NINETEENTH ANNUAL REPORT

OF THE

BOSTON WATER BOARD.

FOR THE

YEAR ENDING JANUARY 31, 1895.

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Printed for the Department.

BOSTON:
ROCKWELL AND CHURCHILL, CITY PRINTERS.
1895.

Office of the Boston Water Board,
City Hall, Boston, February 1, 1895.

Hon. Edwin U. Curtis,
Mayor of the City of Boston:

Sir: The Boston Water Board, in charge of the Water-Supply Department, herewith submit their annual report for the financial year ending January 31, 1895.

The receipts and disbursements of the department for the year were as follows:

The total receipts of the Water-Works, from all sources, for the year ending January 31, 1895, were as follows, viz.:

Income from sales of water	$2,091,959 60	
Income from shutting off and letting on water, and fees	4,099 76	
Elevator, fire and service pipes, sale of old materials, etc.	50,829 04	
		$2,146,888 40

The total expenditures of the Water-Works, from revenue, for the year ending January 31, 1895, were as follows, viz.:

Current expenses, viz.:		
Water-Supply Department . $537,071 28		
Less stock used purchased in previous years . . . 4,782 12		
$532,289 16		
Water-Income Department . 64,765 52		
	$597,054 68	
Interest on funded debt	833,771 04	
Sinking-fund requirement, 1893–94 . .	229,380 00	
Carried forward,	$1,660,205 72	

Brought forward,	$1,660,205 72	
Refunded water-rates	2,774 76	
Extension of mains, etc.	263,111 67	
Amount paid Chelsea, Somerville, and Everett, under contracts . . .	152,657 96	
Balance to sinking-fund	68,138 29	
		$2,146,888 40

COST OF CONSTRUCTION, AND CONDITION OF THE WATER DEBT.

Cost of construction of Water-Works to February 1, 1894	$24,449,065 36
Cost of construction of Water-Works to February 1, 1895	[1] 25,400,581 03
Increase during the year	$951,515 67

Stock on hand February 1, 1894	$144,785 23
Stock on hand February 1, 1895	156,982 22
Increase during the year	$12,196 99

The outstanding Water Loans February 1, 1894, were .	$17,157,273 98
The outstanding Water Loans February 1, 1895, were .	17,761,273 98
Increase during the year	$604,000 00

The Water Sinking-Fund February 1, 1894, was .	$7,914,715 13
The Water Sinking-Fund February 1, 1895, was .	[2] 8,444,773 55
Increase during the year	$530,058 42

Net Water Debt February 1, 1894	$9,242,558 85
Net Water Debt February 1, 1895	9,316,500 43
Increase during the year	$73,941 58

[1] See page 23.

[2] Consisting of investments (city of Boston bonds) $8,315,460.00 and cash to the amount of $129,313.55.

EXTENSION OF MAINS.

The work of extending mains exceeded that of the previous year by about one and one-half miles, 17.9 miles having been laid and 5.1 miles having been abandoned; making a total of 572.8 miles of pipe now connected with the Cochituate system. To meet the requirements of the city in its rapid growth, from twenty to twenty-five miles of pipe should be laid annually, so it will be seen that the average during the past year was considerably below what it should have been. As during the previous year, we were obliged to economize in many directions in the effort to keep within the appropriation allowed us for this work. The total amount appropriated was $250,000, and the amount expended was $263,111.67, being $13,111.67 in excess of the appropriation; but as there remains on hand stock to the amount of $19,013.58 over the amount on hand at the beginning of the year, it leaves the actual cost for extensions $244,098.09, or $5,901.91 less than the appropriation. These expenditures have been provided for entirely from water revenue.

The second force main (36″) from the Chestnut Hill to the Fisher Hill reservoir has been laid during the year, at a cost of $72,461.94, including connections. The excessive cost was largely due to the fact that a portion of the pipe was necessarily laid at a great depth. In view of the contemplated new main from Washington Village to South Boston flats, *via* Dorchester avenue and D street, the pipe contract for 1894 was considerably increased; but as we were obliged to postpone this work for another year, we have the pipe on hand, and we hope to be able to carry out this work during the coming summer.

The main across the new Dover-street bridge has been completed and connected, and the temporary pipe which supplied water to South Boston during the work of abolishing the grade crossing, has been removed.

This temporary pipe was a source of great anxiety, as it passed through a large building for storing lumber in a lumber-yard, and in case of fire would have been in a very dangerous position. The Board took every precaution to protect it, by having it enclosed in a sheet-iron box and placing a line of automatic sprinklers inside the boxing.

Considerable work has been done during the year in enlarging the pipe system and locating new hydrants in the district formerly covered by the Jamaica pond aqueduct service.

The Board contemplate beginning early in the spring the important work of laying a new high-service supply main from the junction of Fisher Hill avenue and Boylston street, in Brookline, to the city proper. This main will be 48 inches in diameter to the junction of Huntington avenue and Heath street, where it will be reduced to 42 inches, and continued through Huntington avenue and Boylston street, across the Common to Park-street gate. A 36-inch main will be laid from the corner of Huntington avenue and Heath street, across the Roxbury district to Grove Hall, for the improvement of the supply in Roxbury and Dorchester. The estimated cost of this work when completed is $400,000.

It is hoped that when this work is finished an ample supply of water can be furnished in all the various localities from which complaints have come for several years past of lack of water, particularly during extreme cold weather in winter, when many water-takers allow their taps to run continually to prevent the water from freezing, thereby causing a great loss of head, and in many instances, in the more elevated localities, even taking away the supply entirely for several days at a time.

CONSUMPTION OF WATER, RAINFALL, ETC.

The daily average consumption of water during the past year was 46,560,000 gallons on the Cochituate and Sudbury, and 10,282,100 gallons on the Mystic; that of the combined supplies being 56,842,100 gallons, or a decrease of 2.3 per cent. over the previous year. The consumption per capita was 97.4 gallons.

The rainfall was below the average, the total for the year on the Sudbury water-shed being 39.74 inches. Although the season of 1894 was an unusually dry one, yet with the addition of the new basin No. 6, which was filled during the winter and spring, and from which water was drawn for the first time, we were enabled to supply the needs of the city without much anxiety so far as the Cochituate and Sudbury supply was concerned.

The water in Mystic lake fell to such a point that by September 12 it was necessary to let on the Cochituate water to supply Charlestown, as the Mystic supply would not have been sufficient for that district and the cities of Chelsea, Somerville, and Everett. Pumping was resorted to from August 31 to November 15, and the water in the lake reached a lower point than ever before. The old temporary pumps and engines at the lake were in such bad condition through age and use, that, by advice of the City Engineer, two new engines and one new pump were purchased, and the pump and one of the engines were at once put into service.

HARBOR SERVICE.

The submerged pipes for supplying water to Long, Rainsford, and Gallop's islands and Fort Warren are still a source of great annoyance and expense to the Board, especially during the cold weather. Notwithstanding the fact that they are buried at the shore ends, the storms cause the water to wash the covering away, thereby exposing the pipes, and when there is any great decrease of the circulation they freeze and burst.

Between Long and Gallop's islands and between Long and Rainsford islands the pipes are of wrought iron, three inches in diameter, and are so badly eaten by rust that it is very difficult and expensive to keep them sufficiently in repair to maintain the supply even in the summer season.

In order to provide for emergencies, and also to furnish a supply for fire purposes, the Board of Commissioners of Public Institutions have constructed a reservoir on Long island which has a capacity of 1,300,000 gallons. Water was admitted to this reservoir on December 7, 1894.

The Board have recommended to the Commissioners of Public Institutions that a reservoir be built on Rainsford island; and also to the Board of Health, that one be built on Gallop's island,— so that the buildings on those islands may have a supply of water in case of emergency. The work of extending pipes for the harbor system was commenced in the year 1888, and water was let into the pipes August 21, 1889.

It is proposed, during the coming season, to lay new lines of pipe between all of these islands (with the exception of the line from Long island to Fort Warren, which was laid by the United States Government), and, if possible, to protect them from freezing.

The original cost of laying the entire system from Neponset to Moon, Thompson's, Long, Rainsford, and Gallop's islands, and the change from the low to the high service system, was $66,024.93, and the repairs on the same, up to February 1, 1895, have amounted to $12,891.72.

The following is an extract from a letter of the Board to Mayor Matthews, on January 18, 1894, concerning the whole harbor pipe system: "These submerged pipes are a constant source of expense to this department, and we should be glad to turn all the pipes, from the point where they leave the mainland, over to the Public Institutions, and deliver them water without charge."

NEW HIGH-SERVICE PUMPING-ENGINE.

The first shipment of the parts of the new 20,000,000-gallon per day high-service pumping-engine was made February 17, 1894, and the work of setting it up at the Chestnut-Hill pumping-station was begun at once. As stated in our last report, it was hoped to have had the pump in operation by July 1, but many unforeseen delays occurred which made this an impossibility. It became necessary to build an addition to the boiler-house in order to accommodate the new boiler constructed by the Atlantic Works, and considerable delay was experienced in securing a special car from the Calumet & Hecla Mining Company, which they were courteous enough to allow us to use to transport the boiler from the works at East Boston to Chestnut-Hill station, as an ordinary flat car would have made the load too high to pass beneath the railroad bridges. On account of the various delays the new engine was not ready to receive steam until October last. The engine has been run from time to time in order to get the bearings and joints in proper condition before finishing the work of lagging and painting. It is now expected that the pump will be put into service by about the middle of March. The new boiler is in place and working very satisfactorily. This boiler will furnish steam to the engine at considerable less expense for coal than boilers of the ordinary type.

FIRE SERVICE.

It has been the aim of the Board to keep the fire service of the city up to the highest standard, and the proposed pipe referred to, under the head of Extension of Mains, is for increasing that service throughout the business district. Constant watch has been kept upon the hydrants during the cold weather, and the Fire Department has had no serious trouble from them this winter, as yet. It will be the policy of the Board to extend the high service in the business section as rapidly as necessity requires. Owing to the increased number of high buildings, and the extension of the automatic-sprinkler system, many demands have been made for high service. In May last the Board requested the City Engineer to report what work was necessary to be done in order to furnish better fire protection. He subsequently reported, recommending larger pipes and more hydrants in many of the streets, and the Board will from time to time carry out his recommendations.

In addition to the pressure-recording gauges that were placed in many of the fire-engine houses last year, more have been added, and arrangements have been made with the Fire Commissioners whereby, in case of a conflagration in the high-service district of the city proper, if the recording gauge at City Hall shows a pressure of not more than 25 pounds, certain gates between the high and low service mains will be opened at once by employees of this department; the location and number of the gates to be opened to depend upon the locality and magnitude of the fire, thus ensuring an ample supply of water when needed.

WHITEHALL POND.

On August 2, 1894, by the advice of the Law Department and with the approval of the Mayor the Board settled with Eben D. Jordan, owning two-thirds, and on August 30 with Wood Bros. & Newhall, owning one-third, of Whitehall pond, for an aggregate sum of $286,500. Plans are being drawn for a new dam, and a contract for its construction will probably be made during the coming summer. When this dam is finished and the pond cleaned the quality of the water will be greatly improved, and the storage capacity of the Sudbury supply increased some 1,256,900,000 gallons.

All the land damages and claims abutting on the pond have been settled, with the exception of four or five small cases which the Board expect to dispose of at an early day.

BASIN 6.

Basin 6 was filled during the winter and spring, and water was first drawn from it in September. The work of finishing around the basin was continued during the season, and is practically completed. The Board, on January 1, turned the care and maintenance of this basin over to the superintendent of the Western Division.

Much work has been done in straightening out the brook leading from the basin to the Sudbury river below the dam, and in building filtering beds to be used in conjunction with the basin, and a keeper's house has been provided at one end of the dam. There being a large swamp at the head of Basin 6, in which the water became discolored by being held back, it was deemed advisable to take several acres of land for the purpose of controlling the outlet into the basin.

BASIN 5.

A portion of the land for this basin, comprising 198.01 acres, was taken by right of eminent domain April 2, 1894, in order that the construction of the new dam might be begun at once, and the balance (2,247.17 acres) was so taken April 30, 1894, the takings being duly recorded in the counties of Worcester and Middlesex. Work on the new dam was begun by Moulton & O'Mahoney, contractors, early in May, and it was pushed as rapidly as possible until the cold weather set in, when it was covered and thoroughly protected from the frost. This work will be resumed as soon as the weather will permit. One contract for stripping in the basin was let to Auguste Saucier on August 27, and the work is now being prosecuted. Other contracts for stripping will be advertised for in the spring, and it is expected that enough of the dam and stripping will be completed so as to admit of the filling of the basin to a height of 25 feet, by another winter. Many of the claims for damages and for land taken have been settled. In the report of last year attention was called to the numerous conferences held with a committee of citizens of Southboro', in regard to the changing of the roads in that town, necessitated by the construction of Basin 5. The result of these conferences was that the following agreement was entered into between the town of Southboro' and the city of Boston:

The city of Boston, a municipal corporation in the county of Suffolk, acting by its water board, and the inhabitants of the town of Southboro', a municipal corporation in the county of Worcester, acting by its committee thereunto duly authorized, on this fourteenth day of February, A.D. eighteen hundred and ninety-four, agree as follows:

First: Said town consents to the discontinuance by said city of certain parts of the town, county and other public ways in said town substantially as shown in blue on a plan hereto annexed, and to the laying out, relocating, altering, building, reconstruction and repair of certain other parts of said ways, which shall thereafter be highways, substantially as shown in red on said plan, and to the changing of the grade of certain other parts of said ways substantially as shown in yellow on said plan, all of which said water board deems necessary for the proper building by said city of its new water-basin in said town.

Second: Said city may discontinue said parts of ways shown in blue as aforesaid and shall do the work on said parts of ways shown in red and yellow as aforesaid in a good and workmanlike manner, making the travelled parts of said ways shown in red and yellow not less than twenty-five feet wide, and of good material, and to the satisfaction and acceptance of the county commissioners of Worcester county, and shall secure to all persons desiring to use any of said parts shown in red, yellow or blue, a safe and convenient way of travel over or around each part from the time said city shall construct or commence work on the same until the completion of the substitute therefor in the manner aforesaid, and shall at all times during the progress of its work secure safe and convenient ways of travel between Southboro' and the neighboring towns, and between the different parts of said town.

Third: Said city shall, wherever practicable, fence the said parts of ways shown in red or yellow with substantially built field-stone walls, and where it is impracticable to place such walls, shall fence said parts of said ways with an iron fence not less than four feet in height, made with two iron gas-pipe rails not less than two and one-half inches in diameter, fixed in iron posts not less than three inches in diameter, and with said posts securely fixed in stone bases, where and as the board of selectmen of said town shall request.

Fourth: Said city shall either take all land lying between Rice's Mill and Williams' Mill, so called, and between the line of said basin on the north and a line marked A and B upon the annexed plan on the south, and compensate the several owners therefor, or it shall build a new way which shall comply with the requirements of the first, second and third clauses, for ways to be built by it, and which shall run from a point near the junction of the Willow Bridge road and the road from Fayville to Marlboro', to a point on the old County road from Framingham to Southboro' near the house of Sullivan T. Ball.

Fifth: Said city shall not commence the construction of any part of said basin, or of any structure connected therewith, except the dam thereof, until descriptions of all lands and other property to be taken for said basin or structures have been filed in the Registry of Deeds for the county of Worcester, and said city shall file such descriptions in said Registry before May 1, 1894.

Sixth: Said city shall pay all damages that shall be sustained by any person in his property, to which damages he may be legally entitled by reason of any discontinuance, relocation, alteration or change of grade of any public way in said town by, or on the petition of, said city, its officers or agents, and shall indemnify and save harmless said town from every suit brought against said town from any cause arising from any such discontinuance, relocation, alteration or change of grade of any public way in said town so made, or from any defect in any such way from the time said city shall obstruct or commence work on the same until the completion thereof in the manner aforesaid, and shall upon reasonable notice appear in, and defend every such suit, and satisfy all judgments in such suit.

Seventh: Said town by its selectmen may, during the construction of said basin and ways, furnish a proper and sufficient lock-up in said town, and may appoint and employ, at wages not exceeding two dollars and a half per day per man, police officers in such numbers as may be agreed upon by said selectmen and said water board, or the agency in charge of its water supply, or in case they cannot agree, in such numbers as the chief of the district police force may determine to be necessary to protect persons and property in said town, and said city shall pay the expense incurred for said lock-up and said police officers as herein provided, at fixed periods at intervals not exceeding six months, as said board or agency and said selectmen may agree upon.

Eighth: Said town may take water from said basin for the purposes of a public water supply for said town not exceeding two hundred thousand (200,000) gallons per day, and may do all necessary and reasonable acts to take said water.

Ninth: Said town, or persons designated by the selectmen of such town and approved by said board or agency, may, under such reasonable regulations as said board or agency may deem necessary for the preservation of the purity of the water of said basin, cut and remove ice from said pond to be sold, delivered and used only in said town, and may construct and maintain ice-houses for the purpose of storing ice, not exceeding two in number, of a total capacity not exceeding twenty-five hundred (2,500) tons, in such place and of such size and construction as said board or agency and said selectmen shall agree upon, and the inhabitants of said town may under such reasonable regulations as said board or agency may deem necessary for the preservation of the purity of the water of said basin, cut and remove ice from said basin for their individual use in said town.

Tenth: Said city shall before July 1, 1894, pay to the treasurer of said town for the use of said town, the sum of fifty thousand dollars ($50,000), being the estimated cost to said town of building other highways, and the extra cost of repairing the ways hereinbefore mentioned, when raised or altered by said city.

CITY OF BOSTON,
By
Thos. F. Doherty,
J. W. Leighton,
Wm. S. McNary,
} *Boston Water Board.*

Inhabitants of the TOWN OF SOUTHBORO',
By
Charles F. Choate,
Joseph Burnett,
Francis D. Newton,
John A. Salmon,
De Clinton Nichols,
} *Committee of said Town.*

Approved: N. Matthews, Jr.,
Mayor.

This agreement was confirmed by an Act of the Legislature approved March 14, 1894.

Several conferences were also had with the commissioners of the counties of Worcester and Middlesex in regard to the proposed changes of highways, and on March 3 the City Engineer was requested to prepare plans and specifications which were approved by the Worcester county commissioners, April 10, for building two roads to take the place of two of those which were to be discontinued. The contract for their construction was awarded to Berry Bros., June 6. These roads have been completed, and they will be opened to public travel in the spring. The town has appointed a police force, for which the city pays, according to the above agreement. In anticipation of the adoption by the State of a metropolitan water-supply from the Nashua river, the plans of the gate-house at Dam No. 5 were modified so as to adapt the structure to the increased flow which would be required on account of an additional supply from said river.

FUTURE SUPPLY.

In recent reports attention has been called to the very important subject of a future supply of water for Boston. As the limit, after the full development of the Sudbury system will be reached in a few years, this subject has been constantly kept in mind by the Board for several years. The Legislature of 1892 appropriated $40,000 to enable the State Board of Health to inquire into the matter of a metropolitan supply for Boston and its suburbs within a radius of ten miles; and it is expected that a report will be made by them to the Legislature some time next month, when this very important subject will doubtless receive the consideration which it deserves; in the meantime work will be continued in the development and for the purification of the entire water system of the Sudbury river and its tributaries.

CEDAR SWAMP.

Cedar swamp, which is in the towns of Hopkinton and Westboro', and through which much of the water of the Sudbury river flows, and derives its high color, contains 1,500 acres, about half of which has been bonded, and it is hoped to obtain rights of drainage through a large part of the remaining lands to build canals so as to drain the entire swamp. When this is done, the most important source of discoloration of the water will be remedied. It is expected that good progress will be made in this work before another winter.

FILTRATION.

The filter beds at the outlet of Pegan brook, in Natick, which have now been in operation several years, have given satisfactory results. Studies on filtration have been pursued during the past year, both for the Cochituate and Sudbury, and the Mystic systems, and much data has been obtained, which will be of great value in future in caring for the city's water-supply. Plans have already been prepared for a series of beds to filter the water of Marlboro' brook, which flows through a part of that city, and into the new Basin 5.

MYSTIC DEPARTMENT.

In our last report attention was called to the proposed park in Winchester, which would remove one of the most serious nuisances upon the Abajona river. It was the opinion of the Board that the removal of several tenement-houses on the banks of the river, a tannery, stables, and various other buildings and workshops, would be a great advantage in the work of purifying this water-supply. After numerous conferences with authorities of the town of Winchester and the Metropolitan Park Commissioners, arrangements were finally made, with the approval of the Mayor, and providing the City Council should so authorize, to contribute the sum of $60,600 towards the removal of these buildings, and the converting of this territory into the Metropolitan park scheme. On November 22 a communication was sent to the Mayor, and by him forwarded to the City

Council, asking for a loan of $65,000 in order to carry out the plans agreed upon. The matter was laid over for the present city government to take up, which it is expected it will do at an early day.

The new pumping-engine for the Mystic works is being constructed by the Geo. F. Blake Manufacturing Company, and it is expected that it will be set up and in working order in the early fall. A contract was made with Mack & Moore, October 27, 1894, to build an extension to the pumping-station in order to accommodate this new engine, and this work is now in process of construction. The foundations for the new engine are finished and ready for the heavy parts of the machinery, as soon as the roof of the building is completed. Owing to the low condition of Mystic lake, the Cochituate water was turned on to Charlestown September 12, and is now supplying that district.

The Cochituate high service has supplied the Bunker Hill section continually since June 29, 1893. The abolishment of the grade crossing at Chelsea bridge made it necessary to relay the pipes which supply Chelsea and East Boston. East Boston was supplied through 20 and 24 in. pipes, and Chelsea by a 16-in. pipe. In place of these a new line of 30-in. pipe was laid to supply East Boston, and a 24-in. pipe to supply Chelsea. These pipes were laid through land of the Boston & Maine Railroad Company, along the line of the street, so as to avoid the foundation of the piers of the highway bridge over the railroad tracks. In the near future the quality of the Mystic water will be greatly improved, as the town of Winchester has constructed, and the city of Woburn is about to construct, sewers, and it is hoped that Stoneham will soon do so. It is expected that the North Metropolitan sewerage system, into which the sewers of these communities will enter, will be in operation by the coming spring.

SEWERAGE SYSTEMS OF MARLBORO', WESTBORO', FRAMINGHAM, AND NATICK.

The Marlboro' sewerage system is working very satisfactorily, and house connections are continually being made. Great improvement has already been noticed in the water of Basin 3, into which the Marlboro' brook flows.

The town of Westboro' is also continually extending its sewerage system, which has removed what has heretofore been a serious menace to one arm of the head-waters of the Sudbury river.

The Framingham sewerage system was constructed several years ago, the city of Boston agreeing to pay the sum of

$25,000 towards it; but payment has been withheld, owing to the construction of an under-drain, which was allowed to discharge into Beaver Dam brook. The authorities have now decided to build a filtering-bed, to care for the water pumped from the under-drain, and the Board have agreed to assist the town in completing the same. This matter, it is expected, will be entirely consummated during the coming summer.

By Chapter 459 of the Acts of 1894 the town of Natick was empowered to construct and maintain a system of sewerage and sewage disposal. Section 2 of this act provides that said town shall build and maintain its collecting-reservoir and pumping-station at such place on the southwesterly side of Lake Cochituate, between West Central street in said Natick and said lake, as the Boston Water Board shall approve; shall carry the sewers connecting with said pumping-station across or through the filter-beds and adjacent lands of said city as said Water Board shall approve; shall carry its sewers, pipes, and conduits across Lake Cochituate only by routes south of the location of the main line of the Boston & Albany Railroad Company; and shall construct and maintain its sewers, pipes, conduits, reservoirs, and pumping-apparatus and sewage-fields in such manner as the State Board of Health shall approve. And in consideration thereof said city of Boston, by its Water Board, shall allow the main line of sewers connecting with the pumping-station of said town to be constructed through or across the filter-beds and adjacent lands of said city without any payment for the right so to do or for any damages caused thereby, and shall, upon the building of said pumping-station and the laying of said main line from Cochituate street in said Natick to said pumping-station, pay to the treasurer of said town the sum of $18,000.

Conferences have been held with the sewer committee of said town, and arrangements have been made for the town to carry the sewage across Lake Cochituate at its southern extremity, and its adjacent location to the Boston & Albany Railroad Company, to a pumping-station to be located on the westerly side of the lake, near the village of Walkerville, so called; from which point the sewage will be pumped to the filtration-fields adjoining those now occupied by Framingham. When this system of sewerage is completed another great source of pollution to Boston's water-supply will be removed.

ELECTROLYSIS.

During the year, Messrs. Stone & Webster have continued their investigations as to the effect of the electric currents on the water-pipes. We are satisfied that some electrolytic action is taking place in our water-pipe system. And, as it is very important that this action be carefully watched in order to prevent any serious damage from occurring, the Board have authorized the City Engineer to employ, from time to time, whatever expert assistance he may deem necessary.

BIOLOGICAL LABORATORY.

The biological studies and experiments at the laboratory at Chestnut Hill, have fully demonstrated by their results the great advantage of work of this character. The accurate knowledge of the condition of the waters of the various basins and reservoirs has amply compensated the department for the expenditure incurred.

ASSETS AND LIABILITIES.

The Board recently requested the City Engineer to make a careful estimate of the value of the property of the Water Department, in order that a statement of the assets and liabilities might be incorporated in this report. In making this estimate he has taken into account only what he considered to be the actual market value. The following is a copy of his estimate:

CITY OF BOSTON, ENGINEERING DEPARTMENT,
50 CITY HALL, January 31, 1895.

COL. THOMAS F. DOHERTY,
Chairman Boston Water Board:

SIR: The following is the estimated present value of the Boston Water-Works:

Reservoir No. 1	$340,000 00
" " 2	487,000 00
" " 3	620,000 00
" " 4	1,050,000 00
" " 5, partially constructed	[1] 500,000 00
" " 6	1,080,000 00
Whitehall pond	386,000 00
Farm pond	20.000 00
Lake Cochituate	1,800,000 00
Sudbury-river aqueduct	3,650,000 00
Carried forward,	$9,933,000 00

[1] This does not include value of land taken, but not paid for.

Brought forward,		$9,933,000 00
Cochituate aqueduct		1,100,000 00
Chestnut-hill reservoir		2,280,000 00
Brookline reservoir		250,000 00
Fisher-hill reservoir		190,000 00
Parker-hill reservoir		206,000 00
East Boston reservoir		150,000 00
South Boston reservoir		50,000 00
Chestnut-hill pumping-station, buildings . .		200,000 00
" " machinery . .		240,000 00
W. Roxbury high service, machinery and buildings,		25,000 00
East Boston " " " " "		35,000 00
Pipe-yard and buildings		250,000 00
Distribution system (573 miles)		7,400,000 00
Total Sudbury and Cochituate works . .		$22,309,000 00
Mystic Water-Works:		
Mystic lake and conduit . .	$1,250,000 00	
Engine-house and machinery .	200,000 00	
Reservoir	200,000 00	
Distribution system (38.6 miles),	600,000 00	
Total Mystic works		2,250,000 00
Total		$24,559,000 00

Yours respectfully,

WILLIAM JACKSON,

City Engineer.

Considering the financial condition of this department it is well to note that the loss of revenue from several of the other city departments is a very serious matter. For instance, in the year 1891 the revenue derived from other departments was $116,895.14, whereas during the past year we have only received $45,096.15, being a loss of $71,-798.99. Since the year 1891 no charge has been made to the Street Department for water for street-sprinkling purposes, or to the Fire Department for hydrants. On the other hand, the expense to this department of restoring streets to the condition they are found in when openings are made for extensions or repairs of pipes has been very largely increased, inasmuch as the roadways are now more thoroughly and expensively built than formerly.

We now receive from the Fire Department $2 per year for the care and maintenance of each hydrant, and the estimated cost to meet the demands for fire service is $15 per year per hydrant.

The total cost of construction of the water-works to February 1, 1895, was	$25,260,439 83
Value, January 31, 1895	$24,559,000 00
Stock on hand January 31, 1895 . . .	156,982 22
	$24,715,982 22
Net debt, January 31, 1895	9,316,500 43
Surplus of assets over liabilities . . .	$15 399,481 79

DETAILED STATEMENT OF THE COST OF COCHITUATE, SUDBURY, AND MYSTIC SYSTEMS OF THE BOSTON WATER WORKS TO FEBRUARY 1, 1895.

Cochituate Supply.

Lake Cochituate:		
Amount paid for lake . .	$100,000 00	
Factories at outlet, $50,000, less amount received for insurance,	20,818 22	
Roads, bridges, swamps, etc. .	38,332 48	
Dam at outlet	8,458 20	
Lower dam at outlet . .	10,940 08	
New dam at outlet . . .	33,436 49	
Gate chamber, superstructure .	29,907 12	
Raising lake, including damages	28.002 18	
Pegan brook dam . . .	1,394 06	
Willow dam	1,567 29	
Dudley pond and connections .	18,982 23	
		$291,838 35
Compensating reservoirs . .		66,859 80
Land and water damages, Cochituate		248,827 34
Engineering expenses to January 1, 1852		40,000 00
Cochituate aqueduct:		
Brick aqueduct . . .	$817,717 73	
Newton tunnel . . .	102,297 36	
Brookline tunnel . . .	47,378 26	
Bridges, culverts, and waste weirs	74,499 54	
Siphon	26,532 35	
		1,068,425 24
Total cost of Cochituate supply .		$1,715,950 73

Sudbury-River Supply.

Reservoir No. 1:		
Land damages	$67,759 46	
Reservoir, including one-third of cost of 48-inch pipe .	44,455 20	
Foundation of dam . . .	75,157 97	
Superstructure of dam . .	50,325 74	
Gate chamber, superstructure .	10,988 92	
Additional work, gates, etc. .	8,456 52	
		$257,143 81
Reservoir No. 2:		
Land damages	$165,013 78	
Reservoir, including one-third of cost of 48-inch pipe . .	71,591 86	
Foundation of dam . . .	80,419 83	
Superstructure of dam . .	57,602 56	
Gate chamber, superstructure .	5,579 12	
Additional work, gates, etc. .	9,381 00	
Removal of shallow flowage .	76,365 96	
		465,954 11
Reservoir No. 3:		
Land damages	$40,512 61	
Reservoir, including one-third of cost of 48-inch pipe . .	53,952 26	
Foundation of dam . . .	111,179 65	
Superstructure of dam . .	70,534 25	
Gate chamber, superstructure .	6,984 25	
Additional work, gates, etc. .	6,251 98	
Removal of shallow flowage .	129,987 72	
		419,402 72
Reservoir No. 4:		
Land damages	$26,330 00	
Reservoir	265,517 93	
Dam	521,998 45	
		813,846 38
Reservoir No. 5:		
Expenditures to date, including land		279,818 86
Reservoir No. 6:		
Land damages	$26,876 59	
Reservoir	334,183 02	
Dam	549,241 57	
		910,301 18
Whitehall pond:		
Land damages	$32,474 61	
Reservoir	28,841 33	
Amount paid Messrs. Jordan & Wood	233,200 00	
		294,515 94
Carried forward,		$3,440,983 00

Brought forward,		$3,440,983 00
Cedar swamp		14,695 21
Work about Farm pond . .		17,297 94
Roadway in Framingham . .		23,947 32
Land damages, exclusive of amts. otherwise specified . . .		340,696 38
Water damages paid to mill-owners below Dam 1	$419,062 88	
Damages paid mill-owners at Ashland	94,000 00	
Water damages on Indian brook .	15.700 00	
Legal expenses	30,127 76	
		558,890 64
Temporary connection with Lake Cochituate		75,611 73
Investigations of Shawshine and Charles rivers, etc. . . .		27,646 59
Protection of supplies:		
Paid toward Marlboro' sewerage system	$62,000 00	
Paid toward Westboro' sewerage system	20,000 00	
[1] Land damages . . .	83,903 81	
Miscellaneous	11,610 58	
		177,514 39
Engineering and engineering expenses from 1872 to 1881 .		300,371 22
Office expenses, travelling, etc. .		80,594 74
Miscellaneous		35,282 93
Sudbury-river conduit:		
Section A, Dam 1 to Farm pond,	$67,548 89	
Farm-pond conduit (across pond)	157,837 97	
Section 1	69,851 42	
" 2	111,479 70	
" 3	156,725 19	
" 4	92,556 00	
" 5	94,967 25	
" 6, Rockland-st. tunnel .	111,241 17	
" 7	148,382 58	
" 8, Badger-hill tunnel .	92,905 32	
" 9	119,857 19	
" 10, Waban bridge . .	182,710 40	
" 11	130,344 68	
" 12	178,342 75	
" 13	105,802 44	
" 14	165,696 78	
" 15, Charles-river bridge .	202,712 55	
" 16	87,145 68	
" 17	88,693 62	
Carried forward,	$2,364,801 58	$5,093,532 09

[1] Previous to 1891, land purchased for protection of supply was charged to the general account of Land Damages.

Brought forward,	$2,364,801 58	$5,093,532 09
Section 18	20,422 56	
" 19	76,170 00	
" 20, Beacon-st. tunnel .	336,630 70	
" 21	39,038 34	
Gate chamber, superstructure, Chestnut-hill reservoir . .	9,471 13	
East siphon chamber, superstructure	7,585 81	
West siphon chamber, superstructure	9,915 45	
Waste-weir chamber, superstructure, Newton . .	2,438 19	
Waste-weir chamber, superstructure, Natick . . .	2,564 18	
Waste-weir chamber, superstructure, Sherborn . .	2,440 29	
Waste-weir chamber, superstructure, Needham . .	2,570 50	
Siphons, sluice-gates, additional work, etc.	121,499 71	
Connections with Chestnut-hill reservoir	87,113 51	
		3,082,661 95
Total cost of Sudbury supply,		$8,176,194 04

Distributing-Reservoirs and Distribution.

Brookline reservoir:		
Land	$58,418 93	
Construction	108,301 92	
Gate chamber . . .	33,356 36	
		$200,077 21
Beacon-hill reservoir:		
Land	$145,107 10	
Construction	368,426 11	
Total	$513,533 21	
Credit by sale of land . .	150,000 00	
		363,533 21
Chestnut-hill reservoir:		
Land	$144,418 32	
Construction	2,124,521 06	
Stable	8,103 55	
		2,277,042 93
South Boston reservoir:		
Land	$55,103 23	
Construction	35,804 87	
		90,908 10
Carried forward,		$2,931,561 45

Brought forward,		$2,931,561 45
East Boston reservoir:		
Land	$23,862 50	
Construction	42,240 59	
		66,103 09
Parker-hill reservoir:		
Land	$99,678 91	
Construction	98,765 00	
Gate-house, superstructure	4,675 00	
Keeper's house	2,674 90	
		205,793 81
Fisher-hill reservoir:		
Land	$92,042 00	
Construction, contract	75,967 27	
Sluice-gates	1,215 00	
Gate-house, superstructure	8,912 00	
Grading, engineering, advertising,	12,999 08	
		191,135 35
Roxbury high service:		
Engines, engine-house, and standpipe		103,829 53
Brighton high service:		
Engine-house, pumps, boilers, and reservoir		7,745 00
East Boston high service:		
Pumping-station, old	$4,200 00	
Pumps and boilers, old	4,800 00	
Pumping-station	8,973 26	
Standpipe, including land	8,749 10	
Boilers and pump foundations,	1,234 86	
Grading, etc.	2,250 90	
		30,208 12
West Roxbury high service:		
Engine-house, including land	$6,741 50	
Pumps and boilers	2,299 56	
Standpipe	10,945 00	
Right of way, grading, etc.	2,360 50	
		22,346 56
Chestnut-hill pumping-station:		
Engine and boiler-house	$205,172 89	
Gaskill engines, Nos. 1 and 2,	48,083 20	
Leavitt engine, No. 3 (to date),	148,178 18	
Two horizontal tubular boilers,	6,003 00	
Belpaire boiler and economizer,	16,417 01	
Economizer, pumps, piping, dynamos, engines, electric work, and miscellaneous	15,324 46	
H. R. Worthington Co., damages for loss of contract	45,907 52	
		485,086 26
Carried forward,		$4,043,809 17

Brought forward,		$4,043,809 17
Jamaica-pond aqueduct:		
Amount paid	$45,217 50	
Amount received . . .	32,000 00	
Balance	$13,217 50	
Amount paid	75,199 70	
		88,417 20
Pipe yards and buildings . .		94,832 16
Engineering expenses to Jan. 1, 1852		57,873 58
Distribution:		
Distribution to January, 1850,	$1,600,000 00	
Extension to East Boston .	254,267 05	
40-inch main	304,991 83	
48-inch main, Chestnut-hill reservoir to Brookline avenue,	254,300 00	
48, 24, and 30 inch mains, Commonwealth avenue, Francis street, and Massachusetts avenue	87,402 28	
24-inch main across Chelsea creek	24,878 08	
12-inch main, South Boston high service . . .	27,860 29	
10 and 12 inch main, East Boston high service . . .	13,960 07	
12-inch main, Breed's-island high service . . .	22,700 00	
Mains for West Roxbury high service	19,000 00	
Mains for new high service works	151,275 23	
Mains to Long, Thompson's, and Gallop's islands, etc. .	66,024 93	
Mains to Deer island . .	74,840 80	
Mains for fire service . .	31,191 42	
24 and 30 inch mains to Charlestown and East Boston . .	158,925 88	
Other mains and services .	6,315,273 15	
		9,406,891 01
Total cost of distributing-reservoirs and distribution		$13,691,823 12

SUMMARY OF COST OF SUDBURY AND COCHITUATE WORKS.

Cochituate supply:		
Lake Cochituate . . .	$291,838 35	
Compensating reservoirs . .	66,859 80	
Land and water damages . .	248,827 34	
Engineering expenses to January 1, 1852	40,000 00	
Cochituate aqueduct . .	1,068,425 24	
		$1,715,950 73
Sudbury supply:		
Reservoir No. 1 . . .	$257,143 81	
" " 2 . . .	465,954 11	
" " 3 . . .	419,402 72	
" " 4 . . .	813,846 38	
" " 5, to date . .	279,818 86	
" " 6 . . .	910,301 18	
Whitehall pond . . .	294,515 94	
Cedar swamp	14,695 21	
Work about Farm pond . .	17,297 94	
Roadway in Framingham . .	23,947 32	
Land damages, not otherwise specified	340,696 38	
Water damages . . .	558,890 64	
Temporary connection with Lake Cochituate . . .	75,611 73	
Investigations of Shawshine and Charles rivers, etc. . .	27,646 59	
Protection of supplies . .	177,514 39	
Engineering and engineering expenses	300,371 22	
Office expenses, travelling, etc.,	80,594 74	
Miscellaneous	35,282 93	
Conduit and connections at Chestnut-hill reservoir .	3,082,661 95	
		8,176,194 04
Distributing reservoirs and distribution:		
Brookline reservoir . . .	$200,077 21	
Beacon-hill " (net cost) .	363,533 21	
Chestnut-hill " . . .	2,277,042 93	
South Boston " . . .	90,908 10	
East " " . . .	66,103 09	
Parker-hill " . . .	205,793 81	
Fisher-hill " . . .	191,135 35	
Roxbury high service . .	103,829 53	
Brighton " " . .	7,745 00	
East Boston high service . .	30,208 12	
Carried forward,	$3,536,376 35	$9,892,144 77

Brought forward,	$3,536.376 35	$9,892,144 77
West Roxbury high service .	22,346 56	
Chestnut-hill pumping-station .	485,086 26	
Jamaica-pond aqueduct . .	88,417 20	
Pipe-yards and buildings . .	94,832 16	
Engineering expenses . .	57,873 58	
Distribution	9,406,891 01	
		13,691,823 12
Total cost of Sudbury and Cochituate works .		$23,583,967 89

Cost of Mystic works to February 1, 1895:

Land damages		$91,855 38
Dam	$17,167 26	
Grubbing at lake . . .	9,393 26	
Lowering Mystic river . .	3,012 06	
		29,572 58
Conduit		129,714 30
Engine-house	$69,840 42	
Engine	161,499 55	
		231,339 97
Reservoir		141,856 26
Distribution		872,258 55
Buildings		18,603 05
Engineering, inspection, and salaries . . .		53,216 27
Mystic-Valley sewer		83,608 70
Miscellaneous		24,446 88
Total cost of Mystic works		$1,676,471 94
Total cost of combined supplies		$25,260,439 83

Changes have been made in the construction account of the Cochituate works on the books of the department, to make the total correspond after February 1, 1895, as shown by the following statement:

Cost of construction to February 1, 1895, as per book account		[1]$23,724,109 09
Add cost of new dam at Lake Cochituate, paid for from revenue		33,436 49
		$23,757,545 58
Deduct cost of temporary pumping plant at Lake Cochituate (now abandoned, and which was not properly chargeable to construction)	$23,577 69	
Credit by sale of Beacon-hill reservoir lot	[2]150,000 00	
		173,577 69
Cost of Sudbury and Cochituate works (as above),		$23,583,967 89

[1] In statement of cost on page 2 the cost of the Mystic works ($1,676,471.94) is included.
[2] This money was used for municipal purposes, and was not credited to water-works.

The outstanding Water Loans on this date, February 1, 1895, are as follows:

Loans.				Date of Maturity.	Amount.
6	per cent.	Currency,	Due	Dec., 1897	$500,000 00
6	"	" "	"	June, 1898	450,000 00
6	"	" "	"	Oct., 1898	540,000 00
6	"	" "	"	April, 1899	250,000 00
6	"	" "	"	Jan., 1901	625,000 00
6	"	" "	"	April, 1901	688,000 00
6	"	" "	"	July, 1901	330,000 00
6	"	" "	"	July, 1902	100,000 00
5	"	" Sterling Loan, (£399,500),	"	Oct., 1902	1,947,273 98
6	"	" Currency,	"	April, 1903	905,000 00
6	"	" "	"	Jan., 1904	8,000 00
6	"	" "	"	April, 1904	38,000 00
6	"	" "	"	Jan., 1905	161,000 00
6	"	" "	"	April, 1905	142,700 00
6	"	" "	"	July, 1905	44,000 00
6	"	" "	"	Oct., 1905	6,000 00
5	"	" Gold Loan,	"	Oct., 1905	1,000,000 00
6	"	" Currency,	"	Jan., 1906	82,550 00
6	"	" "	"	April, 1906	8,750 00
5	"	" Gold Loan,	"	April, 1906	552,000 00
5	"	" "	"	Oct., 1906	2,000,000 00
6	"	" Currency,	"	Oct., 1906	4,000 00
6	"	" "	"	Jan., 1907	8,000 00
6	"	" "	"	April, 1907	5,000 00
6	"	" "	"	July, 1907	1,000 00
5	"	" Currency Loan,	"	Oct., 1907	1,000 00
5	"	" " "	"	April, 1908	12,000 00
4	"	" "	"	April, 1908	588,000 00
4	"	" Loan,	"	July, 1909	82,000 00
4½	"	" "	"	Oct., 1909	268,000 00
4	"	" "	"	April, 1910	280,000 00
4	"	" "	"	April, 1912	324,000 00
4	"	" "	"	July, 1913	111,000 00
4	"	" "	"	Oct., 1913	336,000 00
4	"	" "	"	Jan., 1914	466,000 00
4	"	" "	"	April, 1914	18,500 00
4	"	" "	"	Oct., 1914	16,000 00
4	"	" "	"	Jan., 1915	50,000 00
3½	"	" "	"	April, 1915	50,000 00
4	"	" "	"	April, 1915	145,700 00
3½	"	" "	"	Oct., 1915	50,000 00
4	"	" "	"	Oct., 1915	23,000 00
3½	"	" "	"	Jan., 1916	100,000 00
4	"	" "	"	Jan., 1916	58,000 00
4	"	" "	"	April, 1916	128,500 00
3½	"	" "	"	July, 1916	75,000 00
3½	"	" "	"	Oct., 1916	25,000 00
4	"	" "	"	Oct., 1916	286,300 00
4	"	" "	"	Jan., 1917	21,000 00
3	"	" "	"	April, 1917	200,000 00
3½	"	" "	"	April, 1917	275,000 00
4	"	" "	"	April, 1917	161,000 00
Carried forward					$14,547,273 98

Loans.	Date of Maturity.	Amount.
Brought forward,		$14,547.273 98
4 per cent. Loan,	Due July, 1917	7,000 00
4 " " "	" Oct., 1917	160.700 00
4 " " "	" Jan., 1918	20.000 00
4 " " "	" April, 1918	6,300 00
3½ " " "	" July, 1918	100.000 00
4 " " "	" Oct., 1918	100,000 00
4 " " "	" April, 1919	200,000 00
3½ " " "	" Oct., 1919	145.000 00
4 " " "	" Oct., 1919	300,000 00
3½ " " "	" Nov., 1919	130,000 00
3½ " " "	" Jan., 1920	220,000 00
4 " " "	" Oct., 1920	384,000 00
4 " " "	" April, 1921	100,000 00
4 " " "	" Oct., 1921	162,500 00
4 " " "	" Jan., 1922	100,000 00
4 " " "	" April, 1922	75,000 00
4 " " "	" Oct., 1922	283,000 00
4 " " "	" Oct., 1923	576,275 00
4 " " "	" Oct., 1924	144,225 00
Total		$17,761,273 98

SUMMARY.

3 per cent. Loans,	$200,000 00
3½ " " "	1,170,000 00
4 " " "	5,714,000 00
4½ " " "	268,000 00
5 " " Currency Loans,	13,000 00
5 " " Gold "	3,552.000 00
5 " " Sterling "	1,947,273 98
6 " " Loans,	4,897,000 00
Total	$17,761,273 98

Cochituate Water Debt, Gross and Net,

At the Close of Each Fiscal Year.

Fiscal Year.	Gross Debt.	Sinking-Funds.	Net Debt.
1847–48....	$2,129,056 32[1]	....	$2,129,056 32
1848–49....	3,787,328 98	....	3,787,328 98
1849–50....	4,463,205 56	....	4,463,205 56
1850–51....	4,955,613 51	....	4,955,613 51
1851–52....	5,209,223 26	....	5,209,223 26
1852–53....	5,972,976 11	....	5,972,976 11
1853–54....	5,432,261 11	....	5,432.261 11
1854–55....	5,403,961 11	....	5,403,961 11
1855–56....	5,230,961 11	....	5,230,961 11
1856–57....	5,031,961 11	....	5,031,961 11
1857–58....	4,724,961 11	....	4,724,961 11
1858–59....	4,754,461 11	....	4,754,461 11
1859–60....	3,846,211 11	....	3,846,211 11
1860–61....	3.455,211 11	....	3,455,211 11
1861–62....	3,012,711 11	....	3,012,711 11
1862–63....	2,992,711 11	....	2,992,711 11
1863–64....	2,992,711 11	....	2,992,711 11
1864–65....	2,942,711 11	....	2,942,711 11
1865–66....	3,152,711 11	....	3,152,711 11
1866–67....	3.370.711 11	....	3,370,711 11
1867–68....	3,867,711 11	....	3,867,711 11
1868–69....	5,107,711 11	....	5,107,711 11
1869–70....	5,731,711 11	....	5,731,711 11
1870–71....	6,482,711 11	$1,100,000 00	5,382,711 11
1871–72....	6,812,711 11	1,185,049 67	5,627,661 44
1872–73....	6,912,711 11	1,268,234 97	5,644,476 14
1873–74....	7,863,711 11	1,372,953 62	6,490.757 49
1874–75....	8,123,711 11	1.533,890 28	6,589,820 83
1875–76....	9,735,711 11	1,560,917 83	8,174,793 28
1876–77....	11,548,711 11	1,709,492 60	9,839,218 51
1877–78....	11.545,273 98	2,043.764 73	9 501,509 25
1878–79....	11,753,273 98	2,143,847 85	9,609,426 13
1879–80....	11,697,273 98	1,771,692 92	9,925,581 06
1880–81....	11,631.273 98	1,989,300 88	9,641,973 10
1881–82....	11,631,273 98	2,281,857 89	9,349,416 09
1882–83....	11,955,273 98	2,607,768 46	9,347,505 52
1883–84....	12,882,273 98	2,746,505 58	10,135,768 40
1884–85....	13,045.473 98	3,106,323 82	9,939,150 16
1885–86....	13,491,473 98	3.385,201 26	10,106,272 72
1886–87....	14,142,273 98	3,947,616 92	10,194,657 06
1887–88....	14,741,273 98	4,373,304 09	10,367,969 89
1888–89....	14,941,273 98	4,864,092 54	10,077,181 44
1889–90....	15,696,273 98	5,440,819 47	10,255,454 51
1890–91....	16,267,773 98	5,979,297 80	10.288,476 18
1891–92....	16,423,773 98	6.471,545 34	9,952,228 64
1892–93....	16,758,773 98	7,019,058 38	9,739,715 60
1893–94....	17,055,273 98	7,649.504 87	9,405,769 11
1894–95....	17,761,273 98	8,444,773 55	9,316,500 43

[1] No account taken of amounts borrowed temporarily from 1846 to 1852 and afterwards funded by the issue of the water bonds that figure in this statement.

Mystic Water Debt, Gross and Net,

At the Close of Each Fiscal Year.

Fiscal Year.	Gross Debt.	Sinking-Funds.	Net Debt.	Surplus.
1862–63 [1]	$100,000 00	....	$100,000 00	
1863–64	308,000 00	....	308,000 00	
1864–65	583,000 00	....	583,000 00	
1865–66	641,000 00	....	641,000 00	
1866–67	958,000 00	....	958,000 00	
1867–68	1,020,000 00	....	1,020,000 00	
1868–69	1,022,000 00	....	1,022,000 00	
1869–70	1,022,000 00	....	1,022,000 00	
1870–71	1,172,000 00	....	1,172,000 00	
1871–72	1.357,000 00	$18,151 55	1,338,848 45	
1872–73	1,364,000 00	77,768 46	1,286,231 54	
1873–74 [2]	1,403,000 00	186,655 21	1,216,344 79	
1874–75	1,280,000 00	138,228 76	1,141,771 24	
1875–76	1,318.000 00	45,616 62	1,272,383 38	
1876–77	1,228,000 00	96,701 18	1,131,298 82	
1877–78	1,228,000 00	175,831 79	1,052,168 21	
1878–79	1,153,000 00	252,380 48	900,619 52	
1879–80	1,153,000 00	318,137 06	834,862 94	
1880–81	1,153,000 00	366,898 39	786,101 61	
1881–82	1,127,000 00	468,225 12	658,774 88	
1882–83	1,027,000 00	506,705 12	520,294 88	
1883–84	840,000 00	330,540 15	509,459 85	
1884–85	839.000 00	444,453 69	394,546 31	
1885–86	839,000 00	521,541 93	317,458 07	
1886–87	839,000 00	603,555 62	235,444 30	
1887–88	839,000 00	666,965 00	172,035 00	
1888–89	839,000 00	715,811 53	123,188 48	
1889–90	839,000 00	767,306 65	71,693 36	
1890–91	690.000 00	680,929 44	9,070 57	
1891–92	482,000 00	550,208 70	....	$68,208 70
1892–93	441,000 00	579,254 01	....	138,254 01
1893–94	102,000 00	265,210 26	....	163,210 26
1894–95	....	....	....	[3] 166,894 12

[1] The fiscal year of the city of Charlestown began March 1 and ended February 28.
[2] To April 30, Charlestown annexed to Boston January 5, 1874.
[3] Transferred to Cochituate Water Sinking-Fund.

Cochituate Water Sinking-Fund Receipts

[Since the Establishment of the Board of Sinking-Fund Commissioners in 1871.]

Year.	From Tax Levy or City Income.	Interest on Investments.	Interest on Bank Deposits.	Water-Rates, etc.	Premiums on Loans.	Other Sources.	Totals.
1871. April 30, received from Committee on Reduction of Debt	$1,100,000 00	....	....	....	....	....	$1,100,000 00
1871–72	14,325 00 Taxes, 9,375 00	$61,000 00	$349 67	....	....	....	85,049 67
1872–73	9,000 00	70,137 50	1,017 80	....	....	....	80,155 30
1873–74	30,090 00	76,799 60	2,072 65	....	....	....	108,962 25
1874–75	75,973 28	82,842 25	2,121 13	....	....	....	160,936 66
1875–76	65,554 00	85,470 00	3,617 55	....	....	$386 00	155,027 55
1876–77	234,814 00	86,245 66	4,119 47	$26,480 18	....	915 46	352,574 77
1877–78	Taxes, 214,500 00	85,830 85	10,809 31	27,099 92	....	....	338,240 08
1878–79	Taxes, 207,456 00	93,264 49	6,181 26	177,195 91	....	9,874 21	493,971 87
1879–80	....	90,472 42	5,687 62	214,707 24	....	4,411 64	315,278 92
1880–81	....	86,460 00	167 32	195,668 90	....	1,762 04	284,058 26
1881–82	....	96,546 35	2,767 90	193,840 36	....	494 08	293,648 69
1882–83	....	105,129 51	8,486 33	216,581 72	....	1,241 04	331,438 60
1883–84	Taxes, 973 00	138,120 90	2,268 22	....	....	....	141,362 12
1884–85	....	143,049 45	7,510 40	209,258 39	....	....	359,818 24
1885–86	....	156,694 01	5,804 31	120,129 12	....	442 27	283,069 71
1886–87	Taxes, 75,496 00	181,264 89	2,644 70	297,928 95	....	5,081 12	562,415 66
1887–88	....	199,883 90	4,178 16	221,620 11	....	....	425,682 17
1888–89	....	213,048 22	8,958 69	256,013 57	$11,552 50	....	489,572 98
1889–90	....	228,000 83	11,730 60	300,903 00	36,092 50	....	576,726 93
1890–91	....	229,509 17	29,763 94	242,675 22	36,530 00	....	538,478 33
1891–92	....	175,808 33	22,560 16	275,014 05	....	78,865 00	552,247 54
1892–93	....	260,506 20	30,148 34	240,435 00	16,413 50	....	547,503 04
1893–94	....	298,224 44	18,133 03	299,467 27	14,621 75	....	630,446 49
1894–95	....	312,232 05	18,524 22	297,518 29	....	9,894 12	638,268 68
	$2,037,556 28	$3,556,641 02	$209,622 78	$3,812,537 20	$115,210 25	$113,366 98	$9,844,934 51

DETAILED EXPENDITURES UNDER THE SEVERAL APPROPRIATIONS.

FEBRUARY DRAFT, 1894, TO FEBRUARY DRAFT, 1895.

Extension of Mains, etc. (from Revenue).

Labor	$94,725 97	
Teaming	6,597 93	
Blasting	5,921 52	
Water-pipes, contracts (including inspection, $1,787.49)	115,431 07	
Stock	35,255 68	
Miscellaneous	5,179 50	
		$263,111 67

Additional Supply of Water (from Loans).

(Account of Basin No. 6, Whitehall pond, Cedar swamp, Protection of Supply, and Basin No. 5.)

Salaries and labor	$31,372 71	
Materials	9,791 44	
Contract, pipes and specials for Dam No. 5	4,326 12	
Contract, two roads, in Framingham and Southboro'	12,670 63	
Contract, stripping shallow flowage, and two roads, Section A, Basin 5 (on account)	13,254 98	
Contract, Dam 5 (on account)	88,439 39	
Contract, riprap and paving on Dam No. 6, balance (total, $14,018.19),	6,822 96	
Engineering and supplies	23,485 17	
Land damages	416,440 81	
Teaming	3,351 38	
Travelling expenses	1,429 84	
Printing, stationery, and advertising	577 41	
Miscellaneous	7.137 93	
		$619,100 77

(Account of High Service.)

Labor	$6,805 75	
Materials	10,968 95	
[1] Contract, additional pumping-engine No. 3 (on account)	15,000 00	
Carried forward,	$32,774 70	$619,100 77

[1] Payment of $25,000 also made on this contract from appropriation for High Services.

Brought forward,	$32,774 70	$619,100 77
Contract, addition to pumping-station (on account)	2,097 25	
Settlement of Worthington pump contract suit	45,907 52	
Miscellaneous	745 32	
		$81,524 79
		$700,625 56

High Service (from Loans).

Account of High-service Pumping-engine No. 3, for Chestnut Hill, viz.:		
[1] Contract for engine (on account) .	$25,000 00	
Contract for Belpaire boiler . .	10,490 00	
Contract for addition to pumping-station (on account)	1,500 00	
Work by contractors for pumping-engine outside of contract . .	1,749 99	
Work and materials in connection with boiler foundations, etc. . . .	1,243 67	
Inspection	1,632 74	
Valves, iron and steel, etc. . .	662 04	
Freight on boiler and materials . .	333 38	
Labor, new force-main from Chestnut Hill to Fisher Hill Reservoir . .	5,804 87	
Miscellaneous	106 20	
		$48,524 89

MAINTENANCE ACCOUNTS, COCHITUATE SYSTEM.

(FROM REVENUE)

FEBRUARY DRAFT, 1894, TO FEBRUARY DRAFT, 1895.

Boston Water Board:

Salaries of two Commissioners, Chief Clerk and Secretary, Executive Clerk, Purchasing Agent, two Assistant Clerks, Messenger, and Special Agent	$16,896 97	
Travelling expenses	3,109 83	
Printing and stationery . . .	537 30	
Advertising, postage, and miscellaneous	4,026 58	
		$24,570 68
Carried forward,		$24,570 68

[1] Payment of $15,000 also made on this contract from appropriation for Additional Supply of Water.

