WATER WORKS

1879

REPORT

OF THE

CONSTRUCTION COMMITTEE

OF THE

YLAND WATER WORKS.

ARCH 1, 1879.

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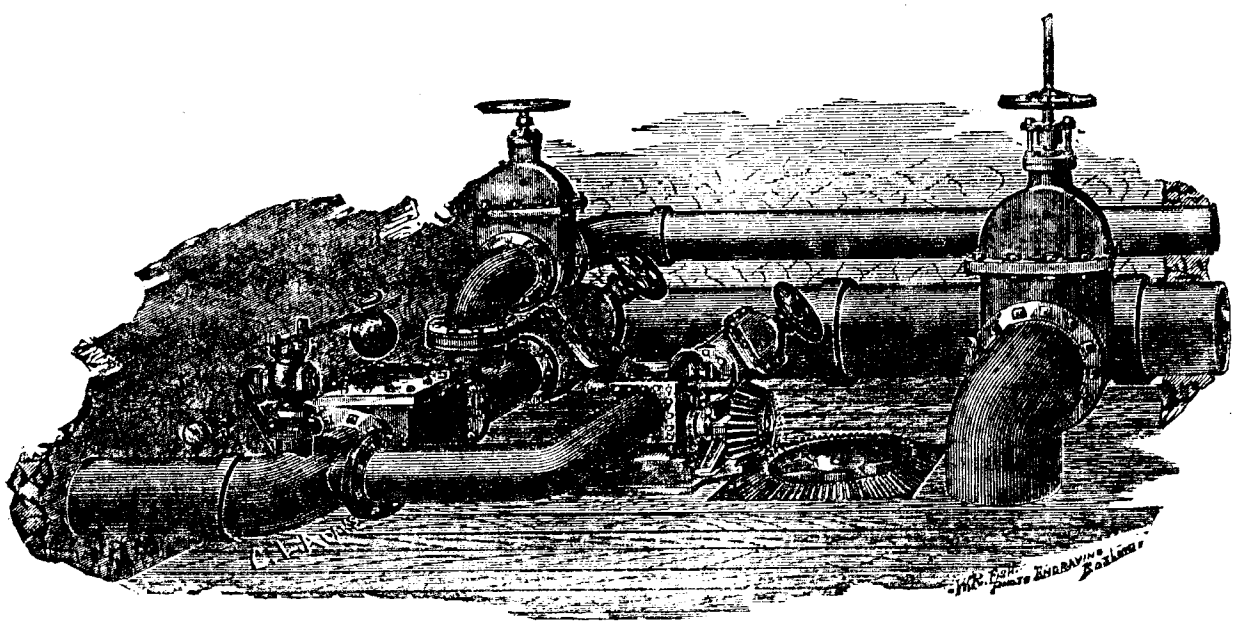

INTERIOR OF PUMP-ROOM.

REPORT.

Votes of the Town of Wayland relative to a supply of pure Water.

OCTOBER 5, 1877.

ARTICLE 2. To see if the town will vote to obtain a supply of water for the village of Cochituate, for fires and domestic purposes, from the source called "Snake Brook," at Rice's Dam, in this town.

2. *Voted*, To obtain a supply of water for the village of Cochituate, for fires and domestic purposes, from the source called "Snake Brook," at Rice's Dam, in this town, by adopting this article.

ART. 3. To choose a committee of three, with full powers to secure such supply, to contract for main pipes, hydrants, hose, and other fixtures necessary therefor, and for properly laying and placing the same, and with authority also to settle with all parties for land and other damages.

3. *Voted*, To choose a committee with full powers, and that the following-named gentlemen constitute said committee, viz: James M. Bent, James S. Draper, Thomas Bryant, H. B. Braman and Albert B. Lyon.

ART. 5. To see if the town will authorize and direct their Treasurer to borrow a sum of money not exceeding thirty-three thousand dollars; twenty-three thousand of the same

to be appropriated for the expenses of the water works in Cochituate village, and the balance to be appropriated for the erection of the new Town House.

5 *Voted*, That the Treasurer be authorized to borrow a sum of money not exceeding thirty-three thousand dollars, in accordance with this article. Yes, 124. No, 8.

NOVEMBER 6, 1877.

ART. 3. To see if the town will petition the Legislature for an act to supply the inhabitants with pure water, or do, or act.

3. *Voted*, That the committee chosen on the subject of a supply of water for Cochituate, petition the Legislature for an act to supply the inhabitants with pure water.

NOVEMBER 6, 1877.

ART. 4. To see if the town will appropriate the sum of two hundred dollars to defray the expense incurred by the committee on water, the same to be paid from the unappropriated money.

4. *Voted*, That the sum of two hundred dollars be appropriated to defray expenses which may be incurred by the committee on water, the same to be paid out of the unappropriated money.

APRIL 1, 1878.

ART. 12. *Voted*, to raise and assess five hundred dollars for fire apparatus for Cochituate,— carriage, hooks and ladders, axes and buckets. Selectmen to expend.

APRIL 30, 1878.

ART. 7. To act upon the purchasing or leasing of land and the erection of a building in Cochituate village suitable for the hook and ladder truck ordered to be purchased, and make provision for paying for the same.

7. This article referred to the Selectmen, with power to lease or purchase land and erect a building for the purpose.

ART. 10. *Voted*, To raise and assess the present year five hundred dollars to establish a sinking fund for the water works, yes, 73; no, 27; and one thousand dollars to build a hook and ladder house in Cochituate.

