H. W. Sanborn.

Eighty-fourth

ANNUAL REPORT

OF THE

CHIEF ENGINEER

OF THE

Philadelphia Water Department

FOR THE YEAR

1885.

PHILADELPHIA:
DUNLAP & CLARKE, PRINTERS AND BINDERS, 819-21 FILBERT STREET.
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JOINT STANDING COMMITTEE ON WATER,

For the year commencing the First Monday in April, 1885.

Select Council.	Common Council.
THOMAS GREEN (*Chairman*),	JOHN L BALDWIN,
ALBERT A. ARDIS, SR.,	JOHN BARDSLEY,
JAMES A. FREEMAN,	J. RAYMOND CLAGHORN,
JOHN H. GRAHAM,	WILLIAM R. CLARIDGE, JR.,
SAMUEL HART,	DAVID C. CLEAVER,
HENRY JOHNSON,	THOMAS FIRTH,
JNO. J. McDEVITT,	WILLIAM HOLEMAN,
WILLIAM McMURRAY,	J. FREDERICK LOEBLE,
THOMAS J. RYAN,	GEO. H. McCULLY,
WILLIAM THORNTON,	JOSHUA T. OWEN,
WM. B. TRITES, M. D.,	JOHN M. WALTON,
JOSEPH B VAN DUSEN,	CARROLL R. WILLIAMS,
JAMES R. GATES, *President of Select Council.*	CHARLES LAWRENCE, *President of Common Council*

PERSONNEL OF THE WATER DEPARTMENT.

CHIEF ENGINEER.

WILLIAM LUDLOW.

Assistant Engineers.

LLOYD BANKSON, ALLEN J. FULLER.

Draughtsmen.

John E. Codman, C. O. Lindroth.

Chief Clerk—JOB T. HICKMAN.
Assistant Clerks—L. L. Dean, Kennedy McNeal.
Correspondence Clerk—E. T. Parker.
Pipe Recording Clerk—William Whitby.
Assistant Clerk—Thomas Spence.
Time Clerk—William J. Innes.
Pipe Inspector—Theo. S. S. Baker.
Messenger—James G. Davis.

Telephone Operators.

Mattie Whittingham, George Weikman.

General Superintendent.

JOHN L. OGDEN.

Clerk to General Superintendent—John A. Hayes.
Assistant Clerk to General Superintendent—Pauline de Haven.

Engineers at Pumping Stations.

FAIRMOUNT—*First Engineer*, Joseph McElwell.
Second Engineer, John Bronson.

SPRING GARDEN—*Engineer in Charge*, A. G. Bonsall.
Assistant Engineers, David Pyke, Wm. H. Wakefield, Abram Stott, George Shaffer.

Telephone Operator—Fannie Shields.

BELMONT—*Engineer in Charge*—Christian Bezold.
Assistant Engineers—Wm. Kiner, Thomas Seddon.

ROXBOROUGH—*Engineer in Charge,*
Assistant Engineers, Joshua Bartley, Lewis Kulp.

MOUNT AIRY—*Engineers,* Archibald Weir, Wm. Fletcher.

CHESTNUT HILL—*Engineer,* James McClenahan.

FRANKFORD—*Engineer in Charge,* Chas. Douglass.

KENSINGTON—*Oilers,* Peter J. Tuttle, W. Lawrence.

Works General.

Foreman Carpenter—Henry Guest.
Foreman Bricklayer—Frank A. Mooney.
Foreman Stonemason—Crawford Lukens.
Foreman Rigger—James Forrest.
Foreman Laborer—Matthew J. Richmond.
General Storekeeper—S. C. Buchanan.

Superintendent of Shop—W. F. Courtney.
Clerk to Superintendent of Shop—Jno. M. Curtis.

PURVEYORS.

First District, John H. Holmes.
Clerk, Wm. J. Mackey.
General Foreman, James Humes. *Foreman of Repairs,* W. W. Wellington.
Office, 1120 Wharton street.

