METROPOLITAN WATER AND SEWERAGE BOARD

SIXTH ANNUAL REPORT

JANUARY 1, 1907

ARTHUR D. BUZBY, C. E.

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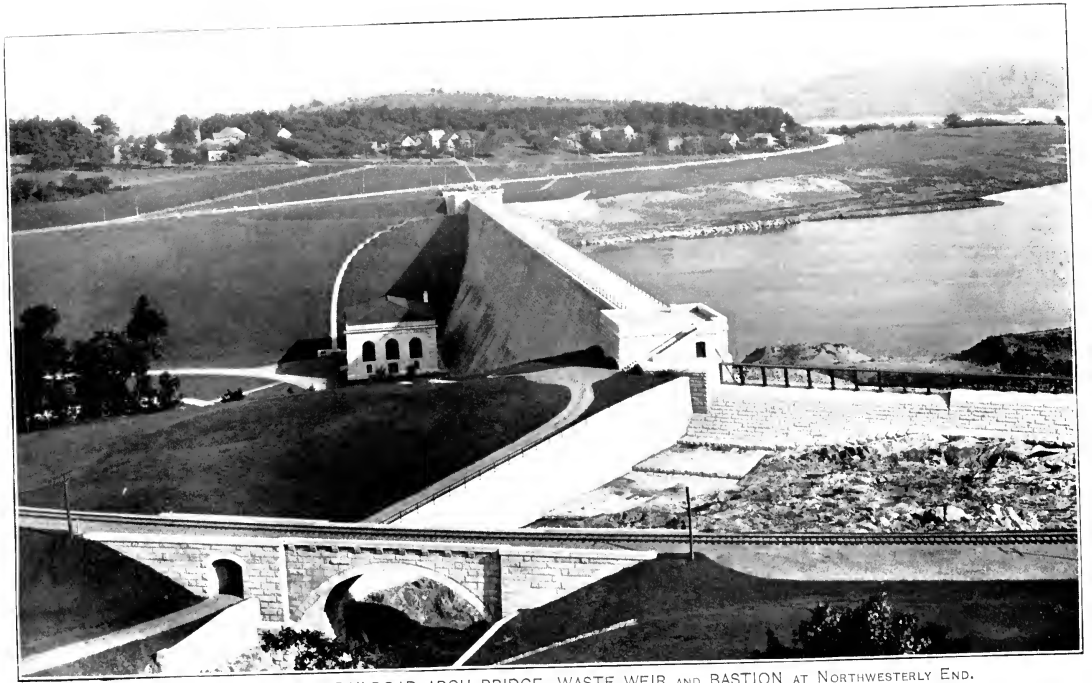

WACHUSETT DAM WITH RAILROAD ARCH BRIDGE, WASTE WEIR AND BASTION AT NORTHWESTERLY END.

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SIXTH ANNUAL REPORT

OF THE

METROPOLITAN WATER AND SEWERAGE BOARD.

JANUARY 1, 1907.

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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the calendar year ending December 31, 1906, and now presents a detailed statement of the operations for the year, being its

SIXTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

I. ORGANIZATION AND ADMINISTRATION.

(1) BOARD, OFFICERS AND EMPLOYÉS.

The term of office of Henry H. Sprague expired on March 21, 1906, and he was reappointed for the three years next succeeding. The membership of the Board has consequently remained as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Jr. William N. Davenport has continued as secretary and in charge of the auditing department. Alfred F. Bridgman has been the purchasing agent and paymaster.

There are also employed in the administrative office a book-keeper, an assistant book-keeper, an assistant in auditing, one general clerk, three stenographers, a telephone operator, a messenger, and a janitor with two assistants, one of whom acts as watchman.

George D. Bigelow has been in charge of the conveyancing work, and he has been assisted by Miss Alline E. Marcy, title examiner. Miss Celia M. Tibbetts has performed the conveyancing work which has been required in the county of Worcester as her services have been needed.

Frederic P. Stearns has continued to hold the position of Chief Engineer of the Board, with special oversight of the Water Works, but, inasmuch as Mr. Stearns was able to give only a part of his services to the Board, much of the work of active supervision has devolved upon Dexter Brackett, the Engineer of the Sudbury and Distribution departments. Thomas F. Richardson remained as Engineer of the Dam and Reservoir Department until July 20, when he resigned, and the supervision of this department also was given to Mr. Brackett.

Joseph P. Davis and Hiram F. Mills are retained to act as consulting engineers if matters arise requiring their consideration.

A reduction has again been made in the engineering force employed in construction on the Water Works, but, on the other hand, a considerable addition has been required in the number employed upon the maintenance and operation of works. The force, both in construction and maintenance, has, upon the average during the year, comprised, in addition to the persons above named, 5 division engineers, 7 assistant engineers, and others, to the number of 41, in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, numbering in all, 53. The maximum engineering force employed at any one time during the year on both construction and maintenance was 61.

Day-labor forces, under the general supervision of the engineers and the immediate direction of foremen, varying in numbers from time to time, have been employed in pipe laying, in general improvements and repairs, and in minor operations.

A further maintenance force, numbering, upon the average during the year, 217, has been required at the pumping stations and upon the reservoirs, aqueducts, pipe lines and other works. This force at the end of the year numbered 214.

William M. Brown, Engineer of the Sewerage Works, has been in charge of both construction and maintenance upon these works.

He was assisted during the year by 3 division engineers, in supervision of both construction and maintenance, 1 division engineer in direct charge of the drafting room and records, 5 assistant engineers, and 12 others, who were employed in various engineering capacities, and a clerk and stenographer. The maximum engineering force em-

ployed at any one time during the year on construction and maintenance of the Sewerage Works was 23.

Day-labor forces, under the general supervision of the engineers and the immediate direction of foremen, have been employed in the construction of the pneumatic tunnel on Section 80 of the High-level Sewer extension in West Roxbury, in the placing of sidewalks and fences at the Ward Street pumping station, in the building of foundations for additional boilers and engine plant at the Quincy pumping station, and the building of a bellmouth connection between the existing Metropolitan Sewer and Section 64 of the Malden sewer extension.

The maximum number of men employed upon contracts and upon day-labor construction upon the Sewerage Works during the year was for the week ending December 22, when the number amounted to 154.

The regular maintenance force required for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of engineers and day-labor construction forces before enumerated, has upon the average numbered 130.

The whole force of the Sewerage Department at the end of the year numbered 156, of whom the engineer in charge and 21 assistants and draftsmen were engaged in general upon the works, and, of the remainder, 79 were employed upon the North System and 55 upon the South System.

(2) Offices and Buildings.

The office of the Metropolitan Water and Sewerage Board is in the buildings numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in which are also located the secretary's, auditing and conveyancing offices, and the main engineering offices of both the Water Works and the Sewerage Works.

The headquarters of the Wachusett Dam and Reservoir Department of the Water Works have been maintained in the office building in Clinton. Headquarters of the Sudbury and Distribution departments have been maintained in the central office in Boston. For the Sudbury Department a branch office has been maintained at South Framingham. Branch headquarters of the maintenance force of the Water Works in the northern part of the District have been

in buildings in the Glenwood pipe yard in Medford, where there are offices, shops, store rooms and stables; and the maintenance force for the southern part of the District has headquarters in like buildings at the Chestnut Hill Reservoir.

Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained at the East Boston and Ward Street pumping stations and at the storage yard at Hough's Neck.

(3) Conveyancing.

Much of the work of the conveyancer has been the revision and bringing up to date of titles, which had been previously examined, when settlement regarding the estates affected had been finally attained, or when the suits involving them had been reached in court proceedings.

The acquisition of lands about Lake Waushacum, for the Water Works, required an extensive examination of new titles, and like examinations have been required on account of the extensions of the North and South Metropolitan Sewerage systems. Not so extensive, though considerable, examinations of titles have been required in the settlement of the many claims for damage to estates arising from the flooding of the Germantown district in Clinton, by reason of the discontinuance of South Main Street in Clinton, from the widening of Crescent Street in West Boylston, and for depreciation in value of estates in West Boylston and Sterling, as well as for the preparation of the suits brought for the alleged depreciation in value of estates in Boylston and damages to meadow lands in Clinton, Lancaster and Bolton by reason of the cessation of floods.

The conclusion of settlements has called for the drafting of many releases and other instruments.

The conveyancer has prepared eleven takings, covering or affecting 29 parcels of land aggregating 203.876 acres, as well as many public streets, and he has, from time to time, made various investigations relative to lands and easements required in matters coming before the Board.

The conveyancing force has also been called upon at several times by the Attorney-General to perform work not relating to this department.

II. METROPOLITAN WATER DISTRICT.

There are now 19 municipalities constituting the Metropolitan Water District, the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy and Somerville, and the towns of Arlington, Belmont, Hyde Park, Lexington, Milton, Nahant, Reveré, Stoneham, Watertown and Winthrop. Of these, the city of Quincy and the towns of Arlington, Lexington, Milton, Nahant and Stoneham have, since the formation of the District by the Act of the year 1895, been admitted into the District in accordance with the provision that the Board shall, on application, admit any other city or town than those originally named, any part of which is within ten miles of the State House, on such payment of money as the Board may determine. The District has an area of 171.7 square miles. The population of the District as now comprised, as of July 1, 1906, the date upon which calculations for the Water Works are based, is estimated at 960,460.

The city of Newton and the town of Hyde Park, though belonging to the District, do not take water from the Metropolitan sources, but still depend upon their own sources of supply.

No city or town has been admitted to the District within the past year.

III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for construction, including real estate acquired and payment of claims on account of the Water Works, during the year 1906, was $1,234,662.79. Of this amount, $186,261.57 was expended on account of the Wachusett Dam and Reservoir; $4,208.21 on account of the Weston Aqueduct and Reservoir; $101,996.14 for the improvement of the Wachusett watershed; $899,259.23 for the acquisition of existing water works, including $896,659.23 paid the cities of Malden, Medford and Melrose; $24,541.17 for construction in the Distribution Department; and the remainder, $18,396.47, for various other operations on the works. The total amount expended on account of construction since the beginning of the Water Works in the year 1895 has been $40,278,877.02.

(1) Wachusett Dam and Reservoir.

(*a*) *Wachusett Dam.*

But little work remained to be accomplished at the beginning of the year in order to secure the substantial completion of the Wachusett Dam.

The McArthur Brothers Company, the contractor for building the dam, completed its contract by the excavation of about 1,400 cubic yards of earth and 1,900 cubic yards of rock on the waste channel. A final settlement with the contractor has not, however, yet been effected.

The granolithic surface on the top of the dam and of the abutment at the southeasterly end and the bastion at the northwesterly end, as well as the granolithic walk from the abutment to Boylston Street, was laid during the early summer, and a heavy fence of brass posts and rails was erected on each side of the top of the dam, between the terminal structures, for general protection.

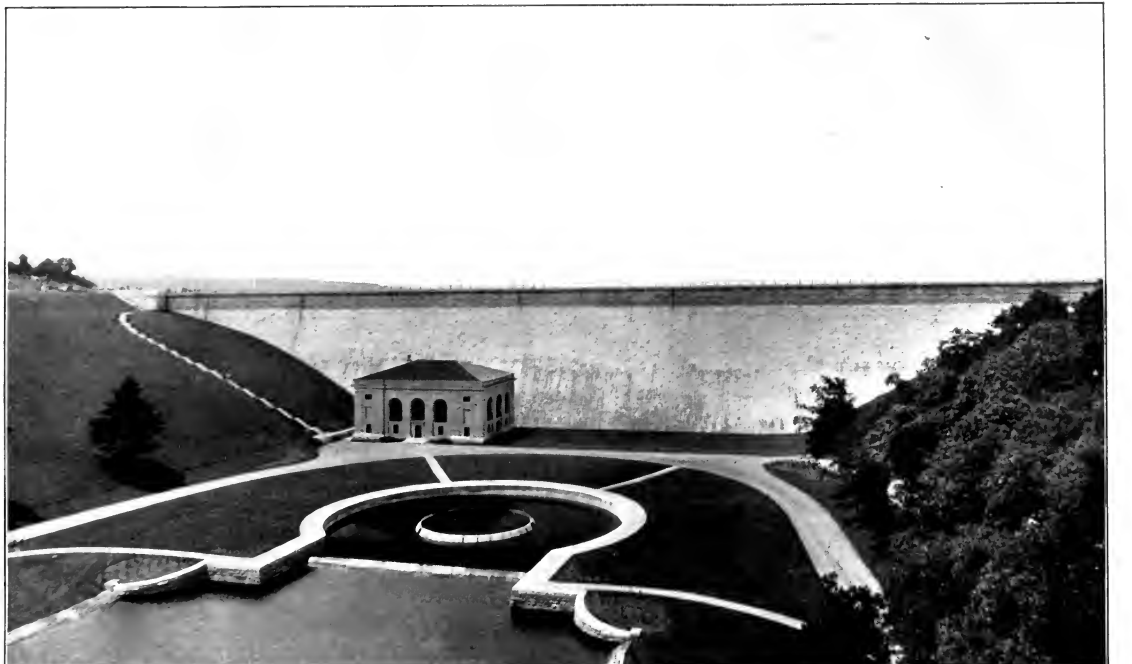
The entrance to the dam from Boylston Street has been completed by the laying of a granolithic walk from the street to the abutment, the erection of steel gates between the massive granite posts at the end of the main dam at its junction with the abutment, and by the building of steel fences, gravel walks and granite curbing on both sides of the entrance and for a considerable distance along the street.

An iron fence has also been built from the bastion on the retaining wall to the railroad bridge.

Permanent pipe connection with a Venturi meter has also been made with the pipe line supplying water to the Lancaster Mills.

The road from the bastion along the northwesterly hillside to the grounds below the dam has been completed, and the hillside has been graded and improved by the removal and use of the large pile of loam which had been stored near the end of the dam, and has also been planted in places with shrubbery.

A lighting and pumping plant for use at the dam has been acquired, and is about ready to be installed in the lower gate-chamber or power-house. The turbine will be operated by water power, and the generator with which it is connected will furnish a current for lighting and for the operation of motors which will be used for various necessary purposes connected with the works in both the gate-chambers.



WACHUSETT DAM WITH POWER AND GATE HOUSE, POOL AND SPILLWAY.

The structure of the dam itself has now been completed. The construction of the dam has required the excavation of 274,087 cubic yards of earth and of 102,640 cubic yards of rock, the placing of 251,920 cubic yards of rubble-stone masonry and a total of 22,519 cubic yards of dimension stone, ashlar, brick and concrete masonry, and there have also been used in the work 81,940 barrels of Portland cement and 182,480 barrels of natural cement.

The maximum height of the dam, from the lowest point to which excavation was made and masonry laid, to the top of the cornice stones, is 228.2 feet. The maximum width or thickness of the dam is 185 feet, and this width decreases to 25.04 feet at the high-water line. At the top of the dam, which is 20 feet above the high-water line, the width is 25.75 feet.

The length of the main dam is 944 feet, and the length of the waste weir beyond the bastion at the northwesterly end, over which the water may overflow, is 452 feet. The total length of the dam, including the corewall, is 1,476 feet.

The preliminary work for determining the proper site was begun on August 7, 1895. Temporary and preliminary work in connection with the construction of the dam began on June 14, 1897. The main contract for the dam was made on October 1, 1900, and was finished on February 27, 1906. Something remains for final settlement, but the sum so far expended upon the construction of the dam has been $2,270,116.85.

(*b*) *Wachusett Reservoir.*

The soil had substantially all been stripped from the bed of the reservoir prior to the past year. There were, however, on both sides of the reservoir steep banks which had been worn away by the frosts and waves, so that they had retreated nearly to the limit of the original soil stripping. Considerable work, therefore, has been done by day labor in clearing, grubbing and removal of soil, in order to increase the area subject to overflow. Some material has also been removed from the bed of the reservoir, in order to fill the gap in the South Dike through which had passed the quarry railroad used in the construction of the dam. In other cases, on both sides of the reservoir near the dam, where the ground is sloping in the vicinity of the flow line, the shores have been protected by cobble-stones.

The work of obtaining the elevations of the bottom of the reservoir after excavation has been completed. The succeeding calculations necessary to determine the capacity of the reservoir at successive elevations of one-tenth of a foot have been nearly completed.

A few further buildings have been removed from the reservoir site during the year, and the work of such removal upon the site of the reservoir has been completed. The total number of buildings removed in West Boylston under the operations of the Board to the present time has been 350. There have also been removed from the site of the reservoir, 108 buildings in Boylston, 7 in Sterling and 45 in Clinton, making the total of removals in all four towns 510 buildings.

Since the beginning of the work the soil has been stripped from 3,943 acres, in order to fit the bottom of the reservoir for the purposes of water supply, and there have been removed 6,900,000 cubic yards of soil. By far the larger part of this soil has been deposited in the North Dike, but a considerable quantity has been placed in the South Dike. Large quantities have been used for filling shallow flowage areas, for deposit in highway and railroad embankments and for grading grounds near the dam.

In order to prepare the reservoir bottom for the filling with water anticipated during the year, a final or further cleaning of the bottom of the reservoir was made from elevation 363 up to elevation 385. This work principally consisted in the removal of weeds, grass and bushes which had grown up since the original stripping of the soil or since the last cleaning. As the reservoir was not filled, owing to the unusually dry season, above elevation 368, considerable work will have to be done during the coming year, or later, in again cleaning the bottom of the reservoir up to elevation 385 and beyond that to elevation 395, the elevation which will be reached when the reservoir is entirely filled.

The reservoir has an area within the water line of 6.44 square miles, or 4,123 acres, and beyond the water line there is a margin of 5.28 square miles, or 3,380 acres. The length of the water line is 38.66 miles. The reservoir when filled to the water line will contain 64,951,400,000 gallons.

The stripping of the soil and the removal of the material to the various places of deposit and other work done in the preparation of

the reservoir, including the building of the North and South dikes, have cost $3,414,837.61.

The additional sum of $2,834,485.88 was expended in payment for real estate taken for the construction of the reservoir.

(c) Forestry.

The forestal work upon the marginal land about the reservoir has been continued during the past year. The Lamson nursery, so called, on the north side, and the Flagg nursery, so called, on the south side, have been maintained for the purpose of raising seedlings for transplanting. From these nurseries have been transplanted more than 188,075 seedlings and plants. This work has been accomplished over an area of 162 acres during the year. For the purpose the larger number of the seedlings used have been white pines, but there has also been a large number of white, Norway and Douglas spruces, besides many chestnuts and some Scotch pines, tamaracks, larches and locusts.

The area which has been planted with trees up to the present time comprises 1,099 acres, and there remains to be planted, as proposed, an area of 321 acres. It is expected that, in addition to the marginal strip along the shores of the reservoir, containing 197 acres, there will also remain open and not planted an area of 300 acres. Of the total 3,380 acres constituting the marginal land, so called, 1,463 acres were forested when acquired. White pines and arbor vitæ seedlings have also been planted during the year along the flow line of the marginal lands of the Commonwealth for a distance of about 4 miles, and some replacing of trees which had been planted in previous years in other parts has been done. There remain but 1½ miles to be planted along the flow line.

There remain in the original seed beds of the Flagg nursery 283,400 white pines and 101,500 arbor vitæ, and in transplanted beds 37,500 arbor vitæ. In the Lamson nursery there remain 20,500 sugar maples, 4,010 white oaks, 3,900 walnuts, 14,860 locusts, 2,400 ashes and 1,030 Norway spruces, all in transplanted beds.

In the making of a fire guard, so called, 40 feet wide, through the wooded parts of the margins of the Commonwealth's land, a further progress of 2¾ miles has been made. About 32 acres of land have been treated by the filling of holes or by grading after

the removal of houses and outbuildings, and put in proper condition and seeded.

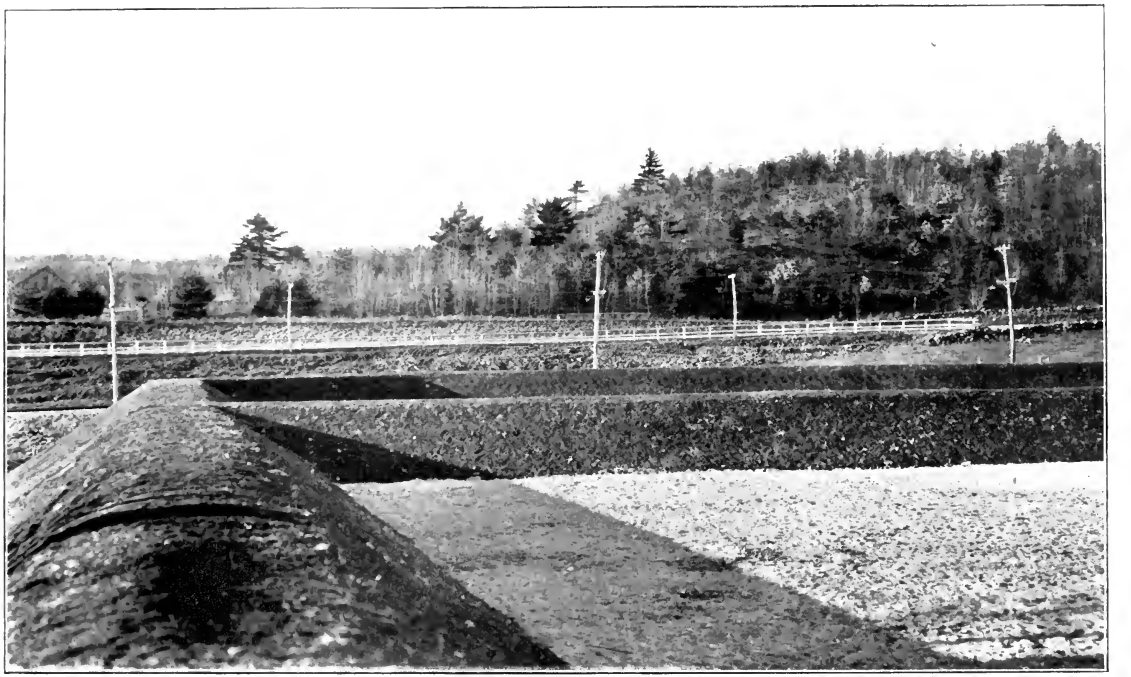
Considerable lumber and fire wood, as well as railroad ties, telephone poles and the like, have been obtained from the cutting out of the trees. The larger part of the lumber and other materials has been sold, but some have been reserved for use on the works.

(*d*) *Location, Construction and Discontinuance of Roads.*

Although no new road has been laid out during the past year and no road has been discontinued, considerable work has been required upon the roads built in previous years. Inasmuch as Boylston Street in the town of Clinton had been badly worn by heavy teaming during the construction of the dam, it was deemed proper to resurface the road from the dam to the Boylston town line with broken stone. Newton Street in West Boylston was also surfaced with gravel for a distance of about 2,200 feet, and Crescent Street for a distance of about 2,600 feet. Much other work has been done upon various roads, in the paving of gutters, building of railings and fences, and in the repairs occasioned by the erosion or washing out of the road-beds.

(*e*) *Clinton Catholic Cemetery.*

A tripartite agreement was entered into on July 1, 1898, between the Roman Catholic Bishop of the diocese of Springfield, the St. John's Catholic Cemetery Association of Clinton, and the Board, by which lands were to be acquired in the southerly part of the town of Lancaster for a new cemetery, and the bodies buried in the old cemetery were to be removed therefrom by the Cemetery Association to the new cemetery site. The Board on February 8, 1899, assented to a supplementary agreement, by which the work of the removal of the bodies was to be performed under the direction of a committee consisting of some of the officers of the Association and representatives of the lot owners, instead of being done by the Cemetery Association. Under these agreements the lands in Lancaster required for the new cemetery were purchased, and the title to the larger part was vested in the Commonwealth. The grounds were properly laid out and prepared for burial purposes, the bodies were all successfully removed from the site of the old cemetery and interred in the new, and all the monuments and other stones were



STERLING FILTER-BEDS ON BROOK EMPTYING INTO WAUSHACUM POND ON WACHUSETT WATERSHED.

reset, and the new cemetery has since been used for burial purposes.

Certification was made and notification given in the year 1900 that everything required by the agreement to be done prior to the final settlement had been accomplished. A considerable balance in money is due from the Commonwealth under the agreement, which provides that on the completion of the work the Bishop, who holds the title, shall convey to the Commonwealth the land formerly embraced in the old cemetery, with a release of damages, and thereupon the Board shall convey the lands in Lancaster, comprised in the new cemetery, to the St. John's Catholic Cemetery Association, and pay to the Association the balance of money due from the Commonwealth.

The Board has repeatedly, but without success, asked for the carrying out of the agreement for the release of the old cemetery site to the Commonwealth, in order that it may on its part, in accordance with its agreement, convey to the Cemetery Association the new cemetery grounds and pay over to the Association the balance of money payable.

(2) Improvement of Wachusett Watershed.

(*a*) *Sterling Filter-beds.*

The waters of a small brook, which has its rise in and about the village of Sterling Centre, flow into West Waushacum Pond and thence by way of the Stillwater River into the Wachusett Reservoir. This village has no sewerage system, and the conditions are such that the overflow from cesspools and other objectionable drainage might possibly run into the brook and thence into the reservoir. It was, therefore, determined to provide against pollution from this source by the building alongside the brook of four filter-beds, each having an area of one-half an acre, into which the water shall be diverted and by which it shall be filtered before entering the reservoir.

A contract for the construction of the beds was made, the work was begun early in September, and at the close of the year it had nearly reached completion. The sum of $9,971.14 had already been spent upon construction, but the land damages have not yet been determined.

(*b*) *Drainage of Swamps.*

The construction of ditches for the drainage of swamps tributary to the Wachusett Reservoir had been suspended in the year 1900, on account of other more pressing work. It was, however, determined during the past year to proceed with the work by the construction of ditches for the drainage of three of the swamps on the watershed, one south of Sterling Centre, and two situated north of the village of Quinepoxet, both partly in the town of Holden and partly in the town of Princeton. The three swamps have areas respectively of 26, 72 and 216 acres, with watersheds embracing a total of 2,600 acres. The work upon the two former has been completed, leaving that upon the larger one still unfinished. The drainage ditches constructed have a total length of 19,700 linear feet. The expenditures for the construction of these ditches, including culverts, farm crossings and watering places, not including engineering, for the year amounted to $9,886, and the work has been done by day labor.

(*c*) *Miscellaneous Improvements.*

Considerable progress has otherwise been made in the accomplishment of the work for preventing the pollution of the Wachusett Reservoir in the towns of West Boylston, Boylston and Sterling. Twenty-eight cesspools, seven cemented vaults, a gravel filter-bed and a drainage ditch have been constructed, in order to prevent sewage and barn drainage from running into the brooks which empty into the reservoir. Other work of various kinds has been done about the Quinepoxet River, in order to prevent polluting matter from entering the streams.

(3) Pumping Stations.

The construction of a new brick pumping station in Arlington for the high-service supply of that town and the town of Lexington was begun on August 27, 1906. This is to take the place of a temporary wooden structure which was erected on land purchased for the purpose of building a permanent station after the admission of the town into the Metropolitan Water District. The building has been about half completed, and during the coming year will be finished and equipped with a new pumping engine and boiler.

DITCHES FOR SWAMP DRAINAGE ON WACHUSETT WATERSHED IN HOLDEN.

Considerable work was done at the Chestnut Hill low-service pumping station for the purpose of so adapting one of the three new engines in that station that it may assist in supplying the demands for the high service. In this way it has been hoped that the necessity of purchasing a large new engine for the high service might be for a time deferred. The work to this end has so far seemed to be successful, and it is anticipated that the addition of a new high-service engine will not be required for the coming year.

(4) Improvement of Spot Pond Brook.

No hearing has been called for during the year under the petition brought by the city of Melrose for the appointment of commissioners under chapter 406 of the Acts of the year 1904, which was an act "to provide for the improvement of Spot Pond Brook by the Metropolitan Water and Sewerage Board."

(5) Police Protection.

The police protection called for by the Metropolitan Water Act for communities where the work of construction was carried on has ceased to be required. The last officers on duty, who were in the town of Clinton, were discharged, on account of the discontinuance of construction about the Wachusett Dam, on March 31, 1906.

A total sum of $210,801.74 has been paid, since the beginning of the work, for police protection during construction, in accordance with the requirements of the Metropolitan Water Act.

Some police service or guard is required about the Wachusett Reservoir, but, inasmuch as this is for the protection of the works, it is regarded as a part of the requirements of maintenance.

(6) Acquisition of Lands and Settlements for Lands Acquired.

The Board acquired during the past year, by purchase, 229.153 acres in fee and easements in 1 acre, and by takings, 9.005 acres in fee and easements in 0.153 acre, — a total of 239.311 acres. The larger part of the lands acquired was situated in Sterling, considerable tracts situated upon and in the vicinity of the West Waushacum Lake having been purchased for the improvement of the watershed, and other parcels having been taken for the building of the filter-beds.

The total area of all the lands acquired for the Metropolitan Water Works since the beginning of operations in the year 1895 has amounted to 16,814.733 acres, or 26.273 square miles.

In some cases the acquisition of lands has first been made by deed, and in other cases takings under the powers given by the Metropolitan Water Act have first been made; but it has been the policy of the Board to follow the conveyances by takings, and, so far as possible, when settlement has been made after takings, to obtain releases by deed.

The number of takings of land made during the year was 7, but 5 of these covered land supposed to have been already acquired by deed.

List of Takings for Metropolitan Water Works for the Year 1906.

No.	Location and Description.	Former Owners.	Recorded.	Purpose of Taking.
			1906.	
108	Arlington (northwest from Brattle Street, adjoining Lexington & Arlington Branch of Boston & Lowell Railroad and the pumping station lot). Area, 0.015 acre in fee.	Sarah Hourty.	Aug. 21.	Addition to pumping station lot.
109	Sterling (southeasterly from Worcester Street, about one mile south from Sterling Centre, between locations of the Worcester Consolidated Street Railway Company and of the New York, New Haven & Hartford Railroad, Fitchburg & Worcester Branch). Area, 3.99 acres in fee and easements in 0.153 acre.	Helen M. Houghton *et al.*, Clara L. Kingsbury, Willie R. Mitchell, Charles O. Nixon.	Sept. 6.	Wachusett improvement (Sterling filter-beds).
110	Westborough (north of Haskell Street, east of State highway, adjoining land of the Westborough Insane Hospital). Area, 0.96 acre in fee.	Heirs of Levi A. Bathrick.	Dec. 31.	Crane Swamp improvement.
111	Berlin and Northborough (Berlin parcel between New York, New Haven & Hartford Railroad and North Brook; Northborough parcel on Berlin line and New York, New Haven & Hartford Railroad). Area, 4.274 acres in fee.	Lizzie J. Spofford and Lettie A. Knight.	Dec. 31.	Wachusett Aqueduct.
112	West Boylston (one parcel south of Holden Street and two parcels on Wilson Place). Area, 43.62 acres in fee.	Myron W. Houghton and Bela T. Chase.	Dec. 31.	Wachusett Reservoir.
113	Clinton and Boylston (on easterly side of new highway to Clinton, both sides of the Berlin road and of the old location of the Central Massachusetts Railroad). Area, 87.56 acres in fee.	Heirs of Lorenzo Wood.	Dec. 31.	Wachusett Reservoir.
114	Sterling and West Boylston (one piece east side Stillwater River, easterly from Waushacum Street; one piece on west side Waushacum Street, a short distance northeast from Main Street; and one at corner of Waushacum and North Main streets). Area, 55.504 acres in fee.	Emily Hosmer *et al.*, Joseph E. White and Mary S. Mason.	Dec. 31.	Wachusett Reservoir.

Settlements under purchases and takings of land, for all purposes of the Water Works, have been effected in the past year in 16 cases, and for an aggregate of 538.526 acres with the buildings thereon. Of these cases, 6 were on account of the Wachusett Reservoir, 1 on account of the Weston Aqueduct, 1 on account of the taking of Spot Pond and the surrounding lands, 1 on account of Spot Pond Improvement, 3 for the improvement of the Wachusett watershed, 2 on account of the improvement of the Sudbury watershed and 2 on account of the Wachusett Aqueduct. The sums paid in all these settlements during the year 1906 have amounted to $976,278.40. In 4 of these cases the settlements have been results of suits at law, and the total amount paid in the court settlements during 1906 has been $900,612.33. Payments on "account" previously made would make the total amount paid in these four cases $1,247,544.30, of which $1,214,523.63 was for Spot Pond and surrounding lands and $25,705.99 for Spot Pond Improvement.

Since the beginning of operations upon the Metropolitan Water Works, the number of settlements effected on account of the acquisition of land for the purposes of the Water Works, including the works of water supply acquired from the city of Boston on January 1, 1898, has amounted to 867; and under them the Board has acquired rights, in fee or easements, in 16,491.876 acres, or 25.768 square miles, for which an aggregate of $18,245,741.16 has been paid. Only 48 of these cases have been settled by judgments obtained in court, and the total amount paid under these judgments has been $1,386,751.59, or less than 8 per cent. of the whole amount paid.

Of the lands acquired, either in fee or in easement, since the beginning of operations upon the Metropolitan Water Works, settlement has been effected with the owners of all these lands except 27.257 acres. This amount does not, however, include 69.75 acres in Lancaster, which the Board stands ready to convey to the St. John's Catholic Cemetery Association; and 40.059 acres of land in Clinton, of which the owners have not been found.

Not including the settlement with the city of Boston, which was effected by agreement out of court, and the settlement with the cities of Malden, Medford and Melrose for Spot Pond and surrounding lands, which was made upon the basis of an award by commissioners, the Board has obtained settlement by voluntary agreement with $17/18$ of all the owners of the lands acquired, and almost $24/25$ of the total

amount of money paid in settlements was under voluntary agreement with the owners.

The above purchases and takings for which the settlements have been made include lands taken in fee with the buildings thereon and the water and other rights connected therewith, and lands in which easements and other rights are taken; but they do not include settlements for diversion of water, depreciation and other damages connected with lands not acquired, and in which no fee or easement has been taken.

Summary of Land Settlements for Water Works to December 31, 1906.

LOCATION.	For the Year 1906.			From Beginning of Work.		
	Area in Acres.	Number of Settlements.	Payments.	Area in Acres.	Number of Settlements.	Payments.
Wachusett Reservoir.						
Berlin,	-	6	$2,243 00	16.700	435	$2,951,680 10
Boylston,	-			4,003.116		
Clinton,	.252			1,275.015		
Holden,	-			167.000		
Sterling,	27.750			797.987		
West Boylston,	.074			1,652.924		
Total,	28.076	6	$2,243 00	7,912.742	435	$2,951,680 10
Improving Wachusett Watershed.						
Holden,	-	3	$72,500 00	151.340	8	$133,460 00
Sterling,	229.150			229.150		
West Boylston,	-			64.430		
Total,	229.150	3	$72,500 00	444.920	8	$133,460 00
Wachusett Aqueduct.						
Berlin,	-	2	$3,953 10	47.815	70	$81,677 08
Clinton,	-			12.310		
Marlborough,	-			51.530		
Northborough,	-			89.000		
Southborough,	8.600			108.660		
Total,	8.600	2	$3,953 10	309.315	70	$81,677 08
Sudbury Reservoir.[1]						
Marlborough,	-	-	-	751.980	153	$658,318 75
Southborough,	-			2,019.080		
Total,	-	-	-	2,771.060	153	$658,318 75

[1] Including settlements made by city of Boston.

Summary of Land Settlements for Water Works, etc. — Continued.

LOCATION.	For the Year 1906.			From Beginning of Work.		
	Area in Acres.	Number of Settlements.	Payments.	Area in Acres.	Number of Settlements.	Payments.
Improving Sudbury Watershed.						
Ashland,	–	2	–	.630	41	$16,522 16
Marlborough,	–			.800		
Northborough,	–			178.049		
Sherborn,	1.000			1.000		
Southborough,	.008			4.829		
Westborough,	–			205.487		
Total,	1.008	2	–	390.795	41	$16,522 16
Clinton Sewerage System.						
Clinton,	–	–	–	5.315	36	$37,794 40
Lancaster,	–			129.835		
Total,	–	–	–	135.150	36	$37,794 40
Weston Aqueduct.						
Framingham,	.520	1	$923 07	102.645	86	$183,593 40
Newton,	–			1.308		
Southborough,	–			.450		
Wayland,	–			73.299		
Weston,	–			295.195		
Total,	.520	1	$923 07	472.897	86	$183,593 40
Distribution System.						
Arlington,	–	–	–	1.896	34	$171,916 85
Boston,	–			1.359		
Brookline,	–			.051		
Malden,	–			.158		
Medford,	–			3.213		
Newton,	–			5.147		
Quincy,	–			5.224		
Revere,	–			.404		
Somerville,	–			.009		
Stoneham,	–			19.409		
Total,	–	–	–	36.870	34	$171,916 85
Improving Lake Cochituate.						
Natick,	–	–	–	2.950	1	$1,600 00
Total,	–	–	–	2.950	1	$1,600 00

Summary of Land Settlements for Water Works, etc. — Concluded.

LOCATION.	For the Year 1906.			From Beginning of Work.		
	Area in Acres.	Number of Settlements.	Payments.	Area in Acres.	Number of Settlements.	Payments.
Spot Pond Water Works (Taking of January 1, 1898).						
Medford,	.630	1	$888,158 32	.630	1	$1,214,523 63[1]
Stoneham,	216.000			216.000		
Total,	216.630	1	$888,158 32	216.630	1	$1,214,523 63
Spot Pond Improvement (Takings of August 5, 1899, and June 2, 1902).						
Medford,	41.447	1	$8,500 91	41.447	1	$25,705 99
Stoneham,	13.100			13.100		
Total,	54.547	1	$8,500 91	54.547	1	$25,705 99
Boston Water Works[2] (Taking of January 1, 1898).						
Arlington,	–	–	–	1.586	1	$12,768,948 80[3]
Ashland,	–			652.124		
Boston,	–			160.630		
Framingham,	–			663.460		
Hopkinton,	–			654.729		
Marlborough,	–			30.552		
Medford,	–			25.140		
Natick,	–			436.223		
Needham,	–			31.695		
Newton,	–			78.308		
Sherborn,	–			40.385		
Somerville,	–			12.426		
Southborough,	–			17.168		
Wayland,	–			177.875		
Wellesley,	–			139.115		
Westborough,	–			545.912		
Winchester,	–			76.094		
Woburn,	–			.578		
Total,	–	–	–	3,744.000	1	$12,768,948 80
Aggregates,	538.526	16	$976,278 40	16,491.876	867	$18,245,741 16

[1] Includes $749.71 paid city of Malden for supplies not part of award.
[2] Estimated areas.
[3] Includes interest.

The settlements above enumerated include all lands acquired for which a complete settlement has been made. About 114.402 acres of the lands acquired and settled for have subsequently been sold and conveyed by the Board. This does not include 0.204 of an acre in Natick, taken for abolition of grade crossing.

The tables of settlements for lands acquired do not include: —

1. Lands for which "payments on account" under chapter 317 of the Acts of the year 1904 have been made, there being 4.89 acres on account of which $1,278.07 has been paid, but for which no settlement has been reached.

2. Lands acquired but not paid or settled for, amounting to about 144.139 acres, including 50.765 acres previously owned by the Commonwealth and 66.761 acres of other lands for which no claims will probably be made.

3. Lands embraced in the St. John's Catholic Cemetery, comprising 26.39 acres in Clinton and 69.75 acres in Lancaster.

4. Areas of streets.

(7) Claims and Settlements for Loss of Business.

For injury to business caused by the carrying out of the Metropolitan Water Act in the towns of Boylston and West Boylston and in portions of the towns of Sterling and Clinton, settlements were made during the year in 17 cases, and in addition 2 cases were disallowed. In some of these cases claims had been previously filed with the Board, but in the greater number suits for damages had been directly brought in court. These suits were brought after the decision of the Supreme Judicial Court declaring that under certain circumstances farming was an established business within the meaning of the Metropolitan Water Act, for which damages could be recovered. Settlements were accordingly effected in several of these suits by the Attorney-General, with the approval of the Board.

The number of claims of this class settled since the beginning of the Water Works has been 322, and the total sum paid on account of such claims has been $153,222.36. All of these claims except 18 have been settled outside of the court.

(8) Claims and Settlements for Loss of Employment.

No claims for loss of employment by residents of West Boylston have been filed during the year, but 3 settlements of cases of this class already pending have been made. These 3 claims had been rejected by the Board, but were allowed by the courts.

The whole number of settlements for such claims effected since the beginning of the operations of the Board has been 477. The total amount paid on account of these claims has been $85,959.65. All of these claims, with the exception of the 3 paid the past year, were settled without resort to the courts.

(9) Claims and Settlements for Depreciation of Real Estate.

Settlements for depreciation in the value of real estate not taken by the Board were made on account of lands situated in the towns of West Boylston and Sterling only, all of the Clinton cases having been previously settled. Settlements have been effected in 10 cases of this class during the year ending December 31, 1906, and the sum of $6,974.02 has been paid. Of these, 1 was settled in court.

The total number of claims for depreciation settled up to December 31, 1906, has been 275, and the total amount paid thereunder has been $265,459.51. All of these claims except 42 were settled out of court.

No settlements or results have been reached in the many suits for damages brought under the Act of the year 1904, which gave to the owners of real estate situated in that part of the town of Boylston lying on the southerly and southeasterly sides of the reservoir, and within the limits of the Nashua River watershed, the right to recover for the depreciation in value of real estate not taken but injured by reason of the operations of the Metropolitan Water and Sewerage Board in a manner similar to that provided for owners of real estate in the town of West Boylston.

(10) Claims on Account of Diversion of Water.

There have been no claims filed during the year for damages for the diversion of water. The total sum paid under settlements and judgments for such claims since the beginning of the construction of the Water Works has been $1,135,708.91.

The sums enumerated as paid in these and in the preceding cases do not include amounts paid for expert services and court expenses.

IV. WATER WORKS — MAINTENANCE.

Dexter Brackett, the Engineer of the Sudbury and Distribution departments, has had supervision over the maintenance and operation of all the Water Works of the Metropolitan System. He has been assisted by Charles E. Haberstroh, who has the immediate supervision of the Sudbury and Cochituate works and of the portion of the Weston Aqueduct above the Weston Reservoir; by George E. Wilde, who has the immediate supervision of the Weston Reservoir and the remainder of the Weston Aqueduct, and of all the reservoirs and pipe lines within the Metropolitan District; and by Arthur E. O'Neil, who has charge of the several pumping stations. Alexander E. Kastl, Division Engineer, has had the immediate charge of both construction and maintenance of the Wachusett Dam, Reservoir and Aqueduct, and of the Clinton Sewerage Works.

(1) Operation of Works.

The maintenance of the Water Works embraces the care and operation of the five water pumping stations, of the Pegan pumping station and of the Clinton sewerage pumping station, the ten storage reservoirs, the ten distributing reservoirs, the four aqueducts, the various filter-beds, the 84 miles of distributing main pipes, as well as the various pipe yards, gate-houses, siphon and terminal chambers, and other structures connected with the several reservoirs and aqueducts, the dwellings for attendants, and various other buildings used or held for operating purposes. There are in addition the Mystic pumping station and the Mystic Aqueduct, which have not been in active operation during the past year.

(2) Storage Reservoirs.

The storage reservoirs of the Cochituate and Sudbury watersheds have normal capacities amounting to 15,858,500,000 gallons, though a somewhat larger amount of water is at certain periods actually held by them. The new Wachusett Reservoir has a capacity of 64,951,400,000 gallons, so that the total capacity of the storage

reservoirs is 80,809,900,000 gallons. The various capacities are as follows: —

	Gallons.
Cochituate watershed: —	
Lake Cochituate, including Dudley Pond,	2,242,400,000
Sudbury watershed: —	
Sudbury Reservoir,	7,253,500,000
Framingham Reservoir No. 1,	287,500,000
Framingham Reservoir No. 2,	529,900,000
Framingham Reservoir No. 3,	1,183,500,000
Ashland Reservoir,	1,416,400,000
Hopkinton Reservoir,	1,520,900,000
Whitehall Reservoir,	1,256,900,000
Farm Pond,	167,500,000
Wachusett watershed: —	
Wachusett Reservoir,	64,951,400,000
Total,	80,809,900,000

On January 1, 1906, the quantity of water stored in all of the storage reservoirs was 28,971,900,000 gallons. There was a considerable gain made during the month of January, but greater gains occurred from the larger rainfalls of the latter part of February and of the months of March and April, and from a single rainfall near the end of May. The maximum amount in storage was reached on July 6, when the quantity stored in all the reservoirs was 49,805,200,000 gallons. This quantity is by far the largest amount of water held in storage at any time, the maximum quantity in the preceding year being 33,708,200,000 gallons. After July 6 there was almost continual loss of storage in the reservoirs, and at the end of the year the quantity in storage was 44,153,200,000 gallons.

Considerable progress has been made during the past year in filling the Wachusett Reservoir, although the yield of the watershed was below the average of past years, and the requirements of the service have caused large quantities of water to be drawn daily from this reservoir. On January 1, 1906, the reservoir contained 17,115,300,000 gallons. The water in the reservoir reached its greatest height on July 10, when the reservoir contained 34,462,500,000 gallons. This quantity was more than half of the capacity of the reservoir, and the water rose to elevation 367.75 above Boston City Base, which is 27.25 feet lower than the level of the reservoir if filled to high-water mark. The quantity of water in storage on

December 31, 1906, was 31,752,900,000 gallons, — a net gain in storage for the year of 14,637,600,000 gallons. The only water discharged from the reservoir into the river below the dam is that provided, in accordance with the statute, for the use of the Lancaster Mills. The average quantity thus discharged was 3,761,000 gallons per day.

The Sudbury Reservoir, which receives all the water furnished to the District through the Wachusett Aqueduct from the Wachusett Reservoir, was during the year full or nearly full for 7 months, the water having flowed continuously over the crest of the dam into Framingham Reservoir No. 3, which is directly below upon the river. The water is drawn from the Sudbury Reservoir substantially during the entire year, a part by way of Framingham Reservoir No. 3 through the Sudbury Aqueduct, and a part through the Weston Aqueduct. Water was drawn from Framingham Reservoir No. 2 during the whole or portions of 6 months; from Ashland Reservoir during portions of 2 months; from the Hopkinton Reservoir during portions of 6 months. Water was drawn from Framingham reservoirs Nos. 1 and 2 in order to increase the supply in Lake Cochituate during portions of 6 months of the year. Water was drawn from Lake Cochituate during 9 months of the year. The water in this lake was lowered toward the latter part of the year, largely in order to make certain repairs which had been found necessary, so that in the middle of November the surface of the lake was 7 feet 6 inches below high water.

It was found necessary to rebuild a portion of the barn at the Sudbury Dam, as it had become unsafe for use. The grounds near the dam have been improved by the covering of wastes which had been left after construction. Trees have also been set out near the dam and at various points around the reservoir. Considerable fencing has been done in connection with adjoining proprietors.

A portion of the house occupied by the gate-keeper at the Ashland Reservoir was destroyed by fire, and that part has been rebuilt.

At Lake Cochituate it was found necessary to replace the flume in the circular dam which was used for keeping the northerly section of the lake, formerly known as the Fiske Meadow, covered with water at times when the level of the water in the lake has been more than usually drawn down. The wooden flume of the dam was replaced by a flume built of Portland cement concrete. The water in

this section of the lake being then so drawn down, the opportunity was afforded to make a thorough cleaning of this basin, and a certain portion of the shore was improved by excavation, so as to prevent shallow flowage.

The usual ordinary repairs have been made at all of the reservoirs.

The number of persons who come to visit the Wachusett Dam has been so great during the summer season that it has been necessary to have several of the men qualified as special policemen and put on duty on Sundays and holidays, so as to preserve order and protect the grounds from damage.

(3) Distributing Reservoirs.

The distributing reservoirs have a capacity of 2,381,230,000 gallons, and are usually kept filled or nearly filled with water. The capacities of these reservoirs are as follows: —

	Capacity in Gallons.
Spot Pond,	1,791,700,000
Chestnut Hill Reservoir,	300,000,000
Weston Reservoir,	200,000,000
Fells Reservoir,	41,400,000
Mystic Reservoir,	26,200,000
Waban Hill Reservoir,	13,500,000
Forbes Hill Reservoir,	5,100,000
Bear Hill Reservoir,	2,450,000
Arlington Standpipe,	550,000
Forbes Hill Standpipe,	330,000
Total,	2,381,230,000

These reservoirs are all situated within the Metropolitan District, and are maintained not only for facilitating the distribution of water, but also to afford protection in cases of emergency. The Weston Reservoir also serves the purpose of an equalizing reservoir near the end of the Weston Aqueduct.

Considerable work has been required for the reconstruction of the gravel walks and resurfacing of a portion of the driveway about the Chestnut Hill Reservoir, made necessary by the changing of the grade of Beacon Street by the city of Boston.

The visitors to the buildings and grounds at several of the distributing reservoirs, particularly on Sundays and holidays, call for

a considerable extra force upon such days for the protection of the works and grounds.

During the past year the Arlington standpipe has been emptied and thoroughly cleaned and painted. The grounds about several of the reservoirs have been much infested by the gypsy and brown-tail moths, and a more extended report of their ravages is given in subsequent pages.

(4) Aqueducts.

Water was drawn through the Wachusett Aqueduct from the Wachusett Reservoir into the Sudbury Reservoir 316 days during the past year, an average of 80,764,000 gallons per day. At the times when the aqueduct was not in use it was thoroughly cleaned, and the structures along the line have been painted and needed repairs have been made.

From the Sudbury Reservoir an average of 32,289,000 gallons per day was drawn through the Weston Aqueduct into the distribution system of the Metropolitan District. From Framingham Reservoir No. 3 an average of 68,363,000 gallons per day, coming principally from the Sudbury Reservoir, was drawn through the Sudbury Aqueduct. In addition, an average of 5,634,000 gallons per day was drawn through the Sudbury Aqueduct from Framingham reservoirs Nos. 1 and 2, making in the aggregate an average of 73,997,000 gallons per day drawn through the Sudbury Aqueduct. The Sudbury Aqueduct was in service 359 days during the year. Besides the usual cleaning of the aqueduct and of the three siphon pipes, joints in the masonry of the siphon chambers and of several of the culverts and waste weirs were repointed, and considerable painting was done for the preservation of the iron and wood work.

The Weston Aqueduct was in operation 355 days. The aqueduct and structures were given the annual cleaning, and some fencing was done along the aqueduct for its protection.

Water was drawn through the Cochituate Aqueduct a total of 237 days, an average of 13,288,000 gallons per day. In addition to the making of usual repairs, accurate surveys for locating the aqueduct and determining the position of property bounds, which have been in progress for several years, were finished, and the most of the alignment and property bounds had been set.

(5) Pumping Stations.

About 73 per cent. of all of the water supplied to the Metropolitan District has been first received through the Chestnut Hill Reservoir or directly from the aqueducts near the reservoir, and pumped at the Chestnut Hill high-service and low-service stations. The remainder of the water received was delivered into the distribution system by gravity through the Weston Aqueduct. A somewhat larger proportion than last year of the water supplied was thus delivered by gravity. From the Chestnut Hill low-service pumping station the water is pumped to the lower districts of Boston, Somerville, Chelsea, Malden, Medford, Everett and Arlington, and also to Spot Pond. The water is pumped from the Chestnut Hill high-service station to the higher districts of Boston, and to Quincy, Watertown, Belmont and a part of Milton. Water is pumped a second time from Spot Pond to Melrose, Revere, Winthrop, Nahant, Swampscott and the higher portions of Somerville, Chelsea, Malden, Medford and Everett; from a station in Arlington to Lexington and the higher portions of Arlington; and from a station in West Roxbury to the higher portions of West Roxbury and Milton.

The total quantity of water pumped at all of the stations during the year was 35,180,570,000 gallons, or 805,660,000 gallons less than the preceding year, a considerably less quantity of water being pumped at the Chestnut Hill low-service station than during the preceding year. The cost of operating all of the stations was $102,377.95, or $2.91 per million gallons pumped, — an increase of 30 cents per million gallons over the corresponding cost in the preceding year. Though this increase in cost of pumping is somewhat due to increase in the cost of fuel, it is partly due to the increased cost of labor and to the increase in the number of employés made necessary by a reduction in the hours of labor from seven days to six days per week.

The cost per million gallons of water raised one foot was: for the Chestnut Hill high-service station, $0.027; for the Chestnut Hill low-service station, $0.033; for the Spot Pond station, $0.031; for the West Roxbury station, $0.216; for the Arlington station, $0.095. These figures show an increase in the cost at the Chestnut Hill high and low service stations and in the West Roxbury station, a slight decrease in the Arlington station, and no change in the Spot Pond station.

Considerable difficulty has been had with the pumping engine at the Arlington pumping station, but it is expected that by temporary repairs the engine can be used until the new engine for the station, which is in process of building, can be installed and put to service.

During the year 12,623.88 tons of coal were purchased for use at the various stations. Of this total, 9,265.52 tons were bituminous, 363.37 tons anthracite, 2,655.95 tons buckwheat anthracite, and 702.41 tons were anthracite screenings. The average price per gross ton for the bituminous coal varied at the different stations from $4.12 to $4.48. The cost of the anthracite used was $7.28, of the buckwheat anthracite $2.84 and $2.93, and of anthracite screenings $2.24 and $2.52.

Tests have been continued in order to determine the heating value of the coal used and offered for use in the several stations, and also to determine the viscosity, specific gravity and burning point of the oil used.

(6) Pipe Lines and Pipe Yards.

Three breaks in the pipes have occurred during the year. The first occurred in the small pipes supplying water to the low-service station at Chestnut Hill; but a more serious one was the sudden breaking of the 48-inch curved casting in one of the force mains at the Chestnut Hill high-service station, which caused the flooding of the basement of the building and considerable damage to the grounds in the vicinity before it was possible to stop the flow of water. The third break occurred in a curve of the 48-inch pipe in Melrose, which was broken by the sewer department of that city while blasting for a sewer trench. The water had been shut off earlier in the day at the request of the Melrose authorities, and the cost of repairing the break was paid by the city of Melrose. Twenty-four leaks in pipes were discovered and repaired, the leaks being generally due to defective leaded joints.

To facilitate the construction of a new conduit by the Cambridge Water Works a main in Watertown was lowered, and in Medford a main pipe was raised to permit of the construction of a water drain by the city. Considerable changes and repairs have been made in the pipe line crossing Chelsea Creek between Chelsea and East Boston. Several insulating joints have been set at various points, for the purpose of attempting to reduce the quantity of electric current flowing along the pipes.

For the purpose of measuring the water supplied to the different cities and towns in the District, two new meters have been introduced and two of the meters originally placed have been enlarged. There are now in service for this purpose 55 Venturi meters and 4 Hersey meters.

The Glenwood pipe yard, so called, in Medford, is maintained as the headquarters of the maintenance force of the Water Works in the northern part of the District. The maintenance force for the southern part of the District has headquarters in buildings at the Chestnut Hill Reservoir.

(7) Sewerage and Filtration Works.

(*a*) *Clinton Sewerage Works.*

The daily average quantity of sewage pumped and filtered at the Clinton Sewerage Works was 23.6 per cent. more than in the preceding year. This increase was due to the amount of water leaking into the local sewers during the heavier rainfalls of the year.

The average quantity of sewage pumped per day was 795,000 gallons, and the cost per million gallons raised one foot was $0.19.

There are now in use 8 settling basins and 25 filter-beds. Experiments have been in progress during the year, under the supervision of the Chief Engineer of the State Board of Health, in order to increase the efficiency of the beds and to improve the character of the effluent.

The cost of operating the pumping station has been $2,731.23 and of the maintenance of the filter-beds $2,020.14, an amount of $6.96 per million gallons filtered. The sum of $1,087.37 has been expended in the experimental work.

The sludge which has accumulated in the settling basins and filter-beds has been given to the neighboring farmers, who have been glad to take it away and dispose of it upon their farms.

(*b*) *Marlborough Brook Filter-beds.*

The Marlborough Brook filter-beds, which receive the waters of a brook that flows through a section of the city of Marlborough before they enter the Sudbury Reservoir, have been in successful operation during the entire year. All the water flowing from the brook has

been filtered before entering the reservoir, except some small quantities on two days when there were heavy rainfalls. The beds have been cleaned and kept in good condition.

(c) *Pegan Brook Filtration Works.*

The Pegan filter-beds receive the water directly from Pegan Brook which flows through portions of the town of Natick, and also the water from the intercepting ditch which collects the water received from other brooks formerly draining into this section of Lake Cochituate, then known as the Pegan Brook Meadow. Water was pumped upon the filter-beds on 191 days during the year. The total quantity pumped during the year was 246,525,000 gallons, of which 158,739,000 gallons came from the Pegan Brook and 87,786,000 gallons came from the intercepting ditch.

The cost of operating the pumping station and of cleaning and caring for the beds and grounds was $17.50 per million gallons pumped.

(8) Sanitary Work and Regulations.

The sanitary inspection of the Wachusett, Sudbury and Cochituate watersheds has been continued, under the direction of William W. Locke, C.E. He has had two regular assistants, and laborers and others have been employed from time to time as required to carry out the improvements and changes which have been ordered.

There were 11 cases of typhoid fever reported during the year upon the Wachusett watershed, and 44 cases reported upon the Sudbury and Cochituate watersheds. None of these cases occurred upon lands belonging to the Board. All of them, however, were investigated as soon as reported, and proper precautions were taken to prevent the pollution of the water supply. So far as known, the purity of the water supply has not been affected by any of these cases.

