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THE BUFFALO, N. Y., WATER WORKS.

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[*Read September 15, 1899.*]

The city of Buffalo acquired by purchase the plant of the Buffalo Water Works Company in August, 1868, paying for the same the sum of $705,000. This amount was specified in the act of the legislature authorizing the city to construct and maintain a water works for the use of the city of Buffalo and its inhabitants.

The plant of the private company consisted of: First, about 34 miles of pipe, as follows: —

3-inch	486 feet
4-inch	51,629 feet
6-inch	79.375 feet
10-inch	19,667 feet
12-inch	9,045 feet
16-inch	11,489 feet
24-inch	7.304 feet
Total	178,995 feet

Second, one double Cornish Bull engine, made by I. P. Morris, of Philadelphia, in 1851, with a rated capacity of 4,000,000 gallons in 24 hours, and one beam engine, made by the Shepard Iron Works of Buffalo, N. Y., in 1866, having a rated capacity of 6,000,000 gallons in 24 hours; total daily rated capacity of pumps, 10,000,000 gallons.

Third, a tunnel 4 feet in diameter and 330 feet long; and fourth, a reservoir of 11,000,000 gallons capacity, on Niagara Street.

At the time of the purchase of the old works, a similar plant could have been constructed for about $500,000. These works have since been extended and improved to meet the demands of a rapidly growing city, until they are now among the largest in the country; in fact, our pumping station is the largest in the world under a single roof.

The following is a general description of the works: —

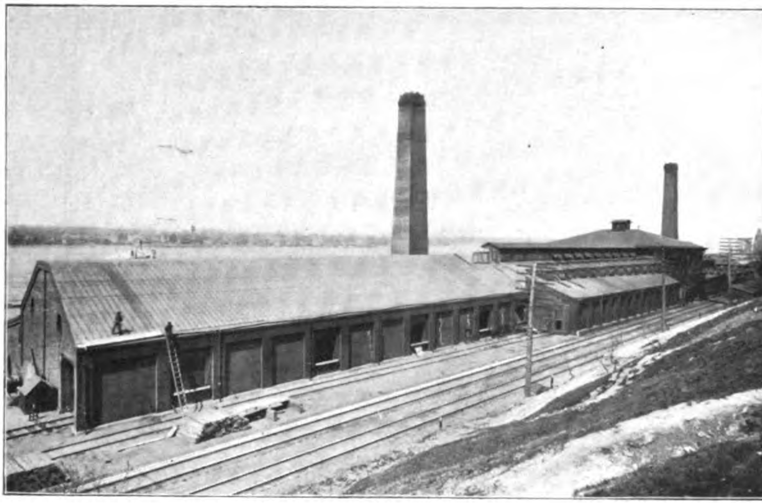

Fig. 1. — Pumping Station.

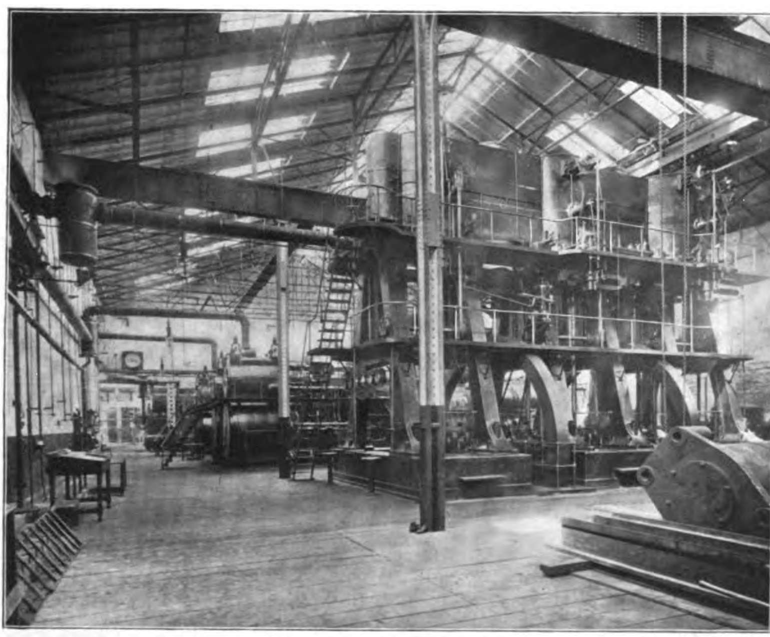

Fig. 2. — Engine Room.

PUMPING STATION.

The pumping station (Plate I, Figs. 1 and 2) is located on the Niagara River about two and one half miles from the City Hall, and contains the following machinery: —

PUMPING ENGINES.