Second District, David A. Craig.
General Foreman, Michael Young. *Foreman of Repairs,* Joseph Bryan.
Office, 918 Cherry street.

Third District, Charles J. Lowry.
Clerk, Robt. J. Barr.
General Foreman, Daniel Ahern. *Foreman of Repairs,* Wm. Magee.
Office, 1420 Frankford avenue.

Fourth District, John Montgomery.
Clerk, Arthur B. Cook.
General Foremen, Geo. W. Showaker, Jas. Hutchinson.
Foreman of Repairs, Jos. Forbes.
Office, 26th and Master streets.

Fifth District, Henry Dawson.
Clerk, W. H. Poulson. *General Foreman,* Chas. Frank.
Office, Lyceum Building, Roxborough.

Sixth District, David B. Morrell.
Clerk, Jonathan Bonsall. *General Foreman,* Edw. Homan.
Office, Town Hall, Germantown.

REGISTRAR'S OFFICE.

Registrar.

A. NEWLIN KEITHLER.

Registrar's Chief Clerk—E. S. Higbee.

Cashier—John F. Scheidt. *Permit Clerk*—Thos. Orr.

Assistant Permit Clerk—Chas. H. Russell.

Registering Clerk—A. Buckheister.

Assistant Registering Clerk—W. W. Widdifield.

Entry Clerks—Geo. S. Macauley, Chas. D. Birney.

Bill Clerk—Wm. J. Halliday.

General Clerks.

Jno. M. Stacker, Chas. L. Hayden, Henry S. Goddard, Henry R. Wildey, Geo. B. Bunn.

Chief Inspector—Joseph Fisher.

Inspectors.

Edw. D. Thomas,	E. M. Rowe,	William Erwin,
W. H. Hergesheimer,	Wm. A. Agnew,	Louis Obermiller,
Jas. H. Graham,	James Cameron,	John Simon,
Albert C. Weaver,	Thomas S. Flanagan,	Theo. Yeager,
Jas. Buchanan,	Geo. Crooks,	Wm. Hasson,
W. L. Kensil,	Alex. McConnell,	Wm. T. Pound,
	John Van Dusen.	

Messenger—Thomas J. Lister.

LETTER OF TRANSMITTAL.

PHILADELPHIA WATER DEPARTMENT.

April 1, 1886.

To the Select and Common Councils
of the City of Philadelphia.

GENTLEMEN:—I have the honor to submit herewith the Annual Report of the Philadelphia Water Department, for the year 1885—the eighty-fourth in the history of the Department, and the third and final one of my service as its Chief Engineer.

I regret that the termination of my official connection with city affairs, and present departure for another field of duty, leave me without adequate time or opportunity to enhance the possible usefulness of this report by formulating therein certain detailed statements and discussions relating to the water service of the city, additional to those which have heretofore been presented; but the apprehension of a duty in this respect partially unfulfilled is tempered by the consideration that my reports for the years 1883 and 1884 contain a large body of important data and recommendations, of which the greater part still remain unacted upon, and that if the conduct of affairs in the future shall proceed with the deliberateness which has marked the securing of urgently needed improvements in the past, so protracted a period will be required for their practical execution as to render superfluous any material additions thereto at the present time.

Respectfully,

WILLIAM LUDLOW.

REPORT.

GENERAL REMARKS.

As is stated in the letter transmitting this report, time has not permitted in its preparation such adequate fullness of consideration and statement of matters relating to the Department and of the operations of its several branches during the past year as has heretofore been attempted in the reports for 1883 and 1884, and reference thereto must of necessity be made briefly and without elaboration.

In many respects the year has been an eventful one, and there are several important topics which it would have been desirable to treat with careful attention but which can now be touched upon only. There are likewise data of general comparative cost of labor and material from which it could be shown that improved methods of administration are as necessary and as productive of advantageous results as the use of improved machinery and appliances, and that in both respects the maximum of accomplishment with the minimum of expenditure can only be secured through the intelligent and faithful application of scientific business methods and single-mindedness of control and endeavor. There are also data relating to the actual and comparative efficiency of machinery and other plant, the discussion of which would have been of some general interest and value.

