THE HISTORY OF THE HAVERHILL AQUEDUCT CO., 1801-1892.

Within the past few years several cities of size and many small cities and towns have bought the works of the companies furnishing their water supplies. It seldom occurs that a price can be agreed upon without arbitration, and in the course of such proceedings engineers are often called upon for testimony of a more or less technical nature. Aside from mere questions of construction and its expense, there are others of great importance relating to the rights and franchises of companies which have some interest, at least, to engineers, and great interest to the officials of water companies and holders of this form of securities.

One of the most interesting recent changes from private to public ownership occurred at Haverhill, Mass., in 1891-2, where the Haverhill Aqueduct Co. took steps to supply water as early as 1801 and did actually supply it from 1803 until it surrendered its works to the city in 1891.

Under statutes which will be referred to further on, but which are common, with possible variations, to most other Massachusetts cities or towns where water supplies are furnished by private companies, on July 6, 1891, the city of Haverhill "took" the works of the Haverhill Aqueduct Co. and soon after the Supreme Judicial Court appointed as commissioners to fix the price to be paid for the works Messrs. Geo. O. Shattuck, John E. Sanford and Weston Lewis.

An attempt made in 1798 to secure the incorporation of a company to supply Haverhill with water failed through opposition of the people of the town.

In 1801 Benj. Willis, Jr., one of the first directors of the Haverhill Aqueduct Co., and others, applied to the town for permission to conduct the water of Round Pond into any part of the town. The report of the town meeting of May 14, 1802, shows the manner in which an application for a waterworks franchise was treated 92 years ago in a Massachusetts town, when only five towns in the state and 17 in the United States had public water supplies. Preserving the orthography and punctuation the report, so far as it relates to the petition, is as follows:

The Report of the Committee on the Pitition of Benjamin Willis, Jun., and others was read and accepted.

Voted that the Report be left in the Care of the Selectmen for their Regulation.

The Committee on the petition of Benjamin Willis, Junr., and others report that in their Opinion the bringing of the water in pipes from the round pond for the supply of the Inhabitants in the Center of Town would be of public Service and if there has been no previous Grant of right of the water for the use of mills (which your Committee have not had time to examine into) they recommend to the Town to give leave to the petitioners and others to form a company for that purpose under such regulations as will Intitle any Individual in the Town to a right in Said Company provided he becomes a subscriber for which purposes the present petitioner shall have a Subscription paper in Sum public place and give notice in the Haverhill paper of the sam and no person Shall be all allowed to Subscribe for more than one Share untill the Same has been So offered for ninety days at the expiration of which time the Subscribers may take all Shares not before Subscribed making in the whole not less than an Hundred and Call a meeting of the Subscribers to form rules and regulations to be offered to the Town for their further approbation.

The action of the selectmen on this report is not stated in the information at hand, but in 1802 the Haverhill Aqueduct Co. was organized with 100 shares of stock, the number named in the report, and in 1803 it began to supply water from Round Pond.

The company organized under an act of the Massachusetts Legislature dated Feb. 21, 1799, entitled, "An Act Enabling Proprietors of Aqueducts to Manage the Same." Under this act provisions were made for the organization and general conduct of aqueduct companies. Authority was given such companies to hold real estate to the value of not over $30,000, but the right of eminent domain was not granted and no provision was made for the acquirement of a water supply. Power was given to dig up streets and lay pipe in the same, but only upon written permission of a majority of the selectmen of the town. The important provision was inserted that any town, in which an aqueduct had been placed under the provisions of this act might draw water from the same for fire protection without paying the company for the water, the town to provide the necessary facilities. Under the last-named provision the town and afterward the city established fire hydrants, free of rental.

In 1867 the legislature authorized the company "to take and use the waters of Round Pond and Plug Pond, so called (now Lake Saltonstall), and Kenoza Lake, in the town of Haverhill, to supply the inhabitants of said town with water." The use of water to drive machinery, otherwise than by steam, was prohibited, as was raising the high or lowering the low water mark in the ponds.