Brought forward,		$24,570 68
Eastern Division:		
Salaries of Superintendent, Assistant Superintendents, Clerks, and Foremen	$15,928 47	
Travelling expenses and transportation of men	1,256 39	
Printing and stationery	428 49	
Miscellaneous	57 02	
		17,670 37
Western Division:		
Salaries of Superintendent, Assistant Superintendent, and Clerks	$27,648 23	
Travelling expenses	655 33	
Printing and stationery	345 47	
Miscellaneous	253 71	
		28,902 74
Engineering		2,465 05
New meters, and setting		13,664 33
Meters, repairing		19,736 78
Machine-shop, Albany street		8,586 10
Telephones		1,780 65
Cochituate Aqueduct		2,136 19
Sudbury Aqueduct		11,455 71
Main-pipe relaying (including stock and labor)		15,605 33
" repairing " " " "		18,458 36
Hydrants " " " " "		20,755 38
Stopcocks " " " " "		4,957 41
Hydrant and stopcock boxes, and repairing (including stock and labor)		4,880 31
Tools and repairing (including stock and labor)		9,029 14
Streets " " " " "		6,522 88
Fountains " " " " "		3,198 59
Stables " " " " "		20,488 82
Waste-detection		27,197 33
Basins, Framingham and Ashland (including stock and labor)		5,854 56
Service-pipe repairing (including stock and labor)		23,297 63
Protection of Sudbury and Cochituate supply		1,265 45
High service, Chestnut Hill (including fuel, salaries, repairs, etc.)		26,109 87
High service, East Boston (including fuel, salaries, repairs, etc.)		4,372 51
High service, West Roxbury (including fuel, salaries, repairs, etc.)		3,379 15
Albany-street yard		5,366 49
Chestnut-Hill Reservoir (including stable, care of grounds, etc.)		12,493 87
Parker-Hill Reservoir		2,218 78
Brookline Reservoir		1,156 47
Carried forward,		$347,576 93

Brought forward,		$347,576 93
East Boston and South Boston Reservoirs . .		1,806 04
Fisher-Hill Reservoir		2,619 64
Lake Cochituate		5,996 68
Chestnut-Hill driveway		12,188 38
Taxes		2,400 81
Damages		2,379 53
Analyses of water, etc.		280 00
Merchandise sold (pipes and castings, in cases of emergency), and stock charged off, which was used on additional supply work		969 94
Filtration		4,647 69
Biological Laboratory		1,275 75
Natick filters		12,113 67
		$394,255 06

MAINTENANCE ACCOUNTS, MYSTIC SYSTEM.

(FROM REVENUE.)

FEBRUARY DRAFT, 1894, TO FEBRUARY DRAFT, 1895.

Boston Water Board:		
Salaries of one Commissioner and one Assistant Clerk	$5,788 92	
Printing and stationery . . .	115 92	
Advertising, postage, travelling expenses and miscellaneous . .	1,152 90	
		$7,057 74
Superintendent's Department:		
Salaries of Superintendent, Assistant Superintendent, and Clerk . .	$5,747 71	
Printing and stationery	187 34	
Travelling expenses	480 50	
Miscellaneous	98 60	
		6,514 15
Engineer's Department		3,210 50
Meters, repairing		3,706 13
Off and on water (labor)		2,736 61
Main-pipe laying (including stock and labor) .		316 29
" repairing " " " " .		1,007 86
Service-pipe laying " " " " .		1,228 22
" repairing " " " " .		1,759 42
Hydrants, repairing " " " " .		1,570 19
Gates " " " " " .		844 91
Streets, repairing " " " " .		502 25
Lake		19,131 98
Conduit		862 15
Carried forward,		$50,448 40

Brought forward,	$50,448 40
New meters, and setting	848 50
Stables	5,358 54
Reservoir	5,273 12
Pumping service (salaries, wages, fuel, repairs, etc.),	34,280 34
Repair-shop	2,566 68
Fountains	772 31
Tools and repairing	504 29
Mystic Sewer (repairs, and pumping and treatment of sewage)	19,016 75
Waste-detection Service	8,555 51
Protection of water sources (including salaries of three Special Agents on Pollution) . . .	5,802 75
Analyses of water	30 00
Filtration	439 49
New Pumping-engine No. 4 (on account) . .	7,183 32
Damages	125 00
Miscellaneous	241 17
	$141,446 17

Contracts Made and Pending during Year commencing February 1, 1894, and ending January 31, 1895.

Contracts marked thus (*) are completed. Amounts marked thus (†) are for extra work.

Date.	Contractors.	Work.	Amount.	Paid on Contract. Previous Years.	Year 1894.	Total.
1892. June 8, Mod'fd Aug. 1,	N. F. Palmer, Jr., & Co.	High-service Pumping-engine No. 3	$124,000 2,500 Less on account Modification. $121,500	$64,431 72	$40,000 00	$104,431 72
Sept. 29,	Lamprey Boiler Furnace Mouth Protector Co.	Attachment to boilers at pumping-stations 6 months' trial free of expense to city	$90 per boiler, if iron $105 " " if brass if accepted.	Payments delayed.		
1893. *Mar. 6,	Osgood & Hart	Iron and service box castings	1 19-20 cents per pound	9,241 48	3,412 74	12,654 22
* " 6,	Granular Metal Company,	Brass castings Composition, No. 1 " " 2 " " 3	$17\frac{1}{2}$ cents " " 15 " " " 14 " " "	3,388 15	1,688 67	5,076 82
*Mar. 6,	Daniel Doherty	Teaming pipes, etc., for year ending March 15, 1894	$0.70 per ton, $2\frac{1}{2}$ miles $1.20 " " over $2\frac{1}{2}$ miles	1,970 09	807 86	2,777 95
*Apr. 15,	Atlantic Works	Belpaire boiler for Pumping-engine No. 3	$10,612.33 f. o. b. cars	......	10,490 00	10,490 00
July 27,	Moulton & O'Mahoney	Building Dam No. 5, Southboro'	$454,729.90 paved $446,829.90 riprapped	......	88,439 39	88,439 39
*Sept. 19,	John Berry	Laying paving and riprap on Dam No. 6	$14,145.91	7,195 23	6,822 96	14,018 19
*Dec. 26,	Thomas Prosser & Son	Steel forgings for the Mystic Pumping-Station	$2,065.15	......	1,973 51	1,973 51
* " 28,	Curran & Burton	1,000 tons Pocahontas coal, delivered in bins at the Mystic Pumping-Station	4.32\frac{1}{2}$ per ton of 2,240 lbs.	......	4,324 98	4,324 98
" 30,	George F. Blake Manf. Co.	Mystic Pumping-engine No. 4	$38,950.00.			

1894. *Jan. 12	John W. Bowers	Blasting, Calumet street, Roxbury	$4.00 per cubic yard		35 20	35 20
*Feb. 1,	R. D. Wood & Co.	15 tons 4-in. B pipe, ‡290, 60 Tons 16-in. A pipe. 700 " 6-in. B " ‡60, 500 " 16-in. B " 450 " 8-in. B " ‡250, 360 " 20-in. A " 320 " 10-in. B " ‡125, 100 " 24-in. A " 420 " 12-in. A " ‡160, 1,050 " 30-in. A " 500 " 12-in. B " 70 tons special castings. 100 " special castings	Additional quantities ordered July 24, 1894, under "20 per cent. increase clause" in contract, see amounts marked thus (‡). $22.45 per ton		114,482 09	114,482 09
* " 14,	Town of Southborough	Discontinuance and changes of certain roads, to allow of construction of Basin No. 5	$50,000		50,000 00	50,000 00
*Mar. 5,	Josiah H. Long	3 — 36-in. stopcocks 9 — 30-in. " 2 — 24-in. " 4 — 20-in. "	$353.83 each $267.31 " $151.26 " $132.23 "		4,298 72	4,298 72
" 7,	Osgood & Hart	Iron and service box castings	1 65-100 cents per lb.		5,250 23	5,250 23
Mar. 7,	Granular Metal Co.	Brass castings, composition No. 1 " " " " 2 " " " " 3	14½ cents per lb. 12¾ " " " 11½ " " "		2,385 68	2,385 68
" 7,	Charles E. Howe	Teaming water-pipes, etc., for one year	64 cents per ton, 2½ miles $1.08 " " over 2½ miles		3,693 00	3,693 00
*April 6,	Martin F. Kelley	Blasting, Geneva avenue, Dorchester	$2.64 per cubic yard		213 31 †150 00	363 31
* " 20,	Dennis Lyons	" Calumet street, Roxbury	$2.60 " " "		13 26	13 26
*May 3,	James McDonald	" Sheridan " "	$3.85 " " "		21 18	21 18
* " 10,	" "	" Holborn " "	$3.20 " " "		12 48	12 48
* " 18,	McNeal Pipe and Foundry Company	85 tons 48-in. pipe 56 " 48-in. specials for Dam No. 5	$21.15 " ton $41.90 " "		4,326 12	4,326 12
* " 18,	Thomas Burke	Blasting, Rockville street, Dorchester	$3.47 " cubic yard		166 91	166 91
* " 19,	James McDonald	" Freeman " "	$3.25 " " "		32 18	32 18

Contracts Made and Pending during the Year. — *Concluded.*

Date.	Contractors.	Work.	Amount.	Paid on Contract. Previous Years.	Year 1894.	Total.
1894. May 28,	N. F. Palmer, Jr., & Co.	36-in. straight pipe for connection of Chestnut-Hill pumping engine with force main, etc.	$330.00	......	$330 00	$330 00
*June 6,	Dennis Lyons	Blasting, Notre Dame street, Roxbury	$2.80 per cubic yard	......	89 04	89 04
* " 7,	Berry Bros.	Two roads in Framingham and Southboro'	$12,242.75	......	12,670 63	12,670 63
* " 19,	Martin F. Kelley	Blasting, Oakridge street, Dorchester	$2.84 per cubic yard	......	98 83	98 83
* " 21,	R. D. Wood & Co.	58 pipes and specials	$21.00 per ton	......	1,978 45	1,978 45
* " 22,	Stephen Brennan	Extension to Chestnut-Hill Pumping-station	$3,578.00	......	3,597 25	3,597 25
*July 2,	James McDonald	Blasting, Park lane, West Roxbury	$2.54 per cubic yard	......	122 43	122 43
* " 11,	Martin J. Connolly	" LaGrange street, West Roxbury	$2.95 " " "	......	10 62	10 62
* " 13,	Garfield & Proctor Coal Co.	2,000 tons coal for Mystic Pumping-station	$4.00 " ton	......	8,267 11	8,267 11
" 13,	Thomas & Co.	800 tons coal for Chestnut-Hill Pumping-station	$4.27 " "	......	2,547 13	2,547 13
* " 17,	Thomas Burke	Blasting, Rock street, Roxbury	$2.63 " cubic yard	......	136 76	136 76
* " 18,	" "	" Clive street, West Roxbury	$2.38 " " "	......	65 45	65 45
" 21,	Thomas & Co.	Trimming coal in bins, Chestnut-Hill Pumping-station, coal under their contract of July 13, 1894	25 cents per ton	......	149 13	149 13
* " 24,	Martin F. Kelley	Blasting, Seaver street, Roxbury	$3.74 per cubic yard	......	1,527 04	1,527 04
*Aug. 2,	James McDonald	" Strathmore road, Brighton	$2.48 " " "	......	90 77	90 77
* " 14,	" "	" Glenway street, Dorchester	$2.34 " " "	......	127 53	127 53

1894. *Aug. 16,	Thomas Burke	Blasting, Clive street, West Roxbury	$6.00 per cubic yard	. . . . . .	31 80	31 80
* " 20,	James McDonald	" Cherokee street, Roxbury	$3.15 " " "	. . . . . .	68 99	68 99
* " 20,	" "	" Montview street, West Roxbury	$3.64 " " "	. . . . . .	5 46	5 46
" 27,	Auguste Saucier	Section A, Basin No. 5	$52,018.50	. . . . . .	13,254 98	13,254 98
* " 28,	James McDonald	Blasting, Paul Gore street, West Roxbury	$6.25 per cubic yard	. . . . . .	16 25	16 25
*Sept. 4,	Thomas Burke	" Payson avenue, Dorchester	$3.99 " " "	. . . . . .	86 98	86 98
* " 12,	R. D. Wood & Co.	60 tons 6-in. Ward joint pipes	1 4-10 cents per lb. f. o. b. cars at Boston . . .	Ordered closed on receipt of 38—6-in. 12½-ft. pipes = 22,026 lbs.	308 36	308 36
* " 29,	Thomas Burke	Blasting, Moreland street, Roxbury	$2.49 per cubic yard	. . . . . .	63 99	63 99
*Oct. 1,	Dennis Lyons	" Woodlawn street, West Roxbury	$2.93 " " "	. . . . . .	247 29	247 29
* " 13,	Martin F. Kelley	" Whiting street, " "	$2.84 " " "	. . . . . .	128 37	128 37
* " 18,	" "	" Seaver street, " "	$4.00 " " "	. . . . . .	132 80	132 80
" 30,	Mack & Moore	Addition to Mystic Pumping-Station	$10,900.00	. . . . . .	3,000 00	3,000 00
*Nov. 5,	Thomas Burke	Blasting, Stanmore place, Roxbury	$2.98 per cubic yard	. . . . . .	282 80	282 80
* " 7,	Martin F. Kelley	" Humboldt avenue, "	$5.50 " " "	. . . . . .	63 25	63 25
* " 14,	Dennis Lyons	" Weld Hill street, West Roxbury	$3.18 " " "	. . . . . .	19 72	19 72
" 23,	George F. Blake Manufacturing Co.	Changes in hand rail stanchions at Mystic Pumping-Station to adapt them for electric lighting	$125.00.			
Dec. 24,	Martin F. Kelley	Blasting, Robeson street, West Roxbury	$5.95 per cubic yard.			
" 26,	" "	" Townsend street, Roxbury (for hydrant) .	$9.00 " " "			
1895. Jan. 28,	David Sturtevant & Co. . .	800 tons George's Creek Cumberland coal, Barton Mine, in bins at the Chestnut-Hill Pumping-Station,	$4.27 " ton, 2,240 lbs.			

CONCLUSION.

We annex hereto appendices, in which will be found the reports of the several Superintendents and the City Engineer, showing more in detail the condition of the works and what has been accomplished. They are as follows:

Appendix A. — Western Division.
Appendix B. — Eastern Division.
Appendix C. — Mystic Division.
Appendix D. — Report of Engineer.

Respectfully submitted,

THOMAS F. DOHERTY,
JOHN W. LEIGHTON,
CHARLES W. SMITH,
Boston Water Board.

GENERAL STATISTICS.

Sudbury and Cochituate Works.	1892.	1893.	1894.
Daily average consumption in gallons	41,312,400	47,453,200	46,560,000
Daily average consumption in gallons per inhabitant	96.1	107.5	99.8
Daily average amount used through meters, gallons	11,225,900	11,651,600	11,170,400
Percentage of total consumption metered	27.2	24.5	24.0
Number of services	65,074	66,586	68,556
Number of meters and motors	4,412	4,585	4,877
Length of supply and distributing mains, in miles	536	560	572.8
Number of fire-hydrants in use	5,793	6,042	6,217
Yearly revenue from water-rates	$1,433,413 78	$1,637,531 94	$1,644,405 25
Yearly revenue from metered water	$649,672 31	$683,948 52	$672,474 17
Percentage of total revenue from metered water	45.3	41.8	40.9
Cost of works on February 1, 1895	$22,243,351 56	$22,727,456 03	$23,583,967 89
Yearly expense of maintenance	$392,762 21	$433,408 18	$440,840 63
Mystic Works.			
Daily average consumption in gallons	9,810,800	10,742,500	10,282,100
Daily average consumption in gallons per inhabitant	78.8	84.4	87.6
Daily average amount used through meters, gallons	1,862,200	1,921,570	2,014,000
Percentage of total consumption metered	19.0	17.9	19.6
Number of services	21,588	22,398	23,257
Number of meters and motors	550	482	515
Length of supply and distributing mains, in miles	160	165	173.7
Number of fire-hydrants in use	1,223	1,306	1,446
Yearly revenue from water-rates	$394,008 75	$421,573 48	$447,554 35
Yearly revenue from metered water	$105,685 56	$109,367 37	$115,811 32
Percentage of total revenue from metered water	26.8	25.9	25.9
Cost of works on February 1, 1895	$1,713,227 00	$1,721,609 33	* $1,676,471 94
Yearly expense of maintenance	$129,354 49	$160,643 97	$156,214 05

* $52,637.00 credited ou account of sale of portion of Mystic Sewer.

APPENDIX A.

REPORT OF THE RESIDENT ENGINEER AND SUPERINTENDENT OF THE WESTERN DIVISION.

SOUTH FRAMINGHAM, January 1, 1895.

THOMAS F. DOHERTY, Esq.,
Chairman Boston Water Board:

SIR: The annual report for the Western Division of the Boston Water-Works is submitted herewith:

SUDBURY-RIVER BASINS.

Water-shed, 75.2 Square Miles.

The rainfall for 1894 was 40.3 inches at Framingham, and 38.2 at Chestnut-Hill Reservoir. The mean rainfall on the Sudbury-river water-shed was 40.58 inches, which is about 7.4 inches less than the average. With so small a rainfall, the city would have been short of water had it not been for the storage in Basin 6, the new basin just completed. This reservoir was nearly filled during the winter and spring of 1894, and its addition to the supply enabled us to meet the demands of the city.

Preparations were made early in the year for the construction of Basin 5, which was described in my last report. As this involved the taking of upwards of 2,000 acres of land in a populous neighborhood, the work necessitated many surveys, plans, and negotiations with different authorities, notably the selectmen and a special committee of citizens from Southboro' and the County Commissioners of Worcester and Middlesex counties.

In accordance with an agreement finally reached and ratified by the Legislature, complete descriptions and plans of all the property to be taken, covering 151 sheets of legal cap and comprising 228 separate parcels of land, were filed on April 2 and April 30, 1894.

A contract had been previously made, July 27, 1893, with Moulton & O'Mahoney for the building of the dam, for $454,729.90.

Owing to the length of time occupied in the negotiations, the execution of the above contract was delayed, but on April 10, 1894, the contractors began stripping the site of the dam. This work was prosecuted with vigor during the year, and $86,250.71 have been expended thus far on the contract. In March it became evident that the scheme for supplying the Metropolitan district from the Nashua river would receive favorable action from the State Board of Health, and the plans of the dam were modified so as to embrace three outlet pipes of 48-in. diameters, instead of two as originally contemplated. This change was made to permit a larger quantity of water to be drawn for the supply of the Metropolitan area than would be necessary for Boston alone. The amended plans were approved by the County Commissioners on April 25. The modification of this contract involves an extra expense to the city, estimated at $21,154.34. It is expected that this amount will be refunded to the city, together with other extra expenses, whenever the scheme is carried out by the State. On February 14, $50,000 were paid to Southboro' for the discontinuance of several miles of highway in that town, and to enable the town to build new roads in other places.

On May 18 a contract was made with the McNeal Pipe and Foundry Company for the outlet pipes for $4,326.12 — $21.15 per ton for the 48-inch pipes and $41.90 per ton for the specials. During the early summer plans and specifications were prepared for Section A, stripping, shallow flowage, and the building of two roads at the Sawins Mill end of the basin.

The following table shows the bids for this work :

CANVASS OF BIDS, AUGUST 23, 1894.

BIDDER AND ADDRESS.	ITEMS AND ESTIMATED QUANTITIES. a. 212,000 cubic yds. Earth Excavation.	b. 650 cubic yards Stone Masonry.	c. 122 cub. yds. Paving in Mortar.	d. 109 cubic yards Concrete.	e. 1,900 square yds. Dry Paving.	f. 1,670 cubic yards Riprap.	g. 120 rods stone wall.	TOTALS.
Auguste Saucier, South Framingham	$0 19⅜	$7 00	$5 25	$6 00	$0 85	$1 20	$3 50	$52,018 50
Berry Bros., Fayville	0 21½	8 00	3 00	5 00	0 75	1 00	3 00	55,146 00
Chas. McDermott, Brockton	0 23	12 00	5 00	6 00	0 60	1 50	3 00	61,829 00
Thos. F. Maney, Boston	0 27½	9 32	7 75	6 00	0 87½	1 50	3 00	70,485 00
Moulton & O'Mahoney, Boston	0 27	12 00	6 00	7 00	1 25	3 00	5 00	74,520 00
Conners & Co., Lowell	0 27⅓	11 86	8 50	7 50	2 65	1 50	1 75	75,260 17
Newell & Snowling, Uxbridge	0 29	11 00	8 00	8 00	1 00	2 00	4 00	76,198 00
H. S. Tuttle, Swampscott	0 29½	10 00	6 50	6 50	0 80	3 00	1 50	77,251 50
Neil McBride, Boston	0 28	12 00	7 00	6 00	1 50	4 00	4 00	78,678 00
Davis & Newell, Boston	0 35½	10 50	5 50	7 00	0 45	1 50	3 25	93,308 00
R. A. Malone & Son, Bos-	0 40	10 00	8 00	5 00	0 75	1 00	2 00	96,156 00
Wm. H. Mague, W. Newton	0 45	10 00	6 00	8 00	0 85	1 80	3 00	108,485 00
H. P. Nawn, Boston	0 67	13 00	7 00	7 50	2 00	4 00	25 00	165,641 50

The contract for the work was let to Auguste Saucier, for $52,018.50. Thus far only $11,285.14 have been expended on account of this contract, owing to unexpected delays. The takings of a portion of the lands of the Burnetts', and of the Deerfoot Farm Company, were made in such a way that the land, after being filled, was to be restored to the original owners, the city reserving simply a narrow strip in the centre of the takings. An injunction was brought, by the parties interested, to prevent the city working on the land where the easement only was taken; and this injunction has not been dissolved.

In May, plans and specifications were drawn for the building of two roads, in Framingham and Southboro', to replace a road running across the site of the new dam. Advertisements were issued for proposals, and the following bids received:

Canvass of Bids, June 4, 1894.

Bidder and Address.	Items and Estimated Quantities. a. 22,100 cubic yards Earth Excavation.	b. 100 cub. yds. Rock Excavation.	c. 360 cub. yds. Split-Stone Masonry in Mortar.	d. 440 cub. yds. Dry Rubble Masonry.	e. 136 cub. yds. Paving in Mortar.	f. 43 cub. yds. Concrete.	g. 800 rods Stone Wall.	Totals.
Berry Bros., Fayville	$0 19	$1 25	$7 25	$3 75	$3 50	$4 25	$3 75	$12,242 75
W. L. McDermott, Brockton,	0 27	1 50	9 00	3 48	5 00	6 00	3 00	14,226 20
Auguste Saucier, South Framingham	0 22½	2 00	9 50	3 50	6 00	5 00	4 90	15,083 50
Quimby & Fergusan, South Boston	0 37	2 00	9 00	5 00	5 50	5 00	3 40	17,500 00
John McBride, Boston . . .	0 29	1 40	9 17	5 50	9 17	4 75	4 95	17,681 57
McCusker Bros. & Co., Waltham	0 30	1 75	10 00	4 00	5 00	6 00	4 50	18,863 00
Gennaro, Long, & Little, So. Braintree	0 29	1 50	9 50	4 50	5 00	6 00	7 50	18,897 00
Newell & Snawling, Uxbridge	0 40	2 00	13 00	6 00	8 00	6 00	2 00	19,306 00
O'Connor, White, & Quiun, Beverly	1 00	2 33	10 00	4 50	5 50	6 00	8 00	35,759 00

The contract was awarded on June 7 to Berry Brothers for $12,242.75. This work was completed by the end of the year, and cost $12,670.63. It was designated as "a portion of proposed Framingham-Marlboro' road," and "proposed road to F. S. Hawkins." The first named extends from the present Framingham road, near the house of N. F. Brewer, a distance of 4,229 feet, and the second road is a branch of the first, extending from a point 1,300 feet easterly from Stony brook to the present highway near the house of F. S. Hawkins, a distance of 3,567 feet.

The above contracts embrace all the work that has been undertaken during the year in connection with the proposed basin. Many engineering problems have, however, been studied and surveys made preparatory to next season's work. It is highly desirable that a large part of the construction should be undertaken at once. Many expenses will be saved, such as police duty, etc., and the bottom could be flowed in the spring of 1896, which would enable us to gain a whole year in time.

Before the dam was begun deep borings were made to determine the position of the bed-rock in the foundation and its nature. It was known from these borings that the rock was extremely rotten in places, and much broken by seams of slate, etc. When the foundations were opened, however, and excavation begun, it was thought best to go much deeper than the original plan contemplated.

Every precaution has been taken to go as deep and to excavate the soft rock as widely as practicable. The rubble laid in the trench was of unusually good character, thoroughly imbedded in cement, and most carefully and conscientiously inspected.

In September a few cases of typhoid fever developed at the dam, and soon spread with something of the nature of an epidemic. As its origin seemed mysterious, Prof. Wm. T. Sedgwick was asked to make an investigation. He found the source of the fever to be in some cheap milk sold in Marlboro'. A sanitary system of inspection was established at once, and vigorous efforts made to keep the disease from spreading. For this or other reasons we had the satisfaction of seeing the epidemic die away gradually.

No unusual growths of algæ have occurred this year in the sources of supply, but the color of the water in the city taps has been .57 at Park square, and .51 at Mattapan, on the average. [Platinum scale.] Last year it was .55 and .50 at the same places, showing a slight increase. The consumption of water has been less this year than last year, and other things being equal the color should have been less, on account of the fact that all the water sent to the city beyond a certain fixed amount received from Cochituate lake, is made up from the higher-colored Sudbury. Accurate color determinations have enabled us to trace the cause to the general higher color of the Sudbury water this year, and also that we have been unable to draw from Basin 3, during the epidemic of typhoid at the head-waters of that basin.

During the latter part of the year a large amount of land was bonded in Cedar swamp for the proposed drainage scheme, and there is now no reason why this work should not be undertaken during the coming season.

When the Framingham sewerage system was constructed a few years ago, an underdrain was built under the sewer. This underdrain served the purpose of carrying off the soil water which found its way into the trenches during construction. The authorities of Framingham kept this underdrain open and discharged it into Beaver Dam brook for several years after the completion of the system. It served the valuable purpose to the town of lowering the water tables and keeping the cellars dry. Boston, however, took the ground that this underdrain was a constant menace to the purity of the waters of Beaver Dam brook, a feeder of Lake Cochituate. Analyses of the water were made at stated intervals, and a close watch maintained on the condition of the effluent. Boston also refused to pay the $25,000 which it had agreed to subscribe towards the Framingham sewerage scheme as long as the underdrain was maintained. A number of studies were made to determine how the matter could be settled. All differences between the city and town were adjusted in December by an agreement on the part of the town to adopt the recommendation of the city and construct some filter beds not far from the sewage pumping-station upon which the underdrain water could be discharged. Boston pays $6,000 more, or $31,000 altogether, when the plans are carried out, and it is expected that the work will be done early in the coming summer. The amount of water to be pumped from the underdrain was measured for a long time over a weir, and found to average 160,000 gallons daily. Three final projects were submitted to the town for the disposal of this water: No. 1, by pumping on to filter beds situated on the south-west side of the hill near the pumping-station; No. 2, by pumping to filter beds on the north-east side of the hill; and No. 3, by mixing the underdrain water with the sewage and pumping it altogether to the present sewage fields outside of the water-shed. The estimated cost of these schemes was $7,430 for No. 1, $10,402 for No. 2, and $7,025 for No. 3.

Basin 1.

Grades, H. W., 161.00; Tops of Flash-boards, 159.29 and 158.41; Crest of Dam, 157.54. Area, Water Surface, 143 acres; Greatest Depth, 14 ft.; Contents, below 161,00, 376,900,000; below 159.29, 288,400,000 gals.

On January 1, 1894, this basin stood at elevation 155.55, and remained at about this height until January 29, when it gradually fell to 154.90, February 14. On February 23 water was wasting over the stone crest, and continued to waste till April 3.

On April 4, when both sets of flash-boards were placed on the dam, the basin was at 157.34; but it soon rose; and on April 7 water was wasting over the flash-boards, and continued to waste till April 10, when the waste-gates were opened, to lower the basin, so as to remove flash-boards. On April 12 waste over the stone crest began, and continued until May 7, when both sets of flash-boards were again placed in position. From May 26 to June 14 water flowed over the flash-boards. The basin fell to 157.32, October 25; and then rose to 157.70, November 8, when, both sets of flash-boards being removed, waste over the stone crest began, and continued until December 3. The basin fell to 156.52 on December 5, and was kept at about elevation 156.50 until December 14, when it rose, and, on December 16 water was wasting over the stone crest.

The highest elevation reached during the year was 159.62, May 29; and the lowest, 154.90, February 14.

Water was drawn wholly from this basin for the supply of the city, from 7 A.M., January 1, to 1 P.M., March 15; and from 11 A.M., December 3, to the end of the year.

The supply was drawn partially from this basin and partially from Basin 2, from 3 P.M., October 30, to 3 P.M., October 31; and partially from this basin and partially from Basins 2 and 3, from 1 P.M., March 15, to 11 A.M., April 10.

If the work of improving the shallow flowage of this basin is to be undertaken this year, it will be necessary to make a topographical survey of the basin at once.

Basin 2.

Grades, H. W., 168.00; Tops of Flash-boards, 167.12 and 166.49; Crest of Dam, 165.87. Area, Water Surface, 134 acres; Greatest Depth, 17 ft.; Contents, below 168.00, 568,300,000; below 167.12, 529,860,000 gals.

January 1, 1894, the water in this basin was at elevation 160.17; but it fell to 159.15, January 15. It then rose to 160.00, January 18; and kept between 160.00 and 161.00 until February 10, when it rose slightly, and remained at about 161.50 until February 19. A rapid rise then ensued, and on February 22 water was flowing over the stone crest, and continued to overflow until April 4, when both sets of flash-boards were placed in position. On February 6 water began to overflow the flash-boards, and so continued until February 12, when both sets of flash-boards were removed. Waste over the stone crest continued till May 7, when both sets of flash-boards were again placed in position. On May 25 water commenced to waste over the flash-boards, and so continued until June 5, when an extra set of flash-boards was placed on the regular flash-boards. The basin then rose a little on June 5; but then fell to 160.06, July 17, when the flow of water from Basin 4 was started, and the basin rose to 162.02, August 1. From August 1 to December 1 there was a gradual rise each month between the following levels:

In August, from 161.66 to 162.70; in September, from 162.33 to 163.10; in October, from 162.94 to 164.36; and in November, from 163.34 to 165.17.

During the above-mentioned months water was drawn the larger part of the time, — first from Basin 4, and afterwards from Basin 6, — to keep Basin 2 moderately full; and also, when not needed for that purpose, to keep the elevation of the basin from fluctuating during the experiments at the siphon pipes. On December 1 the basin stood at grade 164.55; and then fell to 163.94, on December 3, when it began to rise; and on December 15 water flowed over the stone crest, and continued to overflow until the end of the year.

Both sets of flash-boards were placed in position on April 4; removed on April 12; and again placed in position on May 7. On June 5 an extra set of flash-boards was placed on the regular ones; but all flash-boards were finally removed on July 27.

The highest elevation of the basin reached during the year was 167.36, on June 6; and the lowest, 159.15, on January 15.

Water for the supply of the city was drawn wholly from this basin from 11 A.M., May 19, to 11 A.M., May 21; from 11 A.M., June 11, to 11 A.M., June 20; from 7 A.M., July 18, to 3 A.M., August 24; from 7 A.M., August 25, to 3 P.M., September 7; from 3 P.M., September 10, to 3 P.M., October 30; from 1 P.M., November 2, to 12 M., November 17; from 3 P.M., November 21, to 1.20 P.M., November 22; and from 3 P.M., November 27, to 3 P.M., December 1.

Water was drawn partially from this basin and partially from Basin 1, from 3 P.M., October 30, to 3 P.M., October 31; partially from this basin and partially from Basin 3, from 11 A.M., April 10, to 11 A.M., May 19; from 11 A.M., May 21, to 2 P.M., May 23; from 11.30 A.M., May 26, to 7 A.M., June 1; from 2 P.M., June 4, to 11 A.M., June 11; from 11 A.M., June 20, to 7 A.M., July 11; from 3 A.M., August 24, to 7 A.M., August 25; from 3 P.M., September 7, to 3 P.M., September 10; from 12 M., November 17, to 7 A.M., November 20; from 3 P.M., November 23, to 3 P.M., November 27; and from 3 P.M., December 1, to 11 A.M., December 3; and partially from the basin, and partially fromBasins 1 and 3, from 1 P.M., March 15, to 11 A.M., April 10.

In the spring, Fountain-street bridge was entirely replanked, as both the bottom and top floors were found to be in need of renewal. This was the first time that the bottom floor was renewed, though the top floor had been partially renewed several times before. The bottom floor was 3-in. hard-pine, and the top 2-in. spruce. In the autumn, the windows in the gate-house, at Dam 2, were repaired, and the frames and sashes painted on both sides. The windows had not been touched before since the house was built. All of the woodwork in the house, except the floor and ceiling, was varnished.

All forms of animal and vegetable life have been unusually low during 1894. In September diatoms appeared in small quantities. Chlorophyceæ and Cyanophyceæ were present occasionally from June to October. Infusoria were found in small numbers in the spring and fall and occasionally during the summer. The mean number of organisms in standard units was 42 per c.c., and the mean amorphous matter 332 per c.c.

The mean mid-depth temperature of the water during the year was 52.8° Fahrenheit, based on weekly observations.

The mean color was .89, new standard [platinum].

Basin 3.

Grades, H.W., 177.00 ; Crest of Dam (no flash-boards), 175.24.
Area at 177.00, 253 acres ; Contents, below 177.00, 1,224,500,000 gals.
Area at 175.24, 248 acres ; Contents, below 175.24, 1,081,500,000 gals.
Greatest depth, 21 feet.

On January 1, 1894, the water in this basin stood at elevation 168.53, but it gradually rose, and on February 21 was flowing over the stone crest, and continued to overflow until May 8, with the exception of a short time on April 3 and 4. The water now fell to 174.18 on May 12, but soon rose again, and on May 23 was flowing over the stone crest, and overflowed until June 6. The water then receded to 168.41, July 19, 20, and 21, when it gradually rose to 170.46 on August 6. The water now remained between 170.00 and 172.00 until October 26, when it rose rapidly, and on November 8 was flowing over the stone crest, and continued to overflow until December 4. It receded to 174.81 on November 6, remained nearly stationary until December 13, then rose rapidly, and on December 14 was flowing over stone crest, and overflowed until the end of the year.

The highest elevation reached was 176.14 on March 7, and the lowest 168.41 on July 19, 20, and 21.

Water for the supply of the city was drawn wholly from this basin from 2 P.M., May 23, to 11.30 A.M., May 26; from 7 A.M., June 1, to 2 P.M., June 4; and from 7 A.M., November 20, to 3 P.M., November 21. Water was drawn partially from this basin and partially from Basins 1 and 2 from 1 P.M., March 15, to 11 A.M., April 10; partially from this basin and partially from Basin 2, on dates already given under the head of Basin 2.

Almost no water was drawn from this basin during the summer on account of the epidemic of typhoid fever in Marlboro' and at Dam 5.

Diatoms were present in the spring and fall. The spring growth was slight and of short duration. The maximum occurred April 23, when there were 200 per c.c., chiefly Tabellaria. The fall growth began in October, after the water had been stirred up by some very high winds. The maximum growth was attained in November, when there were about 700 per c.c. Asterionella and Tabellaria were most abundant and were about equal in number. Stephanodiscus was present in October for the first time in Basin 3. Chlorophyceæ were present in small numbers during the summer and fall. Cyanophyceæ did not appear until August. The growth was not as extensive as in former years, but during the last of September, and again in October, Cœlosphærium was abundant near the gate-house. Infusoria were found in small numbers in the spring and fall.

The average number of standard units of organisms was 220 per c.c., and of amorphous matter 311 per c.c.

The average mid-depth temperature was 52.5° Fahrenheit, and the mean color of the water, platinum standard, 0.77, almost exactly the same as last year.

Although the plans and specifications for the filter basins on the Marlboro' brook were prepared more than a year ago, nothing has yet been done in the way of construction. I recommend that these basins be built as soon as the frost is out of the ground.

The windows in the gate-house have been repaired, as in the case of the other dams already mentioned.

Basin 4.

Grades, H. W., 215.21; Tops of Flash-boards, 215.21 and 214.89; Crest of Dam, 214.23.

Area, Water Surface, 167 Acres; Greatest Depth, 49 feet; Contents, below 215.21, 1,416,400 Gallons.

On January 1 the surface of the water in this basin stood at elevation 178.83; but the water gradually rose, and on June 6 was flowing over the flash-boards, both sets of flashboards having been placed on the stone crest on May 26. This waste continued until July 7, when the water began to fall, reaching 215.14 on July 17, at which time the flow to Basin 2 was started. On September 11 the outlet gate was closed. The water fell from 215.14, July 17, to 185.01, September 12, making about 30 feet in depth drawn out of this basin in less than two months. From September 12 the water gradually rose to 196.10, December 31.

The highest elevation reached during the year was 215.36, on June 27, and the lowest 178.83, on January 1.

In April quite a large number of shrubs were set out near the banks of the outlet brook and the overflow, just below the dam, and in May some pine-trees were planted in front of the out-buildings near the attendant's house.

In the spring the walks were all resurfaced and rolled.

The organisms in this basin have been unusually low. Last year they averaged 87 per c.c.; this year, 23. The amorphous matter averaged last year 397 per c.c.; this year, 220 per c.c.

The temperature at the surface has averaged 53.2°; mid-depth, 49.4°; bottom, 46.4°; and the color at the dam has averaged 0.71, almost exactly the same as last year; and of the influent (regardless of quantity), 1.04.

Basin 6.

Grades, H. W., 295.00; Top of Flash-boards, 295.00; Crest of Dam, 294.00. Estimated Area, 185 Acres; Estimated Contents, 1,530,300,000 Gallons.

Storage of water in this basin was for the first time begun by closing the outlet gate at 11 A.M., January 10, 1894, but no measurement of the elevation of the surface of the water was taken until 7 A.M., January 12, when it stood at grade 248.91. The water rose rapidly to 288.26, May 1, then slowly to 292.66 on July 1, and remained nearly stationary during July. From August 1 it fell to 292.52 on September 7, at which time one of the outlet gates was opened in order to draw water for the supply of the city. The water now fell to 274.19 on October 31, then rose to 275.28 on November 13, and kept at an average elevation of about 275.25 until November 30, when, the outlet gate being finally closed, the water rose to 278.78 on December 31. The highest elevation reached during the year was 292.75, August 5 and 6.

It will be seen from the above that the water from this basin was used for the first time to supply the city during the autumn. Although the paving was not completed until June 7, the basin was allowed to fill until the surface reached the pavers, and it was only by extra exertions that the contractors succeeded in keeping out of the way of the water. It was fortunate for the city that this basin was completed and filled this year, as there would have been a short supply without this additional storage.

The dam is the most complete and thorough in execution that the city has ever constructed. The leakage has been about 60,000 gallons per day — less than half that of Basin 4. By a series of vertical pipes built into the embankment at different points of its cross section, it has been found that the water table in the dam does not extend into the embankment below the line of the core wall, and that it percolates easily the fine material placed against the up-stream face of the core, following the rise and fall of the basin with only about 1 foot loss of head. The outside of the embankment was graded and the entire dam completed October 19.

The filter basins below the dam were begun September 20, and one bed partially completed.

The water in Basin 6 contained a slight growth of diatoms in May, and again in September and October, but at no time did they reach 100 per c.c. Chlorophyceæ were present in very small numbers in September and October. Cyanophyceæ were entirely absent from the water. In May and June Synura were washed in from the swamp above the basin. Rotifers at that time were also quite abundant. Other infusoria were found in small numbers throughout the summer and fall. Crenothrix was abundant near the dam in August. The amorphous matter was generally low, but about the last of September it became quite abundant.

From observations on the color, and from numerous chemical analyses made while the basin was filling for the first time, it is thought that the basin is doing better work in the purification of its influent than Basin 4, but we cannot be surely convinced of this fact until we have had the opportunity to make further investigations. The stripping of the basin was done more thoroughly than in the case of Basin 4.

Whitehall Pond.

Elevation, H. W., 327.91; Bottom of Gates, 317.78.
Area at 327.91, 601 acres; Contents, between 327.91 and 317.78, 1,256,900,000 gallons.

On January 1, 1894, the surface of the water in this pond stood at elevation 324.94, or 2.97 feet below high water. It remained at about this height until March 3, when it rose, reaching 326.20 on April 8. From this date the water remained between 326.20 and 326.82, until June 4, and then fell to 324.35 on September 19, and then fell more rapidly to elevation 322.40 on October 25. The water now rose to elevation 322.59 on October 27, remained about stationary until November 3, rose to elevation 322.72 on November 7, fell to 322.39 on December 7, and finally rose to 323.23 on the 31st.

The highest point reached was 326.82, on June 4, and the lowest, 322.39, on December 7.

No more water than was necessary for the use of Wood Brothers' shoe factory was drawn from the pond during the year with the exception of a short time from August 17 to

August 21, and from September 13 to October 18, when a daily flow of about ten millions was drawn to keep up the supply of water for Basin 2. The outlet gate was closed and no water drawn from the pond from July 1 to July 9, and from December 7 to December 31.

Weir measurements of the waste, both when the gate was open and closed, have been taken as usual during the entire year.

In the spring the scows and dredger which were anchored in the pond were found to be in a bad condition. The wood of the sides and bottom had commenced to decay, and they and the steamer were towed down the pond to the dam and drawn out on the shore. Openings were made in the ends of the scows and dredger to permit the circulation of air through them, and their decks were thoroughly calked and then painted.

Farm Pond.

Grades, H. W., 149.25; Low Water, 146.00.
Area at 149.25, 159 acres; Contents, between 149.25 and 146.00, 165,500,000 gals.

On January 1, 1894, the water in the pond stood at elevation 148.74, but it rose gradually, and on February 21 had reached high-water mark. From this date the water remained on an average somewhat above high water until June 14, when it gradually fell to 148.17 on September 16. The water stood at about this height until October 25, when it rose to 148.50 on November 6, and reached 148.79 on December 31.

No water was drawn from this pond during the year for the supply of Boston.

The Framingham Water Company has pumped 117,000,000 gallons during the year, an average of 320,548 gallons daily.

The total amount of water wasted was 5,400,000 gallons, all of which was used in cleaning the aqueduct.

Lake Cochituate.

Grades, H. W., 134.36; Invert of Aqueduct, 121.03; Top of Aqueduct, 127.36.
Area, Water Surface at 134.36, 785 acres.
Contents, between 134.36 and 127.36, 1,515,180,000; between 134.36 and 125.03, 1,910,280,000 gals.
Approximate Contents, between 134.36 and 121.03, 2,447,000,000 gals.; between 134.36 and 117.03, 2,907,000,000 gals.

On January 1, 1894, the lake stood at 127.94, and gradually fell to 127.33 on February 13. From this date the lake began to rise. Between March 13 and June 16 water from the Sudbury river was turned into the lake. On April 26 the surface reached 134.20. It was kept a little above 134.00 with the aid of the Sudbury supply until June 16, when it gradually fell to 126.10 on December 15, and then rose to 126.30 on December 31. No water has been wasted from the lake at the outlet during the year.

In March 529,100,000 gallons were turned into the lake from the Sudbury sources; in April, 134,100,000; May, 215,800,000; June, 80,700,000; October, 1,100,000; November, 400,000; December, 1,000,000 gallons; or a total amount of 962,200,000 gallons.

Some repairs were made during the autumn to the driveway near the outlet dam, and the embankment of the old dam was taken down to a level a few feet below high-water mark. Nine hundred and twenty-seven square yards of paving were placed on the slopes of the driveway.

The filter beds at Pegan brook have been used the larger part of the time during the year.

The following table shows the total number of gallons of water pumped, the amounts delivered to each bed, etc., for each month of the year:

Month, 1894.	No. of Days which Pumps ran.	Amount of Water Pumped.		Amount of Water Delivered on to Beds.		
		Total for the Month.	Average for each Day Pump run.	No. 1.	No. 2.	No. 3.
		Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
January	31	18,655,000	601,800	2,638,000	. . . . . .	16,017,000
February	25	19,770,000	790,800	3,919,000	. . . . . .	15,851,000
March	22	17,505,000	795,700	. . . . . .	6,708,000	10,797,000
April	30	32,364,000	1,078,800	. . . . . .	12,211,000	20,153,000
May	30	30,472,000	1,015,700	16,075,000	5,427,000	8,970,000
June	30	19,258,000	641,900	6,482,000	3,995,000	8,781,000
July	15	10,279,000	685,300	. . . . . .	10,279,000	. . . . . .
August	19	5,827,000	306,700	5,036,000	791,000	. . . . . .
September	10	3,693,000	369,300	1,055,000	2,638,000	. . . . . .
October	12	6,974,000	581,200	3,733,000	565,000	2,676,000
November	18	12,738,000	707,700	. . . . . .	. . . . . .	12,738,000
December	22	14,912,000	677,800	. . . . . .	3,392,000	11,520,000
For the Year . .	264	192,447,000	729,000	38,938,000	46,006,000	107,503,000

Total amount of coal used during the year was 180,980 pounds.

Water ran over the overflow in the dam across Pegan brook, during the entire twenty-four hours, on February 19, 20, 22, 23, 24, and 25, and during fourteen hours in the night on March 3 and 4, and on April 13, 14, 15, 16, 17, 18, 19, and 20. Bed No. 1 was cleaned in June and September; Bed No. 2 was cleaned, and the surface — which was quite uneven — was levelled in August; and Bed No. 3 was cleaned in July and August. Although the water in No. 3 froze during the cold weather in January and February so as to form ice six inches thick, the surface of the bed did not freeze.

On February 22 the embankment of Bed No. 1, directly over No. 2 drain, caved in, and the force main was broken. In consequence of this break, no water could be pumped on to the filter beds until February 26.

About two hundred feet of underdrain were dug up in May, and relaid; and, besides this work, a considerable amount of labor has been expended in putting the filter beds into better condition. We have found no trouble in filtering the whole flow of the brook during the winter. In very severe weather the ice sometimes becomes attached to the bottom of the beds, but the applied water finds its way through holes under the ice, and filters through the sand.

Diatoms appeared as usual in April and November. The spring growth reached its maximum, 700 standard units per c.c., during the later part of May, when Melosira, Asterionella, and Tabellaria were present in about equal numbers. In May Melosira and Asterionella disappeared, but the Tabellaria continued to increase until June, when there were about 450 per c.c. Stephanodiscus was present during May and June. Diatoms were absent from the water from July 1 to October 1. Asterionella appeared in October and increased gradually to 700 per c.c. on December 12, after which they rapidly declined. Melosira and Stephanodiscus were present in small numbers during November and December. Chlorophyceæ were present in small numbers from June to November. Cyanophyceæ were present from June to the end of the year. They were most abundant in September. Infusoria were present in the spring and fall, and Crenothrix was abundant after the fall turning over. In December the water had a disagreeable taste, caused by the simultaneous presence of Asterionella, Synura, and Anabæna (sterile).

The southern extremity of Lake Cochituate is separated from the lake by what is known as the circular dam. The bottom of this portion of the lake is a bed of peat and mud of considerable depth. In August an examination was made of the condition of the water over the peat. At that time the water was about five feet deep. At the bottom an intensely thick growth of weeds (chiefly Chara) was found, which were covered with a growth of oscillaria and some of the filamentuous green algæ. Diatoms and desmids were abundant, and infusoria were found in swarms. The effect of this growth of vegetable matter is probably to form a matting which in a measure prevents the stirring up of the mud. It is probable that if the mud was kept in a state of agitation by the wind the effect would be to discolor the water. This was shown by the following laboratory experiment:

A mass of the mud was placed at the bottom of a jar and the jar filled with a practically colorless water, color 0.03. For the first twenty-four hours the water was very turbid. After two days it became quite clear in the upper portion of the jar. This clear water was then siphoned off, filtered through paper, and the color read. It was 0.30.

Color samples taken throughout this portion of the lake did not show any material increase in color from the bottom:

	Color.
No. 1, 200 feet from last culvert on Beaver Dam brook, surface	0.44
No. 2, at circular dam, surface	0.45
No. 3, 500 feet from circular dam towards Dug pond, surface	0.43
No. 4, 500 feet from circular dam towards Dug pond, bottom	0.50

Sample No. 4 was somewhat turbid. This could not be removed by filtering, and probably accounts in part at least for the high color.

The following table shows the condition of the feeders of the lake:

Feeders to Lake Cochituate.

Means of Monthly Observations.

Locality.	Temperature.	Color.	Organisms.	Amorphous.	Bacteria.
Beaver Dam brook, mouth of brook .	53.9°	0.80	58	286	547
" " " last culvert . . .	55.1°	0.79	26	297	563
Course boook	52.8°	0.78	57	174	406
Dug pond	55.0°	0.19	165	195	259
Circular dam	55.6°	0.76	51	212	435
Pegan brook	54.0°	0.25	85	1,480	5,039
Snake brook	53.7°	0.58	39	973	388

Dudley Pond.

Grades, H. W., 146.46; 18-inch Pipe, 130.36 and 127.36.
Area, Water Surface, 81 acres; Greatest Depth, 27 feet; Contents, above 130.36, 250,000,000 gals.

On January 1, 1894, the pond was at elevation 130.36, or 16.1 below high water. On February 8 the stop-planks were put in at the outlet-chamber, and the water rose slowly to 139.96 on December 31.

In August and September the old gate-chamber was torn down and a new one built. The foundation of the old chamber was a wooden platform laid on about a foot of clay. The masonry of the new chamber was laid on concrete, one foot in depth, placed on a 2-in. spruce platform. It now contains an 18-in. iron valve to control the flow of water from the pond. Grooves have been built in the masonry for stop-planks.

Sudbury-River Aqueduct.

Grades, 141,352 at Farm Pond; 124,051 at Terminal Gate-House.
Length, 15.89 miles; Size, 7 ft. 8 in. × 9 ft.; Capacity, 109,000,000 gals. 24 hours.

The three portions of this aqueduct are in goodcondition. The supply and Farm pond aqueducts were cleaned by machine, February 20. The main aqueduct was cleaned by machine, between Station 46+00 and the West Siphon Chamber, on March 9. The tunnels between Farm pond and the West Siphon Chamber were cleaned by hand, as was also that portion from Farm pond to Station 46+00, and from East Siphon Chamber to Chestnut-Hill Reservoir, on April 5 and 6.

The 48-in. pipes in Basin 1 have been flushed into the river below Dam 1 once during the year. The three portions of the aqueduct have been in use for the same length of time, or 343.7 days, the flow having been stopped except for cleaning, and the experiments at the siphon pipes, on two occasions only, and then for but a few hours.

The amount of water sent to the city has been 11,450,600,000 gallons, or a daily average of 31,372,000 gallons. Besides the above, 962,200,000 gallons have been run to Lake Cochituate.

New houses were built in the autumn over the manholes at Stations 17 and 59.

On March 1 and 2 the Rockland and Badger Hill tunnels were cleaned, and on March 9 and 10 the westerly portion of the aqueduct was cleaned by machine from Station 46 to the Siphon Chamber. The portion from Station 0 to Station 46 could not be cleaned on account of an accumulation of gas from leaks in the gas mains in South Framingham. This portion was, however, cleaned by hand on April 5 and

8 after the gas difficulty had been overcome. At the same time the lower portion from the Easterly Siphon Chamber to Chestnut-Hill Reservoir was cleaned. The black deposit was less than in the westerly section, and there was no spongilla. In Beacon-street tunnel 8 cubic feet of rock which had fallen from the roof was found at Station 779+52. The concrete lining is in perfect condition.

The channel at Clark's Waste Weir has been repaired. The original masonry below the outlet was founded on sand, and it did not extend low enough to prevent scour. An excavation 3 feet 8 inches in depth was made beneath the side walls and apron, and a layer of broken stone 2 feet 2 inches was rammed into place, and on top of this a layer of concrete 1 foot in thickness was deposited and brought up by careful ramming to the under side of the old masonry. Paving laid in cement was placed on top of the concrete.

The walk on top of Charles-river bridge was resurfaced with two coats of tar on July 16 and 19.

A number of experiments have been made on the flow of water through the Rosemary Siphon pipes with different heads, and after these were completed the northerly pipe was carefully scraped November 12–15. The pipe had been in use about 18 years. It is 48 inches in diameter and 1,800 feet long. The inside surface was about half covered with small tubercles. These were skilfully removed, and care taken not to injure the old tar coating under the tubercles any more than was necessary. The capacity of the pipe was increased about 25 per cent. by the process, and its original condition nearly restored, as far as loss by friction is concerned. It took 4 days with 14 men to do the work of scraping. Two tip-cart loads of iron rust were wheeled out, and the pipe carefully washed and brushed after the scraping. Each man scraped and cleaned 396 feet of surface per day.

Some of the most experienced of the men on the aqueduct force have superintended the loaming and sodding at Dam 6.

The condition of the Waban arches has been the subject of some solicitude on account of the action of frost. Extended observations on these arches have been made, the result of which has led me to believe that the permanency of the masonry is threatened by the freezing of the water at the exposed outlets, and the consequent accumulations of the water inside of the arches, saturating the spandrels until it runs out of the tell-tale pipes. It is not so difficult to provide a proper remedy when a correct diagnosis of the trouble has been reached, and some plan for providing a permanent outlet beyond the reach of frost, for the drainage of the leakage water, will be made during the coming season.

Cochituate Aqueduct.

Grades, 121.03 at Lake; 116.77 at Brookline Reservoir.
Length, 14.60 miles; Size, 5 ft. × 6 ft. 4 in.; Capacity, 20,000,000 gals. per 24 hours.

This aqueduct has been in constant service during the year, excepting from 5 P.M., March 18, to 5 A.M., March 22, when the flow was stopped to clean the aqueduct. A depth of 6½ feet was maintained, except from January 18 to January 30, from February 20 and from October 5 to end of the year, when the lake was not high enough to furnish this flow.

When the aqueduct was cleaned spongilla was found between the lake and Dedman's brook in rather larger quantities than usual.

New rods have been provided for the gates at the Waste Weirs. The old rods have not been renewed since 1848, and were nearly rusted away around and beneath the nuts that held them in place. The new rods are of galvanized iron, 7 feet 8 inches long, 1¾ inches in diameter, with two composition nuts to each rod.

The loam on the site of the new boulevard, Newton Centre, has been removed and stored on the line of the Sudbury aqueduct for future use.

The siphon culverts have been thoroughly cleaned.

On July 26 an accurate system of observations were made on the water flowing in the Cochituate aqueduct to ascertain whether there was any material difference in the color of the water due to the infiltration of ground water or any other cause. The colors were observed from 8 A.M. at the lake to 7.30 P.M. at Chestnut-Hill Reservoir, the idea being to follow the same water as far as practicable in its passage underground. The readings varied from .27 at the lake to .255 at the reservoir, but the slight variations noticed were within the limits of accuracy of the colorimeter, and when compared in Nessler tubes no difference could be detected, so that it may be stated that there is no change in the color of the water in its passage from the lake to the reservoir.

Chestnut-Hill Reservoir.

H. W., 125.00; Dam, 128; Effluent pipes, 99.80.
Area, Lawrence Basin, 37.5 acres; Contents, 166,000,000 gals.; Bradley Basin, 87.5 acres; Contents, 391,000,000 gals.
Total Contents above grade, 100.00, 557,000,000 gals.

A new 36-in. main was laid from the pumping-station to Fisher-Hill Reservoir during the summer, and in consequence the grounds were much cut up around and in the vicinity of the pumping-station. Permanent connections at two places on this main were made for piezometric observations, and a large and substantial weir erected at the terminus of the pipe at Fisher-Hill Reservoir, to measure the water flowing from the pumps during duty trials.

It will be necessary to make a direct connection during the present year with the Bradlee basin, from the pumps, on account of the difficulty of keeping up the head in the wells with the present arrangements.

The driveways and walks have been kept in excellent order during the year, and thousands of visitors have enjoyed the quiet and beauty of the grounds.

Brookline Reservoir.

H. W., 125.00; Area, 23 acres; Greatest Depth, 24 feet; Contents, 119,583,960 gals.

Everything in connection with the Brookline Reservoir is in good order. No work other than that pertaining to maintenance has been done on this reservoir during the year.

Fisher-Hill Reservoir.

H. W., 241.00; Pipe Inverts, 220.00; Depth, 21 feet; Contents, 15,400,000 gals. above 223.

This reservoir is in good condition.

Inspection of Water Sources.

The following is a digest of the report of Mr. J. S. Concannon, Chief Inspector:

Total number of cases inspected	688
Old cases	669
New cases	19

Of the above, 170 are reported as remedied, 394 safe at present, 45 seem safe, 46 suspected, 33 unsatisfactory. Fifteen legal notices were sent. No legal injunctions were found necessary during the year.

Biological Laboratory.

During the year 1894, 2,475 microscopical examinations of water, 100 examinations of sand, and 2,200 cultures of bacteria, were made at the laboratory.

The following is a list of some of the special studies made during the year:

The color of the water in the different basins and their inflowing streams, with reference to the seasonal changes.

The study of certain species of bacteria found in the water.

The fermentation tube, and its use in determining the presence of Coli communis in the water.

The effect of sunlight on bacteria.

The effect of varying degree of acidity of culture media on bacterial growth.

The microscopical examination of the scum on the surface of sand filters.

The cause of the seasonal distribution of some of the micro-organisms found in the water.

Culture experiments with certain diatoms, with reference to their need of air.

The temperature of the water in the different reservoirs, with special reference to the phenomenon of stagnation.

Attention has frequently been called in the reports of the Western Division for several years past to the various phenomena connected with the period of "stagnation" in Lake Cochituate and other basins or sources of supply. In the seventeenth annual report for 1892, several diagrams were given, showing the temperatures in the lake, every five feet in depth, from April until December. Many years ago the writer thought he had discovered some of the effects of this extraordinary condition of things prevailing during seven months of the year, but he found in some of the very early reports of the department references to the same phenomena, showing that they were in a measure understood soon after the Cochituate works were built. The studies pursued during the past five years have, however, thrown more light on many of the details connected with the changes in the temperature of water, and it may not be out of place to draw up a brief *résumé* of the subject of "stagnation," as it has been observed on the Boston Water-Works.

As far as the temperatures of water in deep ponds are concerned, the year may be divided into three parts. During the winter, that is to say, in December, January, and February, the water at the bottom is warmer than at the surface, it being at about 39.2, the point of maximum density, but varying several degrees from this point, depending upon expanse, depth, and local circumstances. On the breaking up of the ice in March, April, and also during the "great overturning" in November, the water is in complete circulation, and has the same temperature throughout. During the other seven months, April to November, the water is colder at the bottom, and warmer at the surface. This embraces the different conditions; two periods of "stagnation," one short one in the winter, when the surface is colder than the bottom; one long one in the summer, when the opposite conditions of temperature prevail, and the periods of circulation in April and November.