Reference to the accompanying detailed reports will show that in nearly every respect the work of the year 1885 exceeded in magnitude that of any other in the history of the Department, and that the economical results, as shown by comparison of performance with expenditure, were more favorable than have at any previous time been exhibited.

I am not able, as I hoped, to include in this report the final review and statement of all the ascertained data with reference to the interesting and important question of the future water supply. The surveyors and draughtsmen are busily engaged upon the final computations and compilations, and I trust, notwithstanding my absence from the city, to submit the completed report before the adjournment of Councils for the summer. Meanwhile, however, the end is so near and the information so far collated and digested as to make it possible to state in general terms the alternative possibilities, and even to indicate what may be regarded as final conclusions. My remarks upon this subject will be found elsewhere in this report, under the appropriate heading.

EXPENDITURES AND RECEIPTS.

The balance on hand January 1, 1885, as stated in the Annual Report of 1884, was $38,074.56.

This balance was composed of the remainders of special appropriations held over from previous years to make final payments upon engines purchased under contract and to meet other outstanding minor special liabilities. It was found however that the Controller on January 1, 1885 had erroneously and without informing the Department merged or covered back into the Treasury to the general account the sum of $2,592.74 which belonged to an original appropriation of 1882 for the enlargement of the Mt. Airy Station, and was required to meet the final payments under contract for the engines furnished to that station. The circumstance was the more awkward that the contract in the usual manner provided that the contractor should look to that particular balance and no other for his compensation, but the matter was remedied later by a transfer from the annual appropriation. The merging reduced the balance

in hand January 1, to	$35,481 82
which was subsequently increased at the expense of the annual appropriation by transfer in all of	4,135 61
making the total balance to special appropriations	39,617 43
The ordinance of December 31, 1884, appropriated to the Department the gross sum of	894,298 00
Of this the Ordinance of February 3, 1885, withdrew	220,000 00
while the Ordinance of March 24, restored from the surplus of 1884, the sum of	200,000 00
making a net reduction of	20,000 00
In addition minor transfers were made from the annual appropriation by the Ordinances of April 4, May 12 and June 22, 1885, amounting in all to	4,135 61
making a total reduction of	24,135 61
and leaving the net final appropriation	870,162 39
and the final aggregate available	909,779 82
The total expenditure from this amount was	901,931 49
leaving a balance at the close of the year of	7,848 33
of which there were merged into the Treasury as balances from items of regular annual appropriations	1,615 43
and a non-merging balance from special appropriation of	6,232 90

which was on hand January 1, 1886, and available for expenditure during the current year for the purposes to which it is applicable, viz.:

Refunds	$3,082 64	
Engines	96 98	
New Mains	3,053 28	
		$6,232 90

The expenditures are given in detail in the report of the Chief Clerk, and may be briefly summarized here as follows:

For retained payments on engines	$33,810 81
For deficiencies of 1884	6,956 39
For refunding over-paid water rents	2,311 84
For surveys and aërating plant	28,995 30
For new fire hydrants	5,993 09
For new supply mains	192,261 88
For replacing small mains	96,641 84
For general expenses of the Department	534,960 34
Total	$901,931 49

It is impracticable to avoid altogether the occurrence of deficiencies for the preceding year, although this amount shows a gratifying reduction in 1885 from that of previous years. Of the total amount $4,992.36 was owing for coal furnished at the end of 1884, and the remainder for miscellaneous bills. The accounts of all the departments are closed at midnight of December 31, the balances of all regular appropriations are merged, and any bills against the Department then outstanding must be provided for by additional appropriations. With every effort to secure the presentation and audit of all bills, there are invariably some that come in too late to be included in the regular schedules. So again with the item of Refunds. In the very large business of the Registrar's office, involving separate accounts with every individual property in the city, it is impossible to guard against errors on the part of those who ask for bills. In some cases they give the wrong number, in others the wrong street, in others ask for bills which they or an agent have already paid. To prevent this entirely would require examination both of the cash books and books of charges in every case, causing great delay in the transaction of business, and an additional amount of labor which both the inadequate facilities in the Registrar's office and the limited force of clerks at his disposal would render impossible.