It will be noticed that the company was given authority to "take and use" the water of Round Pond, which it had been using since 1803, this being the first legislative permission obtained by the company to draw water from this or any other source. The act also gave the company the right of eminent domain, for the first time, and authorized it to hold real and personal estate to the amount of $100,000.

The act also contained the important provision that the town might at any time thereafter purchase the company's works at a price to be agreed upon, or in case of non-agreement, at a price to be fixed by three commissioners appointed by the Supreme Judicial Court.

Under this act the company began to supply water from Lake Saltonstall, and in 1871 began to pump water from Kenoza Lake to Round Pond, to supplement the gravity supply. In 1879 a 2,000,000-gallon Worthington pump was erected at Kenoza Lake and a 200,000-gallon stand-pipe was built and put in use for high service. In 1880 or 1881 a second 2,000,000-gallon Worthington pump was added at this station.

In 1879 the company bought a small reservoir supplied by springs, used by the Silver Hill Aqueduct Co. to supply a few houses near the reservoir.

In 1882 the company acquired mill privileges on a stream flowing from Crystal Lake, in the western part of the city, and in 1884 it secured from the legislature authority "to take and hold the waters" of this lake for the purpose of increasing its water supply. The act granting this privilege was in intent much like the act of 1867, outlined above, containing the same privilege for purchase. The company laid a pipe line from Crystal Lake into the city and began to supply water from the lake in 1885.

In 1889 a 560,000-gallon stand-pipe or tank was erected by the company.

In 1891 the city of Haverhill petitioned the legislature for authority to use the water of the four lakes forming the source of supply of the Haverhill Aqueduct Co., subject to the rights of the company, for the purpose of supplying the city with water. The legislature granted the petition under condition that the city should buy the "franchises, rights and property" of the company, after which the city, by terms of the act, should "have the sole, exclusive and perpetual right to hold the waters of Round Pond, Plug Pond (Lake Saltonstall), Kenoza Lake and Crystal Lake, great ponds within said city of Haverhill, as a source of water supply." Full powers for the construction and operation of works were granted the city, but it was stipulated that the act should not "be construed to lessen, impair, enlarge or affect the franchises, rights and property heretofore lawfully granted to the or acquired by the Haverhill Aqueduct Co.," or in any manner affect the rights of the city to buy the company's works. The city "took" the works July 6, 1891, as has been stated, but the company remained in possession until Nov. 14, 1891, and collected all rates for water used to Dec. 31, 1891.

The total drainage area of the four ponds, as determined from the state topographical maps, was taken as about 3,200 acres, or some 2,700 acres excluding water areas. This was agreed to by both sides, subject to correction. Some of the testimony taken was to the effect that this area was too small, and some that it was too large.

The engineers' estimates of the average daily water supply that could be drawn from the supply ponds was made up on a somewhat different basis, as will be seen from the following: The average daily yield of the drainage area through a long period of years was estimated by Mr. Wm. Wheeler, of Boston, as 3,329,000 gallons. The average daily yield in the driest year was estimated by Mr. Nathaniel Crafts, of Boston, as 3,652,500 gallons. These estimates were based upon the use of the four ponds in their present condition, and were subject to increase by the possible increase of the storage capacity. Mr. Desmond FitzGerald, also of Boston, took a more conservative view and based his estimate on a change of location of one of the dams and the abandonment of Plug Pond, as being unsafe for future use, owing to population in its drainage area. His estimate of the safe yield of the three remaining ponds was 2,600,000 gallons per day. The capacity of the omitted pond was not claimed by any one to be more than 270,000 gallons per day. The population of the city in June, 1890, was 27,142. The extent and character of the whole pipe and conduit system of the water-works at the time of the taking, July 6, 1891, was as follows:

