Watertown Spring Wagon Company and other concerns, the Black River Cotton & Woolen Manufacturing Company first obtained control of the power, and afterward deeded or leased portions to different manufacturers, reserving 5,000 spindle-power, which later came into the possession of the spring-wagon company. The Black River company leased to one party water "sufficient to carry a paper-mill", and in another case "sufficient for a machine-shop and the necessary appendages of the same". V. P. Kimball has water for 3 runs of stone, or their equivalent, provided that sufficient should thereby be left for the cotton factory and any previous grants, subject to payment, if demanded, of one pepper-corn every July 11 to the party of the first part. He is holden, to a certain extent, for expenses of repairs. In one instance sufficient water was granted for a bark-mill and all necessary appendages of a tan-yard; in another, sufficient to carry four carding-machines, provided that enough should always be left for the cotton factory, paper-mill, and all other establishments previously given rights to the water.

*Estimate of power at Watertown.*

| Stage of river. | Natural drainage area. | Flow per second, average for the 24 hours. | THEORETICAL HORSE-POWER. | | | | | | | | | | Total effective horse-power of wheels in use. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Per foot fall. | Water-works privilege—only partly utilized. | Below water-works to head of Diamond island—not used. | Upper end of Sewall's island—mainly in use. | From crest of lower dam at Sewall's island to crest of Beebee's Island dam—12 or 14 feet partly utilized. | Upper fall at Beebee's island—largely in use. | Lower fall at Beebee's island—unimproved in north channel. | At Taggart's mill—surplus power on south bank. | From lower railroad bridge to lower city line—not used. | Total within city limits. | |
| | *Sq. miles.* | *Cubic ft.* | | 16 *ft. fall.* | 12 *ft. fall.* | 17 *ft. fall.* | 19 *ft. fall.* | 20 *ft. fall.* | 15 *ft. fall.* | 14 *ft. fall.* | 8¾ *ft. fall.* | 122 *ft. fall.* | |
| Low water, dry year | a1,816 | 1,050 | 119.28 | 1,910 | 1,430 | 2,030 | 2,270 | 2,390 | 1,790 | 1,670 | 1,040 | 14,550 | 4,675± |
| Low water, average year | | 1,300 | 147.68 | 2,360 | 1,770 | 2,510 | 2,810 | 2,950 | 2,220 | 2,070 | 1,290 | 18,020 | |
| Available 10 months, average year | | 1,400 | 159.04 | 2,540 | 1,910 | 2,700 | 3,020 | 3,180 | 2,390 | 2,230 | 1,390 | 19,400 | |

*a* Effective drainage area in dry season, 1,541 square miles (see page 5).

NOTE.—Rainfall on basin approximately estimated at 9 inches in spring, 10 in summer, 12 in autumn, 8 in winter, and 39 for the year; there are no data, however, for accurate determination.

*The river below Watertown.*—Passing below Watertown, the river presents numerous opportunities for the development of large powers. The surrounding country is level or very slightly hilly, and the river-banks themselves are generally succeeded at once by level ground, underlaid by limestone and admirably suited to building. The rock is seamy, and might not hold water well in races unless calked in some way; but timber flumes, the almost invariable mode of conveying water at privileges on this river, are always practicable. The stream is quite narrow in this section, and rushes along with rapid fall. Below the city the banks are for a while gentle in rise, and are at times smooth sloping ledges of limestone. Farther down they continue of solid rock, but rise abruptly from the water from 15 to 25 feet. Much of the way the upper layers have been broken off in immense fragments, which still lie in place or tilted, while the lower strata remain firm. Below the smooth sloping banks mentioned there was noticed in particular, and determined roughly by hand-level, a descent of from 3 to 5 feet in 800 feet; then a continuous rapid fall for perhaps a quarter of a mile, amounting to 14 feet, including and terminating in a sudden pitch of about 4 feet; then a continuous rapid, with a fall of about 7 feet in 800; then a fall of 5 feet in about 400, succeeded by slack-water from a dam half a mile below and probably not over 2 miles from Watertown.

The privilege next to be described has recently been developed and is a very fine one. It extends an eighth of a mile below the present mill, and embraces a total fall of probably 45 or 50 feet, of which 30 feet is actually in use. It is owned and employed by C. R. Remington for the manufacture of news-paper from wood-pulp, the works having a capacity of 4 tons per day. The dam extends from the bulkhead 300 feet in a straight piece up stream parallel to the adjacent bank, and then curves around toward the opposite shore with an additional length of 350 feet, making a total overfall of 650 feet. It is built of 6 by 10 inch timbers, those running with the stream inclined, and has a back slope of 3 base to 1 vertical. The height ranges, according to the contour of rock beneath, from $4\frac{1}{2}$ to $6\frac{3}{4}$ feet, and gives therefore an extreme width at base of about 20 feet. The bottom timbers are pinned with $1\frac{1}{8}$-inch pins to bed-rock. The abutment at the north end rises $5\frac{1}{2}$ or 6 feet above the crest, and is considered high enough for all ordinary freshets. In the spring of 1882 the river is said to have been about as high as it often is, and rose 3 feet on the dam. The face of the structure is vertical, and 1 inch back from the crest, on the up-stream slope, a strip of $\frac{1}{4}$-inch iron, 1 foot wide, runs the length of the dam, and guards against damage to the timber-work from floating ice or other material.

The bulkhead is built of masonry, with two 15-foot arches for the gate-ways. It has a length, measured to the extreme ends of the wall, of 110 feet, a width on top of 5 feet, and a batter of 5 inches to the foot. Water is admitted through the bulkhead by means of ten gates, 6 feet deep and 3 feet wide, pivoted in the center at top and bottom. From the bulkhead water is brought about 200 feet to the wheels in a race having an inside width of 30 feet and inclosed on the river side by a wall 3 feet wide on top and battering about 4 inches to a foot. It is received in a timber fore-bay about 33 by 70 feet in size, and runs one 25-inch and six 30-inch Curtis (Ogdensburg) wheels. These are arranged in pairs on a horizontal shaft, which is about on the level of the bottom of the race and extends into the mill as the main shaft, without intermediate gearing. The wheels are provided with draught tubes, run under a head of 30 feet, and have a combined rating of about 900 horse-power. At the time this privilege was visited, in the latter part of November, 1882, the mill had been in operation only about six months, but during the summer the stream had been very low; yet, as has previously been stated, at the lowest stage then observed, with the wheels running at full capacity, there was a wastage of 6 inches of water on the dam. The banks are very rocky at this point, and 1,500 cubic yards of rock had to be blasted out for the tail-race. The main mill is 42 by 106 feet in size, the machine-room 32 by 120 feet, and the boiler-house 30 by 42 feet.

Below the Remington works the gorge deepens, the river is in places less than 50 feet wide, and much of the way is hemmed in by walls of solid rock from 30 to 50 feet high. The descent is very rapid, and is varied now and then by heavy pitches. Thus by hand-level one fall of 10 or 12 feet in 500 feet was measured, and there were other falls equally great or greater both above and below. The river finally enters a still deeper part of the gorge, where the fall is very heavy and the precipitous banks rise 50 or 75 feet high, and there then succeeds a long stretch of smooth swift water. The surrounding country is very level, and the channel of the stream has been cut down into it.

At Brownville, $3\frac{1}{2}$ or 4 miles by road below Watertown, is met the next improved power. The stream is here controlled by a log dam about 100 feet long and 17 or 18 feet high. This is a rough-appearing structure, and is very leaky, as are also the flumes which run from it down each bank. The longer of these is on the right bank, and is probably 800 or 1,000 feet in length. The half of the privilege on the south bank is owned by George Frasier, and is used in part for a 6-run flouring- and grist-mill having a fall of 17 feet, and occasionally in part for a saw-mill. On the north side of the river the mill-owners are associated in the Brownville Dam Company for the purpose of keeping up the dam. The Brownville Yarn Company owns one-quarter of the privilege on that bank, and the mill in which its operations are carried on has been there for over fifty years. It has manufactured cotton-yarns, the mill containing 3,000 spindles, but the works were not running when visited, though expected to start soon. A head of 16 feet is obtained at this mill, which is the first below the dam, and a 137 horse-power wheel is run. There is so much waste on the privilege by leakage and otherwise that it is thought that no more mills could be run, with a certainty of permanent power, than are now accommodated. Besides the cotton factory there are on

that side of the stream Webb's cabinet-shop, employing 4 or 5 hands and using a 60 horse-power wheel; Sluman's flouring- and grist-mill, with 4 runs of stone and using 14 or 15 feet of fall; a good brick foundery, not in operation; and a straw-board paper-mill, which was found to be shut down for the winter.

The cotton factory has a preferred privilege here. The other concerns have rights to surplus water, though the actual amounts are not very definitely specified. Although with economical use of the water much more manufacturing might be sustained, the location as now improved is not an attractive one, and it is said that in some cases the accumulated taxes on unoccupied sites are probably greater than the latter would sell for if unincumbered. Opposite Brownville the river-banks are less steep than generally on this part of the river, but below the mills the gorge, shut in by vertical walls, which has been noticed at Watertown and below, again appears. As naturally might be expected, the rises in such a confined channel are at times very great. Thus at the time of the failure of the state reservoir the water is said to have risen 21 or 22 feet on the crest of the Brownville dam, and in the river below to a height of 5 feet above the tops of the flumes. At times floating ice chokes up the narrow gorge below the mills and causes backwater to rise nearly to the point of submerging the flumes.

The last power on the river is at the little village of Dexter, about 3 miles below Brownville and less than a mile from the head of Black River bay. The ravine which hitherto has shut in the stream now opens out, and though limestone still appears in the banks these are low, and the dam sets back the water over a large extent of land. Navigation for boats of 5½ or 6 feet draught continues up to this point, and considerable lumber is brought here by that means. Two islands in the river form with each other and the adjoining shores three channels, each of which is closed by a section of dam. These sections are built of logs, and are old and extremely rough in appearance. The fall obtained is 10 or 11 feet. A number of concerns are supplied with power, some by races and some by wooden flumes, but none of them are of large size, and there is nearly always water going to waste on the dam. There are two sash-and-blind factories, together employing some 35 hands in the summer season and using yearly from 1,000,000 to 1,500,000 feet of lumber; two flouring- and grist-mills, with 3 runs of stone each; and a small saw-mill. From the pool above the dam a canal leads off across the village to a large and fine stone mill, which was formerly occupied for woolen manufacturing and gave employment to 300 hands. This mill is said to be owned by New York parties, and has been shut down for eight or ten years. With it is reported to be controlled two-thirds of the entire flow of the river at this privilege.

It will be evident, from what has been said, that Black river offers an unusually large amount of available water-power; and there can be little question that, with the advance of time, and the increase of wealth, population, and manufacturing interest in this section, the numerous fine privileges will be developed one after another, those now imperfectly utilized by comparatively unimportant mills being purchased and improved for larger enterprises, until the river shall become, as it is undoubtedly entitled to do, one of the most prominent of the eastern manufacturing streams. Taking the fall from the top of the Carthage dam to the surface of lake Ontario as 477 feet, and the mean volume for this fall, during low water of an ordinarily dry year, as 1,050 cubic feet per second, then the corresponding gross or theoretical power of the river will be represented by 56,900 horse-power, while the total rated effective or net horse-power of wheels in use amounts, for the section of river considered, to only about 7,800 horse-power. The following table presents a summary of the various privileges that have been mentioned. It is not supposed to show in detail all the available sites for power, but only the more prominent ones, such as were brought especially to attention:

*Summary of the principal water-privileges on Black river.*

| Locality. | Natural drainage area. (*a*) | Fall. | Estimated theoretical horse-power. (*b*) | | | Total rated effective horse-power of wheels in use. | Manufacture. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | | Low water, dry year. | Low water, average year. | Available 10 months, average year. | | | |
| | *Sq. miles.* | *Feet.* | | | | | | |
| From North Branch reservoir to crest of Forestport dam. | ..... | 692 | ..... | ..... | ..... | 97 | ..... | Distance by river, 21.6 miles. |
| From crest of Forestport dam to crest of Lyon's Falls dam. | ..... | 327 | ..... | ..... | ..... | 121 | ..... | Distance by river, 17 miles. |
| Lyon's Falls..... | 807 | 64½ | 1,900 | 2,640 | 3,080 | ..... | Privilege recently purchased with the design of developing in 1883 and erecting large manufacturing works. | Total fall about 69 feet, of which 64½ feet is to be developed. Surplus power for disposal. |
| From foot of Lyon's falls to crest of Carthage dam. | ..... | 9½ | ..... | ..... | ..... | ..... | ..... | Fall distributed over 42½ miles. Not available for power. |
| Carthage ..... | 1,741 | 55 | 6,250 | 7,810 | 8,440 | 1,120± | Machinery, iron, pumps, leather, flour, lumber, pulp, hosiery, and various articles in wood. | Fall occurs in 4,600 feet. Numerous opportunities for further use of power. |

*a* The effective drainage area in the dry season is to be considered as 275 square miles less than the figures here given (see page 5).

*b* Based upon average flow for the twenty-four hours.

*Summary of the principal water-privileges on Black river*—Continued.

| Locality. | Natural drainage area. (a) | Fall. | ESTIMATED THEORETICAL HORSE-POWER. Low water, dry year. | Low water, average year. | Available 10 months, average year. | Total rated effective horse-power of wheels in use. | Manufacture. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | *Sq. miles.* | *Feet.* | | | | | | |
| Rawson's mill | 1,750 | 16± | 1,820 | 2,270 | 2,450 | ..... | Power once used for saw- and shingle-mill, but dam carried out by ice about 1870. | Between Carthage and Madame De Ferriet's bridge. |
| Great Bend | 1,763 | 14 | 1,610 | 2,000 | 2,160 | 150–160 | Hanging-paper | Production, 3 tons per day. |
| Felt's Mills | 1,787 | 10± | 1,170 | 1,450 | 1,570 | 125± | Power used in saw- and shingle-mill, grist-mill, ax-helve factory, and large tannery. | 8,000 hides tanned yearly at Veber's tannery. |
| Black River | 1,794 | 16 | 1,890 | 2,340 | 2,530 | 265± | Chairs and chair stock mainly; also flour, cabinet-ware, and shingles. | One firm turns out 20,000 chairs yearly. |
| Within three-quarters of a mile below Black River village. | 1,795 | 45± | 5,320 | 6,590 | 7,110 | ..... | Fall unimproved | Three falls of say 15 feet each. |
| Huntingtonville | 1,801 | 11± | 1,300 | 1,610 | 1,740 | ..... | Power formerly used in saw-mill, and in scythe and ax factory, but the works and dam were carried away when the state reservoir failed. | Say 2 miles from Watertown; not a desirable site for a dam. |
| Watertown | 1,816 | 122 | 14,550 | 18,020 | 19 400 | 4,675± | Mainly paper, pulp, spring-wagons, buggies, sewing-machines, force-pumps, vacuum-brakes, steam-engines, and general machinery. There are 5 flouring- and grist-mills, 1 pearl-barley mill, several tanneries, 2 small woolen-mills, and also various other establishments for the manufacture of lamps, furniture, locks; sashes, doors, and blinds; cabinet-ware, boots and shoes, and baker's goods. | Large amount of unemployed power (see description). |
| Within 3,000 or 4,000 feet above slack-water from Remington's dam. | 1,830 | 30± | 3,610 | 4,460 | 4,840 | ..... | Fall unimproved | Within say 2 miles of Watertown. |
| C. R. Remington's mill | 1,830 | 50± | 6,020 | 7,440 | 8,070 | 900 | News-paper | 30 feet of fall actually developed and in use. Production of mill, 4 tons per day. |
| Brownville | 1,848 | 17± | 2,070 | 2,550 | 2,780 | 300± | Flour, lumber, paper, cotton-yarns, cotton batting, and cabinet-ware. | Cotton-mill has 3,000 spindles. Hydraulic works here are in poor condition. |
| Dexter | 1,855 | 11 | 1,340 | 1,650 | 1,810 | 265+ | Sashes and blinds, flour, and lumber. | Two sash- and blind-factories together employ about 35 hands in summer, and use from 1,000,000 to 1,500,000 feet of lumber yearly. Two-thirds of the entire privilege belongs with a fine woolen-mill, shut down a number of years ago. |
| Total from crest of Carthage dam to mouth of river. | 1,741 to 1,855 | 477 | 56,990 | 70,440 | 75,860 | 7,800± | ..... | Not all practically available. |

*a* The effective drainage area in the dry season is to be considered as 275 square miles less than the figures here given (see page 5).

## THE MOOSE RIVER.

This important tributary of the Black river rises in western Hamilton county, within a few miles to the southwest and south from Raquette lake. It is made up by two principal branches, the more northerly of which receives the drainage from the Fulton chain of lakes. From the junction of these branches the course is westerly, until the stream unites with the main Black river just above the state dam at the head of Lyon's falls. The course of Moose river, even to the mouth, lies through an extremely rugged valley. There is considerable logging about the upper waters, and it is estimated that an average of 7,000,000 or 8,000,000 feet of timber, mainly hemlock and spruce, is annually floated down the stream. In the 30½ miles from the first lake of the Fulton chain to the mouth of the river there is a descent of 882 feet, or an average of very nearly 29 feet per mile. The drainage basin includes approximately 349 square miles.

The Lyon's Falls dam causes slack-water for a mile, more or less, up Moose river, and then occur natural falls almost as abrupt and easy to improve as those on the Black river below the above-mentioned dam. At the head of these an island forms two channels, across the northern of which is a low log dam; the dam across the south channel is not more than 80 or 100 feet long, and consists of loose stone piled up on the ledges, with a plank facing. The descent from the crest of the dam to the foot of the falls was found by hand-level to be about 45 feet. The power is utilized in Gould's large saw- and pulp-mill.

Not over a quarter of a mile above Gould's mill there is a fine privilege occupied by the Herkimer Paper Company for the manufacture of wood-pulp, and embracing a total fall of 33 or 34 feet. The stream is controlled

by a log dam, curving in plan, and water is conveyed a short distance to the mill, part way in a race inclosed by a river-wall of stone, and part way in a wooden flume. The head employed is 27 feet, under which are run 6 wheels of 180 horse-power each, geared in pairs to 3 shafts. For six or eight months in the year 720 horse-power can be realized, and in the lowest stage of river about 360 horse-power. The dam is tight, the wheels are of good pattern, and the power is economically utilized. At the head of the mill-pond there is another sudden fall of about 39 feet, also owned by the Herkimer Paper Company.

Some 3 or 4 miles farther up stream there are two more developed powers. The lower is occupied by Shon's paper-mill, and includes about 27 feet of fall, though the amount of fall or power actually in use was not ascertained. Above this privilege there is a pitch of 8 or 10 feet, and another of 2 or 3 feet, before reaching a fall of 34 feet partially utilized by Joel W. Ager in a small mill for the manufacture of rag wrapping and straw papers.

The Moose river is subject to heavy freshets, and for about two weeks in the year the Herkimer paper-mill is troubled by anchor-ice, though never sufficiently to cause a stoppage of work. Examination of the stream was confined to a few miles of its course above the mouth, including, however, the most important improved powers, and was made November 25, 1882; at that time the Herkimer company's, Gould's, and Shon's mills were all using the entire flow, excepting leakage, which was large at the two last-mentioned points.

*Table of utilized power on the Black river and tributaries.*

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* | |
| Black river | Lake Ontario | New York | Oneida | Saw | 2 | 30 | 37 | ..... | Remsen. |
| Do | do | do | do | do | 1 | 12 | 21 | ..... | Forestport. |
| Do | do | do | do | Flouring and grist | 1 | | 15 | ..... | |
| Do | do | do | do | Furniture | 1 | 8-9 | 10 | ..... | Hawkinsville. |
| Do | do | do | do | Flouring and grist | 1 | | 50 | ..... | |
| Do | do | do | do | Tannery | 1 | 16 | 25 | 25 | |
| Do | do | do | Lewis | Agricultural implements | 1 | Total fall utilized, though by no means to its full capacity, in Lewis county, about 360 feet. | 30 | ..... | |
| Do | do | do | do | Blacksmithing | 1 | | 15 | ..... | |
| Do | do | do | do | Boots and shoes | 1 | | ..... | ..... | |
| Do | do | do | do | Bread, crackers, etc. | 1 | | 25 | ..... | |
| Do | do | do | do | Carriages and wagons, and materials. | 2 | | 325 | ..... | |
| Do | do | do | do | Cotton | 1 | | 137 | ..... | |
| Do | do | do | do | File-shop | 1 | | ..... | ..... | |
| Do | do | do | do | Flouring and grist | 16 | | 1,439 | ..... | |
| Do | do | do | do | Furniture | 8 | | 312 | ..... | |
| Do | do | do | do | Hosiery | 1 | | 40 | ..... | |
| Do | do | do | do | Iron-works | 1 | | ..... | ..... | |
| Do | do | do | do | Lamps and reflectors | 1 | | 30 | ..... | |
| Do | do | do | do | Lumber, planed | 2 | | 20+ | ..... | |
| Do | do | do | do | Machinery | 5 | | 428 | 30 | |
| Do | do | do | do | Paper (including wood-pulp). | 8 | | 3,557 | ..... | About 2,300 horse-power of this is used in Watertown. |
| Do | do | do | do | Piano materials | 1 | | ..... | ..... | |
| Do | do | do | do | Sashes, doors, and blinds | 7 | | 280 | ..... | |
| Do | do | do | do | Saw | 6 | | 100 | ..... | |
| Do | do | do | do | Sewing-machines and materials. | 1 | | 84 | ..... | |
| Do | do | do | do | Shingles | 1 | | ..... | ..... | |
| Do | do | do | do | Tanneries | 8 | | 500 | ..... | |
| Do | do | do | do | Vacuum brakes | 1 | | 250 | ..... | |
| Do | do | do | do | Water-works supplied | 1 | | ..... | ..... | |
| Do | do | do | do | Wheelwrighting | 1 | | 15 | ..... | |
| Do | do | do | do | Wood turning and carving | 3 | | 40+ | ..... | |
| Do | do | do | do | Wooden handles | 1 | | ..... | ..... | |
| Do | do | do | do | Wooden ware | 2 | | 145 | ..... | |
| Do | do | do | do | Woolen | 2 | | 30 | ..... | |
| Do | do | do | do | Wool-carding shop | 1 | | ..... | ..... | |
| Moose river and tributaries. | Black river | do | do | Furniture | 2 | 22 | 14 | ..... | |
| Do | do | do | do | Paper | 3 | 59 | 1,150+ | ..... | |
| Do | do | do | do | Saw | 4 | 57 | 370 | ..... | |
| Do | do | do | do | Tannery | 1 | 14 | 60 | 100 | |
| Independence creek and tributaries. | do | do | do | Saw | 9 | 136 | 400 | ..... | |
| Beaver river and tributaries. | do | do | do | Flouring and grist | 3 | 39 | 125 | ..... | |
| Do | do | do | do | Saw | 6 | 68 | 370 | ..... | |

*Table of utilized power on the Black river and tributaries*—Continued.

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* | |
| Beaver river and tributaries. | Black river | New York | Lewis | Tanneries | 3 | 29 | 115 | | |
| Deer river and tributaries. | do | do | do | Agricultural implements | 2 | 20 | 34 | | |
| Do | do | do | do | Blacksmithing | 1 | 8 | 8 | | |
| Do | do | do | do | Cooperage | 2 | 26 | 30 | 12 | |
| Do | do | do | do | Flouring and grist | 2 | 45 | 160 | | |
| Do | do | do | do | Furniture | 1 | 16 | 10 | | |
| Do | do | do | do | Sashes, doors, and blinds | 1 | 8 | 10 | 12 | |
| Do | do | do | do | Saw | 12 | 132 | 292 | | |
| Do | do | do | do | Tannery | 1 | 14 | 8 | 8 | |
| Sundry tributaries. | do | do | do | Flouring and grist | 10 | 229 | 380 | 40 | |
| Do | do | do | do | Sashes, doors, and blinds | 2 | 58 | 26 | 25 | |
| Do | do | do | do | Saw | 27 | 426 | 753 | | |
| Do | do | do | do | Tanneries | 2 | 13+ | 130 | 80 | |
| Do | do | do | do | Wheelwrighting | 1 | 9 | 15 | | |
| Do | do | do | do | Wooden packing-boxes | 1 | 10 | 30 | | |
| Do | do | do | do | Woolen | 2 | 9+ | 12 | | |
| Do | do | do | Jefferson | Flouring and grist | 1 | 28 | 36 | | |
| Do | do | do | do | Furniture | 1 | 14 | 10 | | |
| Do | do | do | do | Saw | 1 | 20 | 18 | | |
| Do | do | do | Oneida | Flouring and grist | 1 | 28 | 30 | 25 | |
| Do | do | do | do | Saw | 11 | 146 | 358 | | |
| Do | do | do | do | Tanneries | 3 | 42 | 90 | 20 | |
| Do | do | do | do | Wooden ware | 1 | 7 | 8 | | |
| Do | do | do | Herkimer | Saw | 2 | 20 | 18 | | |

# II.—THE OSWEGO RIVER AND TRIBUTARIES.

*Drainage areas.*

| | Square miles. |
|---|---|
| Seneca river | 3,447 |
| Oneida river | 1,421 |
| Oswego river below junction of Seneca and Oneida rivers | 4,868 |
| Oswego river at mouth | 5,013 |

## THE OSWEGO RIVER.

A large part of western central New York is drained by this important river and its tributaries. The main stream is formed some 12 miles northwest of Syracuse by the union of the Seneca and Oneida rivers, whence its course is northwesterly to Oswego, where it empties into lake Ontario. The length by river from the junction at Three-River Point to the mouth is about 20½ miles. The drainage basin along this interval embraces only a narrow strip of country, level or moderately rolling; but above the junction of the Seneca and Oneida rivers it spreads out, attaining an extreme width to the east and west of about 100 miles, and to the north and south of between 70 and 80 miles. From the low and level lands which border lake Ontario there is a gradual rise, south of the Seneca river, to north-and-south ridges, which separate the various lakes of that region, and extending farther south become merged in the still more elevated country lying along the southern water-shed of lake Ontario.

The country naturally tributary to the Oswego river is one of splendid resources, is quite thickly settled, contains important cities and many flourishing villages, and is threaded by a network of water and railroad transportation routes. In common with the northern part of the United States generally, it is more or less overlaid by drift materials—sand, gravel, clay, and bowlders; but the decomposition of native rocks has produced an unusually rich, productive soil, yielding largely in the various grains, and also finely suited to dairying, wool-growing, and stock-raising. There is an abundance of the best of building-stone; gypsum, and rock for both quick-lime and water-lime, are extensively quarried, and in Onondaga county are the valuable salt springs so largely utilized in the vicinity of Syracuse.

Perhaps the most striking feature of the district under consideration is its remarkable collection of beautiful lakes, adding greatly to the attractiveness of this part of the state, and of especial importance to navigation and manufacturing interests. Proceeding from west to east, the principal lakes are, in order, Canandaigua, Keuka or

Crooked, Seneca, Cayuga, Owasco, Skaneateles, and Oneida. These seven include a water-surface of, approximately, 280 square miles, increased by the four lesser lakes, Cross, Onondaga, Otisco, and Cazenovia, to about 295 square miles. The larger of these, Oneida, Cayuga, and Seneca, are utilized for steam-towing navigation, having water connection with the Erie and Oswego canals. More or less freight is transported over Keuka and Canandaigua lakes in steamers, while Owasco, Skaneateles, Otisco, and Cazenovia are controlled by state dams and act as feeders to the Erie canal. On glancing at a map of this region the eye is at once struck by the peculiar shape and position of nearly all these lakes. With the single noteworthy exception of Oneida, they are long and narrow and have a general north-and-south direction; or, more accurately, they are spread out like rays, their courses, if extended, intersecting from 40 to 60 miles northward, in lake Ontario, or in Prince Edward county on its northern shore.

Cayuga and Seneca lakes are particularly noticeable for their depth and for the abrupt slopes of their beds. The correspondence of the rock strata on opposite shores, and other facts, indicate that the depressions were hollowed out by some very powerful action of nature. In a paper upon the geological history of these two lakes,(*a*) Dr. Charles W. Foote elaborates the view that they first occupied depressions previously eroded by the action of an inland sea which extended to the northward, and formed into basins as the land gradually rose; and that these basins were subsequently scooped out and much deepened by glaciers moving southerly. There is also much evidence to show that at some period they had their outlets toward the south, to the Susquehanna, but by the removal of barriers at their northern extremities reversed their flow. As noticed by Dr. Foote, their beds are, in the deepest places, from 50 to 100 feet below the level of tide-water.