There were inspected during the year 1,450 premises on the Wachusett watershed, for the purpose of ascertaining whether there were any conditions needing corrections or improvement, particularly with reference to cesspools, privy and sink drainage, manure piles and manufacturing wastes. Of these, 1,280 were declared to be satisfactory at the end of the year, and 170 premises were pronounced "unsatisfactory," which classification includes all cases where there

may be under the most unfavorable conditions wash from privies or direct sink drainage, all suspected cases, and all cases of manufacturing wastes entering brooks or feeders to the reservoir, although some attempts may have been made to purify them. Remedies were effected by the agents of the Board in 62 cases, 5 of them being remedied by the construction of filter-beds, and the remaining 57 by the building of new cesspools and cemented vaults or by the tearing down or removal of buildings. Partial remedy was applied in 39 other cases.

On the Sudbury and Cochituate watersheds 7,502 premises were inspected, and 7,148 of these were pronounced satisfactory at the end of the year and 354 unsatisfactory. In the cases of 202 of the premises remedies were effected by the agents of the Board, 192 by introducing sewer connections and 10 by other means, and there were 27 premises where partial remedies were accomplished. In addition, connections were made with 37 new houses.

Improvement in sanitary conditions has also been accomplished for the Wachusett watershed by the tearing down or removal of 30 dwelling houses, 10 barns and 1 storehouse on property owned by the Board. One of the mills on the Quinepoxet River, where 50 men had been formerly employed in the manufacture of cloths, was purchased by the Board and was destroyed. A large tract of land upon the southerly and westerly shores of West Waushacum Lake, extending along the margin of the lake about 3,000 feet was acquired and purchased, together with the farm or boarding house and several summer cottages standing upon the land.

At the Whitehall Reservoir more strict inspection has been adopted for the prevention of bathing, and measures have been taken toward the restriction of boating.

Samples of water have been collected at monthly and bi-monthly periods from different points upon the works, and sent to the State Board of Health for analysis and examination. Collections are made much more frequently for the microscopical and biological examinations in the laboratory of the Board. During the past year 2,526 microscopical and 1,017 biological examinations were thus made of the water collected from the main feeders of the Sudbury Reservoir and Framingham Reservoir No. 3 and of Lake Cochituate, as well as monthly tests made to determine the efficiency of the Marlborough Brook filter-beds.

(9) Moth Suppression.

The gypsy and brown-tail moths were found during the past year not only in extended areas in places where they had previously existed, but also in places where they had not formerly been discovered. The regions about Spot Pond have been, as heretofore, much the worse infested, and upon them the largest part of the work of suppression has been carried on. In the early part of the year a large force of men was employed in painting the egg clusters of the gypsy moth with creosote and fuel oil, and later in the season the foliage of the trees and the shrubbery were sprayed with arsenate of lead.

About Spot Pond the larger trouble has come from the presence of the gypsy moth, but considerable work has been done in the destruction of the nests of the brown-tail moths. In places the trees have been encircled with tanglefoot. Much difficulty was experienced in the attempt to protect the southern area of the Spot Pond lands along the long line between the land of the Commonwealth and that of the city of Medford. Much has been accomplished, and little serious damage has come to the trees on the land of the Commonwealth in the custody of the Board.

The lands at the Chestnut Hill and Mystic reservoirs have been more or less infested by both gypsy and brown-tail moths, and considerable work has been done in the destruction of egg clusters and nests. The moths have been advancing along the Cochituate, Sudbury and Weston aqueducts, and have been found in considerable numbers about the Sudbury and Weston reservoirs, and the brown-tail moths have been discovered even upon the grounds about the Wachusett Dam in Clinton.

The work which has been done for the suppression of the ravages of the moths in these regions as well as about Spot Pond has been sufficient to prevent the destruction of the trees or their serious injury. The operations have been carried on by the regular water maintenance force, augmented from time to time, as has been found necessary, by the employment of other experienced men. The total amount expended during the year was $12,700, of which all but about $2,200 was spent on the lands about Spot Pond.

(10) Quality of the Water.

The water delivered to the Metropolitan District has been substantially of the same quality during the last three or four years. During the past year the color of the water has been somewhat less, while the number of microscopic organisms has somewhat increased. No complaints regarding the quality of the water have been received from water takers during the year.

The organisms which prevail more or less in the different reservoirs, and sometimes give the water a noticeable taste or color, are in no respect injurious to the public health. In the Wachusett Reservoir the number of organisms has been small, and they have never imparted an objectionable character to the water. A larger number appeared for a while in the Sudbury Reservoir, and there was a slightly objectionable odor in the water, but they were broken up by passing the water over the Sudbury Dam. There are times in the year when the number is also large in Lake Cochituate and in other reservoirs, and at such times the water is not drawn from these sources. The additional storage given to the water in Spot Pond has caused this water generally to be particularly unobjectionable. Sufficient water has not yet been kept in storage in the Wachusett Reservoir to obtain the full benefit to be expected in the future from long storage in that basin.

(11) The Water Supply.

The amount of water yielded by both the Sudbury and Wachusett watersheds was considerably below the average, although this amount was larger than during the preceding year, in which the yield was abnormally small. The rainfall on the Sudbury watershed was 44.48 inches, only 1.56 inches below the average; and the rainfall on the Wachusett watershed was 49.08 inches, which is but little below the average. This rainfall, however, did not yield a proportional amount of water, because it was more widely distributed during the year, and there was but a comparatively small rainfall during the months when the larger quantity of water is collectible in the reservoirs. The yield of the Sudbury watershed was 19 per cent. less than the average, and that of the Wachusett was 14 per cent. below the average.

Water was supplied not only to all the cities and towns included

within the Metropolitan Water District, except the city of Newton and the town of Hyde Park, but was also supplied, by a special agreement, to the town of Swampscott, which is without the limits of the District, and to a small part of the town of Saugus, which is directly supplied by the town of Revere, under an arrangement with the Board. The estimated population, as of July 1, 1906, of the territory supplied with water was 913,710.

The city of Newton and the town of Hyde Park continue to be supplied from their own sources, which are still adequate for the purpose; and these municipalities are charged, in accordance with the Metropolitan Water Act, as amended in the year 1904, with one-fifth of the assessment which they would have been called upon to pay on the basis of valuation, and are relieved from any charge made on the basis of consumption.

The total quantity of water supplied by the Metropolitan Water Works to the various cities and towns, as determined by pump measurement and by the flow through the Weston Aqueduct, together with the small quantity yielded by Spot Pond, was 43,369,310,000 gallons, an average daily supply of 118,820,000 gallons, which is an increase in the daily supply of 422,000 gallons. The daily average supplied for each inhabitant was 130 gallons, — a slight decrease from last year, when the average was 131.2 gallons.

In addition to the amount thus supplied to the cities and towns in the District, 45,000 gallons daily were supplied to the United States reservation on Peddock's Island, in accordance with arrangements made with the Government.

The town of Framingham was also permitted, under the law, to draw its supply from Farm Pond, but this supply did not enter the aqueducts.

The quantity of water, as measured by the Venturi meters, when delivered to the various municipalities is, owing to leakage from the different reservoirs and pipe lines, as well as in a small degree to the use of water at the pumping stations, somewhat less than the amount given above, the quantity so measured and supplied from the Metropolitan Works to each person daily being 128 gallons.

The city of Newton and the town of Hyde Park supplied from their sources to their respective inhabitants a total of 1,191,546,533 gallons, being a daily average of 62 gallons per inhabitant.

V. WATER WORKS — FINANCIAL STATEMENT.

By chapter 235 of the Acts of the year 1906, the Board was required on or before the third Wednesday in January of each year to report to the General Court an abstract of its receipts, expenditures, disbursements, assets and liabilities for the previous fiscal year (which, by the provisions of chapter 211 of the Acts of the year 1905, is the year beginning with the first day of December and ending with the thirtieth day of November), together with all recommendations for legislation which it deemed desirable; and the Board was also required by the Act of 1906 to present in the month of February a more detailed statement of its doings for the calendar year next preceding, which detailed statement should be printed as its annual report for the year.

The financial abstract for the eleven months of the fiscal year ending with the thirtieth day of November, 1906,[1] was accordingly presented to the General Court in January, and a copy of this financial abstract is printed as Appendix No. 5.

The following detailed statement of its financial doings, in relation to the Metropolitan Water Works, for the calendar year 1906, is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan Water Loans authorized for the construction and acquisition of works have amounted to $40,500,000. To this sum are added the proceeds from the sale of certain property by the Board, and these amounted on January 1, 1907, to $148,361.41. The total amount, therefore, which the Board has been authorized to expend is $40,648,361.41. The amount of expenditures approved by the Board for payment out of the Metropolitan Water Loan Fund was, for the year 1906, $1,234,662.79, and the total amount so approved for payment since the beginning of the work up to January 1, 1907, has been $40,278,877.02. There was accordingly a balance remaining at the beginning of the year 1907 amounting to $369,484.39.

The Treasurer of the Commonwealth has issued from time to time, on the request of the Board, bonds to the amount of $40,193,000.

[1] Since the Act of 1905 changing the fiscal year came into full effect on the first day of January, 1906, the financial abstract submitted in January, 1907, covered only the period of the eleven months of the year 1906 ending with November 30.

These bonds were issued for terms of 39½ and 40 years from the date of issue, and bear interest at the rate of 3 per cent. and 3½ per cent. per annum. The sinking fund established for the payment of the bonds at maturity amounted on January 1, 1907 to $4,897,822.62.

The amount approved by the Board for the maintenance and operation of the Water Works for the year 1906, which was paid out of the annual assessments, was $419,748.23.

The assessments for the year 1906, for the payment of interest on the bonds, for the sinking fund requirements, and for the expenses of operation and maintenance of the Water Works, which were levied upon the various cities and towns in the Metropolitan District, amounted to $2,262,657.20.

Receipts from sales of water to municipalities not belonging to the District and to water companies were distributed back to the cities and towns, in proportion to their respective assessments, to the amount of $19,475.53.

The detailed financial statement regarding the Metropolitan Water Works is as follows: —

(1) Metropolitan Water Loans, Receipts and Payments.

The loans for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to the proceeds of these loans, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1907, have been as follows: —

Loan under chapter 488 of the Acts of 1895,	$27,000,000 00
Loan under chapter 453 of the Acts of 1901,	13,000,000 00
Loan under chapter 367 of the Acts of 1906,	500,000 00
	$40,500,000 00
Proceeds from the sales of property applicable to the construction and acquisition of works (of which $24,595.91 is for the year 1906),	148,361 41
	$40,648,361 41
Amount approved by the Metropolitan Water and Sewerage Board for payments to December 31, 1906 (of which $1,234,662.79 is for the year 1906),	40,278,877 02
Balance January 1, 1907,	$369,484 39

(2) Issues of Metropolitan Water Loan Bonds.

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding $40,500,000, to be designated the "Metropolitan Water Loan," has sold bonds as follows: —

Date of Sale.	Amount of Bonds sold.	Rate of Interest (per cent.).	Price received.	Date due.	Premium.
Sept. 25, 1895,	$5,000,000	3½	110.67	July 1, 1935,	$533,500 00
Nov. 23, 1896,	2,000,000	3½	106.76268	July 1, 1935,	135,253 60[1]
Feb. 8, 1897,	6,000,000	3½	107.82	July 1, 1935,	469,200 00
Jan. 13, 1898,	2,000,000	3½	113.176	Jan. 1, 1938,	263,520 00
Mar. 2, 1898,	2,000,000	3½	112.877	Jan. 1, 1938,	257,540 00
June 15, 1899,	3,000,000	3	100.64	July 1, 1939,	19,200 00
June 28, 1900,	1,000,000	3	102.78	July 1, 1939,	27,800 00
Mar. 5, 1901,	3,000,000	3	102.155	Jan. 1, 1941,	64,650 00
July 24, 1901,	100,000	3	100.375	Jan. 1, 1941,	375 00
July 24, 1901,	150,000	3	100.10	Jan. 1, 1941,	150 00
July 30, 1901,	205,000	3	100.25	Jan. 1, 1941,	512 50
July 31, 1901,	50,000	3	100.25	Jan. 1, 1941,	125 00
Aug. 7, 1901,	50,000	3	100.50	Jan. 1, 1941,	250 00
Aug. 8, 1901,	300,000	3	100.10	Jan. 1, 1941,	300 00
Aug. 8, 1901,	200,000	3	100.25	Jan. 1, 1941,	500 00
Sept. 17, 1901,	3,100,000	3½	106.71	Jan. 1, 1941,	208,010 00
Oct. 1, 1901,	1,345,000	3	100.	Jan. 1, 1941,	-
Oct. 24, 1901,	1,500,000	3	100.	Jan. 1, 1941,	-
Feb. 26, 1902,	500,000	3½	109.13	Jan. 1, 1942,	45,650 00
Feb. 26, 1902,	3,000,000	3½	109.13	Jan. 1, 1942,	273,900 00
April 7, 1903,	250,000	3½	106.725	Jan. 1, 1943,	16,812 50
April 17, 1903,	1,250,000	3½	106.1329	Jan. 1, 1943,	76,661 25
Jan. 15, 1904,	500,000	3½	104.60	Jan. 1, 1943,	23,000 00
Jan. 15, 1904,	2,000,000	3½	104.60	Jan. 1, 1944,	92,000 00
Mar. 24, 1905,	650,000	3½	105.761	Jan. 1, 1945,	37,446 50
June 28, 1906,	943,000	3½	103.09	Jan. 1, 1946,	29,138 70
June 28, 1906,	100,000	3¼	100.	Jan. 1, 1946,	-
	$40,193,000				$2,575,495 05

[1] Including $18,673.60 from readjustment of rate made by the Treasurer in 1897.

(3) Metropolitan Water Loan Sinking Fund.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows: —

December 31, 1895,	$226,286 05
December 31, 1896,	699,860 70
December 31, 1897,	954,469 00
December 31, 1898,	1,416,374 29
December 31, 1899,	1,349,332 97
December 31, 1900,	1,573,619 72
December 31, 1901,	1,662,426 95
December 31, 1902,	2,256,803 81
December 31, 1903,	2,877,835 59
December 31, 1904,	3,519,602 92
December 31, 1905,	4,207,045 69
December 31, 1906,	4,897,822 62

(4) Annual Assessments and Receipts.

Assessments for the year, amounting to $2,262,657.20, were required for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of operation and maintenance of the Water Works. The requirements were: for interest, $1,336,775.37; for the sinking fund, $520,380.51; and for maintenance and operation, $405,501.32. These assessments were made by the Treasurer of the Commonwealth upon the various municipalities as follows: —

Arlington,	$13,663 68	Nahant,	$4,187 88
Belmont,	5,668 67	Newton,	6,234 22
Boston,	1,822,556 33	Quincy,	46,314 16
Chelsea,	57,687 81	Revere,	16,894 21
Everett,	39,583 12	Somerville,	97,160 08
Hyde Park,	1,242 52	Stoneham,	8,088 06
Lexington,	6,205 30	Watertown,	14,778 34
Malden,	38,087 38	Winthrop,	13,351 69
Medford,	31,653 25		
Melrose,	25,230 09		$2,262,657 20
Milton,	14,070 41		

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of these municipalities had reached the safe capacity of its sources, and neither had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property, are, in accordance with the provisions of the Water Act, applied to the reduction of the assessment, and these, for the year 1906, amounted to $7,693.75.

The actual expenditures for the maintenance and operation of the Metropolitan Water Works were, for the year 1906, $419,748.23.

(5) Distribution to Cities and Towns of Sums received from Water furnished to Other Municipalities.

Sums have been received during the year 1906, under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

Swampscott,	$4,800 00
United States Government,	796 19
Wakefield,	200 00
	$5,796 19

The Treasurer, in accordance with the requirements of the Act, distributed to the cities and towns of the District, in proportion to the annual assessments theretofore contributed by them, to which were added considerable sums which had been received in the preceding year too late for distribution. The distribution was made as follows: —

Arlington,	$114 46	Nahant,	$32 46
Belmont,	58 46	Newton,	95 38
Boston,	15,886 82	Quincy,	313 55
Chelsea,	416 77	Revere,	141 16
Everett,	303 80	Somerville,	800 30
Hyde Park,	28 50	Stoneham,	66 48
Lexington,	34 38	Watertown,	137 96
Malden,	433 42	Winthrop,	88 06
Medford,	253 78		
Melrose,	182 82		$19,475 53
Milton,	86 97		

(6) Expenditures for the Different Works.

The following is a summary of the expenditures made in the various operations for the different works: —

Construction and Acquisition of Works.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Administration applicable to all parts of the construction and acquisition of the works,	$10,926 77		$262,601 46	
Wachusett Dam and Reservoir: —				
Wachusett Dam,	$87,472 43		$2,270,116 85	
North Dike,	303 06		749,811 36	
South Dike,	1,574 26		136,371 10	
Removal of soil,	36,293 76		2,528,155 15	
Relocation of railroads,	16,648 62		876,995 94	
Roads and bridges,	15,947 73		545,144 26	
Real estate,	17,380 19		3,179,060 57	
Damages, real estate not taken, business and loss of wages,	10,374 02		504,641 52	
Other expenses,	267 50		6,740 42	
		186,261 57		10,797,537 17
Improving Wachusett watershed,		101,996 14		188,035 81
Wachusett Aqueduct,		4,094 60		1,797,694 80
Sudbury Reservoir,		-		2,922,445 21
Protection of Sudbury supply,		393 30		129,190 36
Amounts carried forward,		$303,672 38		$16,097,504 81

Construction and Acquisition of Works.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Amounts brought forward,		$803,672 38		$16,097,504 81
Improving Sudbury watershed,		278 16		95,385 09
Protection of Cochituate supply,		-		9,000 00
Improving Cochituate watershed,		-		8,860 68
Improving Lake Cochituate,		-		103,537 29
Pipe lines, Dam No. 3 to Dam No. 1,		-		48,471 48
Pipe line, Rosemary siphon,		-		23,142 98
Weston Aqueduct: —				
Aqueduct,	$2,173 20		$2,352,136 32	
Reservoir,	382 26		288,684 36	
Supply pipe lines,	287 93		584,639 71	
Real estate, taxes and other expenses,	1,364 82		204,486 03	
		4,208 21		3,429,946 42
Distribution system: —				
Low service: —				
Pipe lines and connections,	$420 39		$1,751,626 06	
Pumping station, Chestnut Hill,	3,320 22		462,572 19	
Reservoir, Spot Pond,	-		578,101 58	
Gate-house and connections, Chestnut Hill Reservoir,	-		65,480 88	
Real estate and other expenses,	-		90,910 66	
Northern high service: —				
Pipe lines and connections,	-		440,539 28	
Spot Pond pumping station,	-		291,829 35	
Fells Reservoir, Stoneham,	-		141,392 94	
Bear Hill Reservoir, Stoneham,	-		38,267 70	
Real estate and other expenses,	-		14,838 05	
Southern high service: —				
Pipe lines and connections,	5,352 14		514,897 55	
Pumping station, Chestnut Hill,	104 17		242,225 52	
Forbes Hill Reservoir, Quincy,	-		90,003 49	
Waban Hill Reservoir, Newton,	-		61,592 11	
Real estate and other expenses,	-		10,226 36	
Northern extra high service,	15,215 71		29,243 86	
Southern extra high service,	15 00		22,830 67	
Meters and connections,	567 91		76,964 91	
Improving Spot Pond Brook,	274 18		3,991 23	
Glenwood pipe yard,	-		33,100 59	
Chestnut Hill pipe yard,	-		11,311 26	
		25,269 72		4,971,946 24
Diversion of water, South Branch of Nashua River,[1]		2,429 46		1,360,240 46
Acquisition of existing water works: —				
Reimbursement city of Boston, partially constructed Sudbury Reservoir,	-		$1,167,921 59	
To Boston, for works taken January 1, 1898,	-		12,768,948 80	
Amounts carried forward,	-	$335,857 93	$13,926,870 39	$26,148,035 45

[1] Of the total expenditures from the beginning of the work, the sum of $150,734.04 is for Clinton sewerage system.

Construction and Acquisition of Works.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Amounts brought forward,	–	$335,857 93	$13,926,870 39	$26,148,035 45
Acquisition of existing water works — *Con.*				
To Malden, Medford and Melrose for taking of Spot Pond,	$896,659 23		1,240,229 62	
To Newton, for Waban Hill Reservoir,	–		60,000 00	
Transfers of works acquired and other property to accounts for special works,	–		$15,227,100 01 1,240,262 50	
			$13,986,837 51	
Engineering, conveyancing, etc.,	2,600 00	899,259 23	73,126 22	14,059,963 73
		$1,235,117 16		
Pipes, Valves, Castings, etc., sent first to Storage Yards, and afterwards transferred as needed to Different Parts of the Work.				
Sent to storage yards,	$1,864 18		$2,088,374 70	
Transferred from storage yards to works, and included in costs above,	2,318 55		2,017,496 86	
Balance from beginning of work,				70,877 84
Excess of transfers over purchases during the year 1906 (deducted),		454 37		
Total for constructing and acquiring of works,		$1,234,662 79		$40,278,877 02

Maintenance and Operation.	For the Year ending December 31, 1906.	
Administration,		$11,329 36
General supervision,		4,320 54
Taxes and other expenses,		44,744 23
Wachusett Reservoir Department: —		
General superintendence,	$2,460 22	
Reservoir,	70,104 97	
Forestry,	5,709 19	
Sanitary inspection and protection of supply,	1,427 74	
Protection of supply,	923 98	
Buildings and grounds,	2,273 76	
Dam and aqueduct,	4,906 20	
Wachusett dam,	3,075 95	
Wachusett aqueduct,	2,328 93	
Clinton sewerage system: —		
Pumping station,	2,663 81	
Sewers, screens and filter-beds,	2,307 56	
Sanitary inspection,	458 92	
		98,641 23
Amount carried forward,		$159,035 36

MAINTENANCE AND OPERATION.		For the Year ending December 31, 1906.
Amount brought forward,		$159,035 36
Sudbury Department: —		
General superintendence,	$3,764 31	
Superintendence, Framingham office,	7,754 73	
Ashland Reservoir,	3,240 18	
Hopkinton Reservoir,	2,130 81	
Whitehall Reservoir,	383 22	
Framingham Reservoirs, 1, 2 and 3,	4,513 21	
Sudbury Reservoir,	7,310 23	
Lake Cochituate,	7,094 47	
Marlborough Brook filters,	2,300 22	
Pegan filters,	4,314 79	
Sudbury and Cochituate watersheds,	431 96	
Sanitary inspection,	3,058 24	
Cochituate Aqueduct,	6,548 31	
Sudbury Aqueduct,	9,348 42	
Weston Aqueduct,	5,718 39	
Biological laboratory,	2,856 26	
		70,767 75
Distribution Department: —		
Superintendence,	$10,346 93	
Arlington pumping station, pumping service,	6,461 52	
Chestnut Hill low-service pumping station, pumping service,	35,611 24	
Chestnut Hill high-service pumping station, pumping service,	47,215 34	
Spot Pond pumping station, pumping service,	11,400 90	
West Roxbury pumping station, pumping service,	7,370 57	
Arlington standpipe,	553 50	
Bear Hill Reservoir,	210 86	
Chestnut Hill Reservoir,	10,037 05	
Fells Reservoir,	1,265 27	
Forbes Hill Reservoir,	1,156 11	
Mystic Lake, conduit and pumping station,	2,171 28	
Mystic Reservoir,	1,295 88	
Waban Hill Reservoir,	604 94	
Weston Reservoir,	2,483 92	
Spot Pond,	16,954 48	
Buildings at Spot Pond,	1,451 84	
Pipe lines: —		
Low service,	10,145 65	
Northern high service,	2,706 50	
Southern high service,	3,375 06	
Supply pipe lines,	784 87	
Buildings at Chestnut Hill,	1,827 29	
Chestnut Hill pipe yard,	472 26	
Glenwood pipe yard and buildings,	4,098 63	
Stables,	5,096 59	
Waste prevention,	2,924 43	
Venturi meters,	1,922 21	
		189,945 12
Total for maintaining and operating works,		$419,748 23

(7) Detailed Financial Statement under Metropolitan Water Act.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1906.

(*a*) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1906, and ending December 31, 1906, is $1,234,662.79, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1906, is $40,278,877.02.

For maintenance and operation the expenditures for the year have been $419,748.23, and from the beginning of the work, $2,650,962.24.

The salaries of the commissioners, and other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

General Character of Expenditures.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Construction of Works and Acquisition by Purchase or Taking.				
Administration.				
Commissioners,	$4,666 67		$110,310 25	
Secretary and auditor,	1,500 00		47,217 03	
Clerks and stenographers,	3,064 36		55,572 49	
Legal services,	-		2,359 00	
Travelling,	34 40		3,625 48	
Stationery and printing,	585 75		10,767 84	
Postage, express and telegrams,	126 10		2,754 07	
Furniture and fixtures,	-		4,280 89	
Alterations and repairs of buildings,	9 00		5,752 27	
Telephone, lighting, heating, water and care of building,	544 46		10,900 09	
Rent and taxes, main office,	341 41		4,617 21	
Miscellaneous expenses,	54 62		4,444 84	
		$10,926 77		$262,601 46
Amounts carried forward,		$10,926 77		$262,601 46

General Character of Expenditures.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Amounts brought forward,		$10,926 77		$262,601 46
Engineering.				
Chief engineer and department engineers,	$4,105 33		$206,515 56	
Principal assistant engineers,	6,382 12		151,607 61	
Engineering assistants,	22,453 42		1,007,158 82	
Consulting engineers,	-		23,560 07	
Inspectors,	476 50		290,122 39	
Architects,	961 66		36,161 19	
Railroad and street car travel,	44 30		26,779 49	
Wagon hire,	951 63		44,808 48	
Stationery and printing,	404 46		25,870 75	
Postage, express and telegrams,	128 55		7,703 91	
Engineering and drafting instruments and tools,	44 05		19,284 78	
Engineering and drafting supplies,	303 21		24,807 36	
Books, maps and photographic supplies,	175 75		6,801 34	
Furniture and fixtures,	-		14,977 46	
Alterations and repairs of buildings: —				
Main office,	99 00		14,038 86	
Sub-offices,	1 00		2,939 36	
Telephone, lighting, heating, water and care of buildings: —				
Main office,	1,573 76		23,401 15	
Sub-offices,	997 20		19,446 36	
Rent and taxes, main office,	1,024 28		13,620 03	
Rent of sub-offices and other buildings,	13 00		4,526 74	
Field offices and sheds,	-		1,274 49	
Clinton office building,	-		9,866 87	
Unclassified supplies,	29 43		8,240 53	
Miscellaneous expenses,	89 92		8,624 19	
		40,258 57		1,992,137 79
Construction.				
Preliminary work (borings, test pits and other investigations): —				
Advertising,	-		$6,306 22	
Other preliminary work as given in detail in preceding annual report,	-		155,457 41	
				161,763 63
Contracts, Wachusett Reservoir: —				
Contracts completed and final payments made prior to January 1, 1906,	-		$2,644,147 23	
Busch Bros., excavating soil, Sect. 6, and building road, West Boylston and Boylston, — deducted from estimate, September 5, 1900,	$600 00		35,160 63	
The H. Gore Co., surfacing highways, West Boylston, Sect. 1,	398 82		6,856 09	
Sundry bills paid under this contract,	1,000 00		1,000 00	
The H. Gore Co., surfacing highways, West Boylston, Sect. 2,	467 91		8,526 58	
Sundry bills paid under this contract,	1,263 90		1,263 90	
Amounts carried forward,	$3,730 63	$51,185 34	$2,696,954 43	$2,416,502 88

General Character of Expenditures.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Amounts brought forward, . . .	$3,730 63	$51,185 34	$2,696,954 43	$2,416,502 88
Construction — Con.				
Contracts, Wachusett Reservoir — *Con.*				
Newell & Snowling Construction Co., excavating soil from Sect. 8 and completing westerly portion of North Dike (deducted from final estimate), ...	500 00		500 00	
Bruno, Salomone & Petitti, Sect. 10, Wachusett Reservoir, Boylston and West Boylston, ...	26,027 24		543,680 45	
McArthur Bros. Co., building Sect. 2 of the relocation of Central Massachusetts Railroad, ...	13,920 00		286,209 39	
Francis A. McCauliff, masonry arch bridge at West Boylston, ...	1,576 56		12,809 65	
McBride & Co., Stillwater improvement, .	-		23,314 67	
Sundry bills paid under this contract, .	296 40		3,459 45	
John F. Magee & Co., South Dike, . .	720 00		138,608 54	
Sundry bills paid under this contract, .	780 00		780 00	
McArthur Bros. Co., riprap at South Dike,	-		15,385 24	
McArthur Bros. Co., Wachusett Dam, .	46,465 99		1,605,855 73	
Francis A. McCauliff, granite posts, curbing and edgestones, Wachusett Dam, . .	1,700 00		1,700 00	
Henry Parsons & Son, steel gates and fencing for Wachusett Dam, ...	1,349 00		1,349 00	
J. H. McCafferty & Co., brass railing for Wachusett Dam, ...	4,185 00		4,185 00	
Simpson Bros. Corp., reinforced granolithic surface on Wachusett Dam, . . .	2,452 72		2,452 72	
		103,703 54		5,337,244 27
Contracts improving Wachusett Watershed: —				
A. McKenzie & Co., Sterling filter-beds, .		8,490 09		8,490 09
Contracts completed, Wachusett Aqueduct, .	-			1,447,208 55
Contracts completed, Sudbury Reservoir, .	-			1,545,028 33
Contracts completed, protection Sudbury Supply: —				
City of Marlborough, main sewer, . .	-			9,000 00
Contracts completed, improving Lake Cochituate, ...	-			60,657 45
Contracts completed, protection Cochituate Supply: —				
Town of Framingham, low-level sewer, .	-			9,000 00
Contracts completed, Rosemary siphon, . .	-			5,916 96
Contracts completed, pipe line, Dam No. 3 to Dam No. 1, ...	-			17,240 22
Contracts completed, Clinton sewerage system, ...	-			66,878 22
Contracts, Weston Aqueduct: —				
Contracts completed and final payments made prior to January 1, 1906, . . .	-		$1,781,564 31	
Amounts carried forward, ...	-	$163,378 97	$1,781,564 31	$10,923,166 97

General Character of Expenditures.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Amounts brought forward, . . .	–	$163,378 97	$1,781,564 31	$10,923,166 97
Construction — Con.				
Contracts, Weston Aqueduct — *Con.*				
Shanahan, Casparis & Co., . . Sect. 2,	–		201,827 74	
Sundry bills paid under this contract, .	–		2,911 80	
Shanahan, Casparis & Co., . . Sect. 3,	–		126,420 70	
Sundry bills paid under this contract, .	–		4,214 78	
Shanahan, Casparis & Co., . . Sect. 6,	–		108,933 26	
Sundry bills paid under this contract, .	$45 00		7,013 05	
Shanahan, Casparis & Co., . . Sect. 12,	–		138,151 78	
Sundry bills paid under this contract, .	–		3,339 77	
		45 00		2,374,377 19
Contracts, Distribution System: —				
Contracts completed and final payments made prior to January 1, 1906, . . .	–		$4,385,494 64	
C. A. Dodge & Co., Arlington pumping station, ...	$11,190 44		11,190 44	
R. D. Wood & Co, special castings, . .	421 99		2,279 27	
		11,612 43	$4,398,964 35	
Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900, . . .	–		3,139 77	
				4,395,824 58
Additional work: —				
Labor, ...	$36,990 18		$690,780 01	
Professional services, medical services, analyses, etc., ...	20 00		1,819 01	
Travelling, ...	105 60		2,532 82	
Rent, ...	–		3,556 73	
Water rates, ...	14 80		1,454 77	
Freight and express, ...	553 34		12,650 99	
Jobbing and repairing, ...	204 19		9,619 15	
Tools, machinery, appliances, and hardware supplies, ...	872 68		73,112 10	
Electrical supplies, ...	–		4,924 68	
Castings, ironwork and metals, . . .	5,745 51		73,565 24	
Iron pipe and valves, ...	1,981 50		57,918 61	
Blasting supplies, ...	23 40		1,362 88	
Paint and coating, ...	115 75		4,314 68	
Fuel, oil and waste, ...	81 02		10,464 11	
Lumber and field buildings, ...	2,498 02		84,242 42	
Drain pipe, ...	163 03		9,087 31	
Brick, cement and stone, ...	1,157 61		25,161 42	
Sand, gravel and filling, ...	104 25		6,857 81	
Municipal and corporation work, . . .	–		208,166 67	
Police service, ...	505 00		210,801 74	
Sanitary inspection, ...	483 84		13,010 09	
Judgments and settlements for damages, .	4,280 80		46,763 86	
Unclassified supplies, ...	803 93		16,107 29	
Miscellaneous expenses, ...	1,357 26		4,443 09	
		58,056 21		1,572,717 48
Amounts carried forward, ...	. . .	$233,092 61		$19,266,086 22

General Character of Expenditures.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Amounts brought forward,		$233,092 61		$19,266,086 22
Construction — Con.				
Legal and expert:—				
Legal services,	–		$4,668 82	
Expert services,	–		1,862 66	
Court expenses,	$258 16		1,167 20	
Miscellaneous expenses,	–		171 05	
		258 16		7,869 73
Real Estate.				
Legal and expert:—				
Legal services,	–		$4,736 31	
Conveyancer and assistants,	$3,053 00		107,172 97	
Experts,	–		17,871 58	
Appraisers,	196 39		22,157 75	
Court expenses,	507 13		10,330 43	
Counsel expenses,	–		43 25	
Conveyancing supplies,	5 50		3,161 03	
Conveyancing expenses,	58 26		5,852 60	
Miscellaneous expenses,	–		4,195 81	
Settlements made by Board,	72,528 00		3,362,598 84	
Judgments,	7,341 17		166,441 75	
Taxes and tax equivalents,	–		68,182 41	
Care and disposal,	6,140 52		80,752 65	
		89,829 97		3,853,497 38
Damages to Real Estate not taken, to Business and on Account of Loss of Wages.				
Legal and expert:—				
Legal services,	–		$1,130 67	
Expert services,	–		1,635 08	
Court expenses,	$925 00		12,495 29	
Settlements,	4,180 00		401,445 32	
Judgments,	6,194 02		103,196 20	
		11,299 02		519,902 56
Claims on Account of Diversion of Water.				
Legal and expert:—				
Legal services,	–		$3,774 98	
Expert services,	–		19,339 69	
Court expenses,	$966 80		20,072 49	
Miscellaneous expenses,	57 00		1,279 68	
Settlements,	–		917,350 00	
Judgments,	–		218,358 91	
		1,023 80		1,180,175 70
Purchase of Existing Water Works.				
Legal and expert:—				
Legal services,	–		$1,878 89	
Expert services,	–		13,569 82	
Court expenses,	$2,500 00		29,728 38	
Miscellaneous expenses,	–		1,470 94	
Settlements and judgments,	896,659 23		15,227,100 01	
		899,159 23		15,273,748 04
Relocation Central Massachusetts Railroad.				
Settlements,		–		177,597 39
Total amount of construction expenditures,		$1,234,662 79		$40,278,877 02

General Character of Expenditures.		For the Year ending December 31, 1906.
Maintenance and Operation of Works.		
Administration:—		
Commissioners,	$4,666 66	
Secretary, auditor and assistants,	4,011 67	
Postage, printing, stationery and other supplies,	1,160 48	
Travelling,	322 20	
Telephone, heating, lighting and care of building,	443 15	
Alterations and repairs of building,	15 45	
Rent and taxes, office building,	424 74	
Miscellaneous expenses,	285 01	
		$11,329 36
Supervision and general superintendence:—		
Chief engineer and department engineers,	$7,605 75	
Engineering and clerical assistants,	8,066 38	
Postage, printing, stationery and office supplies,	769 23	
Telephone, heating, lighting and care of offices,	1,327 39	
Travelling and incidental expenses,	778 60	
Alterations and repairs of buildings,	663 24	
Rent and taxes, main office,	1,274 28	
Miscellaneous expenses,	407 13	
		20,892 00
Pumping service:—		
Labor,	$50,866 56	
Fuel,	49,002 85	
Oil, waste and packing,	1,144 50	
Repairs and renewals,	4,300 01	
Small supplies and expenses,	1,972 61	
Rent, West Roxbury pumping station,	773 04	
		108,059 57
Superintendents and assistant superintendents,	$3,809 81	
Engineering assistants,	11,508 05	
Laboratory force,	2,264 62	
Sanitary inspectors,	3,336 50	
Recording and scientific instruments and supplies,	430 28	
Labor and teaming,	113,812 43	
Tools, machinery and appliances,	1,496 45	
Lumber and hardware supplies,	3,897 76	
Jobbing and repairing,	2,256 15	
Travelling,	3,182 97	
Horses, vehicles and stable expenses,	5,708 15	
Fuel, lighting and telephone,	4,753 28	
Municipal and corporation work,	93 09	
Unclassified supplies,	6,805 02	
Miscellaneous expenses,	4,857 25	
Conveyancer and assistants,	30 00	
Taxes and tax equivalents,	44,714 23	
Contracts and agreements,	1,282 45	
Contracts for pipes, valves, etc., bought from construction work since January 1, 1906,	240 81	
Clinton award, chapter 498, Acts of 1906,	64,988 00	
		279,467 30
Total expenditures for maintenance and operation,		$419,748 23

(b) Receipts.

The total amount of receipts from rents, sales of property, etc., for the year beginning January 1, 1906, and ending December 31, 1906, is $38,085.85; and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1906, is $500,306.21. The general character of these receipts is as follows: —

General Character of Receipts.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
For distribution back to District: —				
District entrance fees,	-		$92,265 00	
Supplying water outside of District,	$5,796 19		90,675 78	
Water furnished to water companies,	-	$5,796 19	37,145 88	$220,086 66
To the credit of the loan fund: —				
Real estate and buildings,	$5,988 81		$33,641 46	
Labor, tools, supplies and reimbursements,	18,607 10	24,595 91	114,719 95	148,361 41
To the credit of the sinking fund: —				
Forfeiture for contracts awarded but not executed,	-		$500 00	
Rents,	$2,179 48		88,325 61	
Land products,	5,308 51		40,493 95	
Unclassified receipts and interest,	205 76	7,693 75	2,538 58	131,858 14
Total receipts,		$38,085 85		$500,306 21

The foregoing receipts have been credited to the various objects or works, as follows: —

Receipts from Different Works.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Distribution back to District: —				
Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton and Lexington),	-		$92,265 00	
Supplying water to cities and towns outside of Water District (Swampscott, Revere, Lexington, Wakefield, Cambridge and U. S. Government),	$5,796 19		90,675 78	
Water furnished to water companies,	-	$5,796 19	37,145 88	$220,086 66
Amounts carried forward,		$5,796 19		$220,086 66

Receipts from Different Works.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Amounts brought forward,		$5,796 19		$220,086 66
Construction and acquisition of works: —				
Administration,	–		$42 15	
Wachusett Dam,	$724 57		5,624 88	
Wachusett Reservoir,	12,095 43		133,133 28	
Wachusett Aqueduct,	–		5,204 70	
Weston Aqueduct,	115 66		4,863 13	
Sudbury Reservoir and watershed,	458 16		7,735 42	
Distribution system,	3,284 73		65,039 15	
Diversion of water, Clinton sewerage system,	–		1,277 94	
Purchase of existing water works,	6,783 36		17,353 63	
		23,461 91		240,274 28
Maintenance and operation of works: —				
Wachusett Aqueduct,	$280 51		$3,750 87	
Wachusett Reservoir,	4,223 85		14,522 14	
Sudbury system,	2,513 58		10,010 89	
Distribution system,	1,296 48		8,470 93	
Clinton sewerage system,	513 33		3,190 44	
		8,827 75		39,945 27
Total receipts,		$38,085 85		$500,306 21

(*c*) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

(*d*) *Liabilities.*

There are liabilities as follows: —

Current bills unpaid,	$8,319 87
Due on monthly pay rolls,	1,998 94
	$10,318 81

Amounts reserved on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

Name.	Work.	Amount.
C. A. Dodge & Co.,	Arlington pumping station,	$1,974 78
A. McKenzie & Co.,	Sterling filter-beds,	1,233 54
		$3,208 32

Amounts have been agreed upon in the following cases, but the deeds have not yet passed: —

Martha E. Prescott, estate of, $425; Charles F. C. Henderson, $800; West Boylston, town of, $3,100.

On the claims of the following it is impossible to state the amounts due for land damages, water rights and claims for damages to established business, as no sums have been agreed upon, and suits are now pending in the court for the determination of most of them: —

Eliza M. Childs *et al.*, Charles J. Paine, Benjamin H. Clemmons, Edward Dooley, Charles C. Landy, Alfred N. Whiting, Houghton Bros., Robert Johnson, John F. O'Brien, Patrick Bradley, Thomas H. Burgess, Margaret F. Tonry, Lucy A. Wood, Joseph O. Bullard *et al.*, Elwin I. Chase, Alzina A. Wilson, Henry F. Keyes, Robert C. Houghton *et al.*, John Burns, Patrick Daly, Rebecca T. Farr, Annie L. Gibbons, Francis Gibbons, John Gibbons, Henry Wilson Co-operative Bank, Mary J. Hensby, William E. Keating, Millard E. Lewis, Middlesex Fells Springs Company, Lillian F. Pullen *et al.*, William E. Sprague, James E. Welch, Caroline E. Tyson, John E. Stone, Bridget M. Joyce, Israel L. Barnes *et al.*, William L. Bancroft, George H. Chase, Andrew L. Nourse, Byron D. Allen, J. Frank Wood *et al.*, Jennie L. Goodnow, Asa Knight, Worcester County Truant School, James H. Atherton, J. Quincy Dix, John E. Farnsworth, Mary J. Fyfe, estate of William E. Fyfe, Lizzie M. Gray, William B. Haskell, Henry F. Haynes, Sarah G. Haynes, Eben C. Mann, George M. Plummer, Howard D. Stone, Luther Willard, Samuel F. Mason, Edward F. Merriam, Henrietta M. Andrews, James A. Bigelow, First Parish of Boylston, William H. Brigham, John Fitzgerald, estate of Augustus Flagg, Mary J. Hastings, executrix, George R. Hastings, William H. Hastings, Henry J. Hyde, Everett and Oliver S. Kendall, Sanford C. Kendall, William C. Rosenthal, Jennie W. Taylor, administratrix, estate of William H. Vickery, James H. and Hannah S. Wood, Asenath M. Bartlett, estate of Charles I. Longley, estate of Daniel M. Marsh, Henry B. Stone, Francis W. M. Goodale, John S. Ott, McArthur Bros. Company, Helen M. Houghton *et al.*, Sarah Hourty, Clara L. Kingsbury, Willie R. Mitchell, Charles O. Nixon, Margaret Lane, George W. Shattuck, George F. Bond.

CONSTRUCTION OF SEWER TRENCH IN THICKLY SETTLED PART OF MALDEN FOR EXTENSION OF NORTH METROPOLITAN SEWER.

VI. METROPOLITAN SEWERAGE WORKS.

The Metropolitan Sewerage Works are divided into two systems, the North Metropolitan System and the South Metropolitan System. No change has been made in the territory contributing to these systems during the past year.

The North Metropolitan System provides for the district situated largely in the Charles River and Mystic River valleys lying north of the Charles River, and embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville, Woburn and parts of Boston, and the towns of Arlington, Belmont, Revere, Stoneham, Wakefield, Winchester, Winthrop and part of Lexington, 9 cities and 8 towns. The district has an area of 90.50 square miles. It has an estimated population, as of December 31, 1906, based upon the census of 1905, of 488,663; and it is estimated that of this number 386,343, or 79.1 per cent., contribute sewage to the North Metropolitan System.

The South Metropolitan System provides for the areas situated in the Charles River valley lying south of the Charles River, a small portion of the valley north of the Charles River, and also a portion of the Neponset River valley, and embraces the cities of Newton, Quincy, Waltham and portions of Boston, and the towns of Brookline, Hyde Park, Milton, Watertown and part of Dedham, — 4 cities and 5 towns. This district has an area of 100.87 square miles. It has an estimated population, as of December 31, 1906, of 312,380, of which number it is estimated that 167,070, or 53.5 per cent., contribute sewage to the South Metropolitan System.

(1) North Metropolitan Sewerage System — Construction.

By chapter 319 of the Acts of the Legislature of the year 1906, the Board was authorized to extend the North Metropolitan System by the construction of a main sewer from a point near the centre of the city of Malden, near what is known as Barrett's Pond, to the tidal meadows on the southerly borders of the city, where an efficient overflow into the waters of the Malden River is to be found.

When the town of Wakefield was added to the North Metropolitan System, a new trunk line was built between the boundary of that town and the city of Melrose to the centre of the city of Malden; but from this point the original Metropolitan Sewer was estimated to

have a carrying capacity sufficient for both the original line and the new line for a considerable number of years. The time, however, had come when the original Metropolitan Sewer was inadequate to carry away the contents of both sewers.

A contract was made and work was begun for the construction of this sewer in the middle of August, 1906, and the entire work was substantially completed near the end of December. The length of the extension is 2,950.5 feet, and it is built with a diameter varying from about 2.5 feet to 4.5 feet.

Of the entire length of 2,950.5 feet, 608 feet were constructed in private land and 2,342.5 feet through streets and ways.

The expenditures for construction have amounted to $47,369.74, and in addition the damages on account of the taking of real estate have amounted to $2,000. But a small amount of bills or claims remain to be settled.

(2) South Metropolitan System — Construction.

(*a*) *Extension of the High-level Sewer.*

The Board was instructed by chapter 406 of the Acts of the year 1906 to construct an extension of the High-level Sewer from the corner of Centre and Perkins streets in Jamaica Plain through West Roxbury, Brookline and as far as Oak Square in Brighton, substantially as outlined in the Fourth Annual Report made for the year 1904. The Board had submitted in its report for that year a general plan for the construction of the High-level extension from the junction with the sewer already constructed to the point mentioned in Brighton, and thence further into and through the city of Newton to a point near the Charles River at the village of Newton Lower Falls. The instruction of the Legislature was for the building of that portion of the sewer for which the need had already arisen. The Act was passed near the end of May.

The Board at once upon the passage of the Act began the making of detailed plans for the construction of this extension, and for convenience the length of 5.6 miles from West Roxbury to Oak Square in Brighton was divided into sections numbering consecutively from 80 to 86 inclusive. Specifications were also prepared for the building of the portions of the sewer which, as was anticipated, would require the longest periods of time.

The first section, No. 80, in West Roxbury, extending as far as

the Brookline town line, has a length of about 4,500 feet. It was anticipated that the building of this section would be more difficult, because it extends for a part of the distance through quicksands, gravel and clay, and for a portion of the distance is to extend near Jamaica Pond, where the bottom of the tunnel will be about 35 feet below the usual water surface of the pond. It was deemed necessary to carry on the work of building the tunnel by pneumatic processes, and it was accordingly determined to construct this section by day labor, under the immediate direction of a tried expert. Active work was begun at the beginning of October in building a circular shaft 70 feet in depth. After the completion of the shaft the work of tunneling from headings in both directions was begun, and at the end of the year successful progress to the extent of about 134 feet of tunnel had been made.

Near the end of the year bids were asked for the construction of a section to be known as No. 85, which consisted in the building of a tunnel through Commonwealth Avenue and other streets in the Brighton district, to be constructed largely in rock excavation. The bids offered for the construction of this part of the sewer were so largely in excess of the estimates of cost made by the Engineer that it was finally determined to proceed in the construction of a portion of the section by day labor. At the end of the year preparations were in progress for the immediate beginning of the work.

(*b*) *Connection with Portion of Charles River Valley Sewer.*

At the date of the last report a small portion of the Charles River valley sewer, below the point in Vancouver Street where this sewer was connected with the Ward Street pumping station, and extending for a distance of about 1,800 feet to Gainsborough Street, was, by arrangement with the city of Boston, still connected with the Boston Main Drainage Works. The work of changing the grade of this portion of the old sewer, so that the sewage would be made to run in the opposite direction to the Ward Street station and thence be disposed of in the High-level Sewer, was in progress. This work was completed in March of the past year, and thereafter all the sewage from the areas in the city of Boston tributary to this portion was diverted and disposed of in the High-level Sewer. All the necessary work was performed by men belonging to the regular maintenance force.

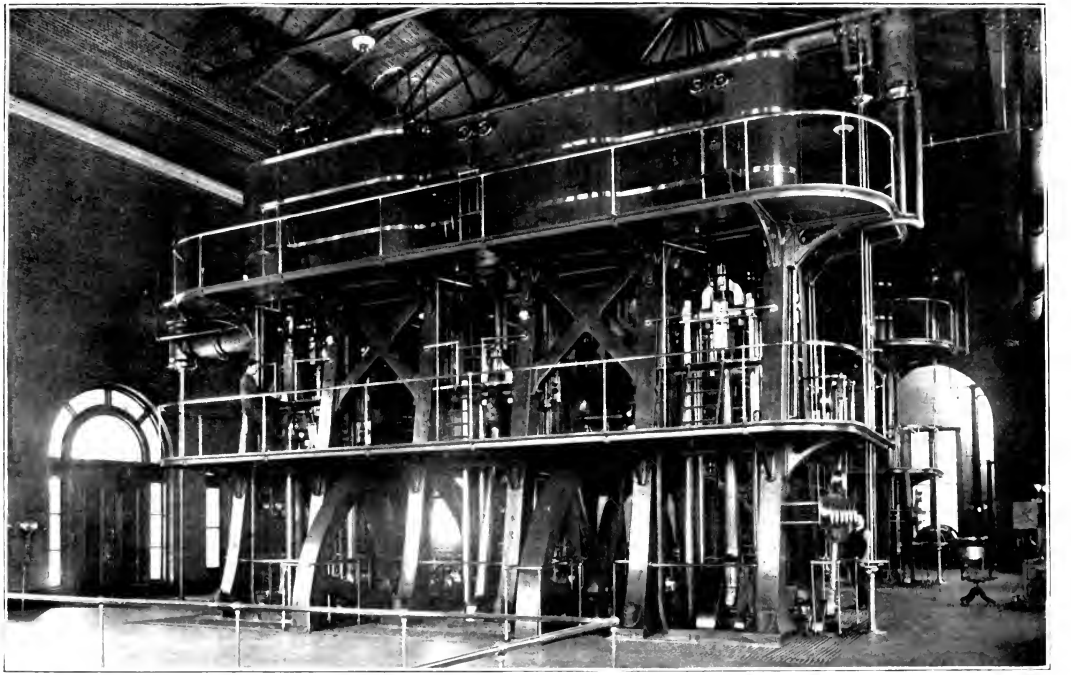
(c) *Ward Street Pumping Station.*

The two pumping engines for raising the sewage from the Charles River valley sewerage district to the High-level Sewer had been previously installed in the pumping station, and had been for a considerable period in operation prior to the past year. Some modifications, however, in order to bring them to the contract requirements, had been in progress, and consequently the final test of the engines had not been made. By the requirements of the contract the engines were to have a capacity each for pumping 50,000,000 gallons of sewage per day, raising the sewage about 40 feet. The various changes were completed in the latter part of the year, the final tests were made successfully, and both engines were accepted. The engines are of the vertical triple expansion type with pump plungers directly under the steam cylinders, were especially designed for pumping sewage, and were furnished by the Allis-Chalmers Company of Milwaukee, Wis. The total cost was $204,000.

During the year granolithic walks have been built around and in the pumping station lot, and fences have been erected along Ward Street and Vancouver Street and upon the north side of the lot. The laying of the walks and the building of the fences have been performed from time to time by the day-labor men upon the maintenance force at times when they could be conveniently withdrawn from regular maintenance work.

(d) *Quincy Pumping Station.*

The ordinary flow of sewage at the Quincy pumping station had so increased as to exceed the capacity of the smaller of the two pumps in use, and during the wet weather the flow had exceeded for considerable periods the capacity of both the pumps. It was therefore necessary to obtain, both in order to provide for the exigency in ordinary periods and also to prevent overflow in wet weather, an additional pumping plant. A centrifugal pump was purchased from the Lawrence Machine Company of Lawrence, Mass., and was installed with a compound Sturtevant engine, both pump and engine being of a standard type. Two additional boilers have also been introduced. The pump, engine and boilers have all been put in place, and it is anticipated that the new plant will be completed so as to be put into operation in the coming spring.



INTERIOR OF BACK BAY SEWERAGE PUMPING STATION with PUMPING ENGINES.

(3) Acquisition of Lands and Settlements for Lands Acquired.

During the year there have been made 4 takings of land and easements, 3 of which were for the purposes of the extension of the High-level Sewer in West Roxbury and Brighton, and 1 for the purposes of the extension of the North Metropolitan Sewer in Malden. These takings embrace 0.018 of an acre in fee, temporary rights in 0.25 of an acre and easements in 20.432 acres, of which 3.48 acres were in public streets.

The following is a list of the takings: —

List of Takings for Metropolitan Sewerage Works for the Year 1906.

No.	Location and Description.	Former Owners.	Recorded.	Purpose of Taking.
12	Malden (from a short distance north of Waverly Street, southerly through Linden Avenue, Pleasant Street and private lands to North Metropolitan Sewer, about 500 feet south of Charles Street). Area, 0.018 of an acre in fee and easements in 2.136 acres.	Alonzo A. West and others, and streets.	1906, Aug. 11.	Section 64, Malden extension, North Metropolitan System.
13	Jamaica Plain (from the westerly end of strip in which easements were taken for the Metropolitan Sewer in Perkins Street, a short distance west of Centre Street, westerly through Perkins Street and Chestnut Street to the Brookline boundary line). Area, easements in 3.48 acres.	Public streets.	Sept. 6.	Section 80, extension of High-level Sewer, South Metropolitan System.
14	Jamaica Plain (on northerly side of Perkins Street, between South Huntington Avenue and Jamaicaway). Area, temporary rights in 0.25 of an acre.	Edward J. Donovan *et al.*, trustees.	Sept. 24.	Section 80, extension of High-level Sewer, South Metropolitan System.
15	Brighton (from Brookline line, through Harlan Street, Commonwealth Avenue, Warren Street, Cambridge Street and Washington Street, to head of Lake Street). Area, easements in 14.816 acres.	Trustees of Crescent Land Company, devisees of Otis Shepard, and public streets.	Dec. 29.	Part of Section 84 and Section 85, High-level Sewer, South Metropolitan System.

Since January 1, 1906, settlements have been effected on account of the takings made in the North Metropolitan District in 2 cases, involving a payment of $2,000; and in cases in the South Metropolitan District 1 settlement has been effected, under which payment has been made amounting to $4,589.66.

Of the 3 sewerage settlements, 2 were on account of the sewer extension to Malden and 1 on account of the Neponset valley sewer in the city of Boston, West Roxbury District.

Summary of Land Settlements for the Year 1906.

Location.	Area in Acres.	Number of Settlements.	Payments.
North Metropolitan District.			
Malden,	0.218	2	$2,000 00
South Metropolitan District.			
Boston, West Roxbury District,	0.506	1	4,589 66
Aggregate,	0.724	3	$6,589 66

(4) North Metropolitan System — Maintenance.

There are maintained in the North Metropolitan System 58.566 miles of main sewers, with which are connected 593.88 miles of local sewers, the number of connections, public and special, with the North Metropolitan System being 620.

The East Boston and Charlestown districts of Boston and the cities of Everett, Cambridge, Somerville and Chelsea still maintain both separate and combined sewers, and no decided gain seems to have been made in any of these municipalities during the year towards the further separation of sewers. All of the other municipalities in the North Metropolitan System maintain separate sewers.

The four pumping stations maintained for this system are the Alewife Brook pumping station at Somerville, the East Boston pumping station, the Charlestown pumping station and the Deer Island pumping station.

There have been pumped at the Alewife Brook pumping station 3,451,000 gallons of sewage per day, with an average lift of 13.08 feet, at a cost of $0.326 per million gallons per foot lifted; at the Charlestown station 30,500,000 gallons per day, 8.26 feet lift, at a cost of $0.142 per million gallons per foot lifted; at the East Boston station 56,100,000 gallons per day, 16.59 feet lift, at a cost of $0.064 per million gallons per foot lifted; and at the Deer Island station 58,100,000 gallons per day, 10.66 feet lift, at a cost of $0.089 per million gallons lifted. The cost of pumping per million gallons, notwithstanding the increased cost of labor, has remained about the same as last year, this cost having been slightly increased in two of the stations and decreased in the remaining two stations.

There has been a decided increase in the amount of sewage pumped in the different stations. The total quantity of sewage discharged at the outlet in Boston harbor, which is represented by the number of gallons of sewage pumped at the Deer Island station, was 58,100,000 gallons per day, which is 3,700,000 gallons in excess of the discharge at the outlet the preceding year.

The amount of sewage discharged in the North Metropolitan District averaged 150 gallons per day for each person, taking the estimated population of the District contributing sewage. Owing, however, to the fact that many of the sewers are combined sewers, this amount represents a considerable quantity of rain water received in the sewers, and would be considerably decreased if all the local sewers were separate sewers, that is, restricted to the admission of sewage proper only.

During the year 5 public and 32 special connections with local sewers have been made, — a total addition of 20.31 miles of connecting sewers.