No.	Capacity in 24 Hours, Gallons.	Makers.	Description.	Year Con-structed.	H.P.
1	12,000,000	Worthington & Lake Erie	Horizontal Compound	1872, 1898	430
2	20,000,000	" " " "	" "	1876, 1898	700
3	20,000,000	" " " "	" "	1882, 1898	700
4	15,000,000	Holly (Gaskell)	" "	1885	550
5	20,000,000	" "	" "	1888	700
6	20,000,000	" "	" "	1889	700
7	20,000,000	" "	" "	1892	700
8	30,000,000	Lake Erie	Triple Expansion	1896	1,200
9	30,000,000	" "	" "	1898	1,200
	187,000,000	Total,			6,880

BOILERS.

North Boiler House — 14 horizontal return-flue boilers, with smokeless furnaces, 150 H.P. each — 2,100 H.P. 80 lbs. steam pressure.

South Boiler House — 14 horizontal return-flue boilers, with smokeless furnaces, 150 H.P. each — 2,100 H.P. 80 lbs. steam pressure.

6 horizontal return-flue boilers, with smokeless furnaces, 300 H.P. each — 1,800 H.P. 165 lbs. steam pressure.

Total H.P., 6,000

The station has an independent electric light plant for illuminating the buildings and grounds.

TUNNELS, INLET PIER, AND ICE ELEVATORS.

The water supply is received from the Niagara River through two tunnels, one of which has an area equivalent to that of a circle 6 feet in diameter, while the other has the same area as a circle 9 feet in diameter. The tunnels are parallel and about 30 feet apart; they are unlined and entirely through rock. Both tunnels are about 1,000 feet in length and terminate in the center of the river about one mile from Lake Erie. The river shafts are protected by an inlet pier of cut stone masonry, finished in 1874 (Plate II, Fig. 1). The average depth of the water at the pier is 15 feet and the bottoms of the intakes are 6 feet above the bottom of the river. The current at the inlet varies from eight to fourteen miles per hour, depending entirely upon the wind.

During the winter months large fields of ice are continually passing down the river from Lake Erie, and to prevent the ice from entering the intakes the latter are protected with shields of steel plates from ⅜ inch to 1 inch in thickness. These shields project out from the pier 2 feet and extend down to within 2 feet of the bottom of the river. They are provided with gates opposite the intakes which are somewhat larger in area than the area of the intakes. When the ice is running, these gates are closed and the supply is then taken from below the shields. In all ordinary runs of ice this is effective and entirely prevents any ice from entering the shafts.

There are times when the river is filled with "slush ice," extending down to the bottom of the river. Then this enters the intakes and shafts in large quantities and has to be removed as soon as possible. On the pier we have an ice elevator and also one at each shore shaft at the pumping station. The elevators at the shore shafts are shown in Plate II, Fig. 2. These elevators are placed upon a rigid framework extending 5 feet below the sills of the intakes and conduits. They are operated by steam and have a double row of perforated buckets working independently. The ice is elevated and discharged into the river or canal, according to the location, through chutes.

The closing of the intakes on the inlet pier by anchor-ice is prevented by raising and lowering the gates in the sides of the shields and running the ice elevator, and by a liberal use of steam and hot water, which is furnished by the boiler on the pier.

The conditions at Buffalo are peculiar and entirely different from those of any other city on the Lakes, and an uninterrupted supply of water during the winter months is only procured by constant care and watchfulness by the men on the pier and at the pumping station.

DISTRIBUTION.

The distribution system consists of 477½ miles of cast-iron pipe of the following sizes and lengths: —

FIG. 1. — INLET PIER IN NIAGARA RIVER.

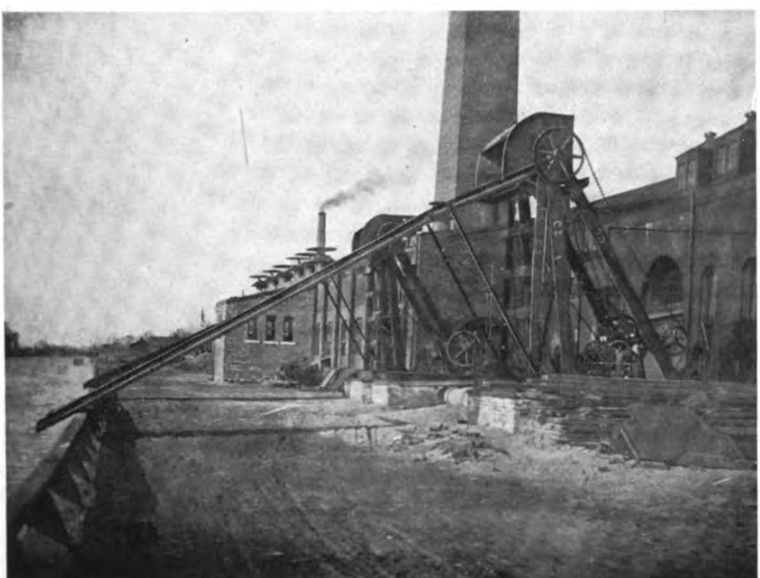

FIG. 2. — ICE ELEVATORS AT SHORE SHAFT.