Size, in.	Wrought iron and cement.	Cast iron.	Lead and iron.	Wooden intake conduits.	Total.
20	.....	12	.....	.....	12
16	20,736	1,380	.....	.....	22,116
12	7,685	5,920	.....	.....	13,605
10	1,980	5,963	.....	.....	7,823
8	9,991	13,282	.....	.....	23,273
6	16,840	34,267	.....	.....	51,107
4	15,542*	50,201*	.....	.....	65,743*
3	.....	2,537	.....	.....	2,537
2	.....	21,034	.....	.....	21,034
1¼†	.....	.....	9,786	.....	9,786
....	.....	.....	.....	1 721	1 721
Total ft.	72.615	134,596	9,786	1,721	218,757*
" miles	13 7	25.5	1.8	0.3	41.4*

* A discrepancy of some 700 ft. appears in the report of the case, so that the total length of 4-in. pipe and the grand total above is about 700 ft. larger than in the report.

† 1¼-in. and less.

The total number of gates on the system July 6, 1891, was 266, including 51 blow-offs. The num-

Yearly Stock Assessments and Dividends and Totals to the End of Each Year from 1802 to 1891, inclusive.

	Assessments. For year.	Assessments. To end of year.	Dividends. For year.	Dividends. To end of year.		Assessments. For year.	Assessments. To end of year	Dividends. For year.	Dividends. To end of year		Assessments. For year.	Assessments. To end of year.	Dividends. For year.	Dividends. To end of year.
1802	$12½	$12½	.....	.....	1832	.....	$3,937½	.....	$1,550	1862	.....	$1,137½	$,000	$23,050
1803	1,500	1,512½	.....	.....	1833	.....	3,937½	.....	1,550	1863	.....	19,137½	3,000	31,050
1804	300	1,812½	$75	$75	1834	.....	3,937½	.....	1,550	1864	.....	19,137½	3,000	34,050
1805	.....	1,812½	150	225	1835	.....	3,937½	.....	1,550	1865	.....	19,137½	3,000	37,050
1806	.....	1,812½	125	350	1836	.....	3,937½	.....	1,550	1866	.....	19,137½	3,000	40,050
1807	.....	1,812½	100	450	1837	.....	3,937½	.....	1,550	1867	.....	19,137½	.....	40,050
1808	.....	1,812½	100	550	1838	$1,000	4,937½	.....	1,550	1868	.....	19,137½	3,000	43,050
1809	.....	1,812½	150	700	1839	800	5,737½	.....	1,550	1869	.....	19,137½	3,000	46,050
1810	.....	1,812½	100	800	1840	.....	5,737½	.....	1,550	1870	.....	19,137½	3,000	49,050
1811	.....	1,812½	100	900	1841	600	6,337½	.....	1,550	1871	.....	19,137½	3,000	53,050
1812	.....	1,812½	.....	900	1812	.....	6,337½	.....	1,550	1872	.....	19,137½	6,000	58,050
1813	.....	1,812½	.....	900	1843	.....	6,337½	.....	1,550	1873	.....	19,137½	6,000	64,050
1814	.....	1,812½	.....	900	1844	1,000	7,337½	.....	1,550	1874	.....	19,137½	6,000	70,050
1815	525	2,337½	.....	900	1845	.....	7,337½	.....	1,550	1875	.....	19,137½	6 000	76,050
1816	.....	2,337½	.....	900	1846	.....	7,337½	.....	1,550	1876	.....	19,137½	6,000	82,050
1817	.....	2,337½	.....	900	1847	.....	7,337½	.....	1,550	1877	.....	19,137½	9 000	91,050
1818	.....	2,337½	.....	900	1848	500	7,837½	.....	1,550	1878	.....	19,137½	12,000	103,050
1819	.....	2,337½	.....	900	1849	4,300	12,137½	.....	1,550	1879	.....	19,137½	12,000	115,050
1820	.....	2,337½	.....	900	1850	.....	12,137½	$1,100	2,650	1880	.....	19,137½	12,000	127,050
1821	500	2,837½	.....	900	1851	.....	12,137½	800	3,450	1881	.....	19,137½	12,000	139,050
1822	1,100	3,937½	.....	900	1852	.....	12,137½	2,000	5,450	1882	.....	19,137½	12,000	151,050
1823	.....	3 937½	.....	900	1853	2,000	14,137½	800	6 250	1883	.....	19 137½	12,000	163,050
1824	.....	3,937½	200	1.100	1854	.....	14,137½	1,000	7,250	1884	.....	19,137½	15,000	178,050
1825	.....	3,937½	250	1,350	1855	5,000	19,137½	2,800	10 050	1885	.....	19,137½	18,000	196,050
1826	.....	3 937½	.....	1,350	1856	.....	19,137½	2,500	12,550	1886	.....	19,137½	18,000	214,050
1827	.....	3 937½	100	1,450	1857	.....	19,137½	3,000	15,550	1887	.....	19,137½	18,000	232,050
1828	.....	3,937½	100	1,550	1858	.....	19,137½	1,500	17.050	1888	.....	19,137½	18.000	250,050
1829	.....	3,937½	.	1,550	1859	.....	19,137½	3,000	20 050	1889	.....	19,137½	18,000	268,050
1830	.....	3,937½	.....	1,550	1860	.....	19,137½	3,000	23,050	1890	.....	19,137½	18.000	286,050
1831	.....	3,937½	.....	1,550	1861	.....	19,137½	3,000	26,050	1891	.....	19,137½	18.000	304,050