ART. 13. To see if the town will adopt the act passed by the Legislature to supply the town with pure water.

13. *Voted*, To adopt the act of the Legislature to supply the town of Wayland with pure water. Yes, 139. No, 65.

ART. 14. To choose a committee of five persons, by ballot, on construction of the water works.

14. Chose James M. Bent, Charles H. Boodey, Charles Fairbanks, A. H. Bryant and James A. Bent.

ART. 15. To choose a Board of three Water Commissioners, by ballot.

15. Chose W. H. Bent for one year, H. B. Braman for two years, Albert B. Lyon for three years.

APRIL 30, 1878.

ART. 16. To see if the town will authorize the Treasurer to borrow a sum of money, not exceeding twenty-five thousand dollars, for the construction of the water works, or do, or act.

16. *Voted*, That the Treasurer be authorized to borrow a sum of money, not exceeding twenty-five thousand dollars, for the construction of the water works. Yes, 90. No, 33.

JUNE 27, 1878.

ART. 9. To see if the town will authorize and instruct the Treasurer to issue "notes, bonds or scrip," at such times, to such amounts and in such denominations as the town shall determine in accordance with section four of the act for supplying the town of Wayland with pure water, or do or act in any way relative thereto.

9. *Voted*, That the Treasurer be authorized to issue bonds from time to time, as may be necessary, not exceeding twenty-five thousand dollars in amount, of such denominations as he shall think best, payable at periods not exceeding thirty years, from the date thereof, with interest, payable semi-annually, at a rate not exceeding six per cent. per annum, with power to sell the bonds, either at public sale, or pledge the same for money borrowed for the purpose of constructing the water works.

Provided, That if the bonds, or any portion of the same, cannot be sold for at least their par value, then the Treasurer be authorized to borrow such a sum of money, which, together with the amount obtained from the bonds disposed of, will not exceed twenty-five thousand dollars.

Each bond issue shall be upon the terms and conditions of Section 4 of the "Act to supply the Town of Wayland with pure water."

SEPTEMBER 4, 1878.

ART. 6. To authorize the Treasurer to borrow such sum of money, in anticipation of the taxes of 1879, as will be necessary to meet the interest upon the Wayland Water Bonds, also the interest upon other notes, bonds or scrip, which may be issued by the town, to liquidate any legal claims, and for the transfer of debt.

6. *Voted*, To authorize the Treasurer to borrow the sum of seventeen hundred and thirty-seven dollars, for interest in anticipation of the taxes of 1879.

NOVEMBER 5, 1878.

ART. 5. To see if the town will vote to purchase a hose carriage and hose, and choose a committee therefor.

5. *Voted*, That the engineers be a committee to purchase a hose carriage and hose.

ART. 6. To authorize the Treasurer to borrow money, in anticipation of the taxes of 1879, to pay for a hose carriage and hose.

6. *Voted*, To authorize the Treasurer to borrow the sum of two thousand dollars, in accordance with this article.

MARCH 3, 1879.

Chose W. H. Bent Water Commissioner, for three years.

The Construction Committee beg leave to submit the following Report:

The committee held their first meeting March 18, 1878, and organized, by electing a chairman and secretary, and entered at once upon the duties assigned them by vote of the town.

The source of supply was the first question of importance that came before them, and after a careful consideration, decided to take the water from Rice's Pond, as the most practicable source.

The purity of the water is unquestioned by competent judges, and with proper care can be kept in this condition, and the supply is believed to be ample for all probable demands for many years.

The selection of pipe was a matter of great importance, and after a careful investigation of the merits of both cast-iron and wrought-iron cement-lined pipe, the committee were unanimously in favor of cast-iron pipe, believing that for strength and durability, it was far superior to the cement pipe.

The committee, realizing the importance of having a competent engineer, secured the services of Mr. Hiram W. Blaisdell of Concord, Mass., who has had considerable experience, being associated with Mr. Wheeler in the construction of the water works at Concord and elsewhere. Mr. Blaisdell came well recommended, and the committee report with pleasure that they are fully satisfied that he performed his duty in a faithful and efficient manner.

The dam was constructed by day-labor, under the supervision of the engineer and committee, and is thoroughly and substantially built, at a cost satisfactory to the committee.

The committee, believing it to be for the best interests of all, decided to construct a filter gallery, which has caused more or less comment; but in their judgment, was a wise course, and certainly adds very much to the purity of the water.

As a means of better protection against loss by fire, the committee bought, and placed in position, a pump at the reservoir, which will increase the head more than double that of the natural head.

The gatehouse is a substantial stone building, with brick corners and slate roof, neat in design and very ornamental.

The road to the dam and gatehouse, and grading and sodding the front slope of the dam was done at a very small expense, and the committee believe that the town will sanction their action, notwithstanding any comments that have been made upon it.

The contract for furnishing pipe, hydrants, gates, valves, &c., and laying pipe, was awarded to Messrs. R. D. Wood & Co., of Philadelphia. The committee are satisfied they have fully complied with every provision of the contract, and that they have given the town a good, substantial job.

JAMES M. BENT,
CHAS. H. BOODEY,
ALFRED H. BRYANT,
JAMES A. BENT,
CHAS. FAIRBANKS,

Construction Committee Wayland Water Works.