Aside from the regular current expenses of the Department, the principal expenditures of the year were for new mains and fire hydrants, and replacing small street mains too long in service. The new supply mains were for West Philadelphia, Gray's Ferry Road, Ridge Road and Falls of Schuylkill, Germantown, and Tioga, and the replacing of unserviceable mains was principally effected in the Fifth and Sixth Wards. Advantage was taken of the opportunity to increase the fire protection by placing many new and greatly improved street hydrants.

For these several purposes the expenditures amounted to $294,896.81, to the great and immediate advantage of the districts and interests concerned.

The general expense or "maintenance" account of the Department includes all salaries and wages, and bills for material, labor, construction, repairs, and miscellaneous charges for work not otherwise provided for in the appropriation ordinance. It covers the cost of the Chief Engineer's and Registrar's offices, of the pumping stations, Purveyors' Districts and Department shop, the purchase and utilization of machinery, boilers, pipes, valves, hydrants, and other material and appliances both of pumping and distribution, the repairs and maintenance of all plant, including machinery, pipes, buildings, grounds, and reservoirs, and the gradual expansion of the service to meet the demand corresponding to the growth of the city.

In addition to the large supply mains and new service mains there were expended from the general appropriation about $90,000 for additional street pipes in compliance with ordinances authorizing them. The sub-division of expenditure is as follows:

General Expense Account.

For salaries	$169 393	72
For fuel, oil, gas, and stores	99,999	22
For repairs to machinery and boilers	39,177	57
For buildings, grounds, and reservoirs	33,929	51
For maintenance and improvement of distribution	134,941	19
For shop labor and material	43,586	87
For contingent and miscellaneous	13,932	26
Total	$534,960	34

With the service in good condition and with appliances in good order, the probable maintenance account under present circumstances would be about $500,000, including therein the regular annual expenditures which would augment as the built-up area of the city enlarges, the pipe system expands and the amount of water required increases. At present, with the maintenance of a pumping plant for the entire service of the city, the urgent requirements for new engines, boilers, mains, and hydrants, to say nothing of storage and subsidence basins and filtering appliances, will overtax the resources of the City Treasury for many years to come.

The following table is a general exhibit of the financial operations of the Department for the past six years:

Year.	Expenditures.	Collections.	Increase of collections over previous years.	Excess of collections over expenditures.
1880	$391,439 60	$1,484,357 06	$18,732 05	$1,092,917 46
1881	583,387 74	1,509,541 34	25,184 28	926,153 60
1882	660,958 45	1,516,904 64	7,363 30	855,946 19
1883	$829,497 19	$1,627,069 16	$110,164 52	$799,571 97
1884	1,033,616 01	1,792,486 01	165,416 85	758,870 00
1885	901,931 49	*1,826,164 04	*33,678 03	*924,232 55
Total, six years	$4,398,830 48	$9,756,522 25	$360,539 03	$5,357,691 77
Average	$733,138 41	$1,626,087 04	$60,089 67	$892,948 63

* NOTE.—These amounts should be credited with $70,000, due to the reduction in charge for horse-power from $3.00 to $2.00 per annum, which took effect in 1885.

It appears from this table that the expenditures for the last three years—which was a period of large additions and extensive repairs to pumping and distributing plant—greatly exceeded those of the previous three years during which appropriations for improvements were withheld, but that on the other hand the increase in collections due in part to natural growth and in part to improved administration nearly kept pace, so that the excess of collections over expenditures, constituting what may be called the net revenue to the city, was not correspondingly diminished. The comparison of the totals for the two periods is as follows:

Years.	Expenditures.	Collections.	Net revenue.
1880–1–2	$1,635,785 79	$4,510,803 04	$2,875,017 25
1883–4–5	2,763,044 69	5,245,719 21	2,482,674 52
Differences	$1,127,258 90	$734,916 17	$392,342 73