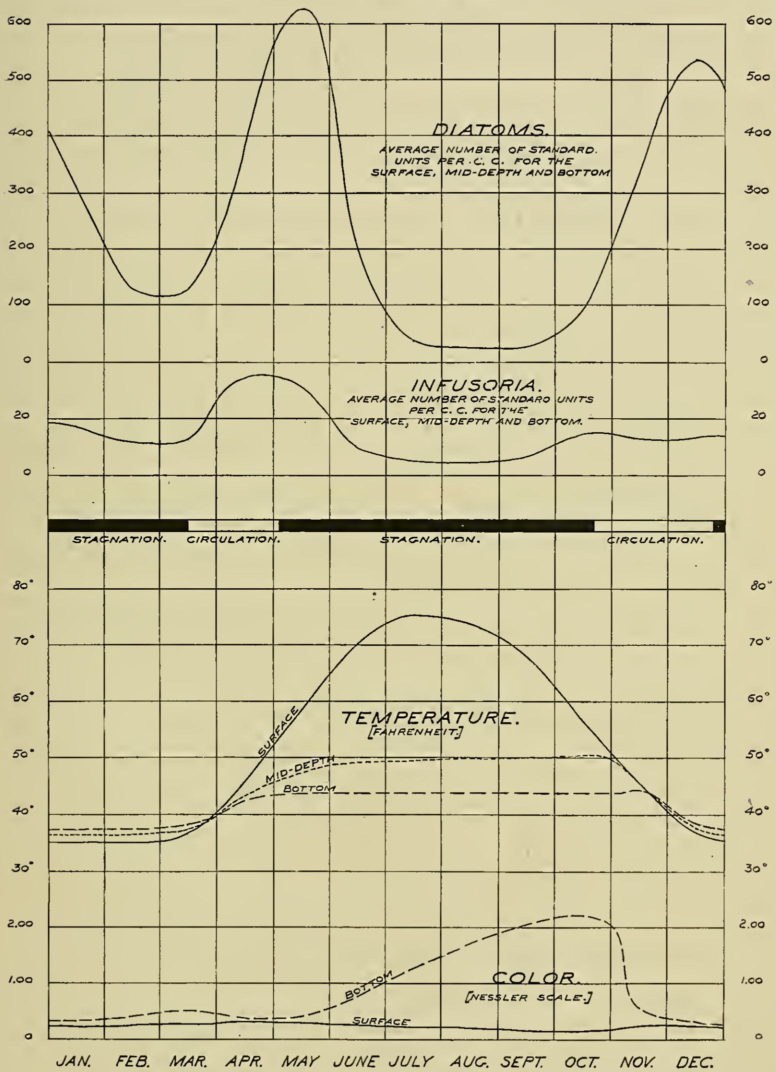
The long period of "stagnation" in the summer is by far the most interesting and important in results. In Lake Cochituate at a depth of sixty feet, when the upper layers begin to grow warmer in the spring, the water is left at the bottom with a temperature of about 44°, and at this temperature it remains for more than half the year without any change whatever. If the diagrams already published and alluded to be studied, it will be seen that the effects of the wind are generally not felt below ten feet in depth; that is to say, the upper ten feet are practically of the same temperature in the summer. The effects of heat and of stirring up, finally, by the middle of July bring the temperatures of the fifteen-feet curve nearly to the surface. At twenty feet there is very little effect, the water remaining for three months at that depth about 15° cooler than the surface.

In a larger lake it is probable that the effects of the wind are felt much below twenty feet, but it is practically true that in Lake Cochituate the effects of the wind are not felt more than twelve feet from the surface. From twenty to sixty feet there is a steady decrease in temperature, without material variation, to the sixty-foot line, where the temperature maintains a perfectly level line throughout, with hardly a variation of a tenth of a degree.

We will now see what are some of the effects of this phenomenon which we are discussing. The water in the summer may have a temperature as high as 84°, observed by the writer, feeling like warm water to the hand when the latter is immersed in it. By sinking a bottle in the same spot to a depth of sixty feet, water at 43° — practically ice cold water — may be brought to the surface. But this water at the bottom is not of good quality. While it has been lying in a quiescent condition during the summer, it has been gradually accumulating all the settlings from the water above, so that at the depth of forty feet it may be of the color of lemonade, while at the bottom it is very yellow and full of dirt. The water, too, at these depths is deficient in oxygen, and would not be at all suitable for domestic purposes. The water on the surface, on the contrary, during these whole seven months, is clear, white, sparkling, and in excellent condition for drinking.

As the water cools in the autumn the lake gradually turns completely over, and generally by the middle of November the process has been completed, and the water is of the same temperature from top to bottom — as the bad water comes to the surface it distributes its long summer accu-

RELATION BETWEEN GROWTHS OF DIATOMS AND INFUSORIA
AND THE PHENOMENON OF
STAGNATION AND CIRCULATION IN LAKE COCHITUATE,
1890-1895.



mulations in a most disagreeable manner. To be sure, a large amount of the organic matter is thus oxidized and otherwise destroyed, but while this is going on the diatoms and the infusoria find an abundant amount of food brought within their reach, with plenty of oxygen, and they begin to increase rapidly. The infusoria belong to the animal kingdom, and the diatoms to the vegetable. The number of the latter may, therefore, be very much greater than the former without producing as bad tastes in the water.

The winter period of stagnation to which we have alluded is due to a somewhat different cause. Here, although the water is four or five degrees warmer at the bottom than at the surface, it is nearer the point of maximum density, while the surface is lighter, although colder, being in the neighborhood of the freezing point. The effects of the turning over, however, in the spring, are exactly the same in principle as in November, although not as marked in degree. The diatoms and infusoria increase largely in this period of circulation.

The microscopical examinations which are made weekly in the laboratory of the Western Division show all these various phases perfectly.

No *résumé* of stagnation phenomena would be complete without a reference to the amount of iron contained in the bottom layers. This whole subject of iron in natural waters will be found most fully discussed in the report for 1892 already alluded to. When the dark waters from the bottom are brought to the surface in the summer, they rapidly grow darker, so that the color taken on the first exposure to the light sometimes increases threefold by the time it has been brought into the laboratory for examination. The average of five different determinations made by Mr. Hollis, at my request, between the last of August and the first of November, when the water at the bottom is at its maximum color, showed, during three successive summers, that the water at the bottom, on collection, had a color equal to six times that of water at the surface, and that after exposure the color increased to twenty times that at the surface.

The ferric hydrate in falling from the upper layers to the quiescent layers gives up its oxygen for the further oxidation of the organic matter, and the iron is thus nearly all reduced to the ferrous or colorless form. When drawn to the surface and exposed to oxygen the ferrous changes rapidly to the ferric condition, giving a yellowish appearance to the water.

A study of the degree and consequent effects of the summer stagnation period gives us the means of judging both of the original purity of the water and the condition of the reservoir in which it is stored. Many engineers are disposed to sneer at the idea of the necessity for removing all the organic matter from the bottom and sides of the valley which is to form a storage basin for a domestic supply. There is a marked difference in the condition of the water below the twenty-foot line in the summer in a properly prepared basin and one that is not treated. In the basins on the Boston Water-Works which have been stripped of loam, stumps, etc., and which have had their shallow flowage removed, the water is comparatively good all the way to the bottom even in October, when the effects of a long period of stagnation are best studied. Oxygen is present, showing that there is not enough organic matter present in a state of decomposition to use up the oxygen; the organisms are few, because there is not sufficient food to support large growths, and the amorphous matter is small in amount. In a sheet of water not so treated, however, we find a very different condition of affairs: there is no oxygen at the bottom, a high color, much organic matter (where decay has been arrested from a lack of oxygen), and a considerable amount of amorphous matter. All of these objectionable characteristics are distributed throughout the whole vertical section on the overturning, in November, resulting in large growths of diatoms and infusoria. It is no wonder that the water occasionally "tastes bad" under these conditions.

The following more detailed description of the diatom and infusoria growths in the Boston reservoirs has been prepared by Mr. G. C. Whipple, assistant in charge of the laboratory work:

Diatoms, or, technically, the Diatomaceæ, are minute plants, forming a group of microscopic algæ, remarkable for their siliceous epiderm, and for their variety of form and markings. They are unicellular, though in some genera the cells are united into filaments. The cell contents consist of a membrane, cell sap, nucleus, chromatophore plates, and sometimes oil globules and starch grains. Living diatoms are surrounded by a gelatinous envelope, which, on account of its transparency, can be seen only by adding coloring matter to the surrounding fluid. Of the cell contents biologists are at the present time most interested in the oil globules, because it is being proved that the oils present in the micro-organism are the direct cause of many of the bad tastes and odors of certain drinking-waters.

Of the one hundred and more genera into which the diatoms have been classified, there are not more than twenty that are commonly found in our water-supplies, and only six have, thus far, been found to be of practical importance;

namely, Asterionella, Tabellaria, Melosira, Synedra, Stephanodiscus, and Diatoma. Some of the other genera occasionally met with are Cyclotella, Cymbella, Epithemia, Fragilaria, Gomphonema, Meridion, Navicula, Nitzschia, Pleurosigma, Schizonema, Stauroneis, and Surirella.

The six most important genera are not always observed in the same reservoir. Generally there are certain diatoms peculiar in certain ponds. Lake Cochituate, for instance, often contains large growths of Asterionella, Tabellaria, and Melosira, and smaller growths of Synedra and Stephanodiscus. Basin No. 3 contains Asterionella, Tabellaria, and Synedra, but no Stephanodiscus nor Melosira. In Basin No. 2 only Synedra and Cyclotella are found.

Diatoms appear with considerable regularity each spring and fall, but the genera which appear at any given season are not always the same. If we consider, for example, the spring growths in Lake Cochituate, we find that in 1890 the Asterionella first appeared, and that this growth was soon followed by one of Tabellaria. In 1891 the growth was chiefly Asterionella, Melosira appearing about the same time, but not developing to any great extent. In 1892, Melosira was the predominant diatom; in 1893, Melosira and Asterionella; and in 1894, Tabellaria, Asterionella, and Melosira.

A comparison of the microscopical examinations of the different reservoirs of the Boston Water-Works shows that Basins No. 2 and No. 4 never have extensive diatom growths, but that in Basin No. 3 and Lake Cochituate these plants develop regularly in the spring and fall.

There are two periods of the year, each about six weeks long, when the water is in circulation from top to bottom. It is during these periods that the diatoms develop. Microscopical examinations have shown that both in Basin No. 3 and in Lake Cochituate the diatom growths occur soon after stagnation ends. The Asterionella, for instance, generally appears about one week after the turning over. It then increases, reaching its maximum growth in from twenty-five to fifty days.

The bottom temperature of Lake Cochituate is considerably lower than the bottom temperature of Basin No. 3 during the summer months, on account of its greater depth; hence its turning over occurs later in the year. This explains why the fall growth of diatoms occurs later in Lake Cochituate.

The examinations of the State Board of Health furnish corroborative evidence that the seasonal distribution of diatoms is controlled by the circulation and stagnation of the water. This may be seen by comparing the diatom growths in deep and shallow ponds. On the assumption that diatoms grow best immediately after the turning over, we should expect to find in the deep ponds two periods of diatom growth,— one in the spring, following the winter stagnation, and one in the fall, after the summer stagnation. In the case of shallow ponds, however, we should expect to find a spring growth following the winter stagnation, and for the rest of the year a uniform or irregular distribution. This is found to be the case. Of twelve ponds and reservoirs more than 30 feet deep, eleven show a well-defined spring and fall growth, while in one instance the growth was uniformly distributed; and of seventeen ponds and reservoirs less than 30 feet deep, eleven have diatom growths appearing at irregular intervals, but having a slight spring maximum, while four have both a spring and a fall growth.

Infusoria. — The water of the Sudbury and Cochituate water-supplies ordinarily contains very few organisms which can properly be classed as animals. Probably 95 per cent. of the total number of micro-organisms found each year are plant forms. Nevertheless, the animal forms are important, because a comparatively small number is sometimes sufficient to make the water very disagreeable, and because they are liable to sudden and extraordinary developments, when, if they increase sufficiently, the water may be rendered entirely unfit for use. The worst tastes which have appeared in the water-supplies of Massachusetts have been caused by growths of infusoria.

Because of the importance of these micro-organisms the following data have been brought together in regard to the infusoria and other animal forms found in the waters of the Boston supply.

The animal micro-organisms usually found in surface waters are ordinarily classified by biologists under the following heads:

Rhizapoda.
Infusoria.
Rotifera.
Crustacea.

A few forms are found which cannot be included in this classification; for instance, the fresh-water sponges, Hydra, certain insect larvæ, and certain worms.

Hydra vulgaris, a very interesting animal belonging to the Hydroid Zoöphytes, is often found on the walls of the gate-houses, on the screens, etc. It is of no special interest, however, from a sanitary point of view.

Fresh-water sponge is quite abundant on the walls of the aqueducts. Both *Spongilla* and *Meyenia* have been found. They belong to the Spongidæ, or Porifera, a class of Protozoa. A favorite habitat of the Spongilla is on the walls of the Cochituate aqueduct just below the gate-house at the lake. Another place where it is very abundant is in Whitehall pond, where it grows on the old stumps in the shallow flowage. Several genera are found there, and they often grow into masses of considerable size. Spongilla also grows to some extent in the city mains. This may be inferred from the fact that at certain seasons the sponge-spicules are found in the samples from the city taps (Park square), while at the same time they are absent from the water as it leaves the reservoirs. At times sponge collects in considerable quantities on the screens at Chestnut-Hill and Brookline Reservoir gate-houses. At present the sponge gives little or no trouble, save for the labor of cleaning it from the walls of the aqueducts; but in 1878 it developed in considerable quantities, and was thought to be the cause of the "cucumber taste" which at that time rendered the water very disagreeable.

Among the vermes may be mentioned *Anguillula fluviatilis*, a nematoid worm akin to the vinegar eel. This is sometimes found in stagnant water, and especially in water contaminated by sewage. It is very seldom observed in the Boston reservoirs, and is never seen in the service-pipes, except, perhaps, at some dead end.

RHIZOPODA.

The rhizopods are quite unimportant. They are never found in reservoirs in large numbers. In the Boston water they have seldom been observed. One reason for this is the fact that there are but a few genera which are naturally free-swimming. The rhizopods love best to move slowly along in the ooze at the bottom of a pond, or to congregate on the stems and leaves of some aquatic plant. Most of them are quite sluggish in their action. They are contented to remain quietly on some submerged stem or log, and allow their food to be brought to them. Occasionally they are found freely floating in the water. *Amœba*, *Actenophrys*, *Arcella*, *Euglypha*, *Difflugia*, *Trinema* have been observed at different times. *Amœba* may be found at almost any time by scraping the walls and screens of the gate-house.

Rotifera.

The rotifers, or wheel-animalcules, are quite often seen in all of the reservoirs, but never in large numbers. *Anuræa* is the most common one, and several species of it are found. Other genera which have been observed are the following:

**Rotifer vulgaris.*
**Conochilus.*
**Polyarthra.*
**Synchæta.*
Asplanchna.
Triarthra.
Mastigocerca.
Floscularia.
Lacinularia.
Brachionus.

Those which are starred are the most important.

Conochilus appears in Basins 2 and 3 during the early part of each summer. It is also frequently present during the periods of the Cyanophyceæ growths in Basin 3, *i.e.*, in August and September. The largest number of rotifers which we have ever seen in a single sample was found in the estuary of Beaver Dam brook, June 30, 1892, when there were eighty Conochilus per cubic centimeter. This is equivalent to about 1,600 standard units. The water at that time had quite a strong taste, but as other organisms were present at the same time, the distinctive taste of Conochilus could not be determined.

Crustacea.

Among the Crustacea the *Cyclops* and *Diaptomus*, belonging to the order Copepoda, and the *Daphnia*, *Bosmina*, and *Alona*, of the order Cladocerca, are frequently found. They are found at all seasons, but chiefly during the summer months. *Cyclops* in its adult and Nauplius forms is the most important crustacean.

Infusoria.

The most important of the animal forms are the Infusoria. They form a very large group of Protozoa, in which there is found a large number of free-swimming forms.

The infusoria have been carefully studied by Ehrenberg, Stein, Pritchard, and others. W. Saville Kent, in his "Manual of the Infusoria," published in 1880, has given very complete descriptions and a classification of all the known infusoria. At the end of this report will be found a key to the identification of the infusoria commonly found in the Boston water-supply. It is based on Kent's classification.

Many of the infusorial forms are sedentary. They may be found on the leaves and stalks of water-weeds, and on the fresh-water algæ growing in shallow ponds or along the edges of brooks. These occasionally become detached from their seats, and are found floating in the water. There are others, not sedentary, which find their food only among the fresh-water algæ. They spend their whole life swimming about these plants. They, too, are sometimes found floating in the water. Certain genera, however, are not confined to the shores and shallow waters, but are able to find sustenance in deeper waters. They are the infusoria which cause trouble.

Such infusoria must, obviously, find their food-supply in the water itself, and it naturally follows that they will be most abundant where there is plenty of food for them, and that they will appear at those seasons of the year when their food is most abundant. Comparatively little is known in regard to the food required by the different infusoria; but certain general principles have been laid down to serve as guides.

The infusoria are classed in the animal kingdom. They differ in many respects from the plant micro-organisms with which they are often found. According to Kent, "the primary basis for the distinction between the plants and animals is associated with the phenomena of nutrition. In a general way it may be said that animals have the capacity to ingest solid particles of food, and depend upon such solid food ingestion for their growth and the display of their various vital functions. Plants, on the other hand, are nourished by the absorption of their food in a purely liquid state. Chemically, also, there is a difference between the food of animals and that of plants. Animal forms are absolutely dependent on proteaceous, or ready-manufactured, organic matter for their food-supply; but plants, with a few exceptions, are able to manufacture this substance themselves out of the crude material distributed, in the liquid or gaseous condition, in the fluids which they imbibe."

From the foregoing we may infer that among the conditions necessary for the growth of infusoria one of the most important is a sufficient abundance of very minute particles of organic matter distributed through the water; and to this, experience justifies us in adding a sufficient supply of oxygen. A study of the local and seasonal distribution of the infusoria indicates that these conditions are fulfilled whenever the infusoria develop in large numbers.

SEASONAL DISTRIBUTION.

The microscopical examination of over 12,000 samples of water from the reservoirs of the Boston water-supply during the past five years has given us an excellent idea of the seasonal distribution of the infusoria in those reservoirs. The results of these examinations have been collated, and a partial summary of them is given in the following table :

Average Number of Standard Units of Infusoria in a Cubic Centimeter of Water during each Month of the Year.

	Lake Cochituate.	Basin 2.	Basin 3.	Basin 4.	Average.
January	17.4	4.2	15.6	2.6	10.0
February	12.0	9.2	6.0	1.6	7.2
March	12.6	4.2	5.2	2.6	6.2
April	35.0	12.6	23.4	14.4	21.4
May	31.6	17.4	18.0	1.8	17.2
June	9.8	10.6	8.0	1.2	7.4
July	5.4	10.6	5.4	2.4	6.0
August	4.2	8.4	12.0	5.0	7.4
September	6.4	6.4	20.6	5.4	9.7
October	14.6	22.2	24.4	5.4	16.7
November	13.0	12.8	57.2	1.2	21.1
December	14.0	11.8	34.5	0.4	15.2
Mean	14.7	10.9	19.2	3.7	12.1

In the reservoirs mentioned in the table the samples were collected each week from the surface, mid-depth, and bottom. The results are expressed in Number of Standard Units (one standard unit equals 400 square microns) per c.c., and the figures indicate the average numbers for each month of the year. Each figure represents the average of about seventy-five samples.

An inspection of curves plotted from the table shows that there are two well-defined maxima, one in April and the other in November. In the summer the growth is much lower, but yet is of some importance. During the winter infusoria are also found, and usually just under the ice, where the oxygen is most abundant. There is a striking contrast between the Boston Water-Works curve and those given by Mr. G. N. Calkins and by Prof. S. W. Williston, the former for the water-supplies of Massachusetts, based on the examination of 912 samples from 26 supplies during three years, and the latter for the water-supplies of Connecticut, based on the examination of about 300 samples from 12 supplies of the State during a period of two years.

The Massachusetts curve differs from the Boston curve at all points of inflection. It has two maxima, — a major maximum in February and a minor maximum in July. The lowest point on the Massachusetts curve is found in November, when the Boston curve is at one of its maxima. The Connecticut curve agrees with the Massachusetts curve in having a February maximum, and with the Boston curve in having a November maximum. The reason for the differences between these curves is that both the Massachusetts and Connecticut curves are based on results obtained from a large number of water-supplies differing greatly in their character.

That fact also accounts for the irregularity of those curves. Some supplies have immense growths of infusoria in the winter, others in the summer; and these excessive growths in a few supplies control the shape of the curves, regardless of the smaller numbers which may be found with great regularity in other places. This emphasizes the fact that each water-supply must be studied by itself.

There is a striking similarity between the shape of the curve representing the seasonal distribution of infusoria and that of the seasonal distribution of diatoms. Both have well-marked spring and fall maxima, and it is a noteworthy fact that these maxima occur at those times when the water is in complete circulation from the top to the bottom. This complete circulation occurs in the spring, after the ice has broken up, and in the fall, after the summer stagnation has ceased. There appears to be a logical reason why the growths should occur at this time.

When the water turns over in the spring and fall, the lower layers are brought to the surface. These lower layers of water are somewhat heavily charged with partially decomposed organic matter, and when this organic matter comes in contact with the oxygen, which is abundant near the surface, its oxidation is completed. The oxidation is indicated by the increase in the nitrates, and is brought about, of course, through the agency of bacteria. At the bottom of the reservoirs there is a deposit of very finely divided organic matter. When the water turns over, much of this is scattered through the water. At the same time it is probable that various plants and animals which have been lying in a dormant condition are also brought up and scattered through the water. Finding themselves liberally provided with food, both diatoms and infusoria develop rapidly. The infusoria find their food in the fine particles of organic matter brought up from the bottom, in the organic matter of the growing plants, and in the bacteria which are carrying on the decomposition; furthermore, oxygen is abundant.

These conditions are best illustrated in Lake Cochituate, where the stagnation phenomena are most marked. In Basins 2, 3, and 4 the growths occur in the spring and fall; but the conditions in those basins are somewhat modified by the drawing down of the basins, and the fact that extensive growths of infusoria are sometimes washed into the basins from the swamps and ponds on the upper portions of the water-shed. If we consider Basin 3, for instance, we find that there is a spring growth in April, as in Lake Cochituate. Late in the summer the infusoria begin to increase, and they ordinarily reach their maximum growth in October; but in November, 1893, the *Synura* and *Dinobryon* developed in very large numbers in the mill-ponds a short distance above the head of the basin, and these were soon washed into the basin. Apparently they found the conditions favorable to their growth, for they remained abundant for several weeks. It was this growth that caused the maximum point on the Basin 3 curve to appear in November instead of in October. Basin 2 has occasionally been seeded in like manner.

As the various genera of infusoria differ somewhat in regard to their seasonal distribution, and their effect on the water, it is best to consider each genus separately. The following are some of the infusoria found in the Boston water-supply:

Dinobryon is one of the most common infusoria in water-supplies. It is found every year in the Boston water, but never in numbers sufficient to cause trouble. It has been found in the spring and fall in Lake Cochituate and Basins 2 and 3, but during the summer months it is practically absent. In Basin 4 it is seldom found. In February, 1891, it was quite abundant in Farm pond, and in Whitehall pond it has several times attained a considerable growth. *Dinobryon* does not go to pieces as rapidly as many infusoria, and consequently it is found in the Chestnut-Hill Reservoir, and occasionally in the service-pipes.

An examination of the microscopical analyses of the various water-supplies of Massachusetts shows that *Dinobryon* is found most often in the spring months, but that there is, also, a considerable fall growth. During the past few years there have been several cases where *Dinobryon* has caused trouble by its great development. These occurrences were seasonally distributed as follows:

January . .	2	May . . .	6	September .	3
February . .	4	June . . .	0	October . .	2
March . . .	3	July . . .	3	November .	2
April . . .	1	August . .	1	December .	0

It is somewhat contrary to our experience in Boston to find *Dinobryon* growing vigorously during the hot weather; but some supplies have vigorous growths in July. This indicates that temperature is not the main cause influencing its seasonal distribution.

Dinobryon sometimes appears and disappears with great rapidity. In Breed's pond. Lynn, there were 1.410 per c.c. on May 25, 1893; and in less than a week, during which the weather was excessively hot, they disappeared completely.

Dinobryon, when present in large numbers, gives to the water a very disagreeable taste. It is, in some respects, similar to that caused by Synura; but it is not as strong nor as oily, although it is doubtless caused by oil globules, which are often observed. The taste is a persistent bitter one, producing a stinging sensation at the back part of the tongue.

Synura has several times been quite abundant in the reservoirs of the Boston supply. These growths are described in the Annual Report of the Boston Water Board for 1893, page 75: "The most extensive growth of *Synura* which has been found in Boston water occurred in the ponds on Stony brook, just above Basin 3, in November and December, 1893. Both in Rice's and in Nichols' mill-ponds the number of colonies frequently reached 200 per c.c. (equal to about 1,000 standard units). These were gradually washed down into Basin 3. At one time 2,000 standard units were found in the influent stream. They soon became numerous in Basin 3 and Basin 1. They were present in the Sudbury gate-house, at the Chestnut-Hill Reservoir, in almost every sample, during November and December. A few were seen in the effluent gate-house and even in the service-taps, but not in numbers sufficient to impart much of a taste to the water."

As a rule, *Synura* growths have occurred in the Boston supply in the spring and fall. This is quite generally true for other supplies, although *Synura* occasionally develops in the summer.

Synura is one of the most disagreeable of the infusoria.

It has a strong, stinging, bitter taste, sometimes being distinctly oily, and occasionally resembling the taste of a cucumber. A comparatively small number is sufficient to cause a noticeable taste.

Uroglena is a very offensive infusorian when present in large numbers. It causes a very intense, oily smell. It is occasionally found in the Sudbury water, but always in small numbers. It usually appears in the winter.

The only large growth that has been noticed in the Boston water occurred in Whitehall pond, in June, 1891. An account of this may be found in the Report of the Boston Water Board for that year. The *Uroglena* appeared very suddenly. On June 11 there were 150 colonies per c.c. at the lower end of the pond, where they were most abundant. The water had a reddish-brown color. This color soon changed to a light-brown; and in a few days the water cleared. The odor caused by the *Uroglena* was intensely oily. It was carried by the wind to a considerable distance from the pond.

Several water-supplies, both in Massachusetts and Connecticut, have been afflicted with *Uroglena*.

Mallomonas is an infusorian which seldom causes trouble, because it is not found in large numbers. As many as 200 were once found in a cubic centimeter of water, and at that time the water had a slight sweetish, aromatic taste, similar to that caused by *Cryptomonas* and *Chloromonas*, which the *Mallomonas* resembles, in having a bright-green color.

Mallomonas is found in Basin 3 in the fall, and in Lake Cochituate in both spring and fall.

Cryptomonas is not often found in the Sudbury and Cochituate supplies; but in the ponds just above Mystic lake it is often abundant. Horn pond, in particular, has tremendous growths of *Cryptomonas*, usually in the winter. Glen Lewis and Walden ponds, Lynn, are likewise famous localities for *Cryptomonas*, as well as *Chloromonas*.

Cryptomonas causes a very strong taste, which resembles that of a violet. It is sweet and aromatic, and not altogether unpleasant.

Trachelomonas is found in Lake Cochituate at all times of the year, but is most common in the fall. It is found in greatest numbers at the bottom, where the water is stagnant, without oxygen, and heavily charged with partially decomposed organic matter.

In Basin 3 it is found only during the latter part of the summer. There, also, it seems to be associated with the stagnant water, being found most commonly at the bottom until the time of the turning over of the water, after which it is more evenly distributed. It is not found to any extent in Basins 2 and 4.

Trachelomonas seems to be associated with decomposing organic matter. It belongs to the same family with the *Euglena*, which is a notable filth infusorian. The facts that it has a rich brown color, and that it is found at the bottom of our ponds, where the stagnant water is rich in iron compounds, seem to indicate that iron may be the cause of its brown color, and perhaps may be necessary to its existence.

Trachelomonas is not a common organism in water-supplies, though it has been found as high as 500 per c.c. The water containing it had a very strong, earthy taste, but that was doubtless caused by the amorphous matter, which was exceedingly abundant, and not by the *Trachelomonas*.

Peridinium and *Glenodinium* are very much alike, and are often mistaken for each other. They are not abundant in the Sudbury and Cochituate water, although there is an occasional spring growth in the lake, and in Basin 3 they are sometimes found during the summer. In Mystic lake, however, *Peridinium* grows vigorously every summer. At times the number has been as high as 3,500 standard units per c.c. They are in great measure the cause of the offensive odor which is noticed every summer in the Mystic water. They usually appear in June or July and last until October.

Peridinium has been found at all seasons of the year, and extensive growths have occurred in January, March, June, and October. Usually, however, its maximum growth is attained in the summer.

Codonella, according to the reports of the State Board of Health, is seldom found in the water-supplies of Massachusetts, but in Lake Cochituate and in Basins 2 and 3 appears quite regularly in the spring and fall. Their number is generally small, but the organisms are of large size. They have never appeared in numbers sufficient for us to determine their effect on the water. The *Codonella* animalcule is usually enclosed in a lorica. Occasionally it leaves this, and is found moving briskly about in the water by means of its rapidly moving cilia.

Tintinnidium, or *Tintinnus*, as it would more properly be called, is akin to *Codonella*. It is not common in water-supplies generally, but in Lake Cochituate it is usually present in the spring months.

The species ordinarily found corresponds to Kent's *Tintinnidium semiciliatum*. In Whitehall pond we have observed a species somewhat different from the *semiciliatum*. It differs chiefly in having its lorica transversely wrinkled or folded, instead of being perfectly cylindrical. As it is free-swimming, it is more properly classed as a *Tintinnus*, and we have designated it as *Tintinnus corrugatus*.

Vorticella is occasionally found during the summer. It is more common in Basin 3 than in other portions of the Boston supply. It is naturally a sedentary form, and one reason why we find it in our samples from the middle of the reservoir is because it attaches itself to floating algæ. It is often found on bunches of *Anabœna* and *Cylindrospermum*. As far as we have observed the *Vorticella* does not feed on these algæ, but uses them as a means of being carried through the water.

Epistylis is similar in many respects to *Vorticella*. It generally appears in clusters. It is not common in Lake Cochituate. In the basins it is occasionally found in the early summer and sometimes in the fall.

Euglena is not found to any extent in the Boston supply. It has occasionally been seen in Stony brook above Basin 3, and in Pegan brook. It is also found in the Abajona river and at the head of Mystic lake. It is an important organism, because its presence is generally an indication of pollution. In waters which are badly polluted it often grows vigorously. Near the laboratory there is a brook which receives the drainage of several houses. *Euglena* is sometimes so abundant in this brook that every stick, stone, and plant is covered with a bright green layer, and the water itself is green with them.

Paramœcium is another infusorian usually found in polluted water. It is not found in the Boston supply, except occasionally in Pegan brook.

Besides those already mentioned, Monas, Cercomonas, Pleuronema, Bursaria, Phacus, Acineta, Uvella, Nassula, Coleps, Placus, Zoothamnium have occasionally been observed.

A KEY TO THE INFUSORIA FOUND IN THE BOSTON WATER-SUPPLY, ACCORDING TO THE CLASSIFICATION OF W. SAVILLE KENT.

Sub-kingdom Protozoa.

Legion. Infusoria.

Protozoa, with definite form and provided with an external membrane, bearing either flagella or cilia: Mouth and anus usually, contracting vacuole, and one or more nuclei always, present. (*1*)

(*1*) Animalcules bearing one, two, or more long, lash-like flagella, which mostly represent the sole organs of progression, but are occasionally supplemented by cilia, pseudopodia, or other locomotive or prehensile appendages. Oral or ingestive system varying in character; definite, diffuse, or indistinct. One or more contractile vesicles almost invariably represented. Multiplying rapidly by binary fission and by the subdivision of their entire body-mass into sporular elements. The sporular reproductive process, often preceded by the complete fusion or conjugation of two or more adult zooids. (*a*) *Class Flagellata, or Mastigophora.*

(*1*) Animacules partly or more or less completely clothed with vibratile cilia, which constitute the essential organs of locomotion and prehension; no supplementary lash-like appendages or flagella; certain of the cilia often modified in the form of setæ, styles, or uncini; occasionally possessing more or less distinct membraniform expansions; a well-developed oral and anal aperture mostly present. (*b*) *Class Ciliata, or Trichophora.*

(*1*) Animalcules bearing neither flagellate appendages nor cilia in their adult state, but seizing their food and effecting locomotion, when unattached, through the medium of tentacle-like processes developed from the culicular surface or internal parenchyma; these tentacles simply adhesive, or tubular, and provided at their distal extremity with a cup-like sucking disc; an endoplast and one or more contractile vesicles usually conspicuously developed; trichocysts rarely, if ever, present; increasing by longitudinal or transverse fission, or by external or internal bud-formation. (*c*) *Class Tentaculifera.*

(*a*) Ingestive area diffuse; flagella representing the sole organs of locomotion. (*d*) *Order Flagellata-Pantostomata.*

(*a*) Ingestive area constituting a true and distinct mouth: flagellum not supplemented by cilia. (*e*) *Order Flagellata-Eustomata.*

(*a*) Ingestive area constituting a true and distinct mouth: flagellum supplemented by a more or less highly developed ciliary wreath. (*f*) *Order Cilio-Flagellata.*

(*b*) Cilia distributed over the entire surface of the body, similar, or differing but slightly in character. (*g*) *Order Holotricha.*

(*b*) Cilia distributed over the entire cuticular surface; the oral series of conspicuously larger size. (*h*) *Order Heterotricha.*

(*b*) Cilia not universally distributed, mostly limited to a conspicuous circular or spiral adoral wreath. (*i*) *Order Peritricha.*

(*c*) Tentacles wholly or partially suctorial. (*j*) *Order Suctoria.*

(*d*) Flagellum single, terminal. Animalcules naked, freely swimming; no pedicle or caudal appendage, globose or ovate; anterior border rounded; polymorphic. *Genus Monas.*

(*d*) Animalcules naked, with a tail-like caudal filament, flagellum single; entirely free-swimming, never attached. *Genus Cercomonas.*

(*e*) One flagellum. Animalcules mostly highly metabolic; endoplasm colored brilliant green; free-swimming, no abnormal pharyngial dilation. (*k*)

(*e*) Two flagella. Endoplasm enclosing two laterally disposed olive or yellow pigment bands. Flagellate appendages, with but rare exceptions, two in number, of similar or diverse length. (*n*)

(*f*) Bearing one or more flagella and a distinct ciliary girdle. (*r*)

(*f*) Flagellum single, terminal; body clothed with long setose cilia, oval, persistent in form, free-swimming, usually green color. *Genus Mallomonas.*

(*g*) Bearing cilia only. (*s*)

(*g*) Bearing cilia and a membraniform expansion. Membrane non-vibratile, extending in front of and around the oral fossa in a hood-like manner; oral aperture and hood-like membrane ventral; cilia rigid, setose; without a caudal seta. *Genus Pleuronema.*

(*h*) Oral cilia forming a simple, straight, or oblique adoral fringe. Animalcules free-swimming, broadly ovate, somewhat flattened on one side, anteriorly truncate; peristome-field pocket-shaped, deeply excavate, situated obliquely on the anterior half of the body, having a broad oral fossa in front, and a cleft-like lateral fissure, which extends from the left corner of the contour border to the middle of the ventral side; no tremulous flap; pharynx very long, funicular, bent towards the left, and forming an immediate continuation of the peristome excavation, adoral ciliary wreath very broad, much concealed, lying completely within the peristome cleft; the cilia of general surface very fine, disposed in longitudinal rows; anal aperture postero-terminal; endoplast band-like, curved or sinuous; contractile vesicles distinct, usually multiple. *Genus Bursaria.*

(*h*) Oral cilia describing a spiral or circular course around the oral aperture. (*u*)

(*i*) Animalcules naked, sedentary or attached; ovate, campanulate, oral aperture terminal, eccentric, associated with a spiral fringe of adoral cilia, the right limb of which descends into the oral aperture, the left limb encircling a more or less elevated, protrusible, and retractile ciliary disc.

Animalcules solitary, attached through the medium of a retractile pedicle. *Genus Vorticella.*

(*i*) Animalcules associated in dendriform colonies. (*v*)

(*j*) Animalcules multitentacular, tentacles similar; loricate, tentacles similar, lorica pedicellate. *Genus Acineta.*

(*k*) Naked. (*m*).

(*k*) Loricate. *Genus Trachelomonas.*

(*m*) Highly metabolic, having a caudal prolongation. *Genus Euglena.*

(*m*) Persistent in shape. No snout-like prominence. *Genus Phacus.*

(*n*) One flagellum; animalcules persistent in shape. *Genus Chloromonas.*

(*n*) Two flagella. (*o*)

(*o*) Naked. (*p*)

(*o*) Loricate. (*q*)

(*o*) Immersed within a gelatinous zoocytium. Zooids not directly united, possessing independent contractile vesicles. *Genus Uroglena.*

(*p*) Solitary, free-swimming, flagella inserted beneath a lip-like prominence. *Genus Cryptomonas.*

(*p*) Social, united in spheroidal free-floating clusters. *Genus Uvella.*

(*q*) Social, forming a compound branching zoothecium. *Genus Dinobryon.*

(*q*) Social, united in free-floating spheroidal clusters. *Genus Synura.*

(*r*) Flagellum single, ciliary girdle central, encuirassed. No horn-like processes. (*l*)

(*r*) With horn-like processes. *Genus Ceratium.*

(*l*) Cuirass facetted. *Genus Peridinium.*

(*l*) Cuirass simple. *Genus Glenodinium.*

(*s*) Animalcules asymmetrical, with distinct dorsal and ventral regions; oral operture ventral. (*t*)

(*s*) Animalcules symmetrically ovate or cylindrical, oral aperture terminal or lateral; pharynx distinct, often armed with rod-like teeth. Persistent in form, mouth lateral. *Genus Nassula.*

(*s*) Animalcules symmetrically ovate; oral aperture terminal; cuticular surface indurated. No anterior or buccal seta. Carapace with spinous processes. *Genus Coleps.*

(*t*) Cuticular surface soft and flexible, with an oblique adoral groove. *Genus Paramoecium.*

(*t*) Cuticular surface indurated; free-swimming; no distinct pharynx. *Genus Placus.*

(*u*) Animalcules permanently or temporarily adherent; peristome and adoral cilia enclosing the entire funnel-shaped or variously expanded frontal border. Peristome-field, subcircular or infundibulate. *Genus Stentor.*

(*u*) Animalcules ovate or pyriform, adoral cilia surrounding the anterior extremity in a simply circular manner. Loricate; animalcules adherent to lorica by retractile pedicle, freely floating in the water. *Genus Tintinnus.*

(*u*) Animalcules loricate, free-swimming, oral cilia forming two circlets, those of the outer circle attenuate, tentaculiform. Cilia of the inner circlet spathulate or lappet-like. *Genus Codonella.*

(*v*) Pedicle retractile. Contractile stalk of entire colony continuous throughout. *Genus Zoothamnium.*

(*v*) Pedicle rigid. Ciliary disc axial; no collar-like membrane. *Genus Epistylis.*

Filtration Experiments.

These experiments, already described in previous reports, were continued through the greater part of the year, but were finally concluded, and the apparatus thrown out of use, the data accumulated having proved sufficient for the purposes for which the investigations were begun.

The six large tanks, having an area of one one-thousandth of an acre, were used for experiments on continuous filtration through sand at a rate of 1,500,000 gallons per acre per day. Experiments with bone, charcoal, and dried alumina have been continued with tanks having an area of one forty-thousandth of an acre. Experiments on the purification of water by precipitation with ferric chloride, followed by rapid filtration through sand, were begun October 16.

Chemical and biological analyses of the applied water and effluents were made weekly until October 16. The results of these analyses have been plotted, giving continuous profiles which show graphically the purifications produced by each tank.

The work has been under the immediate charge of Mr. W. E. Foss, C.E., who has prepared the following description of some of the experiments made under my direction, to determine the effects of sunlight on the decolorization of water. These observations were made in connection with our filtration experiments.

The first experiment was begun November 26, 1890. Three one-gallon bottles were filled with water from the tap. Sample No. 1 was analyzed at once, sample No. 2 was put in a dark closet, and No. 3 was exposed to sunlight in a window. June 28, 1891, samples Nos. 2 and 3 were analyzed, sample No. 3 having been exposed to bright sunlight for 800 hours. The results of the analyses are given in Table I. They show that the color of the water was only slightly reduced in the sample kept in the dark, while it was entirely removed from the sample exposed to sunlight. Observations of the color were not made during the interval, and it is not known how many hours exposure to sunlight were necessary to reduce the color completely. The nitrogen as albuminoid and free ammonia was reduced and the nitrogen as nitrites and nitrates increased in the dark, while in the sample exposed to sunlight the nitrogen as albuminoid and free ammonia and nitrites increased, while the nitrogen as nitrates was reduced.

Samples Nos. 4 to 10 inclusive were collected from the tap for the purpose of following the changes which might take place under the action of sunlight from month to month. No. 4 was analyzed at once, and Nos. 5, 7, and 9 were put in a dark closet, while Nos. 6, 8, and 10 were exposed to sunlight on a bench out of doors. A sample from the dark and one from the sunlight was analyzed each month. The results of the analyses are given in Table I. It will be seen that an exposure to sunlight for 238 hours was not quite sufficient to remove the color completely. In almost every case nitrogen as albuminoid and free ammonia was higher, and the nitrogen as nitrates lower, in the sample exposed to sunlight than in the one kept in the dark. In the samples Nos. 5 to 10 inclusive the clear supernatant portion only was analyzed, the sediment not being included. As the results seemed to show a loss of nitrogen, it was thought that it might be in the sediment, and analyses were therefore made of a mixture of the samples kept in the dark, and also of a mixture of the samples exposed to sunlight, the sediment being included. The results are shown by Nos. 11 and 12, and seem to show that there had not been a loss of nitrogen.

Analyses Nos. 13 and 14 show the changes which took place in a very dark water from an exposure to sunlight for 543 hours. The samples were collected October 24, 1891, from the bottom of Lake Cochituate, at a point 55 feet deep, where the water had been stagnant for some time. When collected the sample contained a large amount of ferrous iron, and dissolved oxygen was entirely absent. Soon after collection the ferrous iron became oxydized, increasing the color of the water to 4.50.

Analyses Nos. 15 to 23 inclusive show the changes from exposure to sunlight in samples from the Cochituate and Sudbury sources and from the Bradlee Basin of the Chestnut-Hill Reservoir, which contains a mixture of the other two.

An increase in the nitrogen as albuminoid and free ammonia and decrease in nitrogen as nitrates, oxygen consumed and color, in the samples exposed to sunlight, is noticed when they are compared with the samples kept in the dark.

August 1, 1892, an experiment was begun to determine the action of sunlight for each month in the year. Three sets of samples were used in this experiment to see if there was any difference in the action on waters having different intensity of color. One set was from Cochituate aqueduct, average color 0.23; one from Terminal chamber, average color 0.79; and one from Chestnut-Hill Reservoir, average color 0.53, being a mixture of the other two. The samples were collected about the first of each month, and one of each set kept in the dark, while another was exposed to sunlight in a box, having three sides and the top of plate glass, which allowed exposure of the samples to sunlight under similar conditions throughout the year. The temperatures and colors of the samples were taken weekly, but in the tables presented herewith only the means for each month are given. The weekly observations showed that the changes went on uniformly. As a basis for comparison the reduction of color per 100 hours of sunlight has been calculated for each month. The total reductions due to exposure to sunlight were obtained by subtracting from the reduction which took place in the sample exposed to sunlight any reduction which took place in the companion sample kept in the dark. The results of the experiment are given in Table II. An examination of them shows that, while the total reduction in color was greatest during the summer months, the reduction per 100 hours of bright sunlight is practically constant for all seasons of the year. It is also seen that the reduction in color varies almost directly with the amount of color present, being in each case about 20 per cent. of the original color.

An experiment was also arranged to see if the sunlight affected the water applied to the filters and the various effluents alike. The results are given in Table III. The only differences noticed are slight, and appear to be due to differences in the original colors.

The following experiments were made to determine, if possible, in what manner the reduction in color by exposure to sunlight was brought about.

As the exposure of a sample of water to sunlight was accompanied by an increase in temperature of the water, an experiment was arranged in which the temperature of the water was maintained at a high point without exposure to sunlight. Two samples of a very highly colored water from the bottom of Lake Cochituate were kept on the radiator in the office, one covered with a black cloth bag and the other exposed to the light. They were kept in this manner from October 27, 1891, to December 8, 1892; the average temperature during the interval was 93° Fahr. The sample kept in the black bag was reduced in color from 4.50 to 4.00, or 0.50; the one exposed to the light was reduced in color from 4.50 to 3.30, or 1.20.

The results show that heat alone was not the cause of the reduction in color.

Experiments to see if sedimentation would hasten the reduction of color were arranged. Samples of water were exposed in glass jars having disks of glass arranged in a series of horizontal layers about one-half inch apart, being separated by small pieces of glass. Samples were also exposed in glass tubes four feet long. Observations on the reduction in color of the water near the top and at the bottom of the tubes were made. No increased reduction of color was noticed in either case due to sedimentation.

From an examination of the results of all of the experiments that had been made, it did not appear that the sediment in the samples exposed to sunlight was any greater than in the samples kept in the dark.

It was thought that the reduction of color in the samples exposed to sunlight might be due to a chemical change going on, caused either by the action of bacteria or by the actinic rays of the sun's light.

That the reduction was due to the action of bacteria did not seem probable, for in several cases examinations were made, and the results always showed that the organisms and bacteria died out in the samples exposed to sunlight and in the samples kept in the dark.

An experiment made to see if the reduction in color was due to chemical action, due to the actinic rays of the sun's light, was arranged as follows:

Samples of water from the same source were exposed to sunlight in bottles of different colored glass, companion samples being kept in the dark.

The colors of the bottles used were white, blue, yellow, and red. The experiments were continued for two months. From the means of these given in Table IV. it appears that the color of the water was reduced the most in the white and blue bottles, being about the same in both cases. The reduction of color of the water in the yellow and red bottles was only about one-half as much, showing that the blue or actinic rays were the most effective in reducing the color.

In what way the sun's rays produce the reduction in the color of a water is unknown. Downes and Blunt[1] found that the action of sunlight entirely prevented the development of bacteria under favorable conditions, and that the red and orange-red rays delayed their development, while the blue and violet rays entirely prevented their growth. They explain this action of light as due to the gradual process of oxidation, which is induced by the sun's rays in the presence of oxygen. It is possible some similar action takes place in the reduction of color by the sun's rays.

The depth below the surface of a pond at which the sun's action would be effective in reducing the color of the water has not been investigated, but it would undoubtedly vary with the character of the water.

CONCLUSION.

From the foregoing experiments the following conclusions have been drawn:

The color of waters such as we have been considering can be entirely removed by sufficient exposure to sunlight.

The action is influenced but slightly, if at all, by increase in temperature.

Sedimentation does not increase the action to any appreciable extent.

The amount of reduction in the color of a given water is the same per 100 hours of sunlight at all seasons of the year.

The amount of the reduction varies almost directly with the amount of color present in the water.

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[1] "Micro-Organisms in Water," by P. and G. C. Frankland, 1894.

TABLE I.—Water Analyses. Boston Water Works.

PARTS IN 100,000.

Locality.	Date of Collection.	Date of Examination.	[1] Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Residue on Evaporation. Change on Ignition.	Chlorine.	Nitrogen. Albuminoid Ammonia. Unfiltered.	Nitrogen. Albuminoid Ammonia. Filtered.	Nitrogen. Free Ammonia.	Nitrogen. As Nitrites.	Nitrogen. As Nitrates.	Oxygen consumed.	Hardness.	Remarks.
	18	90.	N.W													
Tap at Filter Station	Nov. 25	Nov. 25	.42	5.30	1.35	3.95	Blackens, strong peaty odor.	.459	.0152	.0150	.0008	.0002	.0230	.54	2.13	Original sample.
" " " "	Nov. 26	1891. June 28	.40	.....	.....	.....	....	......	.0122	......	.0002	.0004	.0300	.47	1.90	Kept in dark.
" " " "	Nov. 26	June 28	.00	.....	....	.....	....	.....	.0202	......	.0034	.0007	.0050	.70	1.89	Exposed to 800 hours' bright sunlight.
	18	91.														
" " " "	July 17	July 17	.30	.....	.....	.....	....	[2].0363	.0162	.0154	.0000	.0001	.0200	.51	1.69	Original sample.
" " " "	July 17	Aug. 18	.31	4.55	1.25	3.30	Blackens.	......	0.130	.0106	.0000	.0000	.0150	.51	1.56	Kept in dark 1 month.
" " " "	July 17	Aug. 18	.03	.....	.....	.....	....	......	.0128	.0128	.0004	.0001	.0120	.35	1.76	Exposed to 238 hours' bright sunlight.
" " " "	July 17	Sept. 18	.30	.....	.....	.....	....	......	.0098	.0090	.0002	.0002	.0250	.39	1.63	Kept in dark 2 months.
" " " "	July 17	Sept. 18	.00	.....	.....	.....	....	......	.0136	.0124	.0008	.0003	.0150	.25	1.69	Exposed to 420 hours' bright sunlight.
" " " "	July 17	Oct. 16	.30	.....	.....	.....	....	......	.0098	......	.0002	.0004	.0210	.36	.....	Kept in dark 3 months.
" " " "	July 17	Oct. 16	.00	.....	.....	.....	....	......	.0144	......	.0000	.0000	.0000	.29	.....	Exposed to 573 hours' bright sunlight.
	18	92.														
" " " "	July 17	April 15	.25	.....	.....	.....	....	[2].0356	.0102	.0072	.0004	.0000	.0250	.36	....	Kept in dark, mixture of above samples.
" " " "	July 17	April 15	.00	.....	.....	... .	....	[2].0370	.0142	.0110	.0176	.0022	.0030	.17	.....	Exposed to sunlight, mixture above samples.
	18	91.														
Lake Cochituate bottom, 55 feet deep...............	Oct. 24	Oct. 27	4.00	9.85	3.40	6.45	Blackens, strong peaty odor	......	.0352	.0250	.0880	.0003	.0000	1.12	2.20	Original sample.

TABLE I. — Water Analyses. Boston Water Works. — *Continued.*

Parts in 100,000.

Locality.	Date of Collection.	Date of Examination.	[1] Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Residue on Evaporation. Change on Ignition.	Chlorine.	Nitrogen. Albuminoid Ammonia. Unfiltered.	Nitrogen. Albuminoid Ammonia. Filtered.	Nitrogen. Free Ammonia.	Nitrogen. As Nitrites.	Nitrogen. As Nitrates.	Oxygen consumed.	Hardness.	Remarks.
		1892.														
Lake Cochituate bottom, 55 feet deep	Oct. 24	Mar. 29	.02	[3] 12.90	[3] 4.80	[3] 8.10	Blackens, peaty and disagreeable odor.	......	.0700	.0168	.0008	.0005	.0020	[3] 1.53	1.90	Exposed to 543 hours' bright sunlight.
				[4] 6.25	[4] 1.60	[4] 4.65	Slight blackening and odor	......	......	......	......	......	......	[4] .38	.....	
	1894.		P &C													
Cochituate Influent	July 31	Aug. 1	.25	.....	.....	.....	.....	......	.0152	.0134	.0000	.0001	.0100	.42	.....	Original sample.
" "	July 31	Sept. 5	.22	.....	.....	.....	.....	......	.0106	.0090	.0000	.0000	.0150	.33	.....	Kept in dark 1 month.
" "	July 31	Sept. 5	.12	.....	.....	.....	.....	......	.0136	.0112	.0014	.0000	0110	.31	.....	Exposed to 258 hours' bright sunlight.
Sudbury Influent	July 31	Aug. 1	.79	.....	.....	.....	.....	......	.0208	.0160	.0010	.0000	.0050	.76	.....	Original.
" "	July 31	Sept. 5	.62	.....	.....	.....	.....	......	.0166	.0138	.0000	.0000	.0120	.67	.....	Kept in dark 1 month.
" "	July 31	Sept. 5	.32	.....	.....	.....	.....	......	.0182	.0160	.0038	.0000	.0070	.54	.....	Exposed to 258 hours' bright sunlight.
Mixture of Coch. and Sud.	July 31	Aug. 1	.60	.....	.....	.....	.....	......	.0198	.0170	.0010	.0001	.0080	.67	.....	Original.
" " " "	July 31	Sept. 5	.53	.....	.....	.....	.....	......	.0146	.0138	.0000	.0000	.0150	.61	.....	Kept in dark 1 month.
" " " "	July 31	Sept. 5	.24	.....	.....	.....	.....	......	.0170	.0158	.0036	.0000	.0120	.49	.....	Exposed to 258 hours' bright sunlight.

[1] The colors of Nos. 1–14, inclusive, were measured by the Nessler scale. [2] Total Nitrogen. [3] Unfiltered. [4] Filtered.

Note. — Analyses of samples, August 18 to October 16, inclusive, were of the clear portion only, from which all growths and sediment were excluded. The analyses of April 15 were made after the sediment had been mixed with the supernatant liquid.

TABLE II. — Effect of Sunlight, Monthly.

COCHITUATE AQUEDUCT WATER.

Month.	Total Hours.	Hours of Daylight.	Hours of Bright Sunlight.	Sunlight in per cent. of Daylight.	Kept in the Dark.				Exposed to Sunlight.				Difference between Column 13 and Column 9.	Reduction per 100 hours of Daylight.	Reduction per 100 hours of Bright Sunlight.
					Average temperature, Fahr.	Original Color.	Final Color.	Reduction of Color.	Average temperature, Fahr.	Original Color.	Final Color.	Reduction of Color.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1892.															
August 2–31	720	416	174	42	72.7	.22	.16	.06	109.4	.22	.09	.13	.07	.017	.040
September 2–29	672	349	220	63	61.9	.19	.16	.03	97.5	.19	.10	.09	.06	.017	.027
October 1–31	744	340	158	46	57.4	.19	.15	.04	77.0	.19	.10	.09	.05	.015	.032
November 1–30	720	294	93	32	57.2	.20	.16	.04	68.0	.20	.10	.10	.06	.020	.065
December 2–31	720	274	138	50	74.2	.25	.21	.04	61.1	.25	.20	.05	.01	.004	.007
1893.															
January 2–31	720	285	111	39	....	....	....	....	....	....	....	....	....	....	....
February 2–28	648	285	97	34	71.6	.24	.22	.02	71.6	.24	.17	.07	.05	.018	.052
March 2–30	696	344	135	39	63.6	.32	.22	.10	62.2	.32	.11	.21	.11	.032	.081
April 1–29	696	387	154	40	64.0	.23	.22	.01	80.5	.23	.07	.16	.15	.039	.097
May 1–31	744	453	203	45	66.5	.27	.22	.05	97.2	.27	.07	.20	.15	.033	.074
June 1–29	696	441	228	52	68.0	.26	.21	.05	95.7	.26	.09	.17	.12	.027	.053
July 1–31	744	462	310	67	73.6	.22	.21	.01	112.9	.22	.08	.14	.13	.028	.042
Means	....	....	....	....	66.4	.23	.19	.04	84.8	.24	.11	.13	.09	.023	.052

TABLE II. — Effect of Sunlight, Monthly. — *Continued.*

TERMINAL CHAMBER WATER.

Month.	Total Hours.	Hours of Daylight.	Hours of Bright Sunlight.	Sunlight in per cent. of Daylight.	Kept in the Dark. Average temperature, Fahr.	Kept in the Dark. Original Color.	Kept in the Dark. Final Color.	Kept in the Dark. Reduction of Color.	Exposed to Sunlight. Average temperature, Fahr.	Exposed to Sunlight. Original Color.	Exposed to Sunlight. Final Color.	Exposed to Sunlight. Reduction of Color.	Difference between Column 13 and Column 9.	Reduction per 100 hours of Daylight.	Reduction per 100 hours of Bright Sunlight.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1892.															
August 2-31	720	416	174	42	73.0	.65	.55	.10	109.1	.65	.27	.38	.28	.067	.161
September 2-29	672	349	220	63	61.7	.47	.37	.10	99.0	.47	.21	.26	.16	.046	.073
October 1-31	744	340	158	46	52.2	.65	.52	.13	79.5	.65	.32	.33	.20	.059	.127
November 1-30	720	294	93	32	57.3	.52	.40	.12	67.5	.52	.26	.26	.14	.048	.151
December 2-31	720	274	138	50	74.2	1.12	1.12	....	62.5	1.10	.90	.22	.22	.080	.159
1893.															
January 2-31	720	285	111	39	59.6	1.10	.72	.38	60.9	1.10	.65	.45	.07	.025	.063
February 2-28	648	285	97	34	70.3	1.10	.75	.35	70.8	1.10	.48	.62	.27	.095	.278
March 2-30	696	344	135	39	64.1	.77	.51	.26	61.2	.77	.27	.50	.24	.070	.178
April 1-29	696	387	154	40	63.1	.48	.47	.01	78.1	.48	.23	.25	.24	.062	.156
May 1-31	744	453	203	45	66.8	.67	.65	.02	97.7	.67	.27	.40	.38	.084	.187
June 1-29	696	441	228	52	68.1	1.05	.80	.25	94.9	1.05	.39	.66	.41	.093	.180
July 1-31	744	462	310	67	73.4	.84	.78	.06	111.0	.84	.28	.56	.50	.108	.161
Means	......	......	......	......	65.3	.79	.64	.15	82.7	.79	.38	.41	.26	.070	.156

CHESTNUT HILL RESERVOIR WATER.