Advertising,	$41 51
Parker & Gannett, wheelbarrows,	13 50
Davis & Farnum Mfg. Co., pipe and castings,	411 17
P. A. Leavy, blacksmithing,	12 95
Ebenezer Loker, stone and teaming,	64 75
People's store, sundries,	19 90
J. R. Connor, piping,	49 18
City of Boston, pump,	81 56
Goodhue & Birnie, cement,	229 89
Wm. & J. M. Bent, sundries,	10 00
O. Woods & Co., lumber,	4 91
W. A. Bird, coal,	1 00
E. M. Dudley, pick,	1 20
W. D. Parlin, sundries,	50 29
Wm. Jessop & Sons, steel,	2 40
Watson & Bisbee, turbine step,	50
Lambert Bros., glass,	13 80
L. M. Ham & Co., iron frames,	14 50
S. F. & J. A. Gray, brick,	12 75
C. A. Parker, expressing,	61 36
Union Lumber Co., lumber,	131 78
Expressing,	1 50
Walworth Mfg. Co., sundries,	7 92
Austin C. Wellington, cement,	26 87
Morss & Whyte, copper netting,	4 84
B. & A. R. R., freight,	8 47
Frank C. Childs, cement,	15 00
F. McCarty, use of derrick,	72 00
John Welch, stone,	15 00
Whittier Machine Co., pipe, valves and connections, pump, labor, etc.,	785 73
Fiske & Coleman, sewer pipe,	4 62
Ashcroft Mfg. Co., sundries,	7 44
Amount carried forward,	$2,178 29

Amount brought forward,		$2,178 29
National Tube Works, 2-inch pipe,		39 28
Boston Machine Co., sundries,		7 44
Irving & Casson, door and window frames,		19 75
Otis Bramhall, cresting for gatehouse,		15 00
Bowker, Torry & Co., tablets (W. W. W. 1878),		12 28
R. D. Wood & Co., contractors,		14,867 18
French & Dakin, hose nipple,		34
Geo. A. Rice,		2,250 00
Chapman Valve Co., valves,		106 80
Armstrong's Express, expressing,		1 00
Joyce & Richardson, bolts,		2 00
Waldo Bros., cement,		3 88
Wm. & J. M. Bent, cement,		14 00
J. H. Wight, carpenter,		116 97
Geo. W. Fairbank, clay,		15 00
W. F. Devine, slating,		94 50
Geo. A. Rice, sundries,		30 43
H. S. Milton, bond for dust,		2 00
Geo. F. Keep, sundries,		4 50
C. W. Dascomb, painting,		3 50
H. W. Blaisdell, engineer and inspecting pipe,		1,609 85
Wm. M. Fallick, carpenter,		9 50
Howe & Co.'s Express, express on hydrant,		75
Pay Roll in full,		3,304 22
		$24,708 46
R. D. Wood & Co.,		438 74
H. W. Blaisdell,		36 80
Appropriation,	$25,000 00	
Bal. from investigating Committee,	184 00	
	$25,184 00	$25,184 00

$46 paid R. D. Wood & Co., by Selectmen on execution.

The Tablet in gatehouse, with Committee's names, was put in at the expense of Committee.

ENGINEER'S REPORT.

To the Construction Committee of the Wayland Water Works:

Gentlemen:—I respectfully submit a report, descriptive of the works for supplying the village of Cochituate with water for fire and domestic uses, as constructed under my supervision during the past year.

In accordance with your instructions of May 18, 1878, careful surveys were made, to ascertain *first*, whether Snake Brook, the proposed source of supply (for the use of which authority had been obtained), would furnish a sufficient supply for the future demands of the village; and *second*, whether the amount appropriated would be sufficient to construct the works.

The supply and the appropriation having been found to be ample for the purposes, plans and specifications for the entire works were prepared, and proposals called for. The plans, as approved by you, and subsequently amended by the addition of the filter-works, consist of a storage reservoir of 16,000,000 gallons capacity, at a point on Snake Brook, called Rice's Dam, with a waste-weir, at an elevation of 70 feet above the roadway, at the intersection of Main and Lake streets, a filter gallery in the gravel beds on the east side of the reservoir, pump-house and pump just below the dam, to be used in case of fire, a 10-inch supply main, extending to the intersection of Lake and Plain streets,

with a system of distribution connected therewith, capable of supplying the village of Cochituate.

On account of the varied character of the work to be performed, I recommended that the dam, reservoir and filter-works should be constructed by day-labor, believing, as has been proved by the result, that the best interests of the town would be served thereby.

QUANTITY.

The quantity of water required per day, for each inhabitant, depends largely upon the nature or character of the principal industry of the town. Lowell, for example, a manufacturing city, used only 20 gallons per inhabitant, in the year 1874; while Arlington, with a large market-gardening interest, used the much larger amount of 400 gallons per inhabitant, per day, during a portion of the summer, for domestic use and irrigation. The town of Concord is using 50 gallons per day, per inhabitant, and as that town compares very favorably with Cochituate in population, I assume that amount as a basis for my estimate.