The salt-water pipes laid from the East Boston pumping station upon the muddy bed of the Chelsea Creek for the purpose of supplying the condensers of the station had been constantly covered with silt from the changing character of the bed, and frequent removal of the silt had caused constant expense. It was consequently determined to lay a large pipe upon pile supports over the bed of the creek, to the channel where the mouth of the pipe is carried, so low as to remain submerged under all conditions.

Although the extension of the main sewer, which receives the sewage of the town of Wakefield, from a point near the centre of the city of Malden to tide water, has been completed, this extension had not been put into operation at the end of the year.

The cost of maintenance of the North Metropolitan System during the past year was $115,196.33, which is slightly less than the cost of maintenance for the preceding year.

(5) South Metropolitan System — Maintenance.

In the South Metropolitan System there are maintained 38.178 miles of main sewers, with which are connected 468.18 miles of local sewers having 106 connections with the Metropolitan System.

The Back Bay, Brighton and Dorchester districts of Boston and the towns of Brookline and Milton still maintain both separate and

combined sewers. All the other districts contributory to this system maintain separate sewers.

The Ward Street pumping station, the Quincy pumping station and the screen-house at Nut Island are maintained for the disposal of sewage for this system.

The Ward Street pumping station has been in regular operation during the entire year, although the pumping engines had not been finally accepted from the contractors until near the end of the year.

There have been pumped at the Ward Street station an average of 24,500,000 gallons per day, with an average lift of 40.65 feet, at a cost of $0.068 per million gallons per foot lifted; and at the Quincy station 3,528,000 gallons, 21.25 feet lift, at an average cost of $0.226 per million gallons per foot lifted.

An average of 33,600,000 gallons of sewage has passed daily through the screens at the Nut Island screen-house, and has been discharged from the outfalls into the outer harbor. The maximum discharge per day, which occurred during a heavy storm, was 97,000,000 gallons. The discharge of sewage through the outfalls represents the amount of sewage contributed in the South Metropolitan System, which was at the rate of 201 gallons per day per person of the estimated number contributing sewage in the District. The daily discharge of sewage per capita is considerably larger in the South Metropolitan District than it is in the North Metropolitan District, because, owing to the large size of the High-level Sewer, more storm water is admitted at periods of heavy rainfall.

An additional pumping engine has been obtained for the Quincy station and will be put into operation at the beginning of the year, so that the station will soon be relieved from the troubles which have occurred particularly in periods of unusual rainfalls.

Subsequent to the month of March, when the necessary changes had been completed by which the sewage from the Huntington Avenue section of the Charles River valley sewer was raised into the High-level Sewer, the entire Charles River valley sewage has been disposed of by the Metropolitan Works, so that thereafter no further rental on this account was payable to the city of Boston for the disposal of sewage. A small area in the district of Dorchester and town of Milton, which is so low that its sewage cannot be carried into the High-level Sewer except by pumping, still disposes

of its sewage through the Boston Main Drainage Works, and for this a rental is paid to the city of Boston.

The strong tidal currents were found to have caused considerable wearing away of the clay filling of the pipe trenches of the great outfall pipes of the High-level Sewer laid in the harbor off Nut Island. Accordingly it was deemed necessary to lay about 170 cubic yards of small riprap over the pipes in place of the clay washed away. This work was done by a diving contractor. No deposit of the sewage discharge was found remaining about the outlet of the pipes, and for a considerable distance the pipes were entered and found in good condition.

The expenditures for maintenance of the South Metropolitan System for the past year were $82,190.61.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the eleven months of the fiscal year of the Commonwealth ending with the thirtieth day of November, 1906, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is printed as Appendix No. 5.

The following detailed statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1906, is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan sewerage loans for the construction of the Sewerage Works of the North Metropolitan System have amounted to $6,160,865.73, to which are added receipts from various sources amounting to $17,153.40. The amount of expenditures approved by the Board for payment for the year 1906 was $47,369.74, and the total amount of expenditures approved to January 1, 1907, was $6,136,200.30. The balance on hand January 1, 1907, was $41,818.83.

The loans for the construction of the various parts of the South Metropolitan System have amounted to $8,867,046.27. The receipts applicable to the loan fund have been $6,878.47. The amount of

expenditures approved for payment in the year 1906 was $98,730.49. The total amount of expenditures approved for payment from the beginning of the works has been $7,722,773.15. The balance on hand for the South Metropolitan System on January 1, 1907, was $1,151,151.59.

The bonds issued on account of the loans have been for varying periods, not exceeding forty years, and bear interest at the rate of 3 per cent. and 3½ per cent. The premiums received on account of the sale of bonds on the North Metropolitan System have amounted to $175,518.65, and those received on account of the South Metropolitan System have amounted to $394,133.13.

The amount expended for maintenance of the North Metropolitan System in the year 1906 was $115,196.33, and for the South Metropolitan System $82,190.61, a total for both systems of $197,386.94.

The assessments made to meet interest, sinking fund requirements, and maintenance and operation of the North Metropolitan System amounted in the year 1906 to $355,538.73, and the assessments for the South Metropolitan System amounted to $397,322.44.

The following is a detailed financial statement regarding the Metropolitan Sewerage Works: —

(1) Metropolitan Sewerage Loans, Receipts and Payments.

The loans for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, and the expenditures for construction, have been as follows: —

(*a*) *North Metropolitan System.*

Loans under various acts of the Legislature (given in detail in report for the year 1901),	$5,605,865	73
Loans under chapters 242, 336 and 399, Acts of 1903,	500,000	00
Loan under chapter 319, Acts of 1906,	55,000	00
Proceeds from sales of property and from other sources to December 31, 1906,	17,153	40
	$6,178,019	13
Amount approved by the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board for payment to December 31, 1906 (of which $47,369.74 is for the year 1906),	6,136,200	30
Balance, North Metropolitan System, January 1, 1907,	$41,818	83

(*b*) *South Metropolitan System.*

Loans under the Acts of the years 1889 and 1900 (Charles River Valley Sewer),	$800,046 27
Loans under various acts of the Legislature (given in detail in report for the year 1901, Neponset River Valley Sewer),	900,000 00
Loan under chapter 315 of the Acts of 1903 (Neponset River Valley Sewer),	4,000 00
Loan under chapter 424 of the Acts of 1899,	4,600,000 00
Loan under chapter 356 of the Acts of 1903,	996,000 00
Loans under chapters 230 and 246 of the Acts of 1904,	392,000 00
Loan under chapter 406 of the Acts of 1906,	1,175,000 00
Proceeds from sales of property and other sources to December 31, 1906 (of which $256.20 is for the year 1906),	6,878 47
	$8,873,924 74
Amount approved by the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board for payment to December 31, 1906 (of which $98,730.49 is for the year 1906),	7,722,773 15
Balance, South Metropolitan System, January 1, 1907,	$1,151,151 59

(2) Issues of Metropolitan Sewerage Loan Bonds.

The Treasurer of the Commonwealth, under the authority of the successive statutes, has from time to time issued bonds designated "Metropolitan Sewerage Loan," as follows: —

Metropolitan Sewer Loans, North System.

Bonds issued.

Date of Sale.	Amount of Bonds sold.	Rate of Interest (per cent.).	Price received.	Date due.	Premium.
Apr. 2, 1890,	$500,000	3	102.40	Jan. 1, 1930,	$12,000 00
Apr. 2, 1890,	500,000	3	103.02	Jan. 1, 1930,	15,100 00
Apr. 2, 1890,	500,000	3	103.62	Jan. 1, 1930,	18,100 00
Apr. 2, 1890,	500,000	3	102.327	Jan. 1, 1930,	11,635 00
Apr., 1890,	200,000	3	103.	Jan. 1, 1930,	6,000 00
Feb., 1891,	50,000	3	104.	Jan. 1, 1930,	
Mar., 1891,	300,000	3	104.	Jan. 1, 1930,	35,130 30[1]
Mar., 1891,	18,000	3	104.	Jan. 1, 1930,	
Jan., 1892,	35,000	3	100.	Jan. 1, 1930,	-
Feb., 1892,	29,000	3	100.	Jan. 1, 1930,	-
Mar., 1892,	50,000	3	101.	Jan. 1, 1930,	500 00
June, 1892,	436,000	3	101.50	Jan. 1, 1930,	
July, 1892,	150,000	3	101.50	Jan. 1, 1930,	11,060 00[1]
Aug., 1892,	150,000	3	101.50	Jan. 1, 1930,	

[1] Readjustment of Treasurer.

METROPOLITAN SEWER LOANS, NORTH SYSTEM — *Concluded.*

Bonds issued — Concluded.

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (per cent.).	Price received.	Date due.	Premium.
Nov., 1892,	$3,000	3	100.50	Jan. 1, 1930,	$15 00
Nov., 1892,	200,000	3	100.	Jan. 1, 1930,	-
Jan., 1893,	35,000	3	100.50	Jan. 1, 1930,	175 00
Jan., 1893,	25,000	3	100.50	Jan. 1, 1930,	125 00
Feb., 1893,	20,000	3	101.	Jan. 1, 1930,	200 00
Feb., 1893,	5,000	3	100.50	Jan. 1, 1930,	25 00
Feb., 1893,	400,000	3	100.25	Jan. 1, 1930,	1,000 00
Mar., 1893,	94,000	3	100.25	Jan. 1, 1930,	235 00
May 1, 1894,	464,000	3	100.	Jan. 1, 1930,	-
Oct., 1894,	4,000	3	100.	Jan. 1, 1930,	-
Oct., 1894,	1,000	3	100.	Jan. 1, 1930,	-
Nov., 1894,	15,000	3	100.	Jan. 1, 1930,	-
Nov., 1894,	10,000	3	100.	Jan. 1, 1930,	-
Dec., 1894,	6,000	3	100.	Jan. 1, 1930,	-
Apr., 1895,	300,000	3	100.	Jan. 1, 1930,	-
Dec., 1896,	30,000	3	100.	Jan. 1, 1930,	-
June, 1897,	70,000	3½	106.243	Jan. 1, 1930,	5,084 80[1]
June, 1897,	10,000	3½	106.243	Jan. 1, 1930,	
Apr., 1898,	5,000	3	100.	Jan. 1, 1930,	22,843 75[1]
June, 1898,	155,000	3½	100.	Jan. 1, 1930,	
June, 1898,	60,000	3½	100.	Jan. 1, 1930,	
Apr., 1900,	265,000	3	103.948	Jan. 1, 1930,	10,462 20
May, 1903,	200,000	3½	104.9797	Jan. 1, 1930,	9,959 40
May, 1903,	50,000	3½	106.2424	Jan. 1, 1943,	3,121 20
July, 1903,	250,000	3½	104.419	July 1, 1943,	11,047 50
June, 1906,	55,000	3½	103.09	July 1, 1943,	1,699 50
	$6,150,000				$175,518 65

[1] Readjustment of Treasurer.

METROPOLITAN SEWER LOANS, SOUTH SYSTEM.

Bonds issued.

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (per cent.).	Price received.	Date due.	Premium.
Apr., 1890,	$100,000	3	103.	Jan. 1, 1930,	$3,000 00
Apr., 1890,	400,000	3	103.	Jan. 1, 1930,	12,000 00
May, 1890,	300,000	3	104.	Jan. 1, 1930,	12,000 00
Aug., 1895,	300,000	3	100.585	Mar. 1, 1935,	1,755 00
Feb., 1896,	50,000	3	100.	Mar. 1, 1935,	-
Dec., 1896,	135,000	3	100.	Mar. 1, 1935,	-
Dec , 1896,	15,000	3	100.	Mar. 1, 1935,	-
June, 1897,	300,000	3½	106.98	Mar. 1, 1935,	20,940 00

METROPOLITAN SEWER LOANS, SOUTH SYSTEM — *Concluded.*

Bonds issued — Concluded.

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (per cent.).	Price received.	Date due.	Premium.
June, 1898,	$35,000	3½	100.	Mar. 1, 1935,	$4,088 00[1]
June, 1899,	25,000	3	100.64	Mar. 1, 1936,	160 00
June, 1899,	1,000,000	3	100.64	July 1, 1939,	6,400 00
Sept., 1900,	10,000	3	100.79	July 1, 1939,	79 00
Sept., 1900,	912	3	100.	July 1, 1939,	-
Apr., 1901,	40,000	3	100.915	Mar. 1, 1936,	366 00
Sept., 1901,	2,000,000	3½	106.71	July 1, 1940,	134,200 00
Sept., 1902,	14,000	3	100.	July 1, 1939,	-
Sept., 1902,	500,000	3½	107.243	July 1, 1940,	36,215 00
Sept., 1902,	150,000	3½	107.2395	July 1, 1940,	10,859 25
Dec., 1902,	200,000	3½	107.79	July 1, 1940,	15,580 00
Feb., 1903,	100,000	3½	108.25	July 1, 1940,	8,230 56[1]
Apr., 1903,	100,000	3½	106.75	July 1, 1940,	6,750 00
Apr., 1903,	175,000	3½	106.75	July 1, 1940,	11,812 50
Apr., 1903,	203,000	3½	106.75	July 1, 1940,	13,702 50
Apr., 1903,	25,000	3½	106.494	July 1, 1940,	1,623 50
Apr., 1903,	133,000	3½	105.9364	July 1, 1940,	7,895 42
May, 1903,	996,000	3½	106.2424	Jan. 1, 1943,	62,174 31
May, 1903,	4,000	3½	105.5453	Mar. 1, 1935,	221 81
July, 1904,	392,000	3½	104.929	July 1, 1944,	19,321 68
June, 1906,	154,000	3½	103.09	Jan. 1, 1946,	4,758 60
	$7,856,912				$394,133 13

[1] Readjustment of Treasurer.

(3) METROPOLITAN SEWERAGE LOANS SINKING FUND.

Under authority of chapter 122 of the Acts of 1899, and section 14 of chapter 424 of the Acts of 1899, the Treasurer of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan sewerage loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund. The Board received, during the year, from rentals and from other sources, to be applied to the sinking fund, $75.

The sinking fund established has amounted at the end of each year to sums as follows: —

December 31, 1899,	$361,416 59	December 31, 1903,	$754,690 41
December 31, 1900,	454,520 57	December 31, 1904,	878,557 12
December 31, 1901,	545,668 26	December 31, 1905,	1,008,724 95
December 31, 1902,	636,084 04	December 31, 1906,	1,146,998 68

(4) Annual Appropriations, Receipts and Expenditures.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1906, have been as follows: —

North Metropolitan System.

Balance January 1, 1906,	$32,897 15
Appropriation under chapter 153 of the Acts of 1906,	115,986 50
Receipts from pumping and from other sources,	1,013 43
	$149,897 08
Amount approved by the Board for payment,	115,196 33
Balance January 1, 1907,	$34,700 75

South Metropolitan System.

Balance January 1, 1906,	$139 99
Appropriation under chapter 154 of the Acts of 1906,	87,375 00
Receipts from sales of property, from pumping, and from other sources,	51 50
	$87,566 49
Amount approved by the Board for payment,	82,190 61
Balance January 1, 1907,	$5,375 88

(5) Annual Assessments.

Assessments for the year, amounting to $355,538.73 for the North Metropolitan System and to $397,322.44 for the South Metropolitan System, were required for the payment of interest and sinking fund requirements and the cost of maintenance and operation of works. The requirements for the North Metropolitan System were: for interest, $188,299.64; for the sinking fund, $51,252.59; and for maintenance, $115,986.50. For the South Metropolitan System the requirements were: for interest, $263,281.72; for the sinking fund, $46,665.72; and for maintenance, $87,375. The assessments for the North Metropolitan System were made upon the cities and towns in the District in accordance with chapter 369 of the Acts of the year 1906, and the assessments for the South Metropolitan System were made in accordance with ratios fixed by the Apportionment

Commissioners appointed under the provisions of chapter 424 of the Acts of the year 1899, and were as follows: —

North Metropolitan Sewerage System.

Arlington,	$8,043 51	Somerville,	$49,319 97
Belmont,	4,516 64	Stoneham,	4,404 90
Boston,	61,791 73	Wakefield,	7,140 26
Cambridge,	84,895 57	Winchester,	8,006 97
Chelsea,	22,722 35	Winthrop,	6,519 24
Everett,	18,823 32	Woburn,	9,813 86
Lexington,	3,072 26	Revere,	9,696 13
Malden,	27,531 28		
Medford,	17,018 25	Total,	$355,538 73
Melrose,	12,222 49		

South Metropolitan Sewerage System.

Boston,	$164,563 84	Quincy,	$23,813 99
Brookline,	74,105 67	Waltham,	23,302 26
Dedham,	9,746 91	Watertown,	11,777 86
Hyde Park,	12,673 70		
Milton,	18,965 22	Total,	$397,322 44
Newton,	58,372 99		

(6) Expenditures for the Different Works.

The following is a summary of the expenditures made in the various operations for the different works: —

Construction and Acquisition of Works.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
North Metropolitan System.				
Original system, main line and branches,	–			$5,383,932 67
Lexington branch,	–			68,585 15
Everett branch,	–			54,877 12
Wakefield branch,	–			35,698 29
Stoneham branch,	–			11,574 10
Chelsea and Everett outlets,	–			71,216 41
Belmont extension,	–			57,153 06
Malden extension: —				
Administration,	$2,054 00		$2,054 00	
Section 64,	43,140 14		43,140 14	
Land takings, purchase and recording,	2,164 60		2,164 60	
		$47,358 74		47,358 74
Revere extension,		–		215,722 79
Wakefield branch extension,		11 00		190,081 97
Total North Metropolitan System,		$47,369 74		$6,136,200 30

Construction and Acquisition of Works.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
South Metropolitan System.				
Charles River valley sewer, main line,	–			$800,046 27
Neponset River valley sewer: —				
Main line,	–		$866,595 66	
Brookline branch,	$5,797 66		44,935 80	
		$5,797 66		$911,531 46
High-level Sewer: —				
Administration,	$2,247 01		$51,593 57	
Apportionment commission,	–		2,000 00	
Land takings, purchase and recording,	100 00		355,374 82	
Quincy force main,	15 08		18,351 71	
Quincy pumping station,	2,141 54		2,141 54	
Section 43, Quincy,	–		411,749 22	
Section 44, Quincy,	–		299,543 47	
Section 45, Quincy,	–		76,139 36	
Section 46, Quincy,	–		62,551 26	
Section 47, Quincy,	–		109,786 58	
Section 48, Quincy,	–		295,319 29	
Sections 48 and 49, embankments, Quincy,	–		81,548 64	
Section 49, Quincy,	–		169,020 18	
Section 50, Quincy,	–		109,570 35	
Section 51, Quincy,	–		87,203 68	
Section 52, Quincy,	–		155,800 65	
Section 53, Quincy,	–		98,042 42	
Section 54, Quincy,	–		101,918 39	
Section 55, Milton and Quincy,	–		305,816 90	
Section 56, Milton,	–		105,736 94	
Section 57, Milton,	–		68,783 24	
Section 58, Milton,	–		94,089 72	
Section 59, Milton,	–		104,444 62	
Section 60, Milton,	–		60,796 13	
Section 61, Milton,	–		129,598 76	
Section 62, Milton,	–		129,612 28	
Section 63, Milton,	–		127,142 45	
Section 64, Neponset River crossing,	–		47,554 40	
Section 65, Hyde Park,	–		41,333 37	
Section 66, Hyde Park,	–		253,902 72	
Section 67, Hyde Park, Stony Brook crossing,	–		32,298 33	
Section 68, Hyde Park and Roxbury,	–		78,493 62	
Section 69, West Roxbury,	–		102,143 68	
Section 70, West Roxbury,	–		131,375 55	
Section 71, West Roxbury,	–		91,888 22	
Section 72, West Roxbury,	–		127,956 76	
Section 73, West Roxbury,	–		494,290 42	
Section 74, West Roxbury and Roxbury,	–		147,296 69	
Section 75, Roxbury,	–		137,192 99	
Section 76, Roxbury, cast-iron force main,	62 75		80,342 26	
Section 77, Roxbury, Ward Street pumping station,	52,519 15		555,258 47	
Section 78, Roxbury, connecting sewer,	–		35,994 69	
Reversion of grade, Huntington Avenue,	6,047 49		6,503 56	
		63,133 02		5,977,501 90
Amounts carried forward,		$68,930 68		$7,689,079 63

Construction and Acquisition of Works.	For the Year ending December 31, 1906.		From Beginning of Work to December 31, 1906.	
Amounts brought forward, ...	. . .	$68,930 68		$7,689,079 63
South Metropolitan System—Con.				
High-level extension:—				
Charles River valley studies, ...	–		$3,893 71	
Entire line, ...	$11,326 37		11,326 37	
Section 80 (in part), West Roxbury, . .	18,252 60		18,252 60	
Section 85, Brighton, ...	220 84		220 84	
		29,799 81		33,693 52
Total for South Metropolitan System, .	. . .	$98,730 49		$7,722,773 15
Total for construction for both systems, .	. . .	$146,100 23		$13,858,973 45

Maintenance.	For the Year ending December 31, 1906.	From Beginning of Work to December 31, 1906.
North Metropolitan System, ...	$115,196 33	$1,127,975 80
South Metropolitan System, ...	82,190 61	1,018,546 94
Total for maintenance, both systems, ...	$197,386 94	$2,146,522 74

(7) Detailed Financial Statement.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1906:—

(*a*) *Expenditures and Disbursements.*

General Character of Expenditures.	For the Year ending December 31, 1906.	
Construction of Works and Acquisition by Purchase or Taking.		
North Metropolitan System.		
Administration:—		
Secretary, ...	$375 00	
Clerks and stenographers, ...	922 97	
Stationery and printing, ...	148 30	
Telephone, lighting, heating, water and care of building, ...	274 40	
Rent and taxes, main office, ...	333 33	
		$2,054 00
Amount carried forward, ...	. . .	$2,054 00

General Character of Expenditures.			For the Year ending December 31, 1906.
Amount brought forward,			$2,054 00
North Metropolitan System — Con.			
Engineers, inspectors, rodmen, laborers and others,		$4,785 21	
Carriage hire and travelling expenses,		109 40	
Advertising,		49 33	
Office supplies,		18 36	
Books, maps, plans and blue prints,		21 43	
Engineering instruments and repairs of same,		32 75	
Engineering supplies,		9 57	
Tools and repairs of same,		95	
Brick, cement, lumber and other field supplies,		1,939 36	
Teaming and express,		10 50	
Contracts: —			
T. H. Gill & Co., Section 64,		36,126 28	
Land takings, purchase and recording,		2,164 60	
Claims for damages,		48 00	
			45,315 74
Total for North Metropolitan System,			$47,369 74
South Metropolitan System.			
Neponset River Valley Sewer: —			
Brookline branch: —			
Claims and allowances on account of contracts,		$1,200 00	
Land takings, purchase and recording,		4,597 66	
			$5,797 66
High-level Sewer: —			
Administration: —			
Secretary,	$750 00		
Clerks and stenographers,	338 33		
Stationery and printing,	165 84		
Postage, express and telegrams,	35 00		
Telephone, lighting, heating, water and care of building,	624 51		
Rent and taxes, main office,	333 33		
		$2,247 01	
Chief engineer,	$1,250 00		
Engineers, inspectors, rodmen, laborers and others,	20,831 25		
Advertising,	95 88		
Carriage hire and travelling expenses,	203 82		
Office supplies,	48 21		
Postage, telephone and telegrams,	46 89		
Books, maps, plans and blue prints,	89 76		
Engineering instruments and repairs of same,	39 02		
Engineering supplies,	98 76		
Tools and repairs of same,	269 46		
Brick, cement, lumber and other field supplies,	16,252 77		
Teaming and express,	220 00		
Repairs, fittings and supplies, main office,	60 00		
Rent of sub-offices,	80 00		
Contracts: —			
Allis-Chalmers Co., Section 77,	51,000 00		
Land takings, purchase and recording,	100 00		
		90,685 82	
			92,932 83
Total for South Metropolitan System,			$98,730 49

General Character of Expenditures.	For the Year ending December 31, 1906.	
Maintenance and Operation of Works.		
North Metropolitan System.		
Administration:—		
Commissioners, secretary and assistants,	$3,498 34	
Postage, printing, stationery and office supplies,	540 03	
Rent, telephone, heating, lighting and care of offices,	952 12	
Miscellaneous expenses,	150 56	
		$5,141 05
General superintendence:—		
Engineer and assistants,	$7,862 41	
Postage, printing, stationery and office supplies,	671 64	
Rent, telephone, heating, lighting and care of offices,	968 79	
Miscellaneous expenses,	850 25	
		10,353 09
Deer Island pumping station:—		
Labor,	$11,920 13	
Coal,	7,921 89	
Oil and waste,	322 57	
Water,	838 80	
Packing,	172 44	
Repairs and renewals,	1,962 41	
Telephones and office supplies,	178 59	
Miscellaneous supplies and expenses,	1,033 58	
East Boston pumping station:—		
Labor,	11,119 86	
Coal,	9,318 70	
Oil and waste,	311 14	
Water,	1,270 80	
Packing,	109 60	
Repairs and renewals,	866 83	
Telephones and office supplies,	125 46	
Miscellaneous supplies and expenses,	1,023 54	
Charlestown pumping station:—		
Labor,	10,758 05	
Coal,	2,391 32	
Oil and waste,	250 94	
Water,	364 80	
Packing,	107 73	
Repairs and renewals,	498 09	
Telephones and office supplies,	157 70	
Miscellaneous supplies and expenses,	330 50	
Alewife Brook pumping station:—		
Labor,	4,358 44	
Coal,	1,578 45	
Oil and waste,	152 93	
Water,	162 60	
Packing,	56 67	
Repairs and renewals,	153 82	
Telephones and office supplies,	134 20	
Miscellaneous supplies and expenses,	84 60	
		70,037 18
Amount carried forward,		$85,531 32

General Character of Expenditures.		For the Year ending December 31, 1906.
Amount brought forward,		$85,531 32
North Metropolitan System — Con.		
Sewer lines, labor,	$23,009 20	
Supplies and expenses,	2,735 03	
		25,744 23
Horses, vehicles and stable account,		3,920 78
Total,		$115,196 33
South Metropolitan System.		
Administration: —		
Commissioners, secretary and assistants,	$3,508 33	
Postage, printing, stationery and office supplies,	630 75	
Rent, telephone, heating, lighting and care of building,	553 33	
Miscellaneous expenses,	23 30	
		$4,715 71
General superintendence: —		
Engineer and assistants,	$2,853 33	
Postage, printing, stationery and office supplies,	309 21	
Rent, telephone, heating, lighting and care of offices,	643 79	
Miscellaneous expenses,	505 30	
		4,311 63
Ward Street pumping station: —		
Labor,	$14,133 64	
Coal,	6,781 40	
Oil and waste,	865 54	
Water,	1,293 60	
Packing,	747 28	
Repairs and renewals,	23 49	
Telephones and office supplies,	167 92	
Miscellaneous supplies and expenses,	2,114 95	
Quincy pumping station: —		
Labor,	4,799 37	
Coal,	1,647 87	
Oil and waste,	34 27	
Water,	193 56	
Packing,	9 40	
Telephones and office supplies,	39 82	
Miscellaneous supplies and expenses,	552 40	
Nut Island screen-house: —		
Labor,	5,226 97	
Coal,	1,510 00	
Oil and waste,	47 54	
Water,	290 24	
Packing,	11 66	
Repairs and renewals,	22	
Telephones and office supplies,	83 27	
Miscellaneous supplies and expenses,	657 40	
		41,231 81
Sewer lines, labor,	$17,444 10	
Supplies and expenses,	2,423 55	
		19,867 65
City of Boston, for pumping and interest,		9,507 95
Horses, vehicles and stable account,		2,555 86
Total,		$82,190 61

(*b*) *Receipts.*

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

Account.	For Year ending December 31, 1906.	From Beginning of Work to December 31, 1906.
North Metropolitan System, — construction,	–	$17,153 40
South Metropolitan System, — construction,	$256 20	6,878 47
North Metropolitan System, — maintenance,	1,013 43	8,189 96
South Metropolitan System, — maintenance,	51 50	1,078 93
Metropolitan Sewerage Loans Sinking Fund,	75 00	910 20
Totals,	$1,396 13	$34,210 96

(*c*) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate connected therewith.

(*d*) *Liabilities.*

There are liabilities as follows: —

Current bills unpaid,	$20,292 47
Due on monthly pay rolls,	1,206 06
	$21,498 53

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

Name.	Work.	Amount.
High-level Sewer: —		
National Contracting Co.,	Sect. 73, contract abandoned,	$5,516 17
E. W. Everson & Co.,	Sect. 75,	1,000 00
North Metropolitan Construction: —		
T. H. Gill & Co.,	Sect. 64,	4,022 29
		$10,538 46

On the claims of the following it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them: —

Boston Elevated Railway Company, Boston & Maine Railroad, Anna L. Dunican, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Mary Doherty, Mary E. Doherty, Richard Jones, James Doherty, Michael Niland, Alonzo A. West, James Fitzpatrick, Michael Cashman, William H. Gibbons, Francis Normile.

VIII. CONSUMPTION OF WATER.

The average daily quantity of water consumed by the cities and towns supplied by the Metropolitan Water Works during the year, as delivered from the various sources of supply, was 118,820,000 gallons, this being but a slight increase over the number of gallons per day so supplied in the preceding year. The consumption during the year so measured was 130 gallons per inhabitant per day, as against 131.2 gallons in the preceding year. There was an increase in the total quantity consumed in 9 of the municipalities, and in 9 there was a decrease. The change, however, in consumption was not especially noticeable except in the district of West Roxbury, in which there was a large reduction, owing to the discovery of leakages in the local pipes. This reduction in the West Roxbury district of Boston was due to the inspection made by the water officials of that city, who discovered and repaired a break in a 12-inch pipe, together with two other defects in service pipes and numerous others in house plumbing. The break in the main pipe was causing a waste of 108,000 gallons per day, which ran into an old well and disappeared. The reduction made by the discovery and repair of these defects amounted to about 25 per cent. of the total consumption of the District.

The consumption of water during the colder season still continues to increase according to the fall of the temperature. This, of course, is due to the fact that the water on many of the premises is allowed to run continuously in the coldest season in order to avoid the freezing of the pipes, and also that there are at this season many breakages, due to bad plumbing. In certain days of the winter the daily consumption reached 136,000,000 gallons. The great waste is especially shown by the consumption of water which occurs

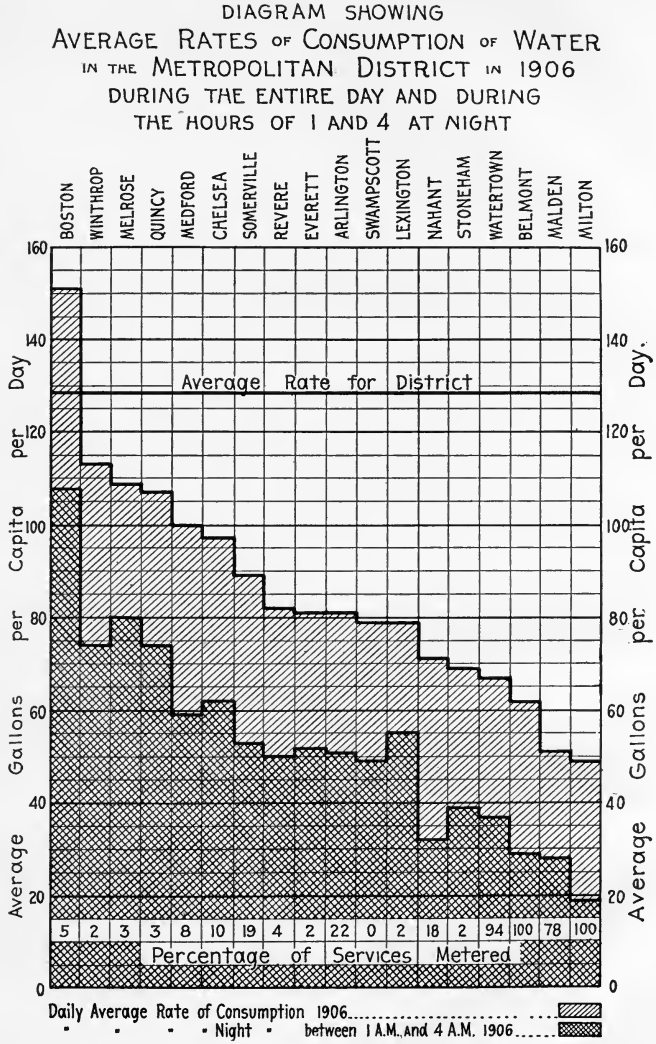


DIAGRAM SHOWING
AVERAGE RATES OF CONSUMPTION OF WATER
IN THE METROPOLITAN DISTRICT IN 1906
DURING THE ENTIRE DAY AND DURING
THE HOURS OF 1 AND 4 AT NIGHT
BOSTON
WINTHROP
MELROSE
QUINCY
MEDFORD
CHELSEA
SOMERVILLE
REVERE
EVERETT
ARLINGTON
SWAMPSCOTT
LEXINGTON
NAHANT
STONEHAM
WATERTOWN
BELMONT
MALDEN
MILTON
160
140
120
100
80
60
40
20
0
Average Gallons per Capita per Day
Average Rate for District
5 2 3 3 8 10 19 4 2 22 0 2 18 2 94 100 78 100
Percentage of Services Metered
Daily Average Rate of Consumption 1906
Night between 1 A.M. and 4 A.M. 1906

between the hours of 1 and 4 in the morning, when only a very small quantity can be used for any legitimate purposes. The consumption between these hours reached a point as high as the rate of 105,000,000 gallons per day during some of the coldest weather, and at several periods of the cold weather exceeded the rate of 90,000,000 gallons per day.

The average amount of the night consumption of water between the hours of 1 and 4, and its extent in comparison with the average consumption for the entire day, is more graphically shown by the accompanying diagram. Notwithstanding the great waste during the past year, indicated by the diagram, there has been a notable decrease from the preceding year in the night rate of consumption, not only during the winter months, but also in the latter part of the year, which seems to show that the increasing use of meters in a few cities and towns and a more careful inspection of leakages are causing a reduction in the quantity of water which is now so wantonly wasted.

The number of new meters which have been set during the past year in the municipalities of the District was 4,257, a number greater than in any previous year, and exceeding by about 1,000 the number of new services which were installed. The greater number of these meters were set in Malden, Somerville and Chelsea, and more especially in Quincy and Swampscott. In two or three of these municipalities the result has seemed to be a decided and gratifying decrease in consumption.

In its report to the Legislature for last year the Board urged the making of consumption an element in the assessment of the city of Boston as well as in the assessments payable by the other cities and towns, believing that the making of consumption an important element in its assessment would also influence the city of Boston, which pays so large a proportion of the total amount, to take measures, by the introduction of meters and more rigorous inspection, for the decrease of waste and leakage.

The Legislature last year passed an act putting the city of Boston on the same basis as to assessments as the other cities and towns in the District. This Act was made to apply to the assessments of Boston during the coming year.

It is not, however, solely in order to reduce current expenditures for the maintenance and operation of works that a decrease in the

unnecessary use and waste of water is demanded; the larger demand comes from the necessity, if such decrease in consumption is not effected, at an earlier period of seeking additional sources of water supply and beginning the construction of large and expensive works. Such additional extensions and constructions, before they are called for by the natural increase of population, will add unnecessarily to the burdens of the municipalities concerned, and will require the taking of properties and privileges from citizens in other parts of the Commonwealth. The Board, as in its last report, "urges upon the various municipalities of the District the adoption of measures, through the introduction of meters, rigorous inspection or otherwise, which shall tend to decrease the unnecessary consumption, and to save unnecessary burdens which fall not only upon the people of the District itself, but, in case of uncalled-for extensions of works, upon residents of other portions of the Commonwealth, whose lands are taken, whose other properties are affected in value, and whose business interests are impaired."

IX. ELECTROLYSIS.

No great improvement has been found in the electrical conditions. The investigations and experiments which had been in progress relative to the extent of the injury done to the water pipes by the underground electric currents, and which have been made for the purpose of overcoming and reducing the injuries which have resulted, have been continued during the past year. If anything, the districts in which the damages occur seem to be extending. In general, the disintegration had not proceeded so far as to require immediate repairs, but the examinations show that the processes are advancing. The pipe lines crossing Chelsea Creek between Chelsea and East Boston were found to be especially subject to disturbance, and at one point it was found that a hole had been made through the pipe, which had to be repaired. New insulating joints have been inserted at several points in Cambridge, for the purposes of experimentation. The subject is one that requires much investigation, not only in order to discover the amount of damages caused and the responsibility therefor, but also in order to adopt adequate means of protecting the pipes.

X. BOATING AND FISHING ON LAKE COCHITUATE.

Boating and fishing on Lake Cochituate had so increased in past years, and there had been such an increase in the use of the lands adjoining the shores of the lake for summer cottages and camping purposes, that it was deemed necessary by the Board to make regulations to check this increase, and to protect the lake from the pollution which such increase tended to cause.

Accordingly, it was provided that there should be no boating or fishing upon the northern division of the lake, situated north of the county road known as Lake Avenue, for the reason that from this section the water is delivered directly into the Cochituate Aqueduct, and the danger from the use of water which is polluted, especially by typhoid germs, is very greatly increased where the conditions are such that the water is used in the Metropolitan District within a comparatively short time after pollution.

Boating was allowed upon the remainder of the lake, in boats which had been registered in accordance with regulations made by the Board, by persons to whom licenses were issued for the purpose. The season was limited to the period beginning April 1 and ending September 20, and the number of boats to be registered was restricted to 125. A fee of $1 was required for registration, and the owner of the boat received a plate bearing a number, which it was required should be attached to the boat in such position as always to be kept in sight.

Fishing was permitted during this season in the same portion of the lake in boats which were duly registered and used in accordance with the requirements of the Board.

Permission was also given to fish from the highway during this season, and at other seasons to enter from the highway and fish through the ice in the same portions of the lake where boating was permitted.

It was provided that applications for registration of boats should be made on or before the first day of April. The total number of persons who applied for registration was 163, but less than 125 in number applied before the time thus fixed for the making of applications. Permission was granted for the registration of 125 boats; in 6 cases the applicant was permitted to use an additional boat or tender, but in all these cases he had had in use 2 or more boats the

previous year. Of the 125 boats registered, 108 belonged to owners resident in Natick and Cochituate, the territory immediately surrounding the lake, and 17 of the boats belonged to owners of cottages upon the marginal lands surrounding the shores of the lake. No resident of Natick or Cochituate and no owner of a cottage upon the margin of the lake who applied within the time limited for application was refused registration.

Three actions were brought for violation of the regulations, and in all of them convictions were obtained. Two of the parties paid small fines, and one case, which was brought against the owner of a cottage who made an application for the use of 3 boats long after the time limit for applications had expired and when the full number had been granted, appealed to the higher courts. As this owner persisted in subsequent violations of the regulations, an injunction was applied for to prevent his use of boats, which was granted. An appeal has been taken to the Supreme Court, upon the ground that the Board had no power to make the regulations for the prevention of boating.

Two inspectors were employed during the summer season to enforce the regulations affecting the use of boats, and also to see that all proper sanitary measures should be adopted by the occupants of cottages and by other persons camping near the lake, in order to prevent the pollution of the water.

The regulations adopted and the measures taken have been successful in improving the sanitary conditions in and around the lake. The owners of the registered boats have carefully observed the regulations which have been made, and there has been a decided reduction in the number of persons camping temporarily around the margins of the lake. The sale of lots for cottage or camping purposes has been discouraged, as well as schemes for the use of adjoining lands for picnic purposes.

It has been determined to permit boating during the year 1907 in like manner upon the portions of the lake other than the northern division. In the granting of registration of boats consideration will be given to the question of residence of the applicant, whether in the neighborhood of the lake or otherwise, and of his ownership of a cottage existing prior to March 1, 1906. Applications will be required to be made before the first day of April. A fee of $1 is required for registration, and the owner will, unless he has already

received a plate containing a proper number, receive a plate containing a number, which must be attached to the boat in such position as will be required by the agent of the Board, and must always be kept in sight.

The season for which boating will be permitted will be extended so that, beginning with April 1, it will end on October 15, instead of September 20, as in the preceding year. The owners of cottages situated near the lake will be required, as a condition of retaining their registration, to maintain their premises in sanitary condition satisfactory to the Board.

XI. LEGISLATIVE ACTS OF THE YEAR 1906.

The legislation of the General Court of the year 1906, authorizing further loans for the Metropolitan Water Works to the extent of $500,000 (chapter 367), authorizing further loans for extensions of the Sewerage Works to the extent of $1,175,000 (chapter 406) and to the extent of $55,000 (chapter 319), relative to annual reports of the Board to the General Court (chapter 235), changing the bases for apportioning the annual assessments for the construction and maintenance of the Metropolitan Water System (chapter 457), and changing the bases for apportioning the annual assessments for the construction and maintenance of the Metropolitan Sewerage Systems (chapter 369), is set forth in other portions of this report.

It was provided by chapter 337 that premiums received from the sale of bonds issued on account of the Metropolitan Water Loan should thereafter be paid into the sinking fund for the extinguishment of the principal indebtedness, instead of being applied to the diminution of the annual assessment as before required; and in like manner, by chapter 338, that premiums received from the sale of scrip, certificates of debt or bonds issued on account of the Metropolitan Sewerage Works should be paid into the sinking fund for the extinguishment of the principal indebtedness, instead of being applied as before in diminution of the assessments for the current year.

By chapter 404 it was provided that all sums of money thereafter received for the admission of a city or town into the Metropolitan Water District should be applied to the payment of the cost of connecting such city or town with the pipes and works of the Metropolitan Water District, and, after such cost was paid, should be paid

into the Metropolitan Water Loan Sinking Fund, the statutes as previously existing having required that sums so received should be deducted from the annual assessments.

By the provisions of chapter 498 the Treasurer of the Commonwealth was required to pay, as a part of the expense of the Metropolitan Water System, the sum of $64,988 to the town of Clinton. This sum was intended to carry into substantial effect an award made by a committee appointed by the Governor in the year 1901 for the payment of $4,000 in each year, in order to indemnify that town for damages caused by the construction of the Metropolitan Water Works. This report of the committee had been made to the General Court of the year 1902, but the award had then failed to receive its confirmation. The Act further provided that all property held by the Board in the town of Clinton, outside of the dam and dike, used in the generation or sale of electricity for power or for manufacturing purposes, should be subject to taxation.

The Treasurer of the Commonwealth was required by the provisions of chapter 533 to pay annually, as a part of the expenses of the Metropolitan Water System, to the town of Holden an amount equal to the average assessment for the three years preceding the purchase of the property by the Commonwealth on all real estate, including water rights and machinery acquired and held by the Commonwealth as a part of the Metropolitan Water System, such payment to be in lieu of taxes or other payments; it being, however, provided that if any buildings standing on land so acquired and held should be removed and remain in the town, the value of such buildings as newly located should be deducted from the valuation for such assessment.

XII. APPORTIONMENT OF ANNUAL ASSESSMENTS FOR METROPOLITAN SEWERAGE SYSTEMS.

The Board in its last report called the attention of the Legislature to the necessity under the existing laws of providing for a new apportionment of the assessments for the North Metropolitan District, but suggested that, as all the five commissions appointed to make the apportionment on the two Metropolitan systems since the beginning of the works had adopted the same bases of apportionment, there would seem to be good reason for fixing the bases of apportionment by legislation, and so avoid the expenditures which were

attendant upon the appointment of commissions for each succeeding period of five years.

The Legislature in accordance with this suggestion passed an act by which it was provided that the proportions in which each of the cities and towns belonging to the North and South Metropolitan Sewerage districts, respectively, should make payments, in order to meet the interest and sinking fund requirements, based upon the respective taxable valuations of the said cities and towns, and that the proportions in which each of the cities and towns should make payments to meet the cost of maintenance and operation of the respective sewerage systems should be based upon the respective populations of the cities and towns. It was further made the duty of the Board annually upon these bases to determine for each system the proportion in which the cities and towns should make payments into the treasury of the Commonwealth for these purposes, and it was made the duty of the Treasurer of the Commonwealth, in accordance with the proportions so determined, to fix the respective assessments of the cities and towns of the District.

XIII. RECOMMENDATIONS FOR ADDITIONAL WATER LOANS.

The Board, in its preliminary report to the Legislature of the year 1907, recommended that provision be made for further additions to the Metropolitan Water Loan Fund sufficient to carry on the necessary construction for the coming year and to meet liabilities already accrued. The recommendations made were as follows: —

It appears from the financial statement that on December 1, 1906, the balance remaining on account of the Metropolitan Water Loan Fund, for the construction and acquisition of works, was $377,173.50.

The Wachusett Dam and Reservoir, the last of the greater works whose construction was specifically called for during the first period of ten years by the Metropolitan Water Act of 1895, have been structurally completed. Some additions to the gate-house at the dam, additional grading and preparation of the marginal lands of the reservoir, and work upon the bed of the reservoir, consequent upon the gradual filling with water, must be done during the present year.

The completion and equipment of the new pumping station in Arlington, whose construction was begun during the past year, necessary additions to

the Chestnut Hill pumping stations, and some minor work upon the aqueducts and pipe lines are demanded.

There remains much to be done for the improvement of the watersheds and for preventing the pollution of the sources of water supply, both for the carrying out of the original plans and in order to meet other demands which are constantly made in the interests of more complete sanitation. Not so much progress was made during the past year in the drainage of swamps and in the building of filter-beds and other works upon the watersheds as was contemplated, but the completion of works begun and the carrying out of undertakings demanded call for considerable expenditures during the current year.

The completion of the Dam and Reservoir has left for final settlement some of the most important contracts connected with the operations of the Board; and naturally at this stage of the work there are left many other claims upon which there has been failure to reach a voluntary agreement, and consequently settlement is to be effected by suits in court. These suits, numbering about 100, are in a few cases for property taken, but by far the larger part arise under claims for damages by reason of alleged depreciation in value of property not taken, or injury to estates by the operations of the Board, or for injuries to established business, — indirect damages, in reference to which agreement is especially difficult, and the amounts recoverable in court cannot be accurately estimated in advance.

Prior to the year 1906 loans for the construction and acquisition of works to the amount of $40,000,000 had been authorized, and last year further loans to the extent of $500,000 were authorized.

It is estimated that the requirements above specified may call for the expenditure of $670,600; but, owing to the balance remaining unexpended, additional loans to so great an amount will not be required. It is recommended that the Treasurer be authorized to issue from time to time, as may be required, additional metropolitan water loans for these purposes, to an amount not exceeding $300,000.

Additional pipe lines and further pumping facilities will be required in the near future, and accidents or emergencies in extensive works of water supply may call for expenditures not anticipated; but the Board believes that the construction of other works than those above enumerated may be deferred for the present year.

XIV. FUTURE WORK.

The Board is charged with the maintenance and operation of all the various works of water supply and for the conveyance and distribution of water to the various municipalities of the Metropolitan Water District, and with the collection and disposal of the sewage

from the various cities and towns constituting the Metropolitan Sewerage District. The sums which it will be necessary for the Board to expend for this work of maintenance and operation for the coming year are estimated to amount to about $650,000.

A portion of the immediate duties before the Board during the coming year, in connection with the Water Works, as has been stated in a previous page, is the settlement of many claims and suits which have arisen especially in connection with the substantial completion of the Wachusett Dam and Reservoir, and of many suits which have been brought for the collection of indirect damages, the limitation of the period in which such suits could be brought having recently expired.

The work of construction contemplated for the coming year does not involve the construction of any large and important works, but rather consists in the finishing up of works already begun, and in the carrying out of many projects which have been made for the improvement of the watersheds and for the prevention of pollution of the sources of water supply.

The Board in its report to the Legislature for the preceding year presented a statement of the works which, as it appeared, might be required sooner or later during a period of the next few years. The estimated cost of these works was a little exceeding $1,800,000. Nearly all of these works were contemplated or formed a part of the scheme presented by the State Board of Health in its report in the year 1895, and in general were works whose construction it was stated would be called for perhaps in the second period of ten years following the year 1895. It is the opinion of the Board that the beginning of the construction of the larger works embraced in the list can be deferred, at least for the present year. The building of some of the main pipe lines cannot, however, be put off for a longer period than one or two years. The construction of others of these works is dependent upon the success of efforts made for checking the waste and unnecessary use of water. The Board, however, in making these estimates included no sums for the acquisition of new sources of water supply, and for machinery which may be needed for the production of power at the Wachusett Dam.

The Legislature of last year authorized the issue of bonds to an amount not exceeding $1,175,000 for the purpose of constructing an extension of the High-level Sewer of the South Metropolitan

System, from the corner of Centre and Perkins streets in Jamaica Plain through West Roxbury, Brookline and as far as Oak Square in Brighton, for which detailed plans had been made. The active work of construction has begun, and will occupy a period of two or more years. The further extension of this sewer through the city of Newton to a point near the Charles River, which is a part of the general plan submitted, will not immediately be called for unless such extension is required for districts not now embraced within the South Metropolitan System.

When the State Board of Health presented its report in the year 1895, recommending the establishment of the Metropolitan Water Works, it accompanied the report with an estimate of the various amounts which would be required to carry out its recommendations. The Legislature of that year, in enacting the Metropolitan Water Act, not only required the Board then instituted to carry out the various recommendations made by the State Board of Health, but it also required the Board to take and pay for the works held by the city of Boston for the purposes of water supply, as well as Spot Pond and the lands under and surrounding the same, owned by the cities of Malden, Medford and Melrose, to construct various minor works, and also to make compensation for various claims for indirect damages, for all of which, calling for additional expenditures, no estimates were made. Subsequent legislatures have also made further requirements calling for large expenditures, but making no further appropriations for meeting them. The State Board of Health estimated the cost of the works called for by its recommendations to be $19,045,800. It further estimated that an aqueduct to Weston would have to be constructed in the latter part of the period embraced within the first ten years, with main distributing pipes extending into the District, at a cost of $4,982,000. It estimated that works which would be called for during the second ten years would require an additional expenditure of $1,300,000.

Not quite all of the works regarded by the State Board of Health as necessary for the first period of ten years have yet been constructed. Some of the works estimated for have been omitted as not being necessary under the matured plans of construction, while, on the other hand, many of the works constructed have been built with greatly increased capacities. Making deductions for the works which have thus been omitted, but making no addition for the works

built with increased capacities, the Board, from careful computations made by its engineers, believes that the cost of the works upon which estimates were originally made by the State Board of Health have not been exceeded in actual construction. While some of the works embraced in the original estimates still remain to be built, it is believed that their construction would not carry the total of the estimates for the works recommended beyond the sums stated by the State Board of Health, were not increased expenditures required on account of the great rise in the cost of labor and materials.

The reports of the Chief Engineer and of the Engineer of the Sudbury and Distribution departments, relating to the Water Works, and the report of the Engineer of the Sewerage Works, with various tables and statistics, are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE.
HENRY P. WALCOTT.
JAMES A. BAILEY, Jr.

Boston, February 27, 1907.

REPORT OF THE CHIEF ENGINEER.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — During the year ending December 31, 1906, I have been engaged, as you know, upon consulting work in various places to such an extent that I have devoted only about one-fifth of my time to the Metropolitan Water Works. As the amount of compensation was proportioned to the time of service, it seemed advisable that I should continue as Chief Engineer until the completion of the larger contracts and the subsequent adjustment of claims in connection with them. During my absence Mr. Dexter Brackett, Engineer of the Sudbury and Distribution departments, has supervised the whole of the work, and even when I have been present he has continued to supervise nearly all of the work. It therefore seems appropriate that the report of the operations of the Engineering Department should be made by him.

Respectfully submitted,

FREDERIC P. STEARNS,
Chief Engineer.

BOSTON, January 1, 1907.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following is a report of the operations of the Engineering Department of the Metropolitan Water Works for the year ending December 31, 1906.

ORGANIZATION.

Thomas F. Richardson, Engineer of the Dam and Reservoir Department, was absent by permission, from January 20 to March 9, and on July 20 he resigned to accept the position of Chief Engineer

and Resident Manager of the Federal Construction Company. Mr. Richardson had been connected with the department since its organization, in 1895, and previous to that time was employed upon the preliminary investigations for the Metropolitan Water Supply, which were made under the direction of the State Board of Health. During his term of service he had charge of the surveys for the location of the Wachusett and Weston aqueducts, of the borings and investigations preliminary to the location of the Wachusett Dam and the North Dike, and was in responsible charge of the construction of the Wachusett Aqueduct, the Wachusett Dam and the South Dike. He also had charge of the construction in the Wachusett Reservoir during the year 1905.

Caleb M. Saville, Division Engineer in the Distribution Department, resigned on June 2, in order to accept a position with French & Bryant, Civil Engineers of Brookline, Mass. The work of which he was in charge, consisting of the supervision of the operation of the Venturi meters and of determining the quantity of water used in the different cities and towns of the Metropolitan Water District, has been subdivided between Alfred O. Doane, Division Engineer, and Samuel E. Killam, Office Assistant.

John W. Lynch, Engineer of Pumping Stations, resigned his position on June 20, on account of ill health. Mr. Lynch was in charge of the high-service station at Chestnut Hill for several years prior to 1898, when the station was owned and operated by the city of Boston. From January 1, 1898, when the station passed into the control of the Metropolitan Water Board, until the date of his resignation, he was in charge of the stations at Chestnut Hill, and after December 20, 1900, he also had general charge of the machinery in all of the water works pumping stations.

Arthur E. O'Neil has been in charge of the stations at Chestnut Hill since August 16.

At the close of the year the principal assistants employed under the direction of the Chief Engineer and the Department Engineer were as follows: —

Alexander E. Kastl,	*Division Engineer in Charge of the Dam and Reservoir Department.*
William E. Foss,	*Division Engineer, Distribution Department.*
Alfred O. Doane,	*Division Engineer, Distribution Department.*
Elliott R. B. Allardice,	*Division Engineer, Dam and Reservoir Department.*

Benjamin F. Hancox,	*Assistant in Charge of Drafting Department.*
Samuel E. Killam,	*Office Assistant.*
Charles E. Haberstroh,	*Assistant Superintendent, Sudbury Department.*
George E. Wilde,	*Assistant Superintendent, Distribution Department.*
Arthur E. O'Neil,	*Engineer of Pumping Stations.*
William W. Locke,	*Sanitary Inspector.*

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 64, and at the end of the year 48.

There has also been a maintenance force, exclusive of the engineers mentioned above, averaging 217, employed in the operation of the several pumping stations and in connection with the maintenance of the reservoirs, aqueducts, pipe lines and other work.

Special gangs of men have been employed in constructing ditches for the drainage of swamps in Sterling, Holden and Princeton, in cleaning weeds from the bottom of the Wachusett Reservoir, in erecting curbing and fences and building granolithic surface at the Wachusett Dam, in completing the South Dike, in resurfacing roads and building gutters in Clinton and West Boylston, in stripping soil and in forestal work. The force thus employed has averaged 74.

Arrangement of Report.

The arrangement which has been adopted in the reports of previous years is followed in continuing this report, and the work charged to the construction account is kept separate from that charged to the maintenance account; but, as the work of construction and maintenance is supervised by the same principal engineers, and in very many cases the assistants are engaged upon both classes of work, it is not feasible to make a complete separation.

CONSTRUCTION.

Contracts.

A detailed statement of the contracts made and pending during the year is given in Appendix No. 1. The following statement gives a summary of all the contracts charged to construction from the beginning of the work to the end of the year 1906: —

Portion of Work.	Number of Contracts.	Approximate Amount.
Wachusett Reservoir,	38	$3,055,252 12
Wachusett Dam,	17	1,754,940 68
Relocation Central Massachusetts Railroad,	6	512,527 67
Wachusett Aqueduct and Clinton sewerage,	19	1,516,259 67
Sudbury Reservoir, the portions of contracts not performed at the time they were assumed from the city of Boston,	11	583,220 54
Sudbury Department, reservoir, filter-beds, pipe lines and improvement of Lake Cochituate, Metropolitan Water Works contracts,	22	956,508 17
Weston Aqueduct and Reservoir,	26	2,212,403 31
Distribution Department, including pipes, valves and special castings purchased for other departments,	163	4,565,975 77
Totals,	302	$15,157,087 93

Amount of 4 contracts made in 1906 (approximate),	$43,629 72
Amount of 3 contracts unfinished December 31, 1906 (approximate),	49,618 00
Value of work done by contract from January 1, 1906, to December 31, 1906,	46,688 76

DAM AND RESERVOIR DEPARTMENT.

The principal construction work in this department has been in connection with the completion of the Wachusett Dam, the building of filter-beds in Sterling, the construction of ditches for the drainage of swamps tributary to the Wachusett Reservoir in Sterling, Holden and Princeton, and the final clearing of the bottom of the Wachusett Reservoir between elevations 365 and 385.

Wachusett Dam.

Contract No. 195, McArthur Brothers Company.

At the beginning of the year the only work remaining to be done under this contract was the completion of the excavation of about 1,400 cubic yards of earth and 1,900 cubic yards of rock in the waste channel below the dam. This work was in progress at the beginning of the year, and was completed on February 27. The following table gives the total amount of work done to the end of the contract, based on the final estimate: —

Earth excavation (cubic yards),	274,087
Rock excavation (cubic yards),	102,640
Rubble stone masonry (cubic yards),	251,920
Ashlar masonry (cubic yards),	9,037
Dimension stone masonry (cubic yards),	2,742
Brick masonry (cubic yards),	1,065
Concrete masonry (cubic yards),	9,675
Slope paving (cubic yards),	1,899
Iron and other metal work (tons),	894
Roadways and paths (square yards),	9,193
Vitrified pipe for drains (linear feet),	3,016

The following quantities of masonry, used in constructing the roadway arch bridge over the waste channel, are not included in the above table: —

Concrete masonry (cubic yards),	322
Ashlar masonry (cubic yards),	83
Dimension stone masonry (cubic yards),	87

Additional Work.