1892.																	
August 2–31	720	416	174	42	72.9	.43	.36	.07	108.5	.43	.24	.19	.12	.029	.069
September 2–29	672	349	220	63	62.4	.43	.29	.14	99.2	.43	.18	.25	.11	.032	.050
October 1–31	744	340	158	46	57.6	.43	.33	.10	78.1	.43	.23	.20	.10	.029	.063
November 1–30	720	294	93	32	57.2	.37	.32	.05	67.9	.37	.22	.15	.10	.034	.108
December 2–31	720	274	138	50	74.9	.44	.41	.03	62.1	.44	.33	.11	.08	.029	.058
1893.																	
January 2–31	720	285	111	39	57.8	.85	.72	.13	58.6	.85	.60	.25	.12	.042	.108
February 2–28	648	285	97	34	69.9	.70	.70	....	71.4	.70	.48	.22	.22	.077	.227
March 2–30	696	314	135	39	63.8	.65	.43	.22	62.3	.65	.31	.34	.12	.035	.089
April 1–29	696	387	154	40	63.7	.39	.39	....	80.7	.39	.21	.18	.18	.047	.117
May 1–31	744	453	203	45	66.8	.48	.42	.06	96.4	.48	.15	.33	.27	.060	.133
June 1–29	696	441	228	52	67.7	.55	.48	.07	95.3	.55	.16	.39	.32	.073	.140
July 1–31	744	462	310	67	73.8	.59	.56	.03	113.3	.59	.14	.45	.42	.091	.135
Means	....	....	....	....	65.7	.53	.45	.08	82.8	.53	.27	.26	.18	.048	.108

TABLE III.—Effect of Sunlight on Water before and after Filtration.

Months. 1892.	Total Hours.	Hours of Daylight.	Hours Bright Sunlight.	Sunlight in p.c. of Daylight.	Kept in the Dark. Average Temperature. Fahr.	Kept in the Dark. Original Color.	Kept in the Dark. Final Color.	Kept in the Dark. Reduction of Color.	Exposed to Sunlight. Average Temperature. Fahr.	Exposed to Sunlight. Original Color.	Exposed to Sunlight. Final Color.	Exposed to Sunlight. Reduction of Color.	Difference, Column 13 and Column 9.	Reduction per 100 Hours Daylight.	Reduction per 100 Hours Bright Sunlight.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Unfiltered Water.															
June 25 to July 27	768	478	257	54	72.9	0.38	0.37	0.01	120.9	0.38	0.17	0.21	0.20	.042	.078
August 6 to September 1	600	347	158	46	71.5	0.43	0.38	0.05	81.0	0.43	0.16	0.27	0.22	.063	.139
September 8 to November 4	1,368	654	359	55	61.5	0.36	0.27	0.09	77.6	0.36	0.10	0.26	0.17	.026	.047
Tank No. 2. Effluent. (Continuously Filtered)															
June 25 to July 27	768	478	257	54	73.1	0.22	0.22	0.00	118.0	0.22	0.10	0.12	0.12	.025	.047
Tank No. 4. Effluent. (Intermittently Filtered)															
June 25 to July 27	768	478	257	54	72.7	0.19	0.22	— 0.03	117.4	0.19	0.08	0.11	0.14	.029	.054
Tank No. 5. Effluent. (Continuously Filtered)															
June 25 to July 27	768	478	257	54	73.0	0.23	0.23	0.00	116.3	0.23	0.11	0.12	0.12	.025	.047
Tank No. 3. Effluent. (Continuously Filtered)															
August 6 to September 1	600	347	158	46	71.2	0.23	0.27	— 0.04	80.7	0.23	0.11	0.12	0.16	.041	.101
September 8 to November 4	1,368	654	359	55	61.4	0.23	0.22	0.01	77.5	0.23	0.17	0.06	0.05	.008	.014
Tank No. 6. Effluent. (Intermittently Filtered)															
June 25 to July 27	768	478	257	54	73.2	0.23	0.26	— 0.03	116.6	0.23	0.12	0.11	0.14	.029	.058
August 6 to September 1	600	347	158	46	71.0	0.22	0.23	0.01	79.6	0.22	0.11	0.11	0.10	.034	.063
September 8 to November 4	1,368	654	359	55	62.0	0.19	0.22	— 0.03	76.8	0.19	0.12	0.07	0.10	.017	.028

TABLE IV.—Effect of Sunlight on Water exposed in Colored Bottles.

Months. 1893.	Total Hours.	Hours of Daylight.	Hours Bright Sunlight.	Sunlight in p.c. of Daylight.	Kept in Dark. Average Temperature. Fahr.	Kept in Dark. Original Color.	Kept in Dark. Final Color.	Kept in Dark. Reduction of Color.	Exposed to Sunlight. Average Temperature. Fahr.	Exposed to Sunlight. Original Color.	Exposed to Sunlight. Final Color.	Exposed to Sunlight. Reduction of Color.	Difference, Column 13 and Column 9.	Reduction per 100 Hours Daylight.	Reduction per 100 Hours Bright Sunlight.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
White Bottle.															
June 1 to June 29	696	441	228	52	68.1	1.05	0.80	0.25	94.9	1.05	0.39	0.66	0.41	.093	.180
June 30 to July 31	744	463	312	67	73.6	0.85	0.75	0.10	92.3	0.85	0.19	0.66	0.56	.121	.179
														Mean ..	.180
Blue Bottle.															
June 2 to June 29	672	426	210	49	68.1	1.02	0.88	0.14	80.1	1.02	0.39	0.63	0.49	.115	.233
June 30 to July 31	744	463	312	67	73.6	0.84	0.72	0.12	95.2	0.85	0.24	0.61	0.49	.106	.157
														Mean ..	.195
Yellow Bottle.															
June 2 to June 29	672	426	210	49	67.7	1.02	0.87	0.15	80.0	1.02	0.58	0.44	0.29	.068	.138
June 30 to July 31	744	463	312	67	74.0	0.84	0.72	0.12	95.0	0.85	0.46	0.39	0.27	.058	.087
														Mean ..	.112
Red Bottle.															
June 2 to June 29	672	426	210	49	68.1	1.05	0.80	0.25	81.4	1.02	0.54	0.48	0.23	.054	.110
June 30 to July 31	744	463	312	67	73.6	0.84	0.72	0.12	95.7	0.85	0.47	0.38	0.26	.056	.083
														Mean ..	.097

Quality of the Water.

The water in Boston has been excellent in quality throughout the year. In December the tap water had a somewhat disagreeable, oily taste, due to Synura, Asterionella, and Anabæna (sterile form), which all came from Lake Cochituate, but on the average the number of organisms found in the water has been unusually low.

The following tables give, first, the average condition of the water as delivered to the consumer, and then means of monthly analyses of different parts of the sources of supply. They afford a ready means of comparison with the condition of the water as given in the last annual report.

The other tables contain the results of examinations made at the biological laboratory, a table for changing colors from the Nessler to the platinum standard, and a table of annual expenditures and rainfall.

Very truly yours,

Desmond FitzGerald,
Resident Engineer and Superintendent.

Average condition of Tap Water, Boston, 1894. Thomas M. Drown, M.D.

PARTS IN 100,000.

Locality.	Color.	Residue on Evaporation.			Chlorine.	Nitrogen.					Oxygen Consumed.	Hardness.	Iron.	Remarks.
						Albuminoid Ammonia.								
		Total.	Loss on Ignition.	Fixed.		Unfiltered.	Filtered.	Free Ammonia.	As Nitrites.	As Nitrates.				
Service-pipe, Mass. Inst. of Technology .	[1] 0.69	4.64	1.83	2.81	0.41	.0169	.0150	.0006	.0001	.0106	0.6295	1.7	.0147	Averages of monthly analyses.

[1] = 0.57 Boston Water-Works Standard [Platinum, Cobalt).

Averages of Monthly Analyses, January 1 to December 31, 1894, by Thomas M. Drown, M.D.

Parts in 100,000.

Locality.	Color.	Residue on Evaporation.			Chlorine.	Nitrogen.					Oxygen Consumed.	Hardness.	Iron.	Remarks.
		Total.	Loss on Ignition.	Fixed.		Albuminoid Ammonia. Unfiltered.	Albuminoid Ammonia. Filtered.	Free Ammonia.	As Nitrites.	As Nitrates.				
Reservoir No, 2, influent	1.31	4.67	2.17	2.51	0.34	.0231	.0210	.0007	.0001	.0059	1.0566	1.2	.0173	
Reservoir No. 2, near outlet	1.12	4.36	2.05	2.31	0.33	.0216	.0192	.0008	.0000	.0057	0.9268	1.3	.0205	
Reservoir No. 3, influent	1.31	6.41	2.64	3.77	0.49	[1] .0302	.0249	.0023	.0001	.0151	1.0533	2.0	.0237	[1] Swamps flooded Basin 5.
Reservoir No. 3, near outlet	0.96	5.48	2.20	3.28	0.41	.0265	.0231	.0018	.0001	.0105	0.8692	1.9	.0152	
Reservoir No. 4, influent	1.44	4.93	2.42	2.52	0.32	.0237	.0214	.0006	.0000	.0042	1.2054	1.3	.0146	
Reservoir No. 4, near outlet	.81	4.14	1.86	2.27	0.29	.0212	.0189	.0025	.0001	.0043	0.8648	1.1	.0126	
Reservoir No. 6, influent	2.11	6.57	3.29	3.28	0.55	.0317	.0294	.0014	.0000	.0020	1.6692	1.6	.0255	
Reservoir No. 6, near outlet, surface . .	0.72	3.85	1.53	2.31	0.38	.0184	.0158	.0013	.0000	.0039	0.6945	1.1	.0165	Surface means 1 foot below surface.
Reservoir No. 6, near outlet, bottom . .	1.00	4.08	1.73	2.35	0.37	.0175	.0148	.0081	.0003	.0026	0.6724	1.1	.0575	
Lake Cochituate, gate-house	0.20	4.76	1.59	3.17	0.51	.0163	.0137	.0008	.0001	.0070	0.3699	2.0	.0077	
Service-pipe, Mass. Inst. Tech., Boston .	0.69	4.64	1.83	2.81	0.41	.0169	.0150	.0006	.0001	.0106	0.6295	1.7	.0147	
Mystic Lake	0.11	15.60	2.53	13.07	3.48	.0235	.0168	.0381	.0012	.0582	0.2608	5.2	.0099	Mystic Supply.

Lake Cochituate, 1894.

Month.	* Organisms.				Amorphous.				Remarks.	
	Sur.	Mid.	Bot.	Mean.	Sur.	Mid.	Bot.	Mean.		
January	300	295	288	294	330	336	450	372	Diatomaceæ.	
February	114	247	238	200	254	320	409	328	Diatomaceæ.	
March	139	164	172	158	260	305	563	376	Diatomaceæ.	Asterionella. Melosira. Tabellaria.
April	610	545	561	572	322	385	326	344	Diatomaceæ. Infusoria.	
May	775	645	460	627	149	242	208	200	Diatomaceæ.	Tabellaria. Asterionella. Stephanodiscus.
June	388	179	127	231	147	154	250	184	Diatomaceæ. Chlorophyceæ. Cyanophyceæ.	
July	121	235	161	172	153	212	663	343	Chlorophyceæ. Cyanophyceæ.	
August	206	141	72	140	189	194	3,110	1,164	Chlorophyceæ. Cyanophyceæ.	
September	186	228	309	241	192	356	3,980	1,509	Cyanophyceæ.	
October	553	378	159	363	335	372	1,592	766	Cyanophyceæ. Diatomaceæ.	
November	652	542	470	555	474	322	279	358	Diatomaceæ. Cyanophyceæ. Infusoria.	Asterionella. Tabellaria.
December	951	784	688	808	293	305	380	326	Diatomaceæ. Cyanophyceæ. Infusoria.	Asterionella. Tabellaria.
Mean	416	365	309	363	258	292	1,018	523		

* Standard units per c. c.

Basin 2, 1894.

Month.	Organisms.					Amorphous.					Remarks.
	Sur.	Mid.	Bot.	Mean.	Influent.	Sur.	Mid.	Bot.	Mean.	Influent.	
January	18	10	6	11	9	332	366	400	366	216	
February	15	9	9	11	25	148	183	195	175	195	
March	18	11	10	13	13	212	174	192	193	183	
April	13	22	24	20	18	179	189	202	190	155	
May	51	81	56	63	32	193	193	232	206	202	Infusoria. Diatomaceæ.
June	59	99	17	58	45	204	210	329	248	221	Infusoria. Cyanophyceæ.
July	110	105	61	92	47	334	399	332	355	193	Infusoria. Cyanophyceæ. Chlorophyceæ.
August	77	64	40	60	18	446	416	398	420	268	Infusoria. Chlorophyceæ.
September	88	78	73	80	43	549	760	1,153	821	576	Diatomaceæ.
October	54	48	63	55	28	312	486	631	476	372	Infusoria. Diatomaceæ.
November	27	45	26	33	9	282	257	318	286	248	Infusoria.
December	10	12	13	12	1	138	268	339	248	138	
Mean	45	49	33	42	24	277	325	393	332	247	

Basin 3, 1894.

Month.	Organisms.					Amorphous.					Remarks.
	Sur.	Mid.	Bot.	Mean.	Influent.	Sur.	Mid.	Bot.	Mean.	Influent.	
January	84	23	16	41	22	253	249	299	267	171	Infusoria.
February	16	11	6	11	24	170	169	164	168	183	
March	23	9	20	17	20	212	225	265	234	210	
April	156	165	136	152	36	188	233	202	208	125	Diatomaceæ. Infusoria.
May	25	108	106	113	19	188	221	329	246	335	Diatomaceæ. Infusoria.
June	59	53	15	42	76	189	200	274	221	327	Infusoria.
July	134	120	76	110	206	222	178	274	225	892	Infusoria. Chlorophyceæ.
August	183	110	131	141	126	283	254	278	272	756	Cyanophyceæ. Chlorophyceæ.
September	1,074	312	250	545	186	527	685	963	725	1,047	Cyanophyceæ. Diatomaceæ. Chlorophyceæ.
October	636	474	417	509	96	544	508	528	527	429	Cyanophyceæ. Diatomaceæ. Infusoria.
November	622	640	611	622	14	473	464	438	458	138	Diatomaceæ. Cyanophyceæ.
December	348	303	364	338	6	190	164	186	180	206	Diatomaceæ.
Mean	289	194	179	220	69	286	296	350	311	393	

Basin 4, 1894.

Month.	Organisms.					Amorphous.					Remarks.
	Sur.	Mid.	Bot.	Mean.	Influent.	Sur.	Mid.	Bot.	Mean.	Influent.	
January	16	7	5	9	11	403	413	447	421	170	
February	7	9	9	8	11	189	137	142	156	93	
March	12	11	8	10	96	205	238	211	218	109	
April	42	24	25	30	13	216	180	158	185	88	Infusoria.
May	24	16	8	16	9	253	167	145	188	157	
June	23	11	3	12	4	165	99	119	128	177	
July	28	7	7	14	5	123	113	105	113	147	
August	11	7	12	10	15	176	177	164	172	146	
September	68	61	66	65	44	236	273	360	290	334	Chlorophyceæ. Infusoria. Diatomaceæ.
October	50	43	65	53	18	297	240	248	262	110	Infusoria.
November	32	29	17	26	13	228	239	346	271	142	
December	26	14	19	20	9	239	248	222	236	130	
Mean	28	20	20	23	21	228	210	222	220	147	

Basin 6, 1894.

MONTH.	ORGANISMS.					AMORPHOUS.					REMARKS.
	Sur.	Mid.	Bot.	Mean.	Influent.	Sur.	Mid.	Bot.	Mean.	Influent.	
January	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
February	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
March	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
April	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
May	195	83	65	114	55	157	187	155	166	110	Infusoria. Diatomaceae.
June	129	40	40	70	8	219	271	341	277	148	Infusoria.
July	28	12	68	36	2	169	280	278	242	134	
August	27	8	215	83	6	180	329	493	334	211	
September	85	91	14	63	134	590	827	1,198	872	1,011	Diatomaceæ. Infusoria.
October	100	85	91	92	19	734	837	1,068	880	172	Diatomaceæ. Infusoria.
November	65	41	43	50	11	372	235	302	303	138	Diatomaceæ. Infusoria.
December	63	58	38	53	4	177	193	243	204	145	Infusoria. Diatomaceæ.
Mean	87	52	72	70	28	304	395	510	410	238	

MONTH.	CHESTNUT HILL RESERVOIR.						BROOKLINE GATE-HOUSE.		TAPS IN CITY.			
	Organisms.			Amorphous.					Organisms.		Amorphous.	
	Sudbury.	Cochituate.	Effluent.	Sudbury.	Cochituate.	Effluent.	Organisms.	Amorphous.	Park Sq.	Mattapan.	Park Sq.	Mattapan.
January	14	243	71	214	266	245	117	239	60	25	182	117
February	25	144	71	186	232	192	84	182	50	27	157	128
March	21	143	54	206	304	218	84	184	38	13	166	70
April	78	548	182	194	266	206	210	171	152	92	169	103
May	33	654	165	258	191	261	294	183	126	76	170	75
June	34	305	199	314	133	161	269	194	137	72	197	154
July	98	95	216	491	196	288	220	226	125	48	224	101
August	57	96	143	375	219	269	118	295	71	29	253	152
September	106	165	242	645	267	324	176	380	155	85	273	130
October	63	607	204	543	261	269	217	251	173	83	235	118
November	130	618	103	356	309	222	195	259	84	71	153	113
December	200	888	197	246	258	225	482	202	196	269	164	194
Mean	72	376	154	336	242	240	206	231	114	74	195	121

Temperatures (Fahrenheit), 1894.

Month.	Lake Cochituate.			Basin 2.			Basin 3.			Basin 4.			Basin 6.		
	Sur.	Mid.	Bot.	Sur.	Mid.	Bot.	Sur.	Mid.	Bot.	Sur.	Mid.	Bot.	Sur.	Mid.	Bot.
Januuary	35.1	36.7	37.6	33.2	33.7	34.7	33.0	34.3	36.0	33.3	33.7	34.1	....	....	....
February	35.9	37.2	37.8	33.0	34.3	35.2	33.1	34.7	36.5	33.3	34.0	35.5	....	....	....
March	39.7	39.7	40.1	40.0	40.5	41.0	38.9	40.1	41.1	39.5	39.5	39.8	....	....	....
April	46.8	42.7	41.4	47.6	47.6	47.6	46.2	46.2	46.5	48.1	45.5	44.3	....	....	....
May	61.5	45.1	41.7	63.8	62.1	61.0	61.7	60.4	58.5	60.3	55.8	48.0	60.8	56.5	47.9
June	70.8	48.9	42.4	73.0	70.6	66.4	70.9	69.4	63.3	70.4	62.0	51.7	71.7	60.0	51.7
July	77.7	47.6	42.7	78.5	75.7	74.8	77.0	74.0	69.6	77.2	61.9	52.5	79.0	57.7	52.0
August	73.2	47.7	43.0	72.9	72.3	71.1	71.9	71.1	69.6	72.5	58.8	52.0	74.0	59.8	52.8
September	68.1	46.7	42.9	67.9	67.6	67.4	69.3	68.9	68.3	68.8	66.6	64.8	69.8	65.0	54.0
October	55.8	48.6	43.2	54.5	54.6	54.6	55.6	55.8	56.0	56.0	55.8	55.8	58.0	58.0	56.5
November	43.4	43.5	44.7	38.2	38.8	38.6	41.2	40.4	41.2	42.1	41.8	41.6	42.3	42.0	41.8
December	37.3	37.5	39.0	35.0	35.2	35.3	35.4	34.9	31.1	37.0	37.1	37.1	35.0	35.5	35.5
Mean	53.8	43.6	41.4	53.1	52.8	52.3	52.9	52.5	51.8	53.2	49.4	46.4	....	....	....

Temperatures (Fahrenheit), 1894.

Month.	Chestnut Hill Reservoir Gate-Houses.			Chestnut Hill Reservoir.			Brookline Gate-House.	Taps.	
	Sudbury.	Cochituate.	Effluent.	Surface.	Middle.	Bottom.		Park Sq.	Mattapan.
January	35.8	38.3	37.1	36.8	36.8	37.1	37.2	41.3	39.6
February	35.6	37.6	36.3	. . .	. . .	. . .	36.8	37.0	38.1
March	40.0	41.2	41.1	42.5	42.7	43.0	41.0	41.9	38.9
April	45.7	46.1	45.2	45.9	44.7	44.7	45.4	46.4	43.1
May	60.4	59.9	59.9	61.1	60.3	56.4	60.6	59.3	51.1
June	66.0	65.9	64.9	70.2	67.1	62.1	66.4	66.3	57.7
July	73.6	75.3	73.3	77.5	73.8	60.6	75.1	73.6	63.9
August	71.9	72.8	72.5	73.3	72.0	65.6	72.9	72.4	66.3
September	67.5	69.1	68.9	69.3	68.2	67.1	68.7	69.3	63.0
October	56.5	57.6	57.4	57.3	57.2	57.1	57.4	58.0	59.2
November	43.6	45.6	43.8	43.5	44.0	43.8	44.1	46.4	50.6
December	36.9	37.9	36.0	. . .	. . .	. . .	37.6	38.7	42.8
Mean	52.8	53.9	53.0	54.2	53.5	51.1	53.6	54.2	51.2

Colors, 1894. (Platinum.)

Month.	Lake Cochituate.					Basin 2.					Basin 3.					Basin 4.					Basin 6.				
	Sur.	Mid.	Bot.	Mean.	Influent.	Sur.	Mid.	Bot.	Mean.	Influent.	Sur.	Mid.	Bot.	Mean.	Influent.	Sur.	Mid.	Bot.	Mean.	Influent.	Sur.	Mid.	Bot.	Mean.	Influent.
January	.23	.25	.30	.26	.67	.92	.92	.91	.92	.86	.71	.72	.70	.71	.82	.92	.94	.93	.93	.99	..	..	..	..	..
February	.22	.24	.28	.25	.59	.73	.75	.76	.75	.76	.71	.71	.73	.72	.79	.80	.81	.81	.81	.88	..	..	..	..	..
March	.21	.28	.30	.26	.65	.77	.76	.76	.76	.82	.63	.66	.66	.65	.85	.77	.77	.79	.78	.96	..	..	..	..	..
April	.28	.30	.30	.29	.84	.77	.77	.78	.77	.87	.71	.71	.72	.71	.92	.72	.73	.74	.73	.93	..	..	..	..	..
May	.27	.28	.30	.28	1.04	.95	.96	.98	.96	1.25	.81	.78	.78	.79	1.45	.74	.74	.74	.74	1.42	.73	.72	.72	.72	1.80
June	.26	.26	.52	.35	.70	1.18	1.20	1.18	1.19	1.20	1.02	1.05	1.01	1.03	1.60	.77	.78	.70	.75	1.59	.78	.79	.76	.78	2.00
July	.26	.27	1.01	.51	.62	.85	.83	.84	.84	.87	.90	.90	.88	.89	1.09	.70	.74	.71	.72	.98	.75	.76	.82	.78	1.52
August	.25	.26	1.37	.63	.31	.76	.75	.79	.77	1.02	.76	.78	.79	.78	1.16	.69	.67	.66	.67	.75	.58	.76	1.16	.83	1.17
September	.25	.29	1.25	.59	.40	.80	.82	.79	.80	.91	.71	.71	.71	.71	.85	.57	.58	.59	.58	.60	.53	.61	1.44	.86	1.12
October	.24	.25	1.02	.50	.71	.75	.75	.76	.75	.77	.71	.72	.71	.71	.84	.53	.52	.52	.52	.69	.48	.49	.50	.49	1.04
November	.34	.34	.37	.35	.58	1.07	1.09	1.07	1.08	1.15	.73	.72	.70	.72	1.21	.54	.54	.54	.54	1.44	.45	.47	.47	.46	1.40
December	.33	.33	.36	.34	.58	1.11	1.11	1.15	1.12	1.06	.85	.85	.85	.85	.92	.68	.69	.75	.71	1.20	.54	.55	.57	.55	1.39
Mean	.26	.28	.62	.38	.64	.89	.89	.90	.89	.96	.77	.77	.77	.77	1.0	.70	.71	.71	.71	1.04	.61	.64	.81	.69	1.39

Colors, 1894. (Platinum.)

Month.	Chestnut Hill Reservoir Gate-Houses.			Chestnut Hill Reservoir.			Brookline Gate-House.	Taps.	
	Sudbury.	Cochituate.	Effluent.	Surface.	Middle.	Bottom.		Park Sq.	Mattapan.
January	.83	.23	.64	.63	.63	.65	.56	.60	.57
February	.68	.23	.59	...	...	...	.50	.56	.50
March	.65	.27	.54	.55	.56	.56	.45	.54	.47
April	.72	.27	.53	.54	.55	.56	.45	.53	.45
May	.85	.26	.55	.55	.55	.55	.48	.54	.46
June	1.06	.27	.57	.62	.62	.56	.58	.59	.53
July	.87	.25	.65	.65	.67	.54	.59	.63	.56
August	.74	.25	.53	.53	.53	.75	.50	.51	.46
September	.76	.24	.54	.56	.55	.55	.54	.54	.48
October	.68	.26	.49	.51	.51	.50	.47	.49	.43
November	.94	.28	.58	.60	.58	.58	.49	.59	.51
December	.94	.31	.77	...	...	...	.60	.71	.64
Mean	.81	.26	.58	.58	.58	.58	.52	.57	.51

Bacteria, 1894.

Month.	Chestnut Hill Reservoir Gate-Houses.			Chestnut Hill Reservoir.			Brookline Gate-House.	Taps.	
	Sudbury.	Cochituate.	Effluent.	Surface.	Middle.	Bottom.		Park Square.	Mattapan.
January	294	20	97	81	168	236	52	73	54
February	436	141	148	. . .	. . .	. . .	70	42	84
March	137	74	110	48	101	110	40	32	30
April	48	22	76	25	77	50	57	32	72
May	54	58	71	152	260	298	47	30	107
June	65	248	90	36	180	187	80	157	92
July	789	1,553	1,080	169	647	650	164	46	80
August	26	192	221	100	569	701	83	102	65
September	65	192	219	69	152	432	64	109	60
October	95	387	242	38	181	225	126	29	42
November	85	161	228	48	120	299	37	50	30
December	49	44	124	. . .	. . .	. . .	17	27	22
Mean	179	258	226	77	246	319	70	61	62

Table for Transforming Color Readings from the "Nessler" to the "Platinum" Standard.

NATURAL WATER STANDARD.	0	.01	.02	.03	.04	.05	.06	.07	.08	.09
0	0	.02	.04	.06	.08	.09	.11	.13	.15	.17
.10	.18	.19	.20	.20	.21	.22	.23	.24	.24	.26
.20	.26	.27	.27	.28	.29	.29	.30	.31	.32	.32
.30	.33	.34	.34	.35	.35	.36	.37	.37	.38	.38
.40	.39	.40	.40	.41	.42	.42	.43	.44	.45	.45
.50	.46	.47	.47	.48	.48	.49	.50	.50	.51	.51
.60	.52	.53	.53	.54	.54	.55	.56	.56	.57	.57
.70	.58	.58	.59	.59	.60	.60	.61	.61	.62	.62
.80	.63	.64	.64	.65	.66	.66	.67	.68	.69	.69
.90	.70	.71	.72	.73	.74	.75	.77	.78	.79	.80
1.00	.81	.82	.82	.83	.84	.84	.85	.86	.87	.87
1.10	.88	.89	.89	.90	.91	.91	.92	.93	.94	.94
1.20	.95	.96	.96	.97	.98	.98	.99	1.00	1.01	1.01
1.30	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.08
1.40	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.15
1.50	1.16	1.17	1.17	1.18	1.18	1.19	1.20	1.20	1.21	1.21
1.60	1.22	1.23	1.23	1.24	1.25	1.25	1.26	1.27	1.28	1.28
1.70	1.29	1.30	1.30	1.31	1.32	1.32	1.33	1.34	1.35	1.36
1.80	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.41	1.42	1.42
1.90	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.48	1.49	1.49
2.00	1.50	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

Maintenance. — Western Division, February 1, 1894, to January 31, 1895.

Drafts.	Western Division.	Basins.	Sudbury Aqueduct.	Cochituate Aqueduct.	Lake Cochituate.	Pegan Filters.	Chestnut Hill Reservoir.	Chestnut Hill Driveway.	Brookline Reservoir.	Fisher Hill Reservoir.	Biological Dept.	Inspection Dept.	Filtration.	Totals.
January 1, 1894 . .	$298 71	$310 22	$202 59	$54 78	$560 60	$199 15	$980 89	$48 64	. . . . .	. . . . .	$82 57	$10 25	$253 16	$3,001 56
February 1, " . .	1,106 88	525 70	574 79	137 75	179 00	303 89	1,089 88	892 72	$127 75	$97 50	311 86	454 36	478 83	6,280 91
March 1, " . .	1,662 36	382 30	537 00	235 83	1,050 30	402 68	1,197 01	781 77	81 50	167 75	369 27	382 72	486 99	7,737 48
May 1, " . .	1,713 39	969 90	512 66	513 05	330 07	551 65	1,068 91	949 28	89 75	127 25	343 54	412 36	420 65	8,002 46
June 1, " . .	2,183 39	534 87	476 84	106 11	160 96	421 24	979 84	678 23	79 00	146 00	376 10	408 81	374 63	6,926 02
July 1, " . .	2,229 38	787 75	467 43	120 42	200 72	420 78	1,773 25	1,039 35	61 90	106 15	331 12	395 02	415 28	8,348 55
August 1, " . .	2,156 79	878 86	608 84	112 50	204 78	236 04	1,131 01	1,042 30	153 00	176 00	253 96	882 46	639 28	8,475 82
September 1, " .	2,023 39	600 86	548 83	191 84	268 38	264 45	939 63	1,620 83	33 25	69 75	289 73	392 76	410 36	7,654 06
October 1, " . .	2,506 26	415 41	693 79	136 56	287 26	514 71	1,901 22	1,137 92	164 75	172 00	384 05	471 55	450 16	9,235 64
November 1, " . .	1,784 67	416 61	514 77	268 21	485 75	7,941 44	995 78	883 69	81 47	288 95	314 35	369 92	400 81	14,746 42
December 1, " . .	2,363 82	463 25	490 31	322 36	1,937 83	307 04	1,155 31	1,288 87	163 85	461 30	268 54	514 94	249 47	9,986 89
January 1 and 31, 1895,	2,659 38	632 59	930 72	196 31	325 33	512 11	2,208 43	1,824 78	120 25	819 49	486 39	757 47	197 00	11,670 25
Totals	$22,688 42	$6,918 32	$6,558 57	$2,395 72	$5,990 98	$12,075 18	$15,421 16	$12,188 38	$1,156 47	$2,632 14	$3,811 48	$5,452 62	$4,776 62	$102,066 06

Table of Rainfall at Chestnut Hill Reservoir for Year ending December 31, 1894.

Date.	Inches.	Snow or Rain.	Duration.
Jan. 5	0.02	Rain.	11.45 a.m. to 6.30 p.m.
" 6	0.04	Snow.	6.30 p.m. to 11.45 p.m.
" 10	0.17	"	2.15 p.m. to 11.45 p.m.
" 15 " 16	0.30	Rain.	10.00 p.m. to 7.30 a.m.
" 18 " 19	0.14	"	10.00 p.m. to 7.00 a.m.
" 24 " 25	0.43	"	3.00 p.m. to 4.00 a.m.
" 26 " 27	1.30	Snow.	10.00 p.m. to 5.00 p.m.
" 29 " 30	1.50	Snow and Rain.	2.00 p.m. to 2.30 p m.
Total.	3.90		
Feb. 4 " 5	0.23	Snow.	2.30 p.m. to 2.30 a.m.
" 9 " 10	0.68	Snow and Rain.	12.45 p.m. to 1.15 p.m.
" 12 " 13	1.20	Snow.	4.25 p-m. to 3.30 p.m.
" 15	0.95	Snow and Rain.	1.30 a.m. to 4.00 p.m.
" 18	0.36	Rain.	5.00 a.m. to 2.30 p.m.
" 19 " 20	0.35	"	3.35 p.m. to 4.45 a.m.
" 26	0.04	Snow.	9.00 a.m. to 4.30 p.m.
Total.	3.81		
Mar. 14	0.12	Rain.	12.30 a.m. to 2.30 p.m.
" 15	0.15	Snow.	3.50 p.m. to 8.30 p.m.
" 21	0.04	Rain.	1.20 p.m. to 5.00 p.m.
" 22 " 23	0.57	"	6.15 p.m. to 2.00 p.m.
Mar. 25 " 26	0.04	Rain and Snow.	2.00 p.m. to 6.15 a.m.
" 29	0.22	Rain and Snow.	4.30 a.m. to 8.30 p.m.
Total.	1.14		
Apr. 4	0.43	Rain.	10.00 a.m. to 9.30 p.m.
" 6	0.02	"	9.25 a.m. to 3.00 p.m.
" 7 " 8 " 9	1.08	Snow.	10.30 p.m. to 1.30 p.m.
" 11 " 12 " 13 " 14	1.41	Snow and Rain.	7.00 p.m. to 8.00 a.m.
" 21	0.08	Rain.	11.40 a.m. to 5.30 p.m.
" 24	0.22	"	1.45 p.m. to 11.45 p.m.
Total.	3.24		
May 4	0.26	Rain.	5.30 p.m. to 11.30 p.m.
" 5 " 6	0.30	"	6.30 p.m. to 11.30 a.m.
" 19	0.65	"	12.05 a.m to 3.30 a.m.
" 20 " 21	0.07	"	6.00 a.m. to 3.30 p.m.
" 23 " 24	0.95	"	11.30 a.m. to 8.00 p.m.
" 25	0.05	"	6.00 p.m. to 7.30 p.m.
" 29	1.17	"	2.00 a.m. to 11.45 a.m.
" 31	0.82	"	2.45 a.m. to 11.50 p.m.
Total.	4.27		

Table of Rainfall at Chestnut Hill Reservoir. — *Concluded.*

Date.	Inches.	Snow or Rain.	Duration.	Date.	Inches.	Snow or Rain.	Duration.
June 2 / " 3	0.15	Rain.	6.40 p.m. to 3.00 a.m.	Oct. 4 / " 5	0.46	Rain.	4.00 a.m. to 7.30 a.m.
" 21	0.05	"	12.50 p.m. to 1.10 p.m.	" 9	0.31	"	2.00 a.m. to 7.30 a.m.
				" 10	1.72	"	5.30 a.m. to 5.00 p.m.
Total.	0.20			" 13 / " 14	1.32	"	12.30 p.m. to 3.30 a.m.
July 3 / " 3	0.13	Rain.	5.00 a.m. to 7.45 a.m. / 2.20 p.m. to 2.40 p.m.	" 25 / " 26	1.71	"	3.15 p.m. to 4.30 a.m.
" 14	0.07	"	12.40 p.m. to 1.00 p.m.	" 30 / " 31	0.52	"	8.30 a.m. to 5.00 p.m.
" 21	1.13	"	1.00 p.m. to 2.00 p.m.				
" 22	0.31	"	3.00 a.m. to 7.45 a.m.				
" 24	0.80	"	2.15 a.m. to 3.15 p.m,	Total.	6.04		
" 25	0.82	"	6.30 p.m. to 8.30 p.m.				
" 29	0.07	"	9.00 p.m. to 10.00 p.m.	Nov. 3	0.60	Rain.	7.45 a.m. to 12.50 p.m.
Total.	3.33			" 5 / " 6	1.43	Rain and Snow.	8.50 a.m. to 6.45 a.m.
				" 8	0.37	Snow.	11.15 a.m. to 8.00 p.m.
Aug. 3	0.12	Rain.	7.00 a.m. to 1.00 p.m.	" 9 / " 10	0.30	Snow and Rain.	1.30 p.m. to 10.30 a.m.
" 4	0.03	"	6.30 a.m. to 10.00 a.m.				
" 9	0.27	"	4.00 a.m. to 8.30 a.m.	" 14	0.17	Rain.	8.30 a.m. to 4.30 p.m.
" 9 / " 10	0.10	"	9.00 p.m. to 6.30 a.m.	" 17	0.11	"	10.30 a.m. to 4.15 p.m.
				" 21	0.21	"	8.45 a.m. to 7.30 p.m.
" 13	0 25	"	4.30 a.m. to 10.00 a.m.	" 25	0.12	Snow.	1.00 a.m. to 12.30 p.m.
" 14	0.10	"	5.00 a.m. to 7.15 a.m.	" 30	0.10	"	12.45 p.m. to 9.00 p.m.
" 20	1.40	"	11.50 a.m. to 4.30 p.m.				
				Total.	3.41		
Total.	2.27						
				Dec. 2	0.47	Snow.	8.15 a.m. to 6.45 p.m.
Sept. 6	0.05	Rain.	3.00 a.m. to 6.15 a.m.	" 8 / " 9	0.78	Snow and Rain.	12.30 p.m. to 11.30 p.m.
" 8	0.34	"	3.00 p.m. to 9.30 p.m.				
" 10	0.02	"	6.30 p.m. to 7.30 p.m.	" 11 / " 12	0.94	Snow and Rain.	8.00 a.m. to 7.30 p.m.
" 15	0.12	"	5.00 a.m. to 6.00 a.m.				
" 17	0.15	"	9.30 a.m. to 12.15 p.m.	" 25	0.22	Rain.	1.00 a.m. to 6.15 a.m.
" 19 / " 20	1.82	"	1.30 p.m. to 9.30 a.m.	" 26 / " 27	1.65	Snow and Rain.	8.30 p.m. to 1.30 p.m.
Total.	2.50			Total.	4.06		

NOTE. — Total Rainfall for year, 38.17 inches.

APPENDIX B.

REPORT OF THE SUPERINTENDENT OF THE EASTERN DIVISION.

Water-Supply Department, Eastern Division,
Boston, Mass., February 1, 1895.

Col. Thomas F. Doherty,
Chairman Boston Water Board:

Dear Sir: I herewith respectfully submit the annual report of the Eastern Division for the year ending January 31, 1895:

Extension of Mains.

During the year there have been laid 17.9 miles of pipe mains, and 27,111 feet of pipe have been abandoned, making a total of 572.8 miles now connected with the system.

A 36-inch force main was laid from the High Service Pumping Station at Chestnut Hill to Fisher Hill Reservoir, and there was also a 20-inch main laid in Brookline through Centre, Harvard, and Fuller streets. This pipe was laid by the town of Brookline, we furnishing the pipe and paying them for the labor.

The work of relaying a 20-inch and a 12-inch pipe across Dover-street bridge is almost complete, there being only a small piece on the South Boston side to take up, and this we expect to do as soon as the weather permits.

There were laid for the Park Department system 1,505 feet of 8-inch pipe through Jamaicaway between Perkins and Pond and Pond and Prince streets. This pipe is not included in the total number of miles laid in our system.

Stop-cocks.

The number of stop-cocks established during the year was 241. Of this number there were two 36-inch connected with the 36-inch force main, and in addition to these there was a 36-inch check-valve put on. Forty-eight stop-cocks were abandoned, making the total number now in service 6,359, all of which have received the usual attention in matters of oiling, testing, etc.

HYDRANTS.

Two hundred and forty-nine hydrants were established and 74 abandoned, making a net increase for the year of 175, and there are now 6,217 in service connected with the system.

Sixteen of the new-pattern post hydrants with independent shut-off were put in during the year. There are still 1,125 Boston hydrants, old pattern, in service, and I recommend that during this coming season 100 of them be replaced by hydrants of the Lowry or Post pattern.

Special attention has been paid to all complaints made by the Fire Department, such as raising or lowering hydrant barrels or boxes. All hydrants have been examined and oiled frequently during the summer, and have also had their usual care during the cold weather. The Fire Department is furnished by this department with the salt used on hydrants, and we have delivered of this to the various houses of the department during the year 4,734 sacks.

SERVICE-PIPES.

Most of the pipes that were connected with the Jamaica Pond system have been relaid and connected to our pipes during the year. They were in most cases ½-inch pipes which did not give a sufficient supply, and were replaced by ⅝-inch.

Under the present law ot laying out new streets we were obliged to lay 103 pipes in Newbury street, 55 in Ivy street, 74 in Mountfort street, 128 in Parker street, and 32 in St. Germain street, making a total of 392 pipes from which no revenue is derived at present.

During the year 2,451 service-pipes have been laid, with an aggregate length of 59,781 feet, and 481 have been abandoned, making a net increase of 1,970 pipes during the year.

WATER-POSTS.

Twenty-nine water-posts were erected, and 4 abandoned, making the number now in use 366. These are erected at the request of the Superintendent of Streets or his agent. All repairs on them are made by us, and charged to the Street Department.

FOUNTAINS.

Fountains have had their usual care during the year. Two for the use of man have been erected: one on Dale street opposite Washington park, and the other on Dudley street, at Guild row. That at Union Depot was changed from a single to a double fountain. In East Boston the fountain for the use of animals, situated on Bennington street, corner of Chelsea street, was replaced by a new one.

From a humane consideration and a love for dumb animals, I would suggest that too many of these fountains cannot be established.

Reservoirs.

East Boston. — The bank on the north of the reservoir was sowed with grass-seed in the spring, and rammed. The fence around the grounds was painted, together with the house that is used as the headquarters for the men of the district. All the grounds have been paid their usual attention.

Parker Hill. — During the summer special attention was paid to the care of the grounds; the keeper's house was painted, as was the gate-house, steps, and the fence around the grounds.

South Boston. — Owing to the care they have received, the grounds are in exceptionally good condition. A sad accident occurred December 25. One Alexander Wilkinson, an eight-year old boy, while skating, broke through the ice and was drowned. His body was recovered. To avoid further accidents of like nature, the ice has since been broken up.

High-Service Tanks.

The tanks at Mt. Bellevue and Breed's island are in good condition. During the coming year it will be necessary to paint both of them. The surrounding grounds are in good condition.

Meters.

Cochituate Division. — Four hundred and twenty-four meters have been set, 131 have been discontinued, and 6 have been lost in service, making a net gain of 287, and the total number now in use, 4,333.

Mystic Division. — Fifty-five have been set, and 22 discontinued, making a net increase of 33, and the total now in service, 494.

WASTE DETECTION.

Premises examined	69,239
" on which defective fixtures were found,	11,035
" reëxamined	12,701
Second notice to repair	1,525
Wilful-waste notices issued	123

The defective fixtures may be divided into the following classes:	
Ball-cocks and valves	7,333
Faucets, sink-bowls, hopper, and bath-tubs .	4,524
Service-pipes burst inside building	72
Wilful waste	123

In connection with the Deacon meter system, out of 2,504 night examinations by means of the sidewalk stop-cocks, there were found 765 defective fixtures, and 41 wilful waste. There were also 100 hand-hose reported for non-payment.

DEACON METER SYSTEM.

Work was commenced April 1, and ended for the season December 1. During this period all sections on the Cochituate system were tested once, and most of them twice. On the Mystic system there were no tests made, partly on account of the main being laid through Chelsea street, and later on account of the dry summer and consequent fall of Mystic lake.

There are now connected with the system 83 meters; 76 on the Cochituate and 7 on the Mystic.

The following table shows a summary of the results attained:

Cochituate.

	1894.							1893.		1894.			
	No. Meters.		Total No. Meters.	Sections.		Total No. Sections.	Population.	2d Reading.		1st Reading.		2d Reading.	
	Tested.	Not Tested.		Tested.	Not Tested.			Daily Consump.	Night Rate.	Daily Consump.	Night Rate.	Daily Consump.	Night Rate.
City Proper	30	. . . .	30	71	. . . .	71	146,130	59.0	40.1	58.6	39.4	60.4	41.1
South Boston	13	. . . .	13	25	. . . .	25	67,790	49.8	35.9	46.3	30.5	48.2	32.8
East Boston	7	. . . .	7	11	. . . .	11	33,710	39.5	26.9	38.3	26.9	. . . . . .	. . . . . .
Roxbury	14	. . . .	14	33	1	34	91,970	56.5	40.2	57.0	38.2	60.0	42.5
West Roxbury	2	. . . .	2	4	. . . .	4	16,880	53.7	28.8	59.9	34.1	58.4	38.4
Dorchester	6	2	8	8	2	10	33,980	54.1	34.1	61.3	37.8	50.8	30.9
Brighton	2	. . . .	2	3	1	4	8,860	63.9	41.8	56.7	36.7	. . . . . .	. . . . . .
Total	74	2	76	155	4	159	399,320	54.7	37.3	54.7	35.9	. . . . . .	. . . . . .

Mystic.

Charlestown	. . . .	5	5	. . . .	10	10	30,875	44.1	26.0	. . . . . .	. . . . . .	. . . . . .	. . . . . .
Chelsea	. . . .	1	1	. . . .	3	3	9,465	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .
Somerville	. . . .	1	1	. . . .	3	3	. . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .
Total	. . . .	7	7	. . . .	16	16	. . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .

HIGH-SERVICE STATIONS.

Chestnut Hill. — No. 1 pump has been overhauled, and such parts as were found to be badly worn were taken out and their dimensions taken for new pieces, with which they will be replaced as soon as possible.

The same may be said of No. 2 pump. The boilers have been carefully examined and such repairs and additions as were necessary have been made. The dynamo engines have been overhauled and the armature taken out and repaired.

The new Engine No. 3 was started for the first time on December 2, and has received several trials to date.

East Boston and West Roxbury Stations. — There is little to say regarding these stations. They have been well cared for and are in good condition.

MAINTENANCE.

Owing to the large amount of other work on hand during the past season, we have been unable to reach that of relaying a number of streets in the city proper, for which we have the permission of your Board. I hope to complete this work during the coming season, as a longer delay would be dangerous.

Of repairs on pipes of all sizes we have made 1,703 during the year. Of those on main pipes (349) we have found the most numerous causes to be defective joints (126), defective packing (101), and defective stop-cocks (25). The causes of leaks and stoppages on service-pipes, which number 1,354, are many, but chief among them are: Rust, 501; fish, 50; struck by pick, 153; settling of earth, 222. It will be seen that these are causes which cannot well be guarded against. On the whole, considering the amount of excavation performed by other departments, as well as by outside corporations, and the severity of the winter so far, I feel that we have been very fortunate. The following tables show in detail the work performed by this department:

Table showing the Length of Supply and Distribution of Mains Laid and the Number of Stop-cocks Established During the Year of 1894 and the Length Connected with the Sudbury and Cochituate Works January 31, 1895.

	Diameter of Pipes in Inches.															Total.
	60	48	40	36	30	28	24	20	16	12	10	8	6	4	3	
Eastern Division.																
Length in use Jan. 31, 1894,	. . .	25,571	23,054	20,844	60,974	244	58,064	59,394	72,471	825,742	49,195	356,037	1,232,760	137,929	11,356	2,933,635
Stop-cocks in same	. . .	1	7	14	25	. . .	49	37	107	1,255	65	698	3,244	657	7	6,166
Length laid or relaid during the year	. . .	. . . .	. . . .	5,454	1,490	. . .	1,209	4,794	4,158	24,056	4,900	22,205	25,603	515	. . . .	94,384
Stop-cocks in same	. . .	. . . .	. . . .	2	5	. . .	1	3	5	52	9	41	116	7	. . . .	241
Length abandoned during the year	. . .	. . . .	. . . .	. . . .	. . . .	. . .	2,489	2,705	. . . .	2,547	900	3,125	7,942	5,103	2,300	27,111
Stop-cocks in same	. . .	. . . .	. . . .	. . . .	. . . .	. . .	3	3	. . . .	5	2	2	19	9	5	48
Length in use Jan. 31, 1895,	. . .	25,571	23,054	26,298	62,464	244	56,784	61,483	76,629	847,251	53,195	375,117	1,250,421	133,341	9,056	3,000,908
Stop-cocks in same	. . .	1	7	16	30	. . .	47	37	112	1,302	72	737	3,341	655	2	6,359
Western Division.																
Length in use Jan. 31, 1895,	266	16,051	1,435	1,166	2,140	. . .	. . . .	. . . .	20	2,043	. . . .	. . . .	360	. . . .	. . . .	23,481
Stop-cocks in same	. . .	5	. . . .	3	. . . .	. . .	. . . .	. . . .	2	4	. . . .	. . . .	2	. . . .	. . . .	16
Total connected with works Jan. 31, 1895	266	41,622	24,489	27,464	64,604	244	56,784	61,483	76,649	849,294	53,195	375,117	1,250,781	133,341	9,056	3,024,389 ft. or 572.8 miles.

Statement of Hydrant, Blow-Off, and Reservoir Pipes, January 31, 1895.

	Diameter in Inches.						Total.
	16	12	9	8	6	4	
Total length in use, January 31, 1894	272	6,938	2,993	28	17,859	10,788	38,878
Length laid or relaid during the year	......	32	......	......	1,881	120	2,033
Length abandoned during the year	......	......	18	......	64	161	243
	272	6,970	2,975	28	19,676	10,747	40,668

Statement of Service-Pipes Laid and Abandoned during the Year ending January 31, 1895.

Size of Service.	Boston.		South Boston.		East Boston.		Roxbury.		Dorchester.		W. Roxbury.		Brighton.		Total.	
	Number of Services.	Length in Feet.	Number of Services.	Length in Feet.	Number of Services.	Length in Feet.	Number of Services.	Length in Feet.	Number of Services.	Length in Feet.	Number of Services.	Length in Feet.	Number of Services.	Length in Feet.	Number of Services.	Length in Feet.
6-inch laid	2	288	1	24	....	....	....	....	....	....	....	....	....	....	3	312
6 " abandoned	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....
4 " laid	32	700	3	94	2	67	3	84	1	151	....	....	1	22	42	1,118
4 " abandoned	7	140	2	73	....	....	1	14	....	....	....	....	....	....	10	227
3 " laid	6	115	1	36	1	13	2	44	3	126	3	162	1	19	17	515
3 " abandoned	6	151	....	....	....	....	....	....	....	....	....	....	....	....	6	151
2 " laid	5	149	...	....	1	37	4	84	....	....	1	7	5	69	16	346
2 " abandoned	5	43	....	....	....	....	6	52	....	....	....	....	4	24	15	119
1½ " laid	5	146	1	57	....	....	4	88	1	30	....	....	11	87	22	408
1½ " abandoned	....	....	....	....	2	34	....	....	1	30	....	....	3	6	6	70
1¼ " laid	20	539	2	50	2	73	8	310	2	51	3	78	3	43	40	1,144
1¼ " abandoned	....	....	....	....	....	....	1	2	1	4	....	....	3	68	5	74
1 " laid	39	959	6	177	5	87	16	277	2	80	8	190	5	183	81	1,953
1 " abandoned	8	158	....	....	....	....	10	220	2	51	....	....	1	50	21	479
¾ " laid	37	1,015	1	49	2	58	17	560	5	199	5	104	3	73	70	2,058
¾ " abandoned	3	70	1	19	....	....	4	46	2	61	....	....	1	23	11	219

5/8 " laid	98	2,279	98	2,485	121	3,231	894	21,219	620	15,091	263	6,133	65	1,411	2,159	51,849
5/8 " abandoned	89	2,056	13	314	18	251	50	592	15	301	13	248	10	431	208	4,193
1/2 " laid	....	....	1	78	....	....	....	....	....	....	....	....	....	....	1	78
1/2 " abandoned	6	321	10	287	6	180	171	3,504	4	58	....	...	1	58	198	4,408
Total laid	244	6,190	114	3,050	134	3,566	948	22,666	634	15,728	283	6,674	94	1,907	2,451	59,781
Total abandoned	125	2,939	26	693	26	465	243	4,430	25	505	13	248	23	660	481	9,940
Net increase	119	3,251	88	2,357	108	3,101	705	18,236	609	15,223	270	6,426	71	1,247	1,970	49,841

Statement of Location, Size, and Number of Feet of Pipe Laid during the Year ending January 31, 1895.

Note. — B., indicates Boston; So. B., South Boston; E. B. East Boston; Rox., Roxbury; Dor., Dorchester: W. R., West Roxbury; Bri., Brighton; Brk., Brookline; Chn., Charlestown.