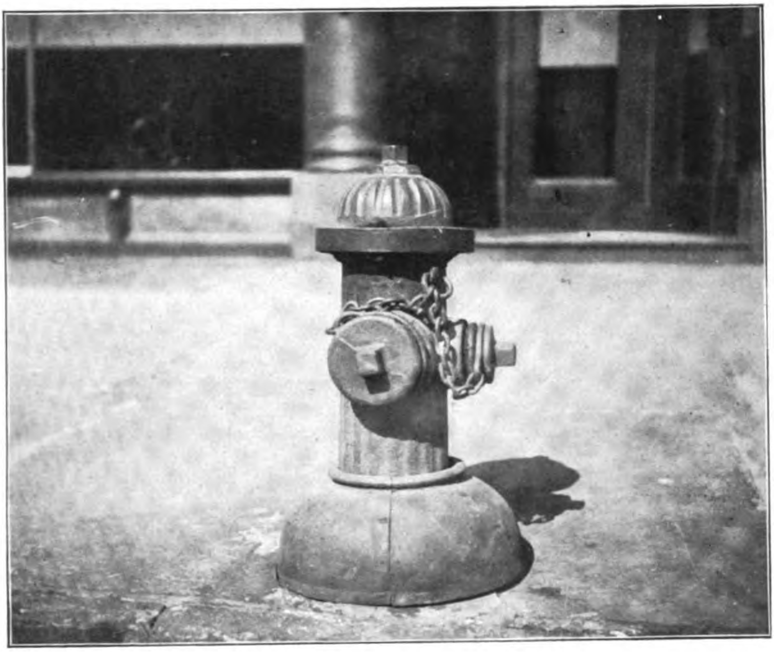

FIG. 1. — BUFFALO HYDRANT.

FIG. 2. — HYDRANT WITH STEEL COVER.

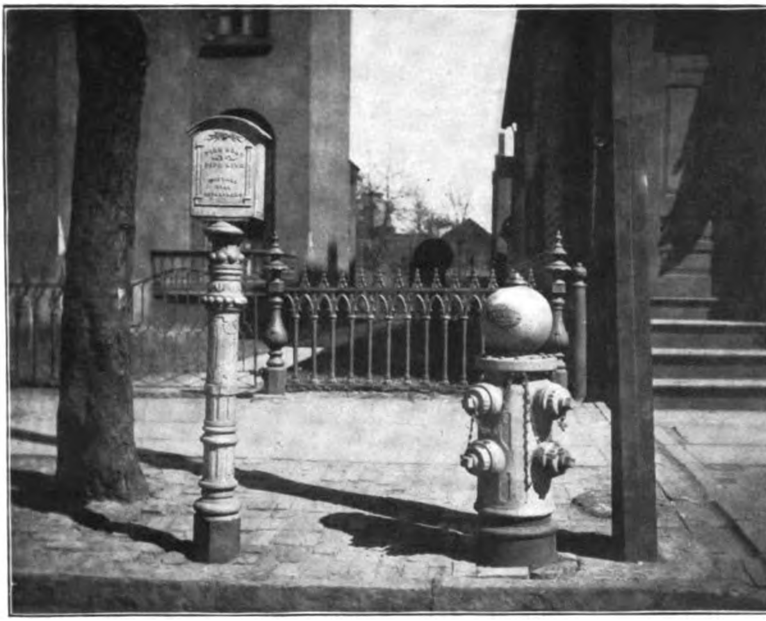

Fig. 1. — Hydrant and Call Box for Fire Boat Pipe Line.

Fig. 2. — Distributing Reservoir.

1½-inch..................	200 feet
2-inch..................	1,845 feet
3-inch..................	7,954 feet
4-inch..................	155,149 feet
6-inch..................	1,439,936 feet
8-inch..................	12,537 feet
10-inch..................	218,916 feet
12-inch..................	202,856 feet
16-inch..................	287,643 feet
20-inch..................	69,705 feet
24-inch..................	15,642 feet
30-inch..................	1,796 feet
36-inch..................	94,144 feet
48-inch..................	12,464 feet
Total...........	2,520,887 feet

The Buffalo hydrant, designed by the writer in 1882, is of the post type, and has a sole leather compression valve, 6-inch standpipe, one 4-inch and one 2½-inch nozzle, and a 6-inch supply pipe (Plate III, Fig. 1). Where the hydrant is supplied from two 6-inch pipes at street crossings, an additional 4-inch nozzle is added. Where the hydrant is supplied by an 8-inch pipe, the standpipe is 8 inches in diameter, with two 4-inch and one 2½-inch nozzles with independent valves.