The construction of the granolithic surface on the top of the dam, including the abutment and bastion, and the granolithic walk from the abutment to Boylston Street, was begun on June 1 and completed on July 10. The granolithic surface has an average thickness of 5½ inches. On the abutment and bastion it is divided into blocks about 11 feet square, and each block is reinforced longitudinally and transversely with ¼-inch corrugated steel bars spaced 18 inches apart. Between the terminal structures it is divided into blocks by joints across the dam spaced 9 feet 9 inches apart, placed opposite the brass posts of the fence on top of the dam. Each block is reinforced across the dam with ¼-inch corrugated steel bars spaced 18 inches apart, and also with electrically welded fabric made of No. 10 wire with a 10-inch by 12-inch mesh. Over the upper gate-chamber the granolithic surface is further reinforced with ½-inch corrugated steel bars spaced 4 feet 5 inches apart. Before placing the granolithic surface the top of the dam was coated with powdered mica, for the purpose of preventing adhesion between the masonry of the dam and the granolithic surface, thus allowing them to contract and expand independently of each other. The joints between the blocks are about half an inch wide, extend the full depth of the granolithic surface, and were filled with asphaltum.

The granolithic walk from the bastion to Boylston Street is 10 feet wide and 8 inches thick, and divided into blocks 10 feet square. The blocks are reinforced with the electrically welded fabric.

The work was done under the supervision of the Simpson Brothers Corporation of Boston, which furnished the skilled labor; the ordinary labor and materials being furnished by the Board. The total area laid was 23,610 square feet.

A brass fence has been erected on each side of the top of the dam between the terminal structures, the work being done by the day-labor force in March and April. The design of the fence was described in the annual report for the year 1905.

Steel gates have been erected at the southeasterly end of the dam, where it joins the abutment, and a steel fence has been erected around the platform at the bastion.

A steel fence 460 feet long, supported on granite curbing and with granite posts at the gateways and corners, has been erected at the Boylston Street entrance to the dam. It has three gates, one opposite the end of the granolithic walk leading to the dam, the others at either end, opposite the gravel paths leading to the abutment. A gravel walk with granite edgestones has been built along the street, also gravel paths from the ends of the fence to the abutment.

The work of erecting the steel gates and fences and building the gravel walk and paths was done by the day-labor force. The steel gates and fencing were furnished by Henry Parsons & Son of Marlborough, Mass., and the granite posts, curbing and edge stones by F. A. McCauliff of Fitchburg, Mass.

An iron pipe rail fence 235 feet long has been erected on top of the retaining wall, extending along the easterly side of the waste channel from the bastion to the Central Massachusetts Railroad bridge.

Early in the year a permanent connection was made between the 48-inch equalizer pipe in well No. 4 of the lower gate-chamber and the 24-inch pipe line supplying water to the Lancaster Mills. For this purpose 269 feet of 12-inch cast-iron pipe were laid, controlled by a 12-inch valve, including a 12-inch Venturi meter for use in measuring the quantity of water delivered to the mills.

A 10-inch Venturi meter and a 10-inch valve and valve chamber have been set in connection with the 10-inch pipe line from the

lower gate-chamber to the fountain in the inner pool, for the purpose of regulating and measuring the water supplied to the fountain.

The road on the westerly hillside, extending from the grounds below the dam to the bastion, has been improved by the building of 975 feet of paved gutter and seven 8-inch vitrified pipe culverts with drainage inlets in the gutter. The road has also been resurfaced with screened gravel.

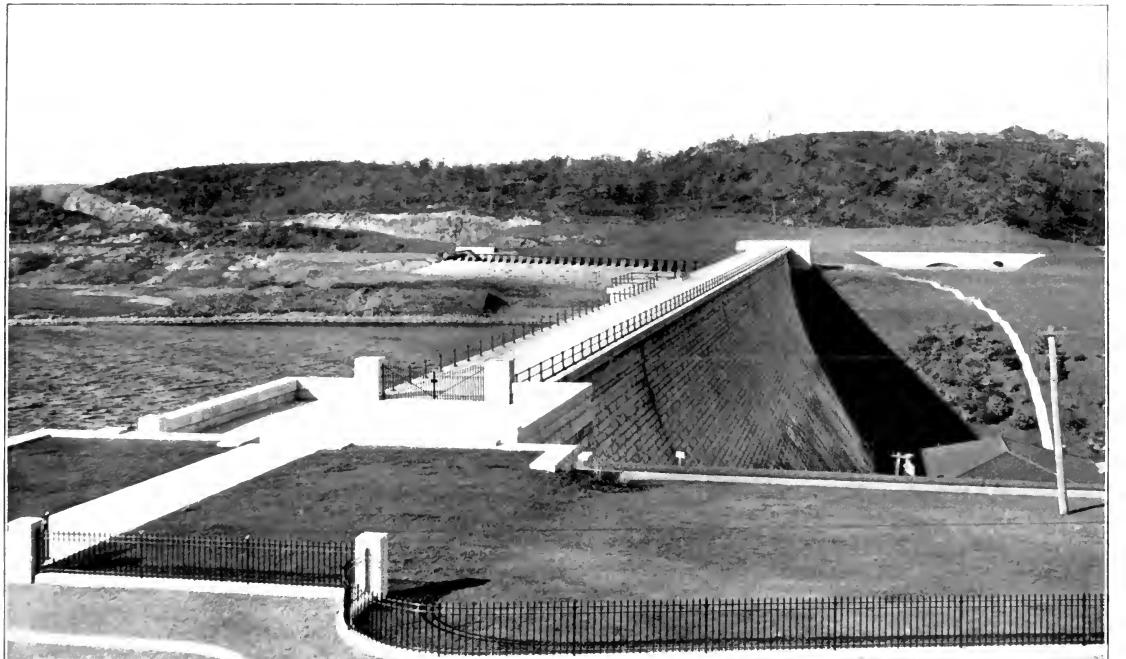
The joints in the cobble-stone paved gutter at the foot of the down-stream side of the dam have been pointed with cement mortar, in order to prevent the growth of weeds and the washing out of the stones.

A large pile of loam, which had been stored near the bastion at the northwesterly end of the dam, has been used in grading the hillside; and all the newly finished grounds in the vicinity of the dam which had been covered with soil, but not seeded, have been graded and seeded. There have been planted in beds in the vicinity of the walks and roadways 2,230 shrubs, comprising 31 varieties.

Machinery for a lighting and pumping plant for use at the dam, to be installed in the lower gate-chamber and operated by water power, has been delivered, but is not yet in position. It consists of a 9-inch turbine, furnished by the Holyoke Machine Company, which is to be directly connected to a 22½ kilowatt generator. The generator will furnish current for lighting the building, for operating a 10 horse-power motor connected with a 6-inch submerged pump to be used for pumping water from the wells in the lower gate-chamber, and will also furnish current for operating the electric motor on the crane used for handling stop-planks and screens in the upper gate-chamber. The generator and motor were built by the Stanley Electric Company, and are being furnished and installed by the Frank Ridlon Company.

South Dike.

At the end of 1905 about 1,000 cubic yards of material still remained to be placed for the filling of the gap in the South Dike, through which had passed the quarry railroad used in the construction of the Wachusett Dam. This filling was completed by a day-labor force working at various times between April 7 and September 3. The surface was finished with soil to a depth of 18 inches, and seeded.



WACHUSETT DAM WITH ENTRANCE FROM BOYLSTON STREET AND ABUTMENT AT THE SOUTHEASTERLY END.

Relocation and Construction of Roads.

All the contract work on the last of the new highways required on account of the construction of the Wachusett Reservoir was completed in November, 1905; but some work of a minor character, not included in the contracts, remained to be done this year, such as paving gutters subject to erosion, improving the drainage, building additional guard rail fences and repairing the surfacing where it had settled or had been damaged by heavy teaming during the construction of other work on the reservoir.

In West Boylston the following work has been done: On the highway crossing the Stillwater River arch the northerly gutter was paved with cobble-stones from North Main Street, in Oakdale, to the entrance to the grounds of the Worcester County Truant School, a distance of about 2,200 feet, and the gravel walk next to the gutter surfaced from the Worcester, Nashua & Portland Railroad to the Stillwater arch, a distance of about 700 feet. On the new location of Worcester Street, south of Prospect Street, the westerly gutter was paved with cobble-stones for a distance of about 500 feet. Newton Street was surfaced with gravel for a distance of about 2,200 feet southerly of the Quinepoxet River arches, and Crescent Street for a distance of about 2,600 feet northerly of Prospect Street. A 12-inch iron pipe culvert was built on Crescent Street, near the junction of the new and old locations of the street. Much other miscellaneous work was done, such as building and painting additional highway railings, placing sand on those parts of the broken-stone highways which had begun to disintegrate, grading gutters, and grading and surfacing gravel sidewalks.

During the construction of the dam, Boylston Street, in the town of Clinton, from the Clinton-Boylston town line to the dam, had been badly worn by heavy teaming; therefore it was decided to resurface this part of the street with broken-stone screenings. The work was commenced on July 21 and completed on August 20. The steam road roller and the watering cart used on the work were hired from the town of Clinton. At the request of the chairman of the road commissioners, an additional length of street was surfaced in order to reimburse the town for the use of the road roller and watering cart. The length of street surfaced is 5,697 feet, of which 4,419 feet is the length from the town line to the dam, and 1,278

feet the additional length surfaced below the dam to reimburse the town for the use of the road roller and watering cart. In this work 454½ tons of broken-stone screenings were used. Wooden rail fences, aggregating 655 feet in length, were built at several points along the westerly line of Boylston Street, between the Wachusett Dam and the Boylston town line.

Removal of Soil.

Additional Soil Stripping.

On both shores of the Wachusett Reservoir near Sawyer's Mills, and on the southerly shore near Boylston Centre and Pine Hill, additional clearing, grubbing and removing of soil have been done back of where the steep banks, acted upon by waves, frost and rain, have caved away and retreated nearly to the limit of the original soil stripping or of the additional soil stripping done last year. The soil has been stripped along an aggregate length of about 5,000 feet of shore line for a width of from 10 to 20 feet, the aggregate area being 1.40 acres.

Cleaning of the Reservoir Bottom.

The final cleaning of the reservoir bottom was done between elevations 363 and 385, from August 25 to December 8, and consisted in removing and disposing of the weeds, grass and bushes which had grown up since the original stripping of the soil or since the last cleaning. Over the greater part of the area the ground was harrowed with spring-tooth harrows, and the weeds, grass and bushes, together with the roots, were afterwards raked and burned. Over the remaining area, where the harrows could not be used on account of the ground being rocky, steep or wet, the weeds, grass and bushes were mowed close to the ground, and afterwards raked and burned. There was cleaned a total of 1,205 acres of ground, at a cost of $9,585, or an average cost of $7.95 per acre. This cost per acre is much larger than for the cleaning done during the previous year, for several reasons. During the past year a larger proportion of the area was cleaned by harrowing and raking, — a more expensive method than by mowing and raking, but giving better results; also, for the reason that more than half the area cleaned had not been touched since the original stripping was done several years ago, and the growth was consequently heavy. The rate of wages paid was also higher than in previous years.

Shore Protection.

From a point about 500 feet south of the Wachusett Dam, the easterly shore of the reservoir, in the vicinity of the flow line, has been covered with cobble-stones to a depth of about 9 inches, for a distance of 1,250 feet and a width of 20 feet, in order to protect it from wave action. On the northwesterly shore of the reservoir, just above the northwesterly end of the waste weir of the dam, the slope of the ground in the vicinity of the flow line was steeper than the natural slope of the material, and in order to protect this stretch of shore from being undermined by wave action, it has been covered with gravel for a distance of 165 feet.

Relocation of Railroads.

The principal part of the contract work upon the relocation of railroads was completed in 1903. As noted in previous reports, the only part not completed was on what is known as Section 2 of the relocation of the Central Massachusetts Railroad, Contract No. 195A (245), McArthur Brothers Company, near the westerly end of the Wachusett Dam, where it was necessary to build a temporary location for the Central Massachusetts Railroad, in order not to interfere with the use of the traveling cableways used in connection with the construction of the dam. Last year this gap in the permanent line was finished and put in operation, and the removal of the embankment of the temporary line was then begun and was nearly completed at the beginning of 1906. The work was completed on January 11.

The following table gives the total amount of work done to the end of the contract, based on the final estimate: —

Earth excavation (cubic yards),	43,012
Rock excavation (cubic yards),	56,033
Tunnel excavation (cubic yards),	18,967
Rubble stone masonry (cubic yards),	987
Concrete masonry not in tunnel (cubic yards),	2,443
Concrete masonry in tunnel (cubic yards),	2,208
Dimension stone masonry (cubic yards),	833
Face stone masonry for railroad arch bridge (cubic yards),	340
Dry paving (cubic yards),	158

The only day-labor work in connection with the relocation of railroads has been the sowing of grass seed on the slopes of the

railroad embankments between the end of the viaduct and the railroad arch bridge over the waste channel, and the gathering up and disposing of some old material from the old location of the Central Massachusetts Railroad.

Improvement of Wachusett Watershed.

Drainage of Swamps.

The construction of ditches for the drainage of swamps tributary to the Wachusett Reservoir, which was suspended on July 7, 1900, was resumed during the year, and has been in progress in three swamps, one in the town of Sterling just south of Sterling Centre, and two in the towns of Holden and Princeton above the junction of Trout and Governor brooks.

The methods of carrying on the work have been substantially the same as described in the annual report of January 1, 1899. In all cases where ditches have been built permission has been obtained from the owners of the land for their construction and maintenance, without payment to the owners.

The ditches constructed have, with few exceptions, a board bottom 1 foot wide, with 4-inch by 4-inch triangular wooden strips rabbeted at the square corner to the edges of the board. The board bottom is nailed to 2-inch by 4-inch wooden cross-pieces, 2 feet long, spaced about 3 feet apart and laid across the bottom of the excavation. The triangular strips make wooden sides to the ditch 3 inches high, and serve as a footing for the stone paving on the slopes of the ditch. As the bottom of the excavation for the ditches is generally in water and the material very soft, it is necessary to use some form of board bottom in order to preserve the grade of the ditch and afford a support for the slope paving, and the form of bottom used facilitates the cleaning of the ditches. Where the ditches have steep grades and the ground is more firm, the bottom is also paved with stone; and where the ground is stony, no paving is used.

The swamp south of Sterling Centre has an area of 26 acres, and the watershed tributary to its outlet has an area of 225 acres. The village of Sterling Centre is at the northerly end of this watershed, and a brook rising in the village flows into the swamp. The drainage of the swamp has been accomplished by means of two ditches, having an aggregate length of 6,173 feet, one on either side of the

DITCH FOR SWAMP DRAINAGE ON WACHUSETT WATERSHED IN HOLDEN.

swamp. The depth of the ditches is generally 2½ to 3 feet, and the slope paving is carried to a height of 1 foot above the board bottom. The work was done by a day-labor force, between June 11 and August 20.

The maximum force employed was 39 men and 2 horses, during the week ending July 21, and the average force was 24 men and 2 horses.

The amount of work done was as follows: 6,173 linear feet of ditches, with board bottom and stone paving on the sides; 11 farm crossings, and 1 culvert repaired under the New York, New Haven & Hartford Railroad where one of the ditches crosses it.

The two swamps above the junction of Trout and Governor brooks in which work has been done are partly in the town of Holden and partly in the town of Princeton north of the village of Quinepoxet.

The swamp on Trout Brook has an area of 72 acres, and the area of the watershed above its outlet is about 750 acres. The system of drainage consists of two marginal ditches in the upper half of the swamp where it is wide, uniting into one ditch in the lower half of the swamp where it is narrow. Below the swamp the brook was improved by clearing out the brush and removing obstructions in its channel for a distance of 600 feet in order to increase its carrying capacity. Several minor brooks tributary to the ditches were also improved from their junction with the ditches to the edge of the swamp. The depth of the ditches is generally 1½ to 2 feet, and the slope paving is carried to a height of 8 to 12 inches above the bottom. The work, which was done by a day-labor force, was commenced on June 25 and completed on September 18.

The maximum force employed was 28 men and 3 horses, during the week ending July 28, and the average force was 25 men and 2 horses.

The amount of work done was as follows: —

Ditches with board bottom and stone paving on the sides (linear feet),	7,088
Ditches with stone paving on bottom and sides (linear feet),	207
Ditches without board bottom or stone paving (linear feet),	1,635
Total length of ditches (linear feet),	8,930
Brooks improved (linear feet),	916
Farm crossings,	7
Watering places,	4

The swamp on Governor Brook has an area of 216 acres, and the area of the watershed above its outlet is about 1,625 acres. The drainage of this swamp will require the construction of 28,400 linear feet of ditches. Work was commenced on this swamp on September 19, and was suspended on December 1, on account of cold weather and snow. The depth of the ditches thus far constructed is generally 1½ to 3 feet, and the slope paving is carried to a height of 1 to 2 feet above the bottom. In connection with this work a 2-foot by 2-foot concrete culvert was built across the Quinepoxet-East Princeton highway, where one of the ditches crosses the highway at the Holden-Princeton town line. The old culvert at this place was not properly located, and was of insufficient capacity. A highway watering place was also built to replace the one at the old culvert. The work has been done by a day-labor force.

The maximum force employed was 27 men and 2 horses, during most of the month of October, and the average force was 24 men and 2 horses.

The amount of work done was as follows: —

Ditches with board bottom and stone paving on the sides (linear feet),	4,095
Ditches with stone paving on bottom and sides (linear feet),	112
Ditches without board bottom or paving (linear feet),	390
Total length of ditches (linear feet),	4,597
Brook improved (linear feet),	120
Farm crossings,	5
Watering places,	3
2-foot by 2-foot concrete highway culvert,	1

The total length of ditches constructed during the year was 19,700 feet, equal to 3.73 miles, at a cost, exclusive of engineering, of $9,886, or $0.502 per linear foot. This cost is somewhat higher than that of previous years, due to the higher rate of wages paid, the higher cost of materials, and to being obliged to begin with foremen and laborers who were not familiar with the work. The cost of the work includes the cost of building the culvert, farm crossings and watering places.

On all the swamp drainage work done during the year, the maximum force was 63 men and 2 horses, during the week ending July 21, and the average force was 32 men and 3 horses.

Since November 23, 1899, when the drainage of swamps in the Wachusett watershed was commenced, there have been constructed 34,748 linear feet of ditches, equal to 6.58 miles.

Sterling Filter-beds.

Plans and specifications for the construction of four filter-beds, to be used for filtering the water of a small brook which has its head waters in the village of Sterling Centre, were completed in July, and a contract for the construction of the beds was made with A. McKenzie & Co. on September 1. The beds are located alongside the brook, about one mile below the village of Sterling, and just below a swamp on which 8,000,000 gallons of water can be temporarily stored whenever the flow of the brook exceeds the filtering capacity of the beds.

The watershed tributary to the brook above the filter-beds is 225 acres. By means of a small concrete dam across the brook the water will be diverted to the filter-beds through a paved channel 382 feet long. There are four beds, each having an area of about half an acre, arranged in two pairs adjacent to each other. The beds are partly in excavation and partly in fill.

The material encountered on the site of the beds, aside from the surface soil, has been gravel with pockets of sand. The soil and other material unsuitable for filtration purposes have been excavated from the site of the beds and used in building the embankments surrounding the beds. The gravel and sand from the parts of the beds in excavation have been used in building the parts of the beds in fill, all stones more than 4 inches in diameter having been removed and used in embankments, paving and elsewhere. The parts of the beds in excavation have been excavated 8 inches deeper than the finished surface, and refilled with screened or selected gravel and sand free from clay and stones more than 1 inch in diameter, and the same kind of material has been used for the upper foot of the parts of the beds in fill.

The surface of the beds in the northerly or upper pair is 7 feet higher than that in the southerly or lower pair. Embankments have been built around and between the beds to such an extent as to have the surface of the upper beds 8 feet below the top of their embankments, and the surface of the lower beds 6 feet below the top of the lower embankments.

From the diverting dam across the brook channel a paved ditch 382 feet long runs to the middle of the northerly or upper boundary of the beds. From the end of the ditch an 18-inch vitrified pipe drain runs between the two upper beds to a concrete manhole opposite their centres. From this manhole a 15-inch vitrified pipe drain runs to a concrete manhole between and opposite the centres of the two lower beds. From the latter manhole a 12-inch vitrified pipe drain runs to the lower boundary of the beds, where it discharges into a paved ditch which joins the brook below the beds. Twelve-inch vitrified pipe drains, one to each bed, running from the sides of the manholes next to the beds, will conduct the water to the beds. Each manhole is provided with a system of shear gates and overflow weirs, arranged in such a manner that water can be turned on to any one bed or any combination of them; and at the same time, if too much water should come, or a bed should become clogged, the water cannot rise higher than within a safe distance of the top of the embankments, as it will flow over the weirs into the other beds, or, if all the beds are full, over the last weir into the 12-inch vitrified pipe drain at the lower end of the beds, which is intended for a safety drain.

As the embankment next to the brook encroached upon it in several places, it was necessary to relocate the brook, and a new channel has been excavated for it along the foot of the embankment. This new channel is paved, and receives the effluent from the underdrains of the filter-beds. Each pair of beds has three lines of underdrains laid at right angles to the new brook channel, those in the two beds farthest from the brook being 6 inches and those in the two beds next to the brook being 8 inches in diameter. For 212 feet above and 60 feet below the diverting dam the brook channel was very narrow, and ran close to the embankment of the New York, New Haven & Hartford Railroad. This part of the brook channel has been relocated farther away from the railroad embankment, and the old brook channel has been filled. The relocated channel is paved from its upper end to 15 feet below the dam. At its upper end it connects with the system of ditches draining the swamp through which the brook formerly ran.

The diverting dam has an opening 4 feet wide, closed with stop-planks. In case it is desired to divert the water from the filter-beds, on account of unusual floods or for any other cause, the

stop-planks can be removed and the water turned into the brook channel below the dam. The diverting dam is so designed that water can be allowed to run over its crest, which is 25 feet in length.

Alongside of the Worcester Consolidated Street Railway track, and adjacent to the high part of the beds, about 350 feet of 12-inch vitrified pipe underdrain will be laid, for the purpose of taking care of any water which may filter into the railway cut.

The following table gives the quantities of work done to the end of the year, and the estimated quantities required to complete the work: —

	To December 31, 1906.	Estimated Quantities required to complete Work.
Earth excavation (cubic yards),	25,270	2,900
Concrete masonry (cubic yards),	41	16
Dry rubble stone masonry and paving (cubic yards),	166	69
18-inch vitrified pipe (linear feet),	132	7
15-inch vitrified pipe (linear feet),	269	0
12-inch vitrified pipe (linear feet),	145	375
8-inch vitrified pipe (linear feet),	856	0
6-inch vitrified pipe (linear feet),	880	38

The maximum force employed by the contractor was 79 men and 14 horses, during the week ending October 6, and the average force was 62 men and 12 horses.

Sewage Disposal.

For the purpose of preventing objectionable drainage from entering the brooks draining into the Wachusett Reservoir, 28 cesspools, 7 cemented vaults and one gravel filter-bed have been constructed, to take care of barn, sink and privy drainage in the towns of Boylston, West Boylston and Holden.

For the purpose of diverting the surface water from the barnyard of the Jennie L. Goodnow farm in West Boylston, a culvert crossing Fairbank Street, opposite the barn, has been closed, and a new stone culvert built across the street at a point about 200 feet north of the old culvert. An open ditch 400 feet long has been excavated and paved for about 150 feet of its length.

Improvement of River Channels.

At Warfield's Mill, on the Quinepoxet River above Oakdale, the head of the canal leading from the mill-pond has been filled with earth for a length of about 20 feet, so as to permanently prevent any water from entering the canal.

At the Canada Mills, in Holden, the masonry of the dam for about one-third of its length has been removed sufficiently low to drain the mill-pond, and the head of the canal has been permanently closed by gravel filling.

Real Estate, Care and Disposal.

During the year about 32 acres of land about the margins of the reservoir, in the towns of Clinton, Boylston and West Boylston, have been graded and seeded. This land required considerable grading, on account of the holes remaining after the removal of 26 houses and 11 barns.

Forestry.

The work of cutting out fruit, mature and undesirable trees, preparatory to planting, has been done over about 25 acres.

The fire guard, 40 feet wide, along the margins of the land purchased by the Board, has been extended through timber land for about 2¾ miles in West Boylston and Oakdale. An area of 112 acres was planted between April 16 and 28, and an area of 50 acres between October 20 and November 9, with two and three year old seedlings from the Flagg nursery. Of the above, about 60 acres were in heavy grass land, where three-year-old white and Scotch pine, Norway, white and Douglas spruce, European larch and American tamarac seedlings have been planted in rows 6 feet apart each way. The remaining 102 acres were pasture and sprout land, which have been planted with two and three year old white and Scotch pines, and Norway and white spruces, 6 feet or 10 feet apart each way, with chestnuts planted between for fillers, where a suitable filler did not exist. In doing this work the following seedlings from the Flagg nursery have been used: 97,800 white pines, 5,800 Scotch pines, 31,640 white spruces, 7,250 Norway spruces, 22,845 Douglas spruces, 4,100 American tamaracs, 840 European larches, 300 locusts and 17,500 chestnuts. The cost of taking trees from

the nursery and setting them in the ground has averaged $4.54 per 1,000 trees, or $5.07 per acre.

The following table gives information regarding land belonging to the Board above the flow-line of the reservoir (outlying land and land along the Quinepoxet River above the road which formerly crossed the river to the Harris Mills are not included in this table) : —

	Acres.
Area of land which was forested when acquired,	1,468
Area which has been planted with trees,	1,099
Area to be planted with trees,	321
Area open and which will probably not be planted,	300
Area of marginal strip along shores of reservoir,	197
Total area belonging to Board,	3,380

Two and three year old white pine seedlings and three-year-old arbor vitæ seedlings have been planted along 4 miles of the reservoir margin, and where trees planted in previous years have died, they have been replaced for about ¼ of a mile.

The total length of the flow-line of the reservoir, including 1.28 miles around Cemetery Island, is 39.94 miles. Arbor vitæ and white pine seedlings have been planted in the marginal strip along 29 miles, and arbor vitæ alone on about 2 miles more of the flow-line, where the margin is only 30 feet wide, making a total marginal strip planted of about 31 miles of flow-line. Along the dikes, highways and railroads, for a distance of 5.7 miles, trees will not be planted. There remain about 1.5 miles along the Stillwater River to be planted with trees.

The necessary care has been given to the Flagg and Lamson nurseries during the year. There were transplanted from the nursery beds to the transplant rows at the Flagg nursery 123,980 white pines, 175 hemlocks and 3,870 white spruces. Besides the above stock, this nursery contains, in original seed beds, 283,400 white pines and 101,500 arbor vitæ; also, in transplant beds, 37,500 arbor vitæ.

At the Lamson nursery there are 20,500 sugar maples, 4,010 white oaks, 3,900 walnuts, 14,860 locusts, 2,400 ashes and 1,030 Norway spruces, all of which were transplanted from seed beds to transplant beds in the spring.

The trees cut out were largely apple, chestnut, pine, oak and

hemlock. The logs obtained were for the most part cut into lumber, telephone poles, railroad ties, saw-logs and cord-wood, the principal quantities being as follows: —

20,000 feet B. M. apple-wood lumber.
6,000 feet B. M. 2-inch white pine plank.
10,000 survey stakes.
350 fence pickets.
168 railroad ties.
45 telephone poles.
300 cords fire wood.
55 cords saw-logs.

The apple-wood lumber, railroad ties, saw-logs and most of the cord-wood have been sold. The other material has been used or reserved for use on the work, or remains to be sold.

All the above-mentioned work has been done by day labor, except the manufacture of the lumber, which was done at the saw-mill of Lowe & Flagg in West Boylston.

The maximum day-labor force employed was 41 men and 5 horses, during the week ending April 28.

Engineering.

In addition to the engineering work necessarily connected with the preparation of the final estimates of contract work finished during the latter part of 1905 and the beginning of 1906, and that connected with the supervision of the contract and day-labor work in progress, the engineering force of the Dam and Reservoir Department has done much other engineering work, principally as follows: —

Plans, specifications and estimates have been prepared for the construction of the Sterling filter-beds. Surveys, calculations and plans have been made for a number of takings of lands which had been acquired by deed. The plans of the Wachusett Dam have been for the most part corrected so as to represent the work as actually constructed, for the purpose of making record drawings of the dam. Much work has been done in revising land plans. Progress has been made on the survey of the marginal line of the watershed, about 34½ miles having been surveyed during the year; about 5 miles remain to be surveyed. The entering on the final record sheets of the elevations of the bottom of the reservoir, taken after

the removal of the soil, has been completed. Contour lines have been drawn on these record sheets, covering an area of about 380 acres, making a total of 3,800 acres covered by final record sheets on which the contour lines have been drawn. Considerable progress has been made in calculating the capacity of the reservoir between elevations 370 and 395, and at the end of the year the results were being tabulated.

SUDBURY AND DISTRIBUTION DEPARTMENTS.

The principal work charged to construction in these departments has been in connection with the new pumping plant for the northern extra high-service district in Arlington and Lexington, and in making changes at the Chestnut Hill low-service pumping station, for the purpose of adapting one of the engines for pumping to the high-service reservoir.

Arlington Pumping Station.

A contract for the construction of a brick building, 90 feet long by 46 feet wide, with trimmings of Longmeadow brownstone, together with a concrete coal pocket 33 feet by 27 feet and a brick chimney 70 feet high, was made with C. A. Dodge & Co. on August 23. The contractor began work on the excavation for the building on August 27, and at the close of the year the value of the work done was about half the contract price. The brick walls of the building were completed to the tops of the windows, the chimney was finished, and the concrete foundation for the new engine practically completed.

The Allis-Chalmers Company, which has a contract for furnishing the engine, has done but little actual construction, as it has been evident that the building would not be ready to receive the engine before May 1, 1907. The detailed plans have, however, all been made and approved, and the contractor now promises to hasten the construction work.

Chestnut Hill Pumping Station.

New suction and discharge piping and valves have been installed in the low-service pumping station in connection with engine No. 7, and the pump chambers of that engine have been strengthened for the purpose of adapting the engine for use in pumping to the high-service reservoir.

OFFICE FORCE.

During the year the drafting force has made plans for gates and fences at the Wachusett Dam; detailed drawings of the floor of the exciter room, and the arrangement of electrical and pumping plant at the lower gate-chamber at the Wachusett Dam; construction drawings and specifications for a new 64-inch horizontal tubular boiler and setting for the Chestnut Hill high-service pumping station; and drawings and specifications for two 54-inch horizontal tubular boilers for the Arlington pumping station. Several designs were made for a new pumping station building to be built in Arlington, and working drawings of the accepted design, together with specifications for doing the work have been prepared. Plans have been made for the reconstruction of the attendant's house at the Ashland Reservoir; record drawings of the Weston Aqueduct have been completed; and some work has been done on record drawings of the Wachusett Reservoir and Aqueduct and Spot Pond. The whole number of drawings completed during the year was 120. The force employed in the drafting department numbered 5 throughout the year.

The office force, averaging 6 during the year, has performed work of a varied character, a large proportion of which has been connected with the maintenance of the works. This force has supervised the making of plans for land takings on the Wachusett watershed; has made computations in connection with the daily measurement of water used in the several cities and towns supplied from the Metropolitan Works; also the computations for determining the amount of the Metropolitan water assessment to be paid by the several municipalities; and has attended to the procuring of supplies and the making of blue prints and photographs.

MAINTENANCE.

Rainfall and Yield.

The total rainfall for the year on the Sudbury watershed has been 44.48 inches, or 1.56 inches below the average for 32 years. On the Wachusett watershed the total rainfall has been 49.08 inches, which is but little below the average for the 10 years during which records have been kept. On both the Sudbury and Wachusett watersheds the yield, although larger than during the year 1905,

has been considerably below the average, as a result of the small rainfall during the months when the greatest percentage is collectible in the reservoirs.

Statistics relating to rainfall and yield of watersheds may be found in Appendix No. 3, tables Nos. 1 to 11.

Storage Reservoirs.

The quantity of water stored in all of the storage reservoirs on January 1, 1906, was 28,971,900,000 gallons. During the month of January there was an increase of a little less than 2,000,000,000 gallons in the quantity stored, but nearly half of this amount was lost during the first twenty days of the month of February. During the latter part of February and during the months of March and April there was a gain in storage of 13,500,000,000 gallons. During May the gain was small until near the end of the month, when a rainfall of about 4 inches caused a gain of over 3,000,000,000 gallons in storage in three days. The maximum for the year was reached on July 6, when the quantity stored in all the reservoirs was 49,805,200,000 gallons. During July, August, September and October there was an almost continual loss of storage. During November there was practically no loss, followed by a small loss during December; and at the end of the year the quantity stored was 44,153,200,000 gallons.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month: —

Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.

Date.	In Wachusett Reservoir (Gallons).	In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons).	In All Other Storage Reservoirs (Gallons).	Total (Gallons).
1906.				
January 1,	17,115,300,000	6,831,300,000	5,025,300,000	28,971,900,000
February 1,	18,159,900,000	6,848,600,000	5,755,400,000	30,763,900,000
March 1,	18,689,100,000	7,000,100,000	6,260,500,000	31,949,700,000
April 1,	24,018,300,000	6,904,000,000	6,606,100,000	37,528,400,000
May 1,	28,981,800,000	7,621,900,000	6,881,400,000	43,485,100,000
June 1,	32,305,400,000	8,031,000,000	7,170,500,000	47,506,900,000
July 1,	33,984,900,000	7,994,300,000	7,191,600,000	49,170,800,000
August 1,	34,062,900,000	7,960,600,000	6,983,900,000	49,007,300,000
September 1,	33,442,500,000	7,865,200,000	6,437,200,000	47,744,900,000
October 1,	31,694,700,000	7,921,600,000	5,793,900,000	45,410,200,000
November 1,	31,149,200,000	7,890,300,000	5,225,300,000	44,264,800,000
December 1,	31,132,700,000	7,762,600,000	5,380,900,000	44,276,200,000
1907.				
January 1,	31,752,900,000	6,748,900,000	5,651,400,000	44,153,200,000

Wachusett Reservoir. — At the beginning of the year the water in this reservoir was at elevation 344.06, and the reservoir contained 17,115,300,000 gallons of water, or slightly more than one-fourth its full capacity. The yield of the watershed, although greater than in 1905, was still below the average. The highest elevation reached during the year was 367.75, on July 10, when the reservoir contained 34,462,500,000 gallons. Water was drawn for the supply of the Metropolitan District as follows: from January 7 to March 4; March 19 to May 28; June 7 to June 17; June 19 to August 16; August 18 to August 29; September 4 to December 16; and December 26 to December 31. At the end of the year the water stood at elevation 364.57, and the reservoir contained 31,752,900,000 gallons, — a net gain in storage for the year of 14,637,600,000 gallons, which is an increase of 1,931,900,000 gallons over the net gain during the previous year. The only water discharged from the reservoir into the river below the dam was that required for the use of the Lancaster Mills, and to keep the surface of the Lancaster Mills pond up to the crest of its dam. The average quantity as measured at the gaging station below the Lancaster Mills was 3,761,000 gallons per day.

The 50-foot marginal strip along the full reservoir flow-line has been kept mowed, and miscellaneous rubbish has been collected from time to time along the shore line of the reservoir and burned.

A large hole was made in the bed of the Quinepoxet River, just below the highway bridge in Oakdale, during the spring freshets. This has been filled with large stones gathered from the reservoir bottom in the vicinity.

The grass on the north and south dikes has been sold at auction for $1,046.50.

At the Wachusett Dam the maintenance work, consisting of the operation of the valves controlling the flow of water, the cleaning of screens, taking care of the gate-chambers and of the grounds above and below the dam, has been done by 3 gate-keepers, assisted by from 2 to 5 laborers whenever necessary. On Sundays and holidays during the summer season the presence of a large number of visitors on the dam and grounds has made it necessary to keep several of our men, who have been qualified as special police, on duty to preserve order and protect the grounds from damage.

In the lower gate-chamber temperature cracks in the concrete foundations have been cut out and pointed with Portland cement mortar. The brick piers supporting the 48-inch pipes in wells Nos. 2 and 3 have been repaired, and a 48-inch flanged ¼-turn in the equalizer pipe in well No. 4, which was found to be cracked, has been replaced. During the year the Anna Tucker house and barn in Boylston, and the Henry March house and barn in Oakdale, which are now occupied by employés of the Board, have been thoroughly repaired and painted. The Clinton office building has been shingled and the exterior painted.

Sudbury Reservoir. — At the beginning of the year the water in this reservoir stood at elevation 256.97, or 2.03 feet below the stone crest of the dam. During the winter and early spring months the water was kept for the greater part of the time from 2 to 3 feet below the crest of the dam, in order to provide storage in case of large yields from the watershed. From May 3 until December 7 the water, except for a short time in September, was flowing continuously over the crest of the dam, the elevation of the reservoir being kept at the proper height by water furnished from the Wachusett Reservoir. The flow from the Wachusett Reservoir was shut off from December 16 to 26, and at the end of the year the water in the Sudbury Reservoir was about 3 feet below the crest of the dam.

Early in the year it was found that about half of the barn at the Sudbury Dam was so badly decayed that it was unsafe for use. This portion of the barn has been rebuilt, and the whole barn and the house occupied by the foreman have been shingled. The barn was painted by our own employés.

The grounds near the dam have been improved by covering an unsightly rock dump with loam, planting two dozen swamp maples, and by sodding the steep slope of the hillside near the head-house of the Weston Aqueduct.

During the winter 81 electric railway poles and 1,425 ties were cut and sold to the Boston & Worcester Street Railway Company, and 593 chestnut posts were cut for use on the works.

When opportunity offered, some work has been done toward the construction of a rough road, 13,000 feet long, along the northerly side of the reservoir, from the dam to Parmenter Street, for use in reaching our property on the north side of the reservoir.

A four-strand twisted wire fence, 1,109 feet long, has been built, and 203 feet of stone wall repaired on the property line between land of the Commonwealth and of Robert A. Clark, who will build an equal amount of fence to complete the fencing of the line between himself and the land of the Commonwealth.

During August and September 3,200 pine trees were set out at various points around the reservoir. In the winter and early spring an inspection of all the woods belonging to the Commonwealth around the reservoir was made for gypsy and brown-tail moths. None of the former were found, but 3,500 nests of brown-tail moths were destroyed, the greater proportion of these being found in Marlborough, in the vicinity of the Marlborough filter-beds.

Marlborough Brook Filter-beds. — These beds have been in use throughout the year, and have filtered all the water received from the brook except for a small amount on March 10 and during a thunder-shower in the night of July 31. All of the beds have been cleaned during the year, and grass and weeds were removed from the surface of the beds about the first of August. The receiving and settling reservoir was cleaned in June, and about 1,100 cubic yards of material were removed and used for filling a depression on the easterly side of the reservoir, near Walker Street. During July and August there was a flow of tar from the reservoir of the Marlborough Gas Company into Marlborough Brook, the quantity at one time being so large as to extend down the brook for a distance of several hundred feet. The gas company removed the tar from the brook, and constructed a cut-off trench to prevent its entering the brook in the future. There was a flow of diluted sewage from the Marlborough main sewer to the combined storage reservoir and filter-bed on Farm Road during a part of March and for a few days in April, and a small flow of ground water continued through the sewer at times until the first of August.

Framingham Reservoir No. 3. — The water in this reservoir has been kept from 1 to 3 feet below the crest of the dam, its elevation being controlled by drafts from the Sudbury Reservoir.

Framingham Reservoir No. 2. — This reservoir was kept practically full throughout the year. Water for the supply of the Metropolitan District was drawn from the reservoir during portions of the months of February, May, July, September and November, and continuously during August and October.

A four-strand ribbon wire fence, about 4,000 feet long, was built in the spring on the property line between land of R. H. Long and the Commonwealth on the westerly side of the reservoir.

Framingham Reservoir No. 1. — This reservoir was full throughout the year except when drawn upon for the purpose of filling Farm Pond or of running water to Lake Cochituate. Water was wasted at the dam during the whole or a part of every month in the year except October. Water was drawn from this reservoir into Lake Cochituate on June 14, 15, 19, 20 and 21; from June 30 to July 2; on July 21, 22 and 23; September 4, 5, 6 and 7; November 27 and 28; and December 3, 4 and 5.

Ashland Reservoir. — At the beginning of the year water in this reservoir was at elevation 220.91, or 4.3 feet below high water, but water was flowing over the masonry crest of the waste-way on January 25. The reservoir remained full and water ran over the flash-boards at the waste-way until early in September, when the reservoir was drawn upon for the supply of the Metropolitan District, and on October 20 its surface had been lowered about 5 feet. In the latter part of December the reservoir was again full, and water was flowing over the crest of the waste-way.

On April 19 the upper portion of the gate-keeper's house was destroyed by fire. The house was a small, one and one-half story building, and did not properly accommodate the keeper's family. In rebuilding, another story has been added and a more convenient arrangement of the interior made. The rebuilding, with the exception of the painting, which was done by our own men, was done by A. P. Eldridge of South Framingham, at a cost of $1,200.

Hopkinton Reservoir. — This reservoir was 9.26 feet below high water at the beginning of the year. The water gradually rose during January and February, and on March 5 was flowing over the stone crest of the waste-way. Water was drawn from the reservoir to replenish Framingham Reservoir No. 2 during a portion of each month from May to November, excepting June. The reservoir remained full and water was running over the flash-boards a portion of the time until early in September, when the draft gradually lowered the water to 5 feet below the crest of the dam on November 6. On January 1, 1907, the water had risen to elevation 303, or 2 feet below high water.

The flight of steps leading up the side of the embankment of the

dam, opposite the filter-beds, has been repaired; and a small piece of ground between the foot of the dam and filter-bed No. 1, which was covered with water when the filter-beds were in use, has been raised, to prevent flooding.

During the winter, 1,886 chestnut posts were cut on the southerly side of the reservoir.

Whitehall Reservoir. — Water was allowed to run to waste from this reservoir during January and portions of February and March. The surface of the reservoir fell from elevation 337.27 on January 1 to 335.45 on February 20. Early in July the reservoir reached its old high-water mark, and remained full until the early part of December, when water was again allowed to waste. On January 1, 1907, the elevation of the reservoir was 337.05.

Farm Pond. — The water in this pond ranged between high-water and a foot below during the year. For the convenience of the Framingham Water Works, it was partially filled with water drawn from Framingham Reservoir No. 1 in September and November.

Lake Cochituate. — At the beginning of the year the water in the lake was 5.68 feet below high water. No water was drawn from the lake from January 1 until April 24, and it was so near high-water mark on March 9 that waste was commenced at the outlet dam, and continued for the greater portion of the time until April 24. The lake remained practically full until early in July, after which date it gradually lowered until the middle of November, when it was 7.6 feet below high water. Water was turned into the lake from Framingham reservoirs Nos. 1 and 2 in June, July, September, November and December.

Between October 15 and November 26 the wooden flume through the circular dam which is used for keeping the easterly arm of the lake, known as the Fiske Meadow, covered with water at times when the lake is more than 1 foot below high water, was replaced by a flume built of Portland cement concrete. The flume is 6.25 feet wide, 42.5 feet long on the bottom and 7.25 feet deep at the centre. The floor of the flume and the foundation of the sidewalls are of concrete 14 inches in thickness, reinforced with corrugated steel rods, and are supported upon the spruce piles which supported the old culvert and upon 4-inch by 4-inch spruce timbers driven through the underlying peat and mud to hard bottom. The sidewalls of the flume are 18 inches thick at the top, with a batter of about 3 inches

per foot on the back; they are 7.25 feet high at the centre and 6 inches high at either end. The slope on the down-stream side of the dam was repaved. The elevation of the water above the dam can be controlled by stop-planks set in grooves in the sidewalls of the flume. While the work on the flume was in progress considerable work was done in removing the rubbish from the shores around the basin, and at the easterly end, near West Central Street, the shore was improved by excavating so as to prevent shallow flowage.

During the early part of the year the land between the outlet dam and the attendant's house was improved by cutting out trees and underbrush which had been killed by fire during the previous year, and a few nests of the brown-tail moth were found and destroyed. In the latter part of the year the eggs of the gypsy moth were found in considerable numbers on the east side of the lake, in the neighborhood of the summer camps. The work of destroying these was begun in December.

The barn, store-house and carriage-house used by the foreman, and the roof of the effluent gate-house, have been painted.

No water has been turned from Dudley Pond into Lake Cochituate, and the elevation of the pond has ranged between 3.9 feet below high water at the beginning of the year and 2.39 feet below on June 1.

The surface of Dug Pond has varied between 0.91 of a foot above and 3 feet below the invert of the 18-inch overflow pipe.

Water was pumped on to the Pegan Brook filter-beds on 191 days during the year. The total quantity pumped was 246,525,000 gallons, of which 158,739,000 gallons were from Pegan Brook and 87,786,000 gallons from the intercepting ditch which collects water from the brooks formerly draining into Pegan Brook Meadow. The total quantity of coal consumed was 148,825 pounds, so that 1,656 gallons of water were pumped per pound of coal. The cost of operating the pumping station, cleaning the filter-beds and caring for the grounds was $4,314.79, making the cost per million gallons pumped $17.50. The filter-beds have been cleaned several times in the usual way, by the removal of the deposit which collects on the surface of the beds, and in addition the dark-colored sand composing the upper surface of the beds has been removed to an average depth of about 3 inches. The deeper portion of the receiving reservoir on Pegan Brook has also been cleaned of mud and silt, which gen-

erally had a depth of about 8 inches, except along the location of the old channel, where the depth of the deposit was about 3½ feet. About 1,027 cubic yards of sand were removed from the surface of the filter-beds, and about 2,450 cubic yards of mud and silt from the bottom of the receiving reservoir. The sill of the overflow from the receiving reservoir and the stop-plank grooves of the overflow, which were of wood, and badly decayed, have been removed and replaced by a concrete sill and grooves.

Sources from which Water has been taken.

An average of 80,764,000 gallons of water per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. An average of 32,289,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct into the distribution system of the Metropolitan District. From Framingham Reservoir No. 3 an average of 68,363,000 gallons per day, and from Framingham reservoirs Nos. 1 and 2 an average of 5,634,000 gallons per day, was drawn through the Sudbury Aqueduct to Chestnut Hill Reservoir. An average of 13,288,000 gallons per day was drawn from Lake Cochituate through the Cochituate Aqueduct to Chestnut Hill Reservoir. The Spot Pond drainage area furnished 321,000 gallons per day.

Aqueducts.

The *Wachusett Aqueduct* has been in use 316 days during the year. It was thoroughly cleaned between December 17 and 22. It was also examined at this time and found to be in good condition. All ironwork on structures along the aqueduct, including the terminal chamber, has been painted. The granolithic surfacing on top of the Assabet Bridge has been repaired, and the usual work of maintenance along the line of the aqueduct performed.

The *Sudbury Aqueduct* has been in service 359 days during the year. The aqueduct was cleaned from Framingham Dam No. 1 to Chestnut Hill Reservoir, including the three siphon pipes, from May 22 to 24 and June 5 to 8. The joints in the masonry of several of the culverts and waste-weirs, and in the superstructures of the east and west siphon chambers, have been cut out and pointed, the work on the culverts and waste-weirs being done by our own employés and that on the siphon chambers by R. H. Pickett. Of the 50 culverts, waterways and waste-weirs on the line of this aqueduct,

28 have been repointed within the last few years and 5 have been partially pointed. The ironwork in the roofs of the east and west siphon chambers and the 4 waste-weirs has been thoroughly scraped, to remove the rust, and painted, also the floor beams and gratings of the west siphon chamber. The flash-boards in both the east and west siphon chambers, 161 in number, were painted, also two small buildings over manholes on the line of the aqueduct.

In order to avoid possible claims for damages on account of the running of water from the Sudbury Aqueduct through Course Brook to Lake Cochituate, the right has been obtained from John West, the owner of a parcel of land through which the brook runs, to flood his land to a height not exceeding elevation 150.20 at the culvert under Speen Street, also the right to enter his land for the purpose of repairing or deepening the brook.

The Newton and Watertown Gas Light Company laid eight 3-inch pipes over the aqueduct, under the sidewalk on the easterly side of Walnut Street, and the New England Telephone and Telegraph Company and the Newton and Watertown Gas Light Company laid 3-inch and 8-inch pipes over the aqueduct on Boylston Street at Newton Upper Falls. The town of Needham laid a 4-inch water pipe over the aqueduct at Wellesley Avenue.

Early in the year about 350 nests of the brown-tail moth were destroyed along the line of the aqueduct between the west siphon chamber and the westerly end of the Beacon Street tunnel.

The *Cochituate Aqueduct* was in use 237 days. The aqueduct was cleaned during the month of April. The stone masonry of two of the culverts has been repointed. The surveys for locating the aqueduct and determining the position of property bounds, which have been in progress for several years, have been finished. During the year 73 alignment bounds and 195 land bounds have been set, and at the end of the year but 36 of the property bounds remained to be set to complete the work.

The Newton and Watertown Gas Light Company laid eight 3-inch pipes over the aqueduct at Walnut Street in Newton Centre.

About 8,600 nests of the brown-tail moth were destroyed along the line of the aqueduct between the waste-weir in Wellesley and Chestnut Hill Reservoir, and 170 clusters of the eggs of the gypsy moth were destroyed on the aqueduct line in Newton and Brighton.

Beginning at a point about 850 feet east of the road leading from Cochituate to Natick, and extending for a distance of about a mile,

the land through which the aqueduct runs is wet and swampy. This has been improved by the construction of a ditch 1,550 feet long, 12 inches wide at the bottom and 1½ to 2 feet deep, with side slopes of 2½ to 1, draining westerly into Snake Brook, and by a similar but somewhat smaller ditch, 1,450 feet long, which carries the surface water easterly toward Oak Street into Stevens Brook.

The *Weston Aqueduct* was in use 355 days. It was cleaned from the head-house to siphon chamber No. 4 between March 6 and 17, including the siphon pipes at the Sudbury River and Happy Hollow. Two screens have been made and set in the head-house. In order to keep cattle off the aqueduct embankments, 2,265 feet of 4-strand ribbon wire fence has been built on the property line opposite lands of Bullard and Thomas in Wayland, and 704 feet along the line of Water Street in Framingham. The interior and exterior woodwork of the head-house, meter chamber, 2 gaging chambers and 4 siphon chambers has been painted. During the early winter months a portion of the woodland near siphon chambers Nos. 1 and 2 was improved by cutting underbrush and dead trees, and by thinning out the trees so that the remainder may have a better opportunity to grow. In doing this work 320 chestnut fence posts and about 19 cords of wood were obtained. Quite a number of small trees and considerable underbrush have also been cut along the aqueduct line, for the purpose of saving future expense in protecting the property from the gypsy and brown-tail moths. The trees along the whole length of the aqueduct have been inspected for moths, and both varieties have been found and destroyed in small numbers at different points between the terminal chamber in Weston and the easterly end of tunnel No. 2 in Framingham. In the latter part of November work was begun on a small barn, 20 feet by 30 feet, to be built on the land formerly owned by George A. White, which is to be used by the foreman in charge of the aqueduct line. It is to be built by our regular employés during the winter.

Pumping Stations.

Seventy-three per cent. of all the water supplied to the Metropolitan District has been pumped at the two stations at Chestnut Hill Reservoir; the remainder was delivered by gravity. The total quantity pumped at all of the stations during the year was 35,180,570,000 gallons, or 805,660,000 gallons less than during the preceding year. The cost of operating the stations was $102,377.95, equivalent to

$2.91 per million gallons pumped, or $0.30 per million gallons more than the corresponding cost during the year 1905.

The cost per gross ton of fuel used at the Chestnut Hill high-service station was $0.08 greater, at the Chestnut Hill low-service station $0.04 greater, and at the Spot Pond station $0.36 greater, than during the preceding year. The greater part of the increase in cost of pumping is due to the increased cost of labor, caused both by increase in the rate of wages paid and by increase in the number of employés during the last two months of the year, made necessary by a reduction in the hours of labor from 56 hours to 48 hours per week. The remainder of the increase is due to increase in the cost of fuel, and a slight decrease in the efficiency of the pumping machinery.

Tests have been made from time to time to determine the viscosity, specific gravity and burning point of oil used at the several stations, and tests have been made to determine the calorific value of coal used and offered for use in the several stations. Twenty-four tests have been made of oil and 33 of coal.

Coal for use at the several stations has been purchased as follows: —

	Gross Tons.					Price per Gross Ton, in Bins.
	Chestnut Hill High-service Station.	Chestnut Hill Low-service Station.	Spot Pond Station.	West Roxbury Station.	Arlington Station.	
Merchants Coal Company, bituminous,	173.60	-	-	-	-	$4 79
C. W. Claflin & Co., bituminous,	410.50	-	-	-	-	4 73
Merchants Coal Company, bituminous,	196.39	-	-	-	-	4 56
Merchants Coal Company, bituminous,	518.99	-	-	-	-	4 48
Merchants Coal Company, bituminous,	-	796.07	-	-	-	4 42
Spring Coal Company, bituminous,	53.26	-	-	-	-	4 15
William A. Jepson, bituminous,	2,004.20	-	-	-	-	4 14
Anderson Coal Mining Company, bituminous.	45.81	-	-	-	-	4 10
Merchants Coal Company, bituminous,	1,371.30	-	-	-	-	4 09
William A. Jepson, bituminous,	-	1,379.69	-	-	-	4 05
Merchants Coal Company, bituminous,	-	1,061.86	-	-	-	4 00
C. W. Claflin & Co, buckwheat anthracite.	1,230.70	-	-	-	-	2 93
C. W. Claflin & Co., buckwheat anthracite.	-	1,061.80	-	-	-	2 84
Bay State Fuel Company, screenings,	68.23	-	-	-	-	2 52
Bay State Fuel Company, screenings,	-	3.42	-	-	-	2 52
Malden Coal Company, bituminous,	-	-	305.90	-	-	4 38

	Gross Tons.					Price per Gross Ton, in Bins.
	Chestnut Hill High-service Station.	Chestnut Hill Low-service Station.	Spot Pond Station.	West Roxbury Station.	Arlington Station.	
Locke Coal Company, bituminous,	-	-	447.91	-	-	$4 35
Locke Coal Company, screenings,	-	-	277.39	-	-	2 24
D. J. Cutter & Co., anthracite,	-	-	-	363.37	-	7 28
Locke Coal Company, bituminous,	-	-	-	-	50.01	4 60
Peirce & Winn Company, bituminous,	-	-	-	-	113.54	4 51
Locke Coal Company, bituminous,	-	-	-	-	285.00	4 48
Wellington-Wild Coal Co., bituminous,	-	-	-	-	51.49	4 25
Peirce & Winn Company, screenings,	-	-	-	-	193.24	2 24
Locke Coal Company, screenings,	-	-	-	-	6.35	2 24
Total gross tons, bituminous,	4,774.05	3,237.62	753.81	-	500.04	-
Total gross tons, anthracite,	1,230.70[1]	1,061.80[1]	-	363.37	-	-
Total gross tons, anthracite screenings.	58.23	3.42	277.39	-	199.59	-
Average price per gross ton, bituminous,	$4 26	$4 12	$4 36	-	$4 48	-
Average price per gross ton, anthracite,	2 93[1]	2 84[1]	-	$7 28	-	-
Average price per gross ton, anthracite screenings.	2 52	2 52	2 24	-	2 24	-

[1] Buckwheat.

Chestnut Hill High-service Station.

The water used in the high-service district of Boston, the city of Quincy and the towns of Watertown, Belmont and Milton, was pumped at this station.

The following are the statistics relating to operations at this station: —

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Totals for Station.
Total quantity pumped (million gallons),	1,905.11	514.22	10,310.81	12,730.14
Daily average quantity pumped (gallons),	5,219,000	1,409,000	28,249,000	34,877,000
Total coal used (pounds),	3,014,777	518,933	8,518,537	12,052,247
Gallons pumped per pound of coal,	631.92	990.91	1,210.40	1,056.25
Average head pumped against (feet),	120.99	128.44	131.57	129.86
Cost of pumping: —				
Labor,	$4,945 02	$608 62	$13,465 67	$19,019 31
Fuel,	5,415 43	908 63	15,253 44	21,577 50
Repairs,	2,000 35	246 22	509 36	2,755 93
Oil, waste and packing,	141 58	17 43	385 53	544 54
Small supplies,	144 53	17 79	393 55	555 87
Totals,	$12,646 91	$1,798 69	$30,007 55	$44,453 15
Cost per million gallons pumped,	$6.638	$3.498	$2.910	$3.492
Cost per million gallons raised 1 foot high,	0.055	0.027	0.022	0.027

The repairs on engine No. 2, which were in progress at the beginning of the year, were completed in February, and the engine was placed in service on the 19th of that month. A description of the work done was given in the report for the year 1905.