*Principal lakes in the drainage basin of the Oswego river.*

| Name of lake. | Elevation of water-surface above mean sea-level. | Authority for elevation. | Area of water-surface. (*b*) | Total drainage area above outlet of lake. | Remarks. |
|---|---|---|---|---|---|
| | *Feet.* | | *Square miles.* | *Square miles.* | |
| Oneida lake | 369.78 | State canal profiles | 80.90 | 1,300.0 | Greatest estimated depth, 60 feet. Surface freezes entirely over, usually by January 1. Lake changes but slightly in level during the year. Used for steam-towing navigation. Outlet 16 miles long, with a fall of about 8 feet, and is practically of no value for power. |
| Cazenovia lake | 900.00 | French's *Gazetteer of New York* | 2.80 | 0.0 | Outlet (Chittenango creek) 25½ miles long, with a total fall of about 530 feet to Oneida lake. At Chittenango Falls there is an abrupt pitch of 136 feet, and there is an entire fall of 470 feet in the 9½ miles from Cazenovia lake to the state feeder-dam, where the storage from the lake is diverted to the Erie canal. The creek is used to a moderate extent for power, mainly by flouring- and paper-mills. Area of flowage is as shown on canal map. |
| Seneca lake | 443.07 | State canal profiles | 66.00 | 707.0 | 34 miles long and from 1 to 2½ miles wide. Ordinary range from high to low water, from 2 to 2½ feet; extreme, from 4 to 5 feet. Temporary oscillations of a foot or two due to winds and tides are claimed to occur. Deepest sounding obtained up to 1880 was 580 feet. Scarcely ever does any ice form, except a slight skim occasionally near the extremities. Utilized for navigation. Outlet (Seneca river) falls 63 feet to Cayuga lake, and is largely employed for power at Waterloo and Seneca Falls. Thence to the junction with Oneida river the only use of power is at Baldwinsville. |
| Keuka or Crooked lake. | 720.07 | do | 20.30 | 187.0 | Some freighting and passenger traffic carried on by steamers. Lake is surrounded by hills. Over much of its extent the depth exceeds 200 feet. Annual variation from high to low water 6 or 7 feet, with extreme of 9 feet. Outlet falls 277 feet in 6 or 8 miles to Seneca lake, and is used for power by several flouring-mills. |
| Cayuga lake | 380.07 | do | 66.75 | 1,593.0 | Used for navigation, and nearly always free from ice except within 9 or 10 miles of the foot. Ordinary range from high to low water about 3 feet, with extreme of 7 feet. Deepest sounding, 425 feet. Drainage basin, exclusive of Seneca outlet, 813 square miles. Area of flowage measured on map prepared by students of Cornell university. |
| Canandaigua lake | 687.50 | Ordinary low water by profile of Northern Central railroad. | 18.60 | 175.0 | Commonly freezes over in part. Some freighting carried on over its surface. Depth estimated to be as great as 150 feet in the deeper portions, but is shallow toward the head and foot. Outlet falls 287.5 feet in 26 miles, to Lyons, and is used at various points for manufacturing. |
| Owasco lake | 707.00 | Old survey | 12.40 | 208.0 | Annual range between high and low water about 5 feet. Temporary oscillations of several inches, and even a foot, are caused by winds. Surface freezes over usually by February. The state has a dam at the foot of the lake, and another 9 miles below on the outlet, by the latter of which water is diverted to the Erie canal. The total fall in the outlet is 330 feet, and a large amount of power is in use, chiefly at Auburn. |
| Skaneateles lake | 860.25 | French's *Gazetteer of New York* | 15.10 | 84.0 | Has a narrow basin and is surrounded by high hills. Is usually frozen over from January till April. Deepest sounding, 320 feet. Tides claimed to occur, and sudden oscillations due to winds also noticed. Level highest in spring or early summer, and lowest toward the close of the year. Outlet about 13 miles long, with a fall, to the feeder-dam, of 450 feet, utilized by numerous mills, and offering many unimproved sites. Controlled by the state for feeding the Erie canal. |
| Onondaga lake | 391.00<br>369.00 | French's *Gazetteer of New York*.<br>Charles W. Foote | 4.10 | 267.0 | Greatest depth stated as 65 feet. No power on outlet. |
| Otisco lake | 772.00 | French's *Gazetteer of New York* | 4.00 | 34.4 | Water diverted from outlet (Nine-Mile creek) at Camillus for feeding the Erie canal. Outlet has a fall of 361 feet to the feeder-dam, and is employed for power by a considerable number of mills. Area of flowage measured on canal map. |
| Cross lake | | | 3.90 | | Mere enlargement of Seneca river. |

*a* *Notes upon the Geological History of Cayuga and Seneca Lakes.* *b* Measured on French's map of New York, except where otherwise stated.

The influence of the lakes upon the Oswego river is of the utmost importance in contributing to the steadiness of its flow. The conditions affecting it, aside from the presence of these natural reservoirs, are not favorable to uniformity. The country drained is underlaid to a considerable extent by permeable rocks—shales, sandstones, and limestones—its surface has been quite thoroughly cleared of timber, settled, and drained in the processes of cultivation, and the rainfall is rather light. Even as it is, the discharge at times falls as low as 1,150 or 1,250 cubic feet per second at Oswego, or only from 0.23 to 0.25 cubic foot per second per square mile of effective drainage area, although the ordinary summer flow is stated upon good authority to be twice as great. On the other hand, the flood volume runs as high as between 16,000 and 17,000 cubic feet per second in ordinary floods, and even rises to between 41,000 and 42,000 cubic feet per second in an excessive flood.

No record could be found of any long-continued series of measurements of the discharge, but the following data may be taken as reliable guides to the amounts of water flowing in low and in high stages of river:

1. By a decree of the supreme court, dated August 21, 1875, in the case of Michael J. Cummings against owners and lessees of water on the Varick canal at Oswego, it was assumed as follows concerning the amount of water flowing to this canal, which receives one-half the surplus of the river above the needs of navigation: (1) "That the average flow of water from the Oswego river into the Varick canal in low water in the summer months is about 45,000 to 50,000 cubic feet per minute", making the whole flow of the river say from 90,000 to 100,000 cubic feet per minute (from 1,500 to 1,670 cubic feet per second). (2) "That in extreme low water in the summer, and which usually occurs in the months of July or August, it is about 35,000 cubic feet per minute" (70,000 cubic feet for the whole flow of the river, or 1,170 cubic feet per second). (3) "That the average flow for the whole three summer months is about 75,000 cubic feet per minute" (150,000 cubic feet for the whole flow of the river, or 2,500 cubic feet per second).

2. It is stated by Charles Rhodes, esq., of the Oswego Canal Company, a gentleman who has given much observation and study to hydraulic questions connected with this river, that (1) in an ordinary flood the discharge at Oswego is, in round numbers, 1,000,000 cubic feet per minute (from 16,000 to 17,000 cubic feet per second); (2) in a large flood, 1,500,000 cubic feet per minute (25,000 cubic feet per second); (3) in an excessive flood, 2,500,000 cubic feet per minute (from 41,000 to 42,000 cubic feet per second).

3. In the *Annual Report of the State Engineer and Surveyor* for the year ending September 30, 1879, an estimate is made of the supply of water available for navigation, in which it is assumed that the Seneca river may be relied upon for 54,000 cubic feet per minute, the Oneida river for 20,000 cubic feet per minute; while the Oswego canal receives from the Erie canal at Syracuse 10,000 cubic feet per minute, all of which, not lost on the way, is discharged into the Oswego river via the Seneca river. In all, therefore, the Oswego river is assumed to receive from 74,000 to 84,000 cubic feet per minute (from 1,230 to 1,400 cubic feet per second).

*Summary of data concerning the flow of water in the Oswego river.*

| Locality. | Stage of river. | Drainage area, gross.(a) | Flow per minute.(b) | Flow per second. | Flow per second per square mile of gross drainage area. | Authority. |
|---|---|---|---|---|---|---|
| | | *Sq. miles.* | *Cubic feet.* | *Cubic feet.* | *Cubic feet.* | |
| Oswego | Average flow in low water in the summer months. | 5,013 | 90,000–100,000 | 1,500–1,670 | 0.30–0.33 | Volumes assumed in supreme court decree. |
| | Extreme low water in the summer, usually occurring in July or August. | | 70,000 | 1,170 | 0.23 | |
| | Average flow for the whole three summer months. | | 150,000 | 2,500 | 0.50 | |
| | Ordinary flood | | 1,000,000 | 16,000–17,000 | 3.19–3.39 | Charles Rhodes. |
| | Large flood | | 1,500,000 | 25,000 | 4.99 | |
| | Excessive flood | | 2,500,000 | 41,000–42,000 | 8.18–8.38 | |
| Three-River Point. | Stage not mentioned, but presumably a low one. | 4,868 | 74,000–84,000 | 1,230–1,400 | 0.25–0.29 | Marvin Porter, engineer of middle division of New York state canals. |

*a* Of which about 750 square miles is more or less completely utilized in the dry season for feeding the Erie canal.

*b* The amounts here given are in round numbers, the flow required for lockage, which is in comparison small, being neglected. Probably 3,000 cubic feet per minute, or 50 cubic feet per second, would be a reasonably large average allowance for waste and the demands of lockage.

Various tributaries of the Oswego river are drawn upon to supply water to the Erie canal during somewhat more than half the year. A certain proportion of this water may ultimately find its way into the main river, but its amount can not easily be estimated. An aggregate area of not far from 750 square miles, naturally draining to the Oswego river, is thus controlled and rendered partially tributary to the Erie canal. On the other hand, the Chemung river, flowing to the Susquehanna, is drawn upon to some extent for feeding down the Chemung canal into Seneca lake; and the extreme head-waters of Tioughnioga creek, also naturally flowing to the Susquehanna, are diverted for filling the DeRuyter reservoir, which feeds northerly down the course of Limestone creek to the Erie canal.

*Table of streams in the Oswego basin having their waters diverted to the supply of the Erie canal.*

| Stream. | Location of feeder-dam. | Name of canal level fed. | Natural drainage area controlled. | Remarks. |
|---|---|---|---|---|
| | | | *Sq miles.* | |
| Oneida Creek | Oneida | Long level | 62 | |
| Cowassalon creek | 2 miles westerly from Oneida | do | 23 | |
| Chittenango creek | Chittenango | do | 87 | Includes Erieville reservoir and Cazenovia lake. From the latter down to the feeder-dam, say 9½ miles, the stored waters are available for power. |
| Limestone creek | Manlius | do | 81 | Commands in upper course the storage of DeRuyter reservoir, supplied by an artificial diversion of water from the head-waters of Tioughnioga creek, naturally draining to the Susquehanna. The drainage area given is independent of the Tioughnioga. |
| Butternut creek | 4 miles southeast of Syracuse | do | 47 | Receives the storage of Jamesville reservoir. |
| Nine-Mile creek | Camillus | Jordan level | 77 | Commands the storage of Otisco lake, the waters of which are for 11 miles, to the feeder-dam, available for power. |
| Carpenter brook | 2½ miles east of Jordan | do | 8 | |
| Skaneateles creek | Jordan | do | 114 | Commands the storage of Skaneateles lake, the waters of which are for between 11 and 12 miles, to the feeder-dam, available for power. |
| Putnam brook | Weedsport | Port Byron level | 28 | |
| Spring brook | Centerport | do | 4 | |
| Owasco creek | Port Byron | do | 222 | Commands the storage of Owasco lake, the waters of which are for say 9 miles, to the feeder-dam, available for power. |
| | | | 753 | |

The fall in the river from Three-River Point to the average surface of lake Ontario is 115 feet, which is accomplished partly at dams, partly in rapids, and at Oswego Falls includes an abrupt pitch of several feet. The Oswego canal, striking off from the Erie canal at Syracuse, follows down the east shore of Onondaga lake to the Seneca river; thence to Three-River Point and down the Oswego river, navigation is maintained by a series of seven dams, the slack-water of which is taken advantage of, while stretches of canal make the descents around the dams and rapids from one pool to another. All these dams have been constructed in the most substantial manner, and are owned by the state. It having been established by legal decision that the surplus water at these dams may be used by private parties to supply power for manufacturing purposes, in so far as there is no interference with navigation or the state's improvements, a number of extremely valuable water-powers have thus been made available, and at four points—Oswego, Fulton, Oswego Falls, and Phœnix—are now put to use, and support important manufacturing interests. The stream is, in general, finely adapted to the convenience and security of such employment. The bed and banks are firm, the latter of good height. The volume of water is maintained with great steadiness, and there is freedom from disastrous freshets. On the Oswego dam, having a roll-way of 530 feet, the greatest freshet-depth is stated not probably to have exceeded 6 feet; and below the Minetto dam the ordinary rise is only 3 or 4 feet. The whole surrounding and tributary country is prosperous and rich in resources. The best of water communication is enjoyed, either by way of the great lakes or the New York state canals. The west bank of the river is followed by the Oswego and Syracuse division of the Delaware, Lackawanna, and Western railroad, and the east, below Fulton, by the New York, Ontario, and Western railroad.

The principal hinderance encountered in using water-power on this river is from backwater, caused either by freshets or by ice. The stream sinks slowly from a flood-stage, and for from two to four weeks considerable trouble is experienced at Phœnix from backwater, with even a forced stoppage of work in exceptional cases, but the wheels there are said to be generally designed to use a large amount of water under a moderate fall, to meet such difficulty. Opposite the Varick canal, at Oswego, the net reduction of head in freshets does not exceed 2½ or 3 feet. On the lower river, so far as can be learned, neither anchor- nor floating-ice is especially troublesome, but at the former site of the "horseshoe" dam, between Oswego Falls and Phœnix, anchor-ice collects and sets the river back so as at times nearly or quite to destroy the head at the latter point. A few years ago the river was in this manner set back for seven weeks over the top of the Phœnix dam. The anchor-ice formed a gorge at the "horseshoe" dam, said to have been nearly 20 feet high in places, and to have extended a mile up stream.(*a*) It was generally considered an impracticable thing to clear the river of this gorge, but by determined effort a passage was cut through in a few hours.

*a* This is the only locality that has been brought to the notice of the author, on any stream, where extensive gorges have resulted from the accumulation of true anchor-ice, but careful inquiries indicated that it was this form of ice, and not cake- or skim-ice, which caused the river to become choked up at the "horseshoe" dam.

*Table showing elevations and fall of the Oswego river.*

| Locality. | Distance from mouth, map measurement. | Elevation of water-surface above mean sea-level. | Fall between points. | Distance between points. | Fall per mile between points. | Authority for elevation. |
|---|---|---|---|---|---|---|
| | *Miles.* | *Feet.* | *Feet.* | *Miles.* | *Feet.* | |
| Three-River Point, head of river | 20.6 | 361.93 | 115.32 | 20.6 | 5.6 | 359.86 feet + mean low tide at Albany. New York state canal profiles. |
| Mean surface of lake Ontario | 0.0 | 246.61 | | | | Mean elevation from January 1, 1860, to December 31, 1875, above mean tide at New York, as stated at office of Chief of Engineers, U. S. army. |

*Water-power at Oswego.*—The city of Oswego, with a population of 21,000, is located at the mouth of the river, which widens out into a fine harbor. The stream-bed is composed of low outcropping sandstone ledges, forming rapids at the head of which is the state dam. This curves up stream in plan, and has a vertical face, a timber apron, and heavy masonry abutments rising 6 feet above the crest. The main structure is of stone, with spill-way 530 feet long, and rises some 12 feet above bed-rock. The apron is about 3 feet high, projects 15 feet down stream from the foot of the dam, and is covered with timbers 10 inches thick. The east abutment is 7 feet wide on top, and from it a wing-wall of about the same width extends back to form one side of the navigation canal, which here opens out from the pool and passes around the dam and rapids. Under the tow-path of this canal water enters the Oswego hydraulic canal, running parallel to the former and on the inshore side of it, and at a distance of 450 feet below the entrance is controlled by a timber bulkhead supported by three stone piers, each 5 feet wide. There are 13 gates, with openings about 5 feet 4 inches wide in the clear; each gate is worked by a screw of about 2 inches diameter, power being applied by a lever. Shortly above this bulkhead an additional gate, with an opening 6 or 7 feet wide, communicates with the navigation canal.

The power on this, the east side of the river, not already disposed of, is owned by the Oswego Canal Company. This company's canal is about 4,000 feet long, has a water depth of 6 feet, and an average width at water-surface of probably 60 feet; the latter dimension varies, however, and is greater than 60 feet in the upper part of the canal, decreasing toward the lower end. With 1-foot flash-boards on the dam, the fall to average lake-surface may fairly be stated as 20 feet; but it varies with the lake-level,(*a*) from month to month, and from year to year, and with full canal and low lake has been known to reach 25 feet. The fall in actual use ranges commonly from 12 to 20 feet, according to position on the canal, the latter extending down to the harbor. Some facts regarding the manufacturing along this canal are given below:

*Establishments using power on the Oswego hydraulic canal, November*, 1882.

| Firm. | Kind of mill or manufacture. | Remarks. |
|---|---|---|
| Oswego Starch Factory | Power used in grain elevator | Lowest establishment on the canal; capacity of elevator, 200,000 bushels. |
| Smith, Murdock, & Co | do | Capacity of elevator, 225,000 bushels. |
| M. Merrick & Co | Flouring-mill and elevator | Daily capacity of mill, 500 barrels of flour; storage capacity of elevator, 200,000 bushels. |
| Penfield, Lyon, & Co | 2 flouring-mills and an elevator | Lower mill, rollers, 600 barrels per day; elevator capacity, 300,000 bushels; upper mill, rollers, 500 barrels per day. |
| C. C. Morton | Power used in elevator | Capacity of elevator, 250,000 bushels. |
| Thomas Matthews | do | Capacity of elevator, 230,000 bushels. |
| B. Doolittle & Co | Flouring-mill | Capacity of mill, 125 barrels per day; 150,000 bushels of corn also ground yearly for meal. |
| James McFarland & Co | Wood-pulp | |
| C. W. Pardee | Malt-house | Malting capacity, 125,000 bushels per year. |
| Oswego Wood Pulp Company | Planing-mill, and sash-and-blind factory | |
| Francis Perot's Sons | Malt house | |
| Switz, Condé, & Co | Knit underwear | 9 sets of machinery; value of annual production, about $650,000. |
| Charles North | Large tannery | |
| Oswego Flux Company | Flux for softening iron | Uses a fall of 14 feet and a wheel of about 25 horse-power. |
| Scott & Nesbit | Dry-dock | |
| Lyon & Mott | Malt-house | Malt-house 4 stories high, 130 by 72 feet in plan, cost $40,000; storage for 60,000 bushels of grain; malting capacity, 110,000 bushels of barley during the season of seven months, from October to May; 20 horse-power wheel, under a head of 14 feet, used for elevating and conveying the grain. |

*a* From an article by Charles Rhodes, esq., of Oswego, based upon observations contained in the reports of the Chief of Engineers, U. S. army, are taken the following facts: At Oswego there is a range of 4.76 feet between extreme high water of 1838 and extreme low water of 1846 and 1848. Several different classes of oscillations occur in the surface of the lake. The means for successive periods of five years show a slow general movement, covering in the progression from high to low water, or the reverse, from ten to twenty years' time. The mean monthly levels for any one year show a change from high water, which occurs most often in May or June, though frequently in July, to low water, which is nearly always in December or January. Sudden and unaccountable variations of level also take place. Thus, "for example, in April, 1873, after eighteen months of very low water, lake Ontario rose 2½ feet in about twenty days".

A certain necessary amount of water is first of all required by the state for its canal, and in order to maintain the slack-water level above the dam the pool is not permitted to be drawn down more than 1 foot, probably to the stone crest of the dam; in practice it is always kept very nearly full. Of the water entering the navigation canal a portion is drawn and used by two or three concerns on its upper course, this being allowed by the state in order to avoid the expense of culverts under the canal, which would be necessary if the supply were taken from the hydraulic race; but culverts are also employed in one or two cases. The hydraulic race was built about 1823, before the navigation canal. Below the lower bridge over the river it passes most of the way under the buildings along its course and is opposite navigable water in the stream.

The Oswego Canal Company gives a 999-year lease of water, but land has to be bought by manufacturers from other parties; much unoccupied room, however, is owned by an estate interested in the company. On the lower part of the canal, near the elevators, are two good sites, one formerly occupied by the Lake Ontario mills, 6 runs, and the other by a 4-run mill and an elevator. The buildings were burned and the sites are now vacant.

A "run" of water on this canal is 11¾ cubic feet per second, under the head available at the harbor, say 20 feet. There are assumed to be 32 first-class runs, the annual rental for which is $350 per annum per run; 32 second-class runs, at from $250 to $300 per annum per run; while the balance are surplus runs and bring from one-half to two-thirds the rental charged for first-class runs. In case of a shortage of water the surplus runs would first be shut down successively, in order beginning with the most recent leases; then the second-class runs would share equally with one another in a reduction, and finally, if necessary, the first-class runs would similarly be cut down. In practice all the mills at present on the canal can run their wheels at full capacity as many as eleven months in the year. November 27, 1882, there had been leased on this race 30 first-class runs, about 15 second-class, and about 16 surplus runs.

*Table showing the cost of water-power on the Oswego hydraulic canal.(a)*

[A run is here assumed as 11¾ cubic feet per second under a head of 20 feet=26.7 theoretical horse-power.]

| Assumed efficiency of wheels. | Corresponding effective horse-power. | COST PER EFFECTIVE HORSE-POWER. | | | Assumed efficiency of wheels. | Corresponding effective horse-power. | COST PER EFFECTIVE HORSE-POWER. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | First-class runs at $350. | Second-class runs at from $250 to $300. | Surplus runs at from ½ to ⅔ first-class. | | | First-class runs at $350. | Second-class runs at from $250 to $300. | Surplus runs at from ½ to ⅔ first-class. |
| *Per cent.* | *Per run.* | | | | *Per cent.* | *Per run.* | | | |
| 60 | 16.02 | $21 85 | $15 61–$18 73 | $10 92–$14 57 | 75 | 20.02 | $17 48 | $12 49–$14 99 | $8 74–$11 65 |
| 65 | 17.35 | 20 17 | 14 41– 17 29 | 10 08– 13 45 | 80 | 21.36 | 16 39 | 11 70– 14 04 | 8 19– 10 93 |
| 70 | 18.69 | 18 73 | 13 38– 16 05 | 9 37– 12 49 | 85 | 22.69 | 15 43 | 11 02– 13 22 | 7 72– 10 29 |

*a* See subsequent remarks on comparative cost on Oswego and Varick canals.

On the west side of the river is the Varick hydraulic canal, extending 3,000 feet down from the state dam, but necessarily brought to an end before reaching navigable water owing to the abrupt and rocky character of the bank and the occupation of the ground by other improvements. It is in general about 60 feet wide in its upper course, furnishes a fall ranging between 10 and 15 feet, according to location, and is utilized for manufacturing as follows:

*Establishments using power on the Varick hydraulic canal, November, 1882.*

| Firm. | Kind of mill or manufacture. | Remarks. |
|---|---|---|
| Joseph Hover | Flouring | Fall of 10 feet Owns 5 first-class runs. Capacity of mill, 250 barrels per day. |
| T. Kingsford & Son. (The Oswego Starch Factory.) | Starch | The firm owns 26 first-class and 12 second-class runs. Fourteen water-wheels are run, furnishing in the aggregate 1,220 horse-power; 845 horse-power of steam is also available for use in low water. The firm has manufactured continuously for over 50 years, and in 1848 removed here from Jersey City. The production is 35 tons per day, or 21,500,000 pounds of starch per year. The works cover 5 acres of ground, and the principal buildings have a frontage of 733 feet and a depth of 200 feet. They contain 38 miles of steam-pipe, 5 miles of shafting, 24 pairs of burr-stones for grinding corn, and 6 pairs of heavy iron rollers. |
| O. H. Hastings & Co | Flouring | Eight runs of stone, 6 sets of rollers. Capacity of mill, 300 barrels per day. The firm owns 6 first-class runs and 1 second-class. |
| Nutting & Wright | Printing-paper | Production, 2 tons per day. |

The Varick canal was built in 1834, and is said to have cost $112,000. So far as owning water-rights not yet leased and receiving rents are concerned, the proprietors are M. Pardee and the F. T. Carrington estate, owners also of the adjoining unoccupied land. A perpetual lease of water is given to manufacturers desiring power. As affirmed by a decree of the supreme court,(*a*) a run of water on this race ranges between 1,700 cubic feet per minute under a head of 12 feet and 1,500 cubic feet under a head of 13 feet; it may fairly be taken as 2,000 cubic feet per minute (33⅓ per second) under a head of 10 feet, or its equivalent. There are recognized 50 first-class runs, 17 second-class, and an unlimited number of third-class. For first-class runs the rental is from $250 to $300 per annum;

*a* Dated August 21, 1875. Case of Michael J. Cummings against owners and lessees of water on the canal.

for second- and third class runs it ranges from $125 to $150. November 28, 1882, there had been leased permanently 45 first-class runs and 14 second-class. Five first-class runs had also been temporarily leased, and these, together with about 35 second- and third-class, remained applicable to unsold and unoccupied lands, which include abundance of good building-room. The second-class runs are stated to be reliable for power nine or ten months in the year. At times they have been shut down to about one-quarter of their full amount, and for one or two months the Oswego Starch Factory has, in a very low stage of river, been obliged to bring into use 800 horse-power of steam.

*Table showing the cost of water-power on the Varick hydraulic canal.* (*a*)

[A run is here assumed as 33⅓ cubic feet per second under a head of 10 feet = 37.87 theoretical horse-power.]

| Assumed efficiency of wheels. | Corresponding effective horse-power. | COST PER EFFECTIVE HORSE-POWER. | | Assumed efficiency of wheels. | Corresponding effective horse-power. | COST PER EFFECTIVE HORSE-POWER. | |
|---|---|---|---|---|---|---|---|
| | | First-class runs at from $250 to $300. | Second- and third-class runs at from $125 to $150. | | | First-class runs at from $250 to $300. | Second- and third-class runs at from $125 to $150. |
| *Per cent.* | *Per run.* | | | *Per cent.* | *Per run.* | | |
| 60 | 22.72 | $11 00–$13 20 | $5 50–$6 00 | 75 | 28.40 | $8 80–$10 56 | $4 40–$5 28 |
| 65 | 24.62 | 10 16– 12 18 | 5 08– 6 09 | 80 | 30.30 | 8 25– 9 90 | 4 13– 4 95 |
| 70 | 26.51 | 9 43– 11 32 | 4 72– 5 66 | 85 | 32.19 | 7 77– 9 32 | 3 88– 4 66 |

*a* See subsequent remarks on comparative cost on Oswego and Varick canals.

The Oswego and Varick canals are entitled to divide the water of the river, not needed for navigation, equally between them. In order to do this both have the same aggregate water-way at the head-gates, and by gauges at those points, which are examined when necessary, it can be seen if one canal has been drawn below the other, and the gates can be changed accordingly. On the Varick canal each mill draws its water over a weir,(*a*) which is adjusted from time to time by commissioners and locked in such position that the flow over it shall be what the mill is entitled to receive. Of course, if in low water the level should be drawn down a little the flow over each weir would be slightly and proportionately decreased. On the Oswego canal there is no such contrivance, and more reliance is placed on the wheels as guides to the amounts of water used. On the Varick canal all the establishments are between the canal and the river; on the line of the Oswego hydraulic canal they are between it and the river, but along the upper course some are on one side and some on the other of the navigation canal.

From the tables that have been given it will be seen that the cost of water is apparently much less on the Varick than on the Oswego canal, and without some explanation an erroneous impression may be gained. In the first place, the Oswego hydraulic canal has a substantial advantage over the Varick canal in that it extends to the harbor, thus enabling vessels from the upper lakes to come directly alongside the mills; by this the intrinsic value of the power is increased. Secondly, a first-class run of water can always be depended upon along the Oswego canal, but can not along the Varick canal. No means are at hand of determining with accuracy the actual mean fall which pertains to the entire series of first-class runs on either canal; but judging from the statements contained in the decree of the supreme court, and from such general information as has been obtained concerning the positions of the mills, it may be fair to assume, in view of the actual distribution of the runs in use along the canals, the following as the mean of all the first-class runs:

On the Varick hydraulic canal, 1,600 cubic feet per minute (26⅔ per second), under a head of 12½ feet.

On the Oswego hydraulic canal, 783⅓ cubic feet per minute (13.06 per second), under a head of 18 feet.

It appears, then, that under the conditions of actual practice, the 50 first-class runs on the Varick canal, when all in use, must demand about 80,000 cubic feet of water per minute (1,333 per second), while the 32 first-class runs on the Oswego canal will demand but about 25,000 cubic feet per minute (25,067 more nearly, or 418 per second).

Taking the flow of the river as assumed by the court, and supposing all the first-class runs in use, we have, then, the following three cases:

(1) Extreme low water in summer, flow into Varick canal (and presumably the same into the Oswego canal) about 35,000 cubic feet per minute. An average first-class run on the Varick canal must then be abated to 44 per cent. of its full value, while there will be no abatement on the Oswego canal of first-class runs.

(2) Average flow in low water in the summer months, from 45,000 to 50,000 cubic feet per minute. First-class runs on the Varick canal will then be abated to from 56 to 62 per cent. of their full value. On the Oswego canal there will be no abatement of first-class runs, and a very slight one, if any, of second-class.

*a* In the decree of court already alluded to, it is, among other things, "ordered adjudged and decreed: That it is necessary in order to obtain the greatest head of water in the canal, and to give the most power practicable to the several runs of water, and for the interest of all the parties, that the water to be drawn and taken from the canal by all the parties hereto, their heirs and assigns, as soon as practicable hereafter, and under the direction and control of the commissioners hereinafter appointed, be drawn and taken over weirs with curved crests, the curve of such crests to be as near as may be to ninety degrees of a circle the radius of which shall be 4 inches, and that the weirs be so adjusted that the second-class water may be readily abated or shut off, and so that the first-class water may be readily abated, and so as to secure as much head in all cases as is practicable, and that the water be drawn by gates to be raised from below".

(3) Average flow for the whole three summer months, about 75,000 cubic feet per minute. First-class runs on the Varick will then have about 94 per cent. of their full value, while on the Oswego canal there will be a large surplus beyond the needs of both first- and second-class runs.

In accordance with the general plan of estimates heretofore used, the probable flow and power at Oswego may be placed at the following figures:

*Estimate of power at Oswego.*

| Stage of river. | Rainfall on basin. | | | | | Drainage area, gross. | Whole flow of river per second, average for the 24 hours. | Flow to each hydraulic canal per second. (a) | Theoretical horse-power. | | | Total effective horse-power (rated) of wheels in use. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring. | Summer. | Autumn. | Winter. | Year. | | | | For each hydraulic canal, per foot of fall. | Total for Oswego hydraulic canal, assuming mean fall at 18 feet. | Total for Varick hydraulic canal, assuming mean fall at 12½ feet. | |
| | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Sq. miles.* | *Cubic feet.* | *Cubic feet.* | | | | |
| Low water, dry year | 8 | 10 | 9½ | 7 | 34½ | *b* 5,012 | 1,200 | 575 | 65.3 | 1,170 | 820 | Partial returns give 2,350 horse-power. This does not include the power used in 4 elevators, a paper-mill, a pulp-mill, a dry-dock, and 2 malt-houses. |
| Low water, average year | | | | | | | 1,550 | 750 | 85.2 | 1,530 | 1,000 | |
| Available 10 months, average year. | | | | | | | 2,350 | 1,150 | 130.6 | 2,350 | 1,630 | |

*a* Assumed at half the entire flow after allowing 50 cubic feet per second for leakage and accompanying waste.
*b* Of which about 750 square miles is more or less completely utilized in the dry season for feeding the Erie canal.