In what Street.	Between what Streets.	District.	Size.	Length.
In the field	Chestnut Hill ave. and Pumping-station .	Bri.	36-in,	2,129
Chestnut Hill ave. . .	Beacon st. and Brookline line	"	"	169
" " " .	Fisher ave. and Boston line	Brk.	"	538
Fisher ave.	Chestnut Hill ave. and Fisher Hill Resv.	"	"	2,618
	Total 36-inch	. . . . . .	. . .	5,454
Chelsea st.	On Chelsea bridge	Chn.	30-in.	1,375
Fisher ave.	At Fisher Hill Reservoir	Brk.	"	95
In the field	Chestnut Hill ave. and Pumping-station .	Bri.	"	20
	Total 30-inch	. . . . . .	. . .	1,490
Chelsea st.	Scott's court and Chelsea bridge	Chn.	24-in.	384
Perkins st.	Prince st. and Jamaica Way	W. R.	"	825
	Total 24-inch	. . . . . .	. . .	1,209
Dover st.	Harrison ave. and Foundry st.	B.	20-in.	646
W. Fourth st.	Foundry st. and Dorchester ave.	So. B.	"	382
Perkins st.	Prince st. and Jamaica Way	W. R.	"	300
Centre st.	Beacon st. and Fuller st.	Brk.	"	1,666
Harvard st.	Fuller st. and Boston line	"	"	1,413
Fuller st.	Harvard st. and Centre st.	"	"	387
	Total 20-inch	. . . . . .	. . .	4,794
Ashby st.	Across Commonwealth ave.	Rox.	16-in.	30
Seaver st.	Humboldt ave. and Walnut ave.	"	"	1,330
Talbot ave.	Washington st. and Ashmont st.	Dor.	"	2,798
	Total 16-inch			4,158
Canal st.	Market and Travers sts.	B.	12-in.	309
Beach st.	Washington st. and Harrison ave. . . .	"	"	346
Washington st.	Beach st. and Boylston sq.	"	"	131
Milk st.	Batterymarch and Broad sts.	"	"	141
Causeway st.	Lancaster and Nashua sts.	"	"	27
	Carried forward	. . . . . .	. . .	954

Statement of Location, Size, etc. — *Continued.*

In what Street.	Between what Streets.	District.	Size.	Length.
	Brought forward	. . . . . .	. . .	954
Nashua st.	Causeway and Minot sts.	B.	12-in.	24
Dover st.	Harrison ave. and Foundry st.	"	"	648
Albany st.	Bristol and Troy sts.	"	"	636
D st.	Ninth and Dorchester ave.	S. B.	"	172
Meridian st.	Condor st. and the bridge	E. B.	"	172
Orient ave.	Walley and Farrington sts.	"	"	411
Walley st.	Gladstone st. and Orient ave.	"	"	62
Tower st.	Montmorenci and Orient ave.	"	"	298
Chelsea st.	Curtis st. and the bridge	"	"	454
Addison st.	. . . .	"	"	14
Kemble st.	Gerard and Magazine sts.	Rox.	"	285
St. Alphonsus st. . . .	Smith and Tremont sts.	"	"	200
Massachusetts ave. . .	Chesterfield and Magazine sts.	"	"	872
Parker st.	Westland and Huntington aves.	"	"	1,745
Gainsborough st. . . .	Parker and Falmouth sts.	"	"	24
Lawn st.	Heath and Hayden sts.	"	"	135
Geneva ave.	Columbia and Wilder sts.	Dor.	"	481
W. Selden st.	Morton st. and Cook ct.	"	"	2,261
Rockville st.	Blue Hill ave. and Oakland st.	"	"	425
Oakland st.	Rockville st. and N. Y. & N. E., R.R. .	"	"	545
Rosewood st.	Off Oakland st.	"	"	368
Romsey st.	Sagamore and Saxton sts.	"	"	139
Blue Hill ave.	Tremont and Norfolk sts.	"	"	136
Hillside st.	Off Richview st.	"	"	165
Glen road	Erie ave. and Read st.	"	"	236
Welles ave.	Dorch. ave. and N. Y., N. H. & H. R.R.	"	"	123
Bloomfield st.	Off Geneva ave.	"	"	1,262
Geneva ave.	Josephine and Bloomfield sts.	"	"	70
Lauriat ave.	Don st. and Mountain ave.	"	"	53
Belleflower st.	Boston st. and Dor. ave.	"	"	374
Morton st.	Sanford and Oakridge sts.	"	"	598
Geneva ave.	Westville and Oakley sts.	"	"	36
Jamaicaway	Perkins and Pond sts.	W. R.	"	1,338
	Carried forward	. . . . . .	. . .	15,716

Statement of Location, Size, etc. — *Continued.*

In what Street.	Between what Streets.	District.	Size.	Length.
	Brought forward	. . . . .	. . .	15,716
Canterbury st.	Perkins and Clifford sts.	W. R.	12-in.	475
Park st.	Montview and Centre sts.	"	"	709
Centre st.	Hewlett and Farquhar sts.	"	"	120
Gould st.	Off Belle ave.	"	"	231
Beech st.	Newburg and Anawan aves.	"	"	774
Mt. Vernon st.	Temple and LaGrange sts.	"	"	1,008
Commonwealth ave. . .	Brighton ave. and Allston st.	Bri.	"	2,324
" " . .	Brighton ave. and Essex st.	"	"	2,314
" " . .	Berwick and Strathmore roads	"	"	143
Faneuil st	Market and Parsons sts.	"	"	190
Chestnut Hill ave. . .	At Beacon st.	"	"	52
	Total 12-inch			24,056
Dartmouth st.	Newbury and Marlboro' sts.	B.	10-in.	200
Fairfield st.	" " " "	"	"	203
Hereford st.	" " " "	"	"	199
Falmouth st.	Norway and St. Paul sts.	"	"	33
Haverhill st.	Causeway and the water	"	"	384
St. Germain st. . . .	Massachusetts ave. and Dalton st. . . .	"	"	352
Broad st.	Milk and Wharf sts.	"	"	501
Marine park	Off Q st.	S. B.	"	844
Mountford st.	Arundel and St. Mary sts.	Rox.	"	376
Intervale st.	Off Blue Hill ave.	"	"	411
Roxton st.	Glen road and Greenwood st.	Dor.	"	333
Bellevue st.	Robin and Martin sts.	W. R.	"	492
Landseer st.	LaGrange and Bellevue sts.	"	"	327
Murdock st.	Garden and No. Beacon sts.	Bri.	"	245
	Total 10-inch			4,900
Reed st.	Thorndike and Hunneman sts.	B.	8-in.	110
Hayward pl.	Washington st. and Harrison ave. . . .	"	"	254
Columbus ave.	Berkeley st. and the railroad bridge . .	"	"	150
Union Park st.	Albany st. and Harrison ave.	"	"	915
Court square	Court st. and Williams court	"	"	279
Newbury st.	Brookline ave. and Charlesgate West . .	"	"	1,138
	Carried forward	. . . .	. . .	2,846

Statement of Location, Size, etc. — *Continued.*

In what Street.	Between what Streets.	District.	Size.	Length.
	Brought forward			2,846
Marine park	Off Q st.	S. B.	8-in.	17
Wood Island park . .	Off Parkway	E. B.	"	802
Farrington st.	Orient ave. and Tower st.	"	"	833
Chesterfield st.	Off Massachusetts ave.	Rox.	"	24
Homestead st.	Humboldt and Elm Hill aves.	"	"	1,147
Leon st.	Off Ruggles st.	"	"	17
White st.	Gleason st. and Glen Road	Dor.	"	96
Waldeck st.	Stratford and Lindsey sts.	"	"	59
Lindsey st.	Off Waldeck st.	"	"	665
Magdala st.	Codman and Van Winkle sts.	"	"	399
Oakridge st.	Morton and Codman sts.	"	"	506
Waldeck st.	Melville ave. and Tremlet park	"	"	74
Ballou ave.	Jones ave. and Pratt st.	"	"	48
Welles ave.	Ocean and Argyle sts.	"	"	51
Northern ave.	Whitfield and Washington sts.	"	"	257
Templeton st.	Adams st. and Dorchester ave.	"	"	1,277
Hutchinson st.	Codman and Brook sts.	"	"	212
Holden st.	Off Boston st.	"	"	48
Argyle st.	Ashmont st. and Talbot ave.	"	"	12
Rosseter st.	Bullard st. and Bowdoin ave.	"	"	341
Nightingale st.	Off Bernard st.	"	"	36
Duncan st.	Greenwich and Fenton sts.	"	"	129
Adams st.	Ashmont and Beaumont sts.	"	"	867
Pierce ave.	Off Adams st.	"	"	6
Fenton st.	Fenton place and Clayton st.	"	"	72
Jamaicaway	Pond and Prince sts.	W. R.	"	1,667
Farquhar st.	South and Selwyn sts.	"	"	181
Montview st.	Park and Mt. Vernon sts.	"	"	382
Farrington st.	Kenneth and Anawan aves.	"	"	147
Landseer st, ...	La Grange and Bellevue sts.	"	"	191
Parental School . . .	Off Spring	"	"	828
Aldrich st.	Beech and Cornell sts.	"	"	354
Mendum st.	Fairview and Walter sts.	"	"	192
Ashland st.	Sherwood st. and Brown ave.	"	"	365
	Carried forward			15,148

Statement of Location, Size, etc. —*Continued.*

In what Street.	Between what Streets.	District.	Size.	Length.
	Brought forward	. . . . . .	. . .	15,148
Woodlawn st.	Off Hyde Park ave.	W. R.	8-in.	1,094
Clifford st.	Canterbury and Grew sts.	"	"	1,007
Weld Hill st.	Off Hyde Park ave.	"	"	150
Temple st.	Spring and Hillcrest sts.	"	"	221
Perkins st.	Prince st. and Jamaica Way	"	"	1,845
Stratford ave.	Anawan and Clement aves.	"	"	96
Commonwealth ave. .	Harvard and Allston sts.	Bri.	"	2,076
Street	Off Hobart st.	"	"	71
Strathmore road . . .	Commonwealth and Chestnut Hill aves .	"	"	487
Commonwealth ave. .	Brighton ave. and Harvard st.	"	"	10
	Total 8-inch	. . . . . .	. . .	22,205
Haverhill st.	Causeway st. and the water	B.	6-in.	355
Falmouth st.	St. Paul and Norway sts.	"	"	145
Chauncy st.	Bedford st. and Rowe pl.	"	"	242
Tufts st	Kingston and Lincoln sts.	"	"	183
Fabin st.	Newland and Ivanhoe sts.	"	"	410
Hathaway st.	Congress and Aldine sts.	"	"	32
Williams court	Washington st. and Court sq.	"	"	10
India sq.	Atlantic ave. and India st.	"	"	192
Raleigh st.	Beacon st. and Bay State Road	B.	"	189
Bristol st.	Albany st. and Harrison ave.	"	"	80
Dover st.	" " " " "	"	"	205
Chandler st.	Berkeley and Tremont sts.	"	"	547
St. Botolph st.	Albemarle and Cumberland sts.	"	"	197
Chester place	Northampton st. and Shawmut ave. . .	"	"	254
West Fourth st. . . .	Foundry st. and Dorchester ave.	So. B.	"	408
Story st.	G and H sts.	"	"	90
Fifth-st. place	Off West Fifth st.	"	"	211
Falcon st.	Brooks and Putnam sts.	E. B.	"	264
Street	Off Bayswater st.	"	"	309
Thurston st.	A new st. and Butler ave.	"	"	252
Falcon st.	Border and Meridian sts.	"	"	144
Wood Island park . .	Off Parkway	"	"	100
W. Eagle st.	Border and Meridian sts.	"	"	293
	Carried forward	. . . . . .	. . .	5,112

Statement of Location, Size, etc. — *Continued.*

In what Street.	Between what Streets.	District.	Size.	Length.
	Brought forward	. . . . . .	. . .	5,112
Morris st.	Brooks and Putnam sts.	E. B.	6-in.	112
Addison st.	. . . .	"	"	212
Carey st.	Riverside and Terry sts.	Rox.	"	47
Chapel st.	Weston and Sarsfield sts.	"	"	33
Amory terrace	Amory st. and Amory ave.	"	"	117
Notre Dame st.	Dimock and Bragdon sts.	"	"	264
Rock st.	Regent and Rockland sts.	"	"	144
Rockdale st.	Off Cobden st.	"	"	206
Rand place	Off Rand st.	"	"	24
Cherokee st.	Hillside and Pontine sts.	"	"	145
Arundel st.	Beacon and Mountfort sts.	"	"	322
Ivy st.	St. Mary and Mountfort sts.	"	"	938
Eldora st.	Hillside and Sunset sts.	"	"	36
Landsdowne st. . . .	Massachusetts ave. and Allerton st. . . .	"	"	277
Moreland st.	Dennis st. and Blue Hill ave.	"	"	56
Batavia st.	Parker and Falmouth sts.	"	"	8
Whiting st.	Warren and Moreland sts.	"	"	159
Forbes st.	Centre st. and Chestnut ave.	"	"	303
Roger ave.	Parker st. and Huntington ave.	"	"	24
Courtland st.	" " " " "	"	"	23
Cameron st.	Off Heath st.	"	"	40
Stanmore place	Off Warren st.	"	"	276
Lambert ave.	Bartlett and Dudley sts.	"	"	153
Cathedral st.	Off Fenwick st.	"	"	124
Roslin st.	Harley and Washington sts.	Dor.	"	266
Roach st.	Pleasant st. and Dorchester ave.	"	"	58
Clinton st.	Off Waterlow st.	"	"	67
Hartland st.	Saxton st. and Tuttle ave.	"	"	48
Miller's lane	Washington st. and Baker place	"	"	36
Norfolk terrace	" Norfolk sts.	"	"	207
Cook st.	" Chamberlin sts. . .	"	"	120
Ditson st.	Leroy and Westville sts.	"	"	120
Humphreys square . .	Dudley and Iona sts.	"	"	167
Belfort st.	Saxton st. and Dorchester ave.	"	"	238
	Carried forward	. . . . . .	. . .	10,482

Statement of Location, Size, etc. — *Continued.*

In what Street.	Between what Streets.	District.	Size.	Length.
	Brought forward	. . . . . .	. . .	10,482
Freeman st.	Faulkner st. and Charles st.	Dor.	6-in.	57
Kilton st.	Wheatland and Talbot aves.	"	"	60
Bowdoin square . . .	Westville and Dakota sts.	"	"	453
Cushing place	Off Cushing ave.	"	"	75
Montague st.	Ashmont and Roslin sts.	"	"	253
Tremlet park	Waldeck and Hooper sts.	"	"	9
Leeds st.	Off Savin Hill ave.	"	"	102
Oak ave.	Adams and Plain sts.	"	"	48
Morrill st.	Pleasant and Bakerfield sts.	"	"	401
A st.	" " " "	"	"	400
D st.	" " " "	"	"	404
Willis st.	" " " "	"	"	400
Withington st.	Euclid and Torrey sts.	"	"	48
Stratford st.	Off Waldeck st.	"	"	101
Remington st.	Centre st. and Nixon ave.	"	"	210
Nottingham st.	Bullard st. and Bowdoin ave.	"	"	449
Hopestill st.	Northern and Southern aves.	"	"	336
Clement st.	Off Nixon ave.	"	"	192
Elmont st.	" Waterlow st.	"	"	96
Draper court	Clarkson and Bowdoin aves.	"	"	160
Payson ave.	Hancock and Glendale sts.	"	"	114
Phillips place	Off Dudley st.	"	"	183
Auckland st.	Belfort and Alton sts.	"	"	157
Salcombe st.	Dudley and Cushing aves.	"	"	233
Gibson st.	Adams st. and Dorchester ave.	"	"	233
White st.	Gleason st. and Glen road	"	"	89
Carlos st.	Lauriat and Chapman aves.	"	"	314
Lyndhurst st.	Washington and Allston sts.	"	"	180
Don st.	Lauriat and Chapman aves.	"	"	325
Paisley park	Upland and Bourneside sts.	"	"	571
Street	Off Arcadia st.	"	"	170
Mora st.	Washington st. and Milton ave.	"	"	530
Corwin st.	Westville and Arcadia sts.	"	"	96
Holliday st.	Bowdoin st. and Geneva ave.	"	"	253
	Carried forward	. . . . .	.	18,184

Statement of Location, Size, etc. — *Concluded.*

In what Street.	Between what Streets.	District.	Size.	Length.
	Brought forward	. . . . . .	. . .	18,184
Saxton st.	Hartland and Belfort sts.	Dor.	6-in.	76
Hecla st.	Adams st. and Dorchester ave.	"	"	571
Walton st.	Harley and Washington sts.	"	"	48
Neponset court. . . .	Off Neponset ave.	W. R.	"	256
Congreve st.	Off South st.	"	"	378
Sharon st.	Canterbury and Rowe sts.	"	"	24
Wren st.	Rutledge and Robin sts.	"	"	462
Montview st.	Henshaw and Park sts.	"	"	11
Fletcher st.	Off South st.	"	"	377
Clive st.	Boylston st. and Spring Park ave. . . .	"	"	140
Sycamore st.	Rindge and Florence sts.	"	"	107
Johnson st.	Baker and Johnson sts.	"	"	204
Argyle st.	From Cornwall st.	"	"	22
Gilman st.	Canterbury and Sutton sts.	"	"	165
Jones st.	Fairview and Walter sts.	"	"	255
Plainfield st.	Off Keyes st.	"	"	265
Anson st.	South st. and N. Y., N. H., & H. R.R. .	"	"	36
Allen st.	Off Anawan ave.	"	"	62
Hadwin Way	Hammet st. and Hyde Park ave.	"	"	65
Street	Off Canterbury st.	"	"	223
Heathcote st.	Off Poplar st.	"	"	256
Mozart st.	Walter and Selwyn sts.	"	"	117
Perham st.	Ivory and Mt. Vernon sts.	"	"	349
Garfield st.	Off Washington st.	"	"	209
Hobart st.	Faneuil and Brook sts.	Bri.	"	842
Bentley st.	Henshaw and Sparhawk sts.	"	"	19
Berwick Road	Commonwealth ave. and Chiswick Road,	"	"	73
Eulita Terrace	Winship st. and Chestnut Hill ave. . . .	"	"	354
Windsor Road	Off Lanark Road	"	"	77
Cypress st.	Murdock and Lucas st.	"	"	200
Deer Island		"	"	1,176
	Total 6-inch			25,603
Wood-Island park . .	Off Parkway	E. B.	4 in.	373
Spring Terrace	Off Bowers st.	Rox.	"	142
	Total 4-in.			515

Statement of Pipes Abandoned.

In what Street.	Between what Streets.	District.	Size.	Length.
Albany st.	Bristol and Troy sts.	B.	12 in.	636
Union park	Albany st. and Harrison ave.	"	6 in.	915
Dartmouth st.	Newbury and Marlboro' sts.	"	"	200
Fairfield st.	" " " "	"	"	203
Hereford st.	" " " "	"	"	199
Haverhill st.	Causeway st. and the water	"	"	57
Bristol st.	Albany st. and Harrison ave.	"	"	80
Dover st.	" " " " "	"	"	205
Tremont st.	Hollis and Warrenton sts.	"	"	300
Dover st.	Harrison ave. and the water	"	20 in.	646
" "	" " " "	"	12 in.	648
East Sixth st.	At Q st	So. B.	"	35
Payson ave.	Hancock and Glendale sts.	Dor.	"	28
Perkins st.	Prince st. and Jamaica Way	W. R.	24 in.	825
" "	" " " " "	"	20 in.	300
" "	" " " " "	"	8 in.	825
Hayward place	Washington st. and Harrison ave. . . .	B.	4 in.	254
Fabin	Newland and Ivanhoe sts.	"	"	410
Court square	Court st. and Williams court	"	"	279
Haverhill st.	Causeway st. and the water	"	"	327
Williams court	Washington st. and Court square	"	"	10
Chelsea st.	On Chelsea bridge	Chn.	20 in.	1,375
" "	" " "	"	24 in.	1,280
" "	Scotts court and Chelsea bridge	"	20 in.	384
" "	" " "	"	24 in.	384

Statement of Pipes Abandoned on the J. P. A. System.

In what Street.	Between what Streets.	District.	Size.	Length.
Tremont st.	Vernon and Pynchon sts.	Rox.	12 in.	1,200
" "	" " " "	"	10 in.	600
Parker st.	Huntington and Rogers aves.	"	6 in.	291
Tremont st.	Vernon and Pynchon sts.	"	"	325
Sarsfield st.	Tremont and Chapel sts.	"	"	300
Leon st.	Off Ruggles st.	"	"	17
Hampden st.	Kemble and Albany sts.	"	"	1,000
Kemble st.	Hampden and Gerard sts.	"	6 in., 4 in. and 3 in.	750
Albany st.	Hampden st. and Hartopp place . . .	"	6 in.	1,600
Washington st.	Eustis and Zeigler sts.	"	6 in. and 4 in.	1,150
Eustis st.	Washington and Dearborn sts.	"	6 in.	350
Vernon st.	Washington and Cabot sts.	"	8 in.	1,200
Palmer st.	Washington and Eustis sts.	"	"	1,100
Cottage st.	Tremont st. and N. Y., N. H. & H. R. R.,	"	10 in.	300
Weston st.	Tremont and Chapel sts.	"	4 in.	250
Chapel place	Weston and Sarsfield sts.	"	"	23
Kent st.	Washington and Vernon sts.	"	"	25
Maiden lane	Hampden and Reading sts.	"	"	250
Reading st.	Kemble and Swett sts.	"	4 in. and 3 in.	1,100
Island st.	Kemble and Gerard sts.	"	4 in.	750
Dearborn st.	Eustis st. and Hartopp place	"	"	250
Eustis st.	Dearborn and Adams sts.	"	"	650
Gerard st.	Kemble and Farnham sts.	"	"	300
Hampden st.	Kemble and Prescott sts.	"	3 in.	650
Prentiss st.	Tremont st. and N. Y., N. H., & H. R.R.,	"	"	250
Chadwick st.	Hampden and Yeoman sts.	"	"	600
Mall st.	Dearborn st. and Harrison ave.	"	"	800

Statement of Pipes Lowered.

In what Street.	Between what Streets.	District.	Size.	Length.
Byron st.	Saratoga and Pope sts.	E. B.	10-in.	345
Seaver st.	Harold st. and Humboldt ave.	Rox.	16-in.	195
Codmanst.	Magdala and Carruth sts.	Dor.	12-in.	495
La Grange st.	Shaw and Martin sts.	W. R.	"	30
Argyle st.	Dorchester and Talbot aves.	Dor.	8-in.	310
Salcombe st.	Stoughton st. and Cushing ave.	"	6-in.	100
Park lane	Off Walnut ave.	W. R.	"	200

Cochituate Meters Applied.

	Diameter in Inches.							Totals.
	4	3	2	$1\frac{1}{2}$	1	$\frac{3}{4}$	$\frac{5}{8}$	
B. W. W.	...	...	...	...	...	2	...	2
Champion	...	...	...	...	...	1	...	1
Crown	4	5	6	10	11	15	44	95
Gem	1	...	...	...	...	...	...	1
Hersey	1	...	...	4	1	32	1	39
Metropolitan	...	...	...	...	15	234	1	250
Worthington	2	4	5	3	10	10	2	36
Totals	8	9	11	17	37	294	48	424

Cochituate Meters Abandoned.

	Diameter in Inches.							Totals.
	4	3	2	$1\frac{1}{2}$	1	$\frac{3}{4}$	$\frac{5}{8}$	
B. W. W.	...	...	...	...	...	3	...	3
Crown	1	4	...	5	7	9	32	58
Hersey	...	...	...	2	...	3	1	6
Metropolitan	...	...	...	...	2	23	...	25
Worthington	...	4	4	6	17	6	2	39
Totals	1	8	4	13	26	44	35	131

Cochituate Meters Sent to Factory for Repairs.

	Diameter in Inches.						Totals.
	4	3	1½	1	¾	⅝	
Crown	...	...	1	3	8	53	65
Hersey	...	1	1	...	5	...	7
Metropolitan	...	...	...	...	3	...	3
Worthington	1	...	...	12	...	...	13
Totals	1	1	2	15	16	53	88

Meters Purchased.

	Diameter in Inches.								Totals.
	6	4	3	2	1½	1	¾	⅝	
Crown	1	5	4	11	7	16	72	...	116
Gem	1	...	...	...	...	...	...	...	1
Hersey	...	1	3	...	...	...	38	...	42
Metropolitan	...	...	...	1	1	51	300	...	353
Worthington	...	1	...	2	...	...	...	...	3
Totals	2	7	7	14	8	67	410	...	515

Mystic Meters Applied.

	Diameter in Inches.						Totals.
	4	3	2	1½	1	¾	⅝	
Ball and Fitts	...	...	1	...	...	...	...	1
Crown	1	1	2	...	2	4	3	13
Hersey	...	1	1	..	1	...	...	3
Metropolitan	...	...	...	...	9	25	...	34
Worthington	...	...	1	1	...	2	...	4
Totals	1	2	5	1	12	31	3	55

Mystic Meters Discontinued.

	Diameter in Inches.					Totals.
	2	1½	1	¾	⅝	
Crown	1	...	2	2	6	11
Hersey	1	...	4	...	...	5
Metropolitan	...	...	1	2	...	3
Worthington	2	...	...	1	...	3
Totals	4	...	7	5	6	22

Mystic Meters in Service January 31, 1895.

	Diameter in Inches.								Totals.
	6	4	3	2	1½	1	¾	⅝	
Ball and Fitts	...	...	1	1	...	...	...	...	2
Crown	3	8	8	16	2	31	43	98	209
Hersey	...	1	2	3	2	6	...	...	14
Metropolitan	...	...	...	...	...	22	55	...	77
Worthington	...	11	6	39	8	69	53	6	192
Totals	3	20	17	59	12	128	151	104	494

Mystic Meters sent to Factory for Repairs.

	Diameter in Inches.								Totals.
							¾	⅝	
Crown	...	...	...	...	...	...	4	9	13
Worthington	...	...	...	...	...	...	1	...	1
Totals	...	...	...	...	...	...	5	9	14

Cochituate Meters in Service January 31, 1895.

	Diameter in Inches.								Totals.
	6	4	3	2	1½	1	¾	⅝	
B. W. W.	...	...	...	...	...	...	56	...	56
Ball and Fitts	...	...	...	...	..	...	1	1	2
Champion	...	...	...	...	...	...	1	...	1
Crown	2	23	34	49	112	246	377	1,178	2,021
Desperance	...	...	...	...	...	...	1	...	1
Gem	1	1	...	...	...	...	...	...	2
Hersey	...	2	6	12	22	40	132	18	232
Metropolitan	...	...	...	...	1	102	662	4	769
Nash	...	...	...	...	...	...	...	1	1
Thompson	...	...	...	1	...	...	...	5	6
Worthington	2	11	23	116	102	530	401	57	1,242
Totals	5	37	63	178	237	918	1,631	1,264	4,333

Meters Changed.

Cause.	Cochituate.	Mystic.
Not registering	293	56
For test	217	41
Unsatisfactory	94	10
Stoppage	33	6
Leak at body	24	6
Leak at coupling	8	1
Leak at spindle	34	1
Clock broken	35	....
Clock defaced	16	4
Enlargement of service-pipe	31	3
No force	104	3
Frozen	6	....
Meters burst	1	....
Spindle stuck	1	....
Hands caught	1	....
Hands loose	1	....
To relocate	1	....
Totals	900	131

Meters Repaired in Service.

Cause.	Cochituate.	Mystic.
Leak at coupling	29	13
Leak at spindle	97	9
Leak at stop-cock	3	1
Not registering	39	12
Clock broken	79	11
Clock defaced	48	12
Clock unsatisfactory	370	2
Ratchet broken	....	3
Gear broken	3	....
Spindle stuck	4	....
Cap broken	2	....
Check-valve broken	1	....
Intermediate worn	1	....
Piston-rod bent	1	....
Disc broken	1	....
Driving-pawl stuck	1	....
Glass broken	1	....
Totals	680	63

General Statement of Meters for Year ending January 31, 1895.

	Cochituate.		Mystic.	
	Meters.	Boxes.	Meters.	Boxes.
In service January 31, 1895	4,337	......	494	......
New set	424	104	55	10
Discontinued	131	......	22	......
Lost in service	6	......	......	......
Changed	900	......	131	......
Changed location	22	......	6	......
Tested at shop	2,131	......	221	......
Repaired at shop	498	......	63	......
Repaired at factory	88	......	14	......
Repaired in service	680	58	63	43
Purchased	515	......	......	......

Hydrants Established and Abandoned during the Year.

	Established.					Abandoned.					
	Lowry.	Post.	B. Lowry.	Boston.	Totals.	Lowry.	Post.	B. Lowry.	Boston.	Totals.	Increase.
Boston	15	29	. . .	1	45	7	. .	6	21	34	11
South Boston	. .	4	1	. .	5	. .	. .	. . .	1	1	4
East Boston	1	19	. . .	. .	20	. .	. .	1	2	3	17
Roxbury	2	35	5	1	43	2	. .	2	8	12	31
Dorchester	3	49	17	1	70	1	1	5	6	13	57
West Roxbury	3	43	9	. .	55	. .	3	4	2	9	46
Brighton	. .	8	. . .	. .	8	. .	. .	. . .	2	2	6
Long Island	. .	2	. . .	. .	2	. .	. .	. . .	. .	. .	2
Deer Island	. .	1	. . .	. .	1	. .	. .	. . .	. .	. .	1
	24	190	32	3	249	10	4	18	42	74	175

Total Number of Hydrants in Use January 31, 1895.

	Lowry.	Post.	B. Lowry.	Boston Y.	Boston.	Total.
Boston	699	275	60	. . . .	490	1,524
South Boston	214	97	22	1	258	592
East Boston	139	103	23	. . . .	136	401
Roxbury	663	230	66	. . . .	88	1,047
Dorchester	577	471	196	. . . .	62	1,306
West Roxbury	125	508	171	. . . .	46	850
Brighton	79	277	59	. . . .	34	449
Deer Island	. . . .	17	. . . .	. . . .	. . . .	17
Brookline	5	. . . .	. . . .	. . . .	3	8
Chelsea	. . . .	. . . .	. . . .	. . . .	7	7
Quincy	. . . .	7	. . . .	. . . .	. . . .	7
Long Island	. . . .	6	. . . .	. . .	. . . .	6
Thompson's Island	. . . .	2	. . . .	. . . .	. . . .	2
Rainsford Island	. . . .	. . . .	. . . .	. . . .	1	1
	2,501	1,993	597	1	1,125	6,217

Water-Posts.

District.	Number in use Jan. 31, 1894.	Established during the year.	Abandoned during the year.	Number in use Jan. 31, 1895.
Boston	45	3	....	48
South Boston	28	....	1	27
East Boston	27	4	....	31
Roxbury	64	4	2	66
Dorchester	75	6	1	80
West Roxbury	61	6	....	67
Brighton	41	6	....	47
	341	29	4	366

Hydrant barrels changed for repairs	355
Hydrant boxes renewed	117
Stop-cock boxes renewed	164
Dead ends blown off	150
S. W. cocks repaired	145
Main cocks repaired	45
New S. W. cocks put on	71
Boxes over bridges repaired	4
Fire reservoirs repaired	10
Hydrant boxes repaired in service	269
Stop-cock boxes repaired in service	268

Repairs of Pipes during the Year ending Jan. 31, 1895.

	Diameter of Pipes in Inches.																			Totals.
	48	36	30	28	24	20	16	12	8	6	4	3	2	$1\frac{1}{2}$	$1\frac{1}{4}$	1	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{2}$	
Boston	.	1	2	.	.	23	12	40	9	68	34	5	9	3	4	17	14	478	3	722
South Boston	.	.	.		.	.	.	6	1	8	.	.	3	.	.	1	2	135	15	171
East Boston	.	.	.	.	.	6	1	3	.	9	1	.	4	.	.	2	.	117	5	148
Roxbury	1	2	.	5	.	.	1	15	2	26	3	1	1	2	.	5	4	257	18	343
Dorchester	.	.	.	.	1	.	.	9	4	13	.	.	6	.		1	.	123	4	161
West Roxbury	.	.	.	.	.		2	9	2	10	.	.	4	.	.	.	.	85	2	114
Brighton			.	.	.	.	.	3	1	2	.	.	.	.	.	.	.	22	.	28
Deer Island	.	.	.	.	.		.	.	.	. . .	.	.	.	.	.	.	.	. . . .	.	1
Long Island		.	.	.	.	.		.	.	4	1		.	.	.	.	.	1	.	6
Rainsford Island	.	.	.	.	.	.	.	.	.	. .	4	.	.	.	.	.	.	. . .		4
Galloupe's Island	.	.		.	.	.	.	.	.	. .	3	1	.	.		.	.	. . .	.	4
Moon Island	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	. . .	.	1
	1	3	2	5	1	29	16	85	20	141	46	7	27	5	4	26	20	1,218	47	1,703

Causes of repairs that have been made on pipes of 4-inch diameter and upwards:

Blasting	. . . . . .	8
Settling of earth	. . . . .	15
" in sewer	. . . . .	5
" in tunnel	. . . . .	1
" over foundation-wall	. . .	1
" in channel	. . . . .	2
Struck by pick	. . . . .	2
Defective joints	. . . . .	126
" stop-cocks	. . . .	25
" pipe	. . . . .	15
" packing	. . . . .	101
" check-valve	. . . .	1
" stuffing-box	. . . .	13
" gland	. . . . .	1
Changed grade	. . . . .	1
In way of W. E. St. Ry.	. . .	2
" Park Dept.	. . . .	1
" sewer	. . . . .	8
" tunnel	. . . . .	1
Carried forward,		329

Brought forward,	329	
Took out meter and connected with pipe	2	
Drilled	3	
Frozen	5	
Cap blown off	2	
Clamp loose	1	
Put in air chamber	1	
Capped on each side of bridge	1	
Changed connection	1	
From low to high service	1	
Eaten by soil	1	
Carried over tunnel	2	
		349
On 3-inch and on service-pipes:		
Stopped by rust	501	
" dirt	29	
" fish	50	
" gasket	3	
Eaten by soil	5	
" electricity	3	
Broken by pick	153	
" settling of earth	222	
" pounding from Pumping-station,	3	
" settling in service-pipe box	5	
" settling in sewer trench	33	
" frost	7	
" blasting	3	
" steam-roller	2	
" plough	1	
Gnawed by rats	11	
Defective pipe	57	
" coupling	29	
" joints	33	
" stop-cocks	26	
" valve	14	
" packing	14	
In way of sewer	13	
" B. E. Lt. Company	2	
" Park Dept.	1	
" W. E. St. Ry.	2	
" N. E. Tel. Co.	5	
" edgestone	9	
Changed grade	68	
" direction inside line	1	
Clamp loose	1	
Carried forward,	1,306	349

Extended across new line . . .	3	
Frozen	30	
Cock blown out	3	
Took out S. W. cock and connected with pipe	5	
Connected to new main	5	
Put cock in cap for blow-off . . .	2	
		1,354
		1,703

In addition to the above, 381 service-pipes were shut off for repairs inside street line, and notice of the same sent to the On and Off Division of the Income Department.

Statement of Leaks and Stoppages from 1850 to 1894.

Year.	Diameter in Inches.		Total.
	Four inches and upwards.	Less than four inches.	
1850	32	72	104
1851	64	173	237
1852	82	241	323
1853	85	260	345
1854	74	280	354
1855	75	219	294
1856	75	232	307
1857	85	278	363
1858	77	234	311
1859	82	449	531
1860	134	458	592
1861	109	399	508
1862	117	373	490
1863	97	397	494
1864	95	394	489
1865	111	496	607
1866	139	536	675
1867	122	487	609
1868	82	449	531
1869	82	407	489
1870	157	707	864
1871	185	1,380	1,565
1872	188	1,459	1,647

Statement of Leaks and Stoppages from 1850 to 1894.— *Concluded.*

YEAR.	DIAMETER IN INCHES.		TOTAL.
	Four inches and upwards.	Less than four inches.	
1873	153	1,076	1,229
1874	434	2,160	2,594
1875	203	725	928
1876	214	734	948
1877	109	801	910
1878	213	1,024	1,237
1879	211	995	1,206
1880	135	929	1,064
1881	145	883	1,028
1882	170	1,248	1,418
1883	171	782	953
1884	253	1,127	1,380
1885	111	638	749
1886	150	725	875
1887	172	869	1,041
1888	216	1,140	1,356
1889	183	849	1,032
1890	180	718	898
1891	194	758	952
1892	212	1,232	1,444
1893	327	1,555	1,882
1894	349	1,354	1,703

Respectfully submitted,

WILLIAM J. WELCH,

Superintendent.

REPORT OF THE SUPERINTENDENT OF THE MYSTIC DIVISION.

OFFICE OF SUPERINTENDENT,
CORNER MEDFORD AND TUFTS STREETS,
BOSTON, February 1, 1895.

COL. THOMAS F. DOHERTY,
Chairman, Boston Water Board:

SIR: The report of the Mystic Division of the Boston Water-Works from January 31, 1894, to February 1, 1895, is herewith submitted.

MYSTIC LAKE.

Water was wasted over the dam until June 8, when the highest point was recorded, 6.89 above tide-marsh level. After this date the surface gradually lowered, and in August preparations were made for pumping into the conduit. The pumping machinery, consisting of two Hoadley engines and boilers and two centrifugal pumps, was repaired and placed in position. The cast-iron gratings at the inlets of the gate-chamber were replaced with new ones, and the gates repaired and refitted with new stems.

On August 31, with the surface of the lake at 8.42 below high water and only 2.75 above the conduit invert, the pumping into the conduit began. The surface of the lake continued to fall, and reached a lower point than ever before making it necessary to lengthen the suction-pipes. As the pumping machinery which had been in use for years was of insufficient capacity two new 60-horse power engines and boilers and one new pump, having a capacity of 18,000,000 gallons per day, were purchased. As the service of either pump could not be dispensed with, and as the engine-room was already inadequate, a new engine-house was constructed. The engine-house is a wooden frame building, 65 ft. × 19½ ft., supported by a pile foundation. To make an approach to the new building some filling was required, so the riprap was removed and utilized again on the extended water front.

On October 10 the surface of the water reached its lowest point, 0.91 below the conduit invert, but after this date it began to rise. The old engine in Engine-house No. 2 was disconnected and removed, but further work of setting up the second new engine and boiler was suspended. On November 15 the lake had risen to 2.72 above the conduit invert. Pumping was stopped, and the water again flowed by gravity to the Pumping-station.

The sources of supply have been carefully looked after throughout the year. The Metropolitan Sewerage Commission built a siphon under the Abajona river, near the railroad, and have riprapped the banks adjoining the abutments, making an improvement at that point. Bacon's bridge has been rebuilt with a much stronger structure than the former one. A new fence was built on the west side of Mystic street opposite the ledge, also one near the dam, on the division line of the Brooks' property. The gate-tender's house has also been repaired. A force of men were engaged throughout the summer months in removing the vegetable growth from the shallow portions of the river and ponds. There was a large decrease in this growth during the past year. The filtration experiments, which have been carried on for upwards of two years, have been discontinued, it having been demonstrated that the entire Mystic supply could be filtered so as to furnish water of a satisfactory quality.

The rainfall on the Mystic water-shed for the past twelve months was as follows:

February	3.31	August	2.52
March	1.09	September	2.52
April	3.48	October	5.58
May	5.18	November	3.49
June	0.72	December	3.97
July	3.45	January	3.54
Total			38.85

RESERVOIR.

Two 30-inch stop-gates in the gate-chamber were repaired, new valve-rods were substituted, and the gearing was rearranged, the old 10 to 1 gears were replaced with gears 4 to 1, thus greatly facilitating the operation of the gates. The walks and grounds about the reservoir received the usual attention. About seventy-five loads of stone were carted from the ledge, and will be properly distributed at a favorable opportunity.

The city of Medford was supplied with Mystic water one day in July and one day in January. On September 12 the Cochituate water was turned on to the Charlestown District.

CONDUIT.

The conduit was cleaned and inspected twice during the year, and, at the last inspection, a large crack was discovered about eight feet from the gate-chamber. It extended around the conduit, leaving intact only about three feet at the bottom, and was immediately repaired by being grouted. The force-mains are in good condition. The necessary changes and repairs at the pipe-chamber which have been recommended in previous reports will be made in the spring.

PUMPING–STATION.

The work on the extension of the engine-house was begun November 1. The pump-well and the foundations will be completed in about three weeks and the walls and roof about April 1.

The extension of the building necessitated a rearrangement of the drains, and a 12-inch cast-iron pipe was substituted for the tile drain that took the discharge from Engine No. 3. Outside of the building wall this was enlarged to a 16-inch iron pipe, which was run to the manhole of the main drain on the south-west side of the engine-house. A 6-inch iron pipe was run from the well-pump to the manhole on the west side, and connection was made with the conductors of the building.

The engines and boilers received some slight repairs during the year, and the independent air-pump was overhauled; two new composition plungers, two new bronze metal piston-rods, and a new set of valves and covers were substituted for the old ones.

The old well-pump of 1,000,000 gallons' capacity, which has been in use for over twenty years, is now undergoing repairs. In the pump-well of Engine No. 3, the south-west wall was strengthened by the addition of sixteen inches of brickwork. A course of brick was laid in the bottom, and the entire surface of the well was plastered with Portland cement.

The bridge opposite the engine-house was strengthened and repaired; the engineers' residences were repaired and supplied with steam-pipes and radiators connected with the boilers of the engine-house.

The stable and the wagon-house were also repaired, and about two acres of the adjacent grounds were ploughed and manured.

Mystic-Valley Sewer.

The quantity of sewage pumped from January 31, 1894, to February 1, 1895, was 120,188,032 gallons to which was applied as a precipitant 281,535 lbs. of crude sulphate of alumina.

The quantity of sludge thrown down by the alumina sulphate was 3,302,678 gallons, which was pumped into the settling-basins for subsequent removal. The amount of coal used was 393,472 lbs. The average quantity of sewage pumped per day was 337,606 gallons, and the average quantity of sludge pumped per day was 9,277 gallons, which is $2\frac{3}{4}$ per cent. of the sewage.

The alumina sulphate was applied at the rate of 2,342 lbs. per million gallons of sewage, or one part of alumina sulphate to 3,557 parts of sewage. The removal of sludge from the settling-basins during the past year was done largely by a neighboring farmer who values it highly for grass land.

In May the engine was dismantled four days for repairs, consisting of realignment, resetting of valves, and rebabbiting of boxes on main shaft.

It is expected that the sewage now treated at this station will be discharged into the Metropolitan sewerage system on and after July 1, 1895, and this plant will then be discontinued.

Chemical precipitation of the sewage from Tidd's tannery, in Stoneham, was continued the past year. The total quantity of sewage pumped by the proprietors was 5,244,545 gallons, and the total quantity of sludge pumped was 680,000 gallons.

The amount of alumina sulphate used was 51,571 pounds, making the rate of application of the precipitant 1 to 847. The percentage of sludge pumped to sewage pumped was 13.

During the time that experiments in chemical tanning were being made at this tannery the sewage was so offensive that some treatment became necessary.

At Fitzgerald's tannery, in Stoneham, a series of tanks were built at the owner's expense. They were arranged in such a manner that the heavy particles of sewage would settle in flowing from one tank to another over separating partitions. No chemicals were used, but the sewage from the beam-house contained more or less lime which acted as a precipitant. This method was continued for four or five months until the experiments were finished.

The effluent discharged from the precipitation tanks at the Mystic station has always been somewhat colored, but as the addition of a sufficient quantity of lime or alumina to render the effluent colorless would greatly increase the cost, it has been thought to be better economy to use a sufficient quantity of precipitant to remove the solid matter, and a fair percentage of the matter in solution, and obtain a reasonably clear effluent.

At Tidd's tannery the sewage was different in character than at Mystic station and less colored, yet it required more precipitant pro rata to throw down the solid matter. The effluent, however, was always clear and colorless, or nearly so.

SOURCES OF SUPPLY.

The Metropolitan sewer is expected to be in operation in six or eight months, and the city of Woburn and the towns of Winchester and Stoneham are constructing or arranging to construct, their respective sewerage systems, so that in a short time the Mystic water will be greatly benefited.

A summary of the inspection work for the past year, as reported by Mr. John S. Concannon, Chief Inspector, is as follows: Total number of cases inspected, 694. Of these are, "old cases," 682; "new cases," 12. The present condition of all inspected cases is, at "present safe," 463; "apparently safe," 68; "suspected," 44; "unsatisfactory," 46; "remedied," 73; legal notices served, 43.

In all cases where legal notices were served the cases were attended to and the pollution prevented.

DISTRIBUTION-PIPES.

The distribution-pipes in Charlestown were extended by the addition of 2,612 feet of four-inch pipe, 24,941 feet of six-inch pipe, 5,519 feet of eight-inch pipe, 2,446 feet of ten-inch pipe, and 878 feet of twelve-inch pipe. 54,543 feet of pipe were relaid.

There now remains in Charlestown 6,139 feet of cement-lined pipe, varying in size from 2 to 20 inches.

The abolishment of all grade crossings on Chelsea bridge, which was authorized by the Legislature, and is now being done by the Boston & Maine R.R. Co., necessitated an entire change in the arrangement of the main pipes supplying Chelsea and East Boston. In place of the old 16, 20, and 24 inch pipes there were laid a 24-inch and a 30-inch pipe, the smaller pipe being for the supply of Chelsea and the larger for East Boston. Permission was obtained of the railroad corporation to lay these pipes on their property, and 1,128 feet of each size were permanently laid. In addition, 384 feet each of 16-inch and 30-inch pipe were laid along the side of the temporary street adjoining an unfinished portion of the main thoroughfare, and in the coming summer, when this portion of the road is ready, the 24-inch and the 30-inch pipes will be continued and the temporary pipes removed.

Hydrants and Gates.

One hundred and forty-eight new hydrants, 5 street Lowry hydrants, and 143 Post hydrants, were established in addition to 5 Lowry and 23 Post hydrants set in place of 28 Post hydrants abandoned. Two hundred and thirty-eight gates were established — one 24-inch, three 16-inch, thirteen 12-inch, twenty-two 10-inch, thirty-eight 8-inch, one hundred and thirty 6-inch, and twenty-seven 4-inch. There were forty-four 4-inch, thirty-one 6-inch, six 8-inch and one 12-inch abandoned. Thirteen gate boxes and eleven hydrant boxes were replaced by new ones.

Fountains and Stand-Pipes.

Four new drinking-fountains were established, and twelve new stand-pipes were erected for street-watering purposes.

Service-Pipes.

Eight hundred and fifty-nine new services were laid, distributed as follows: Charlestown, 61; Chelsea, 122; Everett, 315; Somerville, 361; for which 18,436 feet of pipe were required. Three hundred and ninety-nine services were repaired. Twelve services were removed and larger ones substituted. Six service boxes were renewed.

Thirty-one stoppages by eels and thirteen by rust were forced out. Twenty-seven leaking services were repaired.

New Services.

Size	½-in.	⅝-in.	¾-in.	1-in.	1¼-in.	2-in.	3-in.	4-in.	6-in.	Total.	Total ft.
Charlestown	......	41	15	3	....	1	1	......	......	61	1,232
Chelsea	27	86	3	3	....	......	......	3	......	122	3,740
Everett	......	307	......	5	1	1	......	......	1	315	5,736
Somerville	......	......	355	3	....	2	1	.....	......	361	7,728
Totals	27	434	373	14	1	4	2	3	1	859	18,436

Summary of Services, February 1, 1895.

	Charlestown.	Chelsea.	Everett.	Somerville.	Totals.
Number of services	6,144	5,609	3,289	8,215	23,257
Number of feet	164,028	150,957	65,443	274,067	654,495

Breaks and Leaks on Distribution-Pipes.

Size	4.in.	6-in.	8-in.	10-in.	12-in.	16-in.	30-in.	Totals.
Charlestown	......	2	1	......	......	......	1	4
Chelsea	10	8	3	7	......	......	......	28
Everett	3	11	3	2	......	......	......	19
Somerville	15	18	6	1	1	1	......	42
Totals	28	39	13	10	1	1	1	93

Distribution-Pipes Relaid.

Location.	Original Size.	4-in.	6-in.	8-in.	10-in.	12-in.	16-in.	24-in.	Totals.
Charlestown:									
Chelsea Bridge.....	16-in.	......	....	....	....	......	384	1,512	1,896
Chelsea:									
Fifth st............	8-in.	......	....	975	....	.....	......	......	975
" "	4-in.	......	....	272	....	.....	......	......	272
Fremont ave........	4-in.	......	380	....	....	......	......	......	380
Cottage st..........	4-in.	......	1,082	....	....	......	......	......	1,082
Watts st............	4-in.	......	173	....	....	......	......	......	173
Division st.	4-in.	......	257	....	....	......	......	......	257
Wharf st...........	4-in.	......	173	....	....	......	......	......	173
Tudor st.	3-in.	......	1,347	....	....	......	......	......	1,347
Clark ave...........	4-in.	......	1,423	....	....	.....	......	......	1,423
Lawrence st........	3-in.	......	390	....	....	......	......	......	390
Crescent ave........	4-in.	......	860	....	....	......	......	......	860
George st...........	3-in.	......	490	....	....	......	......	......	490
Chestnut st.........	3-in.	......	....	800	....	......	......	......	800
" "	4-in.	......	....	2,100	....	.....	......	......	2,100
Beacon st.	4-in.	......	....	550	....	......	......	......	550
Chestnut st.........	3-in.	......	780	....	....	......	......	......	780
Carey ave.	4-in.	......	97	....	....	......	......	......	97
" "	10-in.	......	....	....	75	......	......	......	75
Everett ave.........	6-in.	......	206	....	....	......	......	......	206
" "	4-in.		615	....	....	......	......	.....	615
Auburn st..........	4-in.	......	625	....	....	......	......	......	625
Williams st.	4-in.	......	275	....	....	......	......	......	275
Everett:									
Union ave..........	3-in.	126	....	....	....	......	.....	......	126
Mystic st...........	4-in.	......	672	....	....	......	......	......	672
Robbins st.	4-in.	......	832	....	....	......	......	......	832
Kippy st.	4-in.	......	456	....	....	......	......	......	456
Harvard st.	4-in.	......	1,113	....	....	......	......	......	1,113
Shute st.	4-in.	......	....	295	....	......	......	......	295
Chelsea	4-in.	......	....	....	365	......	2,183	......	2,548
Ferry Spring.......	6-in.	......	....	....	....	780	......	......	780
Union st.	6-in.	......	....	....	593	......	......	......	593
Ferry st.....	6-in.	......	....	....	4,266	......	......	......	4,266
Carried forward....	....	126	12,246	4,992	5,299	780	2,567	1,512	27,522

Distribution-Pipes Relaid — *Continued.*

LOCATION.	Original Size.	4-in.	6-in.	8-in.	10-in.	12-in.	16-in.	24-in.	Totals.
Brought forward	....	126	12,246	4,992	5,299	780	2,567	1,512	27,522
Summer st.	4-in.	......	....	248	....	......	......	......	248
Hawthorne st.	2-in.	......	337	....	....	......	......	......	337
Everett ave.	6-in.	......	268	....	....	......	......	......	268
Cottage st.	4-in.	......	15	....	....	......	......	......	15
Broadway	4-in.	......	367	....	....	......	......	......	367
Auburn st.	4-in.	15	....	....	....	......	......	......	15
Somerville:									
Elm place	3-in.	13	....	....	....	......	......	......	13
Loring st.	4-in.	6	....	....	....	......	......	......	6
Adams st.	4-in.	......	7	....	....	......	......	......	7
Ashland st.	3-in.	......	47	....	....	......	......	......	47
Beech st.	4-in.	......	21	778	....	......	......	......	799
Chandler st.	4-in.	......	389	....	....	......	......	......	389
Cherry st.	4-in.	......	18	60	....	......	......	......	78
Claremon st.	4-in.	......	585	....	....	......	......	......	585
Craigie st.	4-in.	......	15	1,319	....	......	......	......	1,334
Elm st.	6-in.	......	36	....	....	2,750	......	......	2,786
Evergreen ave.	4-in.	......	27	....	....	......	......	......	27
Harvard st.	8-in.	......	....	....	....	2,775	......	......	2,775
Highland st.	6-in.	......	70	60	....	......	......	......	130
Howe st.	4-in.	......	27	....	....	......	......	......	27
Irving st.	4-in.	......	24	....	....	......	......	......	24
" "	6-in.	......	....	1,182	....	......	......	......	1,182
Mead st.	4-in.	......	270	....	....	......	......	......	270
Moore st.	4 in.	......	574	....	....	......	......	......	574
Park ave.	4-in.	......	516	....	....	......	......	......	516
Pitman st.	4-in.	......	52	....	....	......	......	......	52
Somerville ave.	6-in.	......	30	....	....	1,690	......	......	1,720
Summit st.	4-in.	......	118	....	....	......	......	......	118
Summer st.	6-in.	......	....	....	4,055	......	......	......	4,055
Winter st.	4-in.	......	456	....	....	......	......	......	456
Adams st.	4-in.	......	....	413	....	......	......	......	413
Belmont st.	4-in.	......	....	27	....	......	......	......	27
Harvard st	6 in.	......	....	781	....	......	......	......	781
Lowell st.	6-in.	......	....	14	....	......	......	......	14
Carried forward	....	160	16,515	9,874	9,354	7,995	2,567	1,512	47,977

Distribution-Pipes Relaid — *Concluded.*

Location.	Original Size.	4-in.	6-in.	8-in.	10-in.	12-in.	16-in.	24-in.	Totals.
Brought forward		160	16,515	9,874	9,354	7,995	2,567	1,512	47,977
Linden ave.	4-in.	......	....	1,122	....	......	......	......	1,122
Orchard st.	4-in.	......	....	1,000	....	......	......	......	1,000
Porter st.	4-in.	......	....	61	....	......	......	......	61
Prescott st.	6-in.	......	....	34	....	......	......	......	34
Spring st.	4-in.	......	....	428	....	......	......	......	428
Vinal ave.	6-in.	......	....	40	....	......	......	......	40
Wallace st.	6-in.	......	....	1,360	....	......	......	......	1,360
Marshall st.	6-in.	......	....	....	1,674	......	......	......	1,674
School st.	4-in.	......	....	....	313	......	......	......	313
Central st.	12-in.	......	....	....	....	80	......	......	80
Mossland st.	4-in.	......	....	....	....	394	......	......	394
Sacramento st.	6-in.	......	....	....	....	60	......	......	60
Totals		160	16,515	13,919	11,341	8,529	2,567	1,512	54,543

Extension of Distribution-Pipes.

LOCATION.	4-in.	6-in.	8-in.	10-in.	12-in.	14-in.	16-in.	20-in.	Totals.
Charlestown:									
Rutherford avenue...	......	1,157	......	....	....	......	......	......	1,157
Chelsea:									
Marlboro' street......	......	24	......	....	....	......	......	......	24
Prescott avenue......	......	360	......	....	....	......	......	......	360
Elm street	......	614	......	....	....	......	......	......	614
W. Third street......	......	48	......	....	....	......	......	......	48
Fifth street..........	......	....	1,000	....	....	......	......	......	1,000
Garfield avenue	......	1,504	......	....	....	......	......	......	1,504
Cook avenue.........	......	72	......	....	....	......	......	......	72
Sagamore avenue	......	1,550	......	....	....	......	......	......	1,550
Lambert avenue......	......	278	......	....	....	......	......	......	278
Cheever street........	......	400	......	....	....	......	......	......	400
Maple street..........	......	300	......	....	....	......	......	......	300
Everett:									
George street	337	....	......	....	....	......	......	......	337
Orange court.........	332	....	......	....	....	......	......	......	332
Oliver street	......	316	......	....	....	......	......	......	316
Union avenue........	180	....	......	....	....	......	......	......	180
Pearl street	......	170	......	....	....	......	......	......	170
Tremont street.......	......	333	......	....	....	......	......	......	333
Pleasant street	......	1,571	......	....	....	......	......	......	1,571
Broadway	......	595	......	....	....	......	......	......	595
Carlson street	......	334	......	....	....	......	......	......	334
Betty avenue.........	......	15	......	....	....	......	......	......	15
Baldwin avenue......	......	508	......	....	....	......	......	......	508
Stevenson street......	......	431	......	....	....	......	......	......	431
Jefferson street	......	500	......	....	....	......	......	......	500
Summit avenue	......	15	......	....	....	......	......	......	15
Elm street	......	18	1,496	....	....	......	......	......	1,514
Irving street	......	....	......	805	....	......	......	......	805
Union street..........	......	....	......	505	....	......	......	......	505
Clark street..........	140	28	......	....	....	......	......	......	168
Dyer avenue	207	....	......	....	....	......	......	......	207
Carried forward...	1,196	11,141	2,496	1,310	....	......	......	......	16,143

Extension of Distribution-Pipes. — *Continued.*

LOCATION.	4-in.	6-in.	8-in.	10-in.	12-in.	14-in.	16-in.	20-in.	Totals.
Brought forward	1,196	11,141	2,496	1,310	......	......	......	......	16,143
Locust street	325	......	......	......	......	......	......	......	325
Hazel Park	187	......	......	......	......	......	......	......	187
Glendale street	......	681	......	......	......	......	......	......	681
Union street	......	128	......	......	......	......	......	......	128
Malden street	......	388	......	......	......	......	......	......	388
Henderson street	......	290	......	......	......	......	......	......	290
Francis street	......	1,348	......	......	......	......	......	......	1,348
Sunnyside avenue	......	334	......	......	......	......	......	......	334
Neilson avenue	17	......	......	......	......	......	......	......	17
Blanchard avenue	17	......	......	......	......	......	......	......	17
Ferry street	......	420	......	......	780	......	......	......	1,200
Crescent street	......	109	......	......	......	......	......	......	109
Woodland avenue	......	222	......	......	......	......	......	......	222
Pleasant avenue	......	340	......	......	......	......	......	......	340
Tappan street	......	148	......	......	......	......	......	......	148
Waters avenue	......	210	......	......	......	......	......	......	210
Elmway	......	14	......	......	......	......	......	......	14
Williams street	......	134	......	......	......	......	......	......	134
Norman street	......	145	......	......	......	......	......	......	145
Adams avenue	......	38	......	......	......	......	......	......	38
Jackson avenue	......	41	......	......	......	......	......	......	41
Madison avenue	......	19	......	......	......	......	......	......	19
Springvale avenue	......	545	......	......	......	......	......	......	545
Calhoun avenue	......	300	......	......	......	......	......	......	300
Jefferson street	......	319	......	......	......	......	......	......	319
Cedar street	......	486	......	......	......	......	......	......	486
Bennett street	......	92	......	......	......	......	......	......	92
Bradford street	......	27	......	......	......	......	......	......	27
Magnolia court	173	......	......	......	......	......	......	......	173
Winter street	......	510	......	......	......	......	......	......	510
Vine	......	......	......	45	......	......	......	......	45
Street, off Elm street	......	15	......	......	......	......	......	......	15
Street, off Elm street	......	15	......	......	......	......	......	......	15
Summit street	......	15	......	......	......	......	......	......	15
Carried forward	1,915	18,474	2,496	1,355	780	......	......	......	25,020

Extension of Distribution-Pipes. — *Continued.*

LOCATION.	4-in.	6-in.	8-in.	10-in.	12-in.	14-in.	16-in.	20-in.	Totals.
Brought forward ..	1,915	18,474	2,496	1,355	780	......	......	......	25,020
Somerville:									
Cook street	3	....	.....	....	....	......	......	......	3
Cragie street.........	6	9	......	....	....	......	......	......	15
Lexington avenue....	52	....	......	....	....	......	......	......	52
Linden avenue	285	....	......	....	....	......	......	......	285
Summer street	40	34	......	891	....	......	......	......	965
Walter street	7	....	......	....	....	......	......	......	7
Walter place.	8	....	......	....	....	......	......	......	8
Wheeler street.......	293	....	......	....	....	......	......	......	293
Wyatt street.........	3	....	......	....	....	......	......	......	3
Adams street	......	10	......	....	....	......	......	......	10
Ames street..........	......	6	......	....	....	......	......	......	6
Avon street..........	......	6	......	100	....	......	......	......	106
Bartlett street........	......	316	......	....	....	......	......	......	316
Beech street	......	345	......	....	....	......	......	......	345
Bradley street	......	278	......	....	....	......	......	......	278
Cedar avenue	......	55	......	....	....	......	......	......	55
Centre street.........	......	219	......	....	....	......	......	......	219
Claremon street......	......	6	......	....	....	......	......	......	6
Concord avenue......	......	21	......	....	....	......	......	......	21
Cutter avenue........	......	96	......	....	....	......	......	......	96
Elm street	......	65	......	....	....	......	......	......	65
Francesca avenue	......	7	......	....	....	......	......	......	7
Fremont street.......	......	115	......	....	....	......	......	......	115
Gordonia road	......	16	......	....	....	......	......	......	16
Gorham street	......	6	......	....	....	......	......	......	6
Hall avenue..........	......	7	......	....	....	......	......	......	7
Harvard street.......	......	7	......	....	....	......	......	......	7
Hawthorne street	......	158	......	....	....	......	......	......	158
Highland avenue.....	......	24	......	....	....	......	......	......	24
Irving:	......	8	......	....	....	......	......	......	8
Jenny Lind avenue ..	......	266	......	....	....	......	......	......	266
Linden avenue.......	......	21	......	....	....	......	......	......	21
Marshall street	......	42	......	....	....	......	......	......	42
Carried forward ..	2,612	20,617	2,496	2,346	780	......	......	......	28,851

Extension of Distribution-Pipes. — *Continued.*

LOCATION.	4-in.	6-in.	8-in.	10-in.	12-in.	14-in.	16-in.	20-in.	Totals.
Brought forward ..	2,612	20,617	2,496	2,346	780	......	......	......	28,851
Meacham street......	......	8	......	....	....	......	......	......	8
Mead street..........	......	20	......	....	....	......	......	......	20
Medford street	......	18	......	....	....	......	......	......	18
Melvin street	......	62	......	....	....	......	......	......	62
Minnie avenue	......	722	......	....	....	......	......	......	722
Moore street	......	150	......	....	....	......	......	......	150
Moreland street	......	153	......	100	....	......	......	......	253
Mortimer place	......	100	......	....	....	......	......	......	100
Mossland street......	......	7	......	....	....	......	......	......	7
Munroe street........	......	16	......	....	....	......	......	......	16
Orchard street	......	18	......	....	....	......	......	......	18
Park avenue	......	6	......	....	....	......	......	......	6
Pembroke street	......	62	......	....	....	......	......	......	62
Russell street........	......	283	......	....	....	......	......	......	283
Sacramento street....	......	10	......	....	....	......	......	......	10
School street....... ...	......	7	......	....	....	......	......	......	7
Somerville avenue....	......	20	......	....	....	......	......	......	20
Spring street.........	......	7	......	....	....	......	......	......	7
Staniford street	......	218	......	....	....	......	......	......	218
Sycamore street......	......	602	3	....	....	......	......	......	605
Tower street.........	......	7	600	....	....	......	......	......	607
Veazie street	......	342	......	....	....	......	......	......	342
Wallace street	......	35	......	....	....	......	......	......	35
Walton street........	......	563	......	....	....	......	......	......	563
Ware street..........	......	132	......	....	....	......	......	......	132
Washington street ...	......	9	......	....	....	......	......	......	9
Winter street	......	6	......	....	....	......	......	......	6
Woodbine street	......	472	......	....	....	......	......	......	472
Walter place.........	......	214	......	....	....	......	......	......	214
Banks street	......	....	52	....	....	......	......	......	52
Bradley street........	......	....	204	....	....	......	......	......	204
Burnside avenue	......	....	239	....	....	......	......	......	239
Francesca avenue	......	....	33	....	....	......	......	......	33
Carried forward ..	2,612	24,886	3,627	2,446	780	......	......	......	34,351

Extension of Distribution Pipes. — *Concluded.*

LOCATION.	4-in.	6-in.	8-in.	10-in.	12-in.	14-in.	16-in.	20-in.	Total.
Brought forward	2,612	24,886	3,627	2,446	780	......	......	......	34,351
Tremont street	......	....	567	....	....	......	......	......	567
Hall avenue	......	....	431	....	....	......	......	......	431
Hancock street	......	....	100	....	....	......	......	......	100
Liberty avenue	......	....	218	....	....	......	......	......	218
Meacham street	......	....	504	....	....	......	......	.....	504
Melvin street	......	....	72	....	....	......	......	......	72
Central street	.....	....	......	....	6	......	......	.....	6
Kent street	......	....	......	....	76	......	......	......	76
Lowell street	......	....	......	....	16	......	......	.....	16
Richdale avenue	......	55	......	....	....	......	......	......	55
Totals	2,612	24,941	5,519	2,446	878	......	......	......	36,396

Length of Pipes, Relaid, Extended, and Abandoned.