Plans and specifications have been prepared and a contract will soon be made for an additional boiler of the same size and design as the two 64-inch horizontal tubular boilers now in use at the station.

The joints in the exterior masonry of the pumping station have been repointed.

Chestnut Hill Low-service Pumping Station.

The quantity of water pumped at this station was about 5 per cent. less than during the preceding year.

The following are the statistics relating to operations at this station: —

	Engines Nos. 5, 6 and 7.
Total quantity pumped (million gallons),	18,938.59
Daily average quantity pumped (gallons),	51,887,000
Total coal used (pounds),	7,955,358
Gallons pumped per pound of coal,	2,380.61
Average head pumped against (feet),	51.15
Cost of pumping: —	
Labor,	$16,754 78
Fuel,	13,583 83
Repairs,	682 68
Oil, waste and packing,	535 07
Small supplies,	448 60
Total for station,	$32,004 96
Cost per million gallons pumped,	$1.690
Cost per million gallons raised 1 foot high,	0.033

The cost per million gallons pumped was $0.106 greater than for the year 1905. This was due to the increase in the cost of labor and fuel.

Spot Pond Pumping Station.

At this station practically all of the water was pumped with engine No. 9, the 20,000,000-gallon Holly engine, engine No. 8 having been in operation only 12 hours and 45 minutes during the year.

The following are the statistics relating to operations at this station: —

	Totals for Station. Engines Nos. 8 and 9.
Total quantity pumped (million gallons),	3,031.77
Daily average quantity pumped (gallons),	8,306,000
Total coal used (pounds),	2,533,049
Gallons pumped per pound of coal,	1,196.09
Average head pumped against (feet),	127.98
Cost of pumping: —	
Labor,	$6,771 54
Fuel,	4,485 18
Repairs,	462 26
Oil, waste and packing,	174 97
Small supplies,	311 09
Totals,	$12,205 04
Cost per million gallons pumped,	$4.026
Cost per million gallons raised 1 foot high,	0.031

The cost per million gallons pumped was $0.078 more than for the previous year, due, as at the Chestnut Hill stations, to the increased cost of labor and fuel.

Joints in the exterior masonry of the building were repointed, and repairs made upon the tile roof and copper gutters.

West Roxbury Pumping Station.

At this station water was pumped for supplying the higher portions of West Roxbury and Milton.

The following are the statistics relating to operations at this station: —

Pumps operated 7,892 hours 5 minutes; average, 22 hours per day.	
Daily average quantity of water pumped (gallons),	646,000
Daily average quantity of coal consumed (pounds),	2,238
Gallons pumped per pound of coal,	289
Average lift in feet,	140
Cost of pumping: —	
Labor,	$3,817 81
Fuel,	2,659 72
Repairs and small supplies,	667 26
Total for station,	$7,144 79
Cost per million gallons pumped,	$30.281
Cost per million gallons raised 1 foot high,	0.216

During the first seven months of the year the quantity of water consumed in the district supplied from this station showed a considerable increase, and during several weeks the daily average quantity pumped was between 800,000 and 900,000 gallons per day. The discovery and repair of a number of leaks in the distribution system, one of which amounted to about 108,000 gallons per day, caused a very material reduction in the quantity pumped, and at the close of the year the daily average quantity of water pumped was less than 500,000 gallons.

One of the 54-inch vertical boilers was repaired by putting in new tube sheets, the work being done by the Daniel Russell Boiler Works of South Boston, at a cost of $175. A new Warren air pump was installed in April as an auxiliary to the old air pump, which did not work satisfactorily, and which is now held in reserve. In March a new plunger rod was placed in the No. 2 pump, to replace one which broke while the pump was in operation.

Arlington Pumping Station.

All water supplied to the town of Lexington and to the high-service district of Arlington was pumped at this station.

The following are the statistics relating to operations at this station: —

Pumps operated 8,702 hours 45 minutes; average, 24 hours per day.	
Daily average quantity of water pumped (gallons),	671,000
Daily average quantity of coal consumed (pounds),	4,055
Gallons pumped per pound of coal,	165
Average lift in feet,	283
Cost of pumping: —	
Labor,	$3,620 78
Fuel,	2,670 38
Repairs and small supplies,	278 85
Total for station,	$6,570 01
Cost per million gallons pumped,	$26.843
Cost per million gallons raised 1 foot high,	0.095

The quantity pumped was 86,000 gallons per day, or 14.7 per cent. greater than during the year 1905. The cost per million gallons pumped was $0.28 less than during the previous year, due to the increase in the amount of water pumped, while the cost of operation did not increase in the same proportion.

On October 3 the cast-iron partition between the water cylinders in the compound Blake pump, which is constantly used for pumping at this station, was found to be cracked. Temporary repairs were made by our own employés, which it is expected will permit the use of the pump until the engine in the new station which is now being built is placed in service.

Consumption of Water.

The daily average quantity of water consumed in the cities and towns supplied from the Metropolitan Water Works during the year 1906, as measured by the Venturi meters, was 117,524,600 gallons, equal to 128 gallons per inhabitant in the district supplied. In addition to the above, 45,000 gallons daily were supplied to the United States Government reservation on Peddock's Island. The daily average quantity supplied to the Metropolitan Water District, as determined by pump measurement and by the flow in the Weston Aqueduct and the estimated yield of Spot Pond, was 118,820,000 gallons, equal to 130 gallons per inhabitant. The excess difference of 1,250,400 gallons per day between the quantity delivered by the aqueducts and that measured by meters to the several municipalities is due to differences in methods of measurement, to leakage from the Metropolitan Water Works reservoirs and pipes, and to the use of water at the Chestnut Hill and Spot Pond pumping stations.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the years 1905 and 1906, as measured by the Venturi meters, was as follows: —

	Estimated Population. 1906.	Daily Average Consumption.					
		1905.		1906.		Increase.	Decrease.
		Gallons.	Gallons per Capita.	Gallons.	Gallons per Capita.		
Boston, . .	601,430	89,743,900	151	90,951,800	151	1,207,900	-
Somerville, .	70,950	6,160,900	89	6,301,000	89	140,100	-
Malden, . .	39,040	2,019,500	53	2,000,100	51	-	19,400
Chelsea, . .	38,000	4,091,200	110	3,694,000	97	-	397,200
Everett, . .	30,270	2,592,400	89	2,441,600	81	-	150,800
Quincy, . .	28,300	3,050,100	109	3,021,800	107	-	28,300
Medford, . .	20,080	1,921,800	97	2,014,100	100	92,300	-
Melrose, . .	14,650	1,601,100	112	1,591,300	109	-	9,800

	Estimated Population. 1906.	Daily Average Consumption.					
		1905.		1906.		Increase.	Decrease.
		Gallons.	Gallons per Capita.	Gallons.	Gallons per Capita.		
Revere,	13,390	1,006,800	78	1,093,200	82	86,400	-
Watertown,	11,550	790,700	70	771,300	67	-	19,400
Arlington,	9,940	787,700	81	800,800	81	13,100	-
Milton,	7,120	320,900	45	350,300	49	29,400	-
Winthrop,	7,240	798,300	113	819,800	113	21,500	-
Stoneham,	6,350	514,000	81	441,200	69	-	72,800
Belmont,	4,410	266,300	61	272,900	62	6,600	-
Lexington,	4,230	299,100	74	335,000	79	35,900	-
Nahant,	1,850	136,600	74	131,900	71	-	4,700
Swampscott,	6,240	534,600	88	492,500	79	-	42,100
District,	915,040	116,635,900	129	117,524,600	128	888,700	-

The consumption in the several districts was as follows: —

	Gallons per Day.	Increase (Gallons per Day).
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston,	47,769,800	665,800
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston,	26,258,200	750,800 [1]
Southern high-service district, embracing the high-service districts of Boston, Quincy, Watertown, Belmont, and a portion of Milton,	33,870,300	739,400
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston,	8,309,300	137,300
Southern extra high-service district, embracing the highest portions of West Roxbury and Milton,	646,400	10,400
Northern extra high-service district, embracing Lexington and the highest portions of Arlington,	670,600	85,600
Totals,	117,524,600	888,700

[1] Decrease.

The consumption in the northern low-service district shows a reduction, while all the other districts show an increase, as compared with the quantity used in 1905. This is due to the fact that in Chelsea, East Boston and Somerville, which form a considerable part of the northern low-service district, the waste to prevent freezing of service pipes during the cold months in 1905 was greater in

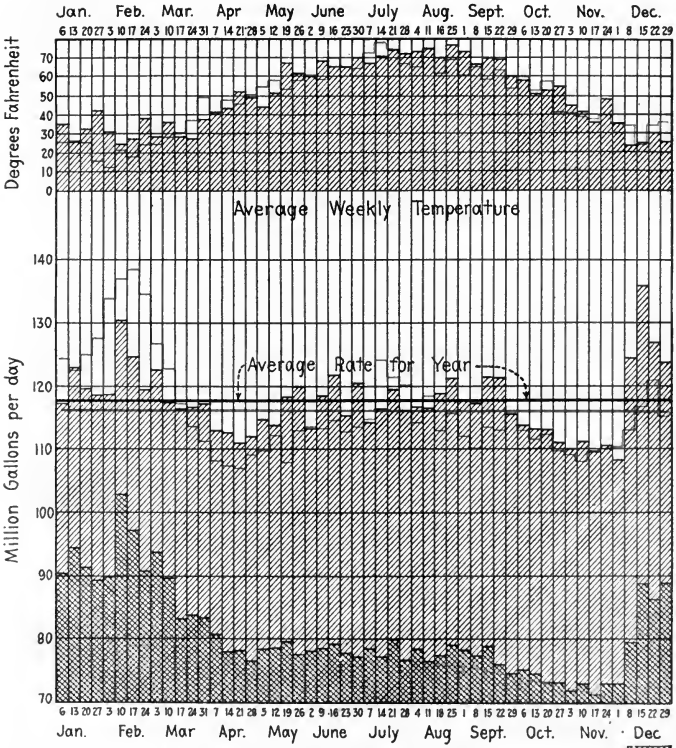
proportion to the total consumption for that year than in any other parts of the Metropolitan District.

The diagram facing this page shows the average rate of consumption in the district supplied by the Metropolitan works for each week during the years 1905 and 1906, also the rate of consumption between the hours of 1 and 4 A.M., and the average temperature of the air for the week. By examination of the diagram it will be seen that during the months of January, February and March, 1906, the consumption was smaller during the past year than during 1905, while during the month of December it was larger during the latter year. These variations in the consumption were largely due to difference in temperature, the earlier months having been much warmer and the last month colder in 1906 than in 1905. The diagram also shows a noticeable drop in the night rate, not only during the winter months but also during the latter half of the year 1906, which appears to indicate that the increasing use of meters in some cities and towns and more careful inspection for leaks are causing a reduction in the quantity of water which is being wasted.

During the latter portion of the year a very noticeable reduction was made in the consumption of the district in West Roxbury, which is supplied with water from the West Roxbury pumping station. This reduction was due to the inspection made by the Boston authorities and the discovery and repair of a large leak in a 12-inch main on Corey Street, together with two leaks in service pipes and numerous defects in house plumbing. The leak from the 12-inch main, due to the blowing out of a leaded joint, caused a waste of about 4,500 gallons per hour, or 108,000 gallons per day, which ran into an old well and disappeared. A reduction of about 200,000 gallons per day, equivalent to about 25 per cent. of the total consumption of the district, was made by the discovery and repair of these defects.

The number of new meters set during the past year in the cities and towns supplied from the Metropolitan Works was 4,257, — a greater number than have been set during any year since the Metropolitan Water Works have been in operation, and about 1,000 more than the number of new services laid. The greater number of the meters were set in Malden, Somerville, Quincy, Swampscott and Chelsea.

AVERAGE RATE OF CONSUMPTION
—IN— METROPOLITAN WATER DISTRICT
—AND— Average Temperature of Air at Chestnut Hill Reservoir
—FOR— Each Week during 1906



Average Rate of Consumption for each week, thus.....

" " " " between 1 and 4 A.M. for each week, thus

Average Rate of Consumption in 1905 shown in red

Quality of the Water.

Samples of water have been collected every two months from 15 points, and monthly from 8 points on the works, and sent to the State Board of Health for analysis and examination. Samples of water have also been collected weekly at 24 points, biweekly at 7 points and monthly at 14 points, and examined microscopically and for color, odor, taste and turbidity in the biological laboratory of the Metropolitan Water and Sewerage Board, which has been in charge of Arthur W. Walker.

The quality of the water delivered in the Metropolitan District has been substantially the same as during the past three or four years, except that the number of microscopic organisms has been somewhat larger and the color of the water somewhat less.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1900 to 1906, inclusive: —

	1900.	1901.	1902.	1903.	1904.	1905.	1906.
State Board of Health Examinations.							
Color (Nessler standard),	0.24	0.24	0.26	0.25	0.23 [1]	0.24 [1]	0.24 [1]
Total residue,	3.80	4.43	3.93	3.98	3.93	3.86	3.86
Loss on ignition,	1.20	1.64	1.56	1.50	1.59	1.59	1.39
Free ammonia,	0.0012	0.0018	0.0016	0.0013	0.0023	0.0020	0.0018
Albuminoid ammonia, total,	0.0157	0.0158	0.0139	0.0125	0.0139	0.0145	0.0159
Albuminoid ammonia, dissolved,	0.0138	0.0143	0.0119	0.0110	0.0121	0.0124	0.0134
Albuminoid ammonia, suspended,	0.0019	0.0015	0.0020	0.0015	0.0018	0.0021	0.0025
Chlorine,	0.25	0.30	0.29	0.30	0.34	0.35	0.34
Nitrogen as nitrates,	0.0076	0.0173	0.0092	0.0142	0.0110	0.0083	0.0054
Nitrogen as nitrites,	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Oxygen consumed,	0.38	0.42	0.40	0.39	0.37	0.35	0.36
Hardness,	1.3	1.7	1.3	1.5	1.5	1.4	1.3
Metropolitan Water and Sewerage Board Examinations.							
Color (platinum standard),	34	34	33	35	32	28	25
Turbidity,	–	2.0	2.3	2.2	2.4	1.9	2.2
Total organisms,	468	243	367	256	303	528	550
Amorphous matter,	97	38	34	36	36	37	42
Bacteria,	181	162	164	126	176	231	154

Note. — Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

[1] Platinum standard.

The color of the water supplied in the northern high-service district is, by storage in the Spot Pond and Fells reservoirs, reduced to about two-thirds that of the water supplied to the remainder of the Metropolitan District.

In the biological laboratory there have been made 2,526 microscopical and 1,017 biological examinations of water collected at various points on the works. Of the microscopical examinations, 1,967 were of the regular weekly and biweekly samples, and 559 were special examinations.

The bacteriological work consisted of routine weekly examinations, the monthly examinations of the main feeders of the Sudbury Reservoir, of Framingham Reservoir No. 3 and of Lake Cochituate, and monthly tests of the efficiency of the Pegan and Marlborough Brook filters.

In the Wachusett Reservoir the number of organisms has been small throughout the year, and never of a character to give the water an objectionable taste or odor. In the Sudbury Reservoir the number of organisms has been much larger than usual, and from March until July Uroglena was present in varying quantities, causing at times an objectionable odor in the water of the reservoir. The organisms were broken up by passing the water over the Sudbury Dam, and both organisms and odor disappeared before the water reached the gate-house at the lower end of Framingham Reservoir No. 3. In Lake Cochituate the number of microscopic organisms has been large, and at times of an objectionable character. From January 1 until April 23 no water was drawn from these sources, on account of the objectionable odor due to the growth of Chlamydomonas. Synura was present at different times during the year, but not in large enough quantities to cause trouble until December, when the odor of the water became so objectionable as to cause its use to be discontinued on December 17. The water in Spot Pond has been generally free from objectionable organisms, but there was a growth of Uroglena in April, which necessitated the shutting off of the reservoir from the distribution system from April 30 to May 11.

Sanitary Inspection.

The sanitary inspection of the Wachusett, Sudbury and Cochituate watersheds has been continued during the year under the direction of William W. Locke, C.E., Sanitary Inspector.

On the Wachusett watershed 11 cases of typhoid fever were reported, 4 in Holden, 1 in Rutland and 6 in Princeton. Five of the cases in Princeton occurred in one house, and an analysis of the

well water indicated that it was polluted from a privy or cesspool, both of which are very near the well.

On the Sudbury and Cochituate watersheds the number of typhoid fever cases reported was 44, — a much larger number than usual. Twenty-three of these cases were reported from houses connected with the public sewers. Ten cases were reported in Marlborough, 16 in Natick, 8 in South Framingham, 2 in Ashland, 2 in Southborough, 2 in Hopkinton, 3 in Westborough and 1 in Cochituate. The cases in Marlborough were scattered throughout the city, and spread over the entire year. Nearly all of the cases in Natick and the 2 cases in Westborough were doubtless due to an infected milk supply, which caused an epidemic in South Natick. All of the cases were investigated as soon as reported, and precautions taken wherever necessary to prevent infection of the water supply.

During the year the sanitary conditions upon the several watersheds have been improved as follows: On the Wachusett watershed 30 dwelling-houses, 10 barns and 1 store on property owned by the Board have been torn down or removed outside the watershed. The Dorr and Warfield mills on the Quinepoxet River, where 50 men were formerly employed in manufacturing satinets and shoddy, have been dismantled. The land on the southerly shore of West Waushacum Pond has been acquired for a distance of about 3,000 feet, including a farmhouse and barn and 5 summer cottages. Twenty-eight cesspools, 7 cemented vaults and 1 gravel filter-bed have been built in Boylston, West Boylston and Holden, for the purpose of preventing 44 cases of unsatisfactory drainage on 31 premises from entering the streams which run into the Wachusett Reservoir.

On the Sudbury watershed 141 old and 13 new premises were connected with the public sewers which convey the drainage outside the watershed. Forty-five of these premises are in Marlborough, 98 in Westborough and 11 in Framingham. The sanitary condition at the Cordaville Mills in Ashland is now being improved by the substitution of water-closets and a sub-surface filtration plant for the privy stacks and boxes heretofore used. At the Whitehall Reservoir a more thorough inspection has been maintained to prevent bathing, and measures have been adopted tending toward the restriction of boating.

On the Cochituate watershed 51 old and 24 new premises were connected with sewers which convey the drainage outside the watershed. Twenty-four of these were in Framingham and 51 in Natick.

The sanitary conditions around Lake Cochituate have been improved by the restriction of boating. The use of boats on the northern section of the lake, from which the supply is directly drawn, has been prohibited, and the number of boats used on the other sections of the lake has been limited. All boats have been registered and numbered and their use confined to persons licensed by the Board. Two inspectors were constantly employed during the summer season, to see that the regulations affecting the use of boats were obeyed, and that the sanitary rules and regulations were obeyed by the occupants of the cottages and by other persons camping near the lake. The restriction of boating caused a considerable reduction in the number of persons camping, particularly those occupying tents and temporary camps.

A summary of the work of sanitary inspection for the year 1906 is given in the following four tables. The first table shows for the Wachusett watershed the number of premises inspected, the classification of cases inspected, and the condition of the premises at the end of the year; the second table gives the corresponding information for the Sudbury and Cochituate watersheds; the third table shows the improvements effected on the Wachusett watershed; and the fourth table the improvements effected on the Sudbury and Cochituate watersheds.

The headings of these tables explain themselves, except in a few instances: under the heading "Premises Vacant" are included all cases which at present furnish no objectionable drainage, but which might furnish such drainage if the premises were occupied; under the heading "Unsatisfactory" are included all cases where there may be, under the most unfavorable conditions, wash from privies or direct sink drainage, all suspected cases, and all cases of manufacturing wastes entering feeders, even though there may be some attempt at previous purification.

In the third and fourth tables no cases are entered as remedied unless complete sewer connections have been made, or all probability of future contamination has been removed; and no cases are entered as partly remedied except where positive improvement in the sanitary condition has been effected.

Summary of Sanitary Inspections on the Wachusett Watershed in 1906.

District.	Number of Premises Inspected.[1]	Classification of Cases Inspected.									Condition at End of Year.	
		Cesspools dug before 1906.	Cesspools dug in 1906.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.	Manure Piles.	Manufacturing Wastes.	Premises Vacant.	Satisfactory.	Unsatisfactory.
French Brook,	73	28	5	–	–	–	11	32	–	12	67	6
Muddy Brook,	32	9	–	–	–	–	7	24	–	–	32	–
Gates Brook,	132	77	12	–	–	–	4	58	–	5	131	1
Malden Brook,	17	7	2	–	–	–	–	13	–	2	17	–
Chaffin Brook,	154	55	17	–	–	–	12	77	1	11	143	11
Asnebumskit Brook,	277	124	24	5	10	27	24	97	3	10	231	46
Muschopauge,	95	24	2	–	6	7	10	52	1	7	78	17
South Wachusett Brook,	82	21	1	2	1	4	3	36	–	10	74	8
Trout Brook,	38	5	–	–	–	–	3	26	–	5	36	2
East Wachusett Brook,	210	59	3	2	7	7	23	109	–	6	186	24
Stillwater River,	149	44	2	–	6	2	11	85	–	7	133	16
Waushacum,	163[2]	42	1	4	9	17	20	67	–	8	124	39
French Hill,	28	14	1	–	–	–	–	15	–	5	28	–
Totals,	1,450	509	70	13	39	64	128	691	5	88	1,280	170

[1] On some premises there are 2 or more cases.

[2] Not including 207 summer cottages located near the Waushacum Lakes.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1906.

District.	Number of Premises Inspected.[1]	Classification of Cases Inspected.									Condition at End of Year.	
		Cesspools dug before 1906.	Cesspools dug in 1906.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.	Manure Piles.	Manufacturing Wastes.	Premises Vacant.	Satisfactory.	Unsatisfactory.
Sudbury Watershed.												
Farm Pond,	242	19	–	–	–	–	1	21	–	5	240	2
Framingham Reservoir No. 3,	71	32	1	–	–	–	35	49	–	2	66	5
Stony Brook,	288	201	2	–	3	2	48	113	–	17	269	19
Angle Brook,	1,973	318	–	–	4	8	152	251	1	66	1,889	84
Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook,	271	96	3	–	2	–	108	113	–	27	259	12

[1] On some premises there are 2 or more cases.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1906 — Concluded.

District.	Number of Premises inspected.[1]	Classification of Cases inspected.									Condition at End of Year.	
		Cesspools dug before 1906.	Cesspools dug in 1906.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.	Manure Piles.	Manufacturing Wastes.	Premises Vacant.	Satisfactory.	Unsatisfactory.
Eastern Sudbury,	239	201	3	–	2	–	47	43	2	6	225	14
Indian Brook,	420	168	1	–	2	7	170	83	–	62	386	34
Western Sudbury,	184	61	2	–	4	5	77	54	1	30	155	29
Whitehall Reservoir,	111	22	–	–	1	1	74	37	–	10	100	11
Cedar Swamp,	811	258	–	–	1	6	92	128	1	55	793	18
Cochituate Watershed.												
Snake Brook,	320	219	2	–	–	2	93	68	–	8	296	24
Pegan Brook,	916	271	3	–	3	4	77	110	1	29	887	29
Course Brook,	88	49	–	–	–	–	29	41	–	7	86	2
Beaver Dam Brook,	1,069	208	9	–	4	3	90	183	3	16	1,020	49
Dug Pond,	499	191	1	–	3	7	36	49	–	8	477	22
Totals,	7,502	2,314	27	–	29	45	1,129	1,343	9	348	7,148	354

[1] On some premises there are 2 or more cases.

Sanitary Improvements effected on the Wachusett Watershed in 1906.

District.	Remedied by Filter-bed.	Otherwise remedied.[1]	Partly remedied.
French Brook,	–	10	6
Muddy Brook,	5	–	–
Gates Brook,	–	10	9
Malden Brook,	–	–	1
Chaffin Brook,	–	7	13
Asnebumskit Brook,	–	1	8
Muschopauge,	–	–	2
South Wachusett Brook,	–	–	–
Trout Brook,	–	10	–
East Wachusett Brook,	–	–	–
Stillwater River,	–	14	–
Waushacum,	–	1	–
French Hill,	–	4	–
Totals,	5	57	39

[1] Including buildings torn down or removed.

Sanitary Improvements effected on the Sudbury and Cochituate Watersheds in 1906.

District.	Remedied by Sewer Connection.	Otherwise remedied [1]	Partly remedied.	Cesspools abandoned on Account of Sewer Connections.
Sudbury Watershed.				
Farm Pond,	6	-	-	4
Framingham Reservoir No 3,	-	1	1	-
Stony Brook,	-	-	2	-
Angle Brook,	38	-	-	37
Framingham Reservoirs Nos. 1 and 2 and Cold Spring Brook.	-	3	3	-
Eastern Sudbury,	-	3	3	-
Indian Brook,	-	-	1	-
Western Sudbury,	-	-	2	-
Whitehall Reservoir,	-	2	-	-
Cedar Swamp,	97	-	-	90
Cochituate Watershed.				
Snake Brook,	-	-	2	-
Pegan Brook,	17	1	3	16
Course Brook,	-	-	-	-
Beaver Dam Brook,	10	-	9	8
Dug Pond,	24	-	1	21
Totals,	192	10	27	176

[1] Including buildings burned, torn down or removed.

Drainage of Swamps.

The drainage ditches in swamps on the Wachusett and Sudbury watersheds, aggregating 27.5 miles in length, not including those built during the past year, have been cleaned, and the grass, weeds and brush on either side of the ditches for widths varying from 10 to 20 feet mowed and burned. About 26,000 linear feet of the ditches draining into the Sudbury Reservoir were repaired by relaying the paving or by driving the stones back into place with a heavy rammer. The places repaired were generally in pastures, where the side slopes of the ditches and the paving had been damaged by the tramping of the cattle. A 48-inch woven wire fence, 663 feet long, has been built on the property line between the G. H. Buck land and land now or formerly belonging to Marshall Richards and John Dolan, for the purpose of preventing cattle from getting into the bog which surrounds Brigham's Pond.

Distributing Reservoirs.

The distributing reservoirs maintained by the Board are the Weston and Chestnut Hill reservoirs; the Waban Hill and Forbes Hill reservoirs and the Forbes Hill standpipe of the southern high-service system; Spot Pond and the Mystic Reservoir, near Tufts College, of the northern low-service system; the Fells and Bear Hill reservoirs of the northern high-service system; and the Arlington standpipe of the northern extra high-service system.

Weston Reservoir.

Several beds of shrubbery have been planted in the vicinity of the screen-chamber and the attendant's residence. Considerable labor has been expended in protecting the grounds from the gypsy and brown-tail moths, both by destroying the eggs, nests and caterpillars and by cutting and burning underbrush and thinning out trees, so as to make the work of destroying the moths easier in the future. The reservoir, grounds and buildings are in good condition.

Chestnut Hill Reservoir.

The gate-houses and grounds have received the usual care. The reconstruction of the gravel walk around the reservoir, which was begun a few years ago, has been continued as opportunity offered, and 3,627 feet have been rebuilt during the year. On account of the raising of the grade of Beacon Street by the city of Boston, it became necessary to resurface a portion of the driveway between the two basins of the reservoir, also to trim the lower branches of the trees on the northerly side of the street for a distance of about 1,500 feet. Considerable time was expended in destroying gypsy and brown-tail moths. Sixteen screens have been made for the effluent gate-house No. 2, using wire from the old screens, with new frames and baskets.

Waban Hill Reservoir.

Three beds of shrubbery were set out on the grounds in the spring. The grounds have received the usual care, and both reservoir and grounds are now in good condition.

Forbes Hill Reservoir and Standpipe.

Several beds of shrubbery were set out on the grounds early in the spring. The joints in the masonry of the stone steps leading to the reservoir embankment have been repointed. The reservoir and grounds have been kept in order, and the iron and wood work of the gate-chamber and standpipe tower have been kept painted by the attendant.

Spot Pond.

The reservoir and grounds are in good condition, but a large amount of work is constantly required to protect the trees from being destroyed by the gypsy and brown-tail moths. This work is described in detail in another part of this report. The growth of small birch trees and underbrush on about 50 acres of land in Bear Hill swamp, north of the reservoir, has been thinned out; the brook draining the meadow north of Doleful Pond has been deepened and straightened for a distance of 1,457 feet, and a concrete floor has been laid in the stable.

Mystic Reservoir.

Both the reservoir and grounds are in good condition. The reservoir was shut off from the distribution system from March 19 to April 28, on account of the objectionable taste and odor of the water caused by a growth of Uroglena.

Fells and Bear Hill Reservoirs.

The east basin of the Fells Reservoir was cleaned between April 9 and 21, and the west basin between April 27 and May 2. The total cost of cleaning the reservoir was $579.55. Both the Fells and Bear Hill reservoirs are in good condition with the exception of the woodwork of the gate-houses, which requires painting. Arrangements for doing this work have been made.

Arlington Standpipe.

Early in April the standpipe was emptied for examination, and a considerable quantity of silt and ice removed. During May it was again emptied, thoroughly cleaned and painted. The interior of the standpipe was given one coat of red lead and linseed oil paint,

and two coats of Gilsonite paint obtained from the Barber Asphalt Company. The under side of the roof and the roof trusses were given two coats of red lead, and the exterior of the standpipe and roof were given one coat of white lead and oil paint. The work was done by F. A. Tibbetts of Malden, at a cost of $425.

Mystic Lake.

The railing of the wooden bridge over the dam and 840 feet of fence on the line of Mystic Street have been painted. The gypsy and brown-tail moths on the trees have been destroyed. The house on the grounds near the dam is now unoccupied, the attendant having resigned and moved away on December 15. Arrangements have been made with the Metropolitan Park Commission to have the elevation of the water in the lake taken and reported daily to this department by one of the park policemen.

Pipe Lines.

Twenty-four leaks have been repaired on the pipe lines, at a cost of $1,685.64. In three cases the pipes broke, in one case the leaded joint between two castings was opened by the movement of a 48-inch curve, and in nineteen cases the leaks were due to defective leaded joints. The first break occurred on February 11, in a 6-inch pipe supplying water to the low-service station at Chestnut Hill. On April 18 a 48-inch curve on the force main leading from the 30,000,000-gallon engine at the Chestnut Hill high-service station split for its entire length, and as a result the basement of the building was flooded with water to a depth of several feet, and the grounds in the vicinity of the building considerably damaged by the water flowing from the pipe. On November 1 a curve in the 48-inch main on Washington Street, Melrose, was broken by the Melrose sewer department while blasting for a sewer trench. There was no water pressure on the pipe at the time of the break, the valves having been closed earlier in the day, at the request of the Melrose authorities. The cost of repairing this break was paid by the city of Melrose. Seven of the defective joints were found on the 36-inch pipes crossing the Charles and Mystic rivers.

Minor changes have been made at several points on the pipe lines, as follows: —

In order to facilitate the construction of the new conduit of the Cambridge Water Works at the junction of Irving and Arsenal

streets in Watertown, the 20-inch main which supplies Watertown and Belmont has been lowered 2.33 feet. The 24-inch pipe near Tufts Square in Medford has been raised 15 inches, to permit of the construction of a surface water drain by the city of Medford. The old 24-inch pipe line crossing Chelsea Creek between Chelsea and East Boston has been straightened at a point near the Chelsea shore, where it is supported upon a pile foundation, and new pile caps have been placed under the pipe. A valve has been set on this line on the East Boston side of the channel, in order to facilitate the control of the flow through the Venturi meter used in measuring the East Boston supply; and brick chambers have been built around two 20-inch valves at the same point, in place of wooden boxes used heretofore.

The pipe bridges over the Saugus and Pines rivers have been cleaned and painted.

Five additional insulating joints have been set in 48-inch pipe lines at different points, for the purpose of reducing the quantity of electric current flowing on the pipes. The location of these joints and the cost of their installation are as follows: —

Location.	Cost.
Boylston and Mount Auburn streets, Cambridge,	$234 81
Massachusetts Avenue and Cambridge Street, Cambridge,	194 98
Franklin and North Harvard streets, Brighton,	156 34
Magazine Street, near Central Square, Cambridge,	212 00
Norfolk Street, near Broadway, Cambridge,	157 88

The insulation of these joints is accomplished by the substitution of wooden staves for lead in the ordinary bell and spigot joints, with a ring of wood separating the spigot end of one pipe from the socket of the pipe to which it is joined. A wooden joint has also been substituted for the rubber joint in the 48-inch pipe on Massachusetts Avenue, near the crossing of the Fitchburg Railroad, in Cambridge; and a wooden insulating joint placed in the 16-inch connection between the Metropolitan and Boston Water Works mains at the corner of Morton Street and Blue Hill Avenue in West Roxbury.

Metered Connections.

For measuring the water supplied to the several cities and towns there are now used 55 Venturi meters and 4 Hersey meters of the disc type.

Changes and additions have been made during the year as follows: —

A 20-inch meter with a throat 5.75 inches in diameter has been set on Broadway, near Williams Street, in Chelsea, for use at times when the flow exceeds the registering capacity of the 10-inch meter. The throat of the 12-inch meter at the Revere Reservoir has been enlarged from 3.75 inches to 5 inches in diameter, and an 8-inch throat has been substituted for the 5.25-inch throat on the meter at the corner of Blue Hill Avenue and Morton Street in West Roxbury. All of these changes were made necessary by increase in the consumption of water in the district supplied. In order to measure the quantity of water used by a few takers in Medford, a 1½-inch Hersey disc meter has been set on a by-pass around an 8-inch weighted check valve.

Pressure Regulators and Recording Gages.

Four pressure regulating valves have been continually in use during the year, for reducing and regulating the water pressure in the pipes in Lexington, Winthrop, Swampscott and Nahant; also two valves operated by floats, for controlling the level of the water in the Revere and Chelsea reservoirs.

No changes have been made in the number of recording gages during the year. The average maximum and minimum elevation of the water, due to the pressure at seventeen points in different parts of the District, as recorded by these gages, are given in Appendix No. 2, Table No. 38.

Electrolysis.

There has been no great improvement in the electrical conditions on the pipe lines during the past year, and in several districts the pipes continue to be seriously damaged. At the suggestion of the officials of the Boston Elevated Railway Company, additional insulating joints have been set on the two 48-inch pipe lines between the Chestnut Hill pumping station and Spot Pond. Three of these

joints were placed in the westerly line: one in Boylston Street, near Mount Auburn Street, in Cambridge, set on May 25; one in Cambridge Common, set June 1; and one in Franklin Street, near North Harvard Street, Brighton, set June 4. Two joints were placed in the easterly line in Cambridge: one in Magazine Street, near Central Square, set June 9; and one in Norfolk Street, near Broadway, set June 12.

Measurements made in May, before setting these insulating joints, showed that there was a fall of potential, averaging about 20 volts, on the uninsulated street railway returns in both the north and south portions of the districts traversed by these pipe lines; that there were 85 amperes of current leaving the easterly line and 135 amperes leaving the westerly line under conditions likely to produce damage to the Metropolitan mains by electrolysis. In addition to these quantities, there were being delivered to the pipe systems of other cities from both the Metropolitan lines 100 amperes of current, as follows: Boston, 50 amperes; Somerville, 40 amperes; and Medford, 10 amperes.

Measurements taken in July, after the additional joints had been set, indicated that the current leaving the easterly line had been reduced from 85 amperes to about 65 amperes.

The effect of the additional joints in the westerly line could not be determined, on account of the breaking down of a joint in Massachusetts Avenue, near the crossing of the Fitchburg Railroad. This joint was replaced on August 24 with a joint having wood insulation. Upon examination of the old joint, it was found that the sheet rubber, one-half inch in thickness, which was used as insulating material, had been changed to a hard, cinder-like substance for about one inch around several of the bolts on the lower side of the joint, and that this change had destroyed its value as an insulating material. Chemical examination indicated that the rubber had been subjected to high heat without access to oxygen, and the conclusion arrived at is that lightning caused the damage. The iron casting on the positive side of the joint was pitted both outside and inside the pipe by electrolysis, while the negative side was in perfect condition. The largest pitting, which was on the inside of the pipe, was about 6 inches by 4 inches by ½ an inch in depth. As this damage was caused in one year and eight months, it is very evident that the joints did not prevent electrolysis of the pipes, and that joints

under conditions similar to this one will require renewal at frequent intervals.

There are now seven insulating joints on the westerly line and six on the easterly line. As a result of setting these joints, the current leaving the westerly line to cause electrolysis of the Metropolitan pipes has been reduced from about 155 amperes to 120 amperes, and on the easterly line from 140 amperes to 65 amperes.

Measurements made in December, 1903, showed currents of from 5 to 15 amperes flowing southerly on each of the two 24-inch submerged pipe lines crossing Chelsea Creek between Chelsea and East Boston, a portion of which left the pipe in the channel. In September of the past year it was discovered that currents of from 2 to 30 amperes were flowing northerly from the East Boston shore on each of the pipe lines, and that nearly all of this was leaving them before reaching the Chelsea shore. Examination of the pipes showed that they were badly disintegrated, and at one point a hole was cut clear through the pipe while making the examination, causing a leak which had to be plugged. An investigation showed that the reversal of the direction of the current on these pipes was due to the fact that the East Boston power station was shut down for the summer, and that the cars in East Boston were being operated with current from the Lincoln Wharf power station in Boston. On September 10 and 24 tests were made to determine the source of the current, by shutting off for a period of one minute the current from the Lincoln Wharf power station, from which current was being supplied to all the cars in East Boston. On both trials the current flowing on the Metropolitan pipes was from 8 to 22 amperes while the cars were running, and from 0 to 4 amperes while the current was shut off from the Lincoln Wharf station.

The 42-inch, 24-inch and 20-inch pipes in Broadway, Chelsea, are being seriously injured by currents of electricity which flow from them toward the power station of the Boston & Northern Railway in Chelsea. In May, 1906, about 150 amperes of current were flowing on the Metropolitan 24-inch main in Second Street, Chelsea, of which about 50 amperes flowed off through a connection with the pipes of the city of Chelsea, and the remaining 100 amperes flowed off of the Metropolitan mains in Broadway under conditions likely to injure the pipes. In the city of Lynn the 12-inch pipe in Washington Street, near Nahant Road, was uncovered and examined

at two points in April, and pittings were found in the pipe from 1/8 to 3/8 of an inch in depth. The pipe which was relaid in 1904 was also uncovered and examined at one point on Washington Street at Sagamore, and several pittings were found about 1/4 of an inch in depth. Measurements made during the past year indicate that the amount of current flowing on the Metropolitan pipes in Lynn has increased since the last survey was made. Other points where current is leaving the Metropolitan pipes are: Commonwealth Avenue in Newton, near the power station of the Boston Suburban Street Railway; West Street in Hyde Park; Main Street in Stoneham, and Boston Avenue in Medford.

In order to protect the lead sheaths of the telephone cables from injury by electrolysis, it is the practice of the telephone and railway companies to place a bond between the railway returns and the telephone cable sheaths. The result of this is to increase the difference of potential between the telephone cables and the water pipes, and to cause the damage to the pipes to be greater than it would be without the bonds. Several instances of damage to local service pipes and mains where they cross the telephone cables have already been noticed in Cambridge, Chelsea and Hyde Park.

In considering this question, it must be remembered that the quantities, voltage and direction of the currents, as given in this report, represent approximately the average condition at the time the observations were made; but the actual conditions are very erratic, and during even the short period of observation vary through a large range, at times increasing to as much as twice the average and at other times decreasing to zero, or even reversing in polarity and direction. There is also a large change in conditions from day to day, due to the varying traffic and to changes in the distribution of the load between the various power stations. The conditions during the past year have been disturbed more than usual by the installation of new power stations. A new station located on Broadway, at Alewife Brook, in Somerville, was put into service during May, and another located on Salem Street, in Medford, near the Fellsway West, was put into service about September.

With the advent of cold weather, some of the power stations which had been shut down during the summer were placed in service, and power was also obtained by the Boston Elevated Street Railway from the Hyde Park station of the Old Colony Street Rail-

way Company. Alternating current was obtained from the Edison Electric Illuminating Company, which was converted to direct current at substations, one near the bridge between Boston and Charlestown, and the other at the Forest Hills car house on Washington Street in West Roxbury.

Gypsy and Brown-tail Moths.

Of the land under the control of the Board, used for the purposes of water supply, amounting to about 9,700 acres, not more than 1,000 acres have as yet been infested by the gypsy and brown-tail moths, and the area where the moths are present in sufficient numbers to seriously injure the foliage does not exceed 500 acres. The gypsy moth has been very prevalent around Spot Pond and Mystic Lake, and has been found in considerable and increasing numbers in the vicinity of the Chestnut Hill and Weston reservoirs, at Lake Cochituate, and along the line of the Sudbury, Cochituate and Weston aqueducts as far west as Framingham. The nests of the brown-tail moths have been found not only where the gypsy moths were present, but also on land around the Sudbury Reservoir in Marlborough, Southborough and Framingham, along the line of the Wachusett Aqueduct, and on the grounds about the Wachusett Dam in Clinton.

During January and February a force of about 25 men was employed on the grounds about Spot Pond in painting the egg clusters of the gypsy moth with a mixture of equal parts of creosote and fuel oil. In March and April the trees were thinned out and underbrush cut on about 50 acres of swamp north of the pond, and the trees on 150 acres were scraped and painted with tanglefoot. The spraying of the foliage with arsenate of lead began on May 19 and was continued until the first week in July, the area covered being about 110 acres. For this work one steam, one gas and two hand spraying machines, together with a force of about 25 men, were used. When all the machines were in operation about 200 pounds of arsenate of lead were used daily.

Adjoining the Water Works land at the south end of Spot Pond, for a distance of 2,500 feet, is land belonging to the city of Medford. This land was badly infested with gypsy moths, but nothing was done toward protecting the property. As a result, the trees were stripped of leaves, and great difficulty was experienced in preventing the caterpillars from entering upon the Water Works land and dev-

astating that also. The most efficient means of preventing this was found to be a line of hemlock boards, 10 inches wide, set on edge along the property line and coated on one side with tanglefoot. Hay, sprinkled with fuel oil, was also used for the same purpose, but proved less efficient. The land around the Fells Reservoir is in the custody and control of the Metropolitan Park Commission; but, as the trees in the vicinity of the reservoir were quite badly infested, with the consent of the superintendent of the Fells Reservation, those on a strip 50 feet wide surrounding the reservoir were painted with tanglefoot, and large numbers of caterpillars were destroyed by our employés. At Mystic Lake and at Chestnut Hill Reservoir the egg clusters were destroyed and the foliage sprayed with arsenate of lead. At the Weston Reservoir the number of trees infested with the gypsy moth was comparatively small, and the foliage was not sprayed. Where the caterpillars were discovered, bands of burlap were placed around the trees and the caterpillars killed. On the lands around the reservoirs in Framingham, Southborough and Marlborough, and in the vicinity of the Wachusett Dam in Clinton, a considerable number of the nests of the brown-tail moth were removed from the trees and destroyed. As a result of the work done during the past two years, the number of gypsy moth egg clusters to be destroyed on the property around Spot Pond is very much less than last year; but at the Chestnut Hill Reservoir and at the Weston Reservoir the number has increased, this increase being due in some measure to the neglect of the owners of adjoining properties.

The total amount expended for the work on all the Water Works lands was about $12,700, of which approximately $10,500 was expended in protecting the lands around Spot Pond.

Clinton Sewerage.

The Clinton sewage disposal works were in daily operation during the whole year. The quantity of sewage pumped and filtered was 795,000 gallons per day, or 152,000 gallons per day more than during the preceding year, and 51,000 gallons per day more than the average during any year since the plant was put into operation in September, 1899. This increase was due to the heavy rainfall during the months of May, June, July and August, which increased the amount of ground water leaking into the town sewers. During these four months the quantity of sewage treated was 60 per

cent. larger than during the corresponding months of the preceding year.

At the pumping station during the early part of the year new plungers and valves were put into the pump. The outside wood work and the interior iron and wood work of the pumping station building have been painted.

Following are statistics relating to the operation of the pumping station: —

Daily average quantity of sewage pumped (gallons),	795,000
Daily average quantity of coal consumed (pounds),	1,361
Gallons pumped per pound of coal,	·584
Number of days pumping,	365
Cost of pumping: —	
Labor,	$1,284 69
Fuel,	1,136 95
Repairs and supplies,	309 59
Total for station,	$2,731 23
Cost per million gallons pumped,	$9 41
Cost per million gallons raised 1 foot high,	0 19

Filter-beds.

The sewage has been applied on the filter-beds in practically the same way as in previous years, except that no distinction has been made between the 19 beds from which all soil had been removed when they were built and the 6 beds from which soil to the depth of 6 inches had been removed in 1904.

The 8 settling basins were used in rotation from January 1 to April 4 and from September 14 to the end of the year. During January, February, March and December the sewage was turned through one of the basins for two weeks, when it was drained off and another basin used. At the other times one basin was used for three days, then immediately drained off and another put into use. From April 5 to September 14, while the use of the settling basins was suspended, one of the regular filter-beds was used for the first 30 minutes of each day as a sludge bed to care for the heavy sewage. After being used about a month in this way it was allowed to dry out and then raked and cleaned. In the mean time, another bed was put into use as a sludge bed. The sludge accumulated in the settling basins, and the so-called sludge bed has been given to the

neighboring farmers, who were only too glad to use it on their farms.

During the warmer part of the year, from March 27 to December 2, the sewage was applied to a bed having an area of one acre for 1½ hours, the amount per application being about 163,000 gallons, and each bed was used about once in 4⅔ days, the average rate being about 34,000 gallons per acre per day.

During the colder parts of the year, when the temperature was below 15 degrees above zero, all the sewage of one day's pumping was applied to one of five beds which had been prepared with furrows 3 feet 6 inches apart, the average amount per application being 491,000 gallons, and each bed was used about once in 7 days, which gives an average of about 71,000 gallons per acre per day. When the temperature was higher than 15 degrees above zero the sewage was applied to the other or flat beds for about 1¾ hours, the amount per application being about 177,000 gallons, and each bed was used about once in 9½ days, which gives an average of about 19,000 gallons per acre per day. In previous years during the winter season when the temperature was above 15 degrees above zero the sewage was applied to the flat beds for about 2½ hours; but this year, owing to the milder weather, it has been possible to keep the beds open with less sewage per application.

The results of chemical analyses of the sewage and effluent are given in the following table: —

[Parts per 100,000.]

	1901.	1902.	1903.	1904.	1905.	January to June, 1906, inclusive.	July to December, 1906, inclusive.	Whole Year 1906.
Albuminoid ammonia, sewage.	1.0025	1.0517	.9233	.7967	1.1250	.9017	.8100	.8558
Albuminoid ammonia, effluent.	.0741	.0891	.0782	.0686	.0787	.1093	.0816	.0955
Per cent removed, . .	91	89	92	91	93	88	90	89
Oxygen consumed, sewage,	10.73	8.85	8.65	8.57	13.11	9.87	9.82	9.84
Oxygen consumed, effluent,	.82	1.15	1.12	.99	1.126	1.44	1.23	1.34
Per cent. removed, . .	91	84	87	88	91	85	87	86
Free ammonia, sewage, .	3.4533	4.3284	3.8292	3.97	4.7533	3.3400	3.7900	3.5650
Free ammonia, effluent, .	.5792	.6862	1.0185	.99	.9588	.9247	1.6200	1.2723
Per cent. removed, . .	83	84	73	75	80	72	57	64
Nitrogen as nitrates, effluent.	.9298	.9815	.4168	.4046	.2665	.0890	.2000	.1445

The character of the effluent has not been as good as during previous years, and experiments have been in progress, under the direction of the Chief Engineer of the State Board of Health, for the purpose of determining the best method of improving the efficiency of the beds. In May and June three of the filter-beds which were not underdrained at the time the works were constructed were underdrained with 6-inch vitrified pipe, and a well was placed in each bed, for the purpose of obtaining samples of the ground water. A small filter-bed, having an area of .01 of an acre, was built for the purpose of filtering a portion of the effluent from the filters. In July wooden conveyers, having an aggregate length of 784 feet, were placed on two of the beds, for the purpose of securing a uniform distribution of the sewage. The cost of this experimental work was $1,087.37. The investigations are still in progress.

The cost of maintaining the filter-beds, exclusive of the cost of the experimental work, has been as follows: —

Labor,	$1,941 52
Repairs and supplies,	78 62
Total,	$2,020 14
Cost per million gallons filtered,	$6 96

Engineering.

A very large portion of the time of the engineering force is now devoted to matters pertaining to the maintenance and operation of the works. The more important of these matters are the superintendence of the operation of the Venturi meters and of the flow of water from the several reservoirs through the aqueducts; the determination of the quantities of water used in the several municipalities; the tabulation of the records of rainfall as measured at twelve stations on the works, of the elevations of the several storage and distributing reservoirs and of the pressures in the mains at different points in the Metropolitan District; the making of calculations to determine the yield of the several watersheds, the quantities delivered by the several aqueducts, the quantities pumped at the several pumping stations and the cost of pumping.

Appended to this report are tables of contracts giving the amount of work done and other information, a long series of tables relating to the maintenance of the Metropolitan Water Works, tables showing the length of main pipes and number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for 1906.

Respectfully submitted,

DEXTER BRACKETT,
Engineer Sudbury and Distribution Departments.

Boston, January 1, 1907.

REPORT OF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1906.

ORGANIZATION.

The engineering organization during the year has been as follows: —

Division Engineers: —

FREDERICK D. SMITH, .	*In charge of maintenance and construction, South Metropolitan System, in Quincy and Milton.*
FRANK I. CAPEN, . .	*In charge of maintenance and construction, North Metropolitan System.*
SETH PETERSON,[1] . .	*In charge of construction of air tunnel, Section 80, South Metropolitan System.*
FRANK A. EMERY, . .	*In charge of office, drafting room and records.*

In addition to the above, there were employed at the end of the year 16 engineering and other assistants.

[1] Part of the year.

METROPOLITAN SEWERAGE DISTRICTS.

Areas and Populations.

During the year no changes have been made in the extent of the sewerage districts. The area of the North Metropolitan District remains at 90.50 square miles, and of the South Metropolitan District at 100.87 square miles, — a total, inclusive of water surfaces, of 191.37 square miles. These districts include the whole or parts of 25 cities and towns, as set forth in the following table.

The populations in the table are based on the census of 1905. It will be noted that the recent census returns do not fully justify all the published forecasts of earlier reports.

Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1906.

	City or Town.	Area (Square Miles).		Estimated Population.	
North Metropolitan District.	Arlington,	5.20		10,080	
	Belmont,	4.66		4,490	
	Boston (portions of),	3.45		94,153	
	Cambridge,	6.11		99,470	
	Chelsea,	2.24		38,330	
	Everett,	3.34		30,810	
	Lexington,[1]	5.11		3,990	
	Malden,	5.07		39,430	
	Medford,	8.35		20,390	
	Melrose,	3.73		14,750	
	Revere,	5.86		13,470	
	Somerville,	3.96		71,740	
	Stoneham,	5.50		6,430	
	Wakefield,	7.65		10,630	
	Winchester,	5.95		8,630	
	Winthrop,	1.61		7,410	
	Woburn,	12.71		14,460	
			90.50		488,663
South Metropolitan District.	Boston (portions of),	20.39		152,390	
	Brookline,	6.81		24,610	
	Dedham,[1]	9.40		7,630	
	Hyde Park,	4.57		14,850	
	Milton,	12.59		7,220	
	Newton,	16.88		37,940	
	Quincy,	12.56		28,850	
	Waltham,	13.63		27,150	
	Watertown,	4.04		11,740	
			100.87		312,380
	Totals,		191.37		801,043

[1] Part of town.

METROPOLITAN SEWERS.

Sewers Purchased and Constructed and their Connections.

Within the Sewerage Districts there are now 96.74 miles of Metropolitan sewers. Of this total, 8.79 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 88 miles of Metropolitan sewers having been constructed by the Metropolitan boards.

The position, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system: —

North Metropolitan System.

City or Town.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1906.	Special Connections. Character or Location of Connection.	Special Connections. Number in Operation.
Boston: —					
Deer Island,	6′ 3″ to 9′,	1.367	4	–	–
East Boston,	9′ to 1′,	5.467	22	Shoe factory,	1
				Navy Yard,	8
				Almshouse,	1
Charlestown,	6′ 7″×7′ 5″ to 1′,	3.292	13	Club house,	1
				Fire Dept. Station,	1
				Bakery,	1
Winthrop,	9′,	2.864	7	Rendering works,	1
				Metropolitan Water Works blow-off,	1
Chelsea,	5′ 4″×9′ 2″ to 1′ 10″×2′ 4″,	5.123	9	Metropolitan Water Works blow-off,	1
				Cameron Appliance Co.,	1
Everett,	8′ 2″×8′ 10″ to 4′ 8″×5′ 1″,	2.925	6	Metropolitan Water Works blow-off,	1
				Private buildings,	120
Malden,	4′ 6″×4′ 10″ to 1′ 3″,	4.493[1]	26	Private buildings,	107
				Factory,	1
				Railroad station,	1
Melrose,	4′ 6″×4′ 10″ to 10″,	6.099[2]	32	Slaughter-house,	1
				City Hospital,	1
				Tannery,	1
Cambridge,	5′ 2″×5′ 9″ to 1′ 3″,	7.167	29	Slaughter-houses (3),	1
				Car-house,	1
				Stable,	1
Somerville,	6′ 5″×7′ 2″ to 1′ 10″×2′ 3″,	3.471	10	Rendering works,	1
				Armory building,	1
				Private buildings,	6
Medford,	4′ 8″×5′ 1″ to 10″,	5.359	20	Stable,	1
				Tannery,	2
				Private buildings,	2
				Gelatine factory,	1
Winchester,	2′ 11″×3′ 3″ to 1′ 3″,	6.428	13	Stable,	1
				Railroad station,	1
Stoneham,	1′ 3″ to 10″,	0.010	4	–	–
Woburn,	1′ 10″×2′ 4″ to 1′ 3″,	0.933	3	Glue factory,	1
				Private buildings,	109
Arlington,	1′ 6″ to 10″,	3.520[3]	33	Railroad station,	1
				Car-house,	3

[1] Includes .988 of a mile of sewer purchased from the city of Malden.

[2] Includes .736 of a mile of sewer purchased from the town of Melrose.

[3] Includes 2.631 miles of sewer purchased from the town of Arlington.

North Metropolitan System — Concluded.

City or Town.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1906.	Special Connections. Character or Location of Connection.	Special Connections. Number in Operation.
Belmont,[1]	– –	–	3	– –	–
Wakefield,[1]	– –	–	1	– –	–
Revere,	4' to 3',	0.048	2	– –	–
		58.566[2]	237		383

South Metropolitan System.

Boston (Back Bay),	6' 6" to 3' 9",	1.500[3]	8	Private house,	1
				Administration building, Boston Park Department,	1
				Simmons College buildings,	1
Boston (Brighton),	5' 6" to 12",	3.714[4]	11	Abattoir,	3
				Chocolate works,	2
Boston (Dorchester).	3'×4' to 2' 6"×2' 7",	2.870[5]	8	Paper mill,	1
				Private buildings,	2
Boston (Roxbury),	6' 6"×7', 4' 0",	1.430	–	– –	–
				Parental school,	1
Boston (West Roxbury).	9' 3"×10' 2" to 12",	7.068	9	Lutheran Evangelical Church,	1
				Private buildings,	4
Brookline,	5' 6",	0.127	2	– –	–
Dedham,	4'×4' 1" to 3' 9"×3' 10",	2.350	5	– –	–
Hull,	60" pipe,	0.750	–	– –	–
				Mattapan Paper Mills,	1
Hyde Park,	10' 7"×11' 7" to 4'×4' 1",	4.527	14	Private buildings,	2
Milton,	11'×12' to 8",	3.600	9	– –	–
Newton,	4' 2"×4' 9" to 1' 3",	2.911	6	Private houses,	2
Quincy,	11' 3"×12' 6" to 24" pipe,	6.580	4	– –	–
Waltham,	3' 6"×4',	0.001	1	– –	–
Watertown,	4' 2"×4' 9" to 12",	0.750[6]	5	Factories,	2
		38.178	82		24

[1] The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.

[2] Includes 2.737 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

[3] Includes .355 of a mile of sewer purchased from the city of Boston.

[4] Includes .026 of a mile of sewer purchased from the town of Watertown.

[5] Includes 1.24 miles of sewer purchased from the city of Boston.

[6] Includes .025 of a mile of sewer purchased from the town of Watertown.

Cost of Construction.

[To December 31, 1906.]

The cost of the 96.7 miles of Metropolitan sewers enumerated above, including seven stations, siphons and appertaining structures, may be summarized as follows: —

North Metropolitan System,	$6,136,200 30
South Metropolitan System,	7,722,773 15
	$13,858,973 45

Information relating to areas, populations, local sewer connections and other data for the whole Metropolitan Sewerage District appear in the following table: —

North Metropolitan District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	Connections made with Metropolitan Sewers.	
					Public.	Special.
90.50	488,663	593.88	386,343	79.1	237	383

South Metropolitan District.

100.87	312,380	468.18	167,070	53.5	82	24

Entire Metropolitan District.

191.37	801,043	1,062.06	553,413	69.1	319	407

Of the estimated gross population of 801,043 on December 31, 1906, 553,413, representing 69.1 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,062.06 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan System by 319 public and 407 special connections. It appears, also, that there has been during the year an increase of 48.75 miles of local sewers connected with the Metropolitan System, and that 9 public and 34 special connections have been added.