*Powers above Oswego.*—Two miles from Oswego is the "high" dam. It is a straight structure of stone, with roll-way 363 feet long and probably 13 or 14 feet high. It is said that the river-bed is here gravelly and that the dam rests upon crib-work. It is provided with an apron having first a downward slope and then running horizontally. In the dry season flash-boards 1 foot high are placed on the crest of the dam. The abutments are of very heavy masonry, that on the west side being 10 feet wide at the top. A canal passes around the east end of the dam, after which boats ascend in the slack-water as far up as the rifts between this and the Minetto dam. The only use of power here is at the Oswego pumping-works at the west end of the dam. Through a timber bulkhead with stone piers water is admitted to a race about 20 feet wide, and passes a short distance to the pump-house. The water-wheels run under a head of 15 feet and furnish power for pumping into reservoirs on each side of the river, whence the city receives its supply. The banks are high and bluffy on both sides, and the opportunities for extensive building are unfavorable; still there is a moderate amount of available room, and space remains for one mill of good size between the bulkhead and the pump-house.

At Minetto, a little village 3 or 4 miles above Oswego, the river is from 450 to 475 feet wide, with a gravelly and stony bed, rapids and rifts reaching a long distance below the dam. The latter is a stone structure, with a roll-way 445 feet long, masonry abutments, and a crib-work apron. It is said to have been built in 1871. The height is about 7½ feet without, or 8½ feet with, the flash-boards commonly in use. The navigation canal ascends around the rifts and dam on the east bank, and then enters slack-water again. From the dam, for 160 feet down to the road bridge which there spans the stream, there is a clear space of 45 feet between the canal and the river, protected next the latter by a masonry wall. Below the bridge the distance between canal and river grows less. The power on this side of the river was stated to be owned by Mr. M. Merrick, of Oswego. There was once a large flouring mill here, but it was burned and only the ruins remain. On the inshore side of the canal a high gravelly bank rises abruptly.

At the west end of the dam there is an old saw-mill, now unemployed except as a shop in connection with the adjoining factory, and containing the wheels from which, by two shafts at right angles to each other, power is conveyed to the works. An extreme fall of 9 feet, and two 30 horse-power wheels, are employed by the Minetto Shade Cloth Company. The annual production of cloth amounts to 2,500,000 yards, and employment is given to 50 hands. This company owns all the power on one side of the river and the land adjoining the latter for a long distance, but is willing to accommodate other manufacturing concerns. The river-bank is of moderate height, and a race could easily be extended alongside of it by continuing the present river-wall; in fact, at this point power might conveniently and largely be utilized on either side of the stream. There is a railroad a third or a half mile away from either bank. A spur has been surveyed on the west side from the Delaware, Lackawanna, and Western railroad and will be built, it is said, if there is sufficient business to warrant it. There is some unimproved fall both above and below Minetto, but whether sufficient to constitute in either locality another privilege of importance is not shown. Slack-water navigation continues a short distance above the Minetto dam, and then a canal is again resorted to.

At Battle island, some 2 miles above Minetto, there is a straight stone dam, with a sloping timber apron extending about half way its length, which is 662 feet between abutments. This is known as the Van Buren dam, and, like the others on the river, is owned by the state. The river bed is here gravelly and stony, with rapids stretching several hundred feet down stream, and falling probably 2 or 3 feet. At the south or left end of the dam the fall over the latter is naturally about 4½ feet, increased to from 6 to 6½ feet by flash-boards. There is a

heavy masonry bulkhead, with gate-openings closed by temporary work, at this end of the dam, and the facilities for using power are good. No power is actually employed, however, either on this or on the opposite side of the river, though it was said that on the latter, which has the advantage of being adjacent to the navigation canal, but which was not visited, there had formerly been starch-works and some other establishments.

The next privilege to be noticed is at the village of Fulton, a place of about 3,900 inhabitants, lying on the east bank of the river, between 11 and 12 miles from its mouth. The state has here two stone dams, about 3,000 feet apart, the Oswego canal making the passage around the falls on the Fulton side. The lower, known as the Fulton dam, extends straight nearly the whole distance across the river, and has a roll-way 503 feet in length. The fall at the east end, from crest to water-surface below, is about 13½ feet, and heavy rapids reach from 700 to 1,000 feet further down stream. Near the dam the river-bed is mainly composed of low ledges, with considerable loose rock. The navigation and hydraulic canals open out side by side from the pool above the dam, the hydraulic canal lying the nearer to the river, between which and itself the mills are chiefly situated. Water for power is admitted through a timber bulkhead about 40 feet long, in which are six gates operated by screws.

*Manufacturing at the east end of the Fulton dam (fall of 1882).*

| Firm. | Kind of mill or manufacture. | Remarks. |
|---|---|---|
| Herrick & Emerick | Wooden boxes | Have two shops. At the upper, water is drawn directly from the pond under about 15 feet fall, 140 horse-power of wheels being in use. At this shop 35,000 feet of lumber is cut up daily, and 5,000 boxes are turned out in the same time. At the lower shop about 1,000,000 feet of lumber is used yearly. |
| W. S. Nelson & Co | Flouring | 10 runs of stone. Capacity of mill, 600 barrels per day. Property said to be owned by the estate of Jesse Hoyt, of New York, deceased. |
| Perine & Wright | Custom- and flouring-mill | 5 runs of stone; capacity of mill, 100 barrels per day. |
| W. G. Gage & Co | Flouring | 17 sets of rollers; capacity of mill, 300 barrels per day. |
| Gardner & Seymour | Flouring | Capacity of mill, 250 barrels per day. |
| Patterson & Smith | Custom-mill | 3 runs of stone. |
| R. N. Hoff | Custom- and flouring-mill | 3 runs of stone. |
| Gilbert Brothers | Custom- and flouring-mill | 4 runs of stone. |
| Victoria Paper Mill Company | Pulp and manila paper | Uses 12 or 13 feet of fall and about 250 horse-power of wheels. Production, 1 ton of pulp, dry weight, per day, and from 1,500 to 5,000 pounds per day of paper, according to kind. |
| Taylor Bros. & Co | Machine-knives | Employ 16 hands. |

In addition to the more important establishments mentioned above, power also is used in a 2-run plaster-mill and in a number of small shops of various kinds. The power on this race is said formerly to have been developed by a private firm which afterward sold off rights to different manufacturers. The privilege is nominally divided into 50 runs, a run being defined as 144 square inches of water under a head of 12 feet, and the expenses of repairs are shared according to the number of runs owned. There is much transferred water, no system of measurements is employed, and in many cases concerns probably use more water than the amounts to which they are entitled. The falls at the mills range in general between 12 and 16 feet, and cables are in several instances employed in transferring small powers. The hydraulic race is too small for the demands made upon it, becomes drawn down from 1 to 3 feet at the lower extremity in low stages of water, and an occasional stoppage of work thus becomes necessary to some of the mills. It is estimated that on the average all the mills can run at full capacity nine months in the year, and at three-quarters capacity the remainder of the time.

New manufacturing enterprises could obtain power here by purchasing from present holders. The privileges belonging with the Nelson and Perine & Wright mills could thus be obtained, and are said to control together probably half the water on the race. Although the river here affords a fine power, Fulton is not regarded as a favorable site for manufacturing, on account of the heavy taxes brought on by granting railroad aid, and stated to amount annually to 3¾ per cent.

At the west end of the Fulton dam the privilege is owned by Schuyler Schenck, of Toledo. The principal users of power are William Waugh & Brother, manufacturers of straw- and all other kinds of wrapping-paper, their production being 2 tons per day. Thirteen or fourteen feet of fall and 80 or 90 horse-power of wheels are employed. A small amount of power is also utilized in a quarry, tool-shop, and saw-mill, but a large surplus remains, half the entire flow of the stream belonging to the privilege on this bank.

At the upper privilege the river is crossed by what is known as the Oswego Falls dam, a low structure 413 feet long, and not more than 2 or 3 feet high, except as the crest is artificially raised by flash-boards, which are used in summer. Perhaps 100 feet below the dam an irregular ledge of red sandstone runs diagonally across the river, forming an abrupt pitch of 6 or 7 feet. Rapids succeed for several hundred feet down stream, and the river-bed is covered with loose slabs of rock. The main use of power is at Oswego Falls, a village of 1,800 inhabitants, on the west bank of the river, where are the extensive works of the Oswego Falls Manufacturing Company, the production of which is in all-worsted goods, including suitings and coatings, Italian cloth, serges, lastings, buntings, and dress-goods. This company runs 600 looms and gives employment to 1,100 hands. The fall obtained is 13 feet, and for ordinary use 9 water-wheels are run—seven 66-inch American turbines and two 56-inch Leffel

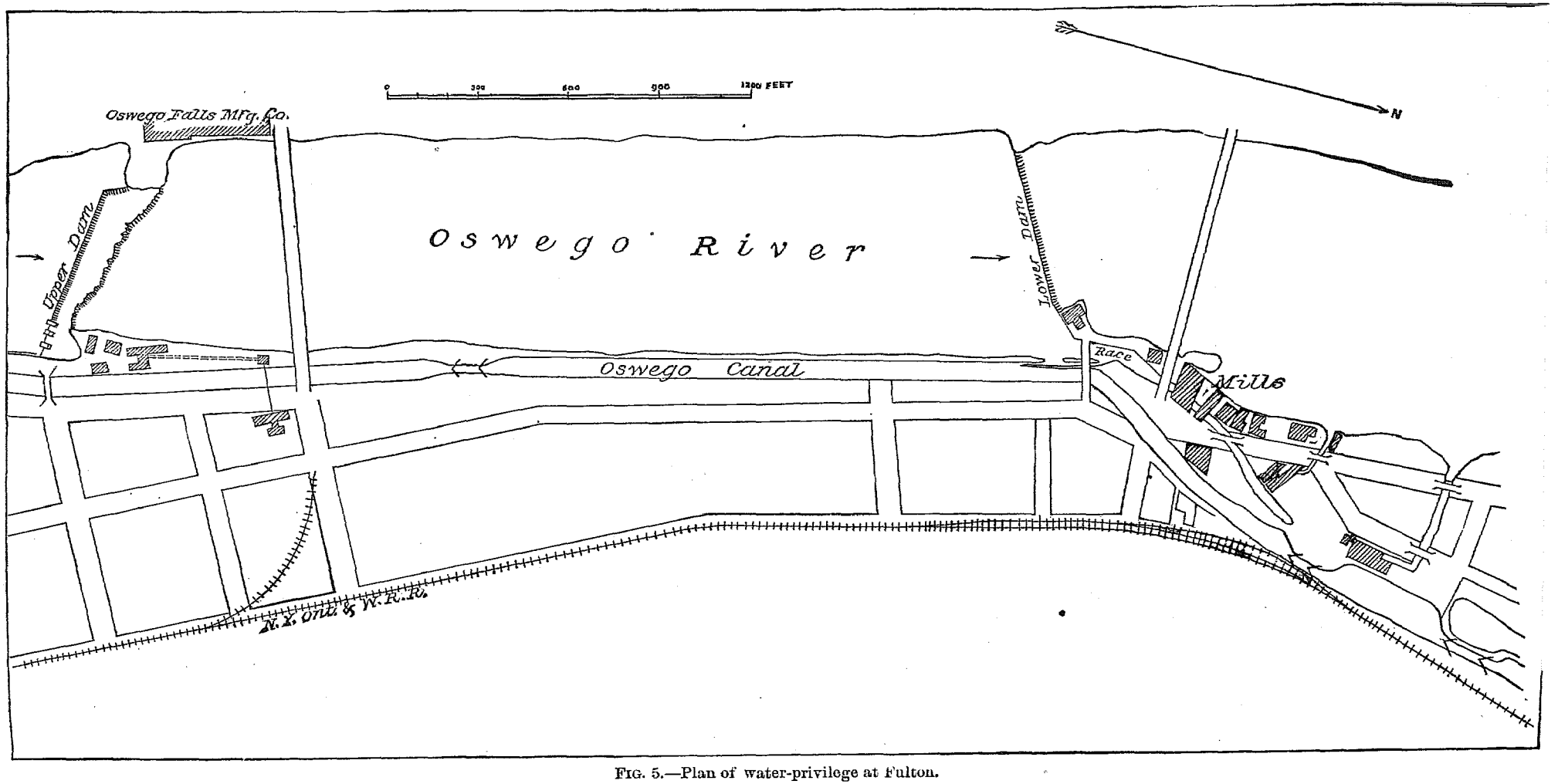


FIG. 5.—Plan of water-privilege at Fulton.

turbines—one of the latter for electric lighting. A small wheel is connected with the fire-pumps. There is nearly always a wastage of water over the dam, but there seems to be no convenient opportunity for further use of power on the Oswego Falls side of the river.

On the east or Fulton side the privilege is owned by Nelson Beardsley, of Auburn; it includes a frontage of about 800 feet along the navigation canal and the river, and a width of strip between them varying in the upper part from 50 to 125 feet. Water is admitted through three 20-foot openings between masonry piers to a short race, and through that and a connecting wooden flume is conveyed some 300 feet to a small saw- and plaster-mill. A grist-mill is also standing, but has not been in operation for a long time. A trunk extends some distance further, under the heel-path of the canal, to a wheel-pit from which power is transferred across the canal, by a shaft 125 feet or more in length, to E. W. Ross & Co.'s machine-shop and foundery, employing 100 hands and 170 horse-power of wheels. A head of 15 feet is obtained in low water, without flash-boards on the dam.

*Estimate of power at the Fulton and Oswego Falls dams.*

| Stage of river. | Drainage area, gross. | Gross flow per second, average for the 24 hours. | Net flow per second, allowing 50 cubic feet for lockage and waste. | Theoretical horse-power. | | | Effective horse-power of wheels in use. |
|---|---|---|---|---|---|---|---|
| | *Sq. miles.* | *Cubic feet.* | *Cubic feet.* | 1 *foot fall.* | 16 *feet fall.* (*b*) | 15 *feet fall.* (*c*) | |
| Low water, dry year | *a* 4,931 | 1,180 | 1,130 | 128.4 | 2,050 | 1,930 | 3,130+. |
| Low water, average year | | 1,630 | 1,480 | 168.1 | 2,690 | 2,520 | |
| Available 10 months, average year | | 2,310 | 2,260 | 256.7 | 4,110 | 3,850 | |

*a* Of which about 750 square miles is more or less completely utilized in the dry season for feeding the Erie canal.
*b* Extreme amount assumed as available below the Fulton dam.
*c* Assumed as available below the Oswego Falls dam.

About 6 miles above Fulton there is a guard-lock in the canal, and opposite there was formerly what was known as the "horseshoe" dam, described as having been but a few feet high. It has been removed, and there is now nothing to indicate its former position except a short but heavy rapid, and a stone abutment on the left bank. Both banks have a gentle slope.

The last dam on the river, at Phœnix, is a mile or so below the junction of the Oneida and Seneca rivers. It is a stone structure, with a fall of about 7 feet from crest of flash-boards, a straight roll-way of 440 feet, masonry abutments, and an apron of timber crib-work bolted to bed-rock, half-way across sloping away from the dam, and the rest of the distance horizontal. Rapids extend several hundred feet down stream, but the fall obtained at the mills is in general about the same as that at the dam, or 7 feet. On the west side of the river water enters a race through three 20-foot openings, and runs 150 or 200 feet to the first establishment using power—Sweet, Northrop, & Co.'s furniture and burial-casket manufactory. This firm owns 2,000 inches of water under a head of 7 feet, employs 20 or 30 hands, and uses 50 or 60 horse-power of wheels. Two-thirds of the remaining power on this side belongs with property lying between the bulkhead and this factory, is unemployed, and is for sale. The other third is owned by Mr. E. Merry, and is utilized, partly at least, in the manufacture of tissue-paper.

On the east side of the river, in the village of Phœnix, a place of 1,300 inhabitants, a portion of the concerns are supplied by a hydraulic race, while the remainder are independent of it. At the end of the dam there are two 6-foot wheels, each of 65 horse-power, running under a fall of 7 feet. A shaft 109 feet long extends thence to the Phœnix Plaster Mill Company's works, whence three cables run distances of from 150 to 650 feet and supply power to the Central City Knife Company, employing 35 hands and turning out about 1,000 dozens per month of pen and pocket cutlery; the Phœnix Manufacturing Company's foundery, and a small cigar-box shop.

A separate flume also conveys water to Glass, Breed, & Co.'s flouring-mill (13 sets of rollers, 3 runs of stone, 200 barrels capacity), using a fall of 5 feet and about 120 horse-power of wheels; and from a tower at the end of the dam a cable transfers power to J. H. Loomis & Son's planing-mill and box-shop, employing 10 hands and about 50 horse-power.

*Estimate of power at the Phœnix dam.*

| Stage of river. | Drainage area, gross. | Gross flow per second, average for the 24 hours. | Net flow per second, allowing 50 cubic feet for lockage and waste. | Theoretical horse-power. | | Effective horse-power of wheels in use. |
|---|---|---|---|---|---|---|
| | *Sq. miles.* | *Cubic feet.* | *Cubic feet.* | 1 *foot fall.* | 7 *feet fall.* | |
| Low water, dry year | *a* 4,870 | 1,170 | 1,120 | 127.2 | 890 | *b* 540+ |
| Low water, average year | | 1,510 | 1,460 | 165.9 | 1,160 | |
| Available 10 months, average year | | 2,280 | 2,230 | 253.3 | 1,770 | |

*a* Of which about 750 square miles is more or less completely utilized in the dry season for feeding the Erie canal.
*b* Returns incomplete.

The hydraulic race is 40 feet wide. It is assumed to supply a certain number of inches of water, of which 2,200 are owned by Pierce & Breed, who have a 4-run custom- and flouring-mill; 300 by A. W. Sweet & Co., manufacturers of caskets and coffins; and part in connection with a small saw-mill.

As has been noticed in the general remarks upon the river, much hinderance is experienced at this locality from the backwater caused by freshets and by gorges of anchor-ice in the river below.

*Summary of the principal water-powers on the Oswego river.*

| Locality of dam. | Approximate distance from mouth of river. | Drainage area, gross. | Assumed fall on privilege. | Estimated theoretical horse-power. Low water, dry year. | Low water, average year. | Available 10 months, average year. | Effective horse-power of wheels in use. | Principal kinds of manufacturing. |
|---|---|---|---|---|---|---|---|---|
| | *Miles.* | *Sq. miles.* | *Feet.* | | | | | |
| Phœnix | 19½ | 4,870 | 7 | 890 | 1,160 | 1,770 | 540+ | Flour, cutlery, cast goods, furniture, burial-caskets, and paper. |
| Oswego Falls | 12½ | 4,931 | 15 | 1,930 | 2,520 | 3,850 | 3,130+ | All-worsted goods at Oswego Falls; machinery on Fulton side. |
| Fulton | 11¼ | | 16 | 2,050 | 2,690 | 4,110 | | Paper on west side; on Fulton side, flour, paper, machine-knives, and wooden boxes. |
| Battle island | 6¾ | 4,908 | 8 | 1,040 | 1,360 | 2,090 | 00 | |
| Minetto | 4½ | 5,001 | 9 | 1,180 | 1,530 | 2,350 | 60 | Shade-cloth. |
| High dam | 2¾ | 5,009 | 15 | 1,960 | 2,560 | 3,920 | 200 | Power used to pump water for the supply of Oswego. |
| Oswego | 1 | 5,012 | *a* 12½-18 | 1,900 | 2,590 | 3,980 | 2,350+ | Flour, starch, paper, knit underwear, and leather. Power is also used in a number of large grain-elevators and malt-houses. |
| Total for falls as here assumed | | | | 11,040 | 14,410 | 22,070 | 6,280+ | |

*a* See detailed estimate of power at Oswego.

It is generally the case upon this river that the mills are either so clustered about the dams, or are so scattered along below them, that the available supply of water is not used under the full head which might be obtained at the foot of the rapids, and consequently the best effect is not secured. The entire falls given in the above table are, on that account, in many cases not really practicable with the present improvements, and could be realized, with the mills located as now, only by considerable outlays in deepening tail-races and perhaps clearing the river channel at some points. They are approximate only, as data for accurate statements in detail concerning the fall along the river could not be obtained, but they will perhaps serve as a basis for conveying an idea of the gross power which would be afforded with suitable works.

## TRIBUTARIES OF THE OSWEGO RIVER.

### ONEIDA RIVER AND LAKE.

This lake is distant, at the nearest point, between 10 and 12 miles in a northeasterly direction from Syracuse, and is surrounded by the counties of Oswego, Oneida, Madison, and Onondaga. It has a length of 20½ miles, an extreme width of nearly 5½ miles, and a surface area of about 81 square miles. The total tributary drainage area above Brewerton, where the outlet begins, including the lake itself, is 1,300 square miles. The principal tributary streams are Fish, Chittenango, and Oneida creeks, the two latter being drawn upon in part for supplying the Erie canal. A considerable portion of the north shore is high and bluffy, but at other points much of the land immediately bordering the lake is low and even marshy; farther back there is a rise to level or rolling country, fertile, and only moderately timbered. The lake has clear water, a firm bottom composed of gravel and clay, and is quite shallow, the depth being estimated to range in general from 20 or 30 feet downward, and at no point to exceed 60 feet. The surface is said to freeze entirely over, usually by the 1st of January or before, and during the year changes but slightly in level.

The waters of the lake escape through the Oneida river—which by map measurement has a length of about 16 miles—and, pursuing a crooked course between Oswego and Onondaga counties, unite with Seneca river at Three River Point. The elevation of the water-surface of the lake is about 370 feet above mean sea-level, and 123 feet above the average surface of lake Ontario. The fall to the mouth of the Oneida river is only about 8 feet, or an average of say 0.5 foot per mile, and it is evident that the stream has substantially no value for power. Steam-towing navigation is carried on through the river between Syracuse and points on the lake, principally Constantia, Barnard's Bay, Cleveland, and Fish Creek. Lumber, sand, and glass are carried down to Syracuse, and coal, feed, and flour returned.

The Oneida river is bordered by a flat country and has low banks. It runs about 300 feet wide at Caughdenoy, and 240 feet wide at Oak Orchard. Lowest water occurs in August and September, while in April or May there is a spring freshet, with an ordinary rise of 4 or 5 feet at Caughdenoy, and an extreme rise of 6 feet. The stream is also subject to fluctuations due simply to the prevalence of a heavy east or west wind, which, at the locality just mentioned, sometimes amount to a foot in a few hours.

At Brewerton there are said to be rifts, but boats pass through them successfully in the channel. At Canghdenoy, a little village 4 miles by river below, is met the only use of power on the stream. The bed is there gravelly and causes rifts, around which boats pass in a canal a quarter of a mile long. The flow through the rifts is partially obstructed by a succession of 5 or 6 eel-weirs, built of vertical stakes against which are placed boards and piles of loose stone. As these serve to keep up the water-level above for navigation, the state has furnished much of the material for them. They raise the river but a few inches, and can have no very important effect upon the lake. A race perhaps 10 rods long conveys water from the canal to Hart's 4-run grist- and saw-mill. The head obtained is the same as the lift of the canal lock, ranging from 2½ to 3½ feet, according to the stage of water, but is commonly about 3 feet. Five water-wheels are employed, and can be run without trouble nine months in the year, and two or three can be run at all times. At Oak Orchard, 4 miles by river below Caughdenoy, the state has a dam, of horseshoe shape, over which there is a fall of perhaps 4 feet, boats passing through a lock at one side, but no power is utilized.

*Drainage areas.*

| | Square miles. |
|---|---|
| Oneida creek | 128 |
| Chittenango creek | 306 |
| Fish creek | 480 |
| Oneida river at Brewerton, foot of lake | 1,300 |
| Oneida river at mouth | 1,421 |

*Cazenovia lake* is described in French's *Gazetteer of New York* as "a beautiful sheet of water, 4 miles long, 900 feet above tide, and completely surrounded by gradually-sloping hill-sides". It is in the western part of Madison county, and discharges northward into Oneida lake through an outlet—Chittenango creek—which, following its meanderings, is by map measurement about 25½ miles long. The outlet of the lake is from the southern extremity, and there the state has a dam for controlling the storage. The flow over this dam, which is so placed, immediately below the lake outlet, as also to command the waters coming down Chittenango creek from above, including those of the Erieville reservoir,(*a*) passes down the natural channel of the creek for say 9½ miles, and is then diverted by a second state dam, through a feeder half a mile long, to the "long" level of the Erie canal. The fall from the lake to the feeder-dam is rapid and large, amounting to about 470 feet, and at Chittenango Falls, 3¾ miles below the foot of the lake, the stream suddenly plunges 136 feet over a limestone ledge. In the 16 miles, more or less, from the crest of the feeder-dam to Oneida lake, the descent is much less rapid, amounting to but 60 feet, and toward the mouth the course winds through low swampy land. The use of power along the creek is moderate in amount, and is principally confined to a half-dozen flouring- and grist-mills, three paper-mills, and several other establishments of small size.

According to a map of the middle division of the Erie canal with its feeders and reservoirs,(*b*) Cazenovia lake flows a surface area of about 2.8 square miles. Its available storage is placed at 4½ feet over an average area of 1,778 acres, or 348,523,560 cubic feet,(*c*) and the supply from the Chittenango Creek feeder, including the waters from both the Erieville and Cazenovia Lake reservoirs, at 42 cubic feet per second for 100 days.

*Table showing the fall in Chittenango creek.*

| Locality. | Elevation above mean sea-level. | Fall between points. | Distance between points, by map measurement. | Authority for elevations. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Miles.* | |
| Cazenovia lake | 900.00 | 469.53 | 9.5 | French's *Gazetteer of New York*, page 22. |
| Crest of feeder-dam | 430.47 | 60.69 | 16.0 | Elevation assumed the same as that of the "long" level in the Erie canal, which by canal profiles is 428.4 feet above mean low tide at Albany. |
| Mouth of Chittenango creek | 369.78 | | | Level of Oneida lake as indicated by state canal profiles. |

SENECA RIVER AND CONNECTING LAKES.

The Seneca river starts from the foot of the lake bearing the same name, and runs in an easterly direction to Cayuga lake, which it enters a mile or so from its northern extremity; issuing from that lake it flows northerly and then easterly, till at Three-River Point it joins the Oneida river to form the Oswego. By map measurement the total length of the stream from Seneca lake is about 60 miles. Until it reaches Cayuga lake it serves simply as an outlet to the waters of Seneca lake, receiving no accessions of importance from other sources. In this distance it falls 63 feet, the descent being nearly all concentrated at two points—Waterloo, where it amounts to 12 or 14 feet, and

*a* Storage, 21¼ feet depth over an average area of 340 acres=318,423,600 cubic feet.

*b* Accompanying the *Annual Report of the Superintendent of Public Works* for the year ending September 30, 1881.

*c* Page 55, *Annual Report of the State Engineer and Surveyor* for the year ending September 30, 1879.

Seneca Falls, where it is between 45 and 50 feet.(a) At both these places, and especially at the latter, the power furnished by the river sustains a large amount of manufacturing. North of Cayuga lake the river pursues its course among extensive marshes which have been partially drained by artificial means. It receives, successively, Clyde river from the west, and the outlets of Owasco, Skaneateles, and Onondaga lakes from the south. On the boundary between Onondaga and Cayuga counties it spreads out and itself forms Cross lake, some 4 miles long. In the 45 miles, more or less, of river below Cayuga lake the descent is only about 18 feet, and the only use of power is at Baldwinsville, where there is a state dam giving a fall of 8 or 9 feet. The Cayuga and Seneca canal starts from Geneva, at the foot of Seneca lake, and, utilizing the outlet for slack-water navigation except at the falls, descends toward Cayuga lake; before reaching the latter it strikes off to the left, and, crossing to the east side of the river below the lake, continues as an independent canal to Montezuma, where it joins the Erie canal. On Seneca river itself navigation in the lower course is maintained by a side cut around the Baldwinsville dam, and another across the bend at Jack's reefs, a short distance east of Cross lake.

The first dam below Seneca lake is at Waterloo, a village of about 3,900 inhabitants, where the use of hydraulic power dates back to the early part of the century. The state has a low dam of timber here, the navigation canal descending the north bank, while a hydraulic race about 25 feet wide runs down the south bank. Water is drawn by mills from this level through both the canal and the race, and in three cases directly from the pool above the dam. The interests of navigation, of course, take precedence, and if there is a scarcity of water for passing boats the mills must shut down until the level is sufficiently raised. Two or three years ago there was more or less shortage of water during a period of six months. The principal manufacturing concern is the Waterloo Woolen Manufacturing Company, located on the line of the navigation canal in the lower part of the village. Its production comprises shawls and ladies' suitings, and 20 sets of machinery are operated. Water is conveyed to the mills through a branch from the canal, 600 or 800 feet long, which also supplies a saw-mill. The other establishments using water from the level created by the state dam include 5 flouring- and grist-mills with an aggregate of 8 runs of stone and 17 sets of rollers, a saw-mill, and a small organ factory. In the vicinity of the dam a fall of about 9 feet is obtained at the various mills, increasing to 12 feet at the woolen-mill.

Half or three-quarters of a mile below the state dam is a private dam, a low, rude, and very leaky structure running out from each bank to an island. A race runs down the latter to a distillery, and on the north main bank there is a turning-shop and a wagon-wheel factory. The fall realized is only about 3 feet, steam is mainly employed, and the water-power has but little attention.

Seneca Falls, 3 miles below Waterloo, is an important manufacturing village of 5,900 inhabitants. The river is there 70 or 80 feet wide where running freely, and in the four falls occurring at the village descends from 45 to 50 feet. Canal-boats make the passage in a canal which follows down the right bank. The demands for lockage and the naturally lessened supply of water in the summer season cause a shortage for manufacturing purposes, commonly lasting for from 2 to 4 months, but which has continued in at least one exceptional instance for 6 months. The land bordering the stream is quite closely built up, except at the lowest fall, and there the power, though unemployed, is not large.

Water for manufacturing-purposes enters the upper level over a stone weir, which is simply a continuation across the stream of the river-wall of the navigation canal, and is confined below the weir by a dam a short distance down stream, its crest perhaps a foot lower than that of the weir. By this means an undue drawing down of the upper pool is prevented. On the south bank are the large Phœnix woolen-mills, now idle. They are entitled to half the surplus flow of the river above the needs of navigation, receive it, when in operation, over a weir wall acting in the same manner as the one already noticed, and discharge tail-water back into the stream under the navigation canal, which runs between. On the north bank are half a dozen establishments of small and moderate size, located opposite the basin which is formed between the weir first described and the dam, and discharging into a covered tail-race which runs along under them and empties just below the dam. The heads actually in use range from 6 or 8 up to 15 feet, which may be considered as about the full fall of the privilege.