1894.	3-in.	4-in.	6-in.	8-in.	10-in.	12-in.	16-in.	24-in.	Totals.
Charlestown:									
Pipes relaid	......	....	....	....	....	......	384	1,582	1,896
Pipes extended	......	....	1,157	....	....	......	......	.....	1,157
Total laid	......	....	1,157	....	....	......	384	1,512	3,053
Pipes abandoned	......	....	....	....	....	......	1,896	......	1,896
Net increase or decrease	.....	....	1,157	....	....	......	1,512	1,512	1,157
Chelsea:									
Pipes relaid	......	....	9,173	4,697	75	......	......	......	13,945
Pipes extended	......	....	5,150	1,000	....	......	......	......	6,150
Total laid	......	....	14,323	5,697	75	......	......	.....	20,095
Pipes abandoned	3,807	8,882	206	975	75	......	......	......	13,945
Net increase or decrease	3,807	8,882	14,117	4,722	....	......	......	......	6,150
Somerville:									
Pipes relaid	......	19	3,282	8,679	6,042	7,749	......	......	25,771
Pipes extended	......	697	6,467	3,023	1,091	98	......	......	11,376
Total laid	......	716	9,749	11,702	7,133	7,847	......	......	37,147
Pipes abandoned	60	9,020	13,836	2,775	....	80	......	......	25,771
Net increase or decrease	60	8,304	4,087	8,927	7,133	7,767	......	......	11,376
Everett:									
Pipes relaid	......	141	4,060	543	5,224	780	2,183	......	12,931
Pipes extended	......	1,915	12,167	1,496	1,355	780	......	......	17,713
Total laid	......	2,056	16,227	2,039	6,579	1,560	2,183	......	30,644
Pipe abandoned	126	6,561	5,907	....	....	......	......	......	12,594
Net increase or decrease	126	4,505	10,320	2,039	6,579	1,560	2,183	......	18,050

	3-in.	4-in.	6-in.	8-in.	10-in.	12-in.	16-in.	24-in.	Totals.
Mystic Works, totals									
Pipes relaid................	......	160	16,515	13,919	11,341	8,529	2,567	1,512	54,543
Pipes extended	......	2,612	24,941	5,519	2,446	878	......	......	36,396
Total laid	......	2,772	41,456	19,438	13,787	9,407	2,567	1,512	90,939
Pipes abandoned	3,993	24,463	19,949	3,750	75	80	1,896	......	54,206
Net increase or decrease ...	3,993	21,691	21,507	15,688	13,712	9,327	671	1,512	36,733

Length of Distributing-Mains connected with Works, February 1, 1895.

	Diameter.												
	3-in.	4-in.	6-in.	8-in.	10-in.	12-in.	14-in.	16-in.	18-in.	20-in.	24-in.	30-in.	36-in.	Totals.
Charlestown	2,436	25,033	65,543	22,951	7,063	15,087	....	18,628	....	6,180	18,494	25,296	974	207,685
Chelsea	14,506	53,480	67,722	15,327	28,536	....	....	2,348	....	....	....	....	....	181,919
Everett	788	56,581	73,222	11,453	20,563	1,937	206	2,233	....	2,900	....	....	....	169,883
Somerville	6,905	74,819	170,319	53,243	20,853	20,938	8,037	996	387	1,063	....	....	....	357,560
Totals	24,635	209,913	376,806	102,974	77,015	37,962	8,243	24,205	387	10,143	18,494	25,296	974	917,047

Number of Gates connected with Works, February 1, 1895.

	3-in.	4-in.	6-in.	8-in.	10-in.	12-in.	14-in.	16-in.	18-in.	20-in.	24-in.	30-in.	36-in.	Totals.
Charlestown	13	170	230	59	20	38	....	25	....	4	12	12	....	583
Chelsea	30	175	108	30	22	....	....	....	....	....	....	....	....	365
Everett	2	155	266	25	36	4	1	4	....	4	....	....	....	497
Somerville	5	197	348	61	38	41	....	2	....	1	....	....	....	693
Totals	50	697	952	175	116	83	1	31	....	9	12	12	....	2,138

Hydrants Established.

	Established.				Increase.	Remarks.
	Lowry.	Boston Lowry.	Post.	Flush.		
Charlestown	10	....	....	....	5	5 P. aban. in Charlestown.
Chelsea	....	....	13	....	13	
Everett	....	....	56	....	56	
Somerville	....	....	97	....	74	23 P. aban. in Somerville.
Totals	10	....	166	....	148	

Total Number of Hydrants in use February 1, 1895.

	Lowry.	Boston Lowry.	Post.	Flush.	Total.	
Charlestown	215	37	74	10	336	
Chelsea	....	....	196	4	200	
Everett	....	....	257	....	257	
Somerville	....	....	642	....	642	
Medford	....	....	2	6	8	
Pumping-station	....	....	2	1	3	
Totals	215	37	1,173	21	1,446	

Respectfully submitted,

EUGENE S. SULLIVAN,

Superintendent.

APPENDIX D.

REPORT OF THE ENGINEER.

ENGINEERING DEPARTMENT,
CITY HALL, January 31, 1895.

THOMAS F. DOHERTY, Esq.,
Chairman Boston Water Board:

SIR: I hereby submit the following report of the work done and records kept during the past year:

SOURCES OF SUPPLY.

The rainfall during the year 1894 was much below the average, and in consequence the supply of water in the different storage reservoirs was reduced to a very small amount.

The rainfall and quantities collected on the several water-sheds were as follows:

	Sudbury.	Cochituate.	Mystic.
Rainfall in inches .	39.74	39.08	39.24
" collected in inches .	16.182	12.99	14.40
Daily average yield of water-shed in gallons . .	57,937,800	11,674,000	18,429,500

Reservoir No. 1.

Grades, H. W., 161.00; Tops of Flash-boards, 159.29 and 158.41; Crest of Dam, 157.54. Area, Water Surface, 143 acres; Greatest Depth, 14 ft.; Contents below 161.00, 376,900,000; Below 159.29, 288,400,000 gals.

The surface of this reservoir was about 2 feet below the crest of the dam on January 1, 1894, and no water was wasted until February 23. With the exception of four days in April, water was wasted over the dam from February 23 until May 7, when the flash-boards were placed upon the dam. On May 26 the reservoir was full and waste began over the flash-boards, continuing until June 13.

The flash-boards were removed on November 8, and waste occurred from November 8 to December 3, from December 16 to 22, and on December 27 and 28.

This dam is in good condition.

Reservoir No. 2.

Grades, H. W., 168.00; Tops of Flash-boards, 167.12 and 166.49; Crest of Dam, 165.87. Area, Water Surface, 134 acres; Greatest Depth, 17 ft.; Contents, Below 168.00, 568,300,000; Below 167.12, 529,860,000 gals.

This reservoir was 7 feet below the level of the top of the flash-boards on January 1, 1894. On February 23 the water level reached the crest of the dam, and the reservoir remained full until the middle of June, when it was drawn upon for the supply of the city, and on July 17 it was 7 feet below the flash-boards. During August and September water was run into the reservoir from Reservoirs 4 and 6, raising the water surface about 2 feet, and in November and December it was gradually filled so that on January 1, 1895, the water surface was about 1 foot below high water.

The dam is in good condition.

Reservoir No. 3.

Grades, H. W., 177.00; Crest of Dam (no Flash-boards), 175.24. Area at 177.00, 253 acres; Contents, below 177.00, 1,224,500,000 gallons. Area at 175.24, 248 acres; Contents below 175.24, 1,081,500,000 gals. Greatest Depth, 21 ft.

On February 1, 1894, this reservoir was 2.68 feet below high-water mark. On February 21 waste began over the dam, and continued during the greater portion of the time until June 6. On July 18 the surface had fallen to 168.42, or 6.82 feet below the crest of the dam. On November 8 the reservoir was again full, and has continued at or near that point to the present time.

The dam is in good condition.

Reservoir No. 4.

Grades, H. W., 215.21; Tops of Flash-boards, 215.21 + and 214.89; Crest of Dam, 214.23. Area, Water Surface, 167 acres; Greatest Depth, 49 ft.; Contents below 215.21, 1,416,400,000 gals.

On February 1, 1894, this reservoir was 29.45 feet below high-water mark. It was gradually filling during March, April, and May, and reached high-water mark on June 6.

On July 17 it was drawn upon for the supply of the city, and on September 11 the reservoir was practically empty, and the outlet gate was closed. Since November 1 it has been gradually filling.

The dam is in good condition.

Reservoir No. 5.

Work upon the construction of the dam was commenced on April 10 by the contractors, and has been prosecuted throughout the year. About two miles of new highway have been built to replace a road cut off by the dam. Surveys have been made and plans and specifications are now being prepared for removing the shallow flowage in the reservoir from the dam to Southboro'. It is proposed to leave the shallow flowage on the Marlboro' branch of the reservoir, which is at a higher level, until next year.

The following report of Desmond FitzGerald, resident engineer, gives further information in regard to the work on this reservoir, as well as other matters connected with additional supply:

South Framingham, Mass., January 1, 1895.

William Jackson, Esq., *City Engineer:*

Dear Sir: The following brief report of engineering work for the year 1894 on Additional Supply is submitted. Basin No. 6 was sufficiently completed on January 1 to be put into service, and furnished the city with water during the summer. It was filled in the spring, and as the water rose the riprap was added on the up-stream slope. Later in the season the walk on top of the dam was added, and the slope on the down-stream side sodded and seeded. The dam and basin may be said to be entirely completed, although the filter beds in connection with Gate-house No. 2 have only been fairly commenced.

The branches and gates for the distribution of the water have, however, been placed in position. On the last day of April the taking plans were filled for Basin No. 5.

They covered 228 separate parcels of land, and the descriptions required 151 sheets of legal cap. The final locations of all the roads have been determined. There are 1.66 miles of road to be raised, 5.8 miles to be rebuilt, and 8.43 miles to be discontinued. The work of cross sectioning the entire basin is now under way.

On April 10 Moulton & O'Mahoney began work on Basin No. 5, and have made excellent progress. The stripping under the dam has been completed, the trenches excavated, and the core-wall laid on its foundations for about half the length of the dam. In the centre of the valley the rock was found to be of very poor quality, as was expected, and the excavations were carried out deeper than the plans called for. The three 48-inch pipes in the Gate-house have been laid and covered with rubble masonry, and the foundations for the overflow carried across the bed of the stream and completed to grade 190. The following table shows the materials handled:

Soil stripping . .	29,794	cubic	yards.
Earth excavation . .	36,548	"	"

Rock excavation	.	14,607	cubic yards.
Concrete masonry	.	3,348	" "
Rubble "	.	6,410	" "
Brick "	.	21	" "
Range work "	.	164	" "
Dimension "	.	84	" "
Plastering "	.	1,207	square "

Early in the spring plans and specifications were prepared for building about two miles of new highway below the dam to replace a road cut off by the dam. Berry Bros. secured the contract on June 7, and work began on June 18, and was completed on November 16. The following is a table of quantities:

NOVEMBER 24, 1894.

Fourth and final estimate of work done and material furnished on two roads in Framingham and Southboro, by Berry Bros., under their contract dated June 7, 1894. (199–1894–27:)

27,245	cubic yards	Earth excavation,	Item "*a*," at 0.19	$5,176 55
555.4	" "	Rock " . .	" "*b*," " 1.25	694 25
287	" "	Split stone Masonry,	" "*c*," " 7.25	2,080 75
459.4	" "	Dry rubble "	" "*d*," " 3.75	1,722 75
113.2	" "	Paving in mortar	" "*e*," " 3.50	396 20
35.75	" "	Concrete . .	" "*f*," " 4.25	151 94
652.85 rods	.	Stone wall . .	" "*g*," " 3.75	2,448 19
Total				$12,670 63

Very truly yours,

(Signed) DESMOND FITZGERALD,
Resident Engineer.

Reservoir No. 6.

Grades, H. W., 295.00; Top of Flash-boards, 295.00; Crest of Dam, 294.00. Estimated Area, 185 acres; Estimated Contents, 1,530,300,000 gals.

This reservoir was so nearly completed that it was used for the storage of water during the spring of 1894.

There was not sufficient rainfall to completely fill the basin, but the surface rose to within 2.25 feet of the high-water mark. During September and October water was taken from this reservoir for the supply of the city, and its surface was lowered about 18 feet. The outlet gate was closed on November 30, and on December 31 the water had risen to 278.78. The riprap on the up-stream slope of the dam has been completed, the down-stream slope sodded and seeded, and a walk made on the top of the dam.

In the fall it was found that a dam on a stream near the head of the reservoir had been rebuilt by the owners of the land, thus flowing a large swamp. The dam and about forty acres of land above have been taken for the purpose of removing the dam and deepening the brook.

The dam is in good condition.

Whitehall Pond.

Elevation, H. W. 327.91; Bottom of Gates, 317.78.
Area at 327.91, 601 acres; Contents, between 327.91 and 317.78, 1,256,900,000 gals.

On January 1 the surface of the pond was 2.97 feet below high water. During the spring it rose, and on June 4 was 326.82 or 1.09 below high water. On September 19, it had fallen to 324.35, and on October 25 to 322.40.

During October, November, and December it remained near this height, rising during the latter month to 323.23 on December 31. About 10,000,000 gallons per day were drawn from the pond from August 17 to 21, and from September 13 to October 18. During the remainder of the year no water was drawn from the pond except to supply Wood Bros. shoe factory. Plans and specifications for a new dam at the outlet of the pond are now being made.

Cedar Swamp. — Surveys have been made for the taking of land, and plans and specifications have been prepared for the draining of the swamp.

Farm Pond.

Grades, H. W. 149.25; Low Water, 146.00.
Area at 149.25, 159 acres; Contents, between 149.25 and 146.00, 165,500,000 gals.

No water was taken from this pond for the supply of the city. The surface of the pond was about .50 below high-water on January 1, 1894. On February 21 it reached high water mark and remained at or near that point until June 14. The lowest point reached was 148.17 on September 16, and on December 31 it was 148.79, or .46 feet below high water mark.

The Framingham Water Company has drawn 117,000,000 gallons from the pond during the year.

Lake Cochituate.

Grades, H. W. 134.36; Invert Aqueduct, 121.03; Top of Aqueduct, 127.36.
Area, Water Surface at 134.36, 785 acres; Contents, between 134.36 and 127.36; 1,515,180,000; between 134.36 and 125.03; 1,910,280,000 gals.
Approximate Contents, Between 134.36 and 121.03, 2,447,000,000 gals.; Between 134.36 and 117.03, 2,907,000,000 gals.

The dam is in good condition.

On January 1 the surface of the lake was 6.42 feet below high-water mark. On March 13 water was turned into the lake from the Sudbury river, and on April 1 it was 1.76

below high water. On May 1 the lake was practically full, and it remained near high-water mark until the middle of June, after which its surface gradually fell until December 10, when it reached the lowest point during the year, 126.10 above tide-marsh level, or 8.26 below high water. Since that date it has risen slightly, and is now, February 1, 7.46 below high-water mark. The beds for filtering the water of Pegan brook have been in use during the greater portion of the year, and 192,447,000 gallons of water have been pumped on to the beds. No difficulty has been experienced in the operation of the beds during the winter.

Water has been drawn from the different reservoirs as follows:

From	7	A.M. Jan. 1	to	1	P.M. Mar. 15	from	Reservoir	No. 1.
"	1	P.M. Mar. 15	"	11	A.M. April 10	"	"	" 1, 2, 3.
"	11	A.M. April 10	"	11	A.M. May 19	"	"	" 2, 3.
"	11	A.M. May 19	"	11	A.M. May 21	"	"	" 2.
"	11	A.M. May 21	"	2	P.M. May 23	"	"	" 2, 3.
"	2	P.M. May 23	"	11.30	A.M. May 26	"	"	" 3.
"	11.30	A.M. May 26	"	7	A.M. June 1	"	"	" 2, 3.
"	7	A.M. June 1	"	2	P.M. June 4	"	"	" 3.
"	2	P.M. June 4	"	11	A.M. June 11	"	"	" 2, 3.
"	11	A.M. June 11	"	11	A.M. June 20	"	"	" 2.
"	11	A.M. June 20	"	7	A.M. July 18	"	"	" 2, 3.
"	7	A.M. July 18	"	3	A.M. Aug. 24	"	"	" 2.
"	3	A.M. Aug. 24	"	7	A.M. Aug. 25	"	"	" 2, 3.
"	7	A.M. Aug. 25	"	3	P.M. Sept. 7	"	"	" 2.
"	3	P.M. Sept. 7	"	3	P.M. Sept. 10	"	"	" 2, 3.
"	3	P.M. Sept. 10	"	3	P.M. Oct. 30	"	"	" 2.
"	3	P.M. Oct. 30	"	3	P.M. Oct. 31	"	"	" 1, 2.
"	3	P.M. Oct. 31	"	1	P.M. Nov. 2	"	"	No flow.
"	1	P.M. Nov. 2	"	12	M. Nov. 17	"	"	" 2.
"	12	M. Nov. 17	"	7	A.M. Nov. 20	"	"	" 2, 3.
"	7	A.M. Nov. 20	"	3	P.M. Nov. 21	"	"	" 3.
"	3	P.M. Nov. 21	"	1.20	P.M. Nov. 22	"	"	" 2.
"	1.20	P.M. Nov. 22	"	3	P.M. Nov. 23	"	"	No flow.
"	3	P.M. Nov. 23	"	3	P.M. Nov. 27	"	"	" 2, 3.
"	3	P.M. Nov. 27	"	3	P.M. Dec. 1	"	"	" 2.
"	3	P.M. Dec. 1	"	11	A.M. Dec. 3	"	"	" 2, 3.
"	11	A.M. Dec. 3	"	7	A.M. Jan. 1	"	"	" 1.

The heights of the water in the various storage reservoirs on the first day of each month are given below:

	Reservoirs. No. 1.	Reservoirs. No. 2.	Reservoirs. No. 3.	Reservoirs. No. 4.	Reservoirs. No. 6.	Farm Pond.	White-hall Pond.	Lake Cochituate.
	Top of Flash-boards.	Top of Flash-boards.	Crest of Dam.	Crest of Dam.	Top of Flash-boards.	High Water.	High Water.	Top of Flash-boards.
	159.29	167.12	175.24	215.21	295.00	149.25	327.91	134.36
January 1, 1894 . .	155.55	160.17	168.53	178.83	. . . .	148.74	. . . .	127.94
February 1, " . .	155.05	160.61	172.32	185.92	259.33	148.98	. . . .	127.59
March 1, " . .	157.87	166.12	175.54	192.70	268.42	149.27	. . . .	128.22
April 1, " . .	157.71	166.01	175.40	204.84	281.52	149.32	. . . .	132.60
May 1, " . .	157.75	166.02	175.39	211.39	288.26	149.50	326.700	134.13
June 1, " . .	159.56	167.24	175.54	214.60	291.08	149.39	326.800	134.24
July 1, " . .	159.12	162.92	172.62	215.26	292.66	149.03	326.435	133.24
August 1, " . .	158.52	162.02	169.29	207.36	292.68	148.66	325.812	131.59
September 1, " . .	157.86	162.57	170.92	191.63	292.54	148.34	324.900	129.88
October 1, " . .	157.46	162.94	170.95	185.54	283.30	148.19	323.680	128.14
November 1, " . .	157.34	164.08	172.77	187.55	274.23	148.34	322.570	126.74
December 1, " . .	157.69	164.55	175.40	191.90	275.29	148.49	322.445	126.27
January 1, 1895 . .	156.50	166.00	175.24	196.18	278.84	148.79	323.230	126.28

Aqueducts and Distributing Reservoirs.

The Sudbury-river aqueduct has been in use 343.7 days, and has delivered 11,450,600,000 gallons into Chestnut Hill Reservoir and 962,200,000 gallons into Lake Cochituate.

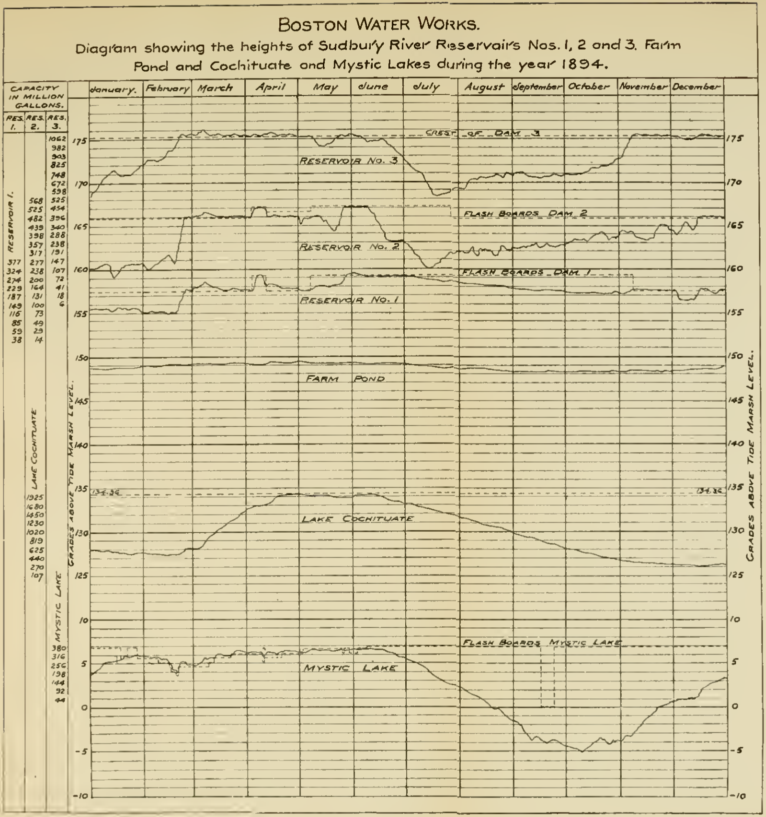
The Cochituate Aqueduct has been used 361.5 days, and delivered 5,520,092,100 gallons. Both aqueducts have been cleaned during the year.

The distributing reservoirs are in good condition.

High Service Pumping-Stations.

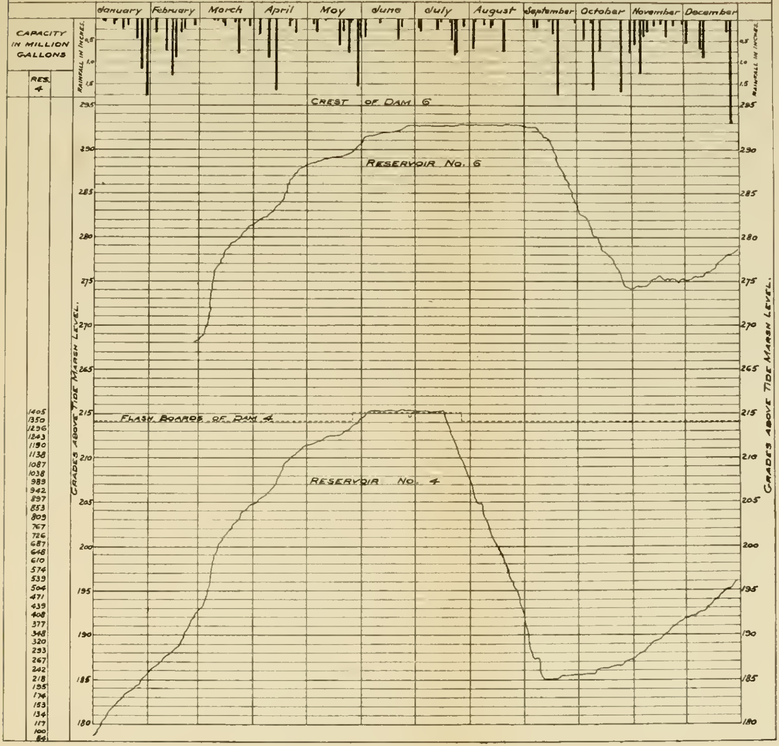
The daily average quantity pumped at the Chestnut Hill station was 8.12 per cent. more than in 1893.

Engine No. 1 was run 4,401 hours 55 minutes, pumping . . .	1,864,913,005 gallons
Engine No. 2 was run 4,642 hours 20 minutes, pumping . . .	1,927,061,540 "
Engine No. 3 pumped . . .	3,856,050 "



Boston Water Works.

Diagram showing the heights of Sudbury River Reservoirs Nos. 4 and 6, and the Rainfall on the Sudbury River Water Shed during the year 1894.



Total amount pumped . . .	3,795,830,595 gallons
Total amount coal used	4,637,660 lbs.
Percentage ashes and clinkers . .	7.4
Average lift in feet . . .	126.18
Quantity pumped per lb. of coal .	818.59 gallons
Daily average amount pumped .	10,399,500 "

Table VII. on page 182 shows in detail the work done by the engines and boilers.

COST OF PUMPING.

Salaries	$15,150 31
Fuel	7,929 59
Repairs	548 48
Oil, waste, and packing	842 59
Small supplies	660 81
Total	$25,131 78

Cost per million gallons raised one foot high .	$0.052
" " " " pumped to reservoir .	6.62

Engine No. 3 has been in process of erection during the year, and was started for the first time on December 3.

The work of lagging and painting the engine is now being done, and the work will soon be completed. This engine, shown on accompanying plates, possesses several novel features.

It has been built by the Quintard Iron Works, of New York, from designs furnished by E. D. Leavitt, of Cambridge, Mass.

It is a triple expansion, three-crank rocker engine, with pistons 13.7, 24.375, and 39 inches in diameter and 6-foot stroke. The cylinders are vertical and inverted, and are carried together, with valve gear, on an entablature supported by six vertical and six diagonal columns.

The steam and exhaust valves are gridiron slides, worked by cams on a horizontal shaft, which is driven by gearing from the crank shaft. The cut-off of the high-pressure cylinder is regulated by the governor through the agency of a hydraulic cylinder, which advances or retards the cut-off cam by means of a spiral sleeve; the cut-offs of the other engines are fixed. The steam passes into the high-pressure cylinder through a separator forming a part of the inlet side-pipe. After expanding in this cylinder it passes through a tubular reheater to the intermediate cylinder, and thence through another similar reheater to the low-pressure cylinder.

The reheaters have steam of boiler pressure, or 185 pounds per square inch, on the inside of the tubes, and the working steam on the outside.

All the cylinders are steam-jacketed on the heads and barrels, the low-pressure cylinder with steam at 100 pounds and the others at 185 pounds. The jackets and reheaters using steam of boiler pressure are drained back to the boilers, while the low-pressure cylinder jacket and the working-steam side of the reheaters are drained by automatic traps discharging into the feed-water heater.

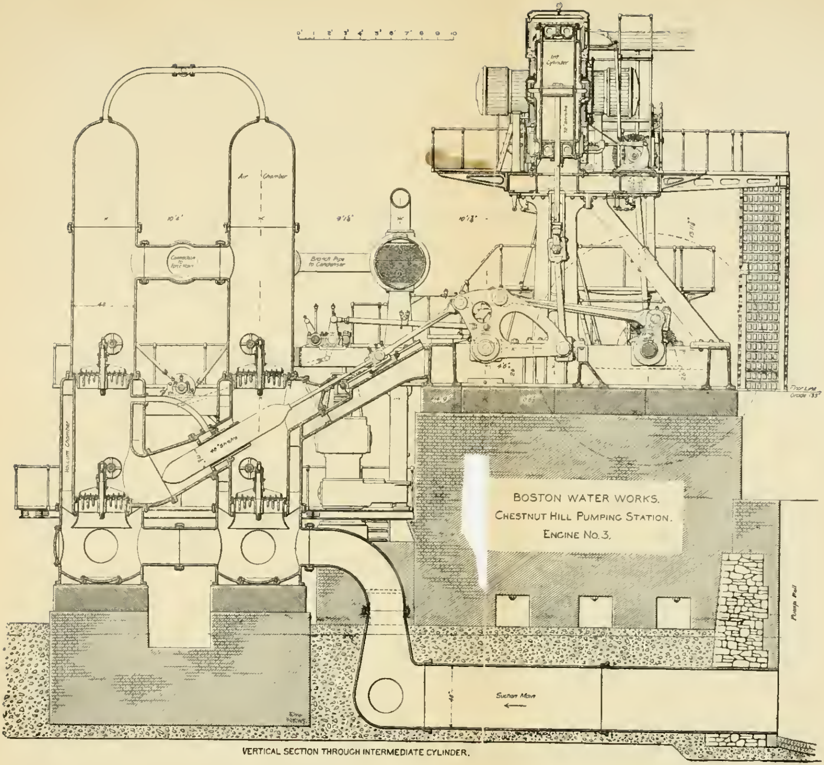
The engine cross-heads work on guides cast in the vertical columns. The motion is transmitted from the cross-heads by links to beams or rockers carried in pedestals on the bed-plate of the engine. From these beams the connecting-rods work off in one direction and the pump links in the opposite direction, but inclined at an angle of about 30 degrees from the horizontal. The leverage of the various pins in the beams is such that the stroke, which is six feet in the case of the steam pistons, is reduced to four feet for the pump plungers, which is also the amount of the double throw of the cranks. The crank-shaft has three cranks set at angles of 120 degrees, the low-pressure crank leading, followed by the intermediate and high-pressure cranks.

The shaft is carried in four adjustable four-box pedestals, with overhung end cranks. Between two of these pedestals is the fly-wheel, and between the other two the gear for driving the cam-shaft. There are three double-acting inclined pumps, having plungers 17.5 inches in diameter and of 4 feet stroke. The pumps are seated on foundations at a lower level than those for the engines, the pump chambers being tied to the engine bed plate by horizontal girders, as well as by the pump cross-head guides, which are inclined 30 degrees from the horizontal. This peculiar arrangement of inclined pumps was found necessary to suit existing conditions of engine-house, pump-well, etc.

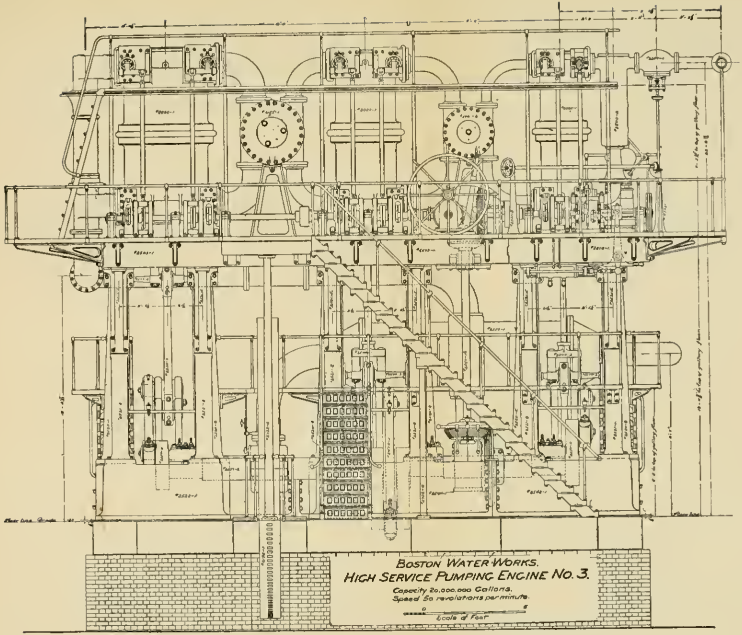
The pump bases, or suction chambers, six in number, one for each end of each pump, are connected together, and the bases of each pump are connected by a separate suction-pipe.

The lower or working pump chambers are surrounded by annular spaces throughout their height, forming vacuum chambers.

The upper pump chambers contain the delivery nozzles, and above these are the air chambers, all six of the latter being connected by pipes. Each end of each pump has one suction and one delivery valve, consisting of a number of rigidly connected rings covering annular openings in the



VERTICAL SECTION THROUGH INTERMEDIATE CYLINDER.


BOSTON WATER WORKS.
HIGH SERVICE PUMPING ENGINE No. 3.
Capacity 20,000,000 Gallons.
Speed 50 revolutions per minute.
Scale of Feet


ATLANTIC WORKS
BOSTON
FOR BOSTON WATER BOARD
CALUMET & HECLA
COMPANY Nº1
HOUGHTON
MICHIGAN

FIG. 1

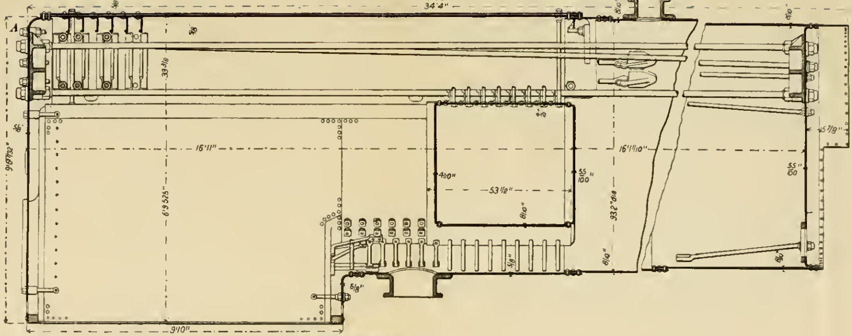


FIG. 2

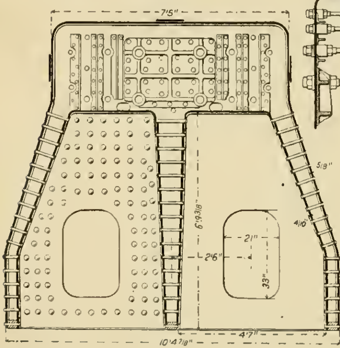


FIG. 5

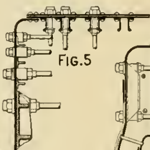


FIG. 3

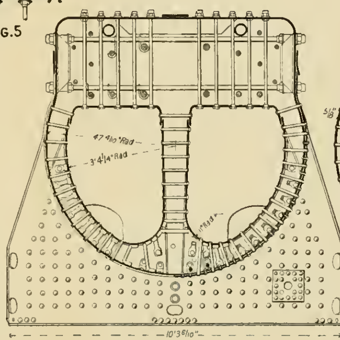
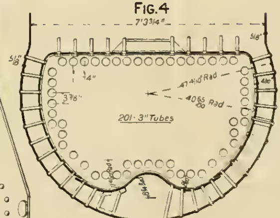


FIG. 4



valve seats. The speed necessary for the required duty capacity of 20,000,000 gallons per 24 hours is 50 revolutions per minute, but the engine has been designed to run easily at 60 revolutions. The head pumped against is 128 feet, or about 55 pounds per square inch.

Each pump contains one suction and one delivery valve, each about three feet in diameter. The use of these large valves, together with the phenominally high speed, is made possible by the method of working the pump valves, which is the invention of Prof. Riedler, of the Royal Polytechnic School, of Berlin, Germany. This invention consists in closing each valve positively at just the moment of reversal of stroke by means of the levers and rods shown in the cuts.

After closing the valves the mechanism moves out of the way, leaving the valves free to open automatically. This is the first engine of the type built in this country, but they are no novelty abroad, being in use at many water-works, notably those of London, Berlin, Hamburg, Leipzig, Buda-Pesth, Breslau, Rotterdam, Heilbron, Manheim, Mulhausen, etc., at some of which places speeds of 75 revolutions per minute are attained.

The condenser is of the surface type, having 1,410 square feet of tube surface, with water passing through the tubes.

The condensing water is taken from one of the upper pump chambers, and after passing through the condenser is delivered into the force main. A butterfly valve in one of the pump discharge-pipes permits the quantity of condensing water to be easily regulated. The air-pump is of the single-acting bucket type, 24 inches diameter and 12-inch stroke, situated directly below the condenser, and worked by an arm on one of the pump valve gear rocker shafts.

Steam for the engine is furnished by a Belpaire fire-box boiler having two separate furnaces and a common combustion chamber. The boiler is 34 feet 4 inches in length, with a least internal diameter of shell of 90 inches. The tubes are 201 in number, 3 inches in diameter, 16 feet long. The feed water, before entering the boiler, passes through a Green Economizer, where it is heated by the escaping gases from the boiler.

To accommodate the new boiler an addition has been made at the rear of the boiler-house at a cost of $3,597.25.

At the West Roxbury pumping-station the daily average quantity pumped was 121,500 gallons, an increase of 25.4 per cent. over the amout pumped in the previous year.

At the East Boston station 385,000 gallons per day have been pumped for the supply of the high-service district, and 30,800 gallons per day for the Breed's Island high-service.

Mystic Lake.

Grades, H. W., 7.00; Invert of aqueduct, —4.17; Contents between 7.00 and 1.50, 442,000,000 gallons.

On January 1, 1894, the lake surface was 3.15 feet below high water. On January 19 it had risen to grade 5.70 above tide-marsh level, and the stop-planks were removed from the dam. Waste continued from January 19 to 22, and from January 26 to May 3.

Additional stop-planks were then placed on the dam, and during the month of May the lake remained near high-water mark.

Waste occurred over the dam from May 21 to June 8, after which date no waste was permitted except at the conduit wasteway and at the fishway, which was finally closed on June 20. During July the lake surface fell from 5.46 to 2.35, and on August 31 the water was 8.42 feet below high-water and but 2.75 feet above the conduit invert.

The temporary pumps used to raise the water into the conduit were then started, and the surface of the lake continued to fall until, on October 10, it was 12.08 feet below high-water and 1.90 feet lower than any previous record.

On November 1 the water surface had risen to grade —3.72, and on November 15 the use of the temporary pumps at the lake was discontinued. On December 1 the lake surface was at grade 0.67, and on January 1, 1895, at grade 3.35. As the old engines and pumps which were in use at the lake were of insufficient capacity and badly worn, two new 60 H.P. engines and boilers and an 18-inch centrifugal pump have been purchased. A pile foundation and wooden frame engine-house, 65 ft. × 19½ ft., has been built, and the new pump and one of the engines placed in position and connected with the conduit.

The dam at the outlet of the lake is in good condition.

Mystic-Valley Sewer.

During the year 1894, 116,908,000 gallons of sewage was pumped and chemically treated with sulphate of aluminum.

Table XI., on page 194, gives the monthly quantities of sewage pumped, coal and aluminum used, etc. With the completion of the North Metropolitan Sewer, which will occur during the present year, the operation of the plant will be discontinued.

Mystic Conduit and Reservoir.

The conduit has been twice cleaned during the year.

In the annual reports for the past three years necessary repairs have been recommended at the conduit screen chamber, and as they have not yet been carried out the recommendations are renewed.

MYSTIC PUMPING-STATION.

Engine No. 1 was used 3,337$\frac{5}{6}$ hours, pumping	731,942,300 gals.
Engine No. 2 was used 2,585 hours, pumping	531,822,000 "
Engine No. 3 was used 7,518$\frac{1}{4}$ hours, pumping	2,487,654,400 "
Total quantity pumped	3,751,418,700 "
Daily average quantity pumped .	10,277,900 "
Total quantity of coal burned . .	8,763,800 lbs.
Percentage ashes and clinkers . .	11.2
Average lift in feet	148.62
Quantity pumped per lb. of coal .	428.1 gals.
Average duty of engines per 100 lbs. coal, no deductions	53,057,500 ft.-lbs.

COST OF PUMPING.

Salaries	$11,242 27
Fuel	19,175 62
Repairs	1,576 30
Oil, waste, and packing	784 36
Small supplies	146 10
Total	$32,924 65

Cost per million gallons raised one foot high,	$0.059
" " " " pumped to reservoir,	8.777

Table VIII., on page 191, shows in detail the work done by the engines during the year. Work upon the new engine for this station has been in progress at the works of the G. F. Blake Manufacturing Company during the year, and the engine is now nearly ready for erection. On October 30, a contract was made with Mack & Moore for building an addition to the engine-house and for the necessary foundations for the engine.

Work under the contract was begun about November 1. The engine foundation is now nearly completed, and it is expected that the erection of the engine will be commenced by April 15 and completed during the year.

CONSUMPTION.

The daily average consumption for the year was as follows:

Sudbury and Cochituate Works . .	46,560,000 gals.
Mystic Works	10,282,100 "
Total for combined supplies . .	56,842,100 "

a decrease of 1,353,600 gallons, or 2.3 per cent. from that of the previous year. One cause of the decreased consumption was the warmer winter of 1893–94. The mean temperature for the month of January, 1893, was 10 degrees lower than for January, 1894. The consumption of the months of January, February, and March, 1894, was 473,372,500 gallons less than for the corresponding months of the previous year, equivalent to 1,296,900 gallons per day for the entire year. The decrease is also due in a considerable measure to the depression in business, as the quantity of water sold by meter measurement averaged 400,000 gallons per day less than in 1893.

On account of the insufficiency of the Mystic supply, all of the Charlestown District lying east of Cambridge street was supplied from the Cochituate works from 3.30 P.M., of September 12, until the end of the year. The following table shows the consumption per inhabitant for the past two years:

Consumption.

Month.	Cochituate. Consumption in Gallons per Capita.		Mystic. Consumption in Gallons per Capita.		Combined Supplies. Consumption in Gallons per Capita.	
	1893.	1894.	1893.	1894.	1893.	1894.
January	123.7	108.1	111.5	91.9	120.9	104.5
February	117.6	109.6	103.7	95.4	114.5	106.5
March	111.4	99.7	91.9	83.0	107.0	96.0
April	104.1	88.9	76.9	79.0	98.1	86.7
May	99.0	92.6	76.7	82.1	94.0	90.2
June	100.4	101.4	81.5	96.4	96.1	100.3
July	110.6	110.3	80.6	93.3	104.0	106.5
August	108.3	104.0	77.6	81.8	101.5	99.0
September	105.5	98.2	71.8	94.3	98.0	97.6
October	104.2	95.0	75.7	80.1	97.8	92.6
November	99.3	94.8	75.0	81.3	93.9	92.7
December	106.9	97.5	90.9	92.8	103.3	96.7
Average	107.5	99.8	84.4	87.6	102.4	97.4

DISTRIBUTION.

On the Cochituate works, 17.88 miles of pipe were laid and 5.13 miles abandoned, making a net increase of 12.75 miles, and a total of 572.8 miles now connected with the system.

About three miles of the pipe which was abandoned was formerly connected with the Jamaica pond supply, and was located in streets where there were mains connected with the Cochituate system. The work of laying a new 36-inch force main from the Chestnut Hill pumping-station to Fisher Hill reservoir has been completed during the year.

The portion of the new 20-inch main for the supply of Brighton, which is in the town of Brookline, 3,446 feet in length, was laid by the superintendent of the Brookline works.

The relaying of the 20-inch low service and the 12-inch high service mains on Dover street, between Albany street and Dorchester avenue, caused by the change of grade and rebuilding of Dover-street bridge, has been practically completed.

The raising of the grade and abolition of grade crossings on Chelsea street, between Medford street and the city of Chelsea, made necessary a relocation of the mains supplying Chelsea and East Boston. For a length of about 1,400 feet a 30-inch main has been substituted for the 24-inch and 20-inch mains supplying East Boston, and a 24-inch main substituted for the 16-inch main supplying Chelsea. These new mains have been laid outside the street location, on the property of the Boston & Maine Railroad Company.

The distributing mains connected with the Mystic works have been extended 6.89 miles, and 10.33 miles have been relaid, in most cases with pipes of larger diameter. The total length now in service is 173.7 miles.

There has been an increase of 175 in the number of hydrants connected with the Cochituate works, making a total now in use 6,217.

On the Mystic works 148 hydrants have been added, and the total now connected with the works is 1,435.

Two hundred and fifty-five petitions for main pipe have been reported upon, and 30 contracts for rock excavation have been made. Various profiles have been made, levels taken, and grades and lines furnished for the main pipe laying. All pipe laid has been located and plotted on the plans.

CORROSION OF PIPES BY ELECTROLYSIS.

The investigations of the effect of electrolysis upon the water-pipes have been continued during the year, under the supervision of Messrs. Stone & Webster, and in brief the results arrived at are as follows:

1. In certain places throughout the city electrolytic action is taking place, and pipes have already been more or less injured and are subject to premature decay.

2. The many excavations which have been made about the city for the purpose of inspecting the pipes have given only negative results, revealing no marked action, and yet not proving that the natural decay had not been accelerated by electrolysis.

3. Action of a serious nature is confined to special localities, where, owing to certain conditions of the railway system, abnormal currents are flowing through the earth, but as a whole, the action has been reduced to so small an amount that it is now difficult to detect.

4. In the places where action is found special precautions in provision of return feeders, and connections with the piping system by the Street Railway Company, will ordinarily reduce the difficulty to a small amount.

5. It is impracticable to entirely eliminate electrolytic action, but by a constant inspection of the water system as a whole, with a view of locating points where difficulty is liable to occur, and applying such remedies as are well known, the danger can be reduced to a minimum.

6. The action at any one point is liable to increase or decrease temporarily from various causes, and tests made at any one locality at any specified time give no reasonable assurance that the same condition of affairs will exist for any considerable length of time.

7. A very small difference in potential, as little as one-thousandth of a volt, will cause electrolytic action.

8. Measurements of small difference of potential between water-pipes and the adjacent earth are of value principally in indicating the direction of flow of electric current rather than amount, and are not entirely reliable unless special precautions in measurements are taken.

This is on account of the battery action, thermal effects, and other disturbing influences.

9. The most practical way of reducing the liability of injury to pipes to a minimum is by detecting the places where action is occurring, through a carefully organized system of inspection and tests, and requiring the Railway Company to provide suitable return conductors or make proper connections with pipes or rails where it is found that such action exists.

10. Special provision can be made for measuring the flow of current from certain pipes to the ground, and, by devices of this sort installed at various places throughout the city, the most reliable information can be obtained in regard

to the quantity of current flowing away from the pipes in any particular section, and a determination made of their actual rate of deterioration.

The following is Messrs. Stone & Webster's report in detail:

WILLIAM JACKSON, *City Engineer, Boston, Mass.*:

SIR: In accordance with your request, we have, during the past year continued the investigation which was commenced some two years ago to determine the extent of the corrosive action of electric currents upon the pipes of the water system in the city of Boston, and beg to submit the following:

It has been our purpose during the past year to conduct such tests and experiments as would enable us to determine as definitely as possible the extent of the injury which has been done up to the present time, and also to predict, if possible, how long a time would probably elapse before damage of a serious nature would result to the piping system as a whole from electrolytic corrosion, if allowed to continue at its present rate.

It was clearly set forth in our report of a year ago that currents of a considerable magnitude were found to be flowing from place to place, through the earth and along the water pipes, but no definite conclusions had at that time been reached as to the extent of damage already done and the rate at which it was progressing.

The results which have been obtained during the past year enable us to state quite positively that up to the present time the effect upon the piping system as a whole has not been serious in the city of Boston, although in other places where we have conducted tests during the past year, we have found that rapid decay was occurring, clearly due to electrolytic action. The reason of the slight action which has been found here is, primarily, that the street railway system is comparatively well equipped with return wires which conduct the greater part of the current back to the power-station without serious damage to the piping system.

Measurements of Potential of Piping System.

During the last year a large number of readings have been taken of the difference of potential between the hydrants and the adjacent ground, and it has been found that this difference, which was formerly in many cases quite large, has been reduced to a comparatively small amount in nearly all parts of the city.

The marked change in this respect over the tests made during the previous year shows that the flow of current from the pipes must have been materially reduced, and that the Railway Company are continually improving their system by bonding the rails and providing new return wires to the power station.

Some difficulty has been experienced in the investigation of this subject on account of the fact that changes in the return system of the Street Railway Company are made so frequently that difference of potential between pipes and surrounding earth in any particular locality frequently varies widely from time to time, and thus prevents any systematic study of the action which is taking place at a point where a considerable difference of potential is once discovered.

During the tests of a year ago, the greater part of our measurements, which were made for the purpose of determining the potential differences, were taken between the pipes, or the hydrants connected with the pipes, and the rails; but a careful study of the conditions convinced us that tests of this sort are unreliable, and consequently all measurements made during the past year have been taken between the pipes and the earth in their immediate vicinity.

The practical way in which the measurements have been made is illustrated in Plate I., where it will be seen that a rod is inserted in the hydrant box, and a metallic connection upon the bottom of this rod touches the ground in the vicinity of the pipe, while the other pole of the measuring instrument is placed in contact with the metal of the hydrant, the valve stem usually being used for this purpose

In course of the investigation some question arose as to whether the true difference of potential between a pipe and the surrounding earth is obtained by a measurement of this sort, and in order to decide this question as definitely as possible, the following readings were taken at several points where excavations had been made throughout the city:

First. The actual difference of potential between the pipes and the ground immediately surrounding them, which is, of course, the measurement desired, was observed.

Second. The difference of potential between the pipe and the surface of the ground was observed.

Third. The difference of potential between the piping system and the earth at the base of the nearest hydrant box was measured in the way described.

In the twelve places where satisfactory observations were made the potential between the pipes and the surface of the ground, and also the potential between the pipes and the earth at the base of the hydrants, was found always to have the same sign as the potential between the pipes and the ground immediately surrounding them.

This would seem to prove conclusively that the method regularly adopted gives the correct polarity of the reading, and approximately the correct value.

The object of the various measurements which were made of the differences of potential was principally to determine the polarity, and the differences so obtained are to be considered of value as indicating the direction rather than the amount of current flowing.

Many measurements were taken in the city proper, and also in South Boston, East Boston, and Charlestown. The work was begun in January, 1894, and over 700 different hydrants have been visited and about 900 observations made. In many places the same hydrants have been frequently visited, to determine whether or not considerable changes in potential difference took place from time to time.

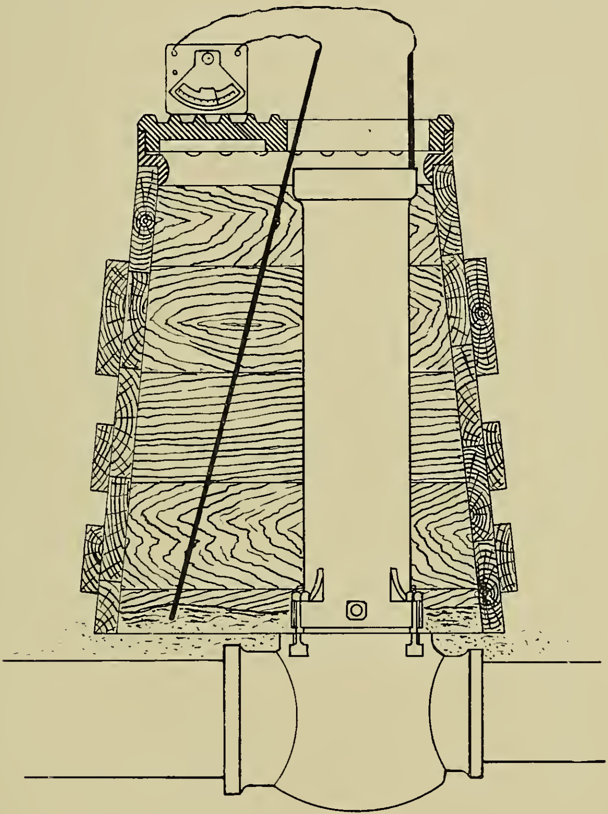
The results of these tests are on file, but we have not thought it necessary to insert them in this report, as the polarity at different points is indicated on the accompanying map, which shows the location of positive and negative hydrants throughout the city. The heavy full line shows a positive polarity, indicating a flow of current from the pipes to the ground, with consequent electrolytic action. The broken line shows a negative polarity at some observations and positive at others, and, being thus subject to change, it may be safely concluded that serious action is not going on in the district where such a state of affairs exist.

The results of these tests show that the theoretical assumption in regard to the existence of a clearly defined danger district is not borne out in practice, and that in a city where reasonable provision for the return of current to the power-station has been made, the effect of electrolytic action, though slight, is widely distributed.

In the immediate proximity of the power station most of the pipes were found very decidedly negative to the surrounding earth.

Pipes at points far remote from the power-station in a few places were found very decidedly positive, due in some cases to the fact that the railway return circuit is not sufficiently large, or is otherwise defective; and in others, to the fact that the piping system is not uniformly continuous in the direction of the power-station, and the return current has a tendency to follow it as far as possible, and then leave it for the earth.

PLATE I.



Stone & Webster.


PLATE II.
CITY OF BOSTON.
MAP
SHOWING
POLARITY OF HYDRANTS.
MAR. 1. 1895.
Stone & Webster.
Positive.
Variable.
CHARLES RIVER
COMMON
PUBLIC GARDEN
Harvard Bridge
Grand Junction R.R.
Broadway
Main St.
W. Boston Br.
Cambridge St.
Beacon St.
Commonwealth Ave.
Boylston St.
Huntington Ave.
Columbus Ave.
Tremont St.
Washington St.
Harrison Ave.
Albany St.
Federal St.
Commercial St.
Atlantic Ave.
State St.
Mt. Vernon St.
Maverick St.
Webster St.
E. Broadway
W. Broadway
Swett St.
Dorchester Ave.
New York & New England R.R.
Boston & Providence R.R.
West End Power Station
Chester Park
Camden St.
W. Chester Park

From the observations made it has been shown that the potential and the polarity of the piping system in many places is continually changing, even when the quantity of current returned remains substantially the same.

This is due:

First. To the degree of moisture in the soil from time to time, which affects the electrical resistance of the earth as a whole.

Second. To the influences of electrically poor joints in the piping-system.

Third. To the fact that lines of piping are not continuous from all parts of the city in a direct line to the power-station, on which account there is a tendency for the current to go across from one pipe to another, and the amount of current which so flows depends to a considerable extent upon the condition of the soil, which is subject to change.

Fourth. To the fact that the copper wires which bond the rails sometimes become corroded at the joints and affect the resistance of the return circuit, particularly where no supplementary wire is used.

Fifth. To the changes in the return system made by the Street Railway, from time to time, which, even if at points remote from the location of hydrants tested, make considerable differences in the potential observed.

Difference of Potential required to Produce Electrolysis.

The difference of potential obtained in the observations just described varies from 0.5 to .0005 volts, the average being perhaps about .02 volts.

It was formerly supposed that a difference of from 1 to 2 volts was required to produce electrolytic decomposition, but recent scientific investigations have been made which prove conclusively that a very small difference of potential is sufficient to cause electrolytic action.

As this question of amount of difference required for the production of electrolytic effects was an important one, we thought it desirable to conduct a series of tests with a view of determining, as definitely as possible, the minimum potential requisite.

For this purpose three cells were made up with electrodes of bright sheet iron immersed in a dilute solution of common salt.

The plates of the first cell (A) were subjected to an electromotive force of .01 volts; of the second cell (B) to an electromotive force of .002 volts, while the third cell (C) was not connected at all to the source of electrical supply, and was only used to observe the rate at which the natural rusting of the iron would take place.

The method of procedure was to immerse all the electrodes at one time, and after ten minutes to test for iron in the solution by means of ferricyanide of potassium. Then to test again, from time to time, and to note which cells showed the strongest reaction.

Three independent tests were made, all giving the same results, which were as follows:

Table Showing Reaction in Test for Iron in the Electrolyte.

Time after immersion.	Cell (A) .01 volt.	Cell (B) .002 volts.	Cell (C) 0 volts.
10 minutes.	Trace.	Trace.	None.
20 "	Distinct.	Slight.	Trace.
30 "	Strong.	Distinct.	Just visible.
60 "	Strong.	Strong.	Slight.

From the above investigation it is obvious that an electromotive force, even so low as .002 volts, is sufficient to cause injurious action from electrolysis.

Flow of Electric Currents through Piping System.

During the first year of our investigation into the matter of electrolytic action we secured abundant evidence that large currents were almost continually flowing through various parts of the piping system, and the question arose immediately as to the amount of damage that such currents were doing.

The tests made during the past year have confirmed the results obtained at first, and we have therefore thought this matter of sufficient importance to make it an object to conduct special laboratory tests to determine the probable extent and nature of injury resulting from this cause.

In this city no well defined case of serious trouble from the passage of currents through the pipes themselves has been discovered, although some difficulty from electrical disturbances has been reported when making connections to the main water-pipe upon Dover street, near the South Boston bridge. But tests have so far revealed nothing of note. In other cities we have found serious action resulting from this cause at points where anything in the nature of an electrically insulated joint occurs.

Plate III. shows a section of pipe which was examined under our direction in a city where considerable trouble had been experienced from electrolytic action. This particular piece of pipe was situated at a distance of some two miles from the nearest electric power-station, and it so happened that the tendency of the current was to flow from the adjacent railway system to Section A, and thence to B, in the direction of the power-house. At X there was a rubber gasket, and under the bolt heads were cotton washers, so that Section A was electrically insulated from Section B. This made it necessary for the current to pass from the inner surface of A to the water, and then back again to the surface of B, in order to get around the joint.

When we first noticed the rubber gasket, this condition of affairs was expected; and, upon inspecting the inside of the pipe, it was found that the inner surface of A was covered with scales, and pitted in many places to a depth of 1-16 of an inch, while the inner surface of B was as clean and smooth as upon the day it was first laid.

As the current flowing through this pipe was not large — probably not amounting, on an average, to more than a fraction of an ampere — it seemed probable that in many places trouble might occur even in a leaded bell and spigot joint, where, through corrosion or other cause, the electrical connection was poor; and even to a greater extent in pipes where cement joints were used.

We have shown by experiment that the action of a current flowing through piping with cement joints, as shown by Plate IV., is exactly similar to the action on the joint with the rubber gaskets described above, except that a portion of the current leaves the outside of the pipe and passes through the earth around the joint. This was impossible where the joint came within a manhole, as in the case just mentioned.