Pumping Stations and Pumpage.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with the corresponding volumes for the previous year: —

CONSTRUCTION OF SEWER BY USE OF EXCAVATING MACHINERY IN STREET IN MALDEN FOR EXTENSION OF NORTH METROPOLITAN SEWER.

Pumping Station.	Average Daily Pumpage.			
	Jan. 1, 1905, to Dec. 31, 1905.	Jan. 1, 1906, to Dec. 31, 1906.	Increase during the Year.	
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	54,400,000	58,100,000	3,700,000	6.8
East Boston,	52,400,000	56,100,000	3,700,000	7.1
Charlestown,	29,900,000	30,500,000	600,000	2.0
Alewife Brook,	3,234,000	3,451,000	217,000	6.7
Quincy,	3,180,000	3,528,000	348,000	10.9
Ward Street,	20,940,000	24,500,000	3,560,000	17.0

CONSTRUCTION.

NORTH METROPOLITAN SYSTEM.

Extension of the Metropolitan Sewer in the City of Malden.

Chapter 319 of the legislative Acts of 1906 authorized the extension of a Metropolitan Sewer in Malden from near Barrett's Pond to the tidal meadows on the southerly side of the city.

In 1900, when the town of Wakefield was added to the District, a new Metropolitan sewer was constructed from Wakefield to Barrett's Pond in Malden, and there connected with an existing Metropolitan Sewer.

The original Metropolitan Sewer below this point is now too small to provide for sewage from both sewers. It has, therefore, been found necessary to extend the sewer authorized in 1900 to a point where it can connect with a larger Metropolitan main with overflow into the tidal waters of Malden River, which may serve until the works are more comprehensively relieved.

This extension has been known as Section 64 of the North Metropolitan System.

Section 64, Malden Extension.

Division Engineer in Charge.— Frank I. Capen.
Contractors.— T. H. Gill & Co., Somerville, Mass.

The section involves a sewer extending from a point on Jackson Street near the crossing of the Saugus Branch of the Boston & Maine Railroad and near Station 55 of Section 40 of the North Metropolitan System, northerly through Jackson Street to Spot Pond

Brook, through private lands, Pleasant Street and Linden Avenue, to a point in Section 58 of the North Metropolitan System 200 feet south of Mountain Avenue, — a total distance of 2,950.5 feet.

Additional data in relation to this route are given in the following table : —

Extension of the Metropolitan Sewer in Malden, authorized by Chapter 319, Acts of 1906.

Location.	Size.	Length (Feet).	Remarks.
Jackson Street from Saugus Branch Railroad to Spot Pond Brook.	4′ 6″,	1,336.98	Excavation for 330 feet of peat and silt; remainder through miscellaneous filling, with a small layer of sand and gravel over fine sand.
Extension of Jackson Street of 205 feet in private land and 582 feet in Linden Avenue at end of section.	3′ 6″,	786.93	205 feet excavation in sand and gravel over fine sand; 582 feet in Linden Avenue, coarse sand and gravel with about 3 feet of hardpan at bottom for last 300 feet with boulders.
In private land from a point about 200 feet beyond Spot Pond Brook to Pleasant Street at Linden Avenue and in Linden Avenue for about 600 feet.	2′4″×3′ 6″,	826.59	Through the private land the excavation was in sand with some miscellaneous filling above; in Linden Avenue excavation was in coarse sand and gravel.

A contract was entered into August 8, 1906, with T. H. Gill & Co., of Somerville, contractors, for this construction. The contract extended from Station 0 + 3.80 to 29 + 54.3, — a total distance of 2,950.5 feet.

The contractors started work on Jackson Street at Charles Street on August 14, 1906, and worked in both directions, using a bucket excavator, northerly to a point 200 feet beyond Spot Pond Brook. Southerly toward the Saugus Branch Railroad the work was started with a portable derrick, but this was soon abandoned, and most of the excavation was done without the aid of machinery. Excavation on this portion of the work was completed late in December.

A second opening was started August 15, in private land north of Spot Pond Brook, and worked for part of the distance with a portable derrick. Generally around curves and between buildings the excavation was made without machinery. This portion of the work was completed about the middle of December.

A third opening was started about September 11, at the corner of Linden Avenue and Pleasant Street. A bucket excavator was used

on this part of the work to the end of the section, for a distance of about 950 feet. This excavation was completed December 24.

At the crossing of Spot Pond Brook the route of the brook was temporarily changed through diversion trenches, while 56 feet of trench was excavated, and four lengths of 42-inch cast-iron pipe placed under the brook location. The work was begun September 13 and was completed November 14.

This whole length of sewer was built of standard concrete, except the overflow at Saugus Branch Brook and manholes on the main line of sewer; these were of brick, reinforced with concrete. For a length of 255 feet on the marsh near the Saugus Branch Brook the concrete of the sewer invert rests on piles. For this length the concrete was reinforced with Ransome steel rods longitudinally and transversely in the invert and transversely in the arch.

At the date of the report the work is practically completed except for minor repairs to surfaces in private lands and resurfacing of streets, which, on account of their frozen condition, will be delayed until spring.

The connection with Section 40 by means of a bellmouth at the lower end of this section was made by day labor of the maintenance force of the North Metropolitan Sewerage Works.

SOUTH METROPOLITAN SYSTEM.

Extension of the High-level Sewer through West Roxbury, Brookline and Brighton.

Chapter 406 of the legislative Acts of 1906 authorized the construction and operation of an extension of the main sewer of the South Metropolitan System, known as the High-level Sewer, through the districts of West Roxbury, Brookline and Brighton.

During the past year surveys and studies of the geology over the route of the sewer have been in progress. As adopted, the route extends from the corner of Perkins and Centre streets, in Jamaica Plain, through Brookline to Oak Square in Brighton. An outline of this route and other data in relation to it are given in the following table: —

Extension of the High-level Sewer, authorized by Chapter 406, Acts of 1906.

Location.	Size (Diameter).	Length (Feet).	Remarks.
West Roxbury: in Perkins and Chestnut streets, from Centre Street to the boundary line between West Roxbury and Brookline.	6′ 6″×7′ 0″ 70″	3,085	600 feet in rock tunnel. 2,485 feet in air tunnel.
Brookline: in Chestnut, Kendall and Cypress streets, Brington Road, private land, Gorham Avenue, Greenough, Washington, Park and Winchester streets, private land and Columbia Street to the Brighton boundary line.	7′ 0″ 6′ 6″×7′ 0″ 6′ 3″×6′ 6″ 5′ 9″×6′ 0″	11,760	3,360 feet in air tunnel. 1,500 feet in rock tunnel. 800 feet in earth tunnel. 6,100 feet in earth open cut.
Brighton: in Harlan Street, private land, Commonwealth Avenue, Warren, Cambridge and Washington streets to Oak Square.	5′ 9″×6′ 0″ 60″ cast-iron pipe.	9,905	6,950 feet in rock tunnel. 300 feet in earth tunnel. 3,555 feet in earth open cut.
Branch lines in Cambridge, Market, Bennett and Washington streets.	24″×28″ to 12″	5,050	2,250 feet in tunnel. 2,800 feet in earth open cut.
		29,800	
		5.64 miles.	

For convenience, this length of 5.64 miles has been divided into contract sections, numbered from 80 to 86, both inclusive.

Section 80, West Roxbury and Brookline.

Division Engineer in Charge. — Seth Peterson.
Superintendent of Construction by Day Labor. — Charles A. Haskin.

This section extends from a branch in the existing bellmouth at the corner of Centre and Day streets along Perkins and Chestnut streets, in West Roxbury, passing Jamaica Pond, to the Brookline town line; thence in Brookline, along Chestnut Street to near Kendall Street, a length of about 4,500 feet. It is wholly in tunnel, at depths ranging from 70 feet in Perkins Street to about 20 feet in Chestnut Street. From Centre Street to near Zamora Street and along Perkins Street it is anticipated the tunnel headings will be in Roxbury puddingstone, with seams of clay and quicksand that may admit water freely to the headings.

From Zamora Street, passing Jamaica Pond, to near the end of the section, the tunnel headings are expected to be in open sand and quicksand. The water line of the sewer passing Jamaica Pond is about 35 feet below the usual elevation of the water surface of the pond. To avoid any possibility of accident to Jamaica Pond, the tunnel work in its vicinity is being carried out by pneumatic proc-

HEADING IN SEWER TUNNEL IN WEST ROXBURY BUILT IN QUICKSAND BY PNEUMATIC PROCESS.

esses and by day labor, under the direction of Charles A. Haskin, pneumatic expert.

A shaft leading down to the tunnel is located on Perkins Street, about 475 feet east of Jamaicaway. At this point an unoccupied lot, about 65 feet by 150 feet, has been rented, and lockers for machinery, tools and supplies erected.

Work on the shaft was begun October 3, 1906. The shaft is circular, 8 feet inside diameter, with 12-inch Portland brick walls. Steel cylinders 20 feet long were first sunk in the street, and lined with 12-inch Portland brickwork; excavation then proceeded in depths of 3 feet, secured by polings. The masonry below the steel casing was suspended by rods from the casing itself.

This method of shaft excavation was pursued for a depth of 57 feet below the surface. At that depth water was encountered. An air lock was then introduced on the head of the steel cylinders at the street, and an air pressure about 6 pounds in excess of atmospheric pressure maintained. The completed shaft is 70 feet in depth. At the date of this report tunnel headings have advanced about 70 feet each way from the shaft. The vertical air lock was removed December 24, and horizontal locks have been constructed in each heading. The west heading is now in fine, sharp sand, and advancing at the rate of about 30 feet per week under 6 pounds of air pressure. The east heading is in sand, gravel and quicksand, and advancing at the rate of about 40 feet per week under air pressure of about 6 pounds per square inch.

The plant for carrying out this work includes 2 horizontal tubular boilers of 100 horse-power each, and 1 of 75 horse-power; 3 air compressors of Rand type, 75 horse-power each; hoisting engine at the shaft, and two electric generating sets of 100 16-candle-power lights each.

The completed tunnel is circular, in cross-section, 7 feet inside diameter, with 12-inch Portland brick walls. Steel tunnel plates are used to cover the arch for about one-half its periphery.

Reversal of Grade at the Lower End of the Charles River Main Sewer.

At the date of the last report about 1,100 feet of the invert of the Charles River main sewer east from Vancouver Street had been modified by introducing a concrete invert about 3 feet in diameter,

having an inclination of 1 foot in 1,500 feet in the direction of the main sewer leading to the Ward Street station.

On March 19, 1,860 feet of the modified invert had been completed, to Bryant Street. This length provides for all Metropolitan connections on this branch, and the sewage from these Metropolitan areas was deflected from the city of Boston works to the South Metropolitan System on the following dates: —

Parker Street district, 15-inch connection,	January 15, 1906.
Hemenway Street district, 12-inch connection,	February 14, 1906.
Bryant Street district, 12-inch connection,	February 14, 1906.
Bryant Street district, 24-inch connection,	March 19, 1906.

Below the Bryant Street connection a 40-inch penstock valve has been introduced at the end of the modified invert.

From Bryant Street to Gainsborough Street the Charles River main sewer, 6 feet 6 inches in diameter, was cleared of deposit, washed, and the exclusion valve at Gainsborough Street closed.

Between the valves at Bryant and Gainsborough Streets is a length of about 1,600 feet of abandoned sewer, now filled with ground water.

From the commissioner's channel of Stony Brook to Bryant Street, for a length of 561 feet, a reinforced concrete drain, equivalent in size to a 36-inch pipe, was constructed below the modified invert. This connects with a 35-inch branch from Stony Brook, which has sometimes been used by the city for flushing the Huntington Avenue sewer with water from Stony Brook. The arch of this drain was reinforced with expanded metal of sufficient strength to resist any pressure that might reach it.

Section 77, Ward Street Station and Connections.

At the date of the last report the pumping plant at the Ward Street station had not been formally tested or accepted. During the past year the tests prescribed in contracts with the engine builders have been successfully carried out, and the plant formally accepted by the Board.

This plant was installed for raising sewage from the Charles River valley Metropolitan Sewerage District, about 40 feet to the High-level Sewer, recently constructed. Through this sewer it is discharged into the waters of Boston harbor, off Nut Island, in Quincy.

The engines, pumps and steam plant were furnished by the Allis-Chalmers Company of Milwaukee, Wis., under a contract dated January 17, 1902. The pumps are specially designed for pumping sewage.

The sewage is delivered to the station through a trunk sewer in Vancouver Street 7 feet 9 inches by 6 feet 6 inches. Before entering the station, sewage is passed through screens which intercept rags, paper and other floating materials.

The screens are of ¾-inch round iron bars, securely held in steel frames. These frames, with intercepted material, are mechanically raised to the level of the screen-chamber floor.

After passing the screens, sewage is delivered through concrete and cast-iron pipes to the pumps. Beyond the pumps, sewage is forced through lines of 48-inch cast-iron pipes, about 1,600 feet in length, to the High-level Sewer, which conveys it by gravity to an outlet in the harbor.

The pumps were first operated in September, 1904. By agreement between the Board and the Allis-Chalmers Company, they have been operated in the regular service of the station since October 14, 1904, prior to official test and acceptance by the Board. The official trials, specified in the contract, were made November 9 and December 4, 1906; on December 12, 1906, the whole plant was formally accepted by the Board.

The tests were conducted by F. I. Capen and F. A. Emery, Division Engineers, and William M. Francis, Engineer in charge of the station, for the Metropolitan Sewerage Works, and T. T. Hubbard, M.E., representing the Allis-Chalmers Company.

Description of Plant.

The contract with the Allis-Chalmers Company was for furnishing and erecting two engines, each of 50,000,000 gallons daily capacity, together with four vertical, tubular boilers of the Deane type, with piping and other accessories.

The engines are of the vertical triple-expansion direct-connected plunger type, with pump plungers directly under the steam cylinders. The pumps up to and including the engine crank shafts were built at the "Reliance Works," and the steam ends, including the massive "A" frames and upper bed-plates, at the West-Allis Works, Milwaukee. The final fitting and assembling of these parts occurred at the Ward Street station.

The steam ends of the pumps are practically standard design, the several cylinders being, respectively, 21 inches, 38 inches and 58 inches in diameter, with a total plunger movement of 60 inches.

The pump plungers are suspended from the cross heads of the several cylinders by four rods guided at intervals throughout their length. This affords a rigid connection between the piston and the plunger and a direct drive from the one to the other. Each engine has two suction and two discharge pipes lying externally to the suction and discharge chambers with which they are respectively connected.

The discharge pipe on either side of each engine lies immediately above and in the same vertical plane with each suction pipe. The plunger chambers lie in the longitudinal centre line of the engine, and between two suction and two delivery chambers, which are in line diametrically opposite to the longitudinal centre line of the engine.

The castings for the discharge chambers are extended vertically, forming air chambers and at the same time supports for the pillow block bed-plates of the engines. X-braces span the distances between the valve chambers, rendering the construction extremely rigid.

Each engine has three single-acting outside-packed plungers, and six suction and six delivery valve chambers. Each suction and delivery chamber contains 36 valves, making a total of 432 valves for each engine. These valves were specially designed to act with sewage, and are of the flap type, with rubber and canvas seats which are bolted to brass plates. They are hinged, and swing on a manganese bronze hinge bolt.

The nominal area of the waterway through the suction and discharge valves is about 200 per cent. of the area of the pump plungers.

The steam inlet and exhaust valves in the heads of the high and intermediate-pressure cylinders are operated by valve gear of the Reynolds-Corliss type. The steam and exhaust valves in the heads of the low-pressure cylinder are in duplicate, and are of the poppet type, operated by cams. The governor controls the time of cutting off in the high-pressure cylinder, or it may be adjusted and fixed by hand.

The cut-off in the intermediate-pressure cylinder is adjustable by hand, while that on the low-pressure cylinder is fixed and cannot

be altered. All valves receive their motion from eccentrics on a lay shaft which is driven by cranks on either end, set at 90° and connected by driving rods with cranks on the main engine shaft.

The steam cylinders are jacketed on barrels. Reheating coils introduced between the cylinders have been isolated and plugged, and the introduction of steam through the jackets is now as follows: Steam from the high-pressure jackets is led to a Flynn trap, the discharge of which outlets to the low-pressure cylinder jacket. A branch from the inlet pipe of this trap furnishes steam, under a pressure which is regulated by hand, to the jacket of the intermediate cylinder. The outlet from the intermediate jacket is piped to a second Flynn trap, which also discharges into the jacket of the low-pressure cylinder. The drain from the discharge side of the low-pressure cylinder jacket is piped to the feed-water tank.

Surface condensers using sewage as a cooling medium were contemplated by the contract. In place of these, a modification of the Bulkley or barometric type of condenser, adapted to the use of sewage for cooling, was introduced. The passages through this condenser are larger than ordinarily used with clear water. These condensers have been furnished in duplicate with each engine, and so arranged that any one may be in operation while all the others are shut off.

Exhaust steam circulates through a feed-water heater placed in the exhaust pipe before entering the condenser.

The supply of fresh water for boiler feed is first circulated around the jacket of the dry-air pump, then to the feed-water heater in the exhaust pipe from the engine, and thence to the supply tank for the feed pump. Here it mingles with the discharges from the cylinder-jacket drains, from which receptacle it is drafted by a feed pump driven from the main engine, and forced through a fuel economizer before arriving at the boilers. The economizer is of the standard Green type, with 140 tubes, each 4 9/16 inches in diameter and 9 feet long, around which the escaping gases from the boilers pass on their way to the chimney.

Steam is furnished by four vertical fire-tube boilers, designed by and built under supervision of Dean & Main, mechanical engineers, for the Allis-Chalmers Company. The steam is supplied to the engine through duplicate lines of 8-inch pipe fitted with Van Stone steam joints and controlled by stop-valves of Chapman make.

The following tables contain principal dimensions of engines and boilers: —

Principal Dimensions of Engines.

Diameter H. P. cylinder (inches),	21
Diameter I. P. cylinder (inches),	38
Diameter L. P. cylinder (inches),	58
Diameter plungers (inches),	48.25
Stroke of pistons and plungers (inches),	60
Diameter of suction pipes (2) (inches),	42
Diameter of discharge pipe (1) (inches),	48
Diameter of fly wheels (2), each engine (feet),	18
Revolutions per minute for capacity,	25
Piston speed per minute for capacity (feet),	250

Principal Dimensions of Boilers.

Length of shell,	24′ 11⅞″
Internal diameter of shell,	90⅝″
Thickness of shell plates,	⅝″
Number and diameter of tubes,	302–2″
Length of tubes,	14′ 11⅜″
Water heating surface (square feet),	1,758.55
Super heating surface (square feet),	627.12
Total heating surface (square feet),	2,385.67
Grate area (square feet),	33.18
Area through tubes (square feet),	5.47
Area through smoke flue nozzle (square feet),	7.00
Ratio water heating surface to grate area,	53: 1
Ratio total heating surface to grate area,	72: 1
Ratio grate area to tube area,	6.07: 1
Ratio grate area to smoke flue nozzle,	4.74: 1

Trials.

The type and design of boiler were specified to the engine builders, so that no formal boiler tests have been required or made.

The engines are duplicates, — all the moving parts are identical in both engines. The record of their operation for about two years has indicated that they are equally efficient.

To avoid delay and inconvenience in maintaining the continuous service at the station, the Board, on May 21, 1906, agreed to accept tests on one engine as representative of both.

The engine selected for testing has been known as No. 1, and is located at the westerly end of the engine room. A 36-inch cast-iron by-pass pipe leads from the discharge pipe of this engine around the easterly end of the station to the suction sewer. It was thus possi-

ble to circulate the discharge from this pump continuously through the pump and station. A controlling valve in the pipe line provided for throttling the pipe until the pressure specified in the contract test was obtained.

A temporary weir was erected along the line of this by-pass. The weir is 10 feet long, with angle-iron crest. The sewage approaches the weir through stilling racks placed in the channel of approach, which is about 24 feet long. The head of water over the weir has been measured by hook gages located in a measuring chamber at one side of the weir. The water in this chamber is supplied through an orifice in the wall of the weir chamber.

Two boilers furnished steam used during the tests. Steam was conveyed to the engine through one of the duplicate 8-inch steam mains, and, in order that leakage should be reduced to the minimum, all connections between it and auxiliary lines were blanked off by pieces of boiler plate inserted between the flanges of connecting branches.

The feed water was taken directly from the city mains, weighed in barrels resting on platform scales, and fed to the boilers by the feed pump connected with the engine under test through a temporary 2-inch pipe line. Pressure on the 36-inch discharge line from the pump was indicated by a mercury column.

During the test the sewage used as a cooling medium in the barometric condensers was delivered over a weir. This amount was determined and proper correction made for it in estimating the total volume of the sewage pumped.

Trial Data and Results.

[Engine tested (represented action of two), No. 1.]

	Capacity and Slip Trial.	Duty Trial.
Date of trial,	Nov. 9, 1906,	Dec. 4, 1906.
Duration of trial,	6 hours,	10 hours.
Average Pressures.		
Steam at boilers (pounds),	-	152.3
Steam at throttle (pounds),	-	151.13
First receiver (pounds),	-	30.63
Second receiver (pounds),	-	—2.54
Vacuum (pounds per square inch),	-	27.9

Trial Data and Results — Concluded.

[Engine tested (represented action of two), No. 1.]

	Capacity and Slip Trial.	Duty Trial.
Average Temperatures (Degrees F.).		
Water fed to boiler,	-	104
Water in force main,	-	54.35
Head pumped against.		
Average net head pumped against (pounds pressure),	17.5	17.6
Average net head pumped against (feet),	40.3	40.5
Revolutions.		
Total revolutions during tests,	8,882	14,591
Average revolutions per minute,	24.67	24.32
Average piston speed (feet per minute),	246.76	243.26
Useful Work performed by Engine.		
Total water pumped (no allowance for slip), plunger displacement of pumps (United States gallons).	12,659,000	20,795,000
Water fed to Boilers.		
Total water fed to boilers (pounds),	-	47,433
Deduction for leakage, storage and use of calorimeter (pounds),	-	1,116
Total steam chargeable to engine (pounds),	-	46,317
Steam used by Engine.		
Average entrainment in steam entering engine (per cent.),	-	.696
Total dry steam used by engine (pounds),	-	45,995
Duties.		
Capacity per 1,000 pounds commercially dry steam, plunger displacement (contract basis) (foot-pounds).	-	152,719,000
Weir Measurements.		
Length of weir (feet),	9.956	9.957
Average depth of water on weir (feet),	1.7145	1.6878
Calculated discharge over weir (gallons),	48,124,000	46,989,000
Calculated discharge of condenser water over weir (gallons per 24 hours).	1,009,000	1,110,000
Total calculated discharge from pumps (gallons per 24 hours),	49,133,000	48,099,000
Volume displaced by plungers (gallons per 24 hours),	50,635,000	49,908,000
Slip (per cent.),	2.97	3.62

Concrete Walks and Fences at Ward Street Station Lot.

During the year a granolithic sidewalk has been placed on the Ward Street front of the pumping station lot, together with a granolithic walk, 12 feet wide, from the sidewalk to the main door of the engine room.

A substantial iron fence secured to masonry posts is being placed along the Ward Street side of the lot. Permanent picket fences have been placed along Vancouver Street and the north side of the station lot. The work on the fences and walks has been carried out from time to time by day labor of the maintenance force, as it was found possible to withdraw the labor from regular maintenance work.

Additional Pumping Plant at Quincy Station.

The ordinary sewage flow at this station exceeds the capacity of the smaller pump now in use, and during wet weather of winter and spring the flow has exceeded for considerable periods the capacity of both pumps now in use.

During the year additional pumping plant has been installed. On August 29 the Board purchased, of the Lawrence Machine Company of Lawrence, Mass., one of their standard design centrifugal pumps. This pump has 16-inch side suction, with 15-inch bottom discharge and 46-inch impellers. The pump is directly connected to a vertical cross-compound Sturtevant engine of the standard type. The steam cylinders are 10 inches and 18 inches in diameter, with 10-inch stroke. This plant has a range of capacity from 4,000,000 to 10,000,000 gallons per 24 hours, with lifts from 17 to 28 feet.

The foundations for the pump and engine were built under the direction of the Engineer by day labor. The suction and discharge piping for the pump was furnished and placed by the Board.

Miscellaneous piping and accessories from the engine to boilers, including feed pump and condenser, are to be furnished by the Board and erected by the engineer in charge of the station and his assistants.

Two additional boilers, of about 100 horse-power each, have also been introduced. These were furnished under contract with the Robb-Mumford Company of South Framingham, dated August 31, 1906. They are of the horizontal return tubular type, with overhanging fronts and masonry settings, similar in general design and

outline to boilers already existing at the station. The foundations for the boilers were built by day labor, under the direction of the Engineer.

General data in relation to these boilers is given in the following table: —

Diameter (inches),	66
Length of tubes (feet),	16
Outside diameter of tubes (inches),	3
Number of tubes,	110
Grate area (square feet),	30
Nominal horse-power of each boiler,	96
Working pressure per square inch (pounds),	125
Hydrostatic test pressure (pounds),	200

At the date of this report the boilers are in place, with smoke flue connected to the chimney. The pump and engine are placed, with suction and discharge piping partly placed. It is anticipated that this new plant will be in condition to operate in the coming spring.

MAINTENANCE.

Scope of Work and Force Employed.

The maintenance of the Metropolitan Sewerage System includes the operation of seven stations and 96.74 miles of Metropolitan sewers, receiving the discharge from 1,062.06 miles of town and city sewers at 319 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 134 men includes 81 engineers and other employés at the pumping stations, and 53 men employed on actual sewer maintenance and care of pumping station grounds. In the three following tables the use of the completed systems and other data are shown: —

North Metropolitan System.

Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1906.]

Cities and Towns.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.[1]	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Square Miles.	Square Miles	Per Cent.	Per Cent.
Boston (Deer Island),	0.70	Separate,	–	–	1,123[2]	1,123[2]	–	–	100.0	–
Winthrop,	26.96	Separate,	1,822	4.0	7,290	7,410	1.23	1.61	98.4	76.4
Boston (East Boston),	27.19	Separate and combined,	4,006[3]	12.5	50,075	52,990	0.99	2.18	94.5	45.4
Chelsea,	9.00[4]	Separate and combined,	1,134	7.1	8,050	38,330	0.42	2.24	21.0	18.8
Everett,	41.91	Separate and combined,	3,957	6.1	24,140	30,810	1.86	3.34	78.4	55.7
Malden,	49.41	Separate,	4,634	5.6	25,950	39,430	2.61	5.07	65.8	51.5
Melrose,	33.36	Separate,	2,461	4.3	10,580	14,750	1.65	3.73	71.7	44.2
Boston (Charlestown),	21.08	Separate and combined,	5,141	7.75	39,845	40,040	0.67	1.27	99.5	52.8
Cambridge,	133.76[5]	Separate and combined,	14,656	6.7	98,195	99,470	4.94	6.11	98.7	80.9
Somerville,	88.67	Separate and combined,	13,300	5.3	70,490	71,740	3.28	3.96	98.3	82.8
Medford,	49.20	Separate,	3,386	5.5	18,620	20,390	2.64	8.35	91.3	31.6
Winchester,	21.85	Separate,	975	5.3	5,170	8,630	1.07	5.95	59.9	18.0
Woburn,	13.00[6]	Separate,	942	5.4	5,085	14,460	0.91	12.71	35.2	7.2
Stoneham,	11.27	Separate,	585	4.3	2,515	6,430	0.60	5.50	39.1	10.9
Arlington,	19.80	Separate,	1,006	6.1	6,135	10,080	1.65	5.20	60.9	31.7
Belmont,	10.05	Separate,	324	6.0	2,370[7]	4,490	0.93	4.66	52.8	20.0
Wakefield,	11.20	Separate,	389	5.5	2,140	10,630	0.42	7.65	20.1[4]	5-5
Lexington,[8]	–	–	–	–	–	3,990	–	5.11	–	–
Revere,	25.47	Separate,	1,785	4.8	8,570	13,470	1.57	5.86	63.6	26.8
Totals,	593.88	–	60,503	6.4	386,343	488,663	27.44	90.50	79.1	30.3

[1] Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1905 extended to May 1, 1906.

[2] Estimated by Superintendent J. R. Gerrish of the Institution on Deer Island.

[3] East Boston house connections recounted from City of Boston Records.

[4] Only the districts connecting at Cypress Street, Revere Beach Parkway, Springvale Avenue and Willoughby Street are now contributing sewage.

[5] Revised in accordance with recent report of the City Engineer.

[6] Exclusive of Mystic River valley sewer and tanneries.

[7] Including 2 connections with McLean Hospital, having an estimated population of 428.

[8] Lexington not connected.

South Metropolitan System.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1906.]

Cities and Towns.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.[1]	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Square Miles.	Square Miles.	Per Cent.	Per Cent.
Boston (Back Bay),	22.15	Separate and combined,	1,519	16.0	24,305	24,460	1.20	1.61	99.4	74.5
Boston (Brighton),	53.53	Separate and combined,	2,679	6.1	16,340	23,250	3.16	3.74	70.3	84.5
Brookline,	57.39	Separate and combined,	3,152	7.5	23,640 [2]	24,610	3.24	6.81	96.1	47.6
Newton,	101.76	Separate,	5,202	5.8	20,170	37,940	6.81	16.88	79.5	40.3
Watertown,	32.68	Separate,	1,657	5.1	8,450	11,740	1.84	4.04	72.0	45.5
Waltham,	41.56	Separate,	2,868	8.65 [2]	24,810	27,150	2.16	13.63	91.4	15.8
Boston (Dorchester),	30.55	Separate and combined,	2,018	6.7	13,520	44,180	1.52	4.89	30.6	31.1
Milton,	7.48	Separate and combined,	195	5.2	1,015	7,220	0.39	12.59	14.0	3.1
Hyde Park,	20.96	Separate,	1,010	7.9 [2]	7,980	14,850	1.10	4.57	53.7	24.1
Dedham,	14.30	Separate,	340	5.1	1,735	7,630 [3]	0.72	9.40	22.7	7.7
Boston (Roxbury),	-	- -	-	-	-	32,720	-	1.23	-	-
Boston (West Roxbury),	38.60	Separate,	1,963	6.75	13,750 [4]	27,780	1.93	8.92	49.5	21.6
Quincy,	47.22	Separate,	2,103	5.4	11,355	28,850	2.36	12.56	39.4	18.8
Totals,	468.13	- -	24,706	6.8	167,070	312,380	26.43	100.87	53.5	26.2

[1] Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1905 extended to May 1, 1906.

[2] Estimated by City Engineer.

[3] Part of town not included in Metropolitan Sewerage District.

[4] Including connection with Institution at Austin Farm having an estimated population of 500.

Whole Metropolitan System.

Table showing Areas delivering Sewage to the Entire System, inclusive of Added High-level Area; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1906.]

System.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Square Miles.	Square Miles.	Per Cent.	Per Cent.
North Metropolitan, .	593.88	Separate and combined,	60,503	6.4	386,343	488,663	27.44	90.50	79.1	30.3
South Metropolitan, .	468.18	Separate and combined,	24,706	6.8	167,070	312,380	26.43	100.87	53.5	26.2
Totals, . . .	1,062.06	– –	85,209	6.5	553,413	801,043	53.87	191.37	69.1	28.1

CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan Sewerage stations: —

North Metropolitan System.

Deer Island Pumping Station.

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 57,600,000 foot-pounds.
Average quantity raised each day: 58,100,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.
Coal used: first-quality Cumberland, costing from $3.44 to $3.95 per ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1906.						
January,	1,867,600,000	60,200,000	48,300,000	91,500,000	10.79	62,600,000
February,	1,744,500,000	62,300,000	49,400,000	84,800,000	10.77	59,800,000
March,	2,471,400,000	79,700,000	63,600,000	124,300,000	11.01	60,200,000
April,	2,219,200,000	74,000,000	53,500,000	108,800,000	11.15	55,800,000
May,	1,803,300,000	58,200,000	45,400,000	111,600,000	10.79	54,300,000
June,	1,670,100,000	55,700,000	48,000,000	72,100,000	10.68	52,600,000
July,	1,684,400,000	54,300,000	42,800,000	81,900,000	10.60	59,400,000
August,	1,459,300,000	47,100,000	39,800,000	58,700,000	10.35	57,300,000
September,	1,399,000,000	46,600,000	41,800,000	62,200,000	10.15	60,700,000
October,	1,445,600,000	46,600,000	39,300,000	71,200,000	10.27	54,100,000
November,	1,576,900,000	52,600,000	42,300,000	89,600,000	10.58	57,400,000
December,	1,858,200,000	59,900,000	45,900,000	85,100,000	10.73	57,300,000
Total,	21,199,500,000	–	–	–	–	–
Average,	–	58,100,000	46,700,000	86,400,000	10.66	57,600,000

East Boston Pumping Station.

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 56,500,000 foot-pounds.
Average quantity raised each day: 56,100,000 gallons.
Force employed: 4 engineers, 4 firemen, 4 oilers, 3 screenmen and 1 relief screenman.
Coal used: first-quality Cumberland, costing from $3.45 to $4.25 per ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1906.						
January,	1,805,600,000	58,200,000	46,300,000	89,500,000	16.47	61,600,000
February,	1,688,500,000	60,300,000	47,400,000	82,800,000	16.73	59,600,000
March,	2,409,400,000	77,700,000	61,600,000	122,300,000	17.43	58,500,000
April,	2,159,200,000	72,000,000	51,500,000	106,800,000	17.31	58,000,000
May,	1,741,300,000	56,200,000	43,400,000	109,600,000	16.68	56,700,000
June,	1,610,100,000	53,700,000	46,000,000	70,100,000	16.53	50,200,000
July,	1,622,400,000	52,300,000	40,800,000	79,900,000	16.42	56,200,000
August,	1,397,300,000	45,100,000	37,800,000	51,700,000	16.24	59,700,000
September,	1,339,000,000	44,600,000	39,800,000	60,200,000	16.20	54,800,000
October,	1,383,600,000	44,600,000	37,300,000	69,200,000	16.20	56,500,000
November,	1,516,900,000	50,600,000	40,300,000	87,600,000	16.23	50,900,000
December,	1,796,200,000	57,900,000	43,900,000	83,100,000	16.60	55,700,000
Total,	20,469,500,000	-	-	-	-	-
Average,	-	56,100,000	44,700,000	84,400,000	16.59	56,500,000

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one, 60,000,000 gallons, with 8-foot lift.
Average duty for the year: 59,300,000 foot-pounds.
Average quantity raised each day: 30,500,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.
Coal used: first quality Cumberland, costing from $3.45 to $3.95 per ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1906.						
January,	939,400,000	30,300,000	23,800,000	47,400,000	7.89	56,700,000
February,	923,900,000	33,000,000	25,800,000	41,900,000	8.55	60,900,000
March,	1,169,800,000	37,700,000	28,800,000	60,200,000	8.79	61,700,000
April,	1,012,500,000	33,700,000	27,100,000	52,100,000	8.50	63,900,000
May,	957,600,000	30,900,000	25,700,000	60,300,000	8.30	62,100,000
June,	905,800,000	30,200,000	26,000,000	40,900,000	8.24	62,700,000
July,	931,600,000	30,100,000	22,100,000	43,500,000	8.17	64,500,000
August,	861,700,000	27,800,000	24,100,000	32,700,000	8.39	61,500,000
September,	809,400,000	27,000,000	23,900,000	38,300,000	8.05	60,800,000
October,	809,900,000	26,100,000	20,600,000	37,400,000	7.93	51,800,000
November,	811,300,000	27,000,000	22,000,000	43,600,000	8.00	50,500,000
December,	1,001,800,000	32,300,000	25,100,000	54,500,000	8.28	54,800,000
Total,	11,134,700,000	-	-	-	-	-
Average,	-	30,500,000	24,600,000	46,100,000	8.26	59,300,000

Alewife Brook Pumping Station.

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.*, two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.
Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.
Average duty for the year: 17,000,000 foot-pounds.
Average quantity raised each day: 3,451,000 gallons.
Force employed: 3 engineers, 1 relief engineer, 2 screenmen and 1 relief screenman.
Coal used: first quality Cumberland, costing from $4.10 to $4.35 per ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1906.						
January,	114,724,000	3,701,000	2,881,000	5,882,000	13.24	18,800,000
February,	107,696,000	3,846,000	3,028,000	5,688,000	13.15	19,000,000
March,	163,396,000	5,271,000	3,622,000	7,403,000	12.65	22,800,000
April,	150,552,000	5,018,000	3,622,000	6,931,000	12.91	22,900,000
May,	116,261,000	3,750,000	2,881,000	6,931,000	13.10	18,300,000
June,	99,897,000	3,330,000	2,645,000	4,983,000	13.16	16,500,000
July,	102,482,000	3,306,000	2,456,000	5,688,000	13.01	16,400,000
August,	77,231,000	2,491,000	2,078,000	3,028,000	13.15	13,800,000
September,	68,522,000	2,284,000	1,952,000	3,430,000	13.16	13,200,000
October,	74,295,000	2,397,000	1,910,000	4,027,000	13.19	13,200,000
November,	81,875,000	2,729,000	2,036,000	4,799,000	13.13	14,400,000
December,	102,039,600	3,292,000	2,550,000	6,206,000	13.14	15,700,000
Total,	1,258,970,000	–	–	–	–	–
Average,	–	3,451,000	2,638,000	5,416,000	13.08	17,000,000

South Metropolitan System.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of pumps: 50,000,000 gallons each, with 45-foot lift.
Average duty for the year: 87,200,000 foot-pounds.
Average quantity raised each day: 24,500,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen, 1 relief engineer, 1 machinist and 1 laborer.
Coal used: first quality Cumberland, costing $4.17 per ton.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1906.						
January,	749,900,000	25,900,000	20,600,000	36,300,000	40.75	103,900,000
February,	755,000,000	26,900,000	18,300,000	33,700,000	40.50	102,000,000
March,	1,016,000,000	32,800,000	23,400,000	41,000,000	42.20	99,900,000
April,	990,100,000	33,000,000	22,200,000	40,200,000	42.55	93,600,000
May,	860,300,000	27,800,000	19,400,000	42,500,000	41.00	95,700,000
June,	638,100,000	21,300,000	18,200,000	31,500,000	39.85	84,200,000
July,	663,400,000	21,400,000	17,300,000	31,500,000	40.45	87,200,000
August,	638,500,000	20,600,000	15,000,000	24,700,000	40.15	80,700,000
September,	680,300,000	22,700,000	15,000,000	28,300,000	39.85	79,300,000
October,	600,000,000	19,300,000	15,300,000	26,400,000	40.25	73,200,000
November,	666,000,000	22,200,000	16,200,000	29,800,000	40.10	71,700,000
December,	628,000,000	20,300,000	15,400,000	30,700,000	40.10	75,400,000
Total,	8,885,600,000	-	-	-	-	-
Average,	-	24,500,000	18,000,000	33,000,000	40.65	87,200,000

Records from plunger displacement.
Average slip for the year about 15.2 per cent.

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines.

Contract capacity of pumps: one, 3,000,000 gallons, the other, 5,000,000 gallons, with 36-foot lift.
Average duty for the year: 32,100,000 foot-pounds.
Average quantity raised each day: 3,528,000 gallons.
Force employed: 3 engineers, 1 relief engineer, 2 screenmen and 1 relief screenman.
Coal used: first quality Cumberland, costing from $4.50 to $6 per ton.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1906.						
January,	110,849,000	3,576,000	3,[illegible],000	3,790,000	21.18	32,500,000
February,	102,813,000	3,672,000	3,427,000	4,158,000	21.16	33,200,000
March,	143,052,000	4,615,000	3,796,000	5,659,000	21.58	35,500,000
April,	139,638,000	4,655,000	3,842,000	5,256,000	22.48	37,600,000
May,	122,394,000	3,948,000	3,394,000	4,508,000	20.91	34,400,000
June,	112,596,000	3,753,000	3,273,000	4,336,000	21.19	33,700,000
July,	103,376,000	3,335,000	2,984,000	4,044,000	21.11	32,600,000
August,	93,004,000	3,000,000	2,716,000	3,261,000	20.99	30,800,000
September,	80,620,000	2,687,000	2,546,000	2,910,000	21.02	26,900,000
October,	87,419,000	2,820,000	2,467,000	3,261,000	21.22	26,000,000
November,	91,521,000	3,051,000	2,596,000	3,518,000	21.29	28,500,000
December,	100,050,000	3,227,000	2,999,000	3,741,000	20.87	33,000,000
Total,	1,287,332,000	-	-	-	-	-
Average,	-	3,528,000	3,112,000	4,037,000	21.25	32,100,000

Nut Island Screen House.

The plant at the house includes two sets of screens in duplicate, actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat for the house and burn materials intercepted at the screens.

Average quantity of sewage passing screens daily, 33,600,000 gallons.
Total materials intercepted at screens during the past year, 1,247 cubic yards.
Materials intercepted per million gallons of sewage discharge, 2.75 cubic feet.
Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.
Coal used: 322 tons first quality Cumberland, costing from $3.59 to $3.95 per ton.

Cost of Pumping.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of six pumping stations are shown in detail: —

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (21,199.5 Million Gallons) × Lift (10.66 Feet) = 225,987 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$9,522 51	$0.04214
Coal,	7,063 11	.03125
Oil,	232 47	.00103
Waste,	73 61	.00033
Water,	808 80	.00358
Packing,	259 73	.00115
Miscellaneous supplies and renewals,	2,142 58	.00948
Totals,	$20,102 81	$0.08896

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (20,469.5 Million Gallons) × Lift (16.59) = 339,589 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$9,470 93	$0.02788
Coal,	9,134 78	.02690
Oil,	280 04	.00083
Waste,	48 15	.00014
Water,	1,270 80	.00374
Packing,	79 51	.00023
Miscellaneous supplies and renewals,	1,634 43	.00482
Totals,	$21,918 64	$0.06454

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (11,134.7 Million Gallons) × Lift (8.26 Feet) = 91,973 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$8,885 15	$0.09661
Coal,	2,909 03	.03163
Oil,	183 89	.00200
Waste,	88 58	.00096
Water,	364 80	.00397
Packing,	111 91	.00122
Miscellaneous supplies and renewals,	559 69	.00608
Totals,	$13,103 05	$0.14247

Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.

Volume (1,258.97 Million Gallons) × Lift (13.08 Feet) = 16,467 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$3,275 63	$0.19892
Coal,	1,620 02	.09838
Oil,	77 17	.00469
Waste,	40 04	.00243
Water,	162 60	.00987
Packing,	53 88	.00327
Miscellaneous supplies and renewals,	147 70	.00897
Totals,	$5,377 04	$0.32653

Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.

Volume (8,885.6 Million Gallons) × Lift (40.65 Feet) = 361,190 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$12,002 90	$0.03323
Coal,	7,893 88	.02185
Oil,	812 78	.00225
Waste,	93 29	.00026
Water,	1,324 80	.00367
Packing,	131 33	.00036
Miscellaneous supplies and renewals,	2,300 21	.00637
Totals,	$24,559 19	$0.06799

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,287.3 Million Gallons) × Lift (21.25 Feet) = 27,355 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$4,020 60	$0.14697
Coal,	1,475 33	.05393
Oil,	23 04	.00084
Waste,	14 00	.00051
Water,	193 56	.00708
Packing,	6 48	.00024
Miscellaneous supplies and renewals,	464 74	.01699
Totals,	$6,197 75	$0.22656

Care of Special Structures.

Salt-water Pipe for supplying Condensers at East Boston Pumping Station.

The existing salt-water pipes for this station were laid on the muddy bed of Chelsea Creek. The bed of this creek is changing, so that the pipes are constantly being covered with silt.

During the year a 10-inch pipe on a pile structure with platform at an elevation of about 4 feet above high water has been carried out to a point nearly 75 feet beyond the bulkhead line of Chelsea Creek, as established by the United States Government. The pipe is turned down at the end of this structure into a depth of water of about 8 feet at low tide, so as to remain submerged under extreme tidal conditions.

This work has been carried out under licenses granted by the Harbor and Land Commission and the United States Government.

The piles were furnished and driven by Lawler Brothers, contractors, and the remainder of the work carried out by the maintenance force.

Riprap Reinforcement at End of 60-inch Outlet Pipe for the South Metropolitan System.

The strong tidal currents at the 60-inch outlet pipes in the harbor off Nut Island have occasioned some scouring of loose clay backfilling of the pipe trenches in that vicinity.

During the month of August the diving contractor who placed the pipes deposited 170 cubic yards of small riprap, in place of clay filling washed away.

The diver found no sand or other visible deposit from the sewage discharge on the bed of the harbor in the vicinity of the outfalls. He entered the pipes for a distance of 50 feet, and found the pipes entirely clean and in normal condition.

South Metropolitan Outfalls.

The 60-inch outlet pipes in the harbor have been in operation twenty-six months at the date of this report. During the past year the average flow through them has been 33,600,000 gallons of sewage per day, with a maximum rate of 97,000,000 gallons at a time of melting snow.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan sewerage stations, consisting of rags, paper and other floating matters, has during the year amounted to 2,141 cubic yards. This is equivalent to 2.8 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan sewerage stations has amounted to 2,942 cubic yards, equal to 6.5 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers, siphons and outfall pipes indicate that they are satisfactorily free from deposit and in normal condition.

Respectfully submitted,

WM. M. BROWN,
Engineer Sewerage Works.

Boston, January 1, 1907.

APPENDIX.

Appendix No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE.—The details of contracts made before

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	195	Wachusett Dam, . .	11	$1,680,870 00	$1,603,635 00[1]	McArthur Brothers Company.
2	245	Section 2 of relocation of Central Massachusetts Railroad (extension of Contract No. 195).	-[2]	-[2]	-[2]	McArthur Brothers Company.
3	288	Pumping engine for the Arlington station.	7	7,900 00	7,830 00	Allis-Chalmers Co., Milwaukee, Wis.
4	289[3]	Brass railing posts, Wachusett Dam.	4	5,780 00	4,150 00[1]	J. H. McCafferty & Co., Boston, Mass.
5	291[3]	Granite posts, curbing and edgestones for Wachusett Dam.	6	1,741 00	1,700 00[1]	F. A. McCaulliff, Fitchburg, Mass.
6	293[3]	Steel gates and fencing at Wachusett Dam.	5	1,485 00	1,349 00[1]	Henry Parsons & Son, Marlborough, Mass.
7	294	Arlington pumping station.	5	29,093 00	28,328 00[1]	C. A. Dodge & Co., Boston.
8	295	Sterling filter beds, Sterling, Mass.	5	10,230 50	9,803 50[1]	A. McKenzie & Co., Leominster, Mass.
9	296[3]	Reinforced granolithic surface on Wachusett Dam.	-[2]	-[2]	-[2]	Simpson Brothers Corporation, Boston.
10	8-M[3]	Remodelling and rebuilding attendant's house at Ashland Dam.	3	1,365 00	1,200 00[1]	A. P. Eldridge, South Framingham, Mass.
11	9-M	Repairing boiler at Chestnut Hill high-service pumping station.	2	2,766 00	1,791 00[1]	Hodge Boiler Works, Boston.

[1] Contract based upon this bid. [2] Competitive bids were not received on this contract.

APPENDIX No. 1.

THE YEAR 1906 — WATER WORKS.

1906 have been given in previous reports.]

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1906.	10. Value of Work done December 31, 1906.	
Oct. 1, '00,	Feb. 27, '06,	-	$1,606,481 04	1
April 18, '02,	Jan. 11, '06,	-	286,521 00	2
Oct. 28, '05,	-	For whole work, $9,790, ...	-	3
Sept. 8, '05,	Feb. 26, '06,	-	4,185 00	4
Dec. 12, '05,	Mar. 7, '06,	-	1,700 00	5
Feb. 3, '06,	Aug. 13, '06,	For whole work, $1,349, ...	1,349 00	6
Aug. 23, '06,	-	For whole work, $28,328, ...	15,000 00	7
Sept. 1, '06,	-	For earth excavation, $0.29 per cubic yard; for concrete masonry, $7.50 per cubic yard; for rubble stone masonry and paving, $2.70 per cubic yard; for furnishing and laying vitrified pipe: 18-inch, $1.50 per linear foot; 15-inch, $1.20 per linear foot; 12-inch, $0.90 per linear foot; 8-inch, $0.65 per linear foot; 6-inch, $0.60 per linear foot.	9,900 00	8
May 7, '06,	July 10, '06,	Cost of work plus $0.04 per square foot on each foot laid.	2,452 72	9
Aug. 15, '06,	Oct. 18, '06,	For whole work, $1,200, ...	1,200 00	10
Nov. 28, '06,	-	For whole work, $1,791, ...	-	11

[3] Contract completed.

CONTRACTS MADE AND PENDING DURING THE

1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1 Special Order.[3]	15 tons special castings, .	3	$59 00 per ton.	$57 50[1] per ton.	Warren Foundry and Machine Co., New York, N. Y.
2 Special Order.	Furnishing and erecting electric apparatus in gate-house at Wachusett Dam.	3	888 23	864 00[1]	Frank Ridlon Co., Boston.
3 Special Order.	Hercules water wheel at Wachusett Dam.	2	1,050 00	900 00[1]	Holyoke Machine Co., Holyoke, Mass.
4 Special Order.	Cut stone for retaining wall at the Arlington pumping station.	4	637 00	598 00[1]	John Harrington, East Cambridge, Mass.
	Total, ...	. .	. . . .	. . . .	. . . . .

[3] Contract completed.

YEAR 1906 — WATER WORKS — *Continued.*

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1906.	10. Value of Work done December 31, 1906.	
April 4, '06,	Sept. 22, '06,	For all castings, $57.50 per ton of 2,000 pounds, .	$935 55	1
June 7, '06,	–	For whole work, $864, ...	750 00	2
Aug. 27, '06,	–	For whole work, $900, ...	800 00	3
Nov. 16, '06,	–	For whole work, $598, ...	50 00	4
. . .	. . .	. . . . .	$1,931,324 31	

[1] Contract based upon this bid.

CONTRACTS MADE AND PENDING DURING THE YEAR 1906 — WATER WORKS — *Concluded.*

Summary of Contracts.[1]

	Value of Work done December 31, 1906.
Wachusett Reservoir, 1 contract,	$9,900 00
Relocation of Central Massachusetts Railroad, 1 contract,	286,521 00
Wachusett Dam, 5 contracts,	1,616,167 76
Distribution Department, 2 contracts,	15,000 00
Total of 9 contracts made and pending during the year 1906,	$1,927,588 76
282 contracts completed from 1896 to 1905, inclusive,	13,716,781 17
	$15,644,369 93
Deduct for work done on 11 Sudbury Reservoir contracts by the city of Boston,	512,000 00
Total of 302 contracts,	$15,132,369 93

[1] In this summary, contracts charged to maintenance are excluded.

Appendix No. 2.

Table No. 1.— *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1906.*

	Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.	Princeton,	2.61	2.60	5.08	3.26	6.31	5.64	5.83	5.48	2.54	3.85	2.28	4.20	49.68
	Jefferson,	2.86	2.81	5.42	3.56	7.18	–	–	4.55	2.94	4.73	2.04	4.28	40.37
	Sterling,	2.33	2.50	4.60	2.63	6.27	5.98	4.34	4.54	2.34	4.03	2.01	4.37	45.94
	Boylston,	2.54	3.03	5.56	3.04	6.57	6.24	6.40	2.79	2.64	3.19	2.66	4.18	48.84
Sudbury Watershed.	Sudbury Dam,	2.33	2.78	6.12	2.80	5.40	3.87	3.45	2.43	2.90	3.12	2.48	4.36	42.04
	Framingham,	2.50	2.88	6.13	2.72	5.25	3.38	3.13	2.64	2.91	3.11	2.50	4.39	41.54
	Ashland Dam,	2.46	2.94	6.45	2.77	5.67	3.76	3.47	3.24	3.42	3.51	2.64	4.53	44.86
	Cordaville,	2.59	3.07	6.56	3.25	6.33	4.63	3.63	3.77	3.99	3.85	3.12	4.68	49.47
Lake Cochituate,		2.66	2.59	6.47	2.60	4.98	3.44	3.04	2.37	2.84	3.26	2.50	4.68	41.43
Chestnut Hill Reservoir,		3.65	3.17	7.42	2.62	5.43	3.56	4.13	1.82	2.92	3.71	3.37	5.36	47.16
Spot Pond,		2.63	2.37	6.46	1.97	5.28	4.61	3.69	2.36	2.26	2.65	3.04	4.54	41.86
Average of all,		2.65	2.80	6.02	2.84	5.88	4.10	3.74	3.27	2.88	3.55	2.60	4.51	44.84
Average, Wachusett watershed,		2.59	2.74	5.17	3.12	6.58	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
Average, Sudbury watershed,		2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48

TABLE NO. 2. — *Rainfall in Inches at Jefferson, Mass., in 1906.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	–	–	–	–	–			–	–	–	–	–
2,	–	–	–	–	–			–	–	–	–	1
3,	1	–	1	–	0.21			–	0.51	–	–	0.10[2]
4,	0.95[3]	–	1.75	0.06	–			0.72	–	–	–	–
5,	–	–	–	1	1			–	–	0.24	–	–
6,	0.03[2]	–	–	0.40	0.75			0.04	–	–	–	0.90[3]
7,	–	–	–	–	–			–	–	–	–	–
8,	0.04[2]	–	–	–	–			0.76	–	–	–	–
9,	–	1.20[3]	0.12[3]	1	1			–	–	1.25	–	1
10,	–	–	–	1	0.25			1	–	–	–	1
11,	–	–	1	1.90[3]	–			0.02	–	–	0.98[2]	0.95[2]
12,	0.45	–	0.28[2]	–	–			–	–	–	–	–
13,	–	–	–	–	–			–	–	–	–	–
14,	0.12[2]	1	–	–	–			–	–	–	–	–
15,	–	0.36[3]	1	0.57	–	No Records.	No Records.	–	–	–	0.49[2]	0.24
16,	0.58	–	1.25[2]	–	–			–	–	–	–	–
17,	–	–	–	–	0.12			–	–	–	0.08	–
18,	0.24[3]	–	–	–	–			–	–	–	–	–
19,	–	–	1	–	–			–	0.15	–	–	–
20,	0.05	–	1.45[3]	–	–			1	0.48	1.88	–	1
21,	–	1	–	–	–			1.00	0.30	–	1	0.33
22,	–	0.75	–	–	–			0.07	0.84	–	0.33	1
23,	1	–	–	0.22	–			1	–	–	–	0.46[2]
24,	0.40	–	–	–	0.50			0.52	–	–	–	–
25,	–	1	–	–	0.60			–	–	1.17	–	–
26,	–	0.50	1	–	–			–	–	–	0.07	–
27,	–	–	0.32	–	1			1.42	0.10	–	–	–
28,	–	–	–	–	4.75			–	–	–	0.09[3]	–
29,	–	–	–	–	–			–	–	–	–	–
30,	–	–	1	0.41	–			–	0.56	1	–	1
31,	–	–	0.25	–	–			–	–	0.19	–	1.30
Total,	2.86	2.81	5.42	3.56	7.18			4.55	2.94	4.73	2.04	4.28

Total for the 10 months, 40.37 inches.

[1] Rainfall included in that of following day. [2] Snow. [3] Rain and snow.

TABLE No. 3.— *Rainfall in Inches at Framingham, Mass., in 1906.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	–	–	–	–	–	–	0.01	–	–	–	–	–
2,	–	–	–	–	0.13	0.02	0.47	–	–	–	0.03[3]	–
3,	[1]	–	[1]	–	–	–	[1]	–	0.04	–	–	0.05[2]
4,	1.00[3]	–	2.20	0.03	–	–	1.02	0.48	–	–	–	–
5,	–	0.04[3]	–	[1]	0.04	[1]	–	–	–	–	–	–
6,	0.02[2]	–	–	0.28	[1]	0.27	–	0.22	–	0.07	–	0.74[3]
7,	–	–	0.04	–	0.60	–	[1]	[1]	–	–	–	–
8,	0.05[2]	[1]	–	–	–	0.01	0.06	0.16	–	–	–	[1]
9,	–	1.18[3]	0.47[3]	[1]	0.11	0.14	0.02	–	–	1.06	0.06	[1]
10,	–	–	–	1.59	–	0.11	0.17	0.05	–	–	–	0.60[3]
11,	–	–	[1]	–	–	–	–	0.02	–	0.01	[1]	–
12,	0.14	–	0.20[2]	–	–	–	–	–	–	–	1.26	–
13,	[1]	0.02	–	–	0.12	–	–	–	0.09	–	–	–
14,	0.28[2]	[1]	–	–	–	–	–	–	–	–	–	[1]
15,	[1]	0.51[3]	1.26[2]	0.49	–	–	–	–	–	–	[1]	0.18
16,	0.50	–	–	–	–	[1]	0.04	–	–	–	0.94[3]	–
17,	–	–	–	–	0.05	[1]	0.21	–	–	–	–	–
18,	0.09[3]	–	–	–	–	[1]	0.17	–	–	–	–	–
19,	–	–	[1]	–	–	1.38	–	–	0.05	0.03	–	–
20,	0.03[3]	–	1.31[3]	–	–	–	–	[1]	[1]	[1]	[1]	[1]
21,	–	0.69	–	–	–	–	0.06	0.06	0.65	1.07	0.10	0.46[3]
22,	0.01	–	–	–	–	–	–	0.38	0.78	–	–	[1]
23,	[1]	–	–	0.19[3]	–	[1]	[1]	0.29	–	–	–	0.35[2]
24,	0.34	–	–	–	0.24	0.26	0.31	–	–	–	–	–
25,	–	0.44	–	–	[1]	–	–	–	–	0.28	–	0.14[2]
26,	–	–	0.05	–	0.24	–	0.04	[1]	–	–	0.04	–
27,	–	–	0.16	–	[1]	–	–	0.98	0.08	–	–	–
28,	0.04	–	–	–	[1]	–	0.01	–	–	–	0.06[3]	–
29,	–	–	–	[1]	3.72	–	[1]	–	–	–	–	–
30,	–	–	[1]	0.14	–	1.19	0.54	–	1.22	[1]	0.01[3]	[1]
31,	–	–	0.44[3]	–	–	–	–	–	–	0.59	–	1.87
Total,	2.50	2.88	6.13	2.72	5.25	3.38	3.13	2.64	2.91	3.11	2.50	4.39

Total for the year, 41.54 inches.