The population of Cochituate has increased very rapidly during the last ten years, it being now about 1,200. Assuming that the increase will be less rapid in the future, and that the decennial increase of 20 per cent. will cover this growth, the consumption per day at the assumed ratio of 50 gallons to each person, will be as follows:

YEAR.	POPULATION.	INCREASE.	DAILY CONSUMPTION.
1878	1200		60,000 gallons.
1888	1440	20 per cent.	72,000 gallons.
1898	1728	20 per cent.	86,400 gallons.
1908	2074	20 per cent.	103,680 gallons.
1918	2488	20 per cent.	124,416 gallons.

Having determined the probable demands of the village for the next forty years, we will apply the result to our source of supply.

FURNISHING CAPACITY OF SNAKE BROOK.

The quantity of water that a stream will furnish depends upon the rainfall of the district, the area of the water-shed, and the percentage of rainfall unconsumed by vegetation, evaporation and absorption, the geological features of the water-shed forming an important consideration, and especially so where the facilities for storage are such as to retain only a small portion of the flood waters, as in this case. The percentage of rainfall received into Lake Cochituate, of which this is one of the sources of supply, has averaged 45 per cent. for the last 26 years.

The area of the water-shed of Snake Brook, above the dam, is 425 acres, which, with sufficient storage capacity for flood-waters, would furnish, with a rainfall of 35 inches (the minimum for 26 years), of which 45 per cent. would be available, 360,000 gallons per day, sufficient for 7,000 inhabitants. Without sufficient storage capacity, however, it will scarcely furnish a continuous supply for four per cent. of that number, or 280 inhabitants—the stream having been gauged in the month of September, 1877, when the flow was but 12,000 gallons per day. This, however, was an exceptional month, the rainfall being but forty-six one-hundredths of an inch; the least for that month for twenty-six years. The intermittent supply to be obtained from the brook alone, made the reservoir an absolute necessity.

RESERVOIR.

The reservoir is on the site of what is called "Rice's Mill Pond," the old dam having been almost entirely removed in the construction of the new dam. The following table gives the area flowed and contents for each foot in height, from the waste-weir to a point 10 feet below it.

ELEVATION OF SURFACE OF WATER.	AREA FLOWED.	CONTENTS.
Waste-weir.	567,792 sq. ft.	16,000,000 gallons.
1 ft. below waste-weir.	466,947 "	11,956,000 "
2 " " "	372,825 "	8,453,000 "
3 " " "	276,831 "	5,627,000 "
4 " " "	170,028 "	4,332,000 "
5 " " "	93,285 "	2,305,000 "
6 " " "	66,501 "	1,606,000 "
7 " " "	51,543 "	1,107,000 "
8 " " "	40,896 "	721,000 "
9 " " "	28,098 "	414,000 "
10 " " "	20,800 "	201,000 "

In order to ascertain whether the reservoir has sufficient storage capacity to supply the village 40 years hence, I propose to take, as the first test case, the months of January, February and March of 1856, during which there was but 2.32 inches of rain, the least for three consecutive months for 26 years, as shown by the record of rainfall at Lake Cochituate.

Quantity required per day, as per table, 124,464 gallons. To this should be added 25 per cent., or 31,116 gallons for excess of greatest summer or winter consumption above the mean for the year, and 10,000 gallons per day for filtration and evaporation, making together a total of 165,580 gallons per day, or 14,902,200 gallons for ninety days.

To supply this, it is evident, from an inspection of the table of rainfall, preceding the three dry months, that we should have a full reservoir of 16,000,000 gallons, a portion of the rainfall during the three months, and a portion of that from several preceding months, which were unusually wet.

The percentage received from the rainfall during the three months under consideration would be very small, for all that fell before the middle of March was in the form of snow, which remained on the ground until that time. So that, with the exception of the last of March, we should have to rely entirely upon the retentiveness of the watershed, which is somewhat better than the average, owing to

a large track of swampy wood-land in the northwestern part of it. There is, also, a large spring in the northern portion that furnishes a constant supply, it being practically the head of Snake Brook.

Under these circumstances it will be safe to rely on 10 per cent. of the mean monthly rainfall for the preceding six months, which was 3.52 inches, or 4,027,083 gallons for the month of January; 7 per cent., or 2,818,956 gallons for February; and 5 per cent., or 2,013,541 gallons for March, a total of 8,859,580 gallons for the 90 days.

We have then for the 90 days supply, 16,000,000 gallons in the reservoir, plus 8,859,580 gallons of ground or spring water, equal to 24,859,580 gallons, minus 7,547,000 gallons, the quantity rendered useless by two feet of ice (its thickness on Lake Cochituate in February, 1856) on the surface of the reservoir when full, leaving 17,312,580 gallons as the available supply. Deducting from this the estimated consumption and waste, 14,902,200 gallons, there would remain 2,410,380 gallons of water, and 7,547,000 gallons of water in the form of ice. The surface of the water would be three feet below the waste-weir and eleven feet above the bottom of the 18-inch pipe, the lowest point from which the water can be drawn.

As a second test case we will take the months of June, July and August, 1854, during which the rainfall was 4.68 inches, the least, with the exception of the preceding case, for 26 years.

Having gauged the flow of Snake Brook during the months of June and July of last year, I found that the average flow was 25 per cent. of the rainfall during those months, 20 per cent. less than the yearly average on account of absorption by vegetation and evaporation. For as the rainfall diminishes, the proportion lost, from these causes, increases until the entire rainfall is consumed, as is shown by the drying up of small brooks. In September, 1877, with a rainfall of .46 inches, this ratio fell as low as 7 per

cent. for a few days only, although the preceding month had nearly an average rainfall.