There are 4,620 hydrants for fire purposes, all made to a standard and interchangeable. In winter these hydrants are protected by a steel cover or case for the convenience of the fire department (Plate III, Fig. 2).

The number of valves in use is 6,758. The total number of service connections is 63,284. The total number of meters in use, mostly large sizes, is 1,014.

The Fire Boat Pipe Line, constructed in 1897, is a 12-inch standard pipe with screw and lead joints, having hydrants and call boxes every 250 feet (Plate IV, Fig. 1). The length is 6,130 feet, the working pressure being 300 pounds per square inch; depth below the surface of pavement is 4 feet; capacity of pumps in the two boats is 10,000 gallons per minute. Each hydrant has four 3½-inch nozzles with independent gates.

RESERVOIR.

The distributing reservoir, finished in 1893 (Plate IV, Fig. 2), is located about in the center of the city, and covers an area of about

20 acres. It has a capacity of 116,000,000 gallons. The elevation of high water is 116.60 feet above the water in the Niagara River at the inlet pier, or 684.68 feet above mean tide at New York.

For a detailed description of the reservoir, see *Engineering News* of January 10, 1891, page 26.

VALUE OF WORKS.

The estimated value of the works is about $9,000,000. The bonded indebtedness is $3,811,882.

CONSUMPTION.

In 1868 the population of the city was 100,000, and the average daily consumption 4,000,000 gallons, or a per capita consumption of 40 gallons. In 1898, thirty years later, the population of the city was 400,000, and the average daily consumption 89,000,000 gallons, or a per capita consumption of 222½ gallons.

The greatest amount of water pumped in twenty-four hours was on February 13 last, when the pumps registered 160,000,000 gallons, or a per capita consumption of 400 gallons.

The total amount of water pumped last year was 32,508,322,830 gallons, of which 40 per cent. was pumped on the direct service, 70 pounds pressure at the pumps, and 60 per cent. on the reservoir service, 50 pounds pressure at the pumps.

The average pressure maintained in the city is about 30 pounds per square inch.

REVENUE.

The annual amount received from all sources is about $700,000, of which $101,446.52 is derived from the sale of 4,785,000,000 gallons of water through meters.

EXPENDITURES.

The $700,000 collected by the department is expended as follows:

Salaries	$200,000
Interest on bonds	160,000
Fuel	54,000
Maintenance, repairs, and supplies	50,000
Extensions and improvements	236,000
Total	$700,000

CAPACITY.

The capacity of the two tunnels is estimated at 350,000,000 gallons per day. The maximum capacity of the present engines is estimated at 205,700,000 gallons per day. In round numbers, the capacity of the plant can be called 200,000,000 gallons per day.

WATER RATES.

Our meter rate to manufacturers is about two cents per 1,000 gallons. There is no meter rate to domestic consumers. The domestic rates are adjusted as nearly as possible to an equivalent of five cents per 1,000 gallons.

ADDITIONAL PUMPING STATION.

Plans have been prepared and approved for an additional station, with a minimum capacity of 200,000,000 gallons per day.

The proposed intake pier will be located in Lake Erie and will be of cut stone, provided with a receiving chamber and four gates, any one of which will exceed in area the area of the tunnel. The length of the tunnel will be 5,460 feet, and its cross section 128½ square feet, or nearly equal to a circle 13 feet in diameter.

In a comparison of the Buffalo Water Works with those of Boston, we find that although the population of Boston exceeds that of Buffalo by 50 per cent., the amount of water supplied to Buffalo exceeds that supplied to Boston by 50 per cent. The cost of the Boston Water Works was three times that of the Buffalo Works. The revenue received at Boston is four times the amount received at Buffalo. The operating expenses, the mileage of pipe, and number of fixtures in Boston are about double those at Buffalo.

DISCUSSION.

MR. GEO. B. BASSETT. A method of collecting rates from the different city departments has been recently established in Buffalo, and I should like to have Mr. Knapp explain that, so that it can go upon the record.

MR. KNAPP. We get from the fire department $20 for each hydrant, and we charge the public buildings, engine houses, schoolhouses, and places of that kind two cents per thousand gallons for the water they use. The schoolhouses use a large amount, as the ventilating apparatus is operated by water power. The meter rates are two cents per thousand gallons to manufacturers. We supply no water through meters unless the consumer pays $24 a year. We collected from the city for water last year $110,000, and next year it will probably be in the neighborhood of $125,000.

MR. J. C. WHITNEY. I should like to ask Mr. Knapp whether this large per capita consumption of which he speaks is owing to the extensive use for manufacturing purposes, or whether it largely represents waste?

MR. KNAPP. We figure that 70 per cent. of the water pumped is wasted.

MR. WHITNEY. And yet apparently you discourage the use of meters.

MR. KNAPP. No, we do not.

MR. WHITNEY. I was thinking about the $24 minimum charge.