A dam 300 feet farther down stream creates the second level, from which water is drawn on the north bank for several small printing-press and other powers; and on the south bank, through a race, to supply a flouring-mill and three other important manufacturing concerns. The falls used on this level are from 12 to 14 feet.

For the third level, water is diverted by a low dam into a race on the north bank, which it enters over a stone weir. On this race are several mills and shops, of which the Silsby works are the largest, and falls ranging from 8 to 10 feet are obtained. The waste over the dam joins the navigation canal, and the basin thus formed is confined farther down by a spill-way, the overflow of which descends into the fourth level. All the land on the south bank opposite the third fall, securing half the flow of the stream, is owned by Mr. John A. Rumsey. The only use of power, however, on that side is by Rumsey & Co., who draw their supply from the navigation canal.

For the fourth level, the dam, in the pool of which the navigation canal crosses, has a fall of perhaps 2½ feet without or 4½ feet with flash-boards such as were found in place, but no power is utilized.

a The fall at these points could not be learned with accuracy, but the figures given are considered to be very near the truth.

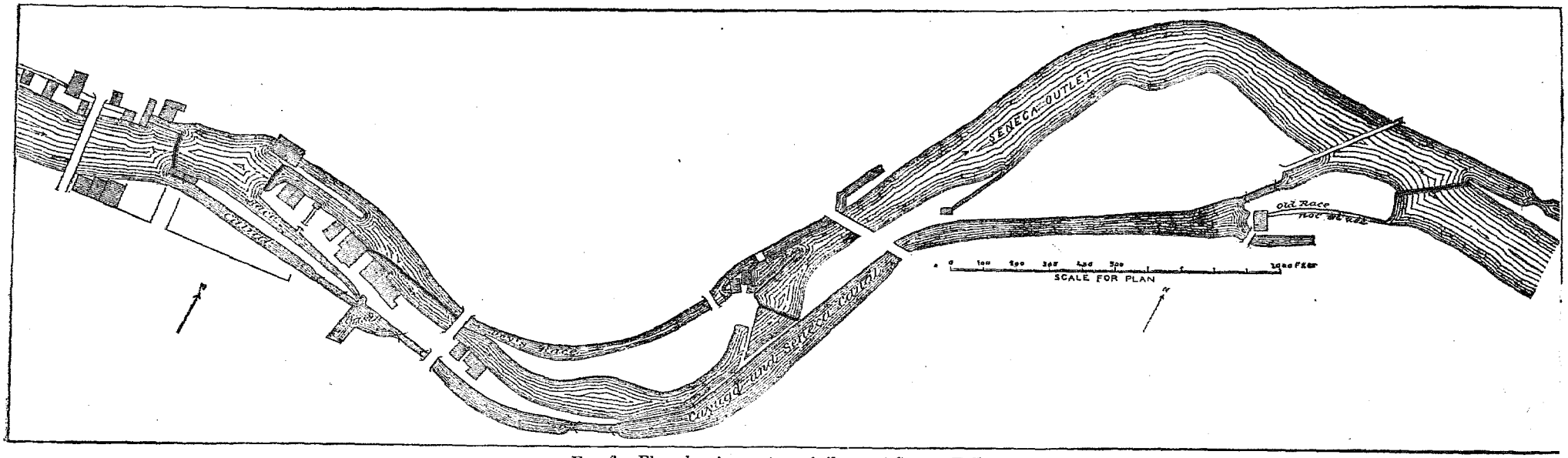


FIG. 6.—Plan showing water-privileges at Seneca Falls.

*Data concerning manufacturing by water-power at Seneca Falls.*

| Level. | Firm. | Kind of mill or manufacture. | Remarks. |
|---|---|---|---|
| First or upper level | Phœnix Mills | Woolen goods | Large mill; not running. |
| Do | City Mills | Wooden ware | Employ 30 hands. |
| Do | Shoemaker, Daniels, & Co | Flouring- and custom-mill | 4 runs of stone. |
| Do | Westcott Brothers | Table-mats | Employ 18 hands. |
| Do | | Two small saw-mills and an advertising concern. | |
| Second level | Cowing & Gleason Manufacturing Company. | Pumps and other iron goods | Uses 3 wheels of about 40 horse-power each. |
| Do | Gleason Knitting Company | Knit underwear | 20 sets of machinery. |
| Do | Roberts & Briggs | Flouring-mill | 3 runs of stone, 6 sets of rollers; 80 barrels, daily production. |
| Do | Goulds Manufacturing Company | Iron pumps and hydraulic machinery | Employs from 275 to 300 hands; uses from 14 to 16 tons of iron per day. |
| Do | Several small powers used on the north bank. | | |
| Third level | Silsby Manufacturing Company | Steam fire-engines, hose-carriages, and force-pumps. | Employs about 200 hands. |
| Do | Seneca Manufacturing Company | Scroll-saws, vises, and mill-castings | Employs 25 hands. |
| Do | J. F. Dalrymple | Custom- and flouring-mill | 4 runs of stone. |
| Do | Charles Chamberlain | Flouring-mill | 6 runs of stone. |
| Do | Rumsey & Co | Pumping- and fire-engines | Value of annual production, from $200,000 to $400,000. |

There yet remains considerable available power at this point. On the upper level, as has been noticed, is the large Phœnix woolen-mill privilege, not in use; and on the opposite side of the river is a good site where a mill was burned. At the second fall it is possible that small powers could be rented in the block on the north bank. On the third level an important power belonging to Mr. Rumsey can be utilized for manufacturing, and the fourth or last fall in the village is entirely unimproved.

*Estimate of power at Waterloo and Seneca Falls.*

| Locality. | Drainage area. | Assumed fall. | Assumed flow per second, average for the 24 hours, ordinary low stage.(a) | Theoretical horse-power. | | Effective horse-power of wheels in use. |
|---|---|---|---|---|---|---|
| | | | | Per foot fall. | Total fall. | |
| | *Sq. miles.* | *Feet.* | *Cubic feet.* | | | |
| Waterloo | 745 | 12 | 275 | 31.2 | 374 | 758 |
| Seneca Falls | 771 | 49 | 275 | 31.2 | 1,529 | 1,090 |

a No record of actual measurements of the volume is found, but on page 68 of the *Annual Report of the State Engineer and Surveyor* for the year ending September 30, 1879, the supply available from Seneca lake is stated at 300 cubic feet per second, which it is judged may safely be relied upon throughout the greater part, if not the whole, of an average year. Allowing as much as 25 cubic feet per second for lockage, there will remain say 275 cubic feet available for power. For 9 or 10 months in the year a considerably larger discharge would doubtless be available.

The only other use of power on the entire river is at Baldwinsville, a place having a population of 2,100, and located about 12 miles from the mouth. The stream is there 250 feet wide, with gravelly bed and rather low banks. The dam runs across straight, with the exception of an offset up stream next the right bank. It is owned by the state, and is a crib-work structure, with stone filling, the face and back slope planked. The fall over it is 8 or 9 feet, without flash-boards, and about that amount of head is obtained at most of the mills. On the right bank, water for power is conveyed in a race 50 or 60 feet wide. The privilege along this race has hitherto been roughly subdivided into runs of stone and saws, but in the fall of 1882 a friendly suit was in progress to determine accurately the amounts of water belonging to the various owners. On the left bank the side-cut for boats passes around the dam and rifts, and all the mills, with one exception, draw water from it and discharge into the river.

*Data concerning manufacturing by water-power at Baldwinsville.*

| Firm. | Kind of mill or manufacture. | Remarks. |
|---|---|---|
| On north race: | | |
| Schoonmaker & Co | Straw wrapping-paper | |
| G. H. & A. T. Houghtaling | Flouring-mill | 10 sets of rollers; capacity of mill, 200 barrels per day; 6 water-wheels, each of about 20 horse-power. |
| Clark, Mercer, & Co | Custom- and merchant-mill | 5 runs of stone. |
| E. Allen | Wagon-shop | Employs 12 or 15 hands. |
| Draw from pond: | | |
| Young & Frazee | Steel goods—forks, rakes, hoes, etc. | Use 2 wheels, each of 25 horse-power; employ 25 hands, and manufacture 15,000 dozen articles per year. |

*Data concerning manufacturing by water-power at Baldwinsville*—Continued.

| Firm. | Kind of mill or manufacture. | Remarks. |
|---|---|---|
| Draw from canal side-cut: | | |
| Frazee & Ducker | Saw- and planing-mill | 4 circular saws. |
| J. C. Miller & Co | Knit underwear | Run 7 sets of machinery and employ about 100 hands; 9 feet fall; 2 wheels, with aggregate of about 100 horse-power. |
| Jacob Amos & Sons | Flouring- and pearl-barley mill | 4 runs of stone; 13 sets of rollers; capacity of mill, 250 barrels of flour per day; 12 feet fall; 8 wheels of 20 or 25 horse-power each. |
| James Frazee | Flouring-mill | 14 sets of rollers. |
| William L. Wickins | Grist-mill | 4 runs of stone. |
| Fuller & Bliss | Sashes, doors, and blinds | Employ 35 hands. |
| Heald & Morris | Pumps and engines | Employ 50 hands; transfer power 150 or 200 feet by cable from tower over wheel-pit. |

Full advantage is not taken in all cases of the available fall, but with the present wheels and manner of development there is no opportunity for further obtaining permanent power. The state has the first right to water, and in low stages of the river the mills are frequently shut down temporarily, so as to bring up the level in the pool and canal and permit boats to pass. There was such a stoppage at the time this privilege was visited, December 1, 1882, and for two months during the summer more or less trouble is generally experienced by the mills, owing to a scarcity of water. Anchor-ice sometimes clogs the river below, raising the level at this point, and on one occasion has brought it up to the top of the dam. Spring high-water also causes some annoyance by reducing the head at the mills.

*Estimate of power at Baldwinsville.*

| Stage of river. | Rainfall on basin. | | | | | Drainage area, gross. | Flow per second, average for the 24 hours. | Theoretical horse-power. | | Effective horse-power of wheels in use. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Spring. | Summer. | Autumn. | Winter. | Year. | | | 1 *foot fall.* | 9 *feet fall.* | |
| | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Sq. miles.* | *Cubic feet.* | | | |
| Low water, dry year | 8½ | 9½ | 9 | 6½ | 33½ | *a* 3,136 | 800 | 90.9 | 820 | 953+ |
| Low water, average year | | | | | | | 1,000 | 113.6 | 1,020 | |
| Available 10 months, average year | | | | | | | 1,500 | 170.4 | 1,530 | |

*a* Of which about 370 square miles is more or less completely utilized in the dry season for feeding the Erie canal.

*Seneca lake.*—This beautiful sheet of water lies between the counties of Seneca on the east, and Ontario and Yates on the west, and at the southern extremity projects half-way across Schuyler county. As shown on French's map, it is 34 miles long and varies in width from 1 mile to 2½ miles. It has a surface area of about 66 square miles, and a total drainage area above its outlet of 707 square miles. Of this area, 94 square miles belongs to Catharine's creek, which empties at the head of the lake, and 213 square miles to Keuka lake and outlet. Seneca lake is 196½ feet above lake Ontario, and 443 feet above sea-level. The surface is 2 feet lower than formerly, having been artificially reduced in level by that amount years ago. The ordinary range between high and low water is from 2 to 2½ feet, with an extreme of 4 or 5 feet. Temporary oscillations, amounting to perhaps a foot or two, are also occasioned by unusually strong winds blowing up or down the lake. A gentleman long familiar with both Seneca and Cayuga lakes states that he has frequently observed strong currents setting sometimes up their courses and sometimes down, and even in opposite directions at one time on different sides of the same lake. A tidal oscillation is also claimed for this lake, and Mr. Franklin Gage, of Waterloo, a gentleman whose duties in connection with the Cayuga and Seneca canal have led to long-continued and careful observations of the lake-level, confidently maintains that there is a tidal rise of about 6 inches, and states that it has been found impossible to run a line of levels from the lake to the Waterloo dam and check successfully, without making allowance for the change of surface going on during the leveling. It is not to be doubted that there may be a frequent, and even for considerable periods a regular, ebb and flow in the lake waters, but it is hardly to be conceived that there should be an appreciable tide, properly so called; and it seems not improbable that the explanation of the changes of level may lie in the fact, which has been observed, that, during portions of the year at least, there is commonly a south wind on the lake in the forenoon and a north wind in the afternoon.

The scenery upon this lake and from the surrounding heights is most charming. At the northern end the banks are comparatively low, but advancing southward they become high and steep; thence eastward from the lake there is a gradual rise by smooth fertile slopes to the summit of a ridge which separates Seneca and Cayuga lakes, and which near their head attains an altitude of 700 or 800 feet above the water. The lake is thus seen to occupy a long, narrow, and deep depression among the hills, the depth of which would appear twice as great were the water removed. The bottom is said to be composed of gravel and rock, while the sides are frequently precipitous masses of solid rock. In 1880 an accurate survey of the lake by the engineering students of Cornell university was in progress, and by the kindness of Professor C. L. Crandall the following results of soundings were furnished to the author:

*Depths of Seneca lake.*

| | Feet. |
|---|---|
| Four miles south of Geneva | 250 |
| Eight miles south of Geneva (off Dey's Landing) | 430 |
| Twelve miles south of Geneva (off Dresden, or opposite the inlet from Keuka lake) | 500 |
| Eighteen miles south of Geneva (off Lodi Landing) | 580 |

The lake is navigable throughout the year, for it is only in remarkably cold seasons that it even becomes skimmed over with ice, except near the foot, and there it freezes but slightly. Canal-boats descend from Elmira through the Chemung canal and are towed down the lake by steam-tugs to Geneva, where they connect with the Cayuga and Seneca canal.

*Drainage areas—Seneca lake and river.*

| | Square miles. | | Square miles. |
|---|---|---|---|
| Catharine's creek at entrance into lake | 94 | Seneca river below Cayuga lake | 1,593 |
| Keuka lake and outlet | 213 | Seneca river at Montezuma | 2,472 |
| Total at head of Seneca outlet or river | 707 | Seneca river at Jack's reefs | 3,080 |
| Seneca river at Waterloo | 745 | Seneca river at Baldwinsville | 3,136 |
| Seneca river at Seneca Falls | 771 | Seneca river at junction with Oneida river | 3,447 |
| Seneca river at entrance to Cayuga lake | 780 | | |

*Keuka* or *Crooked lake*(*a*) lies a little to the westward of Seneca lake, with which it is connected by an outlet 6 or 8 miles long, having a fall of 277 feet. There is a dam at the head of this outlet, and the course of the latter was formerly followed by the Crooked Lake canal; but this has been abandoned, and navigation is now confined to the lake, where in 1880 five steamers were engaged in carrying passengers during the summer, and also in transporting a considerable amount of freight, consisting mainly of wine and grapes, which are largely produced upon the banks.

Keuka lake has an extreme length, measured from Penn Yan to Hammondsport, of 19¼ miles, and varies in general in width from half a mile to nearly a mile and a quarter. On the west, from somewhat south of the middle part of its course, an arm extends 14 miles due north. The area of water-surface is about 20 square miles, the drainage area at the head of the outlet is 187 square miles, and at the point where the outlet enters Seneca lake it is 213 square miles. The shores of the lake are abrupt and hilly, being low only near its foot. The surrounding country rises from 500 to 800 feet above the water-surface, and is quite bare of timber, though once well wooded. At the point where the two northern branches of the lake come together a bluff rises steeply, and attaining a height of 400 feet is continued northward in a ridge. The lake bottom has generally the character of a deposit, but in the deeper portions is thought to be composed of rock; it has quite an even grade, with few abrupt descents. As stated by Mr. George R. Youngs, of Penn Yan, who has devoted much study and observation to Keuka lake, the depth gradually increases from the foot, and at a distance of three-quarters of a mile is about 40 feet; at a distance of 1 mile, 100 feet; and for a distance of from 1½ mile to 12 miles, about 140 feet. Along the west branch the depth ranges from 200 to 250 feet, and from Bluff Point, where the branches unite, to the head of the lake, about 7½ miles, the average depth is more than 200 feet.

This lake is 473½ feet above lake Ontario and 720 feet above ocean-level. Its surface is but little affected in elevation by continued strong winds, and no phenomena of the nature of tides, such as are claimed for Seneca and Skaneateles lakes, have ever been observed, so far as known. There is an annual variation from high to low water of 5 or 6 feet, and the very unusual range of 9 feet has been recorded. High water is reached in April, or occasionally later, while the lowest stage is generally attained in December. Unlike Seneca and Cayuga lakes, Keuka lake commonly freezes over in winter.

According to the enumerators' returns, the use of water-power on the outlet was in 1880 confined to six flouring and grist-mills, employing an aggregate fall of 63½ feet and 420 horse-power of wheels. An estimate is given below of the theoretical power for the entire fall in the outlet, based upon the assumed average discharge from the lake:

*Estimated power of Keuka outlet.*

| Assumed stage of water. | RAINFALL ON BASIN. | | | | | Drainage area at head of outlet. | Mean flow for the year per second, average for the 24 hours. (*b*) | Theoretical horse-power.(*c*) | | Effective horse-power of wheels in use. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Spring. | Summer. | Autumn. | Winter. | Year. | | | 1 *foot fall.* | 277 *feet fall.* | |
| Average discharge in a series of years | *Inches.* 7⅓ | *Inches.* 9⅓ | *Inches.* 8 | *Inches.* 5½ | *Inches.* 30⅓ | *Sq. miles.* 187 | *Cubic feet.* 100 | 21.58 | 5,980 | 420 |

*a* For much of the general information concerning this lake thanks are due to Mr. F. M. Collin, of Penn Yan.

*b* Of course this assumption can not be realized—*i. e.*, the flow maintained with uniformity throughout the year—unless there is a proper control exercised at the outlet; otherwise the natural discharge will gradually decline from spring till winter, being part of the year probably above, and part below, the amount here estimated. By concentration within 12 hours per day the flow could be doubled.

*c* With good wheels, from 60 to 80 per cent. of the theoretical power is available for work.

*Cayuga lake* lies some 10 miles to the eastward of Seneca lake, to which it bears a strong resemblance, and is at an elevation 63 feet less, or, in other words, 133½ feet above lake Ontario and 380 feet above mean sea-level. Aside from Seneca river, which empties into it near the foot, its principal tributary streams are Cayuga inlet and Fall creek at its head, Salmon creek on the east, and Taughanick creek on the west. The total drainage area of the lake at its foot, independent of Seneca river, is 813 square miles. The lake is utilized for steam-towing navigation, and in the deeper portion, including the greater part of its surface, is always free from ice; but the shallow section, extending 9 or 10 miles from the foot, is regularly frozen over as far as between Springport and Aurora. The ordinary change in level from low to high water is 3 feet, with an extreme range of 7 feet. Near the outlet the banks are low, but ascending the lake they grow abrupt and rocky, and are succeeded by easy but continuous ascents, cleared and cultivated, to the summits of hills several hundred feet in height above the water.

Cayuga lake has been carefully triangulated, sounded, and mapped by the engineering students of Cornell university. From the data thus obtained it appears that the lake has a length of about 37½ miles, and a width of from a mile to a mile and a quarter near the head, increasing in the widest part, opposite Aurora, two-thirds of the way down its course, to very nearly 3½ miles. The area of its surface is 66¾ square miles. The greatest depth obtained by soundings was 435 feet, 15½ miles from the head. Following down the center line of the lake the depth is at first shallow, not exceeding about 25 feet for the first mile; it then increases rapidly and reaches 200 feet at 1¾ mile from the head, 300 feet at 3¼ miles, and 400 feet at 6⅛ miles; it then ranges between 350 and 435 feet for the succeeding 16 miles. Opposite Aurora the depth is still from 300 to 340 feet toward the west shore, but in the next 5 miles rapidly decreases to 100 feet or less, and in the remaining 9 or 10 miles to the outlet is under 50 feet, and most of the way under 20 feet. Depths of from 50 to 100 feet, and even more, are common close to the shores in the upper part of the lake, and soundings of 200 and 300 feet and upward are recorded within 1,000 or 1,500 feet of the shores.

*Drainage areas—Cayuga lake and tributaries.*

| | Square miles. |
|---|---|
| Taughanick creek at mouth | 60 |
| Salmon creek at mouth | 90 |
| Fall creek, not including Cascadilla creek | 152 |
| Cayuga inlet, including Cascadilla creek | 173 |
| Total, Cayuga lake at outlet, not including Seneca river | 813 |
| Total, Cayuga lake at outlet, including Seneca river | 1,593 |

*Canandaigua lake* lies mainly in Ontario county, though bordering partly on Yates. It is about 15 miles long, and 1⅜ mile wide in the broadest part. The surface area is between 18 and 19 square miles, and the drainage area at the head of the outlet is 175 square miles. The principal tributary stream is Canandaigua inlet, draining 85 square miles. There is no marshy land along this lake. The shores are generally succeeded by a uniform rise to high hills, but toward the head of the lake become frequently abrupt and rocky. The surrounding country is rich farming land, and at the upper end of the lake there is considerable timber. The water depth is rather shallow toward the head and foot, ranging say from 10 to 30 feet, but a gentleman well acquainted with the lake estimated it to be elsewhere as great as 150 feet. The bed is variously composed of clay, gravel, and rock, and has usually a gradual slope, though there are in places very steep pitches. The surface commonly freezes over in part only. There is no canal-boat navigation upon or in connection with this lake, but some freight is transported over it in steamers. The altitude of the water-surface is given in French's *Gazetteer* and elsewhere as 668 feet above tide, but by the profile of the Northern Central railroad, which crosses the outlet at Canandaigua, ordinary low water in the stream is 687.5 feet above mean ocean-level, and in the absence of other data the lake-surface may be assumed to have at least that elevation.

*Table showing approximately the fall in Canandaigua outlet and Clyde river.*

| Locality. | Elevation of water-surface above mean sea-level. | Distance between points, by map measurement. | Fall between points. | Remarks. |
|---|---|---|---|---|
| | *Feet.* | *Miles.* | *Feet.* | |
| Canandaigua lake | 687.5 | | | Elevation assumed to be the same as in outlet at Northern Central Railroad crossing. |
| Canandaigua outlet at head, where crossed by Northern Central railroad. | 687.5 | 20 | 287.5 | Ordinary low water, by Northern Central Railroad profile. |
| Canandaigua outlet at Lyons (mouth). | 400.0 | 22 | 20.0 | 400 feet assumed as approximately correct. The New York Central and Hudson River railroad crosses near the mouth, and the rails are stated to be 410 feet above sea-level. |
| Clyde river at mouth | 380.0 | | | Elevation assumed to be the same as that of Cayuga lake. |

The Canandaigua outlet pursues a winding course, first to the northward, then to the eastward, and then northerly again, to Lyons, descending in the interval about 287 feet, and passing successively through the towns of Canandaigua, Hopewell, Manchester, Phelps, and Lyons. It has a length of about 30 miles by map measurement, and at the village of Lyons unites with Mud creek, which drains a section to the westward, to form the Clyde river. The latter flows with a general southeasterly trend, including two right-angled bends, for a distance by river of at least 22 miles, and unites with the Seneca river 3 miles below the foot of Cayuga lake. Its slope is small, the entire descent from Lyons amounting to but about 20 feet. Manufacturing by water-power is carried on at various points along Canandaigua outlet, more especially in the towns of Manchester and Phelps, where there are numerous flouring-, grist-, and saw-mills, and establishments for making agricultural implements, carriage and wagon materials, paper, and fertilizers. At other localities along the stream the principal use of power is by flouring- and grist-mills.

*Estimated power per foot of fall at head of Canandaigua outlet.*

| Assumed stage of water. | RAINFALL ON BASIN. | | | | | Drainage area. | Mean flow for the year per second, average for the 24 hours.(a) | Corresponding theoretical horse-power per foot of fall. |
|---|---|---|---|---|---|---|---|---|
| | Spring. | Summer. | Autumn. | Winter. | Year. | | | |
| | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Sq. miles.* | *Cubic feet.* | |
| Average discharge in a series of years | 9 | 10 | 9 | 7½ | 35½ | 175 | 210 | 23.86 |

a In practice the flow could be maintained uniformly at this figure only by a suitable control at the outlet from the lake; otherwise there would be a gradual decline during the year from a higher to a lower discharge than here given. Of course, for twelve hours in the day the flow could be doubled from the estimate given, assuming that to be correct.

*Drainage areas—Clyde river and tributaries.*

| | Square miles. |
|---|---|
| Canandaigua inlet | 85 |
| Canandaigua lake at head of outlet | 175 |
| Canandaigua outlet at Manchester | 211 |
| Canandaigua outlet at Phelps | 390 |
| Canandaigua outlet at Lyons, mouth of outlet | 431 |
| Mud creek at Lyons | 298 |
| Clyde river at Lyons, junction of Canandaigua outlet and Mud creek | 729 |
| Clyde river at Clyde | 807 |
| Clyde river at mouth | 869 |

*Owasco lake* lies in the southern part of Cayuga county, and discharges northward through an outlet 15 miles long to Seneca river. It has a length of 11¼ miles, a width of nearly a mile and a half in the broadest part, and flows an area of about 12.4 square miles. At the head it receives Owasco inlet, draining 120 square miles, and itself commands, at the head of the outlet and including its own surface, a tributary area of about 208 square miles. The country bordering the foot of the lake is flat, while elsewhere the immediate shores generally display a narrow strip of level land, succeeded by an easy uniform slope upward to highlands, rising toward the head of the lake from 1,000 to 1,200 feet above tide, though in places precipitous bluffs approach close to the water. This region has been mainly denuded of its timber, but has a fertile soil and is well suited either to the raising of grains or to pasturage.

The bottom of the lake is largely covered with sand and the shores are gravelly. The water is shallow toward the head and foot, but attains considerable depth elsewhere, though no information was gained of any soundings. Its supply is derived in part from the surface-drainage of its basin, and also in large part from springs, which may extend the effective drainage area beyond the limits which are apparent on the surface. Thus there is a common belief, though it is uncertain what special foundation exists for it, that there is an underground connection between Owasco and Cayuga lake, 8 or 10 miles westward.

Owasco lake freezes entirely over in winter, though not commonly until February, and remains closed into March. Thick ice usually forms in the outlet before the lake becomes frozen, but as soon as the latter freezes its waters seem to grow warmer and the ice in the outlet disappears, or, at the most, only a thin sheet remains. The surface of the lake was raised artificially years ago and the flowage increased by probably from 300 to 500 acres to the present amount. At the same time a new and much straighter channel was made for the outlet near the lake; but southerly storms have filled this considerably with sand, to the injury, it is said, of the powers along the stream below. The water-surface is subject to an annual variation of about 5 feet between high and low water. It is also liable to temporary changes in level of 6 or 8 inches, due to winds, and even of a foot or more in a short time when a north or south wind is followed by the opposite.

*Table showing approximately the fall in Owasco outlet.*

| Locality. | Elevation above mean sea-level. | Fall between points. | Distance between points, map measurement. | Fall per mile between points. | Authority for elevation. |
|---|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Miles.* | *Feet.* | |
| Owasco lake | 707 | 302 | 9.2 | 32.8 | Elevation as given by E. F. Swart, chief engineer of Southern Central railroad. Shown by an old survey. |
| Owasco outlet, crest of state feeder-dam | 405 | 15 | 2.8 | 5.4 | Elevation assumed the same as that of Port Byron level of Erie canal = 402.988 feet + mean low tide at Albany. |
| Owasco outlet, New York Central and Hudson River Railroad crossing below Port Byron. | 390 | 13 | 1.9 | 6.8 | New York Central and Hudson River Railroad profile. Elevation estimated from grade of track at crossing, elevation of latter being 402.06 feet. |
| Mouth of outlet | 377 | | | | Estimated from elevation of Cayuga lake. |

As shown in the foregoing table, there is a total descent of about 330 feet in the 14 miles from Owasco lake to the Seneca river. There are a number of small powers employed at Port Byron, but by far the most important use of the outlet is at the city of Auburn. This place is distant about 2½ miles from the foot of the lake, has a population of 22,000, and is the site of a large amount of manufacturing, partially supported by water-power. At the head of the outlet the state has a dam for controlling the storage of the lake. On the privilege thus developed there is a fall of 16 feet, and in a full stage of water 500 horse-power is utilized by the Auburn water-works; there is also a saw-mill on this fall entitled to four-ninths of the water. Passing down through the city there is a succession of dams, with usually two or three, and often more, establishments grouped around a single fall. Many of the concerns are of important size, and especially to be noticed are the extensive mowing- and reaping-machine works of Messrs. D. M. Osborne & Co., and the Auburn woolen-mill; the latter has a fall of 22 feet and a large pondage. Power is also employed at the state prison and at various mills and factories other than those already mentioned, the manufactures comprising a variety of agricultural implements, flour, woolen goods, tools, axles, scythes, wringers, carpets, starch, lumber, cast goods, patterns, sashes and blinds, and other articles.

There are numerous privileges where in high water there is more or less surplus power, but there is stated to be probably no unoccupied fall of importance at Auburn. Although some of the manufacturing concerns on the stream at this locality are very extensive, they invariably rely largely upon steam for motive power, and it is estimated that, in general, full capacity of the wheels in place can be realized only five or six months in the year.

The available storage of Owasco lake is estimated at 1,481,040,000 cubic feet.(*a*) Some 7 miles below Auburn the state has a second dam across the outlet, and through a feeder 4 miles or more in length so much of the water as is needed is conveyed to the Port Byron level of the Erie canal, the latter crossing the outlet on an aqueduct. The supply of water obtained in this manner, average for an assumed period of 220 days of canal navigation, is estimated as about 100 cubic feet per second,(*b*) as follows:

| | Cubic feet per second. |
|---|---|
| Owasco Creek feeder, natural flow | 67 |
| Owasco Lake reservoir | 33 |

It is stated, however, that an increased supply can readily be obtained from the lake, as a large surplus now wastes over the Port Byron feeder-dam.