In order to be safe we will assume the available supply to be 10 per cent. of the rainfall for the three months, which would give 5,235,416 gallons. We shall then have an available supply of 16,000,000 gallons, plus 5,235,416 gallons, equal to 21,235,416 gallons for consumption, filtration and evaporation. The consumption and filtration will be the same as in the first case, 165,580 gallons per day, or 14,902,200 gallons for 90 days. To this should be added the evaporation, which has been found by experiment to average six inches per month for the months of June, July and August. Applying this to the area of the reservoir two feet below the waste-weir,— the probable mean height for the three months under consideration,— the evaporation is 46,479 gallons per day, or 4,183,092 gallons for 90 days.

The total quantity drawn from the reservoir, in this case, will be 14,902,200 gallons, plus 4,183,092 gallons, equal to 19,085,292 gallons for 90 days. To supply this we have 21,235,416 gallons, leaving in the reservoir at the end of the most severe summer drought known, 2,150,123 gallons, and the surface of the water five feet below the waste-weir, and nine feet above the bottom of the 18-inch pipe.

In the foregoing estimates no allowance has been made for water used by the turbine for fire purposes, its use being very uncertain. There will remain, however, sufficient in the reservoir at the end of the three months to run the turbine about twelve hours.

When the population of Cochituate is equal to, or exceeds 2,500 inhabitants, it will be advisable to raise the dam two feet higher than at present, which will increase the storage capacity of the reservoir by 12,000,000 gallons.

DAM.

As soon as practicable, after the vote of your committee to build the works by day-labor, a gang of men was put to work under the charge of Mr. G. A. Rice.

The soft black mud that had been collecting above the old dam for a century and a half, was run into the brook, it being the easiest method of disposing of it. The removal of the old dam and the excavations for the new were then commenced and carried forward as rapidly as possible. The up-stream half of the old dam was removed, and the ledge followed down on both sides until it met at the bottom, a vertical distance of 29.5 feet below the top of the proposed dam. The ledge on the east side was found to be in a fair condition, and comparatively free from seams, while that on the west side was badly disintegrated, and seamy, necessitating the removal of about seven feet in depth at the bottom of the slope.

The dam is constructed of earth, with a centre-wall of stone laid in cement, in front of which there is a clay puddle. Its total length is 130 feet, measuring from ledge to ledge on the high-water line. Width on top 15 feet, with slopes of one and one-half to one. The centre-wall is three feet thick at the bottom and twenty-two inches at the top, and is constructed of stone removed from the old dam. The two faces were laid in cement-mortar to a depth of eight inches and in courses of about three feet rise, and the interior filled with stone and grouted. Each stone was washed perfectly clean before being laid. Upon the completion of the wall, the up-stream face was covered with a layer of cement, after which it was washed with a coat of pure cement grout, making it almost absolutely water-tight.

The clay puddle is four feet thick at the bottom, and two at the top, and consists of a very retentive clay and loam, mixed in equal parts, and thoroughly puddled and rammed in place. The foot of the puddle extends outward under the embankment to prevent percolation through seams in the ledge.

The embankment above the wall was constructed of a loamy material, obtained from the west side of the reservoir,

deposited in layers of six inches, moistened and thoroughly rammed. That on the lower side was constructed of gravel from a neighboring bank. The upper slope was covered with a foot of coarse gravel, and securely paved. The lower slope, with that of the driveway to the dam, was loamed and sodded.

The waste-weir, located on the west bank, 56 feet north of the dam, is 10 feet wide, and formed in part by removing the top of the ledge, and rubble work laid in cement mortar. From this point the channel curves to the south until it reaches the continuation of the dam, where it passes through a stone culvert six feet wide, and, by a natural channel in the ledge, to the waste-way from the turbine. The banks, where exposed to the action of the water, have been securely protected with rubble walls.

There are three pipes passing through the dam. An 18-inch cast-iron, resting on stone piers, the bottom of the inlet of which is 14 feet below the waste-weir, designed to supply the turbine and pump, also the village when the pump is not in motion, and it is not desired to draw from the filter-works. Six inches above the 18-inch pipe there is a 10-inch cast-iron pipe from the filter-well. There is, also, a three-quarter-inch wrought-iron pipe between the 10 and 18-inch pipes, placed there for use during construction.

FILTER WORKS.

As it was evident when the first estimates were made that the appropriation would be insufficient to excavate a reservoir of so great an area, to a sufficient depth to prevent vegetable growth during the summer,—one-half of the reservoir being less than three feet deep and covered with a rank vegetable growth,—your attention was directed to the construction of filter-works, and test pits were dug in the gravel banks on the east side of the reservoir to a depth of

ten feet through a very hard but porous gravel, which, upon further investigation, was found to underlay nearly the whole reservoir.

The investigation proving satisfactory, a covered filter-gallery was constructed of stone, 18 inches high and 12 inches wide, the bottom of which was 10 feet below high water at the lower, and 6 feet below at the upper end, with a well 6 feet in diameter at the lower end.

The well is located on the east bank, about 200 feet above the dam, from which point the main gallery follows the general contour of the high water-line, in a northerly direction, 400 feet, with two branches, in the gravel under the reservoir, 80 feet long, the covering being thoroughly rammed on the entire line to prevent direct access to the gallery from above. It is connected with the pump-room by 227 feet of 10-inch cast-iron pipe, the entrance to which is protected by a copper netting with one-eighth-inch meshes. The well is capped with a flagstone, through the centre of which there is a hole 20 inches in diameter, for inspection or cleaning.