ber of service taps on the same date was about 3,300, nearly double the number about 10 years previous, April 30, 1881, which was 1,776.

The financial history of the company, considering the 90 years of its existence, is very complete and interesting.

The construction account from 1802 to July 6, 1891, was $490,040. This includes real estate, legal and traveling expenses and other items, some of which the city claimed should have been charged to the expense or operating account. The company claimed no present value for actual construction prior to May 1, 1866, although some of that construction is still in use. Including $14,035 paid for real estate prior to May 1, 1866, and deducting real estate sold, the company claimed that the cost of all their real estate and works proper, of value on July 6, 1891, was $344,592, of which $295,051 was the actual cost of construction of the present works, and $49,541 the cost of land, buildings and mill rights.

Of the $490,090 claimed to have been paid out for construction and real estate, all was derived from earnings except $19,137 assessed upon the shares prior to 1856.

The yearly dividends and assessments of the company from 1802 to 1891, inclusive, were presented at the hearing and are given in the accompanying table, the totals at the end of each year having been added as a matter of interest.

In 1882 the stock of the company was increased from 100 to 1,500 shares and its par value placed at $200 per share. The new stock was mostly held by two men, a resident of Philadelphia owning 720 and a resident of Haverhill 600 shares, in addition to which an out-of-town estate held 105 shares. Popular complaint arising against the company it was decided to try to quell or lessen it by distributing stock among some of the prominent citizens. The large local stockholder thought that the superintendent of the company, who had served it long and faithfully, should be given an interest. The Philadelphian was therefore requested to give the superintendent some stock, since as a non-resident he had not stood the brunt of building up the company and done a large amount of work without pay. Accordingly this non-resident holder donated to the superintendent 45 shares of stock, the same number to some one else, not named, and placed in the superintendent's hands 30 shares to be sold at $250 a share to such parties as three of the local stockholders, including the superintendent, should select. This was called a "strengthening process." The stock was sold to bank and city officials and others, prominent men, in lots of from 1 to 10 shares and only one person to whom it was offered refused it.

A comprehensive exhibit of the recent financial operations of the company is presented in the table below. This table gives the expense account, gross and net receipts, total dividends and the cost of construction for the years 1871 and 1876 and for the 11 years 1881 to 1891, reported by the company as follows:

	Expense account.	Gross receipts.	Net receipts.	Dividends.	Construction.
1871.....	$4,188	$15,872	$11,684	$3,000	$14,454
1876.....	9,058	23,022	13 964	6,000	4,585
1881.....	14,193	38,803	24,610	12,000	14,451
1882 . ..	14,371	39,419	25,077	12,000	11,682
1883.....	18,062	45,962	27,900	12,000	16,063
1884.....	17,017	4 ,910	29,893	15.000	6,680
1885.....	16,092	50.568	34,476	18,000	7,749
1886.....	15,650	57,551	41.901	18 000	56,792
1887	17,189	61,313	44,124	18,000	8,680
1888.....	19,204	65,940	46,736	18,000	10,899
1889.....	18,473	72,253	53,780	18.000	27,454
1890.....	20,359	78.479	58,120	18.000	10.909
1891.....	22,456	85,265	62,809	18,000	21,890