[1] Rainfall included in that of following day. [2] Snow. [3] Rain and snow.

TABLE NO. 4 — *Rainfall in Inches at Chestnut Hill Reservoir in 1906.*

DATE.	Amount.	Duration.
Jan. 4, 5,	1.16[1]	11.00 A.M. to 6.00 P.M.
Jan. 8, 9,	0.17[1]	6.30 P.M. to 4.45 A.M.
Jan. 12,	0.17	4.50 A.M. to 2.45 P.M.
Jan. 14,	0.59[1]	5.15 A.M. to 3.00 P.M.
Jan. 15,	0.82	9.40 P.M. to 3.15 P.M.
Jan. 16,		
Jan. 18,	0.09	10.30 P.M. to 6.00 A.M.
Jan. 19,		
Jan. 21,	0.04	1.30 A.M. to 5.00 A.M.
Jan. 22,	0.53	9.00 P.M. to 6.30 A.M.
Jan. 23,		
Jan. 27,	0.06	– –
Jan. 28,	0.02	– –
Total,	3.65	
Feb. 9,	1.33[2]	3.05 A.M. to 3.15 P.M.
Feb. 13,	0.15	7.15 A.M. to 5.00 P.M.
Feb. 14,	0.40[2]	3.45 P.M. to 1.00 A.M.
Feb. 15,		
Feb. 21,	0.88	2.50 P.M. to 12.50 A.M.
Feb. 22,		
Feb. 25,	0.41	9.00 P.M. to 12.25 A.M.
Feb. 26,		
Total,	3.17	
Mar. 3,	2.63	10.30 A.M. to 5.20 A.M.
Mar. 4,		
Mar. 7,	0.09	1.45 P.M. to 2.25 A.M.
Mar. 8,		
Mar. 9,	0.43[1]	7.15 A.M. to 8.40 P.M.
Mar. 11,	0.20[1]	11.55 P.M. to 6.30 A.M.
Mar. 12,		
Mar. 15,	1.39[1]	9.15 A.M. to 1.30 A.M.
Mar. 16,		
Mar. 19,	1.95[1]	2.15 P.M. to 2.50 A.M.
Mar. 20,		
Mar. 26,	0.07	6.40 P.M. to 11.50 P.M.
Mar. 27,	0.11	8.05 A.M. to 9.00 P.M.
Mar. 30,	0.55	2.45 P.M. to 10.30 A.M.
Mar. 31,		
Total,	7.42	
Apr. 4,	0.04	7.30 P.M. to 10.15 P.M.
Apr. 5,	0.32	11.35 P.M. to 6.20 A.M.
Apr. 6,		
Apr. 9,	1.09	6.15 P.M. to 11.30 A.M.
Apr. 10,		
Apr. 10,	0.25	8.30 P.M. to 1.40 A.M.
Apr. 11,		
Apr. 15,	0.48	1.30 A.M. to 3.15 P.M.
Apr. 23,	0.15	5.27 A.M. to 4.00 P.M.
Apr. 30,	0.29	3.50 A.M. to 10.30 A.M.
Total,	2.62	
May 2,	0.18	5.20 P.M. to 9.30 P.M.
May 5,	0.83	1.30 P.M. to 11.30 A.M.
May 7,		
May 9,	0.20	6.30 P.M. to 12.40 A.M.
May 10,		
May 13,	0.08	7.45 P.M. to 12.20 A.M.
May 14,		
May 24,	0.12	6.00 P.M. to 8.00 P.M.
May 25,	0.13	6.00 P.M. to 8.00 P.M.
May 27,	3.89	2.40 P.M. to 9.00 A.M.
May 29,		
Total,	5.43	

DATE.	Amount.	Duration.
June 2,	0.03	1.30 P.M. to 2.00 P.M.
June 5,	0.10	7.50 P.M. to 7.00 A.M.
June 6,		
June 6,	0.02	3.00 P.M. to 3.30 P.M.
June 6,	0.12	9.10 P.M. to 1.00 P.M.
June 7,		
June 8,	0.04	7.00 A.M. to 9.15 A.M.
June 9,	0.16	7.45 P.M. to 11.35 P.M.
June 10,	0.09	6.00 P.M. to 9.00 P.M.
June 16,	1.09	1.30 P.M. to 9.30 A.M.
June 19,		
June 23,	0.18	12.30 P.M. to 12.40 A.M.
June 24,		
June 29,	0.02	7.30 A.M. to 11.00 A.M.
June 30,	1.71	6.15 A.M. to 7.00 A.M.
July 1,		
Total,	3.56	
July 2,	0.20	4.25 A.M. to 7.10 A.M.
July 2,	0.09	3.30 P.M. to 2.50 A.M.
July 3,		
July 3,	0.94	4.30 P.M. to 5.30 P.M.
July 4,		
July 7,	0.17	5.40 P.M. to 6.00 A.M.
July 8,		
July 8,	0.03	8.15 A.M. to 10.00 A.M.
July 10,	0.25	3.15 P.M. to 5.40 P.M.
July 15,	0.05	1.25 A.M. to 5.10 A.M.
July 17,	0.12	6.20 P.M. to 7.30 P.M.
July 18,	0.09	9.30 P.M. to 10.10 P.M.
July 21,	0.67	11.30 A.M. to 10.30 P.M.
July 23,	0.04	7.45 A.M. to 2.00 P.M.
July 23,	0.17	5.15 P.M. to 5.40 A.M.
July 24,		
July 24,	0.03	7.15 P.M. to 9.30 P.M.
July 26,	0.09	3.30 P.M. to 2.45 A.M.
July 27,		
July 28,	0.03	6.40 A.M. to 7.40 P.M.
July 29,	1.16	11.40 P.M. to 8.00 A.M.
July 30,		
Total,	4.13	
Aug. 2,	0.09	8.30 P.M. to 11.30 A.M.
Aug. 3,		
Aug. 3,	0.30	7.40 P.M. to 7.25 P.M.
Aug. 4,		
Aug. 6,	0.02	3.45 P.M. to 5.30 P.M.
Aug. 8,	0.06	2.10 A.M. to 5.10 A.M.
Aug. 8,	0.10	8.30 A.M. to 10.30 A.M.
Aug. 10,	0.05	4.30 P.M. to 8.30 P.M.
Aug. 21,	0.05	2.00 A.M. to 3.10 A.M.
Aug. 21,	0.05	11.30 A.M. to 12.25 P.M.
Aug. 23,	0.35	9.05 P.M. to 5.00 A.M.
Aug. 24,		
Aug. 27,	0.03	1.10 A.M. to 7.10 A.M.
Aug. 27,	0.72	7.25 P.M. to 11.30 P.M.
Total,	1.82	
Sept. 3,	0.10	4.10 A.M. to 1.05 P.M.
Sept. 14,	0.05	12.55 A.M. to 5.05 A.M.
Sept. 20,	0.68	10.10 P.M. to 7.00 A.M.
Sept. 21,		
Sept. 22,	0.74	11.00 A.M. to 11.45 P.M.
Sept. 27,	0.15	8.20 A.M. to 3.15 P.M.
Sept. 30,	1.20	2.25 A.M. to 8.35 A.M.
Total,	2.92	

[1] Snow.

[2] Rain and snow.

TABLE NO. 4.—*Rainfall in Inches at Chestnut Hill Reservoir in 1906*—Concluded.

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Oct. 6,	0.16	3.30 P.M. to 8.20 P.M.	Dec. 3,	0.16 [2]	8.00 A.M. to 5.20 P.M.
Oct. 9,	1.80	4.55 P.M. to 9.30 A.M.	Dec. 6,	0.74 [1]	4.10 A.M. to 4.30 P.M.
Oct. 10,			Dec. 8,	0.81 [1]	10 00 P.M. to 3.15 A.M.
Oct. 20,	0.55	2.40 P.M. to 7.15 A.M.	Dec. 11,		
Oct. 21,			Dec. 15,	0.28	3.05 A.M. to 7.00 P.M.
Oct. 25,	0.24	5.45 A.M. to 12.00 M.	Dec. 20,	0.64	4.00 P.M. to 5.00 P.M.
Oct. 30,	0.96	12.30 P.M. to 7.30 P.M.	Dec. 21,		
Oct. 31,			Dec. 22,	0.64 [2]	7.00 P.M. to 3.45 P.M.
Total,	3.71		Dec. 23,		
			Dec. 25,	0.16 [2]	8.00 A.M. to 1.25 A.M.
Nov. 2,	0.04 [1]	4.45 A.M. to 11.30 A.M.	Dec. 26,		
Nov. 9,	0.06	11.20 P.M. to 1.10 A.M.	Dec. 31,	0.04	2.12 A.M. to 5.15 A.M.
Nov. 10,			Jan. 1, 1907,	1.89	8.15 A.M. to 5.00 A.M.
Nov. 11,	1.42	9.50 A.M. to 2.15 A.M.	Total,	5.36	
Nov. 12,					
Nov. 15,	1.47 [1]	1.00 P.M. to 9.30 A.M.			
Nov. 16,					
Nov. 21,	0.29	7.15 A.M. to 10.00 A.M.			
Nov. 22,					
Nov. 26,	0.05	9.15 P.M. to 10.00 P.M.			
Nov. 27,	0.04 [1]	10.00 A.M. to 9.00 P.M.			
Total,	3.37				

Total for the year, 47.16 inches.

[1] Rain and snow. [2] Snow.

TABLE NO. 5 — *Rainfall in Inches on the Wachusett Watershed, 1897 to 1906.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897, ...	3.46	2.86	4.01	2.32	5.06	5.11	8.65	3.47	1.93	0.94	7.62	6.41	51.84
1898, ...	6.65	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899, ...	2.93	5.12	6.75	1.94	1.33	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900, ...	4.56	8.69	6.19	2.76	4.34	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901, ...	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902, ...	2.72	4.91	5.27	4.36	2.24	2.51	3.87	3.95	4.26	6.36	0.93	7.20	48.58
1903, ...	2.85	4.42	6.58	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904, ...	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905, ...	6.10	1.72	3.95	2.60	0.83	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906, ...	2.59	2.74	5.17	3.12	6.58	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
Total, ...	37.63	37.55	49.41	41.72	35.01	45.98	46.39	43.98	37.75	35.80	34.92	47.06	493.20
Average, . . .	3.76	3.75	4.94	4.17	3.50	4.60	4.64	4.40	3.78	3.58	3.49	4.71	49.32

NOTE. — The figures tabulated are means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1906, Princeton, Jefferson, Sterling and Boylston.

TABLE NO. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1906.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
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
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.57	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
1899,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78	37.21
1900,	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65
1901,	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902,	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903,	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92	42.82
1905,	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906,	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
Total,	133.92	135.26	147.26	113.85	107.29	101.49	119.00	127.38	109.76	131.70	123.46	122.96	1,473.33
Average,	4.19	4.22	4.60	3.56	3.35	3.17	3.72	3.98	3.43	4.12	3.86	3.84	46.04

[1] Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June, 1898, to December, 1906, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE NO. 7.— *Yield of the Wachusett Watershed in Gallons per Day per Square Mile*[1] *from 1897 to 1906.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	Mean for 10 Years, 1897-1906.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000	659,000	1,266,000	1,132,000	1,177,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000	1,399,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000	3,035,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000	2,471,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000	1,260,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	542,000	1,184,000	916,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	365,000	728,000	533,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	321,000	591,000	520,000
September,	380,000	676,000	250,000	127,000	320,000	241,000	375,000	494,000	1,228,000	277,000	437,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000	347,000	367,000	530,000	581,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	442,000	749,000	808,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,018,000	794,000	1,455,000
Average for year,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	926,000	1,043,000	1,215,000
Average for driest 6 months,	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000	413,000	541,000	613,000	630,000

[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, and to 5.1 per cent. in 1906.

TABLE No. 8.— *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1906.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January,	103,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000	1,235,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,336,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240,000
September,	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000
Average for year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000
Average for driest 6 months,	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000

[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878 inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 8.— *Yield of the Sudbury Watershed in Gallons per Day per Square Mile* [1] *from 1875 to 1906* — Continued.

MONTH.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.
January,	1,461,000	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	693,000	1,034,000	1,084,000
February,	4,801,000	2,829,000	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000
March,	2,059,000	2,868,000	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000
April,	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000
May,	720,000	1,009,000	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	360,000
June,	203,000	413,000	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000
July,	116,000	115,000	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000
August,	94,000	214,000	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000
September,	117,000	111,000	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000
October,	146,000	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000
November,	673,000	369,000	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000
December,	1,020,000	643,000	3,043,000	2,241,000	996,000	544,000	485,000	796,000	716,000	1,782,000	657,000
Average for year,	1,087,000	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000
Average for driest 6 months,	223,000	234,000	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000

[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1906* — Concluded.

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	Mean for 32 Years, 1875-1906.
January,	845,000	1,638,000	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,220,000
February,	1,067,000	3,022,000	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	1,788,000
March,	2,565,000	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	2,953,000
April,	1,515,000	1,829,000	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	1,643,000	1,949,000	2,096,000
May,	915,000	1,246,000	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	1,113,000
June,	962,000	530,000	66,000	316,000	753,000	303,000	1,987,000	419,000	467,000	707,000	526,000
July,	658,000	231,000	19,000	—18,000	306,000	66,000	445,000	62,000	177,000	398,000	199,000
August,	591,000	1,107,000	—35,000	—34,000	424,000	135,000	307,000	170,000	114,000	180,000	282,000
September,	182,000	369,000	94,000	65,000	305,000	178,000	130,000	397,000	1,246,000	19,000	263,000
October,	94,000	1,160,000	115,000	186,000	412,000	506,000	492,000	191,000	158,000	301,000	489,000
November,	909,000	1,986,000	304,000	663,000	474,000	444,000	363,000	289,000	279,000	483,000	838,000
December,	1,584,000	1,799,000	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	887,000	659,000	1,063,000
Average for year,	991,000	1,450,000	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,065,000
Average for driest six months,	564,000	777,000	93,000	194,000	445,000	271,000	388,000	228,000	403,000	341,000	431,000

[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 9.— *Wachusett System.— Statistics of Flow of Water, Storage and Rainfall in 1906.*

[Watershed above gaging station = 119.00 square miles.]

MONTH.	Quantity of Water discharged through Wachusett Aqueduct (Gallons per Day).[1]	Quantity of Water wasted into River below Dam (Gallons per Day).	STORAGE.[2]		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
			Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	95,345,000	29,161,000	36,406,000	–	134,668,000	2.59	2.018	78.1
February,	99,246,000	2,732,000	20,175,000	–	122,154,000	2.74	1.654	60.5
March,	45,003,000	3,648,000	172,694,000	–	221,345,000	5.17	3.317	64.2
April,	83,063,000	4,367,000	163,510,000	–	250,940,000	3.12	3.640	116.5
May,	67,426,000	4,116,000	110,852,000	–	182,394,000	6.58	2.734	41.5
June,	84,690,000	4,230,000	51,927,000	–	140,847,000	5.95	2.043	34.3
July,	85,555,000	3,935,000	–	2,835,000	86,655,000	5.52	1.299	23.5
August,	92,574,000	4,365,000	–	26,590,000	70,348,000	4.34	1.055	24.3
September,	98,353,000	3,977,000	–	69,377,000	32,953,000	2.61	0.478	18.3
October,	69,794,000	4,048,000	–	10,816,000	63,061,000	3.95	0.945	23.9
November,	81,073,000	3,380,000	4,733,000	–	89,187,000	2.25	1.294	57.5
December,	69,768,000	3,306,000	21,465,000	–	94,539,000	4.26	1.417	33.3
Total,	–	–	–	–	–	49.08	21.894	–
Average for year,	80,777,000	3,761,000	39,521,000	–	124,059,000	–	–	44.6

[1] Including small quantities wasted in cleaning aqueduct.

[2] Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE NO. 10.— *Sudbury System.— Statistics of Flow of Water, Storage and Rainfall in 1906.*

[Watershed from 1875 to 1878 inclusive = 77.764 square miles; in 1879 and 1880 = 78.238 square miles; and from 1881 to 1906 inclusive = 75.2 square miles.]

MONTH.	Quantity of Water received through Wachusett Aqueduct (Gallons per Day).[1]	Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day).[2]	Quantity of Water discharged through Weston Aqueduct (Gallons per Day).[2]	Quantity of Water used by Framingham Water Company (Gallons per Day).	Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day).	Quantity of Water wasted into River below Lowest Dam (Gallons per Day).	STORAGE.		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
							Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	95,345,000	91,139,000	33,781,000	542,000	1,713,000	44,781,000	8,213,000	–	84,823,000	2.47	2.012	81.5
February,	99,246,000	92,457,000	34,150,000	571,000	1,825,000	39,457,000	9,032,000	–	78,246,000	2.92	1.676	57.5
March,	45,003,000	81,819,000	33,271,000	565,000	2,245,000	109,348,000	–	1,094,000	181,152,000	6.32	4.297	68.1
April,	83,063,000	76,767,000	32,047,000	557,000	2,167,000	87,370,000	30,693,000	–	146,537,000	2.88	3.364	116.6
May,	67,426,000	65,223,000	32,713,000	568,000	1,216,000	22,026,000	25,342,000	–	79,661,000	5.66	1.890	33.4
June,	84,690,000	80,477,000	32,043,000	597,000	1,277,000	24,040,000	–	610,000	53,133,000	3.91	1.220	31.2
July,	85,555,000	70,223,000	31,768,000	590,000	1,055,000	13,587,000	–	1,765,000	29,903,000	3.42	0.709	20.7
August,	92,574,000	67,500,000	31,923,000	635,000	977,000	6,677,000	–	1,590,000	13,548,000	3.02	0.321	10.6
September,	98,353,000	75,880,000	31,573,000	650,000	697,000	1,507,000	–	10,490,000	1,463,000	3.30	0.034	1.0
October,	69,794,000	66,142,000	31,184,000	626,000	581,000	1,500,000	–	7,568,000	22,671,000	3.40	0.538	15.8
November,	81,073,000	70,683,000	31,347,000	607,000	880,000	10,393,000	3,483,000	–	36,320,000	2.69	0.834	31.1
December,	69,616,000	98,616,000	32,339,000	642,000	1,235,000	20,284,000	–	33,971,000	49,529,000	4.49	1.175	26.2
Total,	–	–	–	–	–	–	–	–	–	44.48	18.070	–
Av. for year,	80,764,000	77,981,000	32,336,000	596,000	1,319,000	31,694,000	1,534,000	–	64,697,000	–	–	40.6

[1] Not including quantities of water wasted in cleaning aqueduct, which were not discharged into Sudbury Reservoir.

[2] Including quantities of water wasted from aqueduct.

TABLE NO. 11.— *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1906.*

[Watershed of lake = 18.87 square miles.[1]]

MONTH.	Quantity of Water received from External Sources (Gallons per Day).[2]	Quantity of Water discharged through Cochituate Aqueduct (Gallons per Day).	Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day).	Quantity of Water wasted at Outlet (Gallons per Day).	STORAGE.		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
					Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	–	–	894,000	–	15,726,000	–	16,619,000	2.66	1.57	59.0
February,	–	–	757,000	–	14,189,000	–	14,946,000	2.59	1.28	49.3
March,	–	–	1,213,000	27,055,000	8,529,000	–	36,797,000	6.47	3.48	53.8
April,	–	4,230,000	1,407,000	21,367,000	2,127,000	–	29,130,000	2.60	2.66	102.5
May,	–	19,094,000	797,000	–	–	2,874,000	17,016,000	4.98	1.61	32.3
June,	12,447,000	20,837,000	7,700,000	–	250,000	–	9,410,000	3.44	0.86	25.0
July,	9,768,000	22,765,000	561,000	–	–	5,755,000	7,803,000	3.04	0.74	24.3
August,	–	24,429,000	297,000	–	–	18,748,000	5,977,000	2.37	0.57	23.8
September,	9,480,000	23,298,000	1,933,000	–	–	8,780,000	5,227,000	2.84	0.48	16.8
October,	–	20,403,000	239,000	–	–	11,635,000	9,006,000	3.26	0.85	26.1
November,	4,647,000	15,597,000	360,000	–	–	2,510,000	8,800,000	2.50	0.80	32.2
December,	2,994,000	8,384,000	390,000	–	9,816,000	–	8,597,000	4.68	0.81	17.4
Total,	–	–	–	–	–	–	–	41.43	15.71	–
Average for year,	3,862,000	13,332,000	655,000	4,054,000	–	64,000	14,115,000	–	–	37.9

[1] Not including the watershed of Dudley Pond.

[2] From Framingham reservoirs Nos. 1, 2 and 3.

TABLE NO. 12.— *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE.	Chestnut Hill Reservoir. Ordinary High Water = 134.00.	Lake Cochituate. High Water = 144.36.	Farm Pond. High Water = 159.25.	Spot Pond. High Water = 163.00.	Weston Reservoir. High Water = 200.00.	Framingham Reservoir. No. 1. Flash Boards 169.27.	Framingham Reservoir. No. 2. Flash Boards 177.12.	Framingham Reservoir. No. 3. Flash Boards 186.50.	Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Flash Boards. 259.97.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. Ordinary High Water = 337.91.	Wachusett Reservoir.
Jan. 1, 1906, .	132.87	138.68	158.77	163.14	199.91	167.87	176.17	182.06	220.91	256.97	295.74	337.27	344.06
Feb. 1, 1906, .	133.88	141.05	158.80	163.39	200.05	167.84	176.14	183.98	224.46	256.64	300.08	336.26	345.72
Mar. 1, 1906, .	133.95	142.84	158.88	163.38	200.02	167.86	176.17	184.00	224.58	257.01	302.95	335.82	346.55
April 1, 1906, .	133.98	143.93	159.23	162.96	200.11	168.12	176.37	181.90	223.56	257.18	303.35	336.11	354.47
May 1, 1906, .	133.97	144.18	159.14	163.09	199.99	167.66	176.46	182.36	224.59	258.84	304.28	336.69	361.14
June 1, 1906, .	133.36	143.83	159.10	163.05	200.09	169.45	177.59	183.32	225.48	259.64	305.03	337.48	365.23
July 1, 1906, .	133.65	143.86	158.90	163.22	200.12	168.62	177.68	184.02	225.44	259.42	305.07	337.81	367.20
Aug. 1, 1906, .	131.62	143.13	158.65	163.05	200.01	167.67	177.56	184.54	225.35	259.24	305.06	338.04	367.29
Sept. 1, 1906, .	132.70	140.51	158.20	162.98	200.05	169.35	177.54	184.18	225.28	259.08	305.03	338.04	366.57
Oct. 1, 1906, .	131.83	139.23	159.13	163.11	200.05	167.12	177.09	184.26	223.22	259.20	302.18	337.97	364.50
Nov. 1, 1906, .	133.18	137.34	158.82	163.04	200.04	168.42	177.06	184.39	221.03	259.10	299.29	338.20	363.84
Dec. 1, 1906, .	133.65	136.92	159.12	162.87	199.97	168.23	177.63	182.03	223.39	259.24	301.11	338.04	363.82
Jan. 1, 1907, .	134.46	138.56	159.22	162.89	200.26	168.31	176.56	183.69	224.80	256.45	303.00	337.05	364.57

TABLE NO. 13.— *Average Daily Quantity of Water flowing through Aqueducts in 1906 by Months.*[1]

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	SUDBURY AQUEDUCT INTO CHESTNUT HILL RESERVOIR.			Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
			From Framingham Reservoir No. 3 (Gallons).	From Framingham Reservoirs Nos. 1 and 2 (Gallons).	Total (Gallons).	
January,	95,345,000	33,781,000	91,139,000	–	91,139,000	–
February,	99,246,000	34,150,000	87,007,000	5,450,000	92,457,000	–
March,	45,003,000	32,716,000	81,819,000	–	81,819,000	–
April,	83,063,000	32,047,000	76,767,000	–	76,767,000	3,707,000
May,	67,426,000	33,713,000	48,232,000	16,229,000	64,461,000	19,094,000
June,	84,690,000	32,043,000	67,323,000	–	67,323,000	20,837,000
July,	85,555,000	31,768,000	60,116,000	339,000	60,455,000	22,765,000
August,	92,574,000	31,923,000	61,500,000	6,000,000	67,500,000	24,429,000
September,	98,353,000	31,573,000	57,113,000	9,287,000	66,400,000	23,293,000
October,	69,794,000	31,184,000	39,423,000	26,719,000	66,142,000	20,403,000
November,	81,073,000	31,347,000	62,790,000	3,247,000	66,037,000	15,597,000
December,	69,616,000	32,339,000	88,623,000	–	88,623,000	8,384,000
Average,	80,764,000	32,289,000	68,363,000	5,634,000	73,997,000	13,288,000

[1] Not including quantities wasted while cleaning and repairing aqueducts, and not including 3,863,000 gallons per day diverted through the Sudbury Aqueduct to Lake Cochituate, and 270,000 gallons per day diverted to Farm Pond.

TABLE NO. 14.—*Statement of Operations of Engines Nos. 1 and 2 at Chestnut Hill High-service Pumping Station for the Year 1906.*

[3 per cent. allowed for slip.]

MONTH.	ENGINE NO. 1.		ENGINE NO. 2.		Total Amount pumped (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).		Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).						No. 1.	No. 2.		
	Hrs. Min.		Hrs. Min.										
January,	491 10	171.77	- -	-	171.77	211,289	22,721	10.8	812.96	119.09	-	80,650,000	83,160,000
February,	458 05	160.18	8 05	2.82	163.00	234,344	23,190	9.9	695.56	119.46	120.38	69,220,000	71,370,000
March,	390 05	128.26	43 50	14.17	142.43	241,598	26,437	10.9	589.53	118.60	119.68	58,300,000	60,110,000
April,	501 30	167.13	135 30	44.57	211.70	324,465	40,360	12.4	652.46	122.95	126.94	67,280,000	69,370,000
May,	362 20	122.35	206 40	73.17	195.52	287,958	34,604	12.0	678.99	123.07	121.71	69,320,000	71,480,000
June,	199 15	69.12	376 40	129.16	198.28	296,290	38,194	12.9	669.21	119.75	120.53	67,040,000	69,120,000
July,	519 05	175.28	37 35	13.50	188.78	285,700	33,369	11.7	660.76	120.86	127.36	66,780,000	68,860,000
August,	180 25	59.20	294 20	95.19	154.39	244,435	30,650	12.5	631.62	121.58	121.69	64,000,000	65,990,000
September,	- -	-	487 -	160.58	160.58	255,558	29,470	11.5	628.35	-	120.98	63,320,000	65,290,000
October,	- -	-	348 45	112.92	112.92	207,834	24,033	11.6	543.32	-	121.38	54,930,000	56,640,000
November,	50 45	17.57	98 30	34.09	51.66	139,036	16,955	12.2	371.56	120.04	121.03	37,350,000	38,510,000
December,	318 15	111.93	118 30	42.15	154.08	286,270	34,442	12.0	538.23	120.52	121.05	54,100,000	55,780,000
Total,	3,470 55	1,182.79	2,155 25	722.32	1,905.11	3,014,777	354,425	-	-	-	-	-	-
Average,	- -	-	- -	-	-	-	-	11.8	631.92	120.62	121.60	63,690,000	65,670,000

TABLE NO. 15. — *Statement of Operations of Engine No. 3 at Chestnut Hill High-service Pumping Station for the Year 1906.*

[7.5 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	–	–	–	–	–	–	–	–	–	–
February,	24	55	23.37	22,127	2,235	10.1	1,056.17	127.79	112,430,000	121,480,000
March,	–	–	–	–	–	–	–	–	–	–
April,	282	15	264.21	272,979	33,028	12.1	967.88	128.32	103,460,000	111,790,000
May,	47	10	44.20	43,944	5,149	11.7	1,005.83	127.22	106,590,000	115,170,000
June,	23	55	22.45	24,100	3,078	12.8	931.54	128.70	99,870,000	107,910,000
July,	119	05	111.80	109,089	13,024	11.9	1,024.85	128.97	110,100,000	118,960,000
August,	48	55	45.42	42,887	5,351	12.5	1,059.06	129.48	114,230,000	123,430,000
September,	–	–	–	–	–	–	–	–	–	–
October,	2	55	2.77	3,807	437	11.5	727.61	124.59	75,510,000	81,590,000
November,	–	–	–	–	–	–	–	–	–	–
December,	–	–	–	–	–	–	–	–	–	–
Total,	549	10	514.22	518,933	62,302	–	–	–	–	–
Average,	–	–	–	–	–	12.0	990.91	128.44	106,020,000	114,550,000

TABLE No. 16.— *Statement of Operations of Engine No. 4 at Chestnut Hill High-service Pumping Station for the Year 1906.*

[3 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting, corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger no Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 1, 2, 3 AND 4.	
										Total Amount pumped, corrected for Slip (Million Gallons).	Daily Average Amount pumped (Million Gallons).
	Hrs. Min.										
January,	739 10	937.09	764,012	84,606	11.1	1,226.54	129.94	132,760,000	136,840,000	1,108.86	35.770
February,	647 25	817.84	645,876	64,387	10.0	1,266.25	130.75	137,910,000	142,150,000	1,004.21	35.865
March,	744 –	942.00	757,323	84,081	11.1	1,243.86	129.94	134,640,000	138,780,000	1,084.43	34.982
April,	434 20	544.99	462,388	61,676	13.3	1,178.64	130.92	128,540,000	132,490,000	1,020.90	34.030
May,	694 35	872.14	736,977	89,239	12.1	1,183.40	132.43	130,550,000	134,560,000	1,111.86	35.866
June,	694 10	874.04	727,687	93,794	12.9	1,201.12	131.73	131,800,000	135,850,000	1,094.77	36.492
July,	615 30	769.64	644,130	74,291	11.5	1,194.85	132.37	131,750,000	135,800,000	1,070.22	34.523
August,	694 30	869.49	737,526	92,808	12.6	1,178.93	132.45	130,070,000	134,070,000	1,069.30	34.494
September,	716 45	892.99	740,756	85,079	11.5	1,205.51	132.26	132,810,000	136,890,000	1,058.57	35.119
October,	737 25	925.12	792,880	91,464	11.5	1,166.78	132.85	129,120,000	133,090,000	1,040.81	33.575
November,	720 –	916.72	759,585	98,126	12.9	1,206.87	131.72	132,420,000	136,490,000	968.38	32.279
December,	743 35	948.75	749,397	90,161	12.0	1,266.02	131.46	138,640,000	142,900,000	1,102.83	35.575
Total,	8,181 52	10,310.81	8,518,537	1,009,712	–	–	–	–	–	–	–
Average,	– –	–	–	–	11.9	1,210.40	131.57	132,660,000	136,740,000	12,730.14	34.877

TABLE No. 17. — *Statement of Operations of Engines Nos. 5, 6 and 7 at Chestnut Hill Low-service Pumping Station for the Year 1906.*

[3 per cent. allowed for slip.]

MONTH.	ENGINE No. 5.		ENGINE No. 6.		ENGINE No. 7.		Total Amount pumped (Million Gallons).	Daily Average Amount pumped (Million Gallons).	Total Amount of Coal consumed (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	AVERAGE LIFT (FEET).			Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).						Engine No. 5.	Engine No. 6.	Engine No. 7.		
	Hrs. Min.		Hrs. Min.		Hrs. Min.											
January,	732 –	866.86	400 15	463.95	300 10	359.56	1,690.37	54.528	748,435	13.2	2,258.54	53.76	54.69	52.84	101,250,000	104,340,000
February,	635 55	800.88	649 25	823.21	– –	–	1,624.09	58.003	696,995	13.5	2,330.13	54.05	53.69	–	104,560,000	107,750,000
March,	639 55	792.92	609 55	749.74	– –	–	1,542.66	49.763	611,030	12.7	2,524.69	47.56	47.37	–	99,830,000	102,870,000
April,	529 50	650.07	649 20	806.40	– –	–	1,456.47	48.549	536,093	11.4	2,716.82	47.69	45.88	–	105,660,000	108,880,000
May,	289 05	321.92	666 25	765.09	405 20	482.12	1,569.13	50.617	627,875	13.2	2,499.10	47.72	48.41	50.82	102,020,000	105,130,000
June,	267 25	306.34	355 45	432.04	665 45	794.80	1,533.18	51.106	639,900	12.9	2,395.97	53.39	54.70	53.22	107,120,000	110,390,000
July,	25 –	32.94	606 45	745.75	614 30	760.78	1,539.47	49.660	648,525	13.7	2,373.80	47.84	51.72	51.23	101,630,000	104,730,060
August,	724 35	817.44	4 40	6.07	703 40	792.99	1,616.50	52.145	701,750	13.9	2,303.53	52.90	48.55	52.87	101,450,000	104,540,000
September,	695 30	809.26	438 10	517.20	231 –	267.39	1,593.85	53.128	684,790	12.5	2,327.50	52.91	52.78	51.05	101,900,000	105,010,000
October,	590 15	754.27	530 35	674.49	77 15	88.78	1,517.54	48.953	622,480	14.2	2,437.89	49.67	49.07	51.12	100,500,000	103,570,000
November,	427 10	532.23	153 10	184.55	550 55	681.80	1,398.58	46.619	589,320	15.1	2,373.21	45.81	45.67	46.26	90,960,000	93,730,000
December,	415 35	509.75	640 30	781.83	467 –	565.17	1,856.75	59.895	848,165	14.0	2,189.14	58.28	53.91	53.29	100,150,000	103,200,000
Total,	5,972 15	7,194.88	5,704 55	6,950.32	4,015 35	4,793.39	18,938.59	–	7,955,358	–	–	–	–	–	–	–
Average,	–	–	–	–	–	–	–	51.887	–	13.4	2,380.61	51.36	50.73	51.43	101,430,000	104,520,000

TABLE NO. 18.— *Statement of Operations of Engines Nos. 8 and 9 at Spot Pond Pumping Station for the Year 1906.*

[Engine No. 8, 2.02 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	SUMMARY FOR ENGINES NOS. 8 AND 9. Total Amount pumped corrected for Slip (Million Gallons).	SUMMARY FOR ENGINES NOS. 8 AND 9. Daily Average Amount pumped (Million Gallons).
	Hrs. Min.										
December,	12 45	6.02	5,545	–	–	1,085.66	129.30	116,930,000	119,340,000	–	–
Total and average,	12 45	6.02	5,545	–	–	1,085.66	129.30	116,930,000	119,340,000	–	–

[Engine No. 9, 3 per cent. allowed for slip.]

	Hrs. Min.										
January,	287 –	231.40	187,651	22,174	11.8	1,233.14	128.21	131,700,000	135,830,000	231.40	7.465
February,	265 –	212.83	175,899	21,339	12.1	1,211.33	127.54	128,630,000	132,720,000	212.83	7.601
March,	289 15	231.91	191,059	24,456	12.8	1,213.81	127.76	129,180,000	133,230,000	231.91	7.481
April,	265 20	208.92	171,324	22,112	12.9	1,219.44	124.66	126,630,000	130,600,000	208.92	6.964
May,	379 45	281.14	241,272	34,732	14.4	1,165.24	128.38	124,610,000	128,520,000	281.14	9.069
June,	336 15	267.98	228,129	38,249	16.8	1,174.69	128.62	125,860,000	129,800,000	267.98	8.933
July,	354 –	284.77	244,147	37,470	15.3	1,166.39	127.41	123,790,000	127,670,000	284.77	9.186
August,	369 45	296.91	250,744	34,824	13.9	1,184.12	127.44	125,700,000	129,640,000	296.91	9.578
September,	359 45	287.83	227,937	22,873	10.0	1,262.76	128.19	134,840,000	139,070,000	287.83	9.594
October,	309 45	250.27	207,303	23,568	11.4	1,207.27	128.99	129,720,000	133,790,000	250.27	8.073
November,	281 45	226.36	189,240	22,189	11.7	1,196.15	128.99	128,520,000	132,550,000	226.36	7.545
December,	306 15	245.43	212,999	22,416	10.3	1,152.26	129.09	123,900,000	127,780,000	251.45	8.111
Total,	3,803 50	3,025.75	2,527,504	326,402	–	–	–	–	–	3,031.77	–
Average,	– –	–	–	–	12.9	1,197.13	127.98	127,620,000	131,620,000	–	8.306

TABLE NO. 19.— *Average Daily Consumption of Water during the Year 1906, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont, Nahant and a Small Portion of Saugus. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 23.)*

MONTH.	Average Daily Consumption (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
January,	119,697,300	907,040	132
February,	123,351,700	907,950	136
March,	117,477,900	908,850	129
April,	112,039,000	909,760	123
May,	116,444,700	912,670	128
June,	118,834,000	915,570	130
July,	116,620,500	918,210	127
August,	118,389,300	919,850	129
September,	118,196,500	920,490	129
October,	112,341,300	920,130	122
November,	109,952,800	919,770	119
December,	127,156,000	921,410	138
For the year,	117,524,600	915,040	128

In addition to the above quantities, the United States Government Reservation on Peddocks Island was supplied with 16,250,000 gallons, equivalent to a daily average rate of 45,000 gallons.

TABLE NO. 20.— *Average Daily Consumption of Water, in Gallons, from the Low-service System in 1906.*

MONTH.	SOUTHERN LOW SERVICE.	NORTHERN LOW SERVICE.	Total Low-service Consumption.
	Boston, excluding East Boston and Charlestown.	Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington.	
January,	48,851,900	27,732,500	76,584,400
February,	50,872,800	29,026,100	79,898,900
March,	47,919,700	26,945,400	74,865,100
April,	45,426,300	25,072,400	70,498,700
May,	45,930,900	25,479,600	71,410,500
June,	46,923,000	25,811,000	72,734,000
July,	46,701,600	25,722,500	72,424,100
August,	47,259,600	26,383,000	73,642,600
September,	47,026,700	25,799,900	72,826,600
October,	46,494,800	24,078,600	70,573,400
November,	46,598,300	23,216,900	69,815,200
December,	53,367,100	29,932,400	83,299,500
For the year,	47,769,800	26,258,200	74,028,000

TABLE NO. 21. — *Average Daily Consumption of Water, in Gallons, from the High-service and Extra High-service Systems in 1906.*

MONTH.	SOUTHERN HIGH SERVICE. Quincy, Watertown, Belmont, and Portions of Boston and Milton.	SOUTHERN EXTRA HIGH SERVICE. Portions of Boston and Milton.	NORTHERN HIGH SERVICE. Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford, Somerville and Saugus.	NORTHERN EXTRA HIGH SERVICE. Lexington and Portion of Arlington.
January,	34,363,200	651,900	7,558,800	539,000
February,	34,480,600	652,000	7,762,100	558,100
March,	33,949,000	650,300	7,451,900	561,600
April,	32,894,700	652,000	7,389,600	604,000
May,	35,254,900	787,400	8,277,400	714,500
June,	35,478,100	830,600	9,033,300	758,000
July,	33,362,800	788,400	9,300,100	745,100
August,	33,800,400	621,300	9,564,700	760,300
September,	34,500,200	635,400	9,417,900	816,400
October,	32,381,800	535,800	8,140,300	710,000
November,	31,389,000	478,000	7,624,600	646,000
December,	34,609,000	474,800	8,145,300	627,400
For the year,	33,870,300	646,400	8,309,300	670,600

TABLE NO 22. — *Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venturi Meters in 1906.*

City or town,	BOSTON.		SOMERVILLE.		MALDEN.		CHELSEA.		EVERETT.		QUINCY.		MEDFORD.	
Population supplied,	601,430.		70,950.		39,040.		38,000.		30,270.		28,300.		20,080.	
MONTH.	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	94,307,000	158	6,154,700	88	1,986,300	51	3,849,800	102	2,469,900	83	2,967,300	105	1,812,400	91
February,	96,899,900	162	6,191,300	88	1,945,900	50	4,430,800	117	2,724,500	91	3,000,100	107	1,877,400	94
March,	92,238,900	154	5,825,800	83	1,896,000	49	3,993,900	106	2,520,900	84	3,035,700	108	1,793,700	90
April,	87,578,500	146	5,707,000	81	1,927,000	50	3,492,700	92	2,330,200	78	2,896,600	103	1,804,500	90
May,	89,632,300	149	6,363,900	90	2,040,900	52	3,390,200	89	2,399,100	80	3,149,800	112	2,086,300	104
June,	90,740,400	151	6,620,900	93	2,120,900	54	3,499,000	92	2,494,800	83	3,309,600	117	2,109,700	105
July,	88,845,700	148	6,523,300	92	2,162,500	55	3,527,800	93	2,409,500	80	3,095,000	109	2,056,700	103
August,	89,613,700	149	6,703,700	94	2,091,700	53	3,681,000	97	2,486,800	82	3,214,600	113	2,169,600	108
September,	89,513,400	149	6,529,100	92	2,112,100	54	3,692,600	97	2,436,600	80	3,268,700	115	2,352,200	117
October,	86,654,400	143	6,342,700	89	1,887,700	48	3,321,400	87	2,244,900	74	2,824,400	99	2,098,300	104
November,	85,592,600	141	6,037,300	84	1,899,500	48	3,154,000	83	2,123,800	69	2,726,400	95	1,945,800	96
December,	100,045,800	165	6,591,800	92	1,927,700	49	4,336,400	113	2,673,400	87	2,775,400	97	2,055,000	101
For the year,	90,951,800	151	6,301,000	89	2,000,100	51	3,694,000	97	2,441,600	81	3,021,800	107	2,014,100	100

TABLE NO. 22. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

City or town,	MELROSE.		REVERE.		WATERTOWN.		ARLINGTON.		MILTON.		WINTHROP.	
Population supplied,	14,650.		13,390.		11,550.		9,940.		7,120.		7,240.	
MONTH.	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	1,623,100	112	882,800	67	685,300	60	687,500	70	255,500	36	700,500	98
February,	1,616,000	111	981,700	74	674,400	59	739,100	75	251,000	35	745,100	104
March,	1,582,400	109	962,600	73	686,800	60	711,100	72	274,700	39	701,500	98
April,	1,621,000	111	875,400	66	730,800	64	713,100	72	295,500	42	690,900	96
May,	1,645,800	113	1,059,100	80	840,000	73	871,700	88	438,100	62	765,600	106
June,	1,545,800	106	1,294,600	97	851,800	74	897,400	90	451,400	64	917,400	127
July,	1,589,900	108	1,324,100	99	811,300	70	829,500	83	398,300	56	979,200	135
August,	1,608,200	110	1,404,200	104	797,700	69	866,200	87	434,100	61	1,057,800	145
September,	1,657,900	113	1,250,900	93	827,600	71	940,400	94	435,500	61	953,000	131
October,	1,566,000	107	984,600	73	827,500	71	824,000	82	335,700	47	784,200	107
November,	1,484,600	101	928,400	68	806,000	69	757,800	76	311,500	43	723,100	98
December,	1,555,300	106	1,158,900	85	710,700	61	768,700	76	315,400	44	811,700	110
For the year,	1,591,300	109	1,093,200	82	771,300	67	800,800	81	350,300	49	819,800	113

TABLE NO. 22. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

City or town,	STONEHAM.		BELMONT.		LEXINGTON.		NAHANT.		SWAMPSCOTT.		METROPOLITAN DISTRICT.	
Population supplied,	6,350.		4,410.		4,230.		1,850.		6,240.		915,040.	
MONTH.	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	396,500	62	166,500	38	235,800	57	57,300	62	459,100	87	119,697,300	132
February,	398,500	63	168,200	38	250,200	60	62,800	68	394,800	75	123,351,700	136
March,	375,900	59	199,600	45	260,600	62	57,400	62	360,400	68	117,477,900	129
April,	391,100	62	235,900	54	310,300	74	63,200	68	375,300	71	112,039,000	123
May,	421,900	67	332,500	76	408,200	97	132,800	69	466,500	74	116,444,700	128
June,	434,400	69	337,500	77	423,900	101	217,200	74	567,300	78	118,834,000	130
July,	438,500	69	312,400	71	405,700	96	232,100	68	679,000	87	116,620,500	127
August,	483,500	76	337,000	76	413,800	98	273,000	80	752,700	96	118,389,300	129
September,	535,800	84	409,100	92	393,700	92	241,200	82	646,700	88	118,196,500	129
October,	498,500	78	288,000	65	335,400	79	93,200	48	430,400	68	112,341,300	122
November,	459,000	72	231,900	52	291,500	68	69,000	74	410,600	76	103,952,800	119
December,	458,600	71	249,500	56	285,100	66	78,700	85	357,900	66	127,156,000	138
For the year,	441,200	69	272,900	62	335,000	79	131,900	71	492,500	79	117,524,600	128

TABLE NO. 23. — *Consumption of Water in the Metropolitan Water District, as constituted in the Year 1906, the Town of Swampscott and a Small Section of the Town of Saugus, from 1893 to 1906.*

[Gallons per Day.]

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January,	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000	83,880,000	96,442,000
February,	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,475,000	103,454,000
March,	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000	85,468,000	90,200,000
April,	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000	76,574,000	86,491,000
May,	61,025,000	60,676,000	65,194,000	73,402,000	76,772,000	76,677,000	89,448,000
June,	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000	83,463,000	97,691,000
July,	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000	88,228,000	96,821,000
August,	66,983,000	67,995,000	72,233,000	78,537,000	84,103,000	87,558,000	92,072,000
September,	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000	88,296,000	91,478,000
October,	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000	89,580,000
November,	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000	78,177,000	86,719,000
December,	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000	86,355,000	85,840,000
Average,	66,165,000	65,382,000	69,499,000	78,360,000	80,793,000	83,651,000	92,111,000
Population,	723,153	743,354	763,557	786,385	809,213	832,042	854,870
Per capita,	91.5	88.0	91.0	99.7	99.8	100.5	107.8

MONTH.	1900.	1901.	1902.	1903.	1904.	1905.	1906.
January,	100,055,000	111,275,000	118,435,000	125,176,000	137,771,000	130,878,000	126,093,000
February,	98,945,000	117,497,000	117,268,000	122,728,000	143,222,000	140,595,000	130,766,000
March,	97,753,000	105,509,000	108,461,000	111,977,000	123,334,000	120,879,000	123,570,000
April,	89,497,000	93,317,000	103,153,000	107,179,000	108,688,000	111,898,000	118,428,000
May,	87,780,000	95,567,000	106,692,000	111,589,000	111,715,000	115,804,000	122,404,000
June,	98,581,000	103,420,000	110,002,000	105,590,000	111,209,000	117,441,000	121,882,000
July,	107,786,000	106,905,000	108,340,000	107,562,000	113,584,000	124,769,000	118,726,000
August,	102,717,000	102,815,000	107,045,000	103,570,000	112,836,000	121,158,000	120,591,000
September,	103,612,000	102,103,000	107,752,000	106,772,000	114,188,000	120,103,000	121,685,000
October,	98,358,000	103,389,000	106,560,000	103,602,000	108,290,000	118,301,000	116,561,000
November,	93,648,000	101,324,000	105,175,000	103,477,000	108,054,000	116,693,000	113,746,000
December,	97,844,000	113,268,000	125,434,000	114,721,000	125,119,000	122,696,000	130,995,000
Average,	98,059,000	104,645,000	110,345,000	110,277,000	118,114,000	121,671,000	122,085,000
Population,	877,698	892,740	907,780	922,820	937,860	953,556	965,990
Per capita,	111.7	117.2	121.6	119.5	125.9	127.6	126.4

This table includes the water consumed in the cities and towns enumerated in Table No. 19, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District, but have not been supplied from the Metropolitan Works. The populations for the years 1901 to 1904 have been revised since the census of 1905 became available, and consequently differ from those published in a corresponding table in the preceding annual reports.

TABLE NO. 24. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1906.																
59009	Jan. 23	V. slight.	Slight.	23	None.	Faintly vegetable.	3.30	1.25	.0020	.0138	.0116	.0022	.25	.0010	.0001	.39	0.8
59200	Feb. 13	V. slight.	V. slight.	23	V. faintly vegetable.	Faintly vegetable.	3.20	1.15	.0024	.0116	.0110	.0006	.28	.0010	.0000	.34	0.6
59550	March 6	V. slight.	V. slight.	25	Faintly vegetable.	Faintly vegetable.	3.00	1.40	.0028	.0134	.0120	.0014	.27	.0030	.0000	.37	1.0
60091	April 3	V. slight.	Slight.	23	Faintly vegetable and unpleasant.	Distinctly vegetable and unpleasant.	2.35	0.80	.0010	.0130	.0108	.0022	.26	.0030	.0001	.37	0.5
60470	May 8	V. slight.	Slight.	23	Faintly vegetable.	Faintly vegetable.	2.45	1.15	.0020	.0162	.0110	.0052	.25	.0020	.0001	.31	0.6
60875	June 5	V. slight.	Cons.	25	Distinctly unpleasant and musty.	Distinctly unpleasant and musty.	3.10	1.05	.0068	.0204	.0118	.0086	.24	.0020	.0002	.35	0.6
61376	July 2	V. slight.	Slight.	24	Faintly vegetable.	Distinctly vegetable.	3.20	1.20	.0030	.0182	.0158	.0024	.21	.0010	.0002	.42	0.6
61812	July 31	V. slight.	Slight.	18	None.	V. faintly vegetable.	3.65	1.60	.0014	.0152	.0122	.0030	.21	.0010	.0000	.40	0.5
62537	Sept. 4	V. slight.	Slight.	21	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	2.50	1.05	.0016	.0198	.0162	.0036	.20	.0010	.0000	.32	0.5
63074	Oct. 2	V. slight.	Slight.	18	Faintly vegetable.	Distinctly vegetable.	3.00	1.00	.0028	.0144	.0130	.0014	.22	.0000	.0001	.28	0.8
63622	Nov. 6	V. slight.	V. slight.	20	Faintly vegetable.	Faintly vegetable.	3.00	1.25	.0018	.0126	.0110	.0016	.23	.0020	.0001	.30	1.0
63973	Dec. 4	V. slight.	V. slight.	17	Faintly vegetable.	Distinctly vegetable.	2.70	1.10	.0016	.0100	.0080	.0020	.22	.0010	.0001	.27	1.0
Av.	.....	.....	.....	22	.....	.....	2.95	1.17	.0024	.0149	.0120	.0029	.24	.0015	.0001	.34	0.7

TABLE NO. 25.— *Chemical Examinations of Water from Sudbury Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Color.						Albuminoid.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1906.																
59160	Feb. 12	Slight.	Slight.	28	Faintly unpleasant.	Distinctly unpleasant, fishy.	3.75	1.35	.0016	.0186	.0126	.0060	.30	.0030	.0000	.40	1.0
59516	March 6	V. slight.	Slight.	26	Faintly unpleasant.	Distinctly unpleasant, fishy.	3.45	1.30	.0028	.0154	.0124	.0030	.28	.0050	.0001	.36	0.8
60046	April 2	V. slight.	Slight.	23	Faintly vegetable.	Distinctly vegetable.	3.60	1.20	.0030	.0160	.0132	.0028	.28	.0080	.0001	.28	1.1
60464	May 7	Slight.	Cons.	23	Faintly unpleasant.	Distinctly unpleasant.	3.65	1.60	.0032	.0196	.0138	.0058	.30	.0090	.0002	.37	1.1
60819	June 4	V. slight.	Slight.	23	Faintly vegetable.	Distinctly vegetable.	3.45	1.20	.0058	.0174	.0114	.0060	.29	.0040	.0001	.30	1.1
61366	July 2	V. slight.	Slight.	25	Faintly vegetable and distinctly sweetish.	Faintly vegetable and distinctly sweetish.	3.40	1.20	.0044	.0192	.0168	.0024	.28	.0020	.0002	.39	1.1
61771	July 30	V. slight.	V. slight.	22	Faintly unpleasant and musty.	Faintly unpleasant and musty.	3.30	1.05	.0032	.0172	.0142	.0030	.27	.0010	.0000	.36	1.0
62541	Sept. 4	V. slight.	Slight.	17	Faintly vegetable.	Distinctly vegetable.	2.95	1.40	.0032	.0136	.0120	.0016	.23	.0000	.0001	.30	1.0
63046	Oct. 2	V. slight.	Slight.	13	Faintly vegetable.	Faintly vegetable.	2.75	1.20	.0044	.0146	.0116	.0030	.24	.0010	.0000	.31	0.6
63574	Nov. 5	V. slight.	V. slight.	16	Faintly vegetable.	Faintly vegetable.	3.10	1.25	.0032	.0158	.0140	.0018	.28	.0010	.0000	.34	1.0
63945	Dec. 3	V. slight.	V. slight.	14	Faintly vegetable.	Distinctly vegetable.	2.95	1.20	.0026	.0144	.0106	.0038	.26	.0020	.0000	.28	1.3
Av.	.....	.....	.....	21	.....	.....	3.30	1.27	.0034	.0165	.0130	.0036	.27	.0033	.0001	.34	1.0

TABLE NO. 26. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Color.						Albuminoid.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1906.																
59150	Feb. 12	V. slight.	V. slight.	12	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.35	1.10	.0016	.0160	.0134	.0026	.34	.0020	.0001	.32	1.1
60045	April 2	V. slight.	Slight.	12	Faint cucumber odor.	Distinct cucumber odor.	3.10	1.35	.0008	.0176	.0146	.0030	.30	.0020	.0001	.18	1.3
60788	June 1	V. slight.	V. slight.	14	Faintly vegetable.	Distinctly vegetable.	3.65	1.55	.0018	.0164	.0140	.0024	.30	.0020	.0000	.29	1.0
61760	July 30	V. slight.	Slight.	12	Faintly unpleasant, anabæna.	Distinctly unpleasant, anabæna.	3.35	1.55	.0024	.0162	.0138	.0024	.36	.0010	.0000	.27	1.6
63088	Oct. 2	V. slight.	Slight.	10	Distinctly vegetable.	Distinctly vegetable.	3.55	1.35	.0022	.0154	.0124	.0030	.32	.0000	.0000	.25	1.1
63923	Dec. 3	V. slight.	Slight.	10	V. faintly vegetable.	Faintly vegetable.	3.55	1.10	.0022	.0156	.0150	.0006	.32	.0020	.0000	.27	1.4
Av.	.....	.....	.....	12	.....	.....	3.43	1.33	.0018	.0162	.0139	.0023	.32	.0015	.0000	.26	1.3

TABLE NO. 27. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1906.																
58980	Jan. 22	V. slight.	Cons.	25	Distinctly unpleasant.	Distinctly unpleasant.	4.50	1.75	.0034	.0230	.0162	.0068	.50	.0010	.0001	.42	1.8
59172	Feb. 12	V. slight.	Slight.	24	Faintly unpleasant.	Faintly unpleasant.	4.85	1.65	.0020	.0198	.0164	.0034	.50	.0000	.0000	.43	1.8
59496	March 5	Slight.	Cons.	24	Distinctly unpleasant and decidedly musty.	Distinctly unpleasant and decidedly musty.	4.55	1.75	.0022	.0196	.0162	.0034	.52	.0010	.0000	.42	1.8
60068	April 2	V. slight.	Slight.	27	Faintly unpleasant.	Distinctly unpleasant.	5.15	1.80	.0018	.0196	.0152	.0044	.47	.0030	.0001	.40	1.6
60461	May 7	Slight.	Cons.	27	Distinctly unpleasant, decaying organisms.	Distinctly unpleasant, decaying organisms.	5.15	1.85	.0022	.0200	.0170	.0030	.51	.0040	.0001	.48	1.7
60800	June 4	V. slight.	Slight.	28	Faintly vegetable.	Faintly vegetable.	5.20	1.85	.0060	.0192	.0170	.0022	.49	.0040	.0002	.46	1.8
61428	July 9	Slight.	Cons.	27	Distinctly vegetable.	Distinctly vegetable.	6.55	1.75	.0026	.0224	.0180	.0044	.51	.0000	.0000	.54	2.0
61766	July 30	Slight.	Cons.	29	Faintly vegetable, anabæna.	Distinctly vegetable, anabæna.	4.70	2.00	.0022	.0254	.0210	.0044	.49	.0000	.0000	.49	1.1
62533	Sept. 4	Slight.	Slight.	25	Faintly vegetable.	Distinctly vegetable.	5.00	1.90	.0034	.0296	.0234	.0062	.53	.0000	.0000	.52	2.0
63027	Oct. 2	V. slight.	Slight.	24	Distinctly unpleasant and vegetable.	Distinctly unpleasant and vegetable.	5.55	2.05	.0008	.0218	.0202	.0016	.50	.0010	.0000	.49	2.0
63575	Nov. 5	Slight.	Slight.	32	Faintly vegetable.	Distinctly vegetable.	6.30	3.60	.0070	.0264	.0224	.0040	.56	.0010	.0001	.48	2.2
63933	Dec. 3	Slight.	Cons.	26	Faintly cucumber, synura.	Decidedly cucumber, synura.	4.70	1.80	.0060	.0224	.0162	.0062	.51	.0020	.0004	.42	2.2
Av.	.....	.....	.....	27	.....	.....	5.18	1.98	.0033	.0224	.0183	.0042	.51	.0014	.0001	.46	1.8

TABLE NO. 28. — *Chemical Examinations of Water from a Faucet at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Color.						Albuminoid.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1906.																
58965	Jan. 22	V. slight.	Slight.	20	Faintly unpleasant and distinctly fishy.	Distinctly unpleasant and fishy.	3.35	1.35	.0020	.0130	.0116	.0014	.30	.0030	.0001	.33	1.1
59137	Feb. 12	V. slight.	V. slight.	22	Faintly unpleasant and cucumber, synura.	Faintly unpleasant and cucumber, synura.	3.40	1.40	.0022	.0148	.0122	.0026	.32	.0070	.0000	.32	1.1
59494	March 5	Slight.	Slight.	23	Distinctly vegetable.	Distinctly vegetable.	3.40	1.30	.0018	.0124	.0112	.0012	.32	.0070	.0001	.31	1.1
60051	April 3	V. slight.	Slight.	25	Faintly unpleasant, fishy.	Distinctly unpleasant, fishy.	3.30	1.45	.0022	.0136	.0118	.0018	.26	.0110	.0001	.31	1.0
60456	May 7	V. slight.	Slight.	28	Faintly vegetable.	Distinctly vegetable.	4.95	1.55	.0020	.0154	.0122	.0032	.34	.0090	.0001	.44	1.3
60774	June 4	Decided.	Cons.	25	Distinctly vegetable.	Decidedly vegetable.	4.15	1.40	.0028	.0224	.0156	.0068	.38	.0090	.0000	.36	1.6
61378	July 3	V. slight.	Slight.	21	Faintly unpleasant, fishy.	Distinctly unpleasant, dinobryon.	4.10	1.50	.0014	.0170	.0150	.0020	.35	.0010	.0000	.38	1.6
61755	July 30	V. slight.	V. slight.	25	V. faintly vegetable.	Faintly vegetable.	4.00	1.25	.0018	.0154	.0146	.0008	.38	.0030	.0000	.36	1.3
62526	Sept. 4	Slight.	Slight.	23	Faintly vegetable.	Faintly vegetable.	4.55	1.75	.0010	.0180	.0148	.0032	.35	.0030	.0001	.34	1.7
63025	Oct. 1	V. slight.	V. slight.	24	Faintly vegetable.	Distinctly vegetable.	3.70	1.10	.0006	.0174	.0150	.0024	.38	.0070	.0000	.38	1.6
63577	Nov. 5	None.	V. slight.	27	V. faintly vegetable.	Faintly vegetable.	3.75	1.00	.0018	.0146	.0134	.0012	.36	.0020	.0001	.45	1.4
63921	Dec. 3	V. slight.	Slight.	19	Distinctly unpleasant, fishy.	Decidedly unpleasant, fishy.	3.65	1.60	.0018	.0164	.0132	.0032	.31	.0030	.0000	.28	1.1
Av.	.....	.....	.....	24	.....	.....	3.86	1.39	.0018	.0159	.0134	.0025	.34	.0054	.0001	.36	1.3

TABLE NO. 29.— *Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1906.*

[Parts per 100,000.]