*Drainage areas—Owasco outlet.*

| | Square miles. |
|---|---|
| Owasco inlet | 120 |
| Owasco lake at head of outlet | 208 |
| Owasco outlet at Auburn | 212 |
| Owasco outlet at mouth | 230 |

*Skaneateles lake* lies in the southwestern part of Onondaga county, bordering for about one-half its length upon Cayuga county to the westward. It has a length varying, according to different authorities, from about 13 to between 15 and 16 miles, and an extreme width of from 1¼ to 1½ mile. As shown on French's map of New York state, the flowage is a little over 15 square miles, or say from 9,600 to 9,700 acres. The drainage area at the foot of the lake, or head of the outlet, is 84 square miles, including the lake-surface, and 117 square miles at the mouth of the outlet. The altitude of the lake is stated as 860¼ feet above tide.(*c*) Its drainage basin is quite contracted, the water-shed line seldom departing more than a mile and a half from the banks, except southeast of the head of the lake, where it recedes to a distance of nearly 5 miles. There is no marshy land bordering the lake; on the

*a* Five feet depth on a mean area of 6,800 acres. See page 55, *Annual Report of the State Engineer and Surveyor* for the year ending September 30, 1879.

*b* Sub-report by Marvin Porter, division engineer, page 92 of above report by state engineer.

*c* French's *Gazetteer of New York*, page 487.

contrary, there is a steady rise to high hills, and toward the southern extremity the banks ascend precipitously several hundred feet, forming very wild and beautiful scenery. The adjoining land is well suited to farming on the west shore for say 7 miles from the foot and on the east to within 4 miles of the head of the lake. A moderate amount of timber is yet standing in this section.

Much of the supply of Skaneateles lake is derived from hidden springs, and its waters are very clear and pure. The surface freezes over by the middle of January, and remains frozen until April. The depth near the outlet is small, ranging from 10 to 30 feet, perhaps, but the bottom then suddenly falls away 50 feet or more. The greatest depth is found south of Borodino, which is about half way up the lake, the deepest sounding being 320 feet. The same phenomenon is noticed here which has been mentioned in connection with Seneca lake. Mr. S. D. Conover, of Skaneateles, who has for years regularly recorded the level of the lake, is firmly convinced, and states it as the general opinion among people in this vicinity, that the lake is subject to tides like those in the ocean. They occur throughout the year, and the time of high tide varies from day to day; but whether or not it varies according to any uniform law, Mr. Conover was unable to say. He considers that these movements can not be due to winds, for they are noticeable when there is no wind, and he has himself observed a change of 4 inches in level in a perfectly calm day. Besides these regularly-recurring oscillations there are others, plainly due to storms and wind. The lake has been known to recede 9 inches in an hour, after a heavy thunder-storm, and there are sometimes several changes or pulsations in an hour.

The following table shows the highest and lowest water levels in each year from 1870 to 1880, referred to extreme high-water mark. In 1878 there was a rise of level of 1½ inch after a three days' rain. In 1877, from March 9 to March 13, the lake rose 7 inches; and from March 13 to April 3 it rose 13 inches. In general, lowest water is reached toward the close of the year, while the highest stage occurs in spring or early summer:

*Record of high and low water in Skaneateles lake, during each year from* 1870 *to* 1880, *as kept by Mr. S. D. Conover, of Skaneateles village.*

[Levels are referred to extreme high water=zero.]

| Year. | High water. | | Low water. | | Year. | High water. | | Low water. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Ft. In. | | Ft. In. | | | Ft. In. | | Ft. In. |
| 1870 | May 23 | 0 0 | December 5 | —4 6½ | 1875 | April 22 | —2 2 | December 22 | —5 4½ |
| 1871 | May 10 | —3 2½ | February 21 | —5 7 | 1876 | June 26 | —0 4 | December 19 | —3 8½ |
| | | | November 15 | —6 6½ | 1877 | April 30 | —1 3 | December 14 | —5 0 |
| 1872 | June 27 | —3 6½ | February 24 | —7 0 | 1878 | May 6 | —2 2½ | November 18 | —4 7½ |
| 1873 | May 12 | —0 6½ | March 17 | —4 11 | 1879 | May 8 | —0 3½ | December 1 | —3 6 |
| 1874 | July 1 | 0 0 | December 29 | —3 6 | 1880 | April 20 | —2 5 | October *a* 11 | —4 11 |

*a* Last record obtained.

The surplus waters of the lake are discharged through Skaneateles creek or outlet, running about 13 miles northward to the Seneca river and lying mainly in the towns of Skaneateles and Elbridge. The fall from the lake to Seneca river is in the neighborhood of 485 feet, and with the supply of water at command gives a steady, and, in the aggregate, important amount of power, which already has been largely put to use. In 1880 there were above Skaneateles Junction, which is between 5 and 6 miles from the lake, 3 flouring- and grist-mills, 4 paper-mills, 2 woolen-mills, and a vacant site where another had been burned, a chair factory, a rolling-mill (not in operation), a pulp-mill, a machine-shop and foundery, an establishment for making water-lime, and a distillery; besides numerous mills and shops farther down the stream, for the manufacture of flour, machinery, paper, and various articles in wood.

There yet remain many unimproved sites along the outlet, which it is the general desire to see developed, and which are said to be held at very reasonable prices. The locality is convenient of access, and on account of the small size and rocky bed of the outlet, and the steady flow and immunity from freshets secured by the lake, the privileges may be securely and yet cheaply improved. The Skaneateles railroad follows the outlet about half way down its course, from the foot of the lake to the New York Central railroad (Auburn line), and the direct line of the latter road also crosses the stream between 1 and 2 miles from its mouth.

The waters of the lake and outlet, besides being employed for power in manufacturing, are utilized by the state for feeding the Erie canal. In order to control the storage in the lake a dam is maintained at the head of the outlet. The flow over this dam passes down the natural channel of the stream, being used at the mills on its way, and about 2½ miles from the mouth is diverted by a second state dam into a short feeder running to the Jordan level of the Erie canal. The state could so regulate the flow from the lake as to shut off for a time the supply from the mills; it is not done, however, in practice, and if it were, a liability for damages would be created, it is claimed, as the manufacturers consider that they are entitled to the benefit of the natural flow. It is stated that the lake can be drawn down as much as 8 feet from extreme high-water line, but the common estimate of available

storage for canal purposes is a depth of 6 feet for an average area of 8,320 acres, or 2,174,515,200 cubic feet.(a) The supply that may be relied upon from this lake and outlet for a period of 120 days is reckoned as about 146 cubic feet per second.(b)

*Table showing the fall in Skaneateles creek.*

| Locality. | Elevation above mean sea-level. | Fall between points. | Distance between points, by map measurement. | Authority for elevation. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Miles.* | |
| Skaneateles lake | 860.25 | | | French's *Gazetteer of New York.* |
| | | 449.61 | 11.7 | |
| Crest of feeder dam | 410.64 | | | Elevation assumed the same as that of Jordan level of Erie canal = 408.568 feet + mean low tide at Albany. |
| | | 28.64 | | |
| Water-surface at Jordan crossing of New York Central railroad | 382.00 | | 1.5 | Elevation estimated from New York Central Railroad profile, grade of track at crossing being 392.07 feet + ocean-level. |
| | | 7.00 | | |
| Mouth of creek | 375.00 | | | Elevation estimated from that of Cayuga lake. |

*Onondaga lake* lies in the northern central part of Onondaga county, immediately to the northwest of Syracuse, and empties northward into Seneca river through a state ditch less than half a mile long. It has a surface of approximately 4.1 square miles, an extreme length of between 4 and 4½ miles, and is perhaps 1¼ mile wide in the broadest part. The principal tributaries are Onondaga creek, draining 118 square miles, and Nine-Mile creek, 100 square miles; while the total area of the drainage basin above the foot of the lake is 267 square miles. The elevation of the lake is variously given as 361 (*c*) and 369 (*d*) feet above tide, and the greatest depth is stated as 65 feet. The water is shallow for half a mile out from the shore, and then rapidly deepens.

As described by Mr. Gardner Van Uxem, this lake is "the remains of an ancient and deep excavation in the Onondaga salt group, of which Onondaga valley forms the southern part, all which has been filled up with sand, gravel, etc., except the part occupied by the lake. * * * The bottom of Onondaga lake and its sides are covered with lake marl, showing a thickness where bored of 6 and more feet". The famous salt springs of this locality are found in and about a marshy piece of ground which extends some 2 miles from the head of the lake. The shores of the latter are low, largely reclaimed land, but are succeeded farther back by a rise to high ground. The lake fills in spring, overflowing its borders, and then gradually declines in level through the year. So far as can be learned there is no power in use on the outlet, and no opportunity for any.

*Otisco lake* lies southwest of Onondaga lake and 2½ or 3 miles east of Skaneateles lake. It drains to the former of these through Nine-Mile creek, which really has a length, by map measurement, of about 18 miles. This creek has a fall of 361 feet to the Camillus feeder-dam, and a total of about 411 feet to the level of Onondaga lake. The power thus afforded is partially utilized by a considerable number of mills, embracing in their production flour, lumber, paper, powder, lime, and leather. As represented on a map of the middle division of the Erie canal, with its reservoirs and feeders, Otisco lake flows 4 square miles. In the *Annual Report of the State Engineer and Surveyor* for the year ending September 30, 1879 (page 55), the storage is placed at 784,000,000 cubic feet. In the same report (page 92) the supply of water afforded is stated as about 116 cubic feet per second for 120 days, from the lake, in addition to which the natural flow of the outlet yields for feeding-purposes 13 cubic feet per second for 220 days; it is also stated that the lake has a drainage basin of 22,000 acres, and that by raising its surface 2 feet the supply from it can be further increased by 10 cubic feet per second.

*Table showing the fall in Nine-Mile creek.*

| Locality. | Elevation above mean sea-level. | Fall between points. | Distance between points, by map measurement. | Authority for elevation. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Miles.* | |
| Otisco lake | 772 | | | French's *Gazetteer of New York*, p. 486. |
| | | 361 | 11.4 | |
| Crest of feeder-dam | 411 | | | Elevation assumed the same as that of Jordan level of Erie canal, = 408.568 feet + mean low tide at Albany, or 410.64 feet + mean sea-level. |
| | | 50 | 6.7 | |
| Onondaga lake | 361 | | | French's *Gazetteer of New York*, p. 22. |

*a* See sub-report by Marvin Porter, division engineer, page 55 of *Annual Report of the State Engineer and Surveyor* for the year ending September 30, 1879.

*b* Page 92, report last referred to.

*c* French's *Gazetteer of New York*, page 22.

*d* *Notes upon the Geological History of Cayuga and Seneca Lakes*, by Charles W. Foote, A. M.

The state has a dam at the foot of the lake for controlling its storage; the discharge over this passes down the natural channel of Nine-Mile creek, and between 11 and 12 miles down stream, at Camillus, is by a second dam turned into a feeder running a mile and a half to the Jordan level of the Erie canal.

*Table of utilized power on the Oswego river and tributaries.*

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* | |
| Oswego river | Lake Ontario | New York | Oswego | Blacksmith-shop | 1 | Total of six utilized falls on the Oswego river, about 80 feet. | 16 | | |
| Do | do | do | do | Cement | 1 | | 25 | | |
| Do | do | do | do | Cigar-boxes | 1 | | | | |
| Do | do | do | do | Coffins and burial-cases | 1 | | | | |
| Do | do | do | do | Cutlery and edge-tools | 1 | | 40 | | |
| Do | do | do | do | Dry-dock | 1 | | | | |
| Do | do | do | do | Elevators (grain) | 4 | | | | Not including those in connection with mills. |
| Do | do | do | do | Flouring and grist | 15 | | 1,939 | | |
| Do | do | do | do | Flux | 1 | | 25 | | |
| Do | do | do | do | Hardware | 1 | | 15 | | |
| Do | do | do | do | Hosiery | 1 | | 70 | | |
| Do | do | do | do | Machine-shops and foundries. | 3 | | 223 | | |
| Do | do | do | do | Malt | 3 | | 40+ | | |
| Do | do | do | do | Paper (including wood-pulp). | 4 | | 330+ | | |
| Do | do | do | do | Planing | 3 | | 140 | | |
| Do | do | do | do | Plaster | 2 | | 75 | | |
| Do | do | do | do | Printing and publishing | 1 | | 8 | | |
| Do | do | do | do | Pumping-works | 1 | | 200 | | Supply Oswego. |
| Do | do | do | do | Quarry | 1 | | | | |
| Do | do | do | do | Sashes, doors, and blinds | 1 | | 10 | | |
| Do | do | do | do | Saw | 4 | | 150+ | | |
| Do | do | do | do | Starch | 1 | | 1,220 | 483 | |
| Do | do | do | do | Tannery | 1 | | 65 | | |
| Do | do | do | do | Wheelwrighting | 2 | | 48 | | |
| Do | do | do | do | Window blinds and shades | 2 | | 120 | 80 | |
| Do | do | do | do | Wooden packing-boxes | 1 | | 140 | | |
| Do | do | do | do | Wooden ware | 1 | | 30 | | |
| Do | do | do | do | Woolen | 1 | | 25 | | |
| Do | do | do | do | Worsted | 1 | | 1,270 | | |
| Do | do | do | Onondaga | Coffins and burial cases | 1 | | 50 | | |
| Do | do | do | do | Paper | 1 | | | | |
| Oneida river | Oswego river | do | do | Flouring, grist, and saw | 1 | 8 | 120 | | |
| Small tributaries | Oneida river | do | Oswego | Saw | 4 | 40 | 92 | | |
| Canaseraga creek and tributaries. | Oneida lake | do | Madison | Fertilizers | 1 | 9 | 25 | | Mills nearly all on tributaries. |
| Do | do | do | do | Flouring and grist | 6 | 118 | 185 | 30 | |
| Do | do | do | do | Saw | 7 | 115½ | 124 | 25 | |
| Chittenango creek and tributaries. | do | do | do | Cotton | 1 | 13 | 60 | 60 | Mills nearly all on main stream. |
| Do | do | do | do | Cutlery and edge-tools | 1 | 9 | | | |
| Do | do | do | do | Flouring and grist | 8 | 129 | 294 | | |
| Do | do | do | do | Iron castings and finishings. | 1 | 6 | 25 | | |
| Do | do | do | do | Paper | 3 | 35 | 180 | | |
| Do | do | do | do | Saw | 5 | 116 | 70 | | |
| Do | do | do | do | Sporting goods | 1 | 4 | 6 | | |
| Do | do | do | do | Wheelbarrows | 1 | 4 | 6 | | |
| Do | do | do | Onondaga | Agricultural implements | 2 | 40 | 22 | | Mills all on tributary streams. |
| Do | do | do | do | Barley | 1 | 12 | 30 | | |
| Do | do | do | do | Carpentering | 1 | 6 | 10 | | |
| Do | do | do | do | Cement | 1 | 8 | 100 | | |
| Do | do | do | do | Fertilizers | 2 | 46 | 58 | | |
| Do | do | do | do | Flouring and grist | 18 | 325½ | 631 | 45 | |
| Do | do | do | do | Furniture | 1 | 24 | 10 | | |
| Do | do | do | do | Hones and whetstones | 1 | 17 | 90 | | |
| Do | do | do | do | Lumber, planed | 1 | 9 | 10 | | |
| Do | do | do | do | Machinery | 1 | 8 | 10 | | |
| Do | do | do | do | Paper | 3 | 55 | 220 | | |
| Do | do | do | do | Sashes, doors, and blinds | 2 | 20 | 70 | | |

*Table of utilized power on the Oswego river and tributaries*—Continued.

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* | |
| Chittenango creek and tributaries. | Oneida lake | New York | Onondaga | Saw | 16 | 258½ | 538 | | Mills all on tributary streams. |
| Do | do | do | do | Tannery | 1 | 11 | 3 | 10 | |
| Do | do | do | do | Wood, turned and carved | 1 | 16 | 14 | | |
| Fish creek and tributaries. | do | do | Oneida | Agricultural implements | 4 | 48 | 37 | | |
| Do | do | do | do | Flouring and grist | 9 | 127½ | 358 | | |
| Do | do | do | do | Furniture | 3 | 30 | 66 | 50 | |
| Do | do | do | do | Hones and whetstones | 1 | 9 | 50 | | |
| Do | do | do | do | Iron castings and finishings. | 3 | 28 | 41 | | |
| Do | do | do | do | Machinery | 1 | 11 | 15 | | |
| Do | do | do | do | Paper | 1 | 5 | 30 | | |
| Do | do | do | do | Sashes, doors, and blinds | 2 | 19 | 27 | | |
| Do | do | do | do | Saw | 31 | 365 | 730 | 10 | |
| Do | do | do | do | Tanneries | 3 | 34 | 38 | 60 | |
| Do | do | do | do | Wheelbarrows | 1 | 6 | 5 | | |
| Do | do | do | do | Wooden packing-boxes | 2 | 30 | 85 | | |
| Do | do | do | do | Wood-pulp | 1 | 7 | 60 | | |
| Do | do | do | do | Wood, turned and carved | 1 | 9 | 4 | | |
| Do | do | do | do | Wooden ware | 1 | 13 | 14 | | |
| Do | do | do | do | Woolen | 1 | 9 | 20 | | |
| Do | do | do | Oswego | Flouring and grist | 1 | 16 | 25 | | |
| Do | do | do | do | Saw | 9 | 106 | 237 | 40 | |
| Do | do | do | Lewis | do | 7 | 84½ | 246 | | |
| Oneida creek and tributaries. | do | do | Madison | Agricultural implements | 1 | 10 | 30 | | Excepting silk-mill and one fertilizer factory, mills all on main stream. |
| Do | do | do | do | Fertilizers | 2 | 24 | 30 | | |
| Do | do | do | do | Flouring and grist | 7 | 144 | 363 | 70 | |
| Do | do | do | do | Lime | 1 | | 10 | | |
| Do | do | do | do | Saw | 5 | 69 | 83 | | |
| Do | do | do | do | Silk | 1 | 23½ | 76 | 76 | |
| Do | do | do | do | Wooden packing-boxes | 1 | 12 | 10 | | |
| Do | do | do | Oneida | Agricultural implements | 1 | 8 | 14 | | With two exceptions, mills all on tributary streams. |
| Do | do | do | do | Carpentering | 1 | 11 | 24 | | |
| Do | do | do | do | Flouring and grist | 5 | 66 | 385 | | |
| Do | do | do | do | Machinery | 1 | | 8 | | |
| Do | do | do | do | Saw | 6 | 67 | 164 | | |
| Do | do | do | do | Surgical appliances | 1 | 23½ | 18 | 65 | |
| Do | do | do | do | Wooden packing-boxes | 3 | 21+ | 62 | | |
| Do | do | do | do | Woolen | 1 | 8 | 10 | | |
| Sundry small tributaries. | do | do | do | Butter and cheese | 1 | 10 | 20 | | |
| Do | do | do | do | Flouring and grist | 3 | 44 | 90 | | |
| Do | do | do | do | Saw | 6 | 100 | 142 | | |
| Do | do | do | Oswego | Flouring and grist | 5 | 62 | 185 | | |
| Do | do | do | do | Saw | 22 | 262½ | 681 | | |
| Do | do | do | do | Tannery | 1 | 15 | 40 | 75 | |
| Seneca river | Oswego river | do | Seneca | Carriage and wagon materials. | 1 | Seneca Falls and Waterloo—total of utilized falls about 60 feet. | 45 | 30 | |
| Do | do | do | do | Cooperage | 1 | | 60 | | |
| Do | do | do | do | Distillery | 1 | | | | |
| Do | do | do | do | Files | 1 | | 85 | | |
| Do | do | do | do | Flouring and grist | 9 | | 610 | | |
| Do | do | do | do | Iron castings and finishings. | 1 | | 20 | 10 | |
| Do | do | do | do | Knit underwear | 1 | | 160 | | |
| Do | do | do | do | Lumber, planed | 1 | | 12 | | |
| Do | do | do | do | Machinery (including pumps). | 5 | | 360 | 95 | |
| Do | do | do | do | Malt | 2 | | 27 | | |
| Do | do | do | do | Organs | 1 | | 20 | | |
| Do | do | do | do | Printing and publishing | 3 | | 60 | | |
| Do | do | do | do | Sashes, doors, and blinds | 1 | | 20 | | |
| Do | do | do | do | Saw | 5 | | 176 | 55 | |
| Do | do | do | do | Table-mats | 1 | | | | |
| Do | do | do | do | Wood, turned and carved | 2 | | 18 | | |
| Do | do | do | do | Woolen | 1 | | 175 | 200 | |

*Table of utilized power on the Oswego river and tributaries*—Continued.

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* | |
| Seneca river | Oswego river | New York | Onondaga | Agricultural implements. | 1 | Baldwinsville—fall 9 feet. | 50 | | |
| Do | do | do | do | Carriages and wagons | 1 | | 16 | | |
| Do | do | do | do | Fertilizers | 1 | | 20 | | |
| Do | do | do | do | Flouring and grist | 5 | | 690 | | |
| Do | do | do | do | Hosiery | 1 | | 100 | 30 | |
| Do | do | do | do | Paper | 1 | | | | |
| Do | do | do | do | Pumps | 1 | | 22 | | |
| Do | do | do | do | Sashes, doors, and blinds | 1 | | 25 | 25 | |
| Do | do | do | do | Saw and planing | 1 | | 30 | | |
| Keuka outlet | Seneca lake | do | Yates | Flouring and grist | 6 | 63½ | 420 | | |
| Sundry tributaries. | Keuka lake | do | Steuben | do | 1 | 19 | 40 | | |
| Do | do | do | do | Saw | 1 | 25 | 25 | | |
| Do | do | do | do | Wooden packing-boxes | 1 | 25 | 6 | | |
| Do | do | do | do | Woolen | 1 | 32 | 17 | | |
| Do | Seneca lake | do | Cayuga | Fertilizers | 1 | 12 | 20 | | |
| Do | do | do | Schuyler | do | 1 | 115 | 40 | | |
| Do | do | do | do | Flouring and grist | 7 | 299 | 246 | 80 | |
| Do | do | do | do | Saw | 6 | 97½ | 117 | 30 | |
| Do | do | do | Seneca | Flouring and grist | 1 | 40 | 40 | 20 | |
| Do | do | do | Yates | do | 5 | 226½ | 206 | 68 | |
| Do | Cayuga lake | do | Cayuga | do | 10 | 270 | 348 | 173 | |
| Do | do | do | do | Saw | 4 | 55 | 105 | | |
| Do | do | do | Cortland | do | 1 | 6 | 15 | | |
| Do | do | do | do | Flouring and grist | 1 | 22 | 27 | | |
| Do | do | do | Schuyler | do | 1 | 22 | 45 | | |
| Do | do | do | do | Saw | 5 | 38+ | 76 | | |
| Do | do | do | Seneca | Flouring and grist | 4 | 121 | 99 | 16 | |
| Do | do | do | do | Saw | 1 | 12 | 18 | | |
| Do | do | do | do | Woolen | 1 | 12 | 10 | | |
| Do | do | do | Tompkins | Agricultural implements. | 4 | 43 | 75 | 15 | |
| Do | do | do | do | Carriage and wagon materials. | 1 | 30 | 24 | | |
| Do | do | do | do | Cooperage | 3 | 25 | 73 | | |
| Do | do | do | do | Fertilizers | 2 | 48 | 70 | | |
| Do | do | do | do | Flouring and grist | 29 | 613 | 1,325 | 110 | |
| Do | do | do | do | Millwrighting | 1 | 7 | 4 | | |
| Do | do | do | do | Paper | 2 | 52 | 252 | 45 | |
| Do | do | do | do | Sashes, doors, and blinds | 1 | 16 | 10 | 15 | |
| Do | do | do | do | Saw | 20 | 269 | 602 | 15 | |
| Do | do | do | do | Tannery | 1 | 13 | 10 | | |
| Do | do | do | do | Woolen | 4 | 47½ | 74 | 92 | |
| Mud creek and tributaries. | Clyde river | do | Wayne | Flouring and grist | 12 | 101 | 386 | 20 | |
| Do | do | do | do | Saw | 1 | 14 | 15 | | |
| Do | do | do | do | Woolen | 1 | 4 | 16 | | |
| Do | do | do | Ontario | Agricultural implements. | 1 | 30 | 12 | | |
| Do | do | do | do | Flouring and grist | 9 | 166 | 269 | | |
| Do | do | do | do | Saw | 4 | 58 | 47 | | |
| Sundry small tributaries. | do | do | Seneca | Flouring and grist | 1 | 16 | 19 | | |
| Do | do | do | Wayne | do | 1 | 12 | 26 | | |
| Do | do | do | do | Saw | 1 | 11 | 26 | | |
| Canandaigua outlet and tributaries (not including those running into Canandaigua lake). | do | do | do | Flouring and grist | 2 | 17 | 110 | | |
| Do | do | do | Ontario | Agricultural implements. | 6 | 71½ | 120 | 10 | |
| Do | do | do | do | Blacksmithing | 1 | | 5 | | |
| Do | do | do | do | Carriages and wagons | 1 | 16 | 13 | | |
| Do | do | do | do | Carriage and wagon materials. | 6 | 57+ | 125 | | |
| Do | do | do | do | Fertilizers | 2 | 26 | 52 | | |
| Do | do | do | do | Flouring and grist | 16 | 177½ | 584 | 30 | |
| Do | do | do | do | Iron castings and finishings. | 1 | 6 | 20 | | |
| Do | do | do | do | Paper | 2 | 40 | 232 | 162 | |
| Do | do | do | do | Saw | 11 | 101½ | 224 | | |

*Table of utilized power on the Oswego river and tributaries*—Continued.

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* | |
| Sundry tributaries. | Canandaigua lake. | New York | Ontario | Flouring and grist | 4 | 83 | 130 | | |
| Do | do | do | do | Saw | 3 | 67 | 81 | 75 | |
| Do | do | do | do | Wheelwrighting | 1 | 14 | 15 | | |
| Do | do | do | Yates | Flouring and grist | 1 | 22 | 30 | | |
| Owasco outlet | Seneca river | do | Cayuga | Agricultural implements | 5 | Total fall in outlet, 330 feet—not all utilized. | 671 | 465 | Principal manufacturing at Auburn. |
| Do | do | do | do | Carpentering | 1 | | 28 | | |
| Do | do | do | do | Carpets | 1 | | 206 | | |
| Do | do | do | do | Chewing- and smoking-tobacco and snuff. | 1 | | 9 | | |
| Do | do | do | do | City water-works operated. | 1 | | 500 | | |
| Do | do | do | do | Fertilizers | 1 | | 50 | | |
| Do | do | do | do | Files | 1 | | 26 | | |
| Do | do | do | do | Flouring and grist | 6 | | 295 | 35 | |
| Do | do | do | do | Hardware | 1 | | 140 | | |
| Do | do | do | do | Iron castings and finishings. | 1 | | 12 | | |
| Do | do | do | do | Iron, forged | 1 | | 300 | 450 | |
| Do | do | do | do | Machinery | 2 | | 112 | | |
| Do | do | do | do | Models and patterns | 1 | | 26 | | |
| Do | do | do | do | Sashes, doors, and blinds | 2 | | 53 | 18 | |
| Do | do | do | do | Saw | 1 | | 25 | | |
| Do | do | do | do | Starch | 1 | | 35 | 10 | |
| Do | do | do | do | Tin, copper, and sheet-iron. | 1 | | 10 | | |
| Do | do | do | do | Washing-machines and clothes-wringers. | 1 | | 20 | | |
| Do | do | do | do | Woolen | 4 | | 480+ | 280 | |
| Sundry tributaries. | Owasco lake and outlet. | do | do | Cooperage | 1 | 70 | 54 | | |
| Do | do | do | do | Flouring and grist | 13 | 236 | 544 | | |
| Do | do | do | do | Machinery | 1 | 8 | 6 | 25 | |
| Do | do | do | do | Pickles, preserves, and sauces. | 1 | 16 | 16 | | |
| Do | do | do | do | Saw | 14 | 357 | 530 | 35 | |
| Do | do | do | do | Tannery | 1 | 10 | 10 | 8 | |
| Do | do | do | do | Wheelwrighting | 1 | 23 | 10 | | |
| Do | do | do | do | Wood, turned and carved | 1 | 6 | 14 | 15 | |
| Do | do | do | do | Woolen | 1 | 14 | 10 | | |
| Do | do | do | Tompkins | Flouring and grist | 3 | 51 | 75 | 27 | |
| Skaneateles outlet. | Seneca river | do | Onondaga | Cement | 1 | 9 | 24 | | The total of fall utilized on the outlet can not accurately be determined from the figures here given, as some of the falls may be duplicated, the census enumerators' returns not distinguishing where several mills are located about a single dam, as is sometimes the case. Entire fall in outlet, about 485 feet. |
| Do | do | do | do | Fertilizers | 1 | 8 | 30 | | |
| Do | do | do | do | Flouring and grist | 6 | 60 | 540 | 45 | |
| Do | do | do | do | Furniture | 6 | 66 | 138 | | |
| Do | do | do | do | Iron castings and finishings. | 1 | 9 | 15 | | |
| Do | do | do | do | Lumber, planed | 3 | 25½ | 81 | 20 | |
| Do | do | do | do | Machinery | 3 | 20 | 57 | 20 | |
| Do | do | do | do | Malt | 1 | 18 | 30 | | |
| Do | do | do | do | Paper | 6 | 80 | 515 | | |
| Do | do | do | do | Saw | 1 | 8 | 22 | | |
| Do | do | do | do | Wheelbarrows | 2 | 13 | 45 | 20 | |
| Do | do | do | do | Woolen | 2 | 34 | 60 | | |
| Tributaries | Skaneateles lake | do | Cortland | Animal oil | 1 | 12 | 35 | | |
| Do | do | do | do | Flouring and grist | 2 | 58 | 68 | | |
| Nine-Mile creek | Onondaga lake | do | Onondaga | do | 6 | 122 | 315 | | |
| Do | do | do | do | Gunpowder | 1 | | 18 | | |
| Do | do | do | do | Lime | 1 | 10 | 40 | | |
| Do | do | do | do | Machinery | 1 | 19 | 40 | | |
| Do | do | do | do | Paper | 2 | 32 | 228 | | |
| Do | do | do | do | Pearl-barley | 1 | 14 | 15 | | |
| Do | do | do | do | Saw | 5 | 101 | 112 | | |
| Do | do | do | do | Tannery | 1 | 10 | 12 | | |
| Do | do | do | do | Wood, turned and carved | 1 | 6 | 16 | | |
| Do | do | do | do | Woolen | 3 | 46½ | 165 | | |
| Tributaries | Nine-Mile creek and Otisco lake. | do | do | Flouring and grist | 4 | 117 | 65 | 10 | |
| Do | do | do | do | Saw | 5 | 126 | 124 | 10 | |
| Onondaga creek and tributaries. | Onondaga lake | do | do | Flouring and grist | 7 | 147 | 310 | 35 | |
| Do | do | do | do | Saw | 6 | 73+ | 135 | | |

*Table of utilized power on the Oswego river and tributaries*—Continued.