Coming now to the price which the city ought to pay the company for its property, the engineer's estimates of the cost of replacing it may first be given. Mr. Desmond FitzGerald, M. Am. Soc. C. E., estimated the cost of replacing the present plant, excluding real estate, water rights and legal expenses, and including engineering and contingencies, at about $272,000. An estimate made by Mr. Freeman C. Coffin, independent of the above, placed the cost at $266,087. Mr. FitzGerald estimated that to put the present works in proper condition to meet the wants of the city $352,000 would be required, and Mr. Coffin placed the cost at $283,000 for the cheapest and $382,000 for the best plan.

In 1890 one of the directors sold 1-12 of the capital stock of the company, or 125 shares, to the superintendent at $250 per share, which would make the whole stock worth $375,000. This, the city urged, indicated the value of the property.

Both sides agreed, it appears, that the value of the constructed works and real estate was in the vicinity of $350,000, but the company claimed liberal compensation for the value of its franchise and prospective earnings at the time of the taking, and also for the rights to the water of the four great ponds. Considering only net earnings as a basis of present value the counsel for the company argued that the earnings 10 years hence should be taken. From the past increase in population, number of taps, operating expenses and revenue, the engineer for the company, Mr. William Wheeler, estimated the net receipts in 1901, 10 years after the taking, as $125,170, and from this a valuation of $3,000,000 or more was deduced. In answer Mr. Wm. H. Moody, one of counsel for the city, urged that while in operation the company was entitled to earn a fair dividend and money for the replacement of the plant and that the city was also entitled to purchase the property at such a price as would enable it to do the same. If the $60,000 of net earnings shown in 1891 by the company was more than a fair and reasonable return for the $358,000 which he claimed represented the company's investment, then the rates had been too high.

As to the company's rights in the four great ponds, the counsel for the city urged that the legislature merely granted it the right to use the water of these ponds until such a time as the city saw fit to buy the company's works. Kenoza Lake was used by the company from 1803 to 1867 without authority from the legislature, but the company claimed by this usage a prescriptive right. Then, why, the city asked, did the company obtain in 1867 legislative authority to use Kenoza Lake? These four ponds were great ponds, whose ownership was vested in the commonwealth. The acts quoted from above gave the company the right "to take and use" and "to take and hold" the water of the ponds, but to the city, in case it bought the property of the company, was granted the exclusive and perpetual right in the ponds.

After hearing all the evidence and arguments of both sides, the commissioners of appraisal on Oct. 17, 1892, reported the price which the city should pay for the property as $637,500, with interest from the date of the taking. The commissioners in such cases, it seems, fix their own fees, which in this instance amounted to $7,655, and was awarded to be paid by the city. The award amounted to nearly 10% upon the net earnings of the company in 1891, was a little over $400 per share, double their par value, was only about one-fifth of the amount claimed by the company and about 135% above the estimated cost of replacing the plant, as calculated by the engineers for the city.

We have been unable to learn the basis upon which the commissioners made their award. We are indebted to Mr. Wm. H. Moody, of Haverhill, and to Mr. Desmond FitzGerald, M. Am. Soc. C. E., Brookline, Mass., for courtesies extended in connection with the preparation of this article.

HARLEM RIVER DRAWBRIDGE; NEW YORK CENTRAL & HUDSON RIVER R. R.

(With inset.)