LOCALITY.	Samples Collected.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				CHLORINE.	NITROGEN AS		OXYGEN CONSUMED.	HARDNESS.
						ALBUMINOID.							
		Platinum Standard.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
Quinepoxet River, Holden,	Bi-monthly,	34	4.81	1.55	.0022	.0179	.0147	.0032	.33	.0060	.0001	.55	0.7
Stillwater River, Sterling,	Bi-monthly,	39	3.61	1.43	.0018	.0140	.0123	.0017	.23	.0032	.0001	.45	0.7
Wachusett Reservoir, West Boylston,	Monthly,	36	3.35	1.33	.0028	.0161	.0139	.0022	.24	.0046	.0001	.45	0.7
Wachusett Reservoir, Clinton, surface,	Monthly,	22	2.95	1.11	.0024	.0149	.0120	.0029	.24	.0015	.0001	.34	0.7
Wachusett Reservoir, Clinton, El. 288,	Monthly,	22	3.02	1.20	.0031	.0136	.0116	.0020	.24	.0023	.0001	.34	0.7
Marlborough (Walker's Brook),	Bi-monthly,	52	16.98	4.96	.2782	.0444	.0339	.0105	2.14	.1574	.0049	.80	5.5
Marlborough Brook filter-beds, effluent,	Bi-monthly,	8	13.97	–	.0240	.0[illegible]	–	–	1.79	.2308	.0006	.17	4.4
Wachusett Aqueduct, Southborough,	Monthly,	28	3.26	1.33	.0036	.0149	.0125	.0021	.24	.0034	.0002	.39	0.9
Sudbury Reservoir, surface,	Monthly,	21	3.30	1.27	.0034	.0165	.0130	.0036	.27	.0033	.0001	.34	1.0
Framingham Reservoir, No. 3, near dam,	Monthly,	21	3.47	1.39	.0024	.0158	.0131	.0027	.28	.0035	.0001	.33	1.1
Hopkinton Reservoir, inlet,	Bi-monthly,	138	6.00	3.00	.0029	.0307	.0290	.0017	.52	.0018	.0001	1.43	1.4
Hopkinton Reservoir, surface,	Bi-monthly,	64	4.03	1.86	.0034	.0205	.0186	.0019	.35	.0027	.0001	.70	0.9

TABLE No. 29. — *Averages of Examinations of Water, etc.* — Concluded.

[Parts per 100,000.]

LOCALITY.	Samples Collected.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
		Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID. Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
Ashland Reservoir, inlet,	Bi-monthly,	110	5.43	2.54	.0028	.0270	.0244	.0026	.34	.0027	.0001	1.14	1.2
Ashland Reservoir, surface,	Bi-monthly,	62	3.65	1.75	.0025	.0213	.0185	.0028	.29	.0015	.0001	.74	0.8
Framingham Reservoir No. 2, inlet,	Bi-monthly,	81	4.38	2.01	.0033	.0223	.0200	.0022	.33	.0042	.0001	.83	1.0
Framingham Reservoir No. 2, near dam,	Bi-monthly,	75	4.28	1.83	.0033	.0226	.0199	.0026	.33	.0023	.0001	.82	0.9
Lake Cochituate,	Monthly,	27	5.18	1.98	.0033	.0224	.0183	.0042	.51	.0014	.0001	.46	1.8
Terminal chamber, Sudbury Aqueduct,	Bi-monthly,	24	3.43	1.33	.0024	.0157	.0128	.0028	.29	.0040	.0001	.35	1.1
Spot Pond,	Bi-monthly,	12	3.43	1.33	.0018	.0162	.0139	.0023	.32	.0015	.0000	.26	1.3
Tap in Revere,	Bi-monthly,	12	3.75	1.24	.0019	.0133	.0122	.0011	.33	.0012	.0001	.27	1.2
Tap at State House,	Monthly,	24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.0054	.0001	.36	1.3
Tap in Quincy,	Bi-monthly,	20	3.91	1.58	.0015	.0136	.0124	.0012	.35	.0072	.0001	.34	1.3

TABLE NO. 30. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1906.*

[Parts per 100,000.]

YEAR.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.				CHLORINE.	NITROGEN AS		OXYGEN CONSUMED.	HARDNESS.
						ALBUMINOID.							
	Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1892, . .	.37	37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	–	1.9
1893, . .	.61	53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
1894, . .	.69	58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
1895, . .	.72	59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
1896, . .	.49	45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
1897, . .	.65	55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6
1898, . .	.41	40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4
1899, . .	.23	28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.0137	.0001	.35	1.1
1900, . .	.24	29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.0076	.0001	.38	1.3
1901, . .	.24	29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.0173	.0001	.42	1.7
1902, . .	.26	30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.0092	.0000	.40	1.3
1903, . .	.25	29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.0142	.0001	.39	1.5
1904, . .	–	23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37	1.5
1905, . .	–	24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.0083	.0001	.35	1.4
1906, . .	–	24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.0054	.0001	.36	1.3

Note relating to Chemical Examinations of Water, Tables Nos. 24–30.

The chemical examinations contained in the tables were made by the State Board of Health. Previous to the year 1904 colors were determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The more important samples are collected and examined monthly; those of less significance, at intervals of two or three months.

TABLE NO. 31. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1906.* (*Means of Weekly Determinations.*)

[Platinum Standard.]

MONTH.	WACHUSETT RESERVOIR.					SUDBURY RESERVOIR.				FRAMINGHAM RESERVOIR NO. 3.	SPOT POND.	FELLS RESERVOIR.
	Surface.	Mid-depth.	Bottom.	Worcester Street Bridge.	Aqueduct Head House.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Mid-depth.	Mid-depth.	Effluent Gate-house.
January,	23	25	26	43	24	23	23	24	38	23	18	18
February,	28	28	28	40	28	26	26	27	32	27	18	18
March,	28	28	28	35	28	26	26	26	54	26	18	18
April,	26	26	26	41	26	26	26	26	36	26	15	15
May,	26	26	26	66	25	26	26	27	43	28	16	17
June,	28	26	26	69	30	27	26	26	35	28	17	16
July,	27	26	25	50	26	24	24	24	29	24	15	15
August,	26	26	26	44	26	23	23	24	27	23	16	16
September,	23	23	23	33	23	20	20	20	24	20	15	15
October,	20	20	21	27	20	19	18	18	22	19	18	16
November,	19	19	19	41	19	18	18	18	26	19	17	17
December,	18	18	18	42	18	18	18	18	25	18	16	15
Mean,	24	24	24	44	24	23	23	23	33	23	17	17

TABLE NO. 31 — *Concluded.*

[Platinum Standard.]

MONTH.	LAKE COCHITUATE.				CHESTNUT HILL RESERVOIR.			NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Surface.	Mid-depth.	Bottom.	Influent Streams.[1]	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	28	29	29	58	23	23	25	26	19	24	25
February,	29	31	32	55	27	-	25	24	19	26	26
March,	29	30	30	60	26	-	25	24	19	25	25
April,	29	29	30	73	24	27	24	23	16	24	24
May,	29	29	35	111	40	29	33	32	22	32	33
June,	29	29	47	148	30	29	29	27	18	29	28
July,	31	30	91	98	27	31	25	23	15	25	26
August,	30	29	72	57	28	29	27	25	16	27	28
September,	28	28	182	46	25	27	24	24	17	25	27
October,	24	26	160	54	32	24	30	28	16	26	30
November,	28	28	71	57	20	27	23	23	18	22	23
December,	26	26	26	54	18	25	18	18	15	18	19
Mean,	28	29	67	73	27	-	26	25	18	25	26

[1] The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

TABLE No. 32.— *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1906. (Means of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high water mark.]

[Degrees Fahrenheit.]

Month.	Wachusett Reservoir.			Sudbury Reservoir (Depth at Place of Observation 54.5 Feet).				Framingham Reservoir No. 3 (Depth at Place of Observation 20.5 Feet).			Lake Cochituate (Depth at Place of Observation 62.0 Feet).		
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January, .	35.7	35.9	35.9	34.9	35.3	35.9	34.5	35.9	36.5	36.6	34.9	36.3	36.3
February, .	34.5	35.0	35.5	35.4	36.4	37.0	34.1	35.7	36.3	37.1	36.5	36.9	37.1
March, .	35.9	36.1	35.9	35.8	36.8	37.5	35.1	36.1	36.4	36.3	37.4	38.3	38.5
April, . .	42.0	41.9	41.2	44.6	44.6	44.5	42.5	47.9	47.6	47.3	45.0	43.0	42.0
May, . .	54.9	53.6	53.0	58.6	56.9	56.1	56.5	61.2	60.9	60.1	59.4	51.9	46.1
June, . .	69.3	68.8	68.3	68.0	64.8	61.8	65.8	71.3	70.0	68.8	68.1	54.9	47.0
July, . .	75.7	63.8	59.0	75.1	70.7	67.2	73.1	75.0	74.8	74.5	73.4	54.8	46.5
August, .	78.3	65.5	60.9	76.8	74.4	71.8	70.6	77.5	76.3	75.6	76.0	55.5	46.8
September, .	72.0	67.9	63.0	70.9	70.6	70.4	68.6	70.9	69.8	69.8	68.9	53.6	46.4
October, .	61.0	58.9	56.3	59.5	59.7	59.9	58.6	58.0	58.1	58.2	57.3	53.6	46.3
November, .	49.8	48.5	49.0	45.5	45.4	45.3	46.3	44.8	44.6	44.5	46.4	45.9	45.1
December, .	34.7	36.0	36.0	33.3	33.6	34.6	34.0	35.0	34.5	35.0	36.0	36.5	36.8
Mean, .	53.7	51.0	49.5	54.0	52.4	51.8	51.6	54.1	53.8	53.7	53.3	46.8	42.9

TABLE No. 32 — *Concluded.*

[Degrees Fahrenheit.]

Month.	Chestnut Hill Reservoir.	Spot Pond (Depth at Place of Observation 28.0 Feet).			Northern Service.		Southern Service.	
	Effluent Gate-house No. 2.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January, . . .	36.2	34.6	34.7	35.0	39.0	37.4	40.7	40.2
February, . . .	37.5	36.0	36.0	36.5	37.9	38.3	40.2	40.5
March, . . .	36.8	35.6	35.9	36.0	37.9	37.4	39.6	37.7
April, . . .	46.8	44.4	44.2	44.1	44.9	44.9	47.1	48.1
May, . . .	59.2	57.9	57.9	56.4	56.1	57.6	59.9	61.0
June, . . .	67.5	67.4	66.6	61.4	63.1	65.1	66.4	67.4
July, . . .	75.0	73.6	73.2	64.4	69.0	71.9	71.6	74.1
August, . . .	76.3	76.0	75.6	66.5	72.3	75.0	73.7	76.1
September, . . .	70.4	70.4	70.4	70.0	68.9	69.4	70.4	71.2
October, . . .	59.0	59.6	59.6	59.6	60.0	59.9	62.1	61.9
November, . . .	45.5	45.1	45.3	45.4	49.5	47.3	49.3	48.7
December, . . .	35.2	33.5	33.6	34.1	40.0	38.1	40.2	38.8
Mean, . . .	53.8	52.8	52.8	50.8	53.2	53.5	55.1	55.5

TABLE NO. 33. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1906.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	68.0	5.0	34.1	67.0	1.0	31.5	62.0	8.0	30.7
February,	61.0	—1.0	29.9	59.0	—6.0	27.3	53.0	—6.0	25.5
March,	55.0	5.0	31.3	55.0	0.0	29.3	52.0	0.0	28.3
April,	74.0	26.0	47.1	75.0	21.0	46.0	74.0	22.0	45.1
May,	91.0	34.0	58.5	89.0	31.0	57.6	89.5	32.0	57.3
June,	88.0	43.0	67.2	88.0	38.0	65.5	86.0	38.0	65.3
July,	90.0	46.0	71.5	88.0	42.0	69.4	87.5	44.0	70.4
August,	94.0	49.0	73.5	92.0	44.0	70.9	90.5	46.0	71.0
September,	93.0	35.0	66.3	90.0	31.0	62.6	86.0	32.5	62.9
October,	73.0	28.0	52.7	73.0	22.0	49.7	70.0	25.0	50.0
November,	67.0	19.0	40.8	64.0	15.0	39.1	60.0	18.0	38.3
December,	50.0	—1.0	27.2	48.0	—6.0	24.2	48.0	—4.0	23.3
Average,	–	–	50.0	–	–	47.8	–	–	47.3

TABLE No. 34.— *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same.*

	DIAMETER OF PIPES IN INCHES.													Total.
	60	48	42	36	30	24	20	16	14	12	10	8	6	
Total length owned and operated January 1, 1906 (feet),	9,069	171,163	8,075	46,638	26,922	46,680	57,059	54,394	26	19,353	614	1,633	858	442,484
Gate valves in same,	–	42	–	40	28	38	37	62	1	70	13	14	15	360
Air valves in same,	5	102	3	35	4	19	34	29	–	9	–	–	–	240
Length laid or relaid during 1906 (feet),	–	67	–	–	–	34	26	7	–	8	–	4	19	165
Gate valves in same,	–	–	–	–	–	2	–	–	–	–	–	–	–	2
Air valves in same,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Length abandoned during 1906 (feet),	–	67	–	–	–	60	–	7	–	8	–	4	–	146
Gate valves in same,	–	–	–	–	–	1	–	–	–	–	–	–	–	1
Air valves in same,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Length owned and operated January 1, 1907 (feet),	9,069	171,163	8,075	46,638	26,922	46,654	57,085	54,394	26	19,353	614	1,633	877	442,503[1]
Gate valves in same,	–	42	–	40	28	39	37	62	1	70	13	14	15	361
Air valves in same,	5	102	3	35	4	19	34	29	–	9	–	–	–	240

[1] 83.80 miles.

TABLE NO. 35. — *Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board.*

	Diameter of Pipes in Inches.								Total.
	24	20	16	12	10	8	6	4	
Total length in use January 1, 1907 (feet), . . .	352	293	2,250	4,421	173	315	2,684	1,144	11,632
Total valves in use January 1, 1907, ...	–	–	18	75	1	1	54	38	187

TABLE NO. 36. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works in 1906.*

BY WHOM OWNED.	INCHES.																			TOTAL.	
	60	48	42	40	36	30	28	24	20	18	16	14	12	10	8	7	6	5	4	Feet.	Miles.
Metropolitan Water Works.	9,069	171,163	8,075	–	46,638	26,922	–	46,654	57,085	–	54,394	26	19,353	614	1,633	–	877	–	–	442,503	83.80
Boston, . . .	–	35,052	16,813	23,104	43,376	89,151	244	77,432	94,654	–	202,753	–	1,199,259	153,137	605,780	–	1,300,103	–	68,935	3,909,853	740.50
Somerville, . .	–	–	–	–	–	–	–	–	3,596	387	3,537	8,037	79,220	48,286	93,830	–	196,546	–	20,456	453,895	85.97
Malden, . . .	–	–	–	–	–	–	–	–	–	–	–	9,152	64,216	27,025	71,743	–	203,047	–	63,860	439,043	83.15
Chelsea, . . .	–	–	–	–	–	–	–	–	–	–	2,380	–	–	39,501	27,235	–	131,152	–	8,491	208,759	39.54
Everett, . . .	–	–	–	–	–	–	–	2,484	2,900	–	2,233	206	5,570	39,206	19,847	–	132,913	–	31,146	236,505	44.79
Quincy, . . .	–	–	–	–	–	–	–	–	2,679	–	23,232	–	24,987	32,166	88,644	994	223,714	948	98,596	495,960	93.93
Medford, . . .	–	–	–	–	–	–	–	–	673	–	6,775	9,784	26,172	33,609	70,570	–	93,349	–	38,992	279,924	53.02
Melrose, . . .	–	–	–	–	–	–	–	–	–	–	5,178	2,920	24,527	14,619	23,764	–	110,216	–	63,021	244,245	46.26
Revere, . . .	–	–	–	–	–	–	–	–	–	–	22,650	5,700	11,000	17,050	18,555	–	52,198	–	70,744	197,897	37.48
Watertown, . .	–	–	–	–	–	–	–	–	–	–	400	12,127	5,959	4,169	19,261	–	113,981	–	12,726	168,623	31.94
Arlington, . .	–	–	–	–	–	–	–	–	–	–	–	–	31,804	20,036	22,758	–	83,578	–	30,419	188,595	35.72
Milton, . . .	–	–	–	–	–	–	–	–	–	–	103	44	22,437	19,031	38,922	–	107,252	–	14,323	202,112	38.28
Winthrop, . .	–	–	–	–	–	–	–	–	–	–	–	–	4,019	4,960	19,329	–	26,283	–	75,928	130,519	24.72
Stoneham, . .	–	–	–	–	–	–	–	–	–	–	–	–	4,525	4,725	2,975	–	90,550	–	13,438	116,213	22.01
Belmont, . . .	–	–	–	–	–	–	–	–	–	–	–	–	2,161	12,302	13,696	–	77,906	–	283	106,348	20.14
Lexington, . .	–	–	–	–	–	–	–	–	–	–	–	–	9,000	2,664	8,113	–	47,602	–	33,874	101,253	19.18
Nahant, . . .	–	–	–	–	–	–	–	–	–	–	–	–	150	11,550	4,850	–	32,900	–	35,300	84,750	16.05
Swampscott, . .	–	–	–	–	–	–	–	–	–	–	–	–	12,072	13,634	13,217	–	50,357	–	9,110	98,390	18.63
Total feet, .	9,069	206,215	24,888	23,104	90,014	116,073	244	126,570	161,587	387	323,635	47,996	1,546,431	498,284	1,164,722	994	3,074,524	948	689,702	8,105,387	–
Total miles, .	1.72	39.06	4.71	4.38	17.05	21.98	.05	23.97	30.60	.07	61.30	9.09	292.89	94.35	220.59	.19	582.30	.18	130.63	–	1,535.11

TABLE NO. 37. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works in 1906.*

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.
Boston,	93,091	5,090	8,076
Somerville,	11,489	2,821	1,018
Malden,	7,031	6,583	428
Chelsea,	6,509	952	316
Everett,	5,090	101	515
Quincy,	5,857	834	701
Medford,	4,298	449	504
Melrose,	3,392	132	291
Revere,	2,802	133	141
Watertown,	1,845	1,814	332
Arlington,	1,940	652	364
Milton,	1,284	1,284	304
Winthrop,	1,973	45	120
Stoneham,	1,311	25	110
Belmont,	754	754	163
Lexington,	708	15	104
Nahant,	425	73	67
Swampscott,	1,259	476	136
Total,	151,058	22,233	13,690

TABLE NO. 38.— *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose, at Different Stations on the Metropolitan Water Works.*

1906. MONTH.	LOW-SERVICE.														SOUTHERN HIGH-SERVICE.			
	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALLSTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		MEDFORD WATER WORKS OFFICE, HIGH STREET.		SOMERVILLE CITY HALL ANNEX, WALNUT STREET.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA WATER WORKS OFFICE, PARK STREET.		BOSTON METROPOLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January,	143	129	186	176	168	165	168	166	168	162	162	159	161	152	248	236	264	261
February,	137	125	185	174	169	165	168	165	168	162	163	159	158	148	248	237	263	259
March,	143	128	182	172	167	164	168	165	166	161	162	159	161	151	248	237	264	259
April,	146	126	186	175	168	164	168	165	167	162	163	160	163	154	249	236	264	258
May,	146	123	185	176	170	165	168	164	166	160	162	157	162	152	248	235	263	255
June,	143	122	184	174	169	164	167	162	166	159	164	159	165	153	247	234	262	255
July,	138	123	181	172	168	165	166	162	164	159	163	160	164	154	246	235	262	255
August,	137	121	185	172	169	164	166	162	167	160	164	160	165	154	247	236	261	253
September,	137	121	183	173	169	165	166	162	165	159	164	161	165	154	247	235	262	253
October,	140	123	180	170	168	164	166	164	164	159	165	162	165	156	247	235	263	256
November,	138	123	181	170	168	164	167	164	165	158	166	160	166	154	248	236	262	256
December,	127	116	183	173	168	163	166	163	164	158	164	161	159	150	246	235	264	259
Averages,	140	123	183	173	168	164	167	164	166	160	164	160	163	153	247	236	263	257

TABLE NO. 38.— *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, etc.* — Concluded.

1906. MONTH.	SOUTHERN HIGH-SERVICE — Concluded.						NORTHERN HIGH-SERVICE.								NORTHERN EXTRA HIGH-SERVICE.	
	BELMONT TOWN HALL, PLEASANT STREET.		MILTON WATER WORKS OFFICE, ADAMS STREET.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STATION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		LEXINGTON TOWN HALL, MASSACHUSETTS AVENUE.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January,	263	257	246	239	237	221	268	258	269	267	263	255	257	248	378	366
February,	263	258	246	240	236	221	268	257	270	266	262	254	262	254	376	363
March,	260	255	246	240	237	220	269	259	270	267	264	255	263	256	376	365
April,	260	253	247	237	238	220	264	250	265	261	260	249	259	248	383	366
May,	260	249	245	235	237	215	266	247	268	264	261	243	259	242	387	366
June,	261	251	244	233	236	210	268	246	269	264	261	232	259	225	386	366
July,	260	253	246	235	238	216	267	248	268	263	261	229	260	219	378	360
August,	260	253	245	235	237	213	268	248	267	262	259	225	255	216	382	363
September,	260	247	245	233	237	212	266	247	268	264	262	230	260	226	384	364
October,	261	253	246	236	239	218	266	250	270	266	265	252	264	250	384	367
November,	262	255	247	237	239	222	270	254	271	268	268	255	266	254	383	368
December,	263	259	245	237	236	221	269	256	272	268	264	253	263	252	381	369
Averages,	261	254	246	236	237	217	267	252	269	265	263	244	261	241	382	365

Appendix No. 3.

Water Works Statistics for the Year 1906.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

City or Town.	Population, Census of 1905.	Estimated Population July 1, 1906.
Boston,	595,380	601,430
Somerville,	69,272	70,950
Malden,	38,037	39,040
Chelsea,	37,289	38,000
Newton,[1]	36,827	37,560
Everett,	29,111	30,270
Quincy,	28,076	28,300
Medford,	19,686	20,080
Hyde Park,[1]	14,510	14,720
Melrose,	14,295	14,650
Revere,	12,659	13,190
Watertown,	11,258	11,550
Arlington,	9,668	9,940
Milton,	7,054	7,120
Winthrop,	7,034	7,240
Stoneham,	6,332	6,350
Lexington,	4,530	4,730
Belmont,	4,360	4,410
Nahant,	922	930
Total population of Metropolitan Water District,	946,300	960,460
Swampscott,[2]	5,141	5,330
Saugus,[3]	200	200

[1] No water supplied to these places during the year from Metropolitan Water Works.

[2] Not in the Metropolitan Water District, but has been supplied with water from the Metropolitan Water Works.

[3] Only a small portion of Saugus is supplied with water.

Mode of Supply.

27 per cent. from gravity.
73 per cent. from pumping.

Pumping.

Chestnut Hill High-service Station:—

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used:—Bituminous: Quemahoning, Orenda, Georges Creek Cumberland, Peerless, Miller Vein, Vulcan Steam and Carbon. Anthracite: buckwheat and screenings. Price per gross ton in bins: bituminous $4.09 to $4.79, buckwheat $2.93, screenings $2.52. Average price per gross ton $4.01. Per cent. ashes, 11.9.

Chestnut Hill Low-service Station:—

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used:—Bituminous: Quemahoning, Orenda and Carbon. Anthracite: buckwheat and screenings. Price per gross ton in bins: bituminous $4 to $4.42, buckwheat $2.84, screenings $2.52. Average price per gross ton $3.82. Per cent. ashes, 13.4.

Spot Pond Station:—

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used:—Bituminous: Georges Creek Cumberland. Anthracite: screenings. Price per gross ton in bins: bituminous $4.35 and $4.38, screenings $2.24. Average price per gross ton $3.97. Per cent. ashes, 12.9.

	Chestnut Hill High-seevice Station.		
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000
Coal consumed for year (pounds),	3,014,777	518,933	8,518,537
Cost of pumping, figured on pumping station expenses,	$12,646.91	$1,798.69	$30,007.55
Total pumpage for year, corrected for slip (million gallons),	1,905.11	514.22	10,310.81
Average dynamic head (feet),	120.99	128.44	131.57
Gallons pumped per pound of coal,	631.92	990.91	1,210.40
Duty on basis of plunger displacement,	65,670,000	114,550,000	136,740,000
Cost per million gallons raised to reservoir,	$6.638	$3.498	$2.910
Cost per million gallons raised one foot,	0.055	0.027	0.022

	Chestnut Hill Low-service Station.	Spot Pond Station.
	Engines Nos. 5, 6 and 7.	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	165,000,000	30,000,000
Coal consumed for year (pounds),	7,955,358	2,533,049
Cost of pumping, figured on pumping station expenses,	$32,004.96	$12,205.04
Total pumpage for year, corrected for slip (million gallons),	18,938.59	3,031.77
Average dynamic head (feet),	51.15	127.98
Gallons pumped per pound of coal,	2,380.61	1,196.89
Duty on basis of plunger displacement,	104,520,000	131,600,000
Cost per million gallons raised to reservoir,	$1.690	$4.026
Cost per million gallons raised one foot,	0.033	0.031

Consumption.

Estimated total population of the nineteen cities and towns supplied wholly or partially during the year 1906,	913,710
Total consumption (gallons),	43,369,310,000
Average daily consumption (gallons),	118,820,000
Gallons per day to each inhabitant,	130.0

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	-[1]	-[2]
Sizes,	60 to 6 inch.	60 to 4 inch.
Extensions, less length abandoned (miles),	-	14.16
Length in use (miles),	83.80	1,535.11
Stop gates added,	1	-
Stop gates now in use,	361	-
Service pipes added,	-	3,264
Service pipes now in use,	-	151,058
Meters added,	-	4,257
Meters now in use,	-	22,233
Fire hydrants added,	-	198
Fire hydrants now in use,	-	13,690

[1] Cast-iron and cement-lined wrought iron.
[2] Cast-iron, cement-lined wrought iron and kalamine.

Appendix No. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	51	Section 64, North Metropolitan System, Malden extension, 42-inch and 54-inch diameter, and 28-inch by 42-inch concrete sewer in open cut.	4	$39,388 50	$33,577 80	T. H. Gill & Co., Boston, Mass.

Contracts relating to the

2	16	Section 77, High-level Sewer, Roxbury, pumping plant for Ward Street pumping station.	3	$207,000 00	$204,000 00	Allis-Chalmers Co., Milwaukee, Wis.
3	52	Two horizontal return tubular boilers with masonry settings and connecting smoke flue for the Quincy sewerage pumping station.	2	4,295 00	3,850 00	Robb-Mumford Boiler Company, Boston, Mass.

APPENDIX No. 4.

THE YEAR 1906 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1906.	10. Value of Work done December 31, 1906.	
Aug. 8, 1906,	-	For earth excavation and refill for 42-inch diameter sewer, $4.60 per linear foot; for 54-inch diameter sewer, $5.60 per linear foot; and for 28-inch by 42-inch sewer, $4.20 per linear foot. Portland cement brick masonry, $14 per cubic yard; Portland cement concrete masonry, $8 per cubic yard. Spruce piles driven and cut off below concrete, $0.25 per linear foot. Rock excavation in trench, $7 per cubic yard. Spruce lumber in place, $20 per M feet B.M.	$40,148 57	1

South Metropolitan System.

Jan. 17, 1902,	Dec. 12, 1906,	-	-	$204,000 00	2
Aug. 31, 1906,	-	-	-	-	3

CONTRACTS MADE AND PENDING DURING THE YEAR 1906 — SEWERAGE WORKS — *Concluded.*

Summary of Contracts.[1]

	Value of Work done December 31, 1906.
North Metropolitan System, 1 contract,	$40,148 57
South Metropolitan System, 2 contracts,	204,000 00
Total of 3 contracts made and pending during the year 1906,	$244,148 57

[1] In this summary the cost of day work and contracts charged to maintenance are excluded.

Appendix No. 5.

Financial Statement presented to the General Court on January 14, 1907.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the eleven months ending November 30, 1906, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

Metropolitan Water Works.

The appropriations under the Metropolitan Water Acts, the receipts which are added to these appropriations, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1906, have been as follows: —

Appropriations under Metropolitan Water Acts,		$40,500,000 00
Receipts from the sales of real estate, and from labor, tools and supplies, which are placed to the credit of the Metropolitan Water Loan Fund: —		
For the eleven months ending November 30, 1906,	$17,506 01	
For years previous to 1906,	123,765 50	
		141,271 51
		$40,641,271 51
Amount approved for payment by the Board, out of the Metropolitan Water Loan Fund: —		
For the eleven months ending November 30, 1906,	$1,219,883 78	
For years previous to 1906,	39,044,214 23	
		40,264,098 01
Balance December 1, 1906,		$377,173 50

The amount approved by the Board for maintenance and operation of the Metropolitan Water Works during the eleven months ending November 30, 1906, was $356,159.77.

The following receipts, from sales of water to municipalities not belonging to the District and to water companies, have been distributed back to the towns and cities of the District by the Treasurer of the Commonwealth, as provided by section 3 of the Metropolitan Water Act: —

For the eleven months ending November 30, 1906,	$5,575 18
For years previous to 1906 (including sums received from municipalities for admission to the District),	214,290 47
	$219,865 65

The Board has also received the following sums from rentals, land products and other sources, which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works: —

For the eleven months ending November 30, 1906,	$6,667 65
For years previous to 1906,	124,164 39
	$130,832 04

Metropolitan Sewerage Works.

The appropriations for the construction of the Metropolitan Sewerage Works, the receipts which are added to the appropriations, and the expenditures for construction, are given below, as follows: —

North Metropolitan System.

Appropriations under the various acts, including those for the Revere, Belmont and Malden extensions,	$6,160,865 73	
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the Metropolitan Sewerage Loan Fund: —		
For the eleven months ending November 30, 1906,	–	
For years previous to 1906,	17,153 40	
Amount approved for payment by the Board [1] out of the Metropolitan Sewerage Loan Fund, North System: —		
For the eleven months ending November 30, 1906,	–	$39,754 65
For years previous to 1906,	–	6,088,830 56
	$6,178,019 13	$6,128,585 21
Balance, North Metropolitan System, December 1, 1906,		$49,433 92

[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

SOUTH METROPOLITAN SYSTEM.

Charles River Valley Sewer.

Appropriations under the various acts, . . .	$800,046 27	
Amount approved by the Metropolitan Sewerage Commission for payment to December 1, 1906, .	–	$800,046 27

Neponset Valley Sewer.

Appropriations under the various acts, . . .	904,000 00	
Receipts for pumping, which are placed to the credit of the South Metropolitan System, . . .	109 50	
Amount approved by Board for payment on account of the Neponset Valley Sewer: —		
For the eleven months ending November 30, 1906,	–	5,797 66
For years previous to 1906, ...	–	905,733 80

High-level Sewer.

Appropriations under the various acts, . . .	$7,163,000 00	
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —		
For the eleven months ending November 30, 1906,	256 20	
For years previous to 1906, ...	6,512 77	
Amount approved by the Board for payments on account of the High-level Sewer: —		
For the eleven months ending November 30, 1906,	–	42,972 65
For years previous to 1906, ...	–	5,918,262 59
	$8,873,924 74	$7,672,812 97
Balance, South Metropolitan System, December 1, 1906, .		$1,201,111 77

For the maintenance and operation of sewerage works annual appropriations are made. The balances, appropriations and expenditures for the eleven months ending November 30, 1906, are as follows: —

MAINTENANCE OF NORTH METROPOLITAN SYSTEM.

Balance January 1, 1906, ...	$32,897 15
Appropriated for the eleven months ending November 30, 1906, .	115,986 50
	$148,883 65
Receipts from pumping and from other sources, which are returned to the appropriation: —	
For the eleven months ending November 30, 1906, . . .	1,013 43
	$149,897 08
Amount approved for payment by the Board: —	
For the eleven months ending November 30, 1906, . . .	105,880 85
Balance December 1, 1906, ...	$44,016 23

MAINTENANCE OF SOUTH METROPOLITAN SYSTEM.

Balance January 1, 1906,	$139 99
Appropriated for the eleven months ending November 30, 1906,	87,375 00
	$87,514 99
Receipts from sales of property and for pumping, which are returned to the appropriation: —	
For the eleven months ending November 30, 1906,	51 50
	$87,566 49
Amount approved for payment by the Board: —	
For the eleven months ending November 30, 1906,	76,101 62
Balance December 1, 1906,	$11,464 87

Appendix No. 6.

Legislation of the Year 1906 affecting the Metropolitan Water and Sewerage Board.

ACTS OF 1906.

[Chapter 153.]

An Act making an appropriation for operating the north metropolitan system of sewage disposal.

Be it enacted, etc., as follows:

North Metropolitan system of sewage disposal.

Section 1. A sum not exceeding one hundred fifteen thousand nine hundred eighty-six dollars and fifty cents is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, for the maintenance and operation of the system of sewage disposal for the cities and towns included in what is known as the north metropolitan system, during the eleven months ending on the thirtieth day of November, nineteen hundred and six.

Section 2. This act shall take effect upon its passage. [*Approved March 12, 1906.*

[Chapter 154.]

An Act making an appropriation for operating the south metropolitan system of sewage disposal.

Be it enacted, etc., as follows:

South Metropolitan system of sewage disposal.

Section 1. A sum not exceeding eighty-seven thousand three hundred and seventy-five dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, dur-

ing the eleven months ending on the thirtieth day of November, nineteen hundred and six.

SECTION 2. This act shall take effect upon its passage. [*Approved March 12, 1906.*

[CHAPTER 235.]

AN ACT RELATIVE TO THE ANNUAL REPORTS OF THE METROPOLITAN WATER AND SEWERAGE BOARD.

Be it enacted, etc., as follows:

Reports of Metropolitan Water and Sewerage Board.

SECTION 1. The metropolitan water and sewerage board shall, on or before the third Wednesday in January in each year, in accordance with the provisions of chapter two hundred and eleven of the acts of the year nineteen hundred and five, report to the general court an abstract of its receipts, expenditures, disbursements, assets and liabilities for the preceding fiscal year, as required by said act, together with all recommendations for legislation which it deems desirable, and shall in the month of February present a more detailed statement of its doings for the calendar year next preceding, the same to be printed as its annual report for the year.

SECTION 2. This act shall take effect upon its passage. [*Approved April 2, 1906.*

[CHAPTER 319.]

AN ACT TO PROVIDE FOR AN EXTENSION OF THE METROPOLITAN SEWER IN THE CITY OF MALDEN.

Be it enacted, etc., as follows:

The Metropolitan sewer to be extended in Malden.

SECTION 1. The metropolitan water and sewerage board shall extend the metropolitan sewer in Linden avenue, in the city of Malden, from a point near Waverly street, through Linden avenue, Pleasant street and private lands, Jackson street and private lands, to a point in the north metropolitan system about five hundred feet south of Charles street, and shall connect the same by overflow and proper appurtenances with the tidal flow of the Malden river.

Authority of the Metropolitan Water and Sewerage Board.

SECTION 2. For the purpose of constructing and maintaining this addition to the extension of the metropolitan sewers, the metropolitan water and sewerage board shall have and exercise all the authority conferred upon the metropolitan sewerage commissioners and their successors by chapter four

hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and acts in amendment thereof and in addition thereto, regarding the original system or anything relating thereto, and the provisions of said chapter and of such other acts are hereby made applicable to this additional construction unless herein otherwise provided.

Treasurer and receiver general to issue bonds, etc.

SECTION 3. To meet the expenses incurred under the provisions of this act for the construction of the sewerage work recommended, the treasurer and receiver general shall, with the approval of the governor and council, issue from time to time bonds, in the name and behalf of the Commonwealth and under its seal, to an amount not exceeding fifty-five thousand dollars. The provisions of section twelve of said chapter four hundred and thirty-nine and of acts in amendment thereof and in addition thereto relative to the indebtedness authorized by and incurred under that chapter, shall, so far as they may be applicable, apply to the indebtedness authorized by this act, in the same manner as if the said provisions had been inserted herein, except that any premiums which may be realized from the sale of said bonds shall be applied in the same manner in which the proceeds of the sale of such bonds, exclusive of the amounts received from premiums, are now applied.

Interest and sinking fund requirements.

SECTION 4. The interest and sinking fund requirements on account of the moneys expended in constructing the extension of the metropolitan sewer in Malden provided for in this act, and the cost of maintenance thereof, shall be deemed a part of the interest, sinking fund requirements and costs provided for by section fifteen of said chapter four hundred and thirty-nine, and shall be apportioned, assessed and collected in the manner provided by that chapter and by acts in amendment thereof or in addition thereto.

SECTION 5. This act shall take effect upon its passage. [*Approved April 28, 1906.*

[CHAPTER 337.]

AN ACT RELATIVE TO PREMIUMS RECEIVED FROM THE SALE OF METROPOLITAN WATER LOAN BONDS.

Be it enacted, etc., as follows:

Premiums from sale of securities to be paid into sinking fund.

SECTION 1. Premiums received from the sale of bonds issued on account of the Metropolitan Water Loan, under section seventeen of chapter four hundred and eighty-eight of

the acts of the year eighteen hundred and ninety-five, and acts in amendment thereof and in addition thereto, shall hereafter be paid into the sinking fund for the extinguishment of the principal indebtedness.

SECTION 2. This act shall take effect upon its passage. [*Approved April 30, 1906.*

[CHAPTER 338.]

AN ACT RELATIVE TO PREMIUMS RECEIVED FROM THE SALE OF METROPOLITAN SEWERAGE LOAN BONDS.

Be it enacted, etc., as follows:

Premiums from sale of securities to be paid into sinking fund.

SECTION 1. Premiums received from the sale of scrip, certificates of debt or bonds, issued on account of the metropolitan sewerage works, shall hereafter be paid into the sinking fund for the extinguishment of the principal indebtedness.

SECTION 2. This act shall take effect upon its passage. [*Approved April 30, 1906.*

[CHAPTER 367.]

AN ACT TO PROVIDE FOR AN ADDITIONAL METROPOLITAN WATER LOAN.

Be it enacted, etc., as follows:

Additional Metropolitan water loan.

SECTION 1. The treasurer and receiver general shall from time to time, upon the request of the metropolitan water and sewerage board, issue negotiable bonds in the name and behalf of the Commonwealth and under its seal, designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding five hundred thousand dollars in addition to the forty million dollars authorized to be issued under the provisions of section seventeen of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and of chapter four hundred and fifty-three of the acts of the year nineteen hundred and one; and the provisions of said chapter four hundred and eighty-eight and of acts in amendment thereof and in addition thereto shall apply to this additional loan to the same extent as if the amount authorized by said act had been forty million five hundred thousand dollars instead of twenty-seven million dollars.

SECTION 2. This act shall take effect upon its passage. [*Approved May 8, 1906.*

[CHAPTER 369.]

AN ACT TO ESTABLISH THE BASIS FOR DETERMINING THE ANNUAL ASSESSMENTS UPON THE MUNICIPALITIES WITHIN THE METROPOLITAN SEWERAGE DISTRICTS FOR INTEREST AND SINKING FUND REQUIREMENTS AND COST OF MAINTENANCE AND OPERATION.

Be it enacted, etc., as follows:

Proportion of expense of the Metropolitan sewerage system to be borne by cities and towns, etc.

SECTION 1. The proportions in which each of the cities and towns belonging in whole or in part to the north metropolitan and south metropolitan sewerage districts, respectively, shall annually pay money into the treasury of the Commonwealth to meet the interest and sinking fund requirements for each year, as estimated by the treasurer of the Commonwealth, and to meet any deficiency in the amount previously paid in, as found by said treasurer, shall be based upon the respective taxable valuations of the property of said cities and towns, as last established by the general court for the purpose of constituting a basis of apportionment for state and county taxes.

Proportion of payments to be based on population, etc.

SECTION 2. The proportions in which each of the cities and towns belonging in whole or in part to the north metropolitan and south metropolitan sewerage districts, respectively, shall annually pay money into the treasury of the Commonwealth to meet the cost of maintenance and operation of the respective sewerage systems, as estimated by the metropolitan water and sewerage board and certified by the treasurer of the Commonwealth, and to meet any deficiency in the amount previously paid in, as found by said treasurer, shall be based upon the respective populations of said cities and towns as ascertained by the last preceding state or United States census.

Proportion when part of a city or town is included, etc.

SECTION 3. If less than the whole area of any city or town is included in either of said metropolitan sewerage systems, the valuation and population only of that part of the city or town which is included in either of said systems, as determined by the metropolitan water and sewerage board, shall be used as a basis in determining the proportion and amount which it shall pay as its share of interest and sinking fund requirements and of the cost of maintenance and operation of works.

The Metropolitan Water and Sewerage Board to fix the proportions, etc.

SECTION 4. The metropolitan water and sewerage board shall annually, in accordance with the provisions of the foregoing sections, determine for each system the proportion in which each of the cities and towns belonging in whole or in

part to such system, shall annually pay money into the treasury of the Commonwealth to meet the interest and sinking fund requirements and to meet the cost of maintenance and operation of such system, and shall transmit the determinations of the board to the treasurer of the Commonwealth.

Interest and sinking fund requirements.

SECTION 5. The amount of money required each year from every such city or town to meet the interest and sinking fund requirements and cost aforesaid for that system in which it is included, and the deficiency, if any, shall be estimated by the treasurer of the Commonwealth in accordance with the proportions as determined aforesaid by the metropolitan water and sewerage board, and shall be included and made a part of the sum charged to such city or town, and shall be paid by the city or town into the treasury of the Commonwealth at the time required for the payment of its proportion of the state tax.

Not to affect any decree of the supreme judicial court.

SECTION 6. This act shall take effect upon its passage, but shall not modify or affect any decree of the supreme judicial court heretofore made. [*Approved May 8, 1906.*

[CHAPTER 404.]

AN ACT RELATIVE TO THE DISPOSITION OF THE MONEY RECEIVED FROM MUNICIPALITIES FOR ADMISSION TO THE METROPOLITAN WATER DISTRICT.

Be it enacted, etc., as follows:

Sums received to be applied to cost of connecting water pipes, etc.

SECTION 1. All sums of money which shall hereafter be received under section three of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, providing for a metropolitan water supply, for the admission of a city or town into the metropolitan water district, shall be applied to the payment of the cost of connecting such city or town with the pipes and works of the metropolitan water district, and after such cost is paid the balance shall be applied by the treasurer and receiver general to the sinking fund established for the payment of bonds issued on account of the metropolitan water district.

Repeal.

SECTION 2. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 3. This act shall take effect upon its passage. [*Approved May 21, 1906.*

[CHAPTER 406.]

AN ACT TO PROVIDE FOR AN EXTENSION OF THE SOUTH METROPOLITAN SEWER THROUGH THE DISTRICTS OF WEST ROXBURY, BROOKLINE AND BRIGHTON.

Be it enacted, etc., as follows:

The South Metropolitan sewerage system to be extended, etc.

SECTION 1. The metropolitan water and sewerage board shall construct, maintain and operate as part of the south metropolitan system of sewage disposal, a sewer extending from the corner of Centre and Perkins streets in Jamaica Plain, through West Roxbury, Brookline and as far as Oak Square in Brighton, substantially as outlined in the fourth annual report of said board, and in part execution of the plan outlined in said report.

Certain powers conferred, etc.

SECTION 2. For the purpose of constructing and maintaining this additional sewer, the metropolitan water and sewerage board shall have and exercise all the authority conferred upon the metropolitan sewerage commissioners and their successors by chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine and acts in amendment thereof and in addition thereto, and all the provisions of said chapter and other acts are hereby made applicable to this additional construction, unless herein otherwise provided.

Treasurer and receiver general to issue bonds, etc.

SECTION 3. To meet the expenses incurred under the provisions of this act the treasurer and receiver general shall, with the approval of the governor and council, issue from time to time bonds in the name and behalf of the Commonwealth, and under its seal, to an amount not exceeding one million one hundred and seventy-five thousand dollars. The provisions of section fourteen of said chapter four hundred and twenty-four and of all acts in amendment thereof and in addition thereto relative to the indebtedness authorized by and incurred under that chapter shall, so far as they may be applicable, apply to the indebtedness authorized by this act, in the same manner as if the said provisions had been inserted herein. Any premium realized on the sale of said bonds shall be paid into the Metropolitan Sewerage Loan Sinking Fund, South System.

Certain provisions of law to apply.

Assessment and collection of interest, etc.

SECTION 4. The interest and sinking fund requirements on account of the moneys expended in constructing the extension of the south metropolitan sewer provided for in this act, and the cost and maintenance thereof shall be deemed a

part of the interest and sinking fund requirements and costs provided for in said chapter four hundred and twenty-four, and shall be apportioned, assessed and collected in the manner provided by that chapter and by acts in amendment thereof and in addition thereto.

SECTION 5. This act shall take effect upon its passage. [*Approved May 21, 1906.*

[CHAPTER 457.]

AN ACT RELATIVE TO THE APPORTIONMENT OF THE ANNUAL ASSESSMENTS REQUIRED FOR THE CONSTRUCTION AND MAINTENANCE OF THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Apportionment of cost to cities and towns in the Metropolitan water district to be based partly on valuation and partly on consumption of water.

The treasurer of the Commonwealth, for the purpose of making the apportionment to the cities and towns in the metropolitan water district of the amount required in each year to pay the interest, sinking fund requirements and expenses of maintenance and operation of the metropolitan water system provided for by section nineteen of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, as amended by chapter four hundred and eighty-nine of the acts of the year nineteen hundred and one, shall, in the year nineteen hundred and seven, and in each year thereafter, apportion such amount to the cities and towns in said district, one third in proportion to their respective valuations for the preceding year and the remaining two thirds in proportion to the consumption by the cities and towns, respectively, in the preceding year, of water received from all sources of supply as determined by the metropolitan water and sewerage board, and certified to said treasurer: *provided, however,* that there shall be included in reckoning such proportion only one fifth of the total valuation, and nothing for consumption of water, for any city or town which has not reached the safe capacity of its present sources of supply or of the sources of supply of the water company by which it is supplied, determined as aforesaid, or which has not made application to said board for water; and *provided, further,* that any city or town assessed upon its full valuation which obtains a part of its water supply from its own works or receives a supply from a water company shall be allowed and credited in its apportion-

Provisos.

ment with a sum equal to twelve dollars for each million gallons of water furnished as aforesaid, as determined by said board and certified to said treasurer. The treasurer shall annually notify each city and town of the amount of its assessment, and the same shall be paid by the city or town into the treasury of the Commonwealth at the time required for the payment of and as part of its state tax. [*Approved June 6, 1906.*

[CHAPTER 498.]

AN ACT TO MAKE EFFECTIVE THE AWARD OF THE COMMITTEE APPOINTED BY THE GOVERNOR TO DETERMINE THE DAMAGES CAUSED TO THE TOWN OF CLINTON BY THE CONSTRUCTION OF THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

A certain sum to be paid to the town of Clinton on account of construction of the Metropolitan water system.

SECTION 1. The treasurer of the Commonwealth shall pay to the town of Clinton as a part of the expense of the metropolitan water system, the sum of sixty-four thousand nine hundred and eighty-eight dollars on or before the fifteenth day of November in the year nineteen hundred and six.

Taxation.

SECTION 2. All property held by the metropolitan water and sewerage board, or its successors, in the town of Clinton, outside of the dam and dike, used in the generation or sale of electricity for power or for manufacturing purposes, shall be subject to taxation. The provisions for the assessment and collection of taxes contained in chapters twelve and thirteen of the Revised Laws shall apply to such property.

Repeal.

SECTION 3. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 4. This act shall take effect upon its passage. [*Approved June 18, 1906.*

[CHAPTER 500.]

AN ACT TO PROVIDE FOR IMPROVEMENTS AND ADDITIONS AT CERTAIN STATE INSTITUTIONS.

Be it enacted, etc., as follows:

Prisons and hospitals loan.

SECTION 1. To provide funds for the construction or enlargement of certain public institutions hereinafter named, . . .

Trustees of the Westborough insane hospital.

SECTION 2. From the aforesaid loan expenditures may be made as follows: —

. . . . . .

By the trustees of the Westborough insane hospital, a sum not exceeding forty thousand dollars, for the following purposes: — For constructing and furnishing buildings for tuberculous patients, a sum not exceeding five thousand dollars, and for obtaining and installing a new water supply, a sum not exceeding thirty-five thousand dollars; and the said trustees and the metropolitan water and sewerage board are authorized to arrange for taking water from the metropolitan aqueduct, so-called, near the said hospital, upon such terms as the said trustees and the said board may establish: *provided, however,* that the rate to be charged for the water used therefrom for the said hospital shall not exceed thirty dollars per million gallons.

Proviso.

. . . . . .

SECTION 3. This act shall take effect upon its passage. [*Approved June 20, 1906.*

[CHAPTER 517.]

AN ACT TO CONSTITUTE EIGHT HOURS A MAXIMUM DAY'S WORK FOR PUBLIC EMPLOYEES.

Be it enacted, etc., as follows:

Eight hours to constitute a day's work for public employees, etc.

SECTION 1. Eight hours shall constitute a day's work for all laborers, workmen and mechanics now or hereafter employed, by or on behalf of the Commonwealth, or of any county therein, or of any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws; but in cases where a Saturday half-holiday is given the hours of labor upon the other working days of the week may be increased sufficiently to make a total of forty-eight hours for the week's work.

Contracts to contain a certain stipulation, etc.

SECTION 2. Every contract, excluding contracts for the purchase of material or supplies, to which the Commonwealth, or of any county therein, or of any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws, is a party which may involve the employment of laborers, workmen or mechanics shall contain a stipulation that no laborer, workman or mechanic in the employ of the contractor, sub-contractor or other person doing

or contracting to do the whole or a part of the work contemplated by the contract shall be required to work more than eight hours in any one calendar day.

To whom the act shall apply.

SECTION 3. This act shall apply to all laborers, workmen or mechanics engaged upon any works which are or are intended to be the property of the Commonwealth, or of any county therein, or of any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws, whether such laborers, workmen or mechanics are employed by public authority or by a contractor or other private person.

Penalty.

SECTION 4. Any agent or official of the Commonwealth or of any county, city or town who violates any provision of this act shall be subject to a penalty of fifty dollars for each offence.

Not to apply to certain persons.

SECTION 5. The provisions of this act shall not apply to or affect contractors or sub-contractors for work, contracts for which were entered into prior to the passage of this act.

Repeal.

SECTION 6. So much of any act as is inconsistent herewith is hereby repealed.

SECTION 7. This act shall take effect upon its passage. [*Approved June 22, 1906.*

[CHAPTER 530.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO SELL CERTAIN PROPERTY FOR THE RELOCATION OF A PUBLIC WAY IN THE TOWN OF FRAMINGHAM.

Be it enacted, etc., as follows:

Property held by the Commonwealth in the town of Framingham may be sold, etc.

SECTION 1. The metropolitan water and sewerage board may, in its discretion sell, lease or exchange by public or private sale any property of the Commonwealth held and used for water supply purposes, situated in the town of Framingham, southerly of and abutting on or adjacent to the Boston and Worcester turnpike, so-called, whether taken by the Commonwealth by eminent domain or otherwise, if such property is deemed necessary for the alteration, relocation or widening of any public way upon which said property abuts, and is not deemed necessary by said board for public purposes.

SECTION 2. This act shall take effect upon its passage. [*Approved June 27, 1906.*

[CHAPTER 533.]

AN ACT TO PROVIDE FOR CERTAIN ANNUAL PAYMENTS TO THE TOWN OF HOLDEN ON ACCOUNT OF THE CONSTRUCTION OF THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Certain sums to be paid annually to the town of Holden, etc.

SECTION 1. The treasurer of the Commonwealth shall pay annually, as a part of the expenses of the metropolitan water system, on or before the thirty-first day of December, to the town of Holden an amount equal to the average assessment made by the assessors of said town for the three years preceding the purchase of said property by the Commonwealth on all real estate taken or acquired and held by the Commonwealth as a part of the metropolitan water system, on the first day of May in each year, such payment to be in place of taxes, and any other payments required by law on such property:

Proviso.

provided, that, if any buildings standing on land taken or acquired and held by the Commonwealth, as aforesaid, are removed and remain in said town, the value of such buildings, as newly located, shall be deducted by the assessors from the said amount. The words "real estate" as used in this section shall include water rights, and in the case of mills, all machinery therein.

Words "real estate" defined.

SECTION 2. This act shall take effect upon its passage. [*Approved June 29, 1906.*

[CHAPTER 536.]

AN ACT IN ADDITION TO THE SEVERAL ACTS MAKING APPROPRIATIONS FOR SUNDRY AND MISCELLANEOUS EXPENSES AUTHORIZED DURING THE PRESENT YEAR.

Be it enacted, etc., as follows:

Appropriations.

SECTION 1. The sums hereinafter mentioned are appropriated, to be paid out of the treasury of the Commonwealth from the ordinary revenue, except as otherwise provided herein, for the purposes specified in certain acts and resolves of the present year, and for certain other expenses authorized by law, to wit: —

. . . . . .

Town of Clinton.

For the town of Clinton, being an award for damages caused by the construction of the metropolitan water system, as pro-

vided for by chapter four hundred and ninety-eight of the acts of the present year, the sum of sixty-four thousand nine hundred and eighty-eight dollars, to be paid out of the Metropolitan Water Maintenance Fund on or before the fifteenth day of November of the present year; said sum to be assessed on the metropolitan water district by the treasurer and receiver general during the present year.

. . . . . .

SECTION 2. This act shall take effect upon its passage. [*Approved June 29, 1906.*

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ARTHUR D. BUZBY, C. E.

ARTHUR D. BUZBY, C. E.