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* | |
| Onondaga creek and tributaries. | Onondaga lake.... | New York..... | Onondaga..... | Wheelwrighting..... | 1 | 13 | 4 | ..... | |
| Other tributaries.. | ....do ..... | ....do ..... | ....do ..... | Fertilizers..... | 1 | 26 | 32 | ..... | |
| Sundry tributaries. | Seneca river ..... | ....do ..... | ....do ..... | Flouring and grist..... | 1 | 10 | 18 | ..... | |
| Do..... | ....do ..... | ....do ..... | ....do ..... | Saw ..... | 1 | 14 | 20 | ..... | |
| Do..... | ....do ..... | ....do ..... | ....do ..... | Tannery ..... | 1 | 8½ | 16 | ..... | |
| Do..... | ....do ..... | ....do ..... | ....do ..... | Wheelbarrows..... | 1 | 12 | 15 | 40 | |
| Do..... | ....do ..... | ....do ..... | Cayuga ..... | Cutlery and edge-tools.... | 1 | 13 | 10 | ..... | |
| Do..... | ....do ..... | ....do ..... | ....do ..... | Flouring and grist..... | 4 | 57 | 80 | ..... | |
| Do..... | ....do ..... | ....do ..... | ....do ..... | Saw ..... | 5 | 71 | 57 | ..... | |
| Do..... | Oswego river ..... | ....do ..... | Oswego ..... | Flouring and grist..... | 1 | 9 | 10 | ..... | |
| Do..... | ....do ..... | ....do ..... | ....do ..... | Saw ..... | 3 | 30 | 61 | ..... | |
| Do..... | ....do ..... | ....do ..... | ....do ..... | Tannery..... | 1 | 11 | 12 | ..... | |

## III.—THE GENESEE RIVER.

This river has its source in Potter county, northern Pennsylvania, 8 or 10 miles south of the New York boundary. Entering Allegany county of the latter state, it runs northwesterly 32 miles, by general course, but in the town of Caneadea turns, and pursues a northeasterly direction thence to the mouth, a distance measured in a straight line of about 63 miles. It empties into lake Ontario 7 miles north of Rochester. Besides passing across Allegany county, the river forms part of the boundary between the counties of Wyoming and Livingston, and then strikes successively across the latter and Monroe to the lake. By map measurement, the entire length following the bends is about 135 miles, and the drainage area 2,496 square miles. In the northern counties the surface is rolling, with long, easy slopes, except along the streams, which usually lie in deep ravines hemmed in by steep banks. There is a gradual rise, on the whole, away from the lakes, and in the upper half of the basin the country becomes rough and is broken by ridges the summits of which attain elevations of from 2,000 to 2,500 feet above tide. Splendid pine forests once covered this whole section, but have now mostly been cut away. The soil is of good quality and well suited to the raising of grain. In the extreme upper basin the slopes are too steep for convenient cultivation, but stock-raising, wool-growing, and dairying are everywhere successfully carried on, and are probably the leading industries. The prevailing rocks are sandstones, limestones, and shales. These supply abundance of fine building-stone, and by their disintegration form a fertile soil. Drift deposits are well distributed over this region, though they are not very extensive toward its southern limits.

*Table showing the fall in the Genesee river.*

| Locality. | Distance above mouth, map measurement. | Elevation of water-surface above mean sea-level. | Fall between points. | Distance between points. | Fall per mile between points. | Authority for elevation. |
|---|---|---|---|---|---|---|
| | *Miles.* | *Feet.* | *Feet.* | *Miles.* | *Feet.* | |
| Belvidere crossing of the New York, Lake Erie, and Western railroad. | 105.3 | 1,333 | 253 | 39.4 | 6.4 | Levels of New York, Lake Erie, and Western railroad. (*a*) |
| Portage crossing of the New York, Lake Erie, and Western railroad. | 65.9 | 1,080 | 475 | 16.1 | (*b*) | Do. |
| Slack-water above Mount Morris dam..... | 49.8 | 605 | 67 | 21.4 | 3.1 | New York state canal profiles give elevation as 602.64 feet + mean low tide at Albany, = 604.71 feet + mean tide at New York. |
| Avon crossing of the New York, Lake Erie, and Western railroad, Rochester division. | 28.4 | 538 | 28 | 18.8 | 1.5 | Levels of New York, Lake Erie, and Western railroad. |
| Slack-water above feeder-dam at Rochester.. | 9.6 | 510 | 263 | 9.6 | (*c*) | New York state canal profiles give elevation in connecting level of Erie canal as 507.975 feet + mean low tide at Albany, = 510.045 feet + mean tide at New York. |
| Mean surface of lake Ontario..... | 0.0 | 247 | | | | As stated at the office of the Chief of Engineers, U. S. army, the mean surface from January 1, 1860, to December 31, 1875, is 246.61 feet above mean tide at New York. |

*a* For elevations on this railroad, thanks are due to Mr. O. Chanute, chief engineer.

*b* Descent occurs largely in abrupt falls and rapids at Portage and vicinity.

*c* Concentrated in abrupt falls at Rochester.

From the New York, Lake Erie, and Western Railroad crossing at Belvidere, near the center of Allegany county, down to the crossing by the same company's line at Portage, a distance of 39.4 miles, the fall in the water-surface is 253 feet, or an average of 6.4 feet per mile. At Portage the river plunges down in three magnificent falls. It

runs at the bottom of a deep gorge, which continues nearly to Mount Morris, and from under the Portage bridge to the crest of the old state dam at Mount Morris, 16.1 miles, the fall is 475 feet. Thence down to Rochester the river flows through a broad, open, and fertile valley, estimated to average nearly 2 miles in width, and is bordered by meadows subject to occasional overflow. In the vicinity of Mount Morris they are said to have been submerged three times in twenty years. The descent is moderate, and in the 40.2 miles from the crest of the Mount Morris dam to the crest of the state dam at Rochester the total fall is only 95 feet, or an average of 2.4 feet per mile. At Rochester the Genesee leaps down successively over three heavy falls, and within the city descends about 260 feet. Of the 1,086 feet of fall, therefore, occurring between Belvidere and the mouth, from 500 to 600 feet is found concentrated in abrupt pitches at Portage and Rochester, the power at the former point entirely undeveloped, while that at Rochester, though not fully utilized, sustains a very extensive amount of manufacturing.

With the steep slopes which characterize the upper basin, the stream naturally receives promptly the drainage from rainfalls, and in the upper course, at least, rises and falls quickly after heavy storms. In 1865, during a freshet, drift became lodged against the Erie Canal aqueduct at Rochester to such an extent as seriously to obstruct the flow of the stream, which overflowed into the canal and flooded the whole western part of the city. During the summer and autumn the volume of the river sinks quite low, and is also liable to be much reduced during an exceptionally cold period in winter. General I. F. Quinby, of the Rochester university, who for ten or fifeen years had charge of one or more of the hydraulic races at the city, states the average minimum discharge, as indicated by weir measurements, at 400 cubic feet per second, equivalent to about 0.16 cubic foot per second per square mile of drainage area. But, judging from the statements of prominent manufacturers, it appears that the net discharge, which the general use of weirs renders it possible to approximate to, has at times probably fallen considerably below 300 cubic feet per second, or below 0.12 cubic foot per second per square mile.

Above all the private dams at Rochester the state has a dam for the purpose of diverting water, through a feeder 2¼ miles long, to the Erie canal. It is so constructed that, except when put to its designed use, it may be left so as to form but a slight obstruction to the flow of the stream. Previously to the summer of 1878 it was but little used, except to assist in filling the canal in spring; but since that time it has regularly been employed to keep up the supply in the "long" level between Rochester and Lockport. It has thus occasioned quite a heavy draught on the river, to the extent, as claimed by some manufacturers, of reducing the low flow nearly one-half, and there is no reason for supposing that the demand will be much, if at all, lessened in the future.

In a report by Thomas Eversbed, division engineer, in November, 1878,(*a*) it was stated that the capacity of the Rochester feeder was 1,400 cubic feet per minute (23 per second), and that much more would be afforded by properly maintaining the dam so as to force a supply through the feeder. Since the abandonment of the Genesee Valley canal, at the close of the season of 1878, about 1,200 cubic feet per minute (*b*) (20 per second) has been brought from Allen's creek, a tributary of the Genesee, some 10 or 11 miles through the old channel of the canal, to the Erie canal at Rochester. It is fair, therefore, to assume that during the period of canal navigation, at least 40 cubic feet per second, and very likely much more than that, is diverted from the river to the Erie canal.

In the basin of Black creek, one of the upper tributaries of the Genesee from the west, the state has two reservoirs, formerly used for supplying a part of the Genesee Valley canal, but, since that has been given up, retained for the benefit of the Erie canal, which their waters reach through a part of the Genesee Valley canal, the natural channels of Black creek and the main river, and the Rochester feeder. Of these, the Oil Creek reservoir has a water-surface of 605 acres, a mean depth of 20 feet, and a storage capacity of 527,214,000 cubic feet; the Rockville reservoir has a water-surface of 72 acres and a storage capacity of 18,223,000 cubic feet.(*c*)

The series of remarkable lakes farther eastward, tributary to the Oswego river, is continued westward into the Genesee basin, though they are there of smaller size, and includes Honeoye, Canadice, Hemlock, and Conesus lakes. No special data are at hand to show what facilities these possess for storage, or whether they are controlled by dams. Their outlets are described as good mill-streams, and probably owe their value largely to these natural reservoirs. Their areas, as given below, were obtained by planimeter measurement on French's map of the state:

*Principal lakes and reservoirs in the basin of the Genesee river.*

| Name. | Location. | Area of water-surface. | Drainage area at head of outlet. | Name of outlet. |
|---|---|---|---|---|
| | | *Sq. miles.* | *Sq. miles.* | |
| Honeoye lake | Southwestern part of Ontario county | 2.8 | 39 | Honeoye outlet. |
| Canadice lake | Town of Canadice, southwestern part of Ontario county | 1.8 | 15 | Canadice outlet. |
| Hemlock lake | Border between Ontario and Livingston counties | 4.1 | 42 | Hemlock outlet. |
| Conesus lake | Central part of Livingston county | 4.8 | 67 | Conesus outlet. |
| Silver lake | Mainly in town of Castile, Wyoming county | 2.0 | 20 | Silver Lake outlet. |
| Cuba or Oil Creek reservoir | Western border of Allegany county | 0.95 | ..... | Genesee Valley canal and Black creek. |
| Rockville reservoir | Town of Belfast, Allegany county | 0.11 | ..... | Do. |

*a* See *Annual Report of the Superintendent of Public Works* for the year ending September 30, 1878.
*b* See *Annual Report of the State Engineer and Surveyor* for the year ending September 30, 1879, p. 96.
*c* See *Annual Report of the State Engineer and Surveyor* for the year ending September 30, 1879, p. 99.

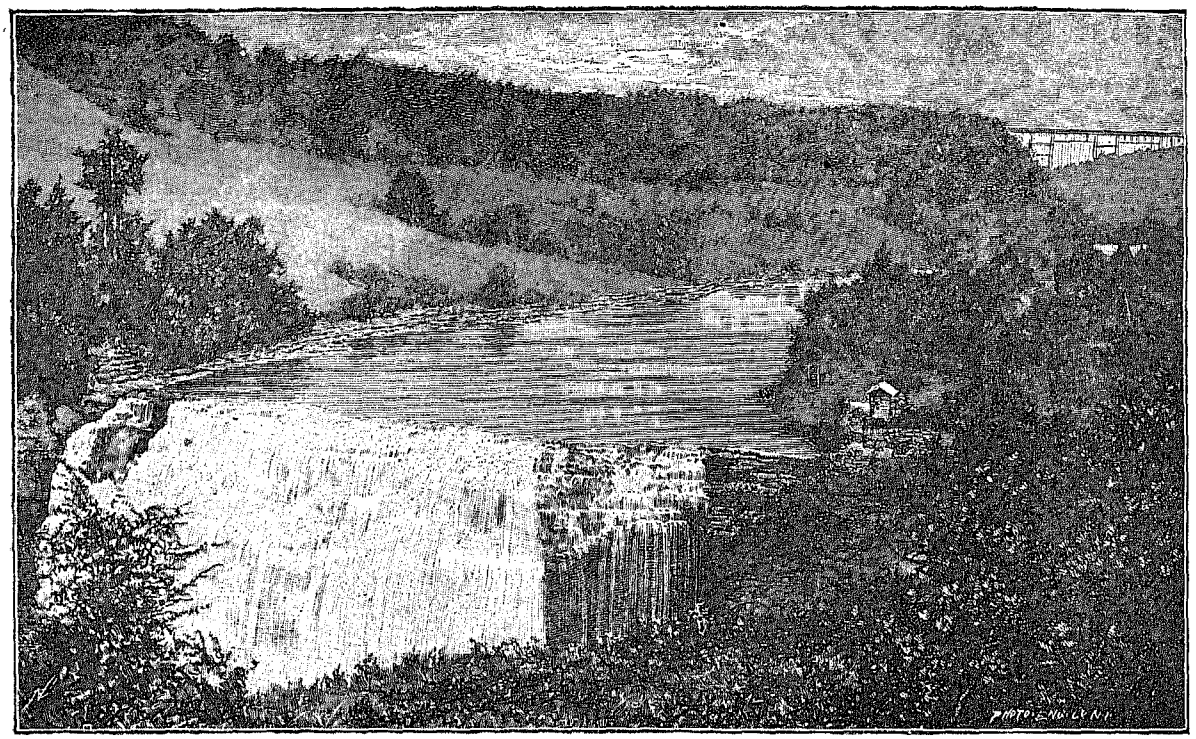

FIG. 7.—Middle falls of the Genesee river at Portage.

At Mount Morris there are several mills and shops, and at intervals elsewhere along the stream are small mills; but, notwithstanding the large aggregate fall, the power of the river, outside of Rochester, has been in general but slightly developed. The Genesee does not freeze very thick between Portage and Mount Morris, on account of the rapid current, and but little hinderance from ice is experienced at the latter point. At Rochester floating ice occasionally troubles at some of the head-gates, but neither that nor anchor-ice causes much difficulty to the mills.

*Drainage areas of the Genesee river and principal tributaries.*

| Stream and locality. | Drainage area. | Stream and locality. | Drainage area. |
|---|---|---|---|
| | *Sq. miles.* | | *Sq. miles.* |
| Genesee river at Phillipsville | 358 | Black creek (town of Belfast) at mouth | 90 |
| Genesee river at Portage | 996 | Canaseraga creek at mouth | 347 |
| Genesee river at Mount Morris | 1,094 | Conesus outlet at mouth | 82 |
| Genesee river at Geneseo | 1,507 | Honeoye outlet at Honeoye Falls | 201 |
| Genesee river at Rochester state dam | 2,468 | Honeoye outlet at mouth | 272 |
| Genesee river at Rochester, center of city | 2,474 | Oatka creek at mouth | 215 |
| Genesee river at mouth | 2,496 | Black creek (town of Chili) at mouth | 184 |

*Water-powers.*—Examinations of this river did not extend above Portage, from which point to the head the census enumerators' returns show the only use of power to be by saw- and grist-mills. Though the valley widens out above the Portage falls and incloses extensive meadows, and is said to continue tolerably open for some distance above, it is described as being in general through Allegany county deep, and bordered by steep hill-sides. The principal villages along the stream in that county are Wellsville, population 2,000, Angelica 700, and Belmont 800.

As we have seen, the average descent in the 39 or 40 miles from Belvidere to Portage is about 6.4 feet per mile. Then follows the wonderful series of falls which has before been alluded to. These falls are distant about 65 miles by river from the mouth, and begin immediately below the crossing of the New York, Lake Erie, and Western railroad. The only settlement very near at hand is the little village of Portageville; 5 miles to the eastward is Nunda, with 1,000 inhabitants, and 3 or 4 miles to the northward Castile, with nearly the same population as Nunda. The Genesee Valley canal formerly descended the west bank, crossed over above the Portage falls, and making a detour to the eastward recrossed at Mount Morris, some 16 miles below. Since the abandonment of the canal its course has been followed part way by a railroad which, it is said, will be continued along the upper river.

At Portage the Genesee lies at the bottom of a deep and narrow ravine, the rocky sides of which rise, and in places very precipitously, to heights of from 250 to 400 feet from the water. The Erie railroad, as it crosses on the famous Portage viaduct, is over 230 feet above the crest of the Upper falls. There are three principal pitches, the Upper, Middle, and Lower, which occur in the horizontal strata of the Portage group (*a*) of rocks. The owner of the property gives the descent as 66 feet at the Upper falls, 110 feet at the Middle, and 90 feet at the Lower. These figures are probably for the more abrupt portions of the falls, and are somewhat less than the aggregate descents as given in the following description, which is taken from French's *Gazetteer of New York* (1860):

The Upper or Horseshoe falls are about three-fourths of a mile below Portageville. The name is derived from the curve in the face of the cliff over which the water flows. For a short distance above the edge of the precipice the water is broken by a succession of steps in the rock, forming a series of rapids. The height of the fall, including the rapids, is about 70 feet. The Middle falls are about one-half mile farther down the river. For two or three rods above the edge of the cliff the water is broken into rapids, and then in an unbroken sheet it pours down 110 feet into a chasm below, bounded by perpendicular ledges. A cave, called the "Devil's Oven", has been worn in the rocks under the west bank, near the bottom of the falls. In low water 100 persons can be seated within it; but when the river is high it is filled with water, and is only accessible by boats. The Lower falls consist of a series of rapids one-half mile in extent, with an aggregate fall of 150 feet. For about 2 miles below the Middle falls the river pursues a winding and rapid course between high perpendicular walls; then descends in a succession of steps almost as regular as a staircase, dives under a shelving rock, shoots out in a narrow pass not more than 15 feet wide, rushes down a nearly perpendicular descent of 20 feet, strikes against the base of high rocks standing almost directly in its course, whirls back, and, turning at nearly right angles, falls into a deep pool overhung with shelving rocks. An isolated mass of rocks, 15 feet in diameter and 100 feet high, known as "Sugar Loaf", rises from the river-bed at the bend of the stream and receives nearly the whole force of the rushing water. It is bordered on one side by the present bed of the stream, and on the other by a deep chasm which separates it from the east bank of the river. Within the memory of people now living, the river flowed over the precipice on the level of the rock which now forms its west bank, and "Sugar Loaf" was an island. These falls are accessible only from the west. The perpendicular bank on the west side of the river at one point is 380 feet high.

The aggregate of the falls proper may therefore be taken as 266 feet, and, including the rapids, as probably at least 330 feet, occurring in a distance of from 2 to 2½ miles. Opposite the Upper falls both banks are steep and rocky, but by tunneling say 200 feet on the west side, water could be brought out on to ground having a moderate slope and succeeded, down to the Middle falls, by a strip of level ground several hundred feet in width. On the east side of the river is the "canal" railroad, and the slope from the stream continues too steep to admit of convenient use of power. Years ago there was a saw-mill at the Middle falls. The power there could easily be utilized on the west bank, since the level piece of ground already mentioned comes close to the river, and there

*a* The Portage group comprises: Portage sandstone (upper); Gardeau flagstones; Coshaqua shales (lower).

is then a vertical drop to the pool below the falls. Mills could be located on the level ground, either close by or stretching up and away from the falls, and power taken by shafts. The Lower falls extend back in a fissure as a series of pitches. The right bank is there abrupt. The left or west bank recedes in a table of several acres 15 or 20 feet above the stream; there is then a second table, to which there is a steep rise of 75 or 80 feet from the first, and beyond is an ascent to high hills.

The Portage power is an important one, and could be used to good advantage in some kinds of manufacturing, though at present it is wholly undeveloped. It is evident, however, that the location for mills is not now convenient of access, being in a deep valley, far below the level of the railroad. Mr. William P. Letchworth, whose residence is close at hand, owns the privilege at the Upper, at the Middle, and part of that at the Lower falls. He states that he would be extremely unwilling to see the magnificent natural beauties of this locality marred by the introduction of manufacturing works, but would not desire to stand in the way of enterprises of sufficient importance to deserve being considered public improvements.

*Estimate of power at Portage.*

| Stage of river. | RAINFALL ON BASIN. | | | | | Drainage area. | Flow per second, average for the 24 hours. | THEORETICAL HORSE-POWER. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring. | Summer. | Autumn. | Winter. | Year. | | | 1 foot fall. | 66 feet, assumed for Upper falls. | 110 feet, assumed for Middle falls. | 90 feet, assumed for Lower falls. | 266 feet, total of abrupt falls, as given by owner of the property. | 330 feet, total of three falls and rapids, as given in French's *Gazetteer*. |
| | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Sq. miles.* | *Cubic feet.* | | | | | | |
| Low water, dry year | 8 | 10 | 8½ | 7 | 33½ | 996 | 140 | 15.9 | 1,050 | 1,750 | 1,430 | 4,230 | 5,250 |
| Low water, average year | | | | | | | 190 | 21.6 | 1,430 | 2,380 | 1,940 | 5,750 | 7,130 |
| Available 10 months, average year | | | | | | | 280 | 31.8 | 2,100 | 3,500 | 2,860 | 8,460 | 10,490 |

From the Portage falls nearly to Mount Morris the river is described as running in constant heavy rapids, and most of the way through a gorge from 50 to 150 feet deep. At Mount Morris there is a leaky timber and stone dam, 335 feet long and 16 feet high. It was formerly owned by the state, the Genesee Valley canal crossing in the pool and being fed from it, but upon the abandonment of the canal the dam came into the hands of the race company. Water is brought to the mills through a head-race a mile long, 25 or 30 feet wide on the average, and not over 7 feet deep. It is said to be too small for the demands made upon it, and to be drawn quite low at times. The tail-race runs some 2 miles and empties into Canaseraga creek. The highest head obtained at Mount Morris is about 14 feet, but the average is stated as probably not over 12½ feet. Power is used by 3 grist- and flouring-mills, having together 12 sets of rollers and 10 runs of stone; and by a number of small establishments, comprising 2 machine-shops, 2 planing mills, a saw-mill, a cider-mill, and a plaster-mill. The power on the race is nominally divided into 40 equal shares, each share commanding a certain width of opening from the race. In some years there is abundance of water throughout for the wants of the mills, but in others there is a shortage for two or three months, though it is thought that this is due in considerable part to the leaky condition of the dam.

*Estimate of power at Mount Morris.*

| Stage of river. | RAINFALL ON BASIN. | | | | | Drainage area. | Flow per second, average for the 24 hours. | Theoretical horse-power. | | | Effective horse-power of wheels in use. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring. | Summer. | Autumn. | Winter. | Year. | | | 1 *foot fall.* | 12½ *feet fall.* | 14 *feet fall.* | |
| | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Sq. miles.* | *Cubic feet.* | | | | |
| Low water, dry year | 8 | 10 | 8½ | 7 | 33½ | 1,094 | 150 | 17.0 | 210 | 240 | a 370+ |
| Low water, average year | | | | | | | 200 | 22.7 | 280 | 320 | |
| Available 10 months, average year | | | | | | | 300 | 34.1 | 430 | 480 | |

*a* Returns incomplete.

From Mount Morris to Rochester the course of the stream lies through a flat open country and is quite winding. On either side are rich meadows devoted to grazing and to the raising of grain. The banks are usually low, but in places rise in bluffs. The bed is composed of clay and gravel with some quicksand. The surface of the water is now and then broken by ripples, but the fall is slight. At Geneseo there is a 4-run flouring- and grist-mill, using 5 feet of fall and 40 horse-power, and at York landing one of 3 runs, with 6 feet of fall and 30 horse-power.

*Power at Rochester.*—The first mill at this point is said to have been built in 1788 or 1789. By 1814 two more mills had been erected and small quantities of flour began to be exported to the Niagara frontier. The manufacture of flour steadily increased in importance, new flouring-mills were added, numerous other industries sprang up, and at the present time there are found here a variety and extent of manufacturing interests, based upon and in the main sustained by the water-power, which are equaled at few other cities. As nearly as could be ascertained, there

were, in the fall of 1882, flouring-mills in operation to the number of 17, with 134 sets of rollers, 30 runs of stone, and a probable aggregate production of at least 3,000 barrels of flour per day.(a) The manufacture of clothing is a great industry here, though not dependent upon water-power. Besides flour, as mentioned above, the productions of the various works receiving their motive power from the river include shoes, which are turned out in large numbers, cotton goods, paper; gauges, lanterns and lamps; stationary engines, car-wheels, screws, pins, and a great variety of general machinery, machinists' tools, and articles in wood.

In 1880 Rochester had a population of about 89,000, an increase of nearly 50 per cent. in the preceding ten years. The location of the city is admirable. Its foundation is solid limestone more or less overlaid by drift. It lies on both banks of the Genesee, and includes about 5 miles of the course of that river. The Erie canal passes directly through the city. The river itself is navigable nearly to the Lower falls, 5 miles from the lake, and at the mouth is the port of Charlotte, a place of about 1,000 inhabitants. The main line of the New York Central and Hudson River railroad passes through Rochester, and other important roads branch out in various directions.

From the pool above the state dam to the mean surface of the lake the descent in the river is 263 feet, nearly or quite all of which is within the city limits. There are three principal pitches, known respectively as the Upper, Middle, and Lower Genesee falls, which together embrace an aggregate abrupt fall of 205 feet.(b) French's *Gazetteer* says of them:

> The falls evidently all once formed a single cascade; but the different degrees of hardness of the several rocks over which the river flows have caused an unequal retrograde movement of the falls, until they have assumed their present position. The surface shales have worn away gradually to a uniform slope, over which the water flows in a series of rapids. At the Upper falls the stream falls a distance of 96 feet over the perpendicular edge of the Niagara limestone underlaid by shale. Below the Upper falls the river flows 1¼ mile, through a deep ravine bounded by nearly perpendicular sides, to the Middle falls, where it has a descent of 25 feet. One hundred rods below it descends 84 feet, over a ledge of Medina sandstone, to the level of lake Ontario.

The principal development of water-power, so far as concerns the number of mills, has been at the Upper Genesee falls, and at a privilege three-quarters of a mile above. At each of these localities there is a dam across the river, and on each bank is a hydraulic race conveying water for use in the mills and shops. They are in the heart of the city, where the ground is closely built upon, and, except perhaps at the Upton privilege, there is but little opportunity for erecting more works. The water-power interests appear to exist upon a very satisfactory basis. For the principal races commissioners are appointed by court, who attend to the proper adjustment of the weirs over which water is drawn into the mills. The entire privilege upon a race is divided into shares, and each mill has a width of weir-opening corresponding to the number of these owned. In abundant water the weirs are lowered so as to permit an unrestricted flow to the wheels, but in low stages of river they are raised to position, and adjusted as often as necessary, according to the volume at disposal, and in such manner that each mill shall secure its due proportion.

So far as could be learned, at all the water-privileges in Rochester, except possibly the Upton—where room and small amounts of power are rented or leased—practically all the rights to strictly permanent water are owned by the manufacturers. In many cases the available fall is not entirely developed, and in some the whole power of the stream, even with the head in use, is not utilized; the latter is true at the Lower falls, and the former both there and at the Upper falls. But, generally speaking, with the present development it is not more than nine or ten months in the year that all the mills and factories on the various races can be run at full capacity. For nearly that length of time, however, there is undoubtedly an important surplus power.

The uppermost dam in the city is that owned by the state and employed to divert water through the feeder to the "long" level of the Erie canal. This dam was not visited, but the fall there is said to be slight—not more than 3 or 4 feet.

A mile and three-quarters below the head of the feeder there is a dam of rubble masonry, which was built in 1856 at a cost of $2,100; it is about 400 feet long, 5½ feet high, 4 feet wide at the top, and has a batter of 3 inches to the foot. Below the dam the river descends over a succession of low ledges, and opposite the foot of the rapids thus formed are the mills. On the east side is "the Johnson & Seymour canal-race", which passes under the Erie Canal aqueduct and under the mills, having a length of about half a mile. The width is 60 feet at the head, decreasing toward the foot. The water-depth is stated to be about 4 feet at the upper end. There were originally 19 equal rights upon this race, but it was extended and 32 second rights were created. As long as the supply of water is abundant no especial restrictions are placed upon its use; but when it becomes sufficiently reduced the second rights are successively shut down, the most recent deeds or leases first, and when the flow in the race falls to 9,500 cubic feet per minute (500 cubic feet per minute for each of the 19 first rights), the second rights are cut off altogether and the water is equally divided among the first rights. At such times a man examines the head-gates and the weirs at the mills twice a day and makes the proper adjustments to secure to each mill its share of the water. The flume-gates range from 1 to 15 feet in width, according to the number of rights owned. These gates or weirs are raised from below. Over each is a horizontal shaft turned by a hand-wheel. At either end of this

a Although the number of mills has somewhat decreased in recent years, the capacity of those remaining is said to have more than correspondingly increased.

b The remaining descent is comprised in rapids and falls over the dams, which are low.

shaft is a beveled cog-wheel, gearing into another at right angles, fastened upon a screw-shaft which serves to raise or lower the weir. The depth of water entering at the head-gates into the race, and the depths on the various weirs at the mills, are read off on a rod resembling an ordinary leveling-rod. The amount of water flowing into the race having been obtained from tables, and the amount due each mill determined, a weir-book shows readily the proper corresponding depth to be allowed on any particular weir. The adjustment having been made, the weir is secured against tampering by a short chain passed through a pair of adjacent cog-wheels, mentioned above, and fastened by a padlock.