A very interesting and expensive part of the improvement which the New York Central & Hudson River R. R. is now making on its line entering New York city is the construction of a high level swing bridge across the Harlem River, some details of which we illustrate on our inset sheet this week. The general plan of the whole improvement contemplated by the company has already been given in considerable detail in our issues of April 13, May 25 and June 15, 1893, but may be summarized briefly as consisting of the construction of a four-track viaduct from 110th St. to the Harlem River, and a high level four-track swing span across the river with a short viaduct approach and an elevated embankment on the north. The swing span, while considerably shorter than several others built in recent years, is notable on account of its great weight and from the fact that it is, we believe, the only four-track swing span of any size in this country. Its general elevation and plan with dimensions were given in our issue of June 15 and details of the turntables and one of the trusses are shown on our inset sheet this week, as before stated.

The swing span consists of three parallel trusses 389 ft. long, c. to c. of end pins, and 26 ft. apart in the clear, resting on a rim-bearing turntable. The trusses are a combination of the Pratt type and the subdivided panel type so commonly used in long spans in this country, with an inclined top chord. The side trusses and middle truss are identical except in respect to the inclinations of the three middle panel members, which were necessarily different in order to bring the inner ends of each truss directly over the wheels of the turntable. This arrangement is made clear in the elevations in Fig. 1. The strains in each truss must be conveyed to the turntable at a panel point for obvious reasons. It is also essential that these panel points be so located that the strains are carried to the drum track by the most direct route, or, in other words, that they be as nearly as possible vertically over the drum track. Now, in the present case, the distance between the end pins of each half side truss and the panel point coming over the drum track is greater than the distance between the corresponding points of the middle truss. To secure the required conditions then necessitated a modification of the panel spacing in the middle truss, which was made as shown in the drawings. That is, the diagonals, or, as they may be called for convenience, the inner end posts of each half side truss have a less inclination than the same member of the middle

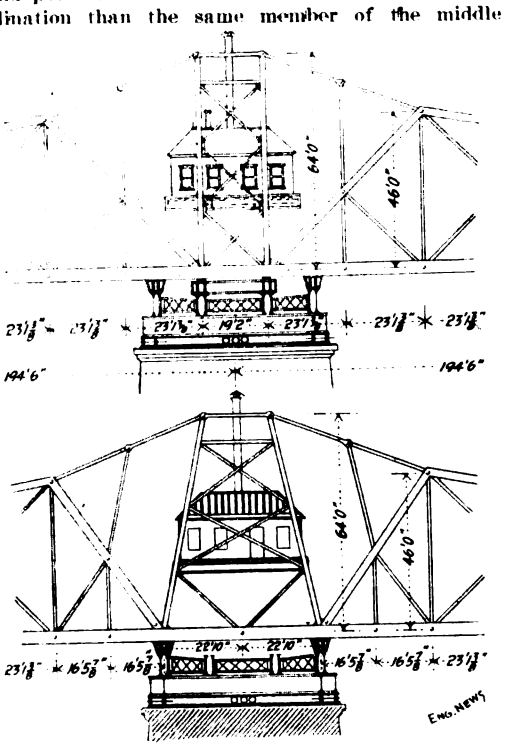

Fig. 1. Arrangement of Truss Members over Turntables.

truss. This it will be seen brings the lower panel points at the required positions over the drum track, but leaves the upper panel points in the same line transversely.

The trusses are 46 ft. high at the center and 25 ft. high at the ends, and consist of two half trusses with stiff bottom and top chords hung by eyebars to a central tower-like arrangement 64 ft. high. Details of one of the side trusses are shown on the inset sheet. With one exception they present no especial novelties. The unusual feature is the manner of connecting the two parts of the counter-braces in the second and third panels. As will be seen they are riveted together by two splice plates instead of being provided with turnbuckles, as is the usual custom. The top chords of the three trusses are connected by transverse compression members and diagonal ties. The compression members consist of four $3\frac{1}{2} \times 3 \times \frac{5}{8}$-in. angles laced together by $2\frac{1}{2} \times \frac{1}{2}$-in. bars and the diagonals are $5 \times 3\frac{1}{2} \times \frac{5}{8}$-in. angles. The solid floor system renders lateral bracing for the lower chords unnecessary. The arrangement of the portal bracing is shown in the illustration.