A three days' test showed that the filter would furnish 200,000 gallons per day,—a continuous supply for two one-inch hose streams,—with a loss of head not exceeding six inches.

Nothing has been done to the land flowed but to cut the brush, a portion of which now lies in the water and should be removed next spring,—a heavier rain having filled the reservoir earlier than was anticipated. With this exception nothing need be done, for although the shallow portions may look uninviting during a portion of the summer, the filter will remove the impurities and render a supply nearly equal to that of the best spring water. This has been proved by its use during the past winter, for when the water was covered with ice, preventing the purifying action of sun and air, it was found to be so charged with decomposing vegetable matter as to be unfit for domestic use. The

filter was then put into use and furnished a supply, colorless and tasteless, which it continues to do, although the water in the reservoir is still unserviceable.

PUMP-HOUSE AND PUMP.

The pump-house, located at the foot of the outer slope of the dam, is a substantial stone structure, 15 feet 4 inches by 16 feet 4 inches on the outside, and 9 feet from the top of the underpinning to the eaves. It is constructed of diamond shaped stones of various colors, roughly shaped with a hammer, laid in cement, with red brick trimmings for the corners and around the door and windows. The roof is covered with the best eastern slate, with red trimmings, and crowned with a neat iron cresting. The work was performed partially by day labor and partially by contract, at a cost of $500 above the underpinning.

The upper floor is 8.5 feet, and the lower 18.75 feet below the elevation of the waste-weir, the lower floor being about 10 feet below the surface of the ground, and entirely free from all danger of injury to the works by frost. The lower room is lighted from the south and west by two horizontal lights on each side. The flooring of this room is two inch hard pine plank, supported upon heavy timbers of the same material.

The arrangement of the pump-works is substantially as follows:—The 18-inch pipe, previously mentioned, enters from the north and passes along the west side of the room, 13 inches from the wall and four inches from the floor, with three branches; an 18-inch to the turbine, a 6-inch to the pump; and a 10-inch for a direct supply from the reservoir, with valves upon each,—the spindle of the 18-inch valve continuing up through the upper floor, and a brake-wheel attached to assist in starting and stopping the turbine. The 18-inch branch continues horizontally 2 feet 9 inches from the valve, and thence downward to the turbine with easy

curves at the angles. The 6-inch branch runs in a straight line to the pump, the centre of which is 3 feet 9 inches from the centre of the 18-inch main. There is a ⊥ immediately connected with the 10-inch valve, which receives the water from the 10-inch pipe from the filter-well, which enters the room and passes along directly over the 18-inch pipe to a quarter-turn and valve, the latter being directly over the 10-inch valve on the main; thence by a quarter-turn to the ⊥. From this point the water passes through a check-valve to a quarter-turn, with a 6-inch branch to the pump, direct into the 10-inch main. There is a 3-inch safety valve on the quarter-turn, to relieve the pressure in case a hydrant is suddenly closed; also a gauge for indicating the pressure.

The pump is of the rotary pattern, and was built by the Amoskeag Manufacturing Company.

It has been in use for some time by the city of Boston, and was purchased for a small percentage of its actual cost. The entire pump, with the exception of the shafts, which are of steel, is constructed of the very best composition metal, and has been tested to 400 revolutions per minute without heating.

The motive power is a 30-inch Blake turbine, connected with the pump by 30-inch mortise and 12-inch level gear, the larger being on the turbine shaft. The available head or height from the surface of water in the wheel-pit, when running with full gate to high water in the reservoir, is 22 feet. The maximum work of the pump is four 1-inch hose streams under twice the natural head, or 140 feet at the corner of Lake and Main streets. The pump and connections were completed ready for use Dec. 16, at a total cost of $1,150, a very small sum for so efficient a fire pump. The work was satisfactorily performed by the Whittier Machine Company of Boston.

SUPPLY AND DISTRIBUTION.

From the pump-house the supply main passes in a southwesterly direction through lands of G. A. Rice, Cyrus Lee,

T. J. Damon and Sidney Loker, to Loker street, thence through Loker and Lake streets to Plain street, a total length of 5,873 feet. There are three air valves on the line of the common stream stop-cock pattern, located at points 513, 1,018, and 2,600 feet, respectively, from the pump-house. There is also an 8-inch blow-off on Lake street, where the main passes under Snake Brook.

The 10-inch main divides at the intersection of Plain and Lake streets, into a 6 and 8-inch, the latter passing through Lake street to and through Main street to Plain street. The 6-inch branch passes through Plain street, connecting with the 8-inch at Main street, and a 4-inch branch through German Hill street, to nearly opposite the house of T. B. Hawes.

From the 8-inch at the intersection of Lake and Main streets there is a 6-inch branch passing through Lake to German Hill street, at which point it is reduced to a 4-inch and continued to the Cemetery. There is a 4-inch through German Hill street, connecting with a 6-inch at either end.

This comprises the main system of distribution, supplemented by 4-inch pipes in the shorter streets and courts. Plugged branches have been placed opposite proposed or existing streets, where future extensions are probable, and where hydrants may be needed in the future.

The pipes were, as a rule, laid 13 feet from the street lines, and 4 feet 9 inches from the surface of the ground to the centre of the pipe.