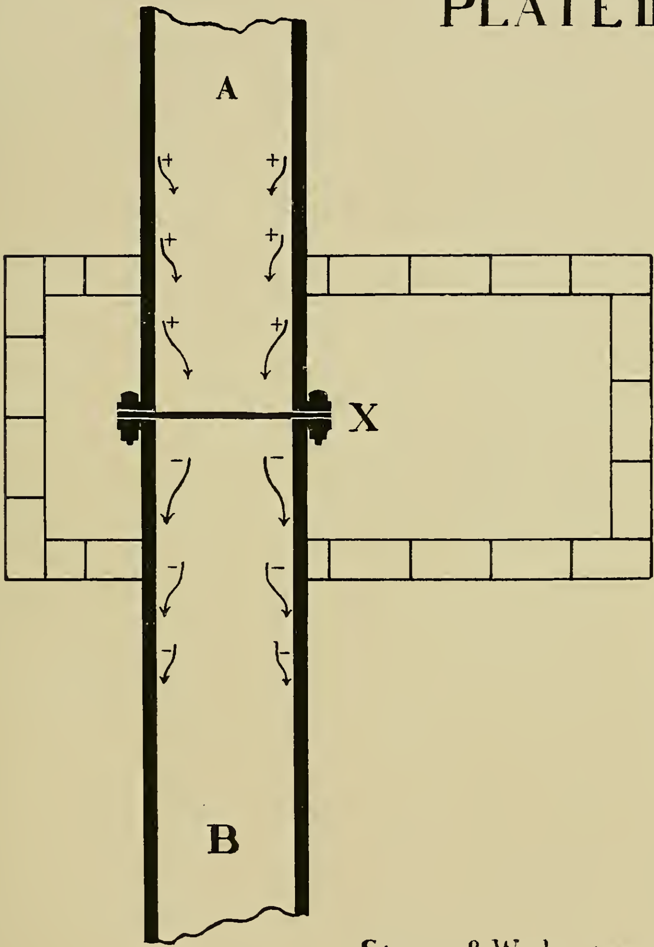
It may be well to state, however, in this connection, that where cement joints are used throughout a piping system, the breaks in the electrical continuity are so frequent that the pipes do not act to any great extent as conductors, so that very little current flows.

With regard to lead joints, we have conducted several experiments to determine whether or not an injurious action would be caused if the current flowing through the pipe should be comparatively large.

The first test was conducted on a section of cast-iron pipe, made up with lead joints, as shown in Plate V. This was placed in a box of sand, with the two ends projecting, and filled with water.

A current of 200 amperes entered at the point marked +, and left at point marked —. The current was allowed to pass for about nine

PLATE III.



Stone & Webster.

PLATE IV.

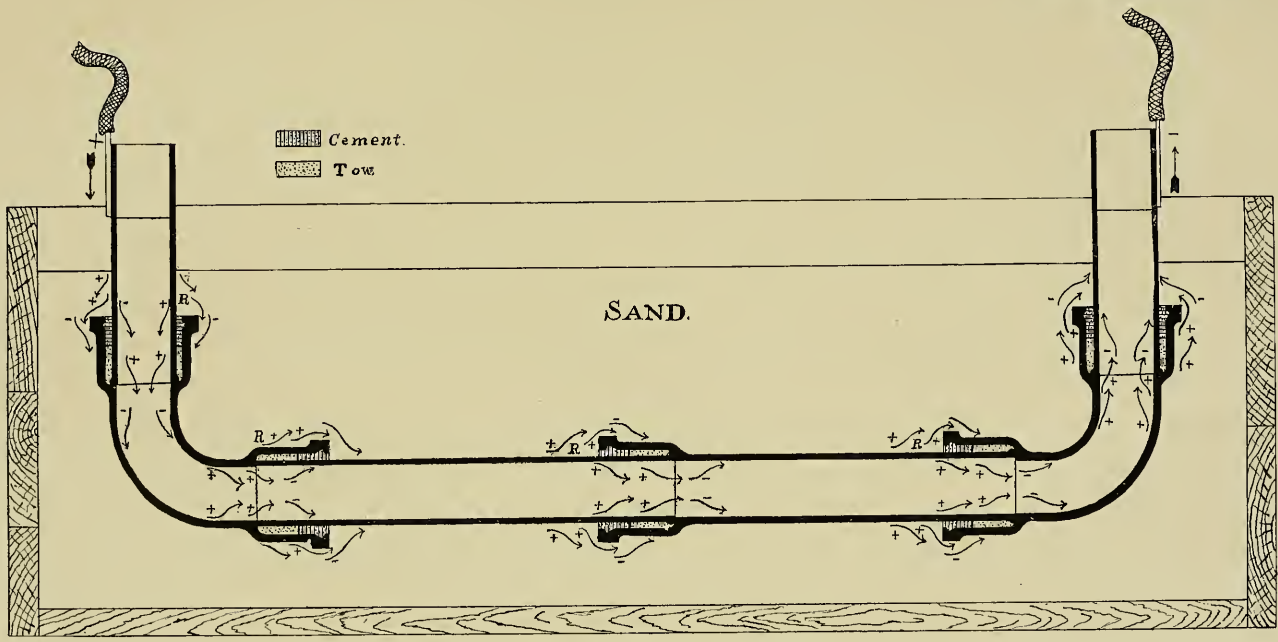
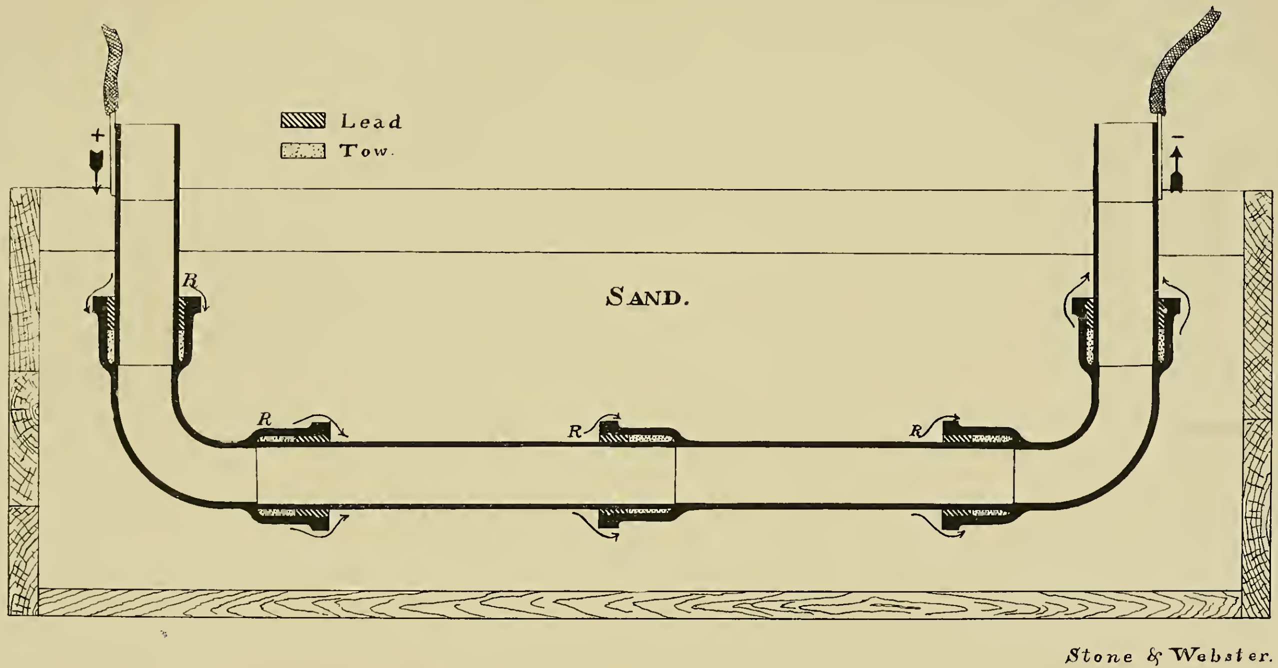


PLATE V



hours; then it was shut off for about thirty-six hours; then allowed to flow again for nine hours; and so on. Two hundred amperes was a large current for the size of the pipe, and it was sufficient to heat it perceptibly, especially at the joints.

After this current had flowed for 70 hours, making a total amount of 14,000 ampere hours, the pipe was removed and examined. The inside of the pipe showed no marked corrosion, but the water had become very turbid, indicating electrical action. On the outside the rust was marked at the points R; also, slight rust was present on some other parts.

The rust at the points R is accounted for from the fact that a portion of the current left the pipe at those points and passed around the joint through the moist sand.

This shows that if a large current is flowing longitudinally in an iron pipe, even with good joints, an injurious action is likely to occur at the joints.

Another and quicker method used for showing the same thing was adopted in the following test:

The apparatus for this test consisted of two systems of iron piping, made as in Plate V. Both of these were filled with water and supported by a wooden frame.

A current of about 200 amperes was passed at intervals through one of the systems of piping. No current was passed through the other; and from time to time samples of water were taken simultaneously from both pipes. In this way we are able to compare the rate at which the water in each pipe became turbid.

The experiment was stopped after 4,700 ampere hours of current had passed. The difference in the samples, while not being striking, was so well marked that there was no mistaking that the pipe with the current passing through was rusting the more rapidly.

From this test it is evident that the flow of an electric current along an iron pipe will increase the rate of decay of the pipe to some extent.

Signs of Electrolytic Action.

In carrying on such investigation as this it was at once recognized that it would be of great advantage to be able to note definitely whether the pipes which are submitted to us for inspection have been acted upon electrically, or are simply corroded from natural causes. With this in view, a study of the characteristic appearance, of both lead and iron pipes, when subjected to electrolysis, was undertaken in order to discover, if possible, signs by which the polarity of the pipes could be known in cases where the action had not been sufficiently energetic to produce the well-known pitting marks.

Samples of both lead and iron pipes were obtained for these tests from the Water Department. These pipes had been removed from the streets and were somewhat corroded. Several pairs of each of these were placed in damp sand, and a current of about one ampere was passed from one to another, thus making one pole of each pair positive to the sand and the other negative. This current was maintained for about three weeks during nine hours of each day, and occasional inspections were made, with the following results:

Lead Pipes.

Both pipes of each pair were originally somewhat corroded, and a small amount of scale adhered to the surface. When the positive pipe was taken out and examined after a few days' run; a mass of sand, about a quarter of an inch in thickness, adhered to it; and the particles of this sand were apparently cemented together with black and with salts of lead. Upon scraping off this outside coating of sand, purplish brown salts of lead could be seen adhering to the surface of the pipe, and after current had been passed through the pipe for a sufficient length of time the well-known pit-marks were observed. The negative electrode, when removed from the sand, was clean, of a grayish color, and with little or no sand adhering to it, and of practically the same appearance as a similar pipe buried in sand and entirely free from electrolytic action of any sort.

The above distinctions between the positive and negative electrodes, while not clearly defined in all cases, were sufficiently marked to enable us to determine pretty definitely whether or not a pipe was subjected to electrolytic action, if inspection were made immediately after the pipe was removed from the ground.

Iron Pipes.

In the case of the iron pipes, the indications were less marked. The pipes were originally covered with a fine incrustation of sand, the particles of which were very firmly cemented together. When the pipes were inspected after a few days' run, the only thing observed was that the scale cracked off more easily where electrolytic action had taken place than where no action whatever was present; but there was no clearly defined difference between the negative and positive pipes, and as a whole the results obtained were not sufficiently definite to warrant a determination as to whether or not iron pipes which are slightly corroded have been subjected to electrolytic influences.

Rate of Deterioration due to Electrolysis.

In places where electrolytic action is slowly taken place on account of the effect of the return currents from the Street Railway system, it is important to determine as accurately as possible the actual rate of decay due to this cause.

Where the action is marked, occasional inspections will, of course, give a rough idea of this; but in the majority of places throughout the city of Boston deterioration is not taking place rapidly enough to make this practicable, so that it seemed desirable to devise some means of actually determining the rate at which the metal is being taken away from any particular length of pipe. With this in view, the apparatus shown in Plate VI. was devised.

This consists of a wooden box (A) of about 7 feet in length, filled with tar, and placed around the service-pipe (S) beneath the surface of the street. Upon the outside of this box is fastened a sheath of lead (L) whose entire surface is of known relation to the surface of the pipe (S). From the lead sheath, and also from the pipe, wires are led through the tube (C) to a point (B) at the surface of the street, where they are available for connection with an ammeter or voltmeter, as desired.

All flow of current away from the pipe (S) throughout the distance where, it is insulated by the box (A), is of course prevented; but if the terminals of the wires at (B) are connected together through an ammeter, the tendency, of course, will be for the current which would naturally leave the pipe (S) to flow up the wire (X) and back by way of the wire (Y) to the lead sheath, and thence from the sheath to the ground.

Several devices of this sort were installed at various places throughout the city and measurements of current taken, but as the apparatus was not put in use until late in the fall, the heavy snows during the winter have prevented satisfactory results.

In other places where we have installed apparatus of this sort, and especially in cities where electrolytic action is taking place at a rapid rate, it has been found that quite reliable measurements as to the quantity of current flowing away from a pipe could be obtained, and as a given quantity of current deposits a certain amount of metal in a

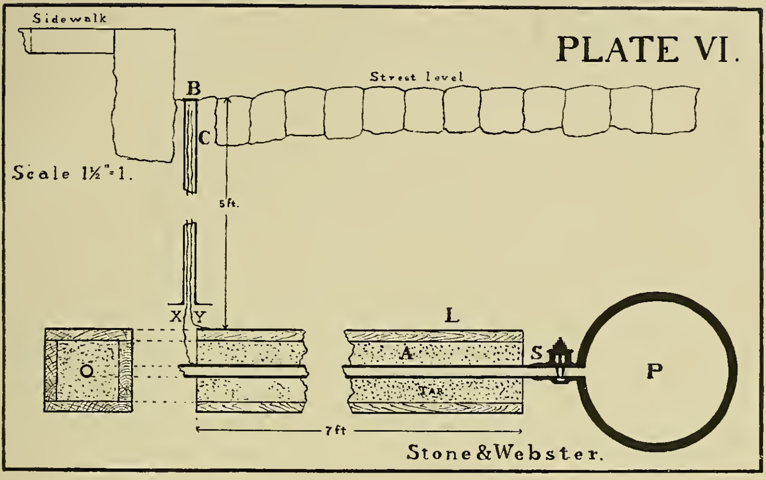


PLATE VI.
Sidewalk
Street level
B
C
Scale 1½"=1.
5ft.
X
Y
L
A
S
TAR
P
7ft
Stone&Webster.

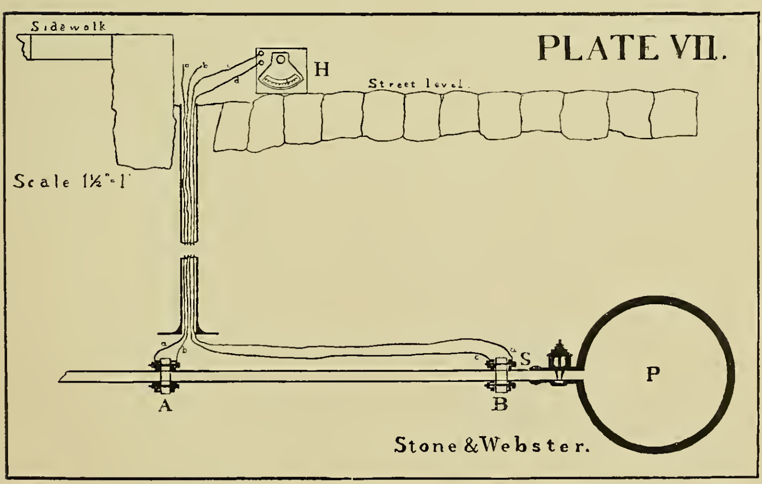


PLATE VII.
Sidewalk
H
Street level.
Scale 1½"=1'
S
P
A
B
Stone&Webster.

given space of time, it has been possible to determine quite accurately the rate at which the pipe submitted to test is undergoing deterioration.

We have recently devised a piece of apparatus, which is illustrated in Plate VII., for obtaining even more satisfactory results than could be obtained from the apparatus illustrated in Plate VI., and if the tests in this city are to be continued, we should advise that devices of this sort be installed at various places through the city, and that frequent measurements of the flow of current be made.

The apparatus consists simply of two insulating joints (A) and (B), with a length of service-pipe, say, ten feet, between them. Wires from each side of each of these insulating joints are carried to the surface of the street. By the insertion of a delicate ammeter between the wires (c) and (d), a measurement of the quantity of current flowing from the main to the service-pipe can be obtained, and if the wires (a) and (b) are left disconnected, this measurement gives approximately the quantity current flowing away from the section (A–B) to the earth, and enables one to determine roughly the rate of deterioration.

By connecting the wires (a and b) together, and leaving the ammeter as shown, connected with wires (c and d) a measurement can be obtained of the quantity of current flowing away from the entire length of service-pipe.

The question will probably be asked whether or not the current flowing through the water in the pipe is not sufficient to vitiate the results, even although an insulated joint in the metal itself is inserted.

In reply to this we would say, that the resistance of the ammeter and leads is so small in comparison with the resistance of the water that for practical purposes it may be said that all the current flowing from the main into the service-pipe will pass through the ammeter (H) and be there recorded.

(Signed) STONE & WEBSTER.

GENERAL CONDITION OF THE WORKS.

The completion of Reservoir No. 6 has increased the daily capacity of the Sudbury and Cochituate supply about 4,000,000 gallons, and the safe capacity of the works in a year of extreme drought is now about 41,500,000 gallons.

As the daily average consumption during the past year was 46,560,000 gallons, it is evident that there is a liability that the supply may be insufficient before Reservoir No. 5 can be completed. The consumption from the Mystic works is now about 11,500,000 gallons per day, an amount far in excess of their capacity. Even during the past year, which was not exceptionally dry, 40,000 people in the Charlestown district were supplied from the Cochituate works for nearly four months, and Mystic lake was drawn to such a low point by the temporary pumps that the quality of the water was affected by the infiltration of salt water from the Lower Mystic lake.

Although the completion of Reservoir No. 5 will raise the safe total capacity of all the sources of supply to 61,500,000 gallons per day, it is evident that the daily consumption, which is now about 57,000,000 gallons, will soon be in excess of the yield of our sources of supply.

Another consideration is the question of the necessity of abandoning the Mystic supply on account of the difficulty in preserving the purity of the water. The annual reports for the past fifteen years have reiterated the statement that the quality of the water from this source is constantly deteriorating, and that it is not practicable, on account of the large population residing on the water-shed, to make any permanent improvement in the quality. As the Mystic supply cannot be abandoned until an additional supply is obtained, and as the construction of Reservoir No. 5 will complete the development of the Sudbury river supply, it is evident that immediate steps should be taken to procure an additional supply sufficient to meet the requirements of the city for future years.

In consequence of the great increase in the high-service consumption the supply mains from Fisher Hill Reservoir and in the Roxbury District are inadequate to furnish a supply without an excessive loss of head. At times the Parker Hill Reservoir has been nearly emptied, and residents on the higher land have been entirely deprived of their supply.

To remedy this difficulty the laying of a 48-inch main has been recommended from the junction of Fisher Hill avenue and Boylston street to the corner of Huntington avenue and Heath street. At this point the main will be divided, a 42-inch main continuing through Huntington avenue and Boylston street for the supply of the city proper, with a connection at Wait street for the supply of Parker Hill Reservoir; the other branch, 36 inches in diameter, to be carried through Heath street and across the Roxbury district.

The new pumping-engines at the Chestnut Hill and Mystic stations will furnish sufficient pumping capacity to meet the requirements at those stations for the next five years.

At the East Boston station all of the pumps are in need of repairs, and a new pump should be purchased for the use of the Breed's Island service.

The relaying of the old tuberculated mains with pipes of larger size and the laying of new supply mains has not kept pace with the growth of the city for the past few years. About 10 miles of the new and enlarged mains which have been recommended to your Board since 1891 still remain to be laid, and I recommend that the work be pushed as fast as possible. From three to four miles of the old 4-inch and 6-inch pipe and from 100 to 200 of the old pattern Boston hydrants should be replaced each year, to meet the demands for better fire protection.

Appended to this report will be found the usual tables of rainfall, consumption, etc., for the past year, and in addition, tables are given of the rainfall, rainfall collected, and percentage collected on the Cochituate water-shed since 1863, on the Sudbury-river water-shed since 1875, and on the Mystic water-shed since 1878. These will be found valuable for future reference.

Yours respectfully,

WILLIAM JACKSON,

City Engineer.

TABLE I.

Daily Average Consumption of Water, in Gallons, from the Cochituate and Mystic Works.

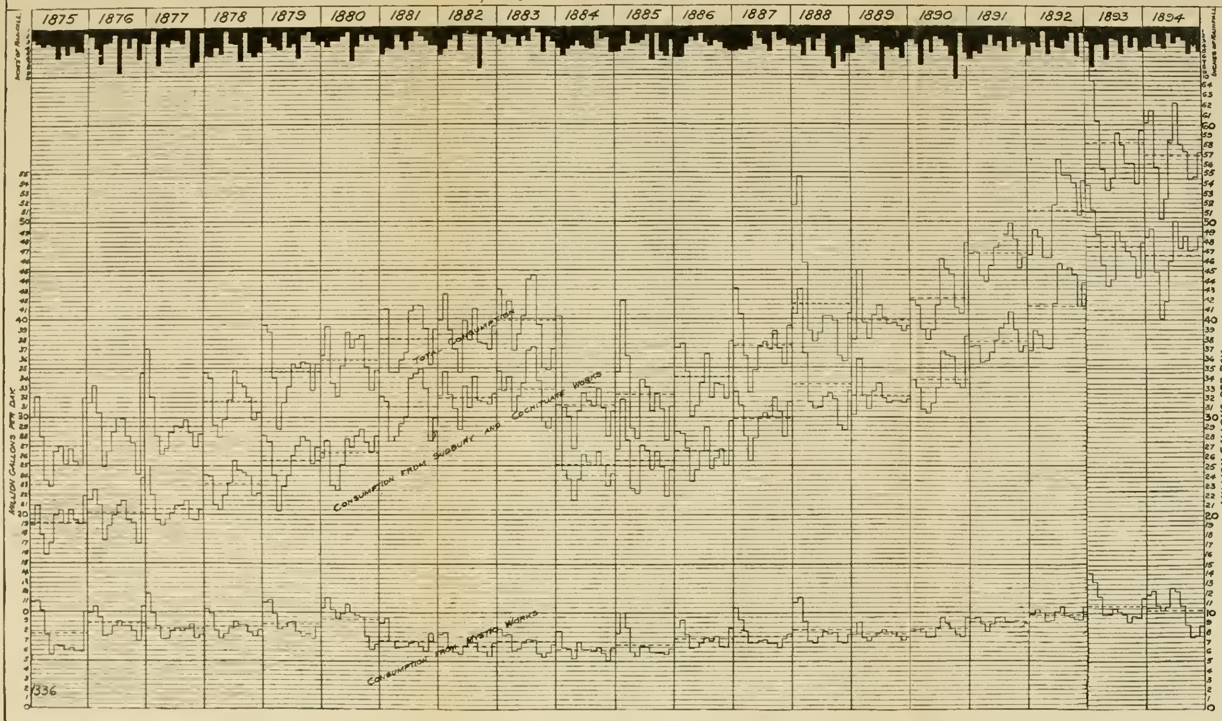
	Cochituate Works.							Mystic Works.						
Month.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
January	40,485,700	30,172,000	33,680,000	37,230,100	36,756,400	53,847,100	48,395,000	11,107,100	7,769,500	8,187,900	9,389,300	9,878,200	14,129,700	11,823,500
February	43,105,000	35,855,200	33,030,700	37,280,700	38,881,500	51,299,400	49,207,500	11,620,900	9,073,600	8,299,700	9,466,900	10,332,200	13,174,700	12,295,000
March	36,463,400	32,180,000	30,844,400	35,533,400	38,395,100	48,700,200	44,844,300	9,242,000	7,537,600	8,055,800	8,811,000	9,970,500	11,692,700	10,720,800
April	31,473,800	30,814,500	30,446,600	35,751,600	37,171,000	45,573,100	40,070,200	7,276,700	7,185,700	7,481,600	8,045,800	9,145,000	9,812,500	10,236,200
May	30,802,000	32,719,500	31,381,200	36,580,700	37,055,900	43,451,500	41,827,700	6,932,300	7,663,600	7,488,400	8,841,300	9,204,900	9,817,400	10,661,000
June	31,026,100	33,377,900	33,022,700	37,801,900	41,564,000	44,125,100	45,906,400	7,615,200	8,017,700	8,396,000	9,478,400	10,146,300	[1]10,460,000	12,552,300
July	32,014,400	31,870,300	36,701,100	39,062,600	45,738,100	48,986,900	50,044,000	8,267,500	8,315,600	9,463,300	9,581,700	10,702,900	[1]10,167,000	12,172,000
August	32,432,700	31,403,200	36,316,000	39,460,400	45,031,600	48,062,000	47,288,500	7,859,100	8,113,200	8,932,200	9,122,300	9,751,500	9,826,200	10,696,700
September . . .	31,836,500	31,722,800	36,165,800	40,677,700	45,261,900	46,926,500	[2]48,558,700	7,266,300	7,966,000	8,436,700	9,128,700	9,549,400	9,115,000	[2]8,703,600
October	29,110,800	31,702,200	33,429,800	53,884,600	44,626,700	46,416,600	47,072,500	7,096,400	7,627,500	7,784,100	9,259,100	9,340,500	9,630,400	7,421,200
November . . .	28,590,900	31,532,400	32,955,100	36,640,800	41,347,800	44,328,900	47,101,500	6,990,800	7,316,700	7,601,300	8,585,200	9,230,000	9,569,700	7,563,100
December . . .	32,686,200	31,829,000	38,334,100	37,342,500	43,766,400	47,807,800	48,511,600	7,918,600	7,473,200	9,448,300	8,960,600	10,473,700	11,620,800	8,667,800
Yearly average .	33,310,700	32,070,000	33,871,700	37,686,900	41,312,400	47,453,200	46,560,000	8,258,400	7,830,500	8,301,400	9,055,200	9,810,800	10,742,500	10,282,100

[1] From June 7 to July 29 about 3,000,000 gallons per day were wasted from a blow-off.
[2] After September 12, Charlestown was supplied with Cochituate water.

BOSTON WATER WORKS.

Diagram showing the rainfall and daily average Consumption for each month.

Yearly Averages shown thus - - - - -



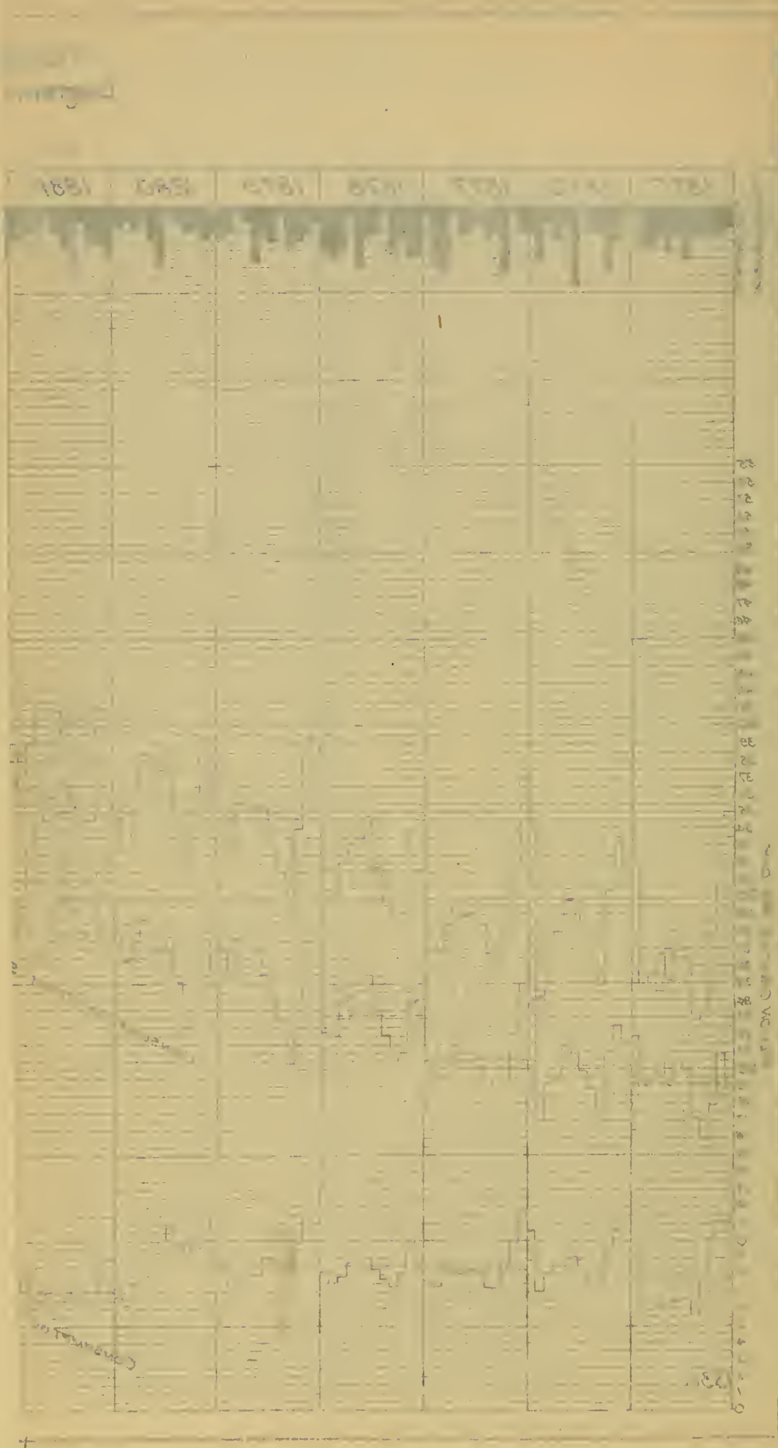


TABLE 11.

Diversion of Sudbury-River Water, 1887–1894.

MONTH.	1887.	1888.	1889.		1890.	1891.	1892.		1893.	1894.	
	To Chestnut Hill Res'r.	To Chestnut Hill Res'r.	To Lake Cochituate.	To Chestnut Hill Res'r.	To Chestnut Hill Res'r.	To Chestnut Hill Res'r.	To Lake Cochituate.	To Chestnut Hill Res'r.	To Chestnut Hill Res'r.	To Lake Cochituate.	To Chestnut Hill Res'r.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
January	602,200,000	895,400,000	. . . . . .	484,500,000	518,600,000	715,900,000	. . . . . .	630,800,000	1,325,900,000	. . . . . .	1,012,000,000
February	472,000,000	906,700,000	. . . . . .	564,600,000	475,000,000	560,800,000	. . . . . .	610,400,000	957,600,000	. . . . . .	944,000,000
March	456,700,000	691,400,000	. . . . . .	584,500,000	498,600,000	573,200,000	45,100,000	625,200,000	1,023,900,000	529,100,000	947,100,000
April	385,400,000	468,800,000	. . . . . .	490,500,000	417,000,000	641,900,000	545,000,000	662,500,000	917,000,000	134,100,000	725,600,000
May	444,200,000	566,300,000	233,400,000	615,700,000	536,300,000	740,300,000	114,700,000	690,490,000	858,600,000	215,800,000	826,500,000
June	463,600,000	489,000,000	. . . . . .	567,600,000	513,100,000	629,500,000	197,500,000	779,300,000	856,700,000	80,700,000	875,500,000
July	387,500,000	528,900,000	. . . . . .	534,000,000	664,100,000	755,100,000	. . . . . .	948,000,000	1,040,800,000	. . . . . .	1,064,600,000
August	352,800,000	626,600,000	. . . . . .	443,700,000	625,500,000	722,900,000	. . . . . .	897,700,000	994,100,000	. . . . . .	951,600,000
September	577,300,000	581,600,000	. . . . . .	475,500,000	606,400,000	732,400,000	. . . . . .	876,300,000	948,300,000	. . . . . .	987,100,000
October	672,300,000	435,900,000	. . . . . .	414,100,000	539,900,000	715,300,000	. . . . . .	908,500,000	956,600,000	1,100,000	958,500,000
November	607,100,000	410,900,000	. . . . . .	454,600,000	526,000,000	752,200,000	. . . . . .	788,000,000	862,700,000	400,000	1,021,000,000
December	703,000,000	605,200,000	. . . . . .	501,200,000	675,500,000	767,100,000	. . . . . .	1,216,100,000	995,700,000	1,000,000	1,137,100,000
Totals	6,124,100,000	7,224,700,000	233,400,000	6,130,500,000	6,596,000,000	8,306,600,000	902,300,000	9,633,200,000	11,737,900,000	962,200,000	11,450,600,000
Total diversion from Sudbury river.	6,124,100,000	7,224,700,000	6,363,900,000		6,596,000,000	8,306,000,000	10,535,500,000		11,737,900,000	12,412,800,000	
Average daily diversion for whole year.	16,778,400	19,739,600	17,435,300		18,071,200	22,757,800	28,800,000		32,158,600	34,007,700	

TABLE III.

Statement showing Amount of Water drawn from Lake Cochituate; Amount wasted; Amount of Rainfall collected in Lake; Amount received into Lake from Sudbury River; Percentage of Rainfall collected, etc., 1852 to 1894; Water-shed of Lake, 12,077 Acres.

Year.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	Amount received into Lake from Sudbury River.	Storage. Gain.	Storage. Loss.	Total Amount of Rainfall collected in Lake.	Daily average amount of Rainfall collected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Inches.*	*Inches.*	*Per cent.*
1852[1]	2,974,042,800	4,020,566,900	....	....	261,360,000	6,733,249,700	18,396,900	47.93	20.61	43.
1853	3,117,939,500	3,166,417,500	....	239,580,000	....	6,523,937,000	17,873,800	55.73	19.51	35.
1854	3,614,230,000	4,187,733,000	....	....	217,800,000	7,584,163,000	20,778,500	43.15	22.87	53.
1855	3,776,399,500	No account kept	....	....	326,700,000	....	....	34.96	.....	.....
1856	4,409,787,600	"	....	598,950,000	....	....	....	40.80	.....	.....
1857	4,644,990,000	10,625,900,000	....	32,670,000	....	15,303,560,000	41,927,600	63.10	46.69	74.
1858	4,689,155,000	1,934,500,000	....	....	141,570,000	6,482,085,000	17,759,000	48.66	19.46	40.
1859[2]	4,808,875,000	7,569,000,000	....	283,140,000	....	12,661,015,000	34,687,700	49.02	38.24	78.
1860	6,309,108,000	None.	....	174,240,000	....	6,483,348,000	17,714,100	55.44	19.40	35.
1861	6,639,095,900	3,377,559,000	....	....	1,459,260,000	8,557,394,900	23,444,900	45.44	25.45	56.
1862	6,059,000,000	33,200,000	....	1,306,800,000	....	7,399,000,000	20,271,200	49.69	22.36	45.
1863	5,927,052,500	2,165,696,500	....	763,300,000	....	8,855,049,000	24,260,400	69.30	26.88	39.
1864	6,105,306,700	1,368,746,000	....	....	1,848,577,000	5,625,475,700	15,370,200	42.60	18.35	43.
1865	4,621,630,000	1,688,120,700	....	743,242,500	....	7,052,993,200	19,323,300	49.46	20.50	41.
1866	4,463,585,000	None.	....	743,242,500	....	5,206,827,500	14,265,300	62.32	16.01	26.
1867	4,951,225,000	2,482,041,000	....	....	698,811,000	6,734,455,000	18,450,600	56.25	21.80	39.
1868	5,405,515,000	2,507,684,000	....	346,371,000	....	8,259,570,000	22,567,200	49.71	24.98	50.
1869	5,503,751,000	1,635,570,000	....	480,882,000	....	7,620,203,000	20,877,300	64.34	21.99	34.
1870	5,477,810,000	4,818,971,000	....	....	1,736,085,000	8,560,696,000	23,453,900	55.89	26.08	47.

1871	5,223,500,000	None.	. . . .	. . . .	250,933,000	4,972,567,000	13,623,500	45.39	15.16	33.
1872	5,775,151,200	None.	1,676,666,400	1,543,995,500	. . . .	5,642,480,300	15,416,600	48.47	17.22	35.
1873	6,511,826,900	2,917,977,000	. . . .	. . . .	515,132,000	8,914,671,900	24,423,800	45.43	27.13	60.
1874	6,623,972,900	1,145,851,700	. . . .	. . . .	1,367,715,000	6,402,109,600	17,540,000	35.93	19.52	54.
1875	7,092,955,500	None.	2,555,800,000	1,222,885,000	. . . .	5,760,040,500	15,780,900	45.49	17.57	39.
1876	7,277,175,200	1,619,243,800	2,528,300,000	43,438,000	. . . .	6,411,557,000	17,517,900	48.49	19.54	40.
1877	7,626,889,200	1,484,978,600	1,894,350,000	378,727,000	. . . .	7,596,244,800	20,811,600	43.80	23.17	53.
1878	7,743,904,700	3,341,875,000	2,668,300,000	219,789,000	. . . .	8,637,268,700	23,663,700	53.58	26.34	49.
1879	6,051,838,900	1,523,361,400	411,300,000	. . . .	1,322,697,300	5,841,203,000	16,003,300	38.01	17.81	47.
1880	4,284,147,100	65,577,700	826,700,000	. . . .	146,265,000	3,376,759,800	9,226,100	35.83	10.30	29.
1881	2,846,459,700	2,231,016,700	187,600,000	468,089,400	. . . .	5,357,965,800	14,679,400	41.09	16.34	40.
1882	3,935,490,600	1,358,543,700	. . . .	. . . .	357,334,700	4,936,699,600	13,525,200	40.29	15.05	37.
1883	4,731,227,700	162,361,800	1,245,100,000	. . . .	334,400,000	3,314,089,500	9,079,700	31.20	10.11	32.
1884	4,533,156,450	1,842,837,100	1,416,300,000	1,340,436,700	. . . .	6,300,130,250	17,213,450	45.57	19.21	42.
1885	4,091,674,900	1,006,622,800	. . . .	8,594,800	. . . .	5,106,892,500	13,991,500	43.66	15.57	36.
1886	4,432,536,100	3,116,283,200	. . . .	. . . .	360,662,000	7,188,157,300	19,693,600	46.97	21.92	47.
1887	4,802,120,700	3,658,652,900	. . . .	. . . .	763,205,000	7,697,568,600	21,089,200	41.58	23.47	56.
1888	4,968,503,100	4,229,200,000	. . . .	959,309,000	. . . .	10,157,012,100	27,751,400	56.93	30.97	54.
1889	5,570,423,600	3,373,929,000	233,400,000	454,766,800	. . . .	9,165,719,400	25,111,600	50.23	27.95	56.
1890	5,722,170,800	2,380,441,200	. . . .	. . . .	64,166,300	8,038,445,700	22,023,100	51.23	24.51	48.
1891	5,508,178,900	6,064,000,000	. . . .	. . . .	1,056,057,800	10,516,121,100	28,811,300	46.42	32.07	69.
1892	5,464,791,300	281,000,000	902,300,000	200,284,300	. . . .	5,033,775,600	13,753,500	39.04	15.35	39.
1893	5,623,532,500	255,300,000	. . . .	. . . .	89,200,000	5,789,632,500	15,862,000	45.28	17.65	39.
1894	5,520,092,100	None.	962,200,000	. . . .	296,900,000	4,260,992,100	11,674,000	39.08	12.99	33.
Averages . . .	5,243,260,900	2,283,921,000	. . . .	. . . .	. . . .	7,123,442,100	19,504,600	47.51	21.66	45.0

[1] Observations of rainfall at Lake Cochituate commenced 1852, and these observations are assumed as correct for the whole district.
[2] Lake raised two feet.

TABLE IV.

Statement showing Amount of Water Diverted from Sudbury River to Lake Cochituate and Chestnut Hill Reservoir; Amount wasted; Amount of Flow in River; Percentage of Rainfall Collected, etc., 1875 to 1894.

(Water-shed from 1875 to 1878, inclusive, = 77.764 sq. miles; in 1879 and 1880 = 78.238 sq. miles; and from 1881 to 1893, inclusive, = 75.2 sq. miles.)

Year.	Amount of Water diverted to Lake Cochituate and Chestnut Hill Reservoir.	Amount of Water used by Framingham Water Co.	Amount of Water wasted from River.	Storage.		Total amount of flow in River.	Daily average amount of flow in River.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1875	2,555,800,000	. . . .	24,971,600,000	66,300,000	. . . .	27,593,700,000	75,599,200	45.490	20.418	44.88
1876	2,528,300,000	. . . .	29,942,300,000	. . . .	160,700,000	32,309,900,000	88,278,400	49.563	23.908	48.24
1877	1,894,350,000	. . . .	32,438,300,000	112,100,000	. . . .	34,444,750,000	94,369,200	44.018	25.847	57.90
1878	3,422,100,000	. . . .	37,125,200,000	654,700,000	. . . .	41,202,000,000	112,882,200	57.931	30.487	52.63
1879	3,749,200,000	. . . .	20,817,500,000	962,200,000	. . . .	25,528,900,000	69,942,200	41.419	18.775	45.33
1880	6,230,200,000	. . . .	11,290,000,000	. . . .	958,600,000	16,561,600,000	42,250,300	38.177	12.182	31.91
1881	8,845,300,000	. . . .	17,279,000,000	751,700,000	. . . .	26,876,000,000	73,633,900	44.169	20.565	46.56
1882	7,735,200,000	. . . .	16,273,900,000	. . . .	352,600,000	23,656,600,000	64,812,300	39.394	18.102	45.95
1883	8,455,000,000	. . . .	7,251,900,000	. . . .	1,086,400,000	14,620,500,000	40,056,200	32.780	11.188	34.13
1884	6,110,600,000	. . . .	23,228,900,000	1,744,600,000	. . . .	31,084,100,000	84,929,200	47.135	23.784	50.46
1885	5,224,700,000	61,800,000	19,878,800,000	. . . .	446,900,000	24,718,400,000	67,721,600	43.545	18.916	43.44
1886	5,266,600,000	76,600,000	23,023,000,000	1,464,500,000	. . . .	29,831,700,000	81,730,700	46.065	22.825	49.55
1887	6,124,100,000	87,500,000	25,334,500,000	117,400,000	. . . .	31,663,500,000	86,749,300	42.705	24.227	56.73
1888	7,224,700,000	61,500,000	39,040,500,000	390,600,000	. . . .	46,717,300,000	127,642,900	57.465	35.749	62.21

1889	6,363,900,000	59,500,000	31,550,400,000	. . . .	2,800,000	37,971,000,000	104,030,100	49.95	29.056	58.17
1890	6,596,000,000	74,500,000	28,667,100,000	. . . .	57,400,000	35,280,200,000	96,658,100	53.00	26.998	50.94
1891	8,306,600,000	80,500,000	28,799,600,000	. . . .	1,100,800,000	36,085,900,000	98,865,500	49.52	27.612	55.76
1892	10,535,500,000	82,800,000	11,143,000,000	. . . .	257,700,000	21,503,600,000	58,753,000	41.83	16.456	39.34
1893	11,737,900,000	103,000,000	17,405,500,000	. . . .	789,800,000	28,456,600,000	77,963,300	48.225	21.774	45.15
1894	12,412,800,000	117,000,000	6,715,900,000	1,901,600,000	. . . .	21,147,300,000	57,937,800	39.740	16.182	40.72
Averages	6,565,992,500	80,470,000	22,608,705,000	. . . .	. . . .	29,362,532,500	80,239,900	45.606	22.234	48.00

TABLE V.

Statement showing Amount of Water drawn from Mystic Lake; Amount wasted; Amount of Rainfall collected in Lake; Percentage of Rainfall collected, etc., 1876 to 1894; Water-shed of Lake, 17,200 Acres.

Year.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	Storage.		Total Amount of Rainfall collected in Lake.	Daily average amount of Rainfall collected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
			Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1876	3,230,101,300	6,369,774,700	. . . .	32,583,000	9,567,293,000	26,140,100	47.00	20.49	43.6
1877	3,069,554,800	7,250,223,500	. . . .	16,291,400	10,303,486,900	28,228,700	43.095	22.06	51.2
1878	3,367,490,400	8,718,547,600	. . . .	26,000,000	12,060,038,000	33,041,200	54.065	25.82	47.8
1879	3,490,848,200	4,625,691,800	. . . .	203,000,000	7,913,540,000	21,680,900	35.30	16.94	48.0
1880	3,692,195,700	2,158,761,200	. . . .	113,500,000	5,703,756,900	15,584,000	54.42	12.21	35.5
1881	2,815,579,900	5,534,300,000	371,200,000	. . . .	8,721,079,900	23,893,400	41.91	18.67	44.5
1882	2,570,896,700	4,444,668,000	15,000,000	. . . .	7,030,564,700	19,261,800	39.165	15.05	38.4
1883	2,664,514,200	2,034,702,600	. . . .	347,579,000	4,351,637,800	11,922,300	31.22	9.32	29.84
1884	2,469,761,000	6,574,003,800	380,600,000	. . . .	9,424,364,800	25,749,600	44.39	20.18	45.46
1885	2,639,278,800	5,558,860,500	. . . .	33,200,000	8,194,939,300	22,451,900	44.50	17.55	39.43
1886	2,862,947,500	7,743,258,900	. . . .	28,400,000	10,577,806,400	28,980,300	45.56	22.65	49.71
1887	2,954,257,500	7,414,213,000	. . . .	11,000,000	10,357,470,500	28,376,600	46.42	22.17	47.77
1888	3,205,121,100	11,334,593,100	. . . .	6,000,000	14,533,714,200	39,709,600	56.745	31.12	54.84
1889	3,007,539,800	8,879,787,500	12,000,000	. . . .	11,899,327,300	32,600,900	50.395	25.48	50.56
1890	3,212,284,500	8,953,727,900	. . . .	3,000,000	12,163,012,400	33,323,300	49.37	26.04	52.75
1891	3,500,817,500	10,027,714,400	. . . .	171,000,000	13,357,531,900	36,600,000	47.40	28.60	60.34
1892	3,811,766,200	3,474,213,200	177,000,000	. . . .	7,462,979,400	20,390,700	39.115	15.98	40.85
1893	4,331,743,200	4,958,528,500	. . . .	95,000,000	9,195,271,700	25,192,500	44.20	19.69	44.54
1894	3,996,805,100	2,752,964,200	. . . .	23,000,000	6,726,769,300	18,429,500	39.24	14.40	36.70
Average	3,204,921,200	6,254,659,700	. . . .	. . . .	9,449,715,000	25,871,200	43.89	20.23	45.36

TABLE VI.

Average Maximum and Minimum Monthly and Yearly Heights, in Feet, above Tide Marsh Level to which Water would rise at Different Stations on the Boston Water-Works.

1894.	Boston Common.		Engine-house No. 8, Salem street.		Engine-house No. 7, East street.		Engine-house No. 38, Congress street, South Boston.		Engine-house No. 2, Fourth street, South Boston.		Engine-house No. 9, Paris street, East Boston.		Engine-house No. 16, River street, Dorchester.		Engine-house No. 32, Bunker Hill street, Charlestown, Mystic Supply.		710 Albany street.		City Hall, High Service.		Engine-house No. 18, Harvard street, Dorchester, High service.		Engine-house No. 24, Warren street, Roxbury, High Service.	
Month.	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*
January. .	118.6	103.1	116.2	98.8	116.8	101.3	114.6	96.5	116.6	96.5	109.1	82.6	116.7	98.9	140.5	125.7	116.8	101.9	217.9	204.4	. .	. .	. .	. .
February .	115.9	100.4	113.9	95.9	115.6	99.5	112.9	94.4	114.2	93.9	103.5	77.4	114.5	96.2	139.4	124.8	115.1	100.2	218.5	205.1	. .	. .	. .	. .
March . .	117.9	102.1	117.5	99.3	119.2	102.4	117.1	96.9	115.6	94.0	110.3	82.3	119.2	100.3	144.4	126.5	118.3	102.9	220.6	205.4	. .	. .	. .	. .
April . . .	119.6	103.0	119.6	101.1	120.4	103.8	119.0	98.4	117.7	95.8	111.9	80.3	120.6	99.9	145.0	127.6	120.0	104.0	220.8	205.6	. .	. .	. .	. .
May . . .	120.0	102.5	119.9	100.5	120.9	103.6	119.1	97.5	118.1	93.5	113.2	76.3	121.2	99.7	145.7	127.2	119.9	103.7	221.0	205.6	. .	. .	. .	. .
June . . .	119.9	102.6	119.7	100.1	120.8	102.6	118.0	94.7	117.5	91.2	110.3	72.0	120.3	95.0	143.8	120.6	119.9	102.6	217.5	201.5	. .	. .	. .	. .
July . . .	118.8	99.8	118.5	97.3	119.6	100.7	116.4	92.2	116.0	89.6	111.2	76.7	118.2	93.6	144.3	123.1	118.4	100.7	216.2	201.6	215.3	181.1	. .	. .
August . .	118.8	101.5	118.4	98.7	119.7	103.0	116.4	94.6	115.7	91.5	109.9	77.2	117.9	95.7	143.2	124.8	119.3	102.3	220.6	205.7	219.6	191.9	222.1	200.0
September,	118.2	99.4	117.6	96.7	119.6	102.5	117.0	95.3	115.3	90.4	110.4	76.9	117.1	93.8	{ 140.2 [1] 115.5 }	{ 122.4 89.5 }	119.0	101.1	216.5	201.5	215.7	191.0	217.2	198.2
October . .	118.4	98.9	117.8	95.3	119.3	100.6	117.6	97.5	116.6	91.7	110.7	77.9	117.7	96.1	116.2	89.7	119.1	100.6	215.0	198.0	214.9	192.8	216.2	199.3
November .	117.5	99.2	117.1	95.5	118.2	100.2	117.1	92.2	115.3	92.8	109.4	78.9	117.2	96.7	115.1	89.9	118.6	100.7	217.7	202.1	217.5	198.4	219.1	204.4
December	115.4	97.6	114.7	93.8	116.1	98.4	114.3	95.1	111.8	89.8	104.8	75.3	115.1	95.5	111.9	87.8	116.4	100.0	215.7	199.1	214.6	196.4	217.4	203.2
Averages	118.2	100.9	117.6	97.7	118.9	101.5	116.6	95.4	115.9	92.6	109.5	77.8	118.0	96.8	. . .	. . .	118.4	101.7	218.3	202.9	216.3	191.9	218.4	201.0

[1] On September 12 Mystic supply was shut off from Charlestown and Cochituate turned on.

TABLE VII.

Statement of Operations at the Chestnut Hill Pumping-Station for 1894.

1894.	Engine No. 1. Total pumping-time.		Engine No. 1. Amount pumped.	Engine No. 2. Total pumping-time.		Engine No. 2. Amount pumped.	Total amount pumped, 2% allowed for slip.	Daily average amount pumped.	Total amount of coal consumed.	Daily average amount of coal consumed.	Total ashes and clinkers.	Per cent. ashes and clinkers.	Quantity pumped per lb. of coal. No correction for heating and lighting.	Quantity pumped per lb. of coal. Corrected for heating and lighting.	Average lift in feet.	Division of Coal. Heating.	Division of Coal. Lighting.	Division of Coal. Pumping.	Duty in ft.-lbs. per 100 lbs. of coal. Without correction for heating and lighting.	Duty in ft.-lbs. per 100 lbs. of coal. Corrected for heating and lighting.	Water evaporated in boilers per lb. of coal. Actual.	Water evaporated in boilers per lb. of coal. From and at 212° F., including feed-water heater.
Month.	*Hrs.*	*Min.*	*Gallons.*	*Hrs.*	*Min.*	*Gallons.*	*Gallons.*	*Gallons.*	*Lbs.*	*Lbs.*	*Lbs.*	*Per cent.*	*Gals.*	*Gals.*	*Feet.*	*Lbs.*	*Lbs.*	*Lbs.*	*Ft.-Lbs.*	*Ft.-Lbs.*	*Lbs.*	*Lbs.*
January .	2	.	792,075	737	05	298,553,275	299,345,350	9,656,300	388,775	12,541	28,438	7.3	770.0	847.3	124.91	12,779	22,721	353,275	80,211,700	88,272,000	9.84	11.64
February,	665	35	282,123,250	. .	.	. . . . . .	282,123,250	10,075,800	354,025	12,644	24,868	7.0	796.9	872.7	124.17	11,576	19,188	323,261	82,525,400	90,379,200	9.69	11.45
March . .	11	30	4,724,720	739	15	298,065,640	302,790,360	9,767,400	381,983	12,322	27,019	7.1	792.7	860.6	125.45	10,371	19,775	351,837	82,934,400	90,040,400	10.34	12.20
April . .	717	55	297,644,675	. .	.	. . . . . .	297,644,675	9,921,500	354,474	11,816	23,927	6.8	839.7	904.0	125.29	8,332	16,871	329,271	87,739,700	94,455,500	10.19	11.97
May . . .	141	05	60,014,800	624	10	255,902,175	315,916,975	10,190,900	365,959	11,805	25,286	6.9	863.3	900.4	[1]125.90	. . .	15,083	350,876	90,642,600	94,539,000	10.30	12.02
June . . .	717	30	306,151,000	78	25	28,039,750	334,190,750	11,139,700	379,723	12,657	26,697	7.0	880.1	912.8	[1]126.63	. . .	13,617	366,106	92,945,900	96,403,000	10.03	11.64
July . . .	247	05	98,468,050	597	.	249,645,225	348,113,275	11,229,500	405,447	13,079	28,942	7.1	858.6	891.2	[1]127.94	. . .	14,850	390,597	91,613,400	95,096,400	9.94	11.47
August. .	266	25	113,365,550	474	50	203,696,025	317,061,575	10,227,800	362,980	11,709	28,234	7.8	873.5	915.7	126.96	. . .	16,733	346,247	92,489,800	96,959,600	10.20	11.76
September,	432	20	185,666,510	323	15	136,674,975	322,341,485	10,744,700	374,788	12,493	28,354	7.6	860.1	901.8	[1]127.26	. . .	17,333	357,455	91,282,700	95,709,000	10.13	11.73
October. .	451	10	191,488,925	357	50	150,680,100	342,169,025	11,037,700	407,821	13,156	33,791	8.3	839.0	897.3	[1]127.62	6,851	19,617	381,353	89,300,900	95,498,900	9.79	11.43
November,	447	50	193,359,225	273	30	116,488,125	309,847,350	10,328,200	402,095	13,403	30,980	7.7	770.6	856.8	[1]126.61	18,272	22,192	361,631	81,367,900	90,472,400	9.59	11.27
December,	301	30	131,114,225	437	.	189,316,250	[2]324,286,525	10,460,900	[3]459,590	14,825	[4]33,030	[4]7.6	705.6	792.9	[1]125.39	25,077	25,500	[3]409,013	76,620,300	86,639,900	8.85	10.47
Totals and averages,	4401	55	1,864,913,005	4642	20	1,927,061,540	3,795,830,595	10,399,500	4,637,660	12,706	339,566	7.4	818.5	878.5	126.18	93,258	223,480	4,320,922	86,459,300	92,829,900	9.89	11.47

[1] For several days during the month, Engines Nos. 1 and 2 were run simultaneously for a few hours.
[2] Including 3,856,050 gallons pumped by Engine No. 3.
[3] Including 22,250 pounds burned under Boiler No. 4.
[4] From old boilers only (Nos. 1, 2, and 3).

TABLE VIII.

Statement of Operations at the Mystic Pumping-Station for 1894.

1894.	Engine No. 1.			Engine No. 2.			Engine No. 3.			Total amount pumped.	Daily average amount pumped.	Daily average amount of coal consumed.	Daily average amount of ashes and clinkers.	Per cent. ashes and clinkers.	Quantity pumped per pound of coal.	Average lift in feet.	Duty in foot-pounds per 100 pounds of total coal.
	Total pumping-time.		Amount pumped.	Total pumping-time.		Amount pumped.	Total pumping-time.		Amount pumped.								
Month.	*Hrs.*	*Min.*	*Gallons.*	*Hrs.*	*Min.*	*Gallons.*	*Hrs.*	*Min.*	*Gallons.*	*Gallons.*	*Gallons.*	*Lbs.*	*Lbs.*	*Per ct.*	*Gals.*	*Feet.*	*Foot-pounds.*
January . . .	. . .	. . .	. . . . . .	578	30	119,909,100	734	00	246,604,800	366,513,900	11,826,900	27,097	2,935	10.8	436.3	148.78	54,140,400
February . . .	58	00	12,487,700	477	45	98,467,100	672	00	233,190,400	344,145,200	12,290,900	27,536	2,760	10.0	446.4	147.75	55,002,300
March	185	15	42,642,400	171	45	36,209,800	743	00	253,491,200	332,343,400	10,720,800	24,484	2,813	11.5	437.9	147.56	53,886,500
April	. . .	. . .	. . . . . .	342	15	68,644,600	719	00	238,412,800	307,057,400	10,235,200	23,467	2,335	10.0	436.2	147.50	53,654,400
May	343	00	75,182,900	497	15	103,087,700	453	00	152,089,600	330,360,200	10,656,800	25,000	2,631	10.5	426.3	147.29	52,363,100
June	623	15	139,342,800	. . .	. . .	. . . . . .	717	30	237,516,800	376,859,600	12,562,000	29,033	3,287	11.3	432.7	149.10	53,802,800
July	625	20	138,316,000	5	30	1,072,100	737	00	237,900,800	377,288,900	12,170,600	27,677	2,897	10.5	439.7	150.09	55,043,300
August	400	30	84,952,600	. . .	. . .	. . . . . .	724	30	236,595,200	321,547,800	10,372,500	23,839	2,899	12.2	435.1	150.28	54,534,100
September . .	354	45	78,187,800	19	30	3,941,100	561	15	188,825,600	270,954,500	9,031,800	21,400	2,686	12.6	422.1	150.25	52,886,200
October . . .	33	45	7,942,600	6	15	1,192,900	695	00	220,748,800	229,884,300	7,415,600	16,516	2,055	12.4	449.0	148.95	55,775,800
November . .	33	15	5,873,900	. . .	. . .	. . . . . .	696	00	220,672,000	226,545,900	7,551,500	17,733	2,133	12.0	425.8	148.69	52,807,100
December . .	680	45	147,013,600	468	15	99,297,600	66	00	21,606,400	267,917,600	8,642,500	24,542	2,707	11.0	[1]352.2	147.16	[1] 43,220,200
Totals and averages,	3,337	50	731,942,300	2,585	00	531,822,000	7,518	15	2,487,654,400	3,751,418,700	10,277,900	24,010	2,678	11.2	428.1	148.62	53,057,500

[1] Steam used in pumping water from excavation for foundation of new engine.