The head obtained on this race ranges in general from 16 to 18 feet, and the power may be considered as fully utilized. During nine months in the year there is surplus water above all demands, but more or less shortage for the rest of the time. It was stated that the lowest allowance made to first rights had been 200 cubic feet per minute, and that in an ordinary summer season it is 300 cubic feet. Power is used by 6 flouring-mills, having altogether 45 sets of rollers, 17 runs of stone, and producing over 900 barrels of flour per day; and by 2 large machine-shops and founderies, a large furniture factory, a brewery, a tannery, a picture-frame molding establishment, a morocco-skin factory, a dental- and barber-chair factory, a billiard-table factory, wholesale rectifying works, and various other shops of small size. The flouring-mills own 16 of the 19 first rights, the other concerns depending mainly upon second rights.

On the west side of the river is "the Rochester, Fitzhugh, & Carroll canal-race",(*a*) from a quarter to a third of a mile in length, and varying in width from 25 to 60 feet. With a full pond it is about 5 feet deep, and gives a head at the mills of about 17 feet. The power is nominally divided into 76 equal shares, of which 32 are owned in connection with a large building and rented to various manufacturers. There being 456 inches width of water-way at the head-gates a share is entitled to 6 inches width of weir-opening. The power is all in use, and the mills are more or less short of water three months in the year. The manufacturing concerns supplied are 3 flouring-mills, 2 printing-offices, and various wood-working shops.

Three-quarters of a mile below the dam last described are the Upper Genesee falls. The river is there 275 or 300 feet wide, and at approximately that distance above the falls is crossed by a low timber dam turning the water into a race on each bank. On the right hand, or east, the bank below the falls is high, and consists of an almost vertical rock wall, and the race runs only to the edge of the fall. Here are located three water-wheels—two 48-inch Leffel under 26 feet head, and one 35-inch Leffel under 65 feet head. A 6-inch wrought-iron shaft extends 400 feet, up the bank from the wheel-pit, parallel to the river, and then a double line continues 400 feet farther. From these main shafts power is transferred throughout extensive buildings to a large number of manufacturing concerns, usually such, probably, as to require but small or moderate amounts of power in their operations. The transfer of power was formerly effected here, even in amounts of 200 or 300 horse-power, by cables, but these have been abandoned. Sheaves ranging in diameter from 10 feet downward were in use, but trouble was experienced from two principal causes—owing to the weight of the large cables the packing in the sheaves wore away rapidly, and the difficulty was much increased by the freezing of spray to the cables in winter, forming a coating of ice; and secondly, it was found that when power was suddenly taken off at any of the works the cable was apt to jump, strike against the flanges of the sheaves, and break the strands.

The whole of the privilege on the east side, with the buildings, formerly owned by the Rochester Hydraulic Company, is now the property of Mr. C. E. Upton. Room and power are rented or leased for short periods, the usual rental for power being $25 per annum per effective horse-power. There is room for more buildings, and these, it was stated by the agent in charge of the privilege, Mr. Upton proposes to erect as demand shall arise, and rent with power. Though the fall is not fully developed, there is said always to be sufficient power, with wheels as at present, to run at full capacity all the works that are in operation. In the fall of 1882 the Rochester Electric Light Company was the largest single user of power, having 175 horse-power and running 175 lights. Power was also rented to a considerable number of shoe-manufacturers, at least 9 or 10; to H. J. Howe & Co., scale-manufacturers; Horton's Edge Tool Manufacturing Company; Tigler's auger-works; the Spencer Fire Escape Company; 3 machine-shops; 2 sash- and blind-factories, and other shops of less note.

The rock at the Upper falls is in part soft and crumbly. It is evident that the falls themselves are gradually receding, and under an old mill at their east end it has been found necessary to build a supporting wall 65 feet high and ranging from 12 to 20 feet in thickness. On the west side the land adjoining the river is level and well suited to building, and the race, known as "Brown's race", is carried some distance below the falls, the wheel-pits being sunk in the rock. The shafts are generally lined with iron tubes, though sometimes with wood, and tail-water is discharged to the river through connecting tunnels. At the time this privilege was visited a shaft and tunnel had recently been completed for Farley, Ferguson, & Wilson's flouring-mill. The shaft is lined with iron tubing and is 40 feet deep; from it a tunnel runs 120 feet to the face of the cliffs. The rock had to be blasted out, and required the labor of 5 or 6 men for six months. No accurate information was obtained as to the fall from the crest of the dam to low-water surface at the foot of all the mills, but it is probably as much as 100 feet. The full available fall is not in use, however, by more than a very few, if it is by any, of the mills, and the heads employed range in

*a* "In 1802, Nathaniel Rochester, William Fitzhugh, and Charles H. Carroll, from Maryland, purchased a tract of 300 acres at the Upper falls, and in 1812 they caused their land to be laid out for settlement."—French's *Gazetteer*, page 404.

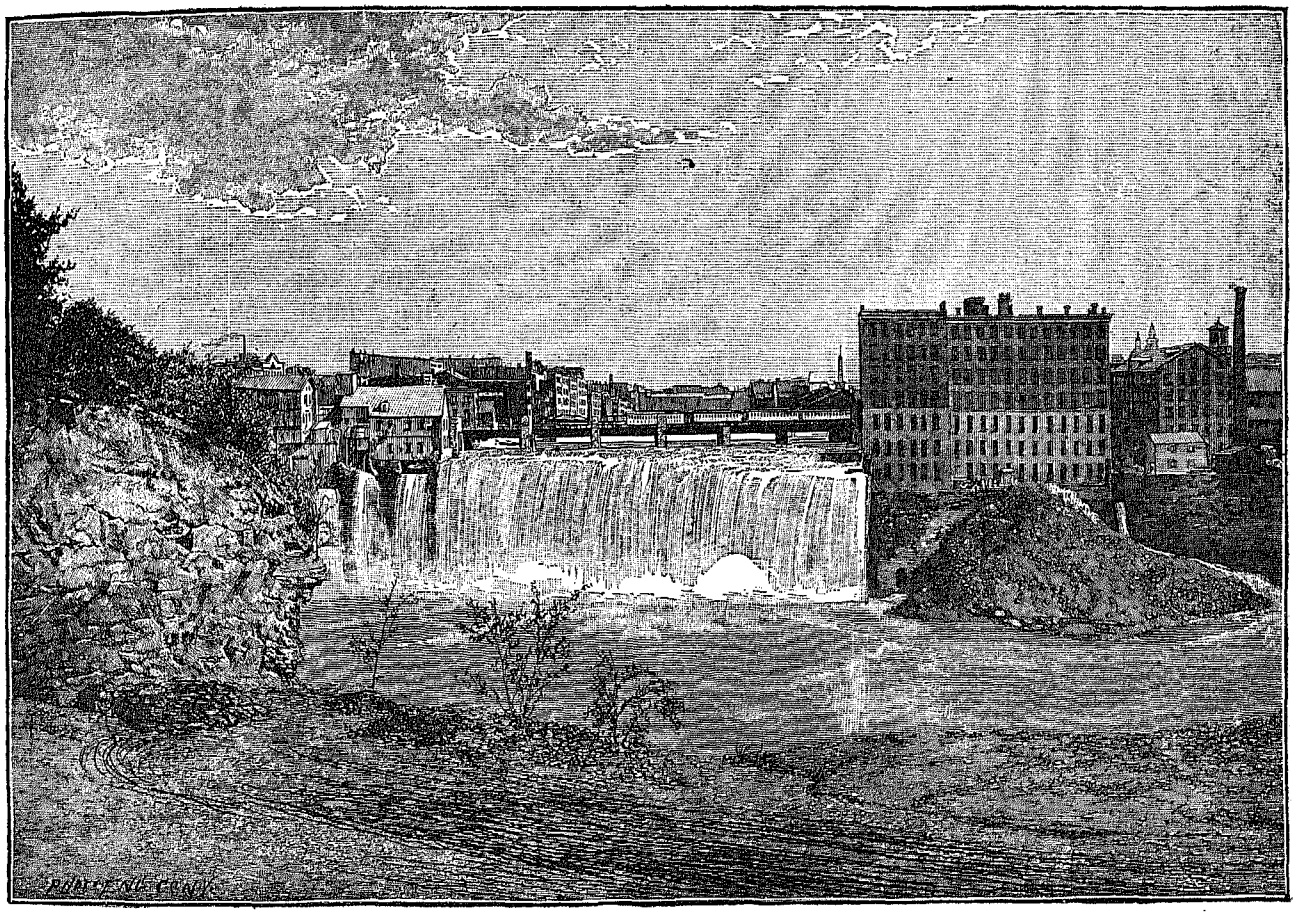

FIG. 8.—Upper falls in the Genesee river at Rochester.

general from 80 or 90 feet downward. The Steam Gauge & Lantern Company obtains a fall of 80 feet from the hydraulic race and 60 feet from one of the city sewers. It has 380 horse-power of wheels, and during abundant water relies upon the race alone, but when the supply from that source falls low it adds the sewer water. As the demands for the various manufactories and mills increase, the wheel-pits are sunk lower and the full development of the power is more nearly approached.

There is at the head-gates 49 feet width of water-way, and the whole power on the race is divided into 79 equal rights, each including about 7½ inches width of weir-opening. During a plentiful supply of water the weirs are not used, and the race may be drawn upon freely, but in low stages of river they are put in operation and properly adjusted by commissioners. In order that there may be the same depth of water falling over all the weirs into the mill-flumes, their absolute elevation gradually decreases toward the foot of the race, while their level, relatively to the water-surface in the race when all the mills are drawing, is intended to be uniform. For two or three months in the year there is a short supply of water, and more or less bargaining of it between the different mill-owners.

*Statistics of manufacturing on "Brown's race".*

| Firm or company. | Kind of mill or manufacture. | Remarks. |
|---|---|---|
| Rochester Cotton Mill | Prints | 231 looms; 10,000 spindles; 48 feet fall. |
| Steam Gauge & Lantern Company | Gauges, lanterns, etc | Employs 265 men, and has 380 horse-power of wheels. |
| J. B. Stevens & Son | Packing-boxes | From 25 to 40 hands. This and a furniture factory receive power from the lantern factory. |
| Rochester Car Wheel Works | Car-wheels | From 35 to 40 hands. Capacity of works, 120 wheels per day, and in the fall of 1882 were turning out half that number. |
| A. J. Johnson & Co | Shoes | Employ about 400 hands, and in busy times turn out about 1,500 pairs of shoes per day. |
| Rochester Machine Screw Company | Machine-screws | 50 hands. |
| R. Whalen & Co | Tobacco factory | 25 hands. |
| William Gleason | Machinists' tools | 80 hands; about 74 feet fall. |
| Kelly Lamp Company | Head-lights and lanterns | About 100 hands. |
| Junius Judson & Son | Steam-governors | From 140 to 150 hands. |
| Judson Pin Works | Pins | 75 hands. |
| Judson Foundery | | |
| Mach & Co | Edge-tools | 200 hands. |
| F. P. Michel | Machinists' tools | About 30 hands. |
| Woodbury, Booth, & Pryor | Boilers and stationary steam-engines | From 70 to 120 hands; 50 feet fall. |
| J. G. Davis & Son | Flouring | 60 feet fall; 10 sets of rollers; 200 barrels per day. |
| J. A. Hinds | do | 60 feet fall; 12 sets of rollers; 2 runs of stone; from 225 to 250 barrels per day. |
| George F. Merz | Custom-mill | 25 feet fall; 3 runs of stone; 7 sets of rollers. |
| Mosely & Motley | Two flouring-mills | 46 single sets of rollers; combined capacity of mills, 500 barrels per day; falls in use, 66 and 56 feet. |
| Stone & Campbell | Flouring | 5 runs of stone; 16-foot overshot wheel, below which is a turbine under 38 feet fall. |
| Boardman, Sherman, & Co | do | 10 sets of rollers; 3 runs of stone; 200 barrels per day; 56 feet fall. |
| Farley, Ferguson, & Wilson | Custom and flouring | 70 feet fall; 2 double sets of rollers. |

NOTE.—In addition to the above there are many other small shops for the manufacture of all kinds of machine and wood work; the city water-works also receive power for pumping.

Between 1¼ and 1½ mile below the Upper falls are the Middle falls, with a natural pitch of 20 or 25 feet. A timber dam runs across in an irregular line, from 25 to 75 feet up stream from the crest. The entire privilege, including both sides of the river, is owned by the Rochester Paper Company, and all power not now employed is reserved for the company's use. On the east bank a small batting-mill utilizes not over 25 horse-power. On the west bank a short race leads to the paper-mill, where American and Leffel turbines with an aggregate of 1,200 horse-power are in use, running under a head of about 30 feet. The company makes news printing-paper, employing 100 hands, and produces 9 or 10 tons per day. The rag- and straw-pulp, and most of the wood-pulp, are manufactured in the works. For three or four months in about every year there is some scarcity of water, but it is thought that the supply would be sufficient were it not for the demands made at the feeder-dam for the Erie canal.

A quarter of a mile, more or less, below the Middle falls are the Lower falls, where the river suddenly plunges down nearly 90 feet. A low dam extending across at the top raises the available head for power to about 94 feet. Below the falls are rapids for a short distance, and then the river becomes smooth. It lies in a deep gorge, the rocky sides of which rise precipitously, on the west probably 30 and on the east at least 75 feet higher than the top of the falls. The rock strata in the banks are horizontal, and are composed of sandstone overlaid by blue limestone.

On the east side of the river all the power is owned by the Hydraulic Motor Company. Water is to be carried in a flume a short distance to a vertical tower which rests on a narrow shelf between the river and the side of the gorge. This tower contains two tubes designed for compressing air, which is to be conveyed in an iron pipe to the top of the neighboring bank. The intention is to supply this form of motive power to the street-cars of Rochester, but the enterprise advances very slowly.

On the west bank it is claimed that all the power is owned by the Hydraulic Motor Company, except 1,265 horse-power which is leased to the Brush Electric Light Company with privilege of sale. From this end of the

dam water passes through a timber bulkhead and a race cut in a projecting flat surface of rock for about 100 feet, to a wheel-house, and power is thence transferred by cable to the top of the adjoining bluff. A 165 horse-power wheel was in use in November, 1882, under a head of 34 feet, the power being partly employed by the Brush company in generating electricity. A building at the top of the bank was being occupied temporarily, but a new structure for the main works was being erected close to the river. It was stated that the company designed to expend some $45,000 here, and would extend its system of lighting over the whole city. A grist-mill and a small carpenter- and planing-shop are also supplied from the Brush company's building, the latter by a shaft and the former by a long cable.

The banks are so steep and rocky as to forbid long open races at this privilege, and therefore either the power must be distributed from one or two points near the falls, or water must be conveyed through tunnels, which would be practicable, though expensive. It was stated that new manufacturing enterprises could probably obtain power on the west bank, and there is some 10 acres of level ground adjacent which is finely suited to building. For most of the year there must evidently be a very great surplus power here; but without knowing definitely how much is likely to be required for the wants of the Brush and Hydraulic Motor companies it is of course impossible to estimate the amount of strictly permanent power remaining available for general manufacturing.

The New York Central and Hudson River railroad crosses the Genesee river immediately above the Upper falls, and between their crest and the dam which diverts water into the Brown and Upton races. According to the railroad levels the bed of the river beneath the bridge is 477 feet above ocean-level. The mean surface of lake Ontario being 247 feet above the same plane of reference, the fall from the top of the Upper falls to the lake is 230 feet. If we assume of this, 96 feet for the Upper falls below the bridge, 30 feet as the total descent at the Middle falls, and 94 feet at the Lower falls, then 220 feet is thus accounted for, leaving not over 10 feet to be made up by rapids and the gradual slope of the stream.

*Estimate of power at Rochester.*

| Stage of river. | RAINFALL ON BASIN. | | | | | Drainage area. | Net flow per second, average for the 24 hours. (a) | THEORETICAL HORSE-POWER. | | | | | | | Total effective horse-power of wheels in use. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring. | Summer. | Autumn. | Winter. | Year. | | | 1 foot fall. | 17 feet fall, assumed for Upper privilege. | 100 feet fall, assumed for privilege at Upper falls. | 30 feet fall, assumed at Middle falls. | 94 feet fall, assumed at Lower falls. | 241 feet fall, total of four privileges. | 263 feet fall, assumed as total within city limits. | |
| | *In.* | *In.* | *In.* | *In.* | *In.* | *Sq. miles.* | *Cu. feet.* | | | | | | | | |
| Low water, dry year | | | | | | | 300 | 34.1 | 580 | 3,410 | 1,020 | 3,210 | 8,220 | 8,970 | |
| Low water, average year | | | | | | | 350 | 39.8 | 680 | 3,980 | 1,190 | 3,740 | 9,590 | 10,470 | |
| Available 10 months, average year | | | | | | | 600 | 68.2 | 1,160 | 6,820 | 2,050 | 6,410 | 16,440 | 17,940 | |
| Available 9 months, average year | 8 | 9½ | 9 | 7 | 33½ | 2,474 | 830 | 94.3 | 1,600 | 9,430 | 2,830 | 8,860 | 22,720 | 24,800 | 6,442+ |
| Available 8 months, average year | | | | | | | 1,100 | 125.0 | 2,120 | 12,500 | 3,750 | 11,750 | 30,120 | 32,880 | |
| Available 7 months, average year | | | | | | | 1,570 | 178.4 | 3,030 | 17,840 | 5,350 | 16,770 | 42,990 | 46,920 | |
| Available 6 months, average year | | | | | | | 2,060 | 234.0 | 3,980 | 23,400 | 7,020 | 22,000 | 56,400 | 61,540 | |

*a* Although certain statements made to the author indicate that the discharge at Rochester has been known to fall even lower than the lowest figures here assumed, yet such occurrences appear to have been so exceptional and of so short duration that they are here neglected.

*Table of utilized power on the Genesee river and tributaries.*

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* |
| Genesee river | Lake Ontario | Pennsylvania | Potter | Saw | 5 | 74 | 97 | ..... |
| Do | do | do | do | Woolen | 2 | 10 | 30 | ..... |
| Do | do | New York | Allegany | Flouring and grist | 6 | 58 | 226 | ..... |
| Do | do | do | do | Machinery | 2 | 24 | 124 | ..... |
| Do | do | do | do | Saw | 6 | 59 | 188 | ..... |
| Do | do | do | Wyoming | Flouring and grist | 1 | 7½ | 35 | ..... |
| Do | do | do | do | Saw | 1 | 12 | 75 | ..... |
| Do | do | do | Livingston | Flouring and grist | 3 | Mt. Morris fall, 14 feet. | 145+ | ..... |
| Do | do | do | do | Machinery | 2 | | 200 | ..... |
| Do | do | do | do | Planing | 1 | | ..... | ..... |
| Do | do | do | do | Plaster | 1 | | ..... | ..... |
| Do | do | do | do | Saw | 1 | | 25 | ..... |
| Do | do | do | do | Flouring and grist | *a* 1 | 5 | 40 | ..... |
| Do | do | do | do | do | *b* 1 | 6 | 30 | ..... |

*a* Geneseo. *b* York.

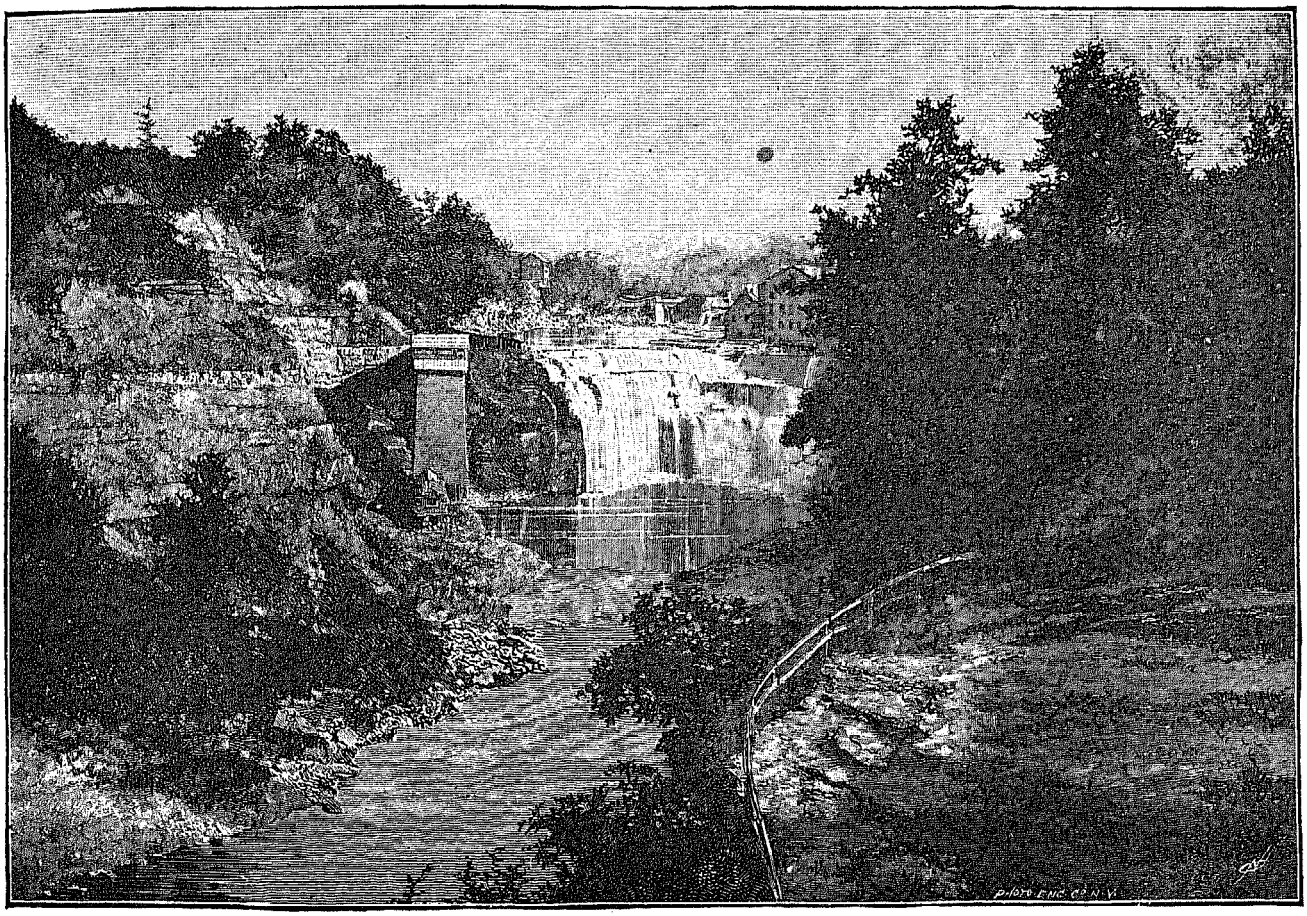

FIG. 9.—Lower falls in the Genesee river at Rochester.

*Table of utilized power on the Genesee river and tributaries*—Continued.

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* |
| Genesee river | Lake Ontario | New York | Monroe | Agricultural implements | 2 | Rochester—total fall at four privileges, 241 feet, of which perhaps 170 or 180 feet is actually utilized. | 41 | |
| Do | do | do | do | Architectural and ornamental iron-work | 1 | | 35 | |
| Do | do | do | do | Axles | 1 | | 30 | |
| Do | do | do | do | Billiard tables | 1 | | | |
| Do | do | do | do | Blacking | 1 | | 20 | |
| Do | do | do | do | Boots and shoes | 9 | | 191 | |
| Do | do | do | do | Boot and shoe cut stock | 1 | | 12 | |
| Do | do | do | do | Boilers and steam-engines | 1 | | | |
| Do | do | do | do | Brewery | 1 | | | |
| Do | do | do | do | Carpentering | 2 | | 78 | |
| Do | do | do | do | Car-wheels | 1 | | | |
| Do | do | do | do | Chairs | 3 | | 95 | 30 |
| Do | do | do | do | Cigar-boxes | 3 | | 31 | |
| Do | do | do | do | Cotton | 2 | | 138 | |
| Do | do | do | do | Cutlery and edge-tools | 8 | | 339 | |
| Do | do | do | do | Electric lighting | 2 | | 340 | |
| Do | do | do | do | Fire-escapes | 1 | | | |
| Do | do | do | do | Fire-proof safes, doors, and vaults | 1 | | 2 | |
| Do | do | do | do | Files | 2 | | 29 | |
| Do | do | do | do | Flouring and grist | 17 | | 1,520 | |
| Do | do | do | do | Furniture | 6 | | 158 | 75 |
| Do | do | do | do | Hardware | 2 | | 75 | |
| Do | do | do | do | Iron castings | 1 | | 10 | |
| Do | do | do | do | Iron forgings | 1 | | 30 | |
| Do | do | do | do | Ivory and bone work | 1 | | 15 | |
| Do | do | do | do | Lasts | 2 | | 60 | |
| Do | do | do | do | Looking-glass and picture frames | 4 | | 83 | |
| Do | do | do | do | Machinery | 19 | | 581 | |
| Do | do | do | do | Models and patterns | 1 | | 45 | |
| Do | do | do | do | Morocco-skin factory | 1 | | | |
| Do | do | do | do | Needles and pins | 1 | | 180 | |
| Do | do | do | do | Paper | 1 | | 1,200 | |
| Do | do | do | do | Printing and publishing | 2 | | 60 | 18 |
| Do | do | do | do | Professional and scientific instruments | 1 | | 5 | |
| Do | do | do | do | Rectifying works | 1 | | | |
| Do | do | do | do | Sashes, doors, and blinds | 5 | | 87 | |
| Do | do | do | do | Scales and balances | 2 | | 50 | |
| Do | do | do | do | Steam-gauges and lanterns | 1 | | 380 | |
| Do | do | do | do | Silverware | 1 | | 1 | |
| Do | do | do | do | Soap and candles | 1 | | 35 | |
| Do | do | do | do | Steam-fitting and heating apparatus | 1 | | 60 | |
| Do | do | do | do | Tobacco factory | 1 | | | |
| Do | do | do | do | Tannery | 1 | | | |
| Do | do | do | do | Tools | 1 | | 120 | |
| Do | do | do | do | Trunks and valises | 1 | | 50 | |
| Do | do | do | do | Watch and clock repairing | 1 | | 2 | |
| Do | do | do | do | Wooden packing-boxes | 2 | | 95 | 51 |
| Do | do | do | do | Wood, turned and carved | 8 | | 146 | |
| Do | do | do | do | Women's clothing | 2 | | 13 | |
| Canaseraga creek and tributaries | Genesee river | do | Allegany | Flouring and grist | 1 | 31 | 40 | |
| Do | do | do | Steuben | do | 3 | 70 | 104 | |
| Do | do | do | do | Saw | 1 | 14 | 14 | |
| Do | do | do | Livingston | Flouring and grist | 11 | 180 | 523 | |
| Do | do | do | do | Pumps | 2 | 31 | 24 | |
| Do | do | do | do | Sashes, doors, and blinds | 1 | 12 | 30 | |
| Do | do | do | do | Saw | 6 | 120 | 160 | |
| Do | do | do | do | Wooden ware | 1 | 16 | 20 | |
| Conesus outlet and tributaries | do | do | do | Flouring and grist | 7 | 176 | 332 | 42 |
| Do | do | do | do | Saw | 1 | 10 | 60 | |
| Honeoye creek and tributaries | do | do | do | Flouring and grist | 7 | 125 | 224 | 33 |
| Do | do | do | do | Saw | 4 | 78 | 115 | 4 |
| Do | do | do | Monroe | Agricultural implements, etc | 1 | 6 | 15 | |
| Do | do | do | do | Fertilizers | 1 | 23 | 65 | |
| Do | do | do | do | Flouring and grist | 5 | 84 | 308 | |
| Do | do | do | do | Sashes, doors, and blinds | 1 | 15 | 25 | |
| Do | do | do | do | Saw | 2 | 42 | 98 | |

*Table of utilized power on the Genesee river and tributaries*—Continued.