The greatest head or pressure is on Main street, opposite Commons court, where it is 77 feet. The least head, 52 feet, is at the highest point of German Hill street.

The pipes were warranted by the contractor to stand 200 pounds pressure, equal to 461 full head, after they were laid. They were subjected to a test of 150 pounds, upon the completion of the works, with satisfactory results.

The thickness and weights are as follows:

DIAMETER.	THICKNESS.	STANDARD WEIGHT.
10 inches.	.60 inch.	60 pounds per ft.
8 "	.57 "	45 " "
6 "	.49 "	30 " "
4 "	.48 "	20 " "

No pipe was accepted that fell short of the standard weight by more than 5 per cent. and the total weights were not allowed to fall short of the standard by more than $2\frac{1}{2}$ per cent.

The pipes were cast expressly for these works, and each had the letters W. W. W., 1878, the running number or order in which they were cast, and initials of the maker cast on it for identification, and were tested by a hydraulic pressure of 300 pounds per square inch.

They were coated with a preparation of coal tar, by Dr. Angus Smith's process, which adds greatly to their durability, and prevents the formation of tubercles on the inside.

The pipes were inspected by Geo. W. Whitman, who executed his work so faithfully that not a single imperfect pipe arrived on the work.

The depth of lead was as follows: For 10-inch pipe, 1 3-8 inches; for 8-inch pipe, 1 1-4 inches, and for 6 and 4-inch pipes, 1 1-8 inches.

VALVES AND HYDRANTS.

In connection with the system of distribution, 10 valves have been set, affording the means of regulating the flow of water, and shutting it off from any desired section, for extension or repairs. The valves were made by the Chapman Valve Company, of Boston, and were tested to 300 pounds pressure, before being brought upon the work. They are covered with wooden boxes, fitted with cast-iron covers, marked W. W. W.

Valves at the intersection of streets are set in range with one of the street lines, which facilitates finding them if the signs put up for that purpose are missing.

The Mathews Post Hydrants, manufactured by R. D. Wood & Co., of Philadelphia, were adopted and are furnished, with their latest improvements, including the movable frost-jacket, preventing the frost heaving or breaking the hydrant. They are placed at street corners, as far as possible, and at intervals of about 500 feet along the streets. The connections with the mains are 4 inches in diameter, except that at the corner of Lake and Main streets, which is 6 inches; the hydrant having a 6-inch barrel. The balance of the hydrants have 4-inch barrels, and each has two hose and one steamer nozzle, of the pattern used by the Natick Water Works. Twenty-nine hydrants have been set, as indicated on the map.

The trenching for pipe-laying was commenced September 26th; the first pipe laid on the 30th, and the last on November 2d, on which date they were filled with water. With the exception of one joint in a wet place, accidentally covered with earth before being run with lead, no leaks of any importance have shown themselves.

The work speaks for itself and is a credit to the contractors, Messrs. R. D. Wood & Co., of Philadelphia, represented by Mr. W. F. Inman, who have spared neither labor or materials to make the work first-class in every respect, and whose relations with the officers in charge have always been of the most pleasant character.

Submitted herewith are tables (see appendix), showing:

1. Location and amount of pipe laid.
2. Number and location of valves.
3. Number and location of hydrants.

I also transfer to your custody, for the use of those having charge of the works hereafter, a large map on mounted paper, on a scale of 200 feet to an inch, showing the location of the reservoirs, supply main and distribution, and valves and hydrants.

The constant endeavor has been to obtain thorough and permanent construction throughout the entire works, rendering justice to all parties, and in this effort it is with much satisfaction that acknowledgment is made to your committee for the kindness and assistance which you have rendered me during the construction of the works.

Respectfully submitted,

HIRAM W. BLAISDELL,

HYDRAULIC ENGINEER,

32 PEMBERTON SQ., BOSTON.

MARCH 1, 1879.

ENGINEER'S APPENDIX.

TABLE I.

Showing the Location and Amount of Pipe Laid.

STREET.	FROM	TO	18-INCH.	10-INCH.	8-INCH.	6-INCH.	4-INCH.	2-INCH.
	Inlet	Pump Room	70.5	....	....	....	....	....
	Filter Well	" "	....	227	....	....	....	....
	Pump Room	Loker	....	3,000	....	....	....	....
Loker		Lake	....	1,450	....	....	....	....
Lake	Loker	Plain	....	1,423	....	....	....	....
Lake	Plain	Main	....	....	3,200	....	....	....
Main	Lake	Plain	....	....	1,482	....	....	....
Main	Lake	Commons Court	....	....	....	....	426	....
Main	Plain	Dead end	....	....	....	....	924	....
Commons Court	Main	Dead end	....	....	....	....	....	356
Plain	Lake	Main	....	....	....	2,700	....	....
Plain	Main	Dead end	....	....	....	1,704	....	....
Lake	Main	German Hill	....	....	....	1,095	....	....
Lake	German Hill	Dead end	....	....	....	....	475	....
German Hill	Lake	Plain	....	....	....	....	2,406	....
Harris	German Hill	Dead end	....	....	....	....	565	....
	Main	High School-house	....	....	....	....	283	....
Willard	Main	Dead end	....	....	....	....	583	....
Dean	Main	Dead end	....	....	....	....	248	....
Harrisson	Main	Dead end	....	....	....	....	473	....
Damon	Main	Dead end	....	....	....	....	259	....
Staunton	Main	Dead end	....	....	....	....	278	....
	Hydrant connections		....	....	....	18	296	....
	Blow-off		....	....	14	....	....	....
			70.5	6,081	4,696	5,517	7,216	356

Total, 23,936.5 feet, or about 4½ miles.