TABLE IX.

Statement of Operations at the East Boston Pumping-Station for the Year 1894.

1894.	Engine No. 2.				Engine No. 3.				Total amount of coal consumed.	Per cent. of ashes and clinkers.
	Total pumping-time.		Total amount pumped to reservoir.	Daily average.	Total pumping-time.		Total amount pumped to tank.	Daily average.		
Month.	*Hrs.*	*M.*	*Gallons.*	*Gallons*	*Hrs.*	*M.*	*Gallons.*	*Gallons*	*Pounds.*	*Per ct.*
Jan. .	276	50	11,362,540	366,500	56	50	787,020	25,400	30,800	19.1
Feb. .	276	05	11,847,640	423,100	55	20	793,440	28,300	32,960	18.7
March,	266	25	11,453,960	369,500	63	15	915,000	29,500	30,740	18.9
April .	297	55	12,327,140	410,900	64	40	925,080	30,800	34,260	18.7
May .	269	00	10,921,820	352,300	64	20	912,240	29,400	30,040	18.8
June .	255	25	10,538,080	351,300	80	25	1,119,660	37,300	31,960	18.9
July .	292	50	12,422,060	400,700	88	00	1,275,840	41,200	34,310	18.7
Aug. .	283	50	12,034,120	388,200	68	50	973,860	31,400	32,550	18.7
Sept. .	264	10	11,154,220	371,800	64	05	940,500	31,400	30,370	18.9
Oct. .	309	25	12,709,900	410,000	60	15	891,060	28,700	34,200	18.7
Nov. .	293	20	11,637,360	387,900	57	20	812,160	27,100	32,400	19.0
Dec. .	313	50	12,123,160	391,100	62	00	900,240	29,000	36,050	19.1
Totals,	3,399	05	140,532,000	385,000	785	20	11,246,100	30,800	390,640	18.9

Note. — Engine No. 1 was not run during 1894.

TABLE X.

Statement of Operations at the West Roxbury Pumping-Station for the Year 1894.

1894.	Total pumping-time.		Total amount pumped.	Daily average amount pumped.	Quantity pumped per lb. of coal.	Total amount of coal consumed.	Per cent. of ashes and clinkers.	Average lift.
Month.	*Hours.*	*Min.*	*Gallons.*	*Gallons.*	*Gallons.*	*Pounds.*	*Per cent.*	*Feet.*
January . .	275	00	3,229,275	104,200	139.8	23,100	20.3	136.26
February .	253	30	3,198,000	114,200	140.6	22,750	20.0	135.82
March . . .	259	30	3,152,400	101,700	138.9	22,700	20.4	136.36
April . . .	255	30	3,090,150	103,000	153.2	20,175	20.2	135.66
May	320	00	4,001,700	129,100	165.4	24,200	20.9	136.82
June . . .	364	30	4,700,925	156,700	170.3	27,600	18.6	136.95
July	424	00	5,377,875	173,500	166.2	32,350	19.4	137.70
August . .	321	30	4,022,175	129,700	172.8	23,275	16.5	137.53
September .	315	00	3,865,500	128,900	176.5	21,900	16.0	136.42
October . .	292	00	3,183,450	102,700	166.0	19,175	15.5	137.21
November .	285	30	3,059,550	102,000	153.4	19,950	17.5	137.01
December .	316	00	3,470,100	111,900	143.4	24,200	18.0	136.95
Totals and averages,	3,682	00	44,351,100	121,500	157.6	281,375	18.7	136.72

TABLE XI.

Table showiny Work done at Mystic Sewage Pumping-Station during the Year 1884.

1894.	Pumping time.		Amount of sewage pumped and treated.	Sulphate al. used.	Coal used.	Daily average amount of sewage pumped and treated.
	Hrs.	*Min.*	*Gallons.*	*Lbs.*	*Lbs.*	*Gallons.*
January	471	35	9,585,000	24,060	29,150	342,300
February	474	05	10,291,000	24,785	29,500	367,500
March	548	15	12,091,000	29,440	33,200	390,000
April	497	50	10,759,000	22,475	29,800	371,000
May	433	35	8,389,000	21,600	25,650	322,700
June	511	25	9,610,000	25,060	17,300	320,300
July	490	55	8,778,000	23,150	25,950	292,600
August	527	15	9,255,000	23,855	29,500	298,500
September	472	40	8,154,000	18,225	28,800	281,200
October	508	25	9,263,000	20,975	29,900	319,400
November	496	25	9,693,000	21,390	29,300	334,200
December	498	35	11,040,000	19,350	29,700	368,000
Totals	5,931	00	116,908,000	274,365	337,750	334,000

TABLE XII.

Rainfall in Inches and Hundredths on Sudbury River Water-shed for the Year 1894.

1894.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	...	0.025	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	...	...	...	...	...	...	...	0.515
3	...	...	...	...	...	0.420	0.210	0.700	...	...	0.605	...
4	...	0.295	...	0.375	0.110	...	0.290	0.045	...	...	...	...
5	0.045	...	...	...	...	0.005	...	...	...	0.460	...	...
6	0.085	...	...	...	0.290	...	...	...	0.190	...	1.260	...
7	...	...	...	...	0.005	...	...	...	...	...	...	...
8	...	...	...	...	...	...	...	...	0.200	...	0.375	...
9	...	...	0.010	0.890	...	...	...	0.145	...	0.080	...	...
10	...	0.730	...	...	...	...	...	...	...	1.645	0.280	0.675
11	0.135	...	0.030	...	0.025	0.100	...	...	...	...	...	...
12	0.055	...	...	...	...	...	...	...	...	...	...	0.875
13	...	1,295	...	1.625	...	...	...	0.210	...	...	...	...
14	0.020	...	0.095	...	...	...	0.250	0.140	...	0.730	0.150	...
15	...	0.865	0.160	...	...	...	...	0.030	0.050	...	...	...
16	0.220	...	...	...	...	...	0.075	...	...	...	...	...
17	...	...	...	...	...	...	...	...	0.350	...	...	...
18	...	0.310	...	...	...	...	...	...	...	...	0.110	...
19	0.145	...	...	...	0.615	...	...	...	...	...	...	...
20	...	0.245	...	...	...	...	...	0.760	1.755	...	...	...
21	...	...	0.075	0.160	0.280	0.460	0.090	...	...	...	0.395	...
22	...	...	...	0.040	...	...	0.500	...	...	...	...	...
23	...	...	0.830	...	0.030	0.170	...	...	...	...	...	...
24	0.460	...	...	0.325	0.785	...	0.845	...	...	...	...	...
25	...	...	...	...	0.080	...	0.800	...	...	...	0.150	0.255
26	...	0.145	0.060	...	0.025	...	...	...	...	1.670	...	...
27	1.160	...	...	...	...	...	...	...	...	...	...	2.490
28	...	...	...	...	...	...	...	...	...	...	...	...
29	...	...	0.175	...	1.545	...	0.195	...	...	...	...	...
30	1.765	...	...	...	...	...	...	...	0.090	...	0.100	...
31	...	...	...	...	0.445	...	...	...	...	0.760	...	...
Totals	4.090	3.910	1.435	3.415	4.235	1.155	3.255	2.030	2.635	5.345	3.425	4.810

Total rainfall during the year, 39.740 inches, being an average of two gauges, located at Framingham and Ashland.

TABLE XIII.

Rainfall in Inches aud Hundredths at Lake Cochituate for the Year 1894.

1894.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	...	0.02	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	0.02	...	...	...	...	...	...	0.49
3	...	...	...	...	...	0.45	0.22	0.71	...	...	0.54	...
4	...	...	...	0.33	0.16	...	0.23	0.05	...	...	...	...
5	...	0.21	...	...	...	0.01	...	...	...	0.64	...	...
6	0.04	...	0.01	0.01	0.29	...	...	...	0.10	...	1.46	...
7	0.05	...	...	...	...	...	...	...	...	...	...	...
8	...	...	...	...	...	...	...	0.16	0.16	...	...	...
9	...	...	...	1.03	...	...	...	...	...	0.08	...	...
10	...	0.63	...	...	...	...	...	...	...	1.53	0.64	0.64
11	0.17	...	0.02	...	...	0.08	...	...	...	...	...	...
12	...	...	...	...	...	...	...	...	...	...	...	0.84
13	...	1.31	...	1.42	...	...	...	...	...	...	...	...
14	...	...	0.08	...	...	...	0.14	0.29	...	0.92	0.17	...
15	...	0.85	0.13	...	...	...	...	0.03	0.06	...	...	...
16	0.24	...	...	...	...	...	0.14	...	...	...	...	...
17	...	...	...	...	...	0.26	...	...	0.26	...	0.10	...
18	...	0.34	...	...	...	...	...	...	...	...	0.02	...
19	0.14	...	...	...	...	...	...	0.04	...	...	...	...
20	...	0.22	...	...	...	...	...	1.29	1.62	...	...	...
21	...	...	0.03	...	0.86	0.79	...	...	...	...	0.33	...
22	...	...	...	0.22	...	...	0.86	...	...	...	...	...
23	...	...	0.65	...	...	0.02	...	...	...	...	0.01	...
24	...	...	...	0.26	0.66	...	0.57	...	...	...	...	...
25	0.42	...	...	...	0.08	...	1.24	...	...	...	0.16	0.23
26	...	0.31	...	...	...	...	...	...	...	1.37	...	...
27	1.27	...	...	...	...	...	...	...	...	...	...	2.18
28	...	...	...	...	...	...	...	...	...	...	...	...
29	...	...	0.24	...	1.13	...	0.21	...	...	...	...	...
30	1.62	...	...	...	...	...	...	...	0.07	...	0.10	...
31	...	...	...	...	0.50	...	...	...	...	0.60	...	...
Totals	3.95	3.89	1.16	3.27	3.70	1.61	3.61	2.57	2.27	5.14	3.53	4.38

Total rainfall during the year, 39.08 inches.

TABLE XIV.

Rainfall in Inches and Hundredths at Mystic Lake for the Year 1894.

1894.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	...	...	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	...	...	...	...	...	...	...	...
3	...	...	...	...	...	0.16	0.38	0.44	...	...	0.77	0.44
4	...	...	...	0.39	...	0.02	...	0.06	...	...	...	...
5	...	0.21	...	...	0.24	...	...	...	...	0.52	...	...
6	0.10	...	...	...	0.32	...	...	...	0.06	...	1.59	...
7	0.07	...	...	...	...	0.20	...	...	...	...	...	...
8	...	0.03	...	...	...	...	...	...	0.34	...	...	...
9	...	...	...	1.03	...	...	...	0.29	...	0.16	...	...
10	...	0.78	0.03	...	...	...	...	0.86	0.02	1.70	0.35	0.47
11	...	...	0.01	...	...	...	...	...	...	...	...	...
12	0.21	...	...	...	...	...	...	...	...	...	...	0.81
13	...	0.95	...	...	...	...	...	0.17	...	...	...	...
14	...	...	0.10	1.73	...	...	0.01	0.02	...	1.36	0.18	...
15	...	0.86	...	...	...	...	...	...	0.08	...	...	...
16	0.32	...	0.06	...	...	...	...	...	...	...	...	...
17	...	...	...	...	...	...	...	...	0.44	...	0.16	...
18	...	0.29	...	...	...	...	...	...	...	...	...	...
19	0.23	...	...	...	1.33	...	...	...	...	...	0.02	...
20	...	0.19	...	...	...	...	...	0.68	1.58	...	...	...
21	...	...	0.02	...	0.34	0.34	0.67	...	...	...	0.23	...
22	...	...	...	0.12	...	...	0.80	...	...	...	...	...
23	...	...	0.63	...	0.05	...	...	...	...	...	...	...
24	...	...	...	0.18	...	...	0.81	...	...	...	...	...
25	0.40	...	...	...	0.94	...	0.69	...	...	...	0.09	0.25
26	...	...	0.06	...	0.04	...	...	...	...	1.30	...	...
27	1.20	...	...	...	...	...	...	...	...	0.02	...	2.00
28	...	...	...	0.03	...	...	...	...	...	...	...	...
29	...	...	0.18	...	1.30	...	...	...	...	...	...	...
30	1.40	...	...	...	...	...	0.09	...	...	...	0.10	...
31	...	...	...	...	0.62	...	...	...	...	0.52	...	...
Totals.	3.93	3.21	1.09	3.48	5.18	0.72	3.45	2.52	2.52	5.58	3.49	3.97

TABLE XV.

Monthly Rainfall in Inches, during 1894, at Various Places in Eastern Massachusetts.

PLACE.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Framingham	4.23	3.91	1.41	3.28	4.37	1.11	3.82	1.94	2.78	5.20	3.43	4.81	40.29
Dam 4, Ashland	3.95	3.91	1.46	3.55	4.10	1.20	2.69	2.12	2.49	5.49	3.42	4.81	39.19
Cordaville	3.75	3.98	1.49	3.86	4.78	2.14	3.14	2.75	2.49	5.76	3.58	4.55	42.27
Lake Cochituate	3.95	3.89	1.16	3.27	3.70	1.61	3.61	2.57	2.27	5.14	3.53	4.38	39.08
Chestnut Hill	3.90	3.81	1.14	3.24	4.27	0.20	3.33	2.27	2.50	6.04	3.41	4.06	38.17
Mystic Lake	3.93	3.31	1.09	3.48	5.18	0.72	3.45	2.52	2.52	5.58	3.49	3.97	39.24
Winchester	3.43	3.04	0.96	2.60	4.24	0.31	3.14	1.24	1.97	4.93	3.64	4.18	33.68
Mystic Pumping-station	3.79	3.09	0.99	2.64	4.74	0.52	3.13	1.75	3.04	5.38	3.46	4.46	36.99
Boston Pipe-yard	3.84	3.28	1.42	2.78	3.74	0.79	3.01	2.95	1.55	5.63	3.31	4.62	36.92
Cambridge Observatory	3.33	3.59	0.37	2.67	2.27	0.38	2.56	1.83	2.42	5.23	3.49	4.32	32.46
Waltham, Boston Manufacturing Co.	2.54	2.65	1.20	3.29	4.57	0.51	3.16	1.48	2.29	5.92	3.83	4.30	35.74
Lowell, Locks and Canals Co.	3.35	3.50	1.27	3.76	4.36	0.37	3.00	0.92	3.03	3.46	3.52	3.84	34.38
Average of twelve places	3.666	3.497	1.163	3.202	4.193	0.822	3.170	2.028	2.446	5.313	3.509	4.358	37.367

TABLE XVI.

Table showing the Temperature of Air and Water at Various Stations on the Water-Works.

1894.	Temperature of Air.						Temperature of Water.	
	Chestnut Hill Reservoir.			Framingham.			Brookline Reservoir.	Mystic Engine-House.
	Maximum.	Minimum.	Mean.	Maximum.	Miuimum.	Mean.	Mean.	Mean.
January	56.5	0.0	28.9	54.0	-6.0	26.7	37.2	36.2
February	52.5	-10.0	25.9	49.0	-14.0	24.2	36.9	35.8
March	70.5	17.0	41.8	69.0	15.0	40.6	40.8	38.0
April	80.5	18.0	47.5	79.0	16.0	45.8	45.6	43.7
May	89.0	34.5	59.3	88.0	30.0	57.7	59.7	58.9
June	97.0	41.5	69.7	95.0	40.0	69.3	66.5	66.9
July	105.5	50.0	75.9	98.0	47.0	74.2	74.5	75.9
August	92.5	42.0	69.1	90.0	40.0	67.2	73.2	72.4
September	90.0	40.0	65.2	90.0	31.0	63.8	68.2	67.2
October	76.5	32.5	52.8	76.0	28.0	51.3	57.2	53.8
November	65.0	11.0	36.6	64.0	8.0	35.2	43.8	41.5
December	55.0	5.0	30.4	52.0	0.0	27.7	37.6	36.1

TABLE XVII.

Rainfall in Inches on Cochituate Water-shed, 1863 to 1894.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.	4 months, July-Oct.
1863	4.10	4.38	3.57	11.34	2.66	1.98	14.12	5.61	3.39	4.56	8.54	5.05	69.30	27.68
1864	3.37	0.98	8.44	4.02	2.84	0.58	1.06	3.56	1.52	6.50	5.45	4.28	42.60	12.64
1865	4.99	4.45	5.48	2.18	8.25	0.91	3.10	3.36	1.66	6.99	4.78	3.31	49.46	15.11
1866	1.44	5.80	3.92	1.94	6.46	4.80	13.35	3.98	8.36	3.43	4.52	4.32	62.32	29.12
1867	2.76	5.40	5.65	2.43	6.46	2.95	5.36	12.36	1.08	7.27	2.63	1.90	56.25	26.07
1868	3.70	1.18	2.51	5.61	8.12	2.95	2.16	7.38	7.69	1.19	6.77	0.45	49.71	18.42
1869	3.71	7.07	7.52	2.57	7.59	3.68	2.63	2.34	8.49	9.50	3.26	5.98	64.34	22.96
1870	7.85	4.68	6.04	8.81	3.14	4.05	3.10	2.03	0.64	7.96	4.40	3.19	55.89	13.73
1871	1.31	2.30	5.02	2.29	5.66	5.96	2.20	3.56	1.46	5.38	7.01	3.24	45.39	12.60
1872	1.86	1.37	3.06	1.74	3.24	4.27	5.55	9.76	6.29	3.69	4.22	3.42	48.47	25.29
1873	4.24	2.43	3.98	2.69	3.24	0.38	4.08	7.17	2.62	6.11	4.54	3.95	45.43	19.98
1874	2.96	2.90	1.19	6.36	3.40	4.79	3.16	4.83	1.55	1.04	2.05	1.70	35.93	10.58
1875	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49	17.38
1876	1.83	4.21	7.43	3.24	2.80	1.60	9.49	2.19	3.98	2.00	6.59	3.13	48.49	17.66
1877	3.19	0.53	7.79	3.24	3.73	2.64	2.77	3.35	0.46	8.14	6.94	1.02	43.80	14.72
1878	5.77	5.93	4.20	5.63	0.83	3.33	3.47	6.94	1.12	5.15	6.09	5.12	53.58	16.68
1879	2.00	3.05	3.90	4.69	1.20	4.14	3.38	6.43	1.74	0.90	2.98	3.60	38.01	12.45
1880	3.07	4.05	2.83	2.94	1.98	1.25	7.00	3.81	1.69	2.95	1.70	2.56	35.83	15.45

1881	5.56	4.43	4.79	1.71	3.18	4.83	2.78	1.13	2.13	2.87	3.85	3.83	41.09	8.91
1882	5.93	3.96	2.76	1.89	4.73	1.87	3.49	1.14	9.20	2.22	0.93	2.17	40.29	16.05
1883	2.88	3.59	1.76	2.27	3.95	1.81	2.88	0.39	1.31	5.16	2.06	3.14	31.20	9.74
1884	4.39	6.04	4.50	3.80	2.92	3.88	4.42	4.49	0.90	2.59	2.33	5.31	45.57	12.40
1885	5.25	3.98	1.09	3.71	3.46	2.96	1.73	7.01	1.63	5.26	5.26	2.32	43.66	15.63
1886	6.53	6.86	3.46	2.00	2.97	1.21	3.30	3.75	3.20	3.16	4.76	5.77	46.97	13.41
1887	5.29	5.34	5.10	4.45	1.02	2.58	3.77	3.70	1.28	2.49	2.76	3.80	41.58	11.24
1888	4.13	3.55	5.60	2.51	4.63	2.07	1.67	6.32	8.81	4.95	7.03	5.66	56.93	21.75
1889	5.46	1.56	2.28	3.19	3.64	3.17	9.10	4.57	4.92	3.85	5.79	2.70	50.23	22.44
1890	2.34	3.21	7.35	2.51	5.31	1.78	2.31	3.34	6.47	10.11	1.24	5.26	51.23	22.23
1891	6.67	5.02	5.49	3.62	1.67	3.78	2.99	4.91	2.12	4.14	2.84	3.17	46.42	14.16
1892	4.78	2.80	4.12	0.78	5.46	3.23	3.47	3.79	2.87	1.42	5.14	1.18	39.04	11.55
1893	2.61	7.26	3.13	3.21	5.45	2.75	2.40	5.86	1.76	3.74	2.08	5.03	45.28	13.76
1894	3.95	3.89	1.16	3.27	3.70	1.61	3.61	2.57	2.27	5.14	3.53	4.38	39.08	13.59
Totals.	126.34	125.35	138.86	113.87	127.25	94.03	137.47	147.16	106.04	144.71	136.90	110.88	1508.86	535.38
Averages.	3.95	3.92	4.34	3.56	3.97	2.94	4.30	4.60	3.31	4.52	4.28	3.46	47.15	16.73

TABLE XVIII.

Rainfall Collected, in Inches, on Cochituate Water-shed, 1863 to 1894.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.	4 months, July-Oct.
1863	1.93	3.11	3.71	4.42	1.44	0.67	2.97	1.51	0.98	1.32	2.65	2.17	26.88	6.78
1864	2.39	1.56	4.05	2.65	1.62	0.49	0.41	0.68	0.49	1.43	1.25	1.33	18.35	3.01
1865	2.15	1.74	4.66	2.70	4.70	0.34	0.46	0.47	0.45	0.70	1.00	1.13	20.50	2.08
1866	0.73	2.84	1.76	1.63	1.29	1.10	1.20	0.64	1.34	0.93	0.99	1.56	16.01	4.11
1867	1.10	5.24	3.50	2.87	2.20	0.65	0.59	2.10	0.31	1.02	1.10	1.12	21.80	4.02
1868	1.22	1.12	3.84	3.48	6.17	1.59	0.45	1.18	1.85	0.95	1.96	1.17	24.98	4.43
1869	1.82	1.84	3.31	2.49	2.20	1.07	0.74	0.58	1.10	2.37	1.30	3.17	21.99	4.79
1870	4.71	3.93	3.38	6.87	1.66	0.97	0.53	0.41	0.86	1.11	0.88	0.77	26.08	2.91
1871	1.03	2.28	2.53	1.58	2.00	0.87	0.43	0.85	0.39	0.69	1.30	1.21	15.16	2.36
1872	1.15	0.93	1.41	3.08	1.10	1.49	0.14	1.32	1.70	1.69	2.00	1.21	17.22	4.85
1873	3.09	1.57	3.89	6.09	2.66	0.45	0.62	1.40	0.78	2.04	1.86	2.68	27.13	4.84
1874	3.55	2.19	1.84	3.19	2.78	1.96	0.95	0.92	0.53	0.52	0.58	0.51	19.52	2.92
1875	0.13	2.92	2.66	3.15	1.39	1.48	0.25	0.62	0.60	1.19	1.96	1.22	17.57	2.66
1876	1.09	1.78	5.19	4.20	1.43	0.51	0.84	0.29	0.88	0.49	1.85	0.99	19.54	2.50
1877	1.20	1.37	6.81	3.24	2.04	0.92	0.65	0.67	0.46	1.16	2.69	1.96	23.17	2.94
1878	3.25	3.97	5.40	2.86	1.66	0.76	0.47	0.84	0.29	0.73	2.07	4.04	26.34	2.33
1879	1.29	2.32	3.30	4.48	1.40	0.77	0.33	0.95	0.61	0.60	0.72	1.04	17.81	2.49
1880	1.47	2.24	1.79	1.57	0.44	0.06	0.33	0.23	0.24	0.49	0.83	0.61	10.30	1.29
1881	1.19	2.23	5.66	1.79	1.26	1.31	0.16	0.09	0.23	0.18	0.84	1.40	16.34	0.66
1882	1.84	3.00	3.67	0.93	1.55	0.62	0.06	0.07	0.97	0.84	0.58	0.92	15.05	1.94
1883	0.84	1.59	2.04	1.66	1.26	0.07	0.02	0.07	0.62	0.59	0.41	0.94	10.11	1.30
Am'ts forward	37.17	49.77	74.40	64.93	42.25	18.15	12.60	15.89	15.68	21.04	28.82	31.15	411.85	65.21

Rainfall Collected, in Inches, on Cochituate Water-shed, 1863 to 1894, Concluded.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.	4 months, July–Oct.
Am'ts forward	37.17	49.77	74.40	64.93	42.25	18.15	12.60	15.89	15.68	21.04	28.82	31.15	411.85	65.21
1884	1.84	2.86	4.67	4.00	1.39	0.67	0.26	0.61	0.13	0.34	0.62	1.82	19.21	1.34
1885	1.90	2.00	2.21	2.36	1.61	0.43	0.00	0.33	0.25	0.79	2.05	1.64	15.57	1.37
1886	2.28	7.93	3.51	2.52	1.09	0.18	0.25	0.14	0.30	0.42	1.20	2.10	21.92	1.11
1887	4.06	4.34	4.70	3.36	1.35	0.82	0.72	1.33	0.64	0.49	0.70	0.96	23.47	3.18
1888	1.13	2.77	4.76	3.45	2.37	0.53	0.47	0.94	2.31	2.57	4.21	5.46	30.97	6.29
1889	4.50	1.85	2.08	2.17	1.20	1.18	1.63	3.43	1.79	1.91	2.95	3.26	27.95	8.76
1890	1.92	2.04	5.87	2.23	1.85	1.41	0.33	0.46	1.40	3.40	1.49	2.11	24.51	5.59
1891	6.26	6.62	8.03	4.31	0.88	0.77	0.50	0.72	0.76	0.79	0.83	1.60	32.07	2.77
1892	3.18	1.64	3.12	0.90	2.03	0.49	0.33	0.56	0.60	0.57	1.09	0.84	15.35	2.06
1893	0.64	2.55	4.12	2.42	1.83	0.75	0.38	0.77	0.42	1.09	1.00	1.68	17.65	2.66
1894	1.27	1.69	2.55	2.15	0.91	0.45	0.38	0.41	0.46	0.66	0.92	1.14	12.99	1.91
Totals . . .	66.15	86.06	120.02	94.80	58.76	25.83	17.85	25.59	24.74	34.07	45.88	53.76	653.51	102.25
Averages .	2.07	2.69	3.75	2.96	1.84	0.81	0.56	0.80	0.77	1.06	1.43	1.68	20.42	3.19

TABLE XIX.

Percentage of Rainfall Collected on Cochituate Water-shed, 1863 to 1894.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly.	4 months, July–Oct.
1863	47.0	71.0	104.0	39.0	54.0	34.0	21.0	27.0	29.0	29.0	31.0	43.0	38.8	24.5
1864	71.0	159.0	48.0	66.0	57.0	84.0	39.0	19.0	32.0	22.0	23.0	31.0	43.0	23.8
1865	43.0	39.0	85.0	124.0	57.0	37.0	15.0	14.0	27.0	10.0	21.0	34.0	41.4	13.8
1866	51.0	49.0	45.0	84.0	20.0	23.0	9.0	16.0	16.0	27.0	22.0	36.0	25.7	14.1
1867	40.0	97.0	62.0	118.0	34.0	22.0	11.0	17.0	29.0	14.0	42.0	59.0	38.7	15.4
1868	33.0	95.0	153.0	62.0	76.0	54.0	21.0	16.0	24.0	80.0	29.0	261.0	50.2	24.0
1869	49.0	26.0	44.0	97.0	29.0	29.0	28.0	25.0	13.0	25.0	40.0	53.0	34.2	20.9
1870	60.0	84.0	56.0	78.0	53.0	24.0	17.0	20.0	134.0	14.0	20.0	24.0	46.7	21.2
1871	79.0	99.0	50.4	68.8	35.3	14.6	19.6	23.8	26.8	12.8	18.5	37.4	33.4	18.7
1872	61.8	67.8	46.0	177.3	33.8	34.8	2.6	13.5	27.0	45.7	47.4	35.3	35.5	19.2
1873	72.9	64.8	97.8	226.4	82.2	119.1	15.1	19.5	29.8	33.4	40.9	67.9	59.8	24.2
1874	120.0	75.5	154.7	50.2	81.7	40.8	30.0	19.1	34.3	50.3	28.4	29.9	54.3	27.6
1875	5.5	92.8	71.2	97.5	39.9	23.7	7.1	11.2	17.4	24.6	40.5	129.8	38.6	15.3
1876	59.3	42.4	69.9	129.7	50.9	31.6	8.9	13.3	22.2	24.3	28.1	31.5	40.3	14.2
1877	37.6	258.9	87.4	100.0	54.6	34.8	23.3	19.6	99.8	14.3	38.8	192.6	52.9	20.0
1878	56.3	66.9	128.6	50.7	200.0	23.2	13.5	12.0	25.8	14.3	34.0	78.8	49.2	14.0
1879	64.4	76.3	84.5	95.6	117.0	18.6	9.7	14.7	35.0	66.5	24.2	28.9	46.9	20.0
1880	47.9	55.3	63.3	53.3	22.2	4.5	4.7	6.1	14.3	16.6	48.9	23.8	28.7	8.3

1881	21.5	50.3	118.1	104.8	39.6	27.0	5.8	7.6	10.8	6.4	21.8	36.7	39.8	7.4
1882	31.0	75.9	133.9	49.3	32.8	33.1	1.7	6.2	10.5	37.9	62.4	42.3	37.4	12.1
1883	29.2	44.3	115.8	73.1	31.9	3.7	0.6	18.6	47.4	11.5	20.0	29.8	32.4	13.3
1884	41.8	47.4	103.9	105.1	47.5	17.3	5.0	13.6	14.9	13.1	26.7	34.2	42.2	10.8
1885	36.1	50.2	202.7	63.6	46.7	14.4	0.0	4.8	15.5	15.0	39.0	70.7	35.7	8.8
1886	36.6	107.3	101.9	154.3	43.0	35.5	11.1	7.8	10.7	13.4	21.7	29.7	49.7	8.3
1887	60.2	80.8	72.0	81.3	112.0	47.3	13.2	27.1	32.0	18.7	23.4	25.6	47.8	28.3
1888	27.5	78.0	85.0	137.3	51.2	25.8	28.1	14.9	26.2	51.9	59.9	96.4	54.4	28.9
1889	82.5	118.7	91.5	68.1	32.9	37.1	17.9	75.0	36.4	49.6	50.9	120.9	55.6	39.0
1890	82.0	63.4	79.9	88.9	34.9	79.1	14.2	13.9	21.6	33.7	120.0	40.2	47.9	25.1
1891	93.8	131.9	146.3	119.1	52.8	20.4	16.7	14.7	35.9	19.0	29.2	50.5	69.1	19.6
1892	66.6	58.5	75.7	115.5	37.1	15.3	9.5	14.7	21.1	40.2	21.2	71.1	39.3	17.8
1893	24.5	35.1	131.7	75.7	33.5	27.2	15.9	13.2	23.9	28.8	48.4	33.4	39.0	19.3
1894	32.3	43.5	219.7	65.8	24.6	27.9	10.4	16.1	20.0	12.8	26.1	26.1	33.3	14.1
Totals	1664.3	2505.0	3128.0	3019.4	1718.1	1063.8	446.5	555.0	963.3	875.8	1148.4	1904.5	1381.9	592.0
Average	52.0	78.3	97.8	94.4	53.7	33.2	14.0	17.3	30.1	27.4	35.9	59.5	43.2	18.5

TABLE XX.

Rainfall, in Inches, on Sudbury River Water-shed, 1875 to 1894.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.	4 months. July-Oct.
1875	2.420	3.150	3.740	3.230	3.560	6.240	3.570	5.530	3.430	4.850	4.830	0.940	45.490	17.380
1876	1.830	4.210	7.430	4.197	2.763	2.040	9.134	1.720	4.614	2.241	5.764	3.620	49.563	17.709
1877	3.216	0.739	8.357	3.435	3.702	2.425	2.951	3.682	0.323	8.515	5.803	0.870	44.018	15.471
1878	5.632	5.973	4.689	5.790	0.956	3.884	2.971	6.937	1.291	6.417	7.024	6.367	57.931	17.616
1879	2.478	3.562	5.140	4.716	1.579	3.789	3.933	6.509	1.878	0.809	2.682	4.344	41.419	13.129
1880	3.566	3.980	3.315	3.105	1.836	2.138	6.273	4.008	1.603	3.740	1.785	2.828	38.177	15.624
1881	5.558	4.646	5.730	2.000	3.511	5.395	2.350	1.358	2.617	2.955	4.091	3.958	44.169	9.280
1882	5.951	4.546	2.649	1.824	5.066	1.664	1.769	1.667	8.741	2.074	1.147	2.296	39.394	14.251
1883	2.810	3.865	1.780	1.845	4.185	2.400	2.680	0.735	1.520	5.600	1.810	3.550	32.780	10.535
1884	5.085	6.545	4.720	4.405	3.470	3.445	3.665	4.650	0.855	2.480	2.645	5.170	47.135	11.650
1885	4.710	3.865	1.070	3.605	3.485	2.865	1.425	7.185	1.425	5.095	6.095	2.720	43.545	15.130
1886	6.365	6.280	3.610	2.225	2.995	1.465	3.265	4.100	2.905	3.235	4.645	4.975	46.065	13.505
1887	5.200	4.780	4.900	4.265	1.165	2.650	3.760	5.280	1.320	2.835	2.670	3.880	42.705	13.195
1888	4.150	3.685	6.020	2.425	4.825	2.535	1.405	6.225	8.585	4.990	7.225	5.395	57.465	21.205
1889	5.370	1.655	2.365	3.410	2.945	2.800	8.940	4.175	4.605	4.255	6.290	3.140	49.950	21.975
1890	2.530	3.505	7.735	2.645	5.210	2.030	2.460	3.865	6.000	10.510	1.200	5.310	53.000	22.835
1891	7.020	5.235	6.475	3.905	2.010	3.770	3.395	4.725	2.380	3.830	3.090	3.685	49.520	14.330
1892	5.850	3.140	4.060	0.830	5.585	2.760	4.230	4.440	2.840	1.170	5.800	1.125	41.830	12.680
1893	2.925	8.195	3.670	3.605	6.610	2.380	2.570	5.415	1.735	4.065	2.195	4.860	48.225	13.785
1894	4.090	3 910	1.435	3.415	4.235	1.155	3.255	2.030	2.635	5.345	3.425	4.810	39.740	13.265
Totals	86.756	85.466	88.890	64.877	69.693	57.830	74.001	84.236	61.302	85.011	80.216	73.843	912.121	304.550
Averages . . .	4.338	4.273	4.445	3.244	3.485	2.891	3.700	4.212	3.065	4.250	4.011	3.692	45.606	15.227

TABLE XXI.

Rainfall Collected, in Inches, on Sudbury River Water-shed, 1875 to 1894.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.	4 months, July-Oct.
1875	0.184	2.411	2.862	5.263	2.119	1.501	0.573	0.706	0.358	1.152	2.248	1.041	20.418	2.789
1876	1.147	2.282	7.911	5.683	2.031	0.383	0.326	0.723	0.318	0.417	1.878	0.809	23.908	1.784
1877	1.174	1.529	8.586	4.132	2.482	1.031	0.360	0.216	0.103	1.127	2.447	2.300	25.487	1.806
1878	3.228	3.972	6.256	2.807	2.487	0.873	0.229	0.848	0.277	0.921	2.922	5.667	30.487	2.275
1879	1.249	2.756	4.156	5.379	1.987	0.713	0.281	0.705	0.243	0.126	0.355	0.825	18.775	1.355
1880	2.000	2.982	2.451	2.017	0.917	0.303	0.315	0.212	0.138	0.181	0.354	0.312	12.182	0.846
1881	0.740	2.491	7.142	2.669	1.721	2.309	0.493	0.264	0.340	0.331	0.682	1.383	20.565	1.428
1882	2.213	3.872	5.064	1.497	2.304	0.913	0.154	0.099	0.529	0.534	0.362	0.561	18.102	1.316
1883	0.597	1.664	2.873	2.330	1.673	0.518	0.206	0.140	0.157	0.331	0.354	0.345	11.188	0.834
1884	1.775	4.742	6.752	4.925	1.838	0.719	0.399	0.458	0.076	0.148	0.302	1.650	23.784	1.081
1885	2.203	2.182	2.805	3.133	2.383	0.735	0.111	0.429	0.209	0.599	2.033	2.094	18.916	1.348
1886	2.606	7.734	3.672	3.361	1.285	0.350	0.206	0.168	0.203	0.260	1.161	1.819	22.825	0.837
1887	4.619	4.558	5.116	4.522	1.799	0.714	0.204	0.382	0.191	0.339	0.636	1.147	24.227	1.116
1888	1.878	3.255	5.775	4.566	2.912	0.728	0.209	0.677	1.994	3.565	4.761	5.428	35.749	6.446
1889	4.963	1.926	2.388	2.434	1.569	1.128	1.130	2.554	1.422	2.194	3.351	3.997	29.056	7.300
1890	2.237	2.463	6.498	3.236	2.437	0.980	0.191	0.235	0.790	4.053	2.097	1.776	26.993	5.269
1891	5.383	5.616	7.944	4.138	1.039	0.714	0.266	0.290	0.350	0.375	0.526	0.971	27.612	1.281
1892	3.335	1.574	3.488	1.504	2.245	0.739	0.382	0.500	0.396	0.224	1.204	0.865	16.456	1.502
1893	0.773	2.485	5.789	3.668	5.143	0.759	0.282	0.322	0.187	0.395	0.550	1.421	21.774	1.186
1894	1.236	1.596	3.992	2.832	1.498	0.723	0.287	0.373	0.258	0.668	1.442	1.277	16.182	1.586
Totals	43.540	62.090	101.520	70.096	41.869	16.833	6.604	10.301	8.539	17.941	29.665	35.688	444.686	43.385
Averages . . .	2.177	3.105	5.076	3.505	2.093	0.842	0.330	0.515	0.427	0.897	1.483	1.784	22.234	2.169

TABLE XXII.

Percentage of Rainfall Collected on Sudbury River Water-shed, 1875 to 1894.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly.	4 months, July Oct.
1875	7.6	76.5	76.5	162.9	59.5	24.0	16.0	12.8	10.4	23.8	46.5	110.7	44.9	16.0
1876	62.7	54.2	106.5	135.4	73.5	18.8	3.6	42.0	6.9	18.6	32.6	22.3	48.2	10.1
1877	36.5	206.9	102.7	120.3	67.0	42.5	12.2	5.9	31.9	13.2	42.2	264.4	57.9	11.7
1878	57.3	66.5	133.4	48.5	260.2	22.5	7.7	12.2	21.5	14.3	41.6	89.0	52.6	12.9
1879	50.4	77.4	80.9	114.1	125.8	18.8	7.1	10.8	12.9	15.6	13.2	19.0	45.3	10.3
1880	56.0	74.9	73.9	65.0	50.0	14.2	5.0	5.3	8.6	4.8	19.9	11.0	31.9	5.4
1881	13.3	53.6	124.6	133.4	49.0	42.8	21.0	19.4	13.0	11.2	16.7	34.9	46.6	15.4
1882	37.2	85.2	191.2	82.1	45.5	54.9	8.7	5.9	6.0	25.7	31.5	24.5	45.9	9.2
1883	21.2	43.0	161.4	126.3	40.0	21.6	7.7	19.1	10.4	5.9	19.5	9.7	34.1	7.9
1884	34.9	72.5	143.1	111.8	53.0	20.9	10.9	9.8	8.9	6.0	11.4	31.9	50.5	9.3
1885	46.8	56.4	262.1	86.9	68.4	25.7	7.8	6.0	14.7	11.8	33.3	77.0	43.4	8.9
1886	40.9	123.2	101.7	151.1	42.9	23.9	6.3	4.1	7.0	8.0	25.0	36.6	49.5	6.2
1887	88.8	95.3	104.4	106.0	154.5	26.9	5.5	7.2	14.5	12.0	23.8	29.6	56.7	8.5
1888	45.3	88.3	95.9	188.3	60.3	28.7	14.9	10.9	23.2	71.4	65.9	100.6	62.2	30.4
1889	92.4	116.4	100.9	71.4	53.3	40.3	12.6	61.2	30.9	51.6	53.3	127.3	58.2	33.2
1890	88.4	70.3	84.0	122.3	46.8	48.3	7.8	6.1	13.2	38.6	174.7	33.5	50.9	23.1
1891	76.7	107.3	122.7	106.0	51.7	18.9	7.8	6.1	14.7	9.8	17.0	26.3	55.8	8.9
1892	57.0	50.1	85.9	181.1	40.2	26.8	9.0	11.3	13.9	19.2	20.7	76.9	39.3	11.8
1893	26.4	30.3	157.7	101.7	77.8	31.9	11.0	5.9	10.8	9.7	25.1	29.2	45.2	8.6
1894	30.2	40.8	278.2	82.9	35.4	62.6	8.8	18.4	9.8	12.5	42.1	26.5	40.7	12.0
Totals . .	970.0	1589.1	2587.7	2297.5	1454.8	615.0	191.4	280.4	283.2	383.7	756.0	1180.9	959.8	259.8
Averages .	48.5	79.5	129.4	114.9	72.7	30.7	9.6	14.0	14.2	19.2	37.8	59.0	48.0	13.00

TABLE XXIII.

Rainfall, in Inches, on Mystic Water-shed, 1878 to 1894.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.	4 months, July-Oct.
1878	5.67	5.74	3.93	5.73	0.67	2.62	3.52	7.51	3.19	4.95	5.69	4.845	54.065	19.17
1879	1.82	2.73	3.52	4.65	1.86	3.98	2.39	5.48	1.60	0.77	2.76	3.74	35.30	10.24
1880	2.62	4.23	2.49	2.18	2.02	1.49	7.23	3.64	1.42	2.70	1.90	2.50	34.42	14.99
1881	5.82	3.63	6.69	1.54	2.98	6.84	2.60	0.67	2.17	2.16	3.52	3.29	41.91	7.60
1882	5.545	4.68	2.49	2.11	4.58	2.09	2.34	1.065	8.35	1.94	1.745	2.23	39.165	13.695
1883	2.67	3 065	2.22	2.47	3.585	1.635	2.785	0.87	1.495	5.45	1.98	2.995	31.22	10.60
1884	4.745	6.085	4.255	3.18	2.95	4.635	3.72	4.855	0.70	2.70	2.005	4.56	44.39	11.975
1885	4.83	3.40	1.175	3.445	3.945	4.41	2.04	5.90	1.425	5.52	6.31	2.10	44.50	14.885
1886	6.315	7.175	3.84	2.10	2.945	1.54	3.71	3.24	2.955	2.85	4.065	4.825	45.560	12.755
1887	5.245	4.47	5.00	4.605	1.69	2.695	6.585	4.965	1.50	3.04	3.05	3.575	46.42	16.090
1888	4.05	3.28	5.185	2.84	5.095	2.20	2.23	6.23	8.56	4.955	6.85	5.27	56.745	21.975
1889	5.505	1.86	2.285	3.61	4.64	3.315	8.455	3.92	4.705	3.59	5.65	2.86	50.395	20.67
1890	2.725	3.38	6.68	2.405	6.30	3.38	2.265	3.64	3.70	8.84	1.385	4.67	49.37	18.445
1891	6.245	5.075	6.07	3.15	2.46	4.43	3.18	3.88	2.16	4.735	2.605	3.41	47.40	13.955
1892	4.515	3.015	4.005	0.815	5.585	4.15	2.575	4.82	2.005	1.835	4.645	1.15	39.115	11.235
1893	2.26	7.50	2.55	3.37	6.26	2.10	2.04	5.41	2.01	4.10	2.25	4.35	44.20	13.56
1894	3.93	3.31	1.09	3.48	5.18	0.72	3.45	2.52	2.52	5.58	3.49	3.97	39.24	14.07
Totals . . .	74.510	72.625	63.475	51.680	62.745	52.230	61.115	68.615	50.465	65.715	59.900	60.340	743.415	245.910
Averages . . .	4.383	4.272	3.734	3.040	3.691	3.072	3.595	4.036	2.969	3.865	3.524	3.549	43.730	14.465

TABLE XXIV.

Rainfall Collected, in Inches, on Mystic Water-shed, 1878 to 1894.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.	4 months, July-Oct.
1878	3.55	3.97	4.91	2.21	2.16	0.78	0.48	1.11	0.56	0.71	1.75	3.63	25.82	2.86
1879	1.21	2.33	3.31	3.97	1.95	0.97	0.54	0.70	0.48	0.34	0.45	0.69	16.94	2.06
1880	1.70	2.54	1.95	1.50	0.96	0.51	0.67	0.54	0.45	0.36	0.44	0.59	12.21	2.02
1881	0.82	2.14	6.79	2.17	1.51	2.05	0.87	0.35	0.31	0.29	0.50	0.87	18.67	1.82
1882	1.37	3.03	4.19	1.16	1.85	0.81	0.35	0.22	0.53	0.58	0.39	0.57	15.05	1.68
1883	0.70	1.43	1.88	1.63	1.20	0.52	0.30	0.22	0.18	0.39	0.42	0.44	9.31	1.09
1884	1.49	3.89	5.42	3.85	1.48	0.85	0.58	0.60	0.23	0.27	0.35	1.17	20.18	1.68
1885	1.79	1.81	2.05	2.03	2.18	0.86	0.47	0.54	0.34	0.68	2.41	2.39	17.55	2.03
1886	2.31	7.70	3.91	3.24	1.27	0.55	0.41	0.25	0.32	0.38	0.88	1.43	22.65	1.36
1887	3.16	3.61	3.60	3.75	1.89	1.27	0.87	1.35	0.48	0.57	0.71	0.91	22.17	3.27
1888	1.43	3.32	4.28	3.27	2.88	0.84	0.39	0.54	1.31	2.74	5.04	5.08	31.12	4.98
1889	4.51	1.83	1.60	2.27	2.18	1.89	1.33	2.05	1.06	1.21	2.49	3.06	25.48	5.65
1890	2.07	2.23	5.37	2.93	3.00	1.92	0.43	0.46	0.58	2.61	1.95	2.49	26.04	4.08
1891	6.29	5.97	7.21	3.43	1.40	1.01	0.42	0.44	0.42	0.58	0.56	0.87	28.60	1.86
1892	2.49	1.76	3.03	1.33	2.10	1.17	0.66	0.49	0.56	0.45	1.07	0.87	15.98	2.16
1893	0.75	2.14	4.52	2.72	4.42	1.04	0.47	0.69	0.41	0.55	0.71	1.27	19.69	2.12
1894	1.37	1.87	3.05	2.27	1.31	0.91	0.49	0.38	0.36	0.58	0.91	0.90	14.40	1.81
Totals	37.01	51.57	67.07	43.73	33.74	17.95	9.73	10.93	8.58	13.29	21.03	27.23	341.86	42.53
Averages . . .	2.18	3.03	3.95	2.57	1.98	1.06	0.57	0.64	0.51	0.78	1.24	1.60	20.11	2.50

TABLE XXV.

Percentage of Rainfall Collected on Mystic Water-shed, 1878 to 1894.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly.	4 months, July–Oct.
1878	62.6	69.2	125.0	38.6	322.9	29.6	13.5	14.8	17.7	14.3	30.8	74.9	47.8	14.9
1879	66.6	85.4	93.9	85.3	104.9	24.5	22.6	12.8	29.7	44.2	16.2	18.6	48.0	20.1
1880	64.9	60.1	78.4	68.8	47.3	34.3	9.2	14.7	31.7	13.5	22.9	23.8	35.5	13.5
1881	14.2	58.9	101.5	141.1	50.7	29.9	33.3	51.9	14.1	13.6	14.3	26.3	44 5	23.9
1882	24.8	64.8	168.4	55.0	40.4	38.6	14.9	20.8	6.3	30.0	22.2	25.5	38.4	12.3
1883	26.1	46.7	84.8	65.9	33.5	31.8	10.8	25.7	12.1	7.2	21.1	14.7	29.8	10.3
1884	31.5	63.9	127.3	121.2	50.2	18.3	15.5	12.4	33.5	9.9	17.4	25.6	45.5	14.0
1885	37.1	53.3	174.5	58.8	55.3	19.6	22.8	9.2	23.7	12.2	38.2	113.6	39.4	13.6
1886	36.6	107.3	101.9	154.3	43.0	35.5	11.1	7.8	10.7	13.4	21.7	29.7	49.7	10.7
1887	60.2	80.8	72.0	81.3	112.0	47.3	13.2	27.1	32.0	18.7	23.4	25.6	47.8	20.3
1888	35.2	101.3	82.5	115.2	56.6	38.1	17.5	8.8	15.3	55.3	73.6	96.4	54.8	22.7
1889	81.8	98.2	70.2	63.0	46.9	57.0	15.8	52.2	22.5	33.7	44.1	107.0	50.6	27.3
1890	75.6	66.0	80.4	121.8	47.6	56.9	19.0	12.7	15.6	29.5	141.2	53.5	52.8	22.1
1891	100.7	117.6	118.7	109.0	57.0	22.8	13.3	11.3	19.3	12.1	21.7	25.6	60.3	13.3
1892	55.0	58.5	75.7	163.6	37.5	28.3	25.7	10.2	27.7	24.3	23.1	75.2	40.9	19.2
1893	33.3	28.6	177.3	80.7	70.6	49.5	23.2	12.6	20.5	13.4	31.5	29.1	44.5	15.6
1894	34.8	56.5	280.1	65.4	25.3	125.8	14.2	15.1	14.3	10.5	26.0	22.7	36.7	12.9
Totals . .	841.0	1217.1	2012.6	1589.0	1201.7	687.8	295.6	320.1	346.7	355.8	589.4	787.8	767.0	286.7
Averages .	49.5	71.6	118.4	93.5	70.7	40.5	17.4	18.8	20.4	20.9	34.7	46.3	45.1	16.9

TABLE XXVI.

Yield of Sudbury-River Water-shed, 1875-1894. Area of water-shed used, includes water surfaces.

Year.	Rain-fall.	Daily Average Yield for Year.	Yield per Square Mile per day.	Rain-fall, July–Oct.	Daily average Yield, July–Oct.	Yield per Square Mile per Day.	Minimum Monthly Yield.				Minimum Yield in any Week.		
								Rain-fall.	Daily average Yield for Month.	Yield per Square Mile per Day.		Daily average Yield for Week.	Yield per Square Mile per Day.
	Inches.	Gallons.	Gallons.	Inches.	Gallons.	Gallons.	Month.	Inches.	Gallons.	Gallons.	Week.	Gallons.	Gallons.
1875	45.490	75,599,200	972,200	17.380	30,650,400	394,100	January . . .	2.420	About 8,000,000	102,900			
1876	49.563	88,278,400	1,135,200	17.709	19,603,300	252,100	July	9.134	14,229,000	183,000		4,000,000	51,400
1877	44.018	94,369,200	1,213,500	15.471	19,832,100	255,000	September . .	0.323	4,633,300	59,600		1,800,000	23,100
1878	57.931	112,882,200	1,451,600	17.616	25,001,600	321,500	July	2.971	9,983,900	128,400		5,300,000	68,200
1879	41.419	69,942,200	894,000	13.129	14,974,000	191,400	October . . .	0 809	5,532,300	70,700			
1880	38.177	45,250,300	578,400	15.624	9,356,100	119,600	September . .	1.603	6,280,000	80,300			
1881	44.169	73,633,900	979,200	9.280	15,178,900	201,800	August . . .	1.358	11,135,500	148,100			
1882	39.394	64,812,300	861,900	14.251	13,977,200	185,900	August . . .	1.667	4,158,100	55,300	Aug. 20–26	2,604,000	34,600
1883	32.780	40,056,200	532,700	10.535	8,870,700	118,000	August . . .	0.735	5,906,500	78,500			
1884	47.135	84,929,200	1,129,400	11.650	11,487,000	152,800	September . .	0.855	3,303,300	43,900	Sept. 14–20	51,300	700
1885	43.545	67,721,600	900,600	15.130	14,313,000	190,300	July	1.425	4,667,700	62,100			
1886	46.065	81,730,700	1,086,800	13.505	8,891,900	118,200	August . . .	4.100	7,077,400	94,100			
1887	42.705	86,749,300	1,153,600	13.195	11,874,800	157,900	September . .	1.320	8,346,700	111,000	Sept. 18–24	6,162,900	82,000
1888	57.465	127,642,900	1,697,400	21.205	68,478,000	910,600	July	1.405	8,825,800	117,400			

1889	49.950	104,030,100	1,383,400	21.975	77,563,400	1,031,400	July	8.940	47,645,200	633,600			
1890	53.000	96,650,400	1,285,200	22.835	55,975,600	744,400	July	2.460	8,064,500	107,200	July 13–19	3,446,800	45,800
1891	49.520	98,865,500	1,314,700	14.330	13,608,900	181,000	July	3.395	11,212,900	149,100			
1892	41.830	58,753,000	781,300	12.680	15,957,700	212,200	October . . .	1.170	9,461,300	125,800			
1893	48.225	77,963,300	1,036,700	13.785	12,602,400	167,600	September . .	1.735	8,126,700	108,100			
1894	39.740	57,937,800	770,400	13.265	16,856,900	224,200	September . .	2.635	11,243,300	149,500			
Averages .	45.606	80,389,900	1,057,900	15.228	23,252,700	306,500							

SUMMARY OF STATISTICS.

REPORT FOR 1894.

Boston Water-Works, Suffolk County, Massachusetts, supplies also the cities of Somerville, Chelsea, and Everett.

Population by census of 1890:	
Boston	448,477
Chelsea	27,909
Somerville	40,152
Everett	11,068
Total	527,606
Date of construction:	
Cochituate Works	1848
Mystic "	1864

By whom owned. — City of Boston.

Sources of supply. — Lake Cochituate, Sudbury river, and Mystic lake.

Mode of supply. — Sixty-five per cent. from gravity works.
Thirty-five " " pumping "

Pumping.

	Cochituate.	Mystic.
Builder of pumping machinery	Holly Mfg. Co., and Quintard Iron Works.	H. R. Worthington.
Description of coal used:		
a Kind	Bituminous.	Bituminous.
c Size	Broken.	Broken.
e Price per gross ton, in bins	$4.40, $4.52	$4.45, $3.85, $3.75, $5.25
f Per cent. of ash,	7.4	11.2

	Cochituate.	Mystic.
Coal consumed for year, in lbs.	4,637,660	8,763,800
Total pumpage for year, in gallons	3,795,830,595	3,751,418,700
Average dynamic head, in feet	126.18	148.62
Gallons pumped per lb. of coal	818.6	428.1
Duty in foot-lbs. per 100 lbs. of coal	86,459,300	53,057,500

	COCHITUATE.	MYSTIC
Cost of pumping figured on pumping-station expenses, viz.:	$25,131.78	$32,924.65
Cost per million gallons raised to reservoir	$6.62	$8.777
Cost per million gallons raised one foot high	$0.052	$0.059

CONSUMPTION.

Estimated population	466,500	117,400
Estimated No. of consumers,	460,000	116,000
Total consumption, gallons,	16,994,405,800	3,752,970,500
Passed through meters	4,077,196,000	735,110,000
Percentage metered	24.0	19.6
Average daily consumption, gallons	46,560,000	10,282,100
Gallons per day, each inhabitant	99.8	87.6
Gallons per day, each consumer	101.2	88.6
Gallons per day to each tap,	679.2	442.1

DISTRIBUTION.

Mains.

	COCHITUATE.	MYSTIC.
Kind of pipe used,	Cast-Iron.	Cast-Iron, Wrought-Iron, and Cement.
Sizes	48 in. to 4 in.	30 in. to 3 in.
Extended, miles	12.75	6.9
Total now in use	572.80	173.7
Distribution-pipes less than 4-in., length, miles	1.7	4.7
Hydrants added	175	148
Hydrants now in use	6,217	1,446
Stop-gates added	193	156
Stop-gates now in use	6,359	2,138

Services.

Kind of pipe used,	Lead.	Lead and Wrought-Iron.
Sizes	$\frac{5}{8}$ in. to 6 in.	$\frac{1}{2}$ in. to 4 in.
Extended, feet	49,841	18,436
Service-taps added	1,970	859
Total now in use	68,556	23,257
Meters added	291	33
Meters now in use	4,337	494
Motors and elevators in use	540	21

BOSTON WATER BOARD,

Organized July 31, 1876.

TIMOTHY T. SAWYER, from July 31, 1876, to May 5, 1879; and from May 1, 1882, to May 4, 1883.
LEONARD R. CUTTER, from July 31, 1876, to May 4, 1883.‡
ALBERT STANWOOD, from July 31, 1876, to May 7, 1883.
FRANCIS THOMPSON, from May 5, 1879, to May 1, 1882.‡
WILLIAM A. SIMMONS, from May 7, 1883, to August 18, 1885.
GEORGE M. HOBBS, from May 4, 1883, to May 4, 1885.
JOHN G. BLAKE, from May 4, 1883, to August 18, 1885.
WILLIAM B. SMART, from May 4, 1885, to March 18, 1889.
HORACE T. ROCKWELL, from August 25, 1885, to April 25, 1888.
PHILIP J. DOHERTY, from March 18, 1889, to May 4, 1891.
THOMAS F. DOHERTY, from August 26, 1885, to May 5, 1890; and from May 4, 1891, to present time.
ROBERT GRANT, from April 25, 1888, to July 18, 1893.
JOHN W. LEIGHTON, from May 5, 1890, to present time.
WILLIAM S. MCNARY, from August 15, 1893, to November 5, 1894.
CHARLES W. SMITH, from January 23, 1895, to present time.

ORGANIZATION OF THE BOARD FOR YEAR 1894.

Chairman.

THOS. F. DOHERTY.

Secretary and Chief Clerk.

WALTER E. SWAN.

City Engineer and Engineer of the Board.

WILLIAM JACKSON.

Superintendent of the Western Division and Resident Engineer of Additional Supply.

DESMOND FITZGERALD.

Superintendent of the Eastern Division of Cochituate Department.

WILLIAM J. WELCH.

Superintendent of Mystic Division.

EUGENE S. SULLIVAN.

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‡ Deceased.

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