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* |
| Honeoye creek and tributaries | Genesee river | New York | Monroe | Woolen | 1 | 11 | 20 | ..... |
| Do | do | do | Ontario | Carriage and wagon materials | 1 | 14 | 14 | ..... |
| Do | do | do | do | Flouring and grist | 6 | 102 | 211 | ..... |
| Do | do | do | do | Machinery | 1 | 12½ | 12 | ..... |
| Do | do | do | do | Paper | 1 | 15 | 90 | 40 |
| Do | do | do | do | Saw | 5 | 58½ | 173 | ..... |
| Oatka creek and tributaries | do | do | Wyoming | Cooperage | 1 | 12 | 20 | ..... |
| Do | do | do | do | Flouring and grist | 6 | 78 | 154 | ..... |
| Do | do | do | do | Machinery | 1 | 8 | 12 | ..... |
| Do | do | do | do | Saw | 2 | 25 | 46 | ..... |
| Do | do | do | do | Wood, turned and carved | 1 | 14 | 12 | ..... |
| Do | do | do | Monroe | Fertilizers | 2 | 32 | 137 | ..... |
| Do | do | do | do | Flouring and grist | 5 | 80 | 233 | 20 |
| Do | do | do | do | Woolen | 1 | 6 | 18 | ..... |
| Do | do | do | Genesee | Agricultural implements | 1 | 5 | 20 | ..... |
| Do | do | do | do | Fertilizers | 1 | 4 | 50 | ..... |
| Do | do | do | do | Flouring and grist | 4 | 40 | 183 | ..... |
| Do | do | do | do | Linseed oil | 1 | 7 | 2 | ..... |
| Do | do | do | do | Paper | 1 | 28 | 50 | ..... |
| Do | do | do | do | Sashes, doors, and blinds | 1 | 7 | 6 | ..... |
| Do | do | do | do | Saw | 2 | 22 | 45 | ..... |
| Black creek and tributaries | do | do | Monroe | Flouring and grist | 2 | 8+ | 90 | 30 |
| Do | do | do | do | Saw | 1 | 8 | 20 | ..... |
| Do | do | do | Genesee | Flouring and grist | 7 | 141 | 275 | 65 |
| Do | do | do | do | Saw | 4 | 70 | 61 | ..... |
| Do | do | do | do | Woolen | 1 | 20 | 15 | ..... |
| Sundry other tributaries | do | Pennsylvania | Potter | Flouring and grist | 1 | 20 | 15 | ..... |
| Do | do | New York | Allegany | do | 17 | 311 | 476 | 45 |
| Do | do | do | do | Paper | 1 | 20 | 55 | 75 |
| Do | do | do | do | Saw | 12 | 165 | 411 | ..... |
| Do | do | do | Wyoming | Agricultural implements | 3 | 38 | 123 | ..... |
| Do | do | do | do | Cooperage | 1 | 9 | 12 | ..... |
| Do | do | do | do | Flax, dressed | 2 | 29 | 33 | ..... |
| Do | do | do | do | Flouring and grist | 11 | 186 | 349 | ..... |
| Do | do | do | do | Lumber, planed | 1 | ..... | 10 | ..... |
| Do | do | do | do | Sashes, doors, and blinds | 1 | 18 | 15 | ..... |
| Do | do | do | do | Saw | 11 | 121 | 342 | ..... |
| Do | do | do | do | Wooden ware | 1 | 10 | 53 | ..... |
| Do | do | do | do | Woolen | 2 | 29 | 47 | ..... |
| Do | do | do | Livingston | Flouring and grist | 2 | 34 | 80 | ..... |
| Do | do | do | do | Saw | 1 | 20 | 20 | ..... |
| Do | do | do | Monroe | Flouring and grist | 2 | 15 | 70 | ..... |

*Table of utilized power on sundry streams flowing into lake Ontario.*

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* |
| Sandy creek and tributaries | Lake Ontario | New York | Jefferson | Blacksmithing | 2 | 24 | 26 | ..... |
| Do | do | do | do | Carpentering | 1 | 12 | 20 | ..... |
| Do | do | do | do | Cooperage | 1 | 12 | 12 | ..... |
| Do | do | do | do | Flouring and grist | 12 | 159 | 462 | 15 |
| Do | do | do | do | Furniture | 2 | 25 | 20 | ..... |
| Do | do | do | do | Lumber, planed | 1 | 12 | 20 | 10 |
| Do | do | do | do | Paper | 1 | 18 | 50 | ..... |
| Do | do | do | do | Sashes, doors, and blinds | 1 | 9 | 15 | ..... |
| Do | do | do | do | Saw | 21 | 244 | 443 | ..... |
| Do | do | do | do | Tannery | 1 | 6 | 21 | 12 |
| Do | do | do | do | Wooden handles | 1 | 14 | 10 | ..... |

*Table of utilized power on sundry streams flowing into lake Ontario*—Continued.

| Stream. | Tributary to what. | State. | County. | Kind of mill or manufacture. | Number of mills. | Total full utilized. | Total water-power utilized. | Auxiliary steam-power. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | *Feet.* | *H. P.* | *H. P.* |
| Sandy creek and tributaries | Lake Ontario | New York | Jefferson | Woolen | 1 | 18 | 12 | |
| Do | do | do | Lewis | Furniture | 1 | 14 | 6 | |
| Do | do | do | do | Saw | 3 | 30 | 61 | 25 |
| Salmon river and tributaries | do | do | Oswego | Cooperage | 1 | 5 | 10 | |
| Do | do | do | do | Flouring and grist | 6 | 57 | 288 | |
| Do | do | do | do | Furniture | 1 | 5 | 10 | |
| Do | do | do | do | Machinery | 1 | 10 | 15 | |
| Do | do | do | do | Paper | 2 | 22½ | 120 | |
| Do | do | do | do | Sashes, doors, and blinds | 3 | 20 | 65 | |
| Do | do | do | do | Saw | 19 | 176½ | 399 | |
| Do | do | do | do | Tanneries | 3 | 23 | 39 | |
| Do | do | do | do | Wheelwrighting | 1 | 5 | 20 | |
| Do | do | do | do | Wooden packing-boxes | 1 | 12 | 20 | |
| Do | do | do | do | Woolen | 1 | 15 | 20 | |
| Do | do | do | Lewis | Saw | 5 | 52 | 183 | |
| Irondequoit creek and tributaries | do | do | Monroe | Paper | 1 | 18 | 111 | |
| Do | do | do | do | Flouring and grist | 6 | 75½ | 237 | |
| Do | do | do | Ontario | do | 2 | 16+ | 80 | |
| Oak Orchard creek and tributaries | do | do | Orleans | Agricultural implements | 2 | 18 | 30 | |
| Do | do | do | do | Carpentering | 1 | 7 | 10 | |
| Do | do | do | do | Flouring and grist | 8 | 139 | 464 | |
| Do | do | do | do | Machinery | 2 | 32 | 245 | |
| Do | do | do | do | Paper | 1 | 21 | 88 | 84 |
| Do | do | do | do | Saw | 7 | 110½ | 350 | 126 |
| Do | do | do | Genesee | Flouring and grist | 1 | 21 | 46 | |
| Do | do | do | Niagara | do | 1 | 15 | 80 | |
| Do | do | do | do | Saw | 2 | 22 | 50 | |
| Eighteen-Mile creek and tributaries | do | do | do | Agricultural implements | 1 | 7 | 10 | |
| Do | do | do | do | Flouring and grist | 4 | 62 | 300 | |
| Do | do | do | do | Saw | 3 | 37 | 98 | 70 |
| Other small streams | do | do | Jefferson | Agricultural implements | 1 | 12 | 22 | |
| Do | do | do | do | Butter and cheese | 1 | 3 | 1 | |
| Do | do | do | do | Flouring and grist | 9 | 130 | 343 | 53 |
| Do | do | do | do | Sashes, doors, and blinds | 1 | 22 | 6 | |
| Do | do | do | do | Saw | 7 | 74½ | 253 | 55 |
| Do | do | do | Oswego | Agricultural implements | 1 | 9 | 10 | |
| Do | do | do | do | Carpentering | 1 | 12 | 8 | |
| Do | do | do | do | Cooperage | 1 | 4 | 10 | |
| Do | do | do | do | *Flouring and grist* | *13* | *166* | *710* | |
| Do | do | do | do | Iron castings and finishings | 1 | 8 | 28 | 18 |
| Do | do | do | do | Lumber, planed | 1 | 10 | 8 | |
| Do | do | do | do | Machinery | 1 | 9 | 10 | |
| Do | do | do | do | Sashes, doors, and blinds | 3 | 28 | 56 | |
| Do | do | do | do | Saw | 42 | 438½ | 937 | 10 |
| Do | do | do | do | Tannery | 1 | 10 | 18 | 15 |
| Do | do | do | do | Wheelwrighting | 1 | 9 | 4 | |
| Do | do | do | do | Woolen | 2 | 12+ | 34 | |
| Do | do | do | Cayuga | Flouring and grist | 4 | 52 | 135 | |
| Do | do | do | do | Saw | 8 | 82 | 235 | 30 |
| Do | do | do | Wayne | Flax, dressed | 1 | 9 | 12 | |
| Do | do | do | do | Flouring and grist | 12 | 185 | 490 | 180 |
| Do | do | do | do | Pumps | 1 | 8 | 10 | |
| Do | do | do | do | Saw | 11 | 134½ | 200 | 15 |
| Do | do | do | Monroe | Flouring and grist | 10 | 174 | 520 | 20 |
| Do | do | do | do | Saw | 4 | 50 | 60 | |
| Do | do | do | Orleans | Flouring and grist | 8 | 181 | 460 | |
| Do | do | do | do | Pickles, preserves, and sauces | 1 | 11 | 36 | |
| Do | do | do | do | Saw | 4 | 64 | 153 | |
| Do | do | do | do | Vinegar | 2 | 23 | 44 | |
| Do | do | do | Niagara | Flouring and grist | 1 | 10½ | 50 | |
| Do | do | do | do | Paper | 1 | 13 | 50 | |
| Do | do | do | do | Saw | 2 | 37 | 80 | |

*Summary of utilized power on streams tributary to*

| | Stream. | FLOURING- AND GRIST-MILLS. | | | SAW-MILLS. | | | PAPER-MILLS. (a) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of mills. | Water-power utilized. | Auxiliary steam-power. | Number of mills. | Water-power utilized. | Auxiliary steam-power. | Number of mills. | Water-power utilized. | Auxiliary steam-power. |
| | | | *H. P.* | *H. P.* | | *H. P.* | *H. P.* | | *H. P.* | *H. P.* |
| 1 | Black river and tributaries | 35 | 2,235 | 65 | 81 | 2,737 | ..... | 11 | 4,707 | ..... |
| 2 | Oswego river and tributaries | 258 | 12,590 | 814 | 227 | 5,906 | 295 | 26 | 2,047 | 207 |
| 3 | Genesee river and tributaries | 126 | 5,667 | 235 | 65 | 1,950 | 4 | 4 | 1,395 | 115 |
| 4 | Sundry other streams | 97 | 4,665 | 268 | 138 | 3,502 | 331 | 6 | 419 | 84 |
| | Total | 516 | 25,157 | 1,382 | 511 | 14,095 | 630 | 47 | 8,568 | 406 |

*a* Including two or three pulp-mills.

NOTE.—The class of "metal-working establishments" includes works for the manufacture of agricultural implements, architectural and ornamental iron-work, iron forgings; sewing-machines and materials, pumps, vacuum-brakes, and general machinery; lamps and reflectors, needles and pins, professional and scientific

The class of "wood-working establishments" includes planing- and shingle-mills; carpentering, cooperage, wheelwrighting, and wood-turning and carving looking-glass and picture frames, models and patterns, organs, packing-boxes, piano materials, sashes, doors, and blinds; washing-machines and clothes-wringers,

The class of "sundry other establishments" includes 1 carpet factory, 4 cotton factories, 5 hosiery-mills, 1 silk-mill, 2 electric-lighting works, 1 dry-dock, 3 grain-elevators, printing and publishing works, tanneries, 1 stone-quarry; and concerns engaged in the manufacture of animal oil, blacking, boots and shoes and whetstones, ivory and bone work, lime, malt, morocco; pickles, preserves and sauces; soap and candles, starch, sporting goods, table-mats, trunks and valises, and

*lake Ontario (not including the Niagara river).*

| WOOLEN-MILLS. (b) | | | METAL-WORKING ESTABLISHMENTS. | | | WOOD-WORKING ESTABLISHMENTS. | | | SUNDRY OTHER ESTABLISHMENTS. | | | TOTAL. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of mills. | Water-power utilized. | Auxiliary steam-power. | Number of mills. | Water-power utilized. | Auxiliary steam-power. | Number of mills. | Water-power utilized. | Auxiliary steam-power. | Number of mills. | Water-power utilized. | Auxiliary steam-power. | Number of mills. | Water-power utilized. | Auxiliary steam-power. | |
| | *H. P.* | *H. P.* | | *H. P.* | *H. P.* | | *H. P.* | *H. P.* | | *H. P.* | *H. P.* | | *H. P.* | *H. P.* | |
| 4 | 42 | ..... | 14 | 879 | 30 | 41 | 1,299 | 57 | 26 | 1,130 | 233 | 212 | 13,029 | 385 | 1 |
| 23 | 2,492 | 572 | 64 | 2,601 | 1,155 | 80 | 1,941 | 313 | 70 | 3,821 | 812 | 748 | 31,488 | 4,168 | 2 |
| 7 | 130 | ..... | 50 | 2,088 | ..... | 50 | 1,125 | 156 | 38 | 1,543 | 13 | 349 | 13,898 | 523 | 3 |
| 4 | 66 | ..... | 13 | 406 | 18 | 24 | 330 | 10 | 10 | 171 | 27 | 292 | 9,559 | 738 | 4 |
| 38 | 2,730 | 572 | 150 | 6,064 | 1,203 | 195 | 4,695 | 536 | 144 | 6,665 | 1,085 | 1,601 | 67,974 | 5,814 | |

* *b* Including a worsted-mill, a hosiery-mill, and a knit-underwear mill.

boilers and steam-engines, car-wheels, cutlery and edge-tools, files, and general hardware; fire-proof safes, doors, and vaults; iron castings and finishings, and instruments, scales and balances, silver-ware, steam-fitting and heating apparatus, surgical appliances, tin-, copper-, and sheet-iron ware.
shops; and works for the manufacture of axles, billiard-tables, carriages and wagons and materials, chairs, cigar-boxes, coffins and burial-cases, furniture, lasts, wheelbarrows, window-blinds and shades, wooden handles, and wooden ware.
pumping-works for water-supply, breweries, distilleries; millwrighting, flax-dressing, wool-carding, watch- and clock-repairing, and file shops; rectifying works, cut-stock; bread, crackers, etc.; butter and cheese, cement, fertilizers, plaster, chewing- and smoking-tobacco and snuff, flux, fire-escapes, gunpowder, hones and women's clothing.

# WATER-POWER

OF THE

# NEW YORK STATE CANALS.

477—59

61-479

# WATER-POWER OF THE NEW YORK STATE CANALS.

Although the Champlain canal was completed as far back as 1823, the Erie in 1825, and the more important of the other New York canals within the succeeding eight years, there were, at the period of their construction, numerous mills scattered through the state which were run by water-power, some of them occupying privileges on streams that were more or less interfered with for feeding the canals and that had their flow diverted to the injury of the mills. Where such diversions were made the owners of the privileges were permitted, under certain conditions, to draw off surplus water from the canals or at the feeder-dams, as the case might be. If the powers at the dams were not thus taken up, then the state sold or leased the rights of the surplus waters to the highest bidders. In this way it has come about that at many of the feeder-dams, and at some points on the lines of the canals, powers are in use that are dependent on the state improvements. Equitable as the granting of these rights may have been originally, the rentals received now appear very small in comparison with the value of the privileges; there is a natural tendency to disregard the rights of the state and to draw down the levels, and, so far as concerns the working of the canals, the withdrawals for hydraulic power can not be regarded as other than prejudicial, though perhaps not greatly so. As late as 1880, at least, the relative rights of the state and of individuals regarding these privileges were an unsettled and disputed question, and the policy observed by the former was not to lease or in any other way dispose of more water.

According to a report made in March, 1871, by the auditor of the New York canal department, there were in force at that time 18 water-leases, yielding to the state a total annual rental of about $3,400. Of this amount, $200 was derived from the surplus water at the head of the locks at Lockport; $210 from the surplus at the Glens Falls feeder-dam; $550 from the surplus at the Troy and Lansingburg dam on the Hudson river, and between $1,500 and $1,600 from surplus waters leased at Black Rock, at the western terminus of the Erie canal.

## POWER AT LOCKPORT.

In the 31 miles from the Buffalo terminus to Lockport the Erie canal is without lift-locks, and the only change in level is that due to a very small slope in the water-surface, and amounting to but 0.8 of a foot in the whole distance. At Lockport there is a sudden descent in a flight of five combined double locks, with a total fall of between 57 and 58 feet, and a second long level succeeds for 62 miles to Rochester, in which the additional fall is only 3.2 feet.(a) At Black Rock, 4 miles to the north of Buffalo, an abundant supply of water is received from the Niagara river. This is indeed the main dependence as far east as the Montezuma level, 140 or 150 miles from the western terminus. The prevalence of a strong east wind, however, is liable to interfere at times with the delivery of water at so great a distance, and the same difficulty, to a much more serious and lasting extent, is caused by the heavy growth of eel-grass in the canal in summer, and at such times additional feeders along its course have to be more or less relied upon. The quantity of water necessary to meet the demands of this long stretch of canal must evidently be large, and is stated by Mr. Olmstead, civil engineer, of Lockport, to be from 30,000 to 36,000 cubic feet per minute, or from 500 to 600 cubic feet per second.

The flight of locks at Lockport lies in a deep and narrow ravine which opens out considerably below, and which was once the valley of a small "wet-weather" creek. The rock strata forming the sides of the ravine are composed of limestone for from 12 to 18 feet down from the surface, below which depth there is for a long distance a hard blue shale. The combined demands of the hydraulic races and of lockage do not at all times equal the volume flowing in the canal, and in order to pass the surplus the state has a waste-way running down beside the locks and emptying into the lower level. Some distance beyond, in the lower part of the city, a considerable discharge of surplus water passes from the canal over a weir into Eighteen-Mile creek, and on its way through that stream to lake Ontario furnishes power to a number of mills.

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a The various figures for the changes in level of the water-surface of the canal are drawn from a profile of the western division accompanying the *Annual Report of the Superintendent of Public Works* for the year ending September 30, 1881.

From the level above the locks two hydraulic races open out, one on each side. That on the south follows along the steep side of the ravine into which it is cut, being supported in part on the outer side by wall and embankment. This race has a water-depth of 6 feet, and, where the topography and material passed through admit, side-slopes of 1 to 1 and a width at bottom of 12 feet. It is perhaps half a mile in length, and tolerably uniform in size, except as it contracts to pass through an arched opening under a road-way. On the line of the race are supplied six flouring-mills, having in the aggregate 13 runs of stone, 65 sets of rollers, and a capacity of 1,200 or 1,300 barrels of flour per day. Still another large flouring-mill draws independently from the Erie canal. Power is also furnished to the works of the Pound Manufacturing Company, employing 50 men and turning out stationary and marine engines, derricks, dredges, etc. The Penfield Block Company has a large establishment in which it makes tackle and hoisting-blocks, sheaves, trucks, and barrows, giving employment to over 50 hands. Trevor & Co. have 40 hands at work in the manufacture of shingle, heading, stave, and wood-pulp machinery. Small powers are also used for a number of printing-presses and goods-elevators, a grain-elevator, two bakeries, two machine-shops, and in a variety of other shops of moderate size, including in their productions faucets, agricultural implements, shirts, patterns, oil, and sashes and blinds.

On the north side a main tunnel, 8 by 12 feet in size, extends from 350 to 400 feet to the works of the Holly Manufacturing Company, manufacturer of water-works machinery, and employing 300 hands. A short intersecting or branch tunnel supplies the Richmond Manufacturing Company, employing 45 hands on flouring-mill machinery. Besides the more direct use of power from turbines, wire cables are quite commonly availed of at Lockport for transmitting power. This mode of transmission is here limited to rather small powers, probably not exceeding 20 or 30 horse-power in any one case. The longest interval overcome by cable is in the neighborhood of 1,500 feet. From the Pound Manufacturing Company's works, which are located on the south slope of the ravine, seven cables run up to the top of the slope and transfer power to a number of printing and small manufacturing shops. The cables are three-eighths of an inch in diameter, and the largest sheave used is 6 feet in diameter. Cables have been run here for periods ranging from two to seven years without wearing out. They are thoroughly coated every week with tar, and the sheaves are packed with tarred rope.

Lockport is a city of 13,500 inhabitants, lying northeasterly from Buffalo, and distant from that city 26 miles by the New York Central and Hudson River railroad. The water-power here described is mainly controlled by the Lockport Hydraulic Company, which bought out the rights of the old lessees. Flour has always been a leading production at this point, but with the growth of the city other branches of manufacturing have also come into prominence. The Hydraulic company owns unoccupied land along its races, but looks for profit chiefly in the disposal of power, and is willing to sell land to manufacturers at very low rates. A perpetual lease is given of the power, and the lessee has the privilege of making the title absolute at any time by paying a principal sum which at 7 per cent. interest would yield the amount of the annual rental. In case of a deficiency in the supply of water, the right of any owner or lessee to its use is subject to all rights conveyed by prior grants or leases. Water is leased in so-called "runs", which are assumed equivalent to 12 effective horse-power each, the number of cubic feet being adjusted to the fall to be employed so as to produce that equivalence. The manner of this adjustment and the condition under which water shall be drawn are thus expressed in the leases:

And the parties of the first and second part, respectively, for themselves and their successors, executors, administrators, and assigns, grant, covenant, and agree, each to and with the other party, —— executors, administrators, successors, heirs, or assigns, as follows: The term "twelve horse-power", as used herein, is defined, and shall be construed, to mean a water-power equivalent to the power given by the discharge and use of —— cubic feet of water in each second when the fall or difference in elevation between the surface water levels of the said —— and the lower or Genesee level of the Erie canal, from and into which the water is to be drawn and discharged, shall be —— feet; and as the fall may sometimes vary from ice, change of levels, or other causes, the quantity of water drawn under this grant shall be increased or diminished as the fall with which it can be used as aforesaid is diminished or increased; and to avoid uncertainty the following table is agreed upon as stating correctly the number of cubic feet of water per second necessary to give one "twelve horse-power" as aforesaid, with each different and respective fall therein given:

*Table giving the number of cubic feet of water per second which is equivalent to "twelve horse-power", on different falls, allowing 25 per cent. for waste and friction.(a)*

| | Cubic feet per second. |
|---|---|
| 24 feet fall | 6.700 |
| 25 feet fall | 6.432 |
| 26 feet fall | 6.184 |
| 27 feet fall | 5.955 |
| 28 feet fall | 5.544 |
| 29 feet fall | 5.360 |
| etc., etc. | |

The water is to be drawn through a water-tight trunk or pipe, and such trunk or pipe and the water-wheels, apertures, and other apparatus for drawing the water shall be constructed of sufficient capacity and proper form to enable the grantee to use more or less water, according to the variations of fall as aforesaid.

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480 *a* According to the table, the allowance for waste and friction appears to be about 35 rather than 25 per cent.

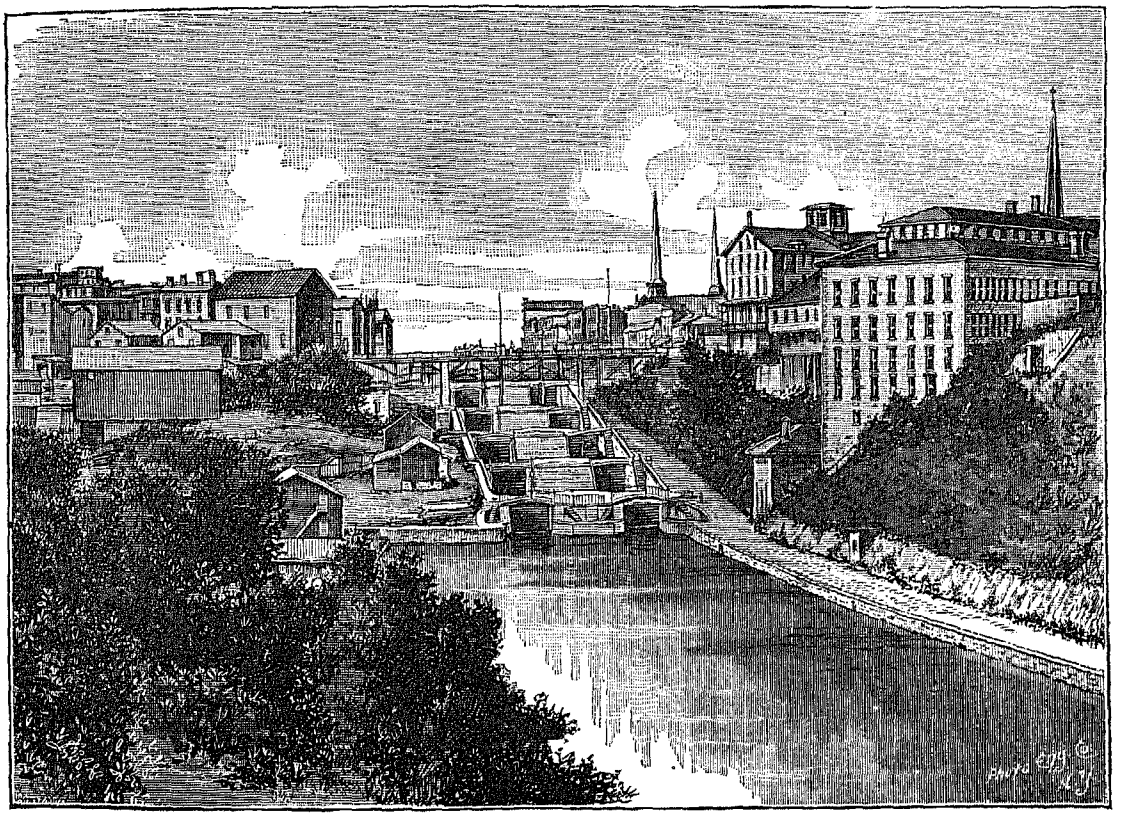

FIG. 10.—Flight of locks in the Erie canal at Lockport.

Assuming the figures previously given—from 500 to 600 cubic feet per second—as the full supply passing through the Erie canal, and allowing 100 cubic feet per second to the possible demands of lockage, there remains say from 400 to 500 cubic feet per second available for power. With a fall of 57 feet the resulting power will be as shown in the following table:

*Estimate of power at Lockport.*

| Assumed volume of water. | Assumed fall. | Corresponding theoretical horse-power. | Corresponding effective horse-power, at 65 per cent. efficiency. | Corresponding number of "twelve horse-power" runs. | Number of runs owned independently of Hydraulic company. | Number of runs rented by company. | Runs remaining not disposed of. | Effective horse-power (at 65 per cent.) remaining not disposed of. |
|---|---|---|---|---|---|---|---|---|
| *Cu. feet per sec.* | *Feet.* | | | | | | | |
| 100 | 1 | 11.36 | 7.38 | 0.61 | ..... | ..... | ..... | ..... |
| 100 | 57 | 647.52 | 420.89 | 35+ | ..... | ..... | ..... | ..... |
| 400 | 57 | 2,590.00 | 1,684.00 | 140+ | 24 | *a* 45 | 71+ | 856.00 |
| 500 | 57 | 3,238.00 | 2,104.00 | 175+ | 24 | *a* 45 | 106+ | 1,276.00 |

*a* December 1, 1882.

NOTE.—By census enumerators' returns the total rated capacity of wheels in place in 1880 was upward of 1,400 effective horse-power; but these wheels are doubtless rated at a considerably higher efficiency than 65 per cent.

It appears, therefore, that with a full stage of water, supposing an average efficiency of 65 per cent. to be attained in its use, the entire privilege is equivalent to from 1,680 to 2,100 effective horse-power, or, at 12 horse-power to the run, to from 140 to 175 runs. But 24 of these runs are owned by individuals who bought before the Hydraulic company, and who are consequently independent of it. On the 1st of December, 1882, 45 runs in addition had been rented by the company to manufacturers, leaving, according to this estimate, from 70 to something over 100 runs, or say from 850 to 1,250 or 1,300 effective horse-power still available.

The rental charged by the company ranges from $150 to $200 per annum per run, or from $12 50 to $16 67 per effective horse-power. The amount of water used by consumers is judged mainly by the wheel-ratings, with occasional measurements in tail-races. It is not probable that the actual surplus of water unemployed would supply the 850 to 1,250 horse-power which has been estimated above, although, of course, by a strict system of measurements it could be appropriated for that purpose. As it is, many of the wheels in use are extremely wasteful, and doubtless draw much more water than they are entitled to. It is said that a decree of court has directed the use of fixed weirs, over which water should be drawn into the various flumes, but they are not generally, if at all, used. In one instance, it was found that, restricting a certain miller by means of a weir, in the specified manner, to the amount of water which was properly his due, he was not able even to start his wheels. It is thought that a system of fixed weirs would not work satisfactorily here, on this account: At Black Rock, where the Erie canal is fed from the Niagara river, the millers employing water-power are in the habit of partially closing the gates into the canal during winter, it being claimed that their own power is thereby slightly benefited; the level at Lockport is thus lowered, even to the extent of 2 or 3 feet, and little or no water would pass over fixed weirs properly adjusted to a full stage.

Although the flow in the canal is quite uniformly maintained in summer, it is during the rest of the year at times much reduced and even stopped. The trouble due to the action of the millers at Black Rock sometimes continues all winter. Again, for from two to four weeks every spring the state has the water entirely drawn out from the canal to admit of inspection and repairs. The Lockport factories are then dependent upon steam-power, while the flouring-mills shut down altogether. For the greater part of the year, however, the hydraulic power at this point is steady and reliable, and is capable of supporting much more manufacturing than at present. Very slight hinderance is experienced from anchor-ice. At times in winter, when the south race becomes drawn down, ice freezes to the bottom and impedes the flow of water; but as soon as the level rises again the current carries along this ice and it is shot out of the race at certain points. At the lower end of the race the experiment has been tried of covering it with planking, which has proved quite successful in guarding against the formation of thick ice. The race on the north side of the ravine, being inclosed in a tunnel, is protected and free from all ice.

*Table of utilized power on the New York state canals.(a)*

[From returns by census enumerators.]

| Canal. | County. | Kind of mill or manufacture. | Number of mills. | Total fall utilized. | Total water-power utilized. | Auxiliary steam-power. |
|---|---|---|---|---|---|---|
| | | | | *Feet.* | *H. P.* | *H. P.* |
| Erie | Niagara | Agricultural implements | 1 | Lockport—total fall available, about 57 feet. | | |
| Do | do | Blocks, sheaves, etc. | 1 | | | |
| Do | do | Cotton-batting | 1 | | | |
| Do | do | Fruits and vegetables, canned and prepared | 1 | | | |
| Do | do | Flouring and grist | 7 | | | |
| Do | do | Goods-elevators | (?) | | | |
| Do | do | Grain-elevator | 1 | | 1,421 | 350 |
| Do | do | Iron castings and finishings | 1 | | | |
| Do | do | Leather, tanned and curried | 1 | | | |
| Do | do | Machinery | 6 | | | |
| Do | do | Printing-presses operated | (?) | | | |
| Do | do | Shirts | 1 | | | |
| Do | do | Woolen | 1 | | | |
| Do | Monroe | Furniture | 1 | 14 | 58 | 12 |
| Do | do | Saw | 1 | 14 | 58 | ..... |
| Do | Oneida | do | 1 | 8 | 30 | ..... |
| Do | Onondaga | Flouring and grist | 1 | 26 | 200 | ..... |
| Black River | Oneida | Sashes, doors, and blinds | 1 | 10 | 24 | 15 |
| Do | do | Saw | 4 | 27+ | 95 | ..... |
| Oswego | Onondaga | Salt | 1 | 27 | 75 | 90 |
| Champlain | Albany | Hardware | 1 | 10½ | 80 | 60 |
| Do | Saratoga | Brooms and brushes | 1 | 11 | 28 | ..... |
| Do | do | Hosiery | 1 | 20 | 90 | ..... |
| Do | do | Machinery | 1 | 8 | 45 | 30 |
| Do | do | Saw | 2 | 32 | 119 | ..... |
| Do | Washington | do | 2 | 26 | 68 | ..... |

*a* Powers at feeder-dams are classed with the rivers on which the dams are located.

# INDEX TO REPORT ON WATER-POWER OF REGION TRIBUTARY TO LAKE ONTARIO.