TABLE II.

Showing the Number and Location of Valves.

STREET.	LOCATION.	18-INCH.	10-INCH.	8-INCH.	6-INCH.	4-INCH.
	Pump House	1	2	....	1	....
Lake	On Blow-off, at Snake Brook	....	....	1	....	....
Lake	Corner of Plain street	....	....	1	....	....
Lake	Corner of Main street	....	....	1	1	1
Plain	Corner of Lake street	....	....	....	1	....
Plain	Corner of Main street	....	....	1	1	1
German Hill	Corner of Lake street	....	....	....	....	1
German Hill	Corner of Plain street	....	....	....	....	1
		1	2	4	4	4

Total number of valves 15.

TABLE III.

Showing the Number and Location of Hydrants.

STREET.	LOCATION.
Loker.	Near house of A. D. Loker.
Lake.	Opposite of Loker street.
Lake.	540 feet east from Plain street.
Lake.	Corner of Plain street.
Lake.	Near house of W. A. Jessop.
Lake.	Near house of Joe Fogarty.
Lake.	Near house of Alfred Loker.
Lake.	Corner of Main street.
Lake.	Near house of Kimball Lovejoy.
Lake.	Corner of Staunton street.
Lake.	Corner of German Hill street.
Main.	Opposite Commons court.
Main.	Corner of Damon street.
Main.	Opposite Willard street.
Main.	Near High School-house.
Main.	Corner of Plain street.
Main.	Near house of A. F. King.
Plain.	700 feet west of Lake street.
Plain.	Near house of J. A. Loker.
Plain.	650 feet east of Main street.
Plain.	Near Hose House.
Plain.	200 feet west of German Hill street.
Plain.	Near house of T. B. Hawes.
German Hill,	Opposite Lyons street.
German Hill	Opposite Harrisson street.
German Hill.	Near house of Marshall Garfield.
Harris.	Near house of Union Lumber Co.
Willard.	Corner of Madisson street.
Harrisson.	400 feet west of Main street.

WAYLAND WATER WORKS.

FINAL ESTIMATE OF WORK PERFORMED BY

R. D. WOOD & CO.

LOCATION.	10 in.	8 in.	6 in.	4 in.	EXTRA TRENCH	ROCK	RATE	AMOUNT.
	FT.	FT.	FT.	FT.	FT.	CU YD		
Rice's Dam to Plain street.	5873	....	.....	.....	.....	55		
Lake and Main streets.....	.....	4682	.....	.....				
Main street	.....	.....	.....	1350				
Plain street.....	.....	.....	4404	.....				
Lake, from Main to German Hill street.....	.....	.....	1095	.....				
Lake, west of German Hill street.....	.....	.....	.....	475				
German Hill street	.....	.....	.....	2406				
Harris street.....	.....	.....	.....	565				
Main street to High School house.....	.....	.....	.....	283				
Willard street.....	.....	.....	.....					
Dean street.....	.....	.....	.....	583				
Harrisson street.....	.....	.....	.....	248				
Damon street.	.....	.....	.....	473				
Staunton street.....	.....	.....	.....	259				
Hydrant connections.....	.....	.....	.....	278				
Blow-off.....	.....	.....	18	296				
Extra trenching.....	.....	14	.....	.....				
	.....	.....	.....	.....	456			
	5873	.....	.....	.....	.....	.....	$ .87½	$5,138 87
		4696	.....	.....	.....	.....	.70	3,287 20
			5517	.....	.....	.....	.51	2,813 67
				7216	.....	.....	.42	3,030 72
					456	.....	.10	45 60
						55	2.00	110 00
Furnishing and setting 29 Hydrants and 10 Valves..	.....	.....	.....	.....	.....	.....	.....	926 00
Setting extra Valve for Blow-off.....	.....	.....	.....	.....	.....	.....	.....	7 44
								$15,359 50

PIPES AND APPURTENANCES.

PIPES AND SPECIALS RESERVED.

24 feet 10-inch pipe, 60 lb. per foot, at .0127,	$18 29	
40 " 4 " " 20 " " " " "	10.16	
1 foot 10 " sleeve, 121 " " " " .0227,	2.75	
1 " 6 " " 80 " " " " "	1.82	
1 " 4 " " 45 " " " " "	1.01	
1 " 8-inch x 8-inch x 4-inch branch, 205 lbs. per foot, at .0227	4.65	41 42
1 foot 6-inch plug, 16 lbs. per foot, at .0227,	.36	
1 " 4 " " 10 " " " " "	.22	
1 " 4-inch x 4-inch x 4-inch branch, 95 lbs. per foot, at .0227	2.16	

Total amount of Contract.....	$15,400 92
Deduct for excess of time occupied in casting pipe, 19 days, at $5.00.....	95 00
Balance....	$15,305 92
Payments previous to Feb. 13, 1879, $6,159 88+$8,650 84+$56 46.....	14,867 18
Balance due R. D. Wood & Co., Feb. 13, 1879 (since paid).....	$438 74