While the expenditures during the later period were 69 per cent. greater than for the former the net revenue was but 14 per cent. less. In other words, in addition to the surplus of nearly 2½ millions, the city obtained during 1883 1884 and 1885 new pumping plant of 47½ million gallons daily capacity and costing $400,000, 54 miles of new distributing mains costing $500,000 more, besides extensive repairs and other improvements to existing plant, or a total value of $1,127,258.90, at a net cost to the Treasury of $392,342.73, and the work of the Department must be credited with the difference, (which corresponds to the increase in the collections) after making proper allowance for the natural increase of receipts during those years due to the growth of the City. For the period 1855–1882, the average annual increase was $42,000, and for the ten years 1872–1882, $44,000, which may therefore be assumed as the normal average. This for three years would be $132,000, which deducted from $734,916.17 leaves over $600,000 to the credit of the Department. This sum however, should be increased by the $70,000 reduction in the horse power charge, causing a loss of revenue to the Department and corresponding gain to steam users. The abnormal increase during 1883 1884 and 1885, is due to the failure in previous years of the water takers to report additions and of the Department to discover and take account of them. The needful corrections having been ascertained and made, the Departmental receipts were largely augmented without any effort to collect the arrearages accruing during the past, beyond those that appeared upon the Department books.

Numerous water appliances upon which the assessment of premises for water rates is based, were found to have been added at various times without the knowledge of or permits from the Department, which had therefore no record of them. These were disclosed by a rapid though careful reinspection of the entire City.

Another large leak was discovered among the brewers. There are some 90 breweries in the City which are charged by the Water Department two cents on each barrel of product. As it requires about six barrels of water in connection with the manufacture of one barrel of beer, and the two cents is charged only on the beer, the tax on this industry is not excessive; but after taking suitable means to ascertain with approximate accuracy what the product really was, comparison with the charges on the Department books showed that on the average the brewers were paying about 50 per cent. only of their actual dues to the City, some nearly the full amount, others much less, and one large concern in particular was making 150,000 barrels and paying for 50,000, or $1,000 water rent instead of $3,000. The sending of a bill for the additional $2,000 occasioned great dissatisfaction in this and similar cases.

In another class of cases certain persons having "influence" of some sort, seemed to have acquired a certain exemption from payment of water rents altogether, and were shown to be delinquent for several years together. The correction of these shortcomings was not at all an agreeable duty, but the typical facts above given are stated as illustrative of the kind of administrative work necessary to the satisfactory conduct of the Department business, and perforce to be assumed by the head of the Department, often without the aid and in many cases with the opposition of those having official relations with the City Government, and who therefore should have been earnest in the support of all proper measures.

The report and tables of the Registrar contain matter of much interest and would repay fuller analysis than can now be given. The several sources whence the Department Revenues are derived are shown, and the comparative table of receipts for the years 1880 to 1885 exhibits the variations during those years.

The delinquent columns display a gratifying reduction due to more systematic work and the enforcement of the ordinances; so also do the collections by the City Solicitor. These are payments of frontage charges for water-pipe obtained by lien, while the pipe charges voluntarily paid appear among the Department collections. It is of interest to note the rapid diminution in the last few years of the proportion of the whole amount collected by legal proceedings. It should be observed that the large pipe receipts do not necessarily imply that the pipe paid for was newly laid. It was found that very many properties supplied with City water, had never paid the pipe charges, and while no systematic effort was made to look these up from lack of time and convenient records, advantage was taken of any change in appliances or applications for new permits to investigate the frontage charges in each case as it occurred, and if unpaid to collect them as required by Ordinance before granting the permit.

Of the new permits issued during the year, there were 4,985 for new buildings, making the total premises on the books 172,833, of which there are supplied with water 151,853, or 88 per cent., and without water 20,980, or 12 per cent. The new permits for baths in dwellings number 3,857, and for water-closets 4,879, making totals of 80,773 baths and 45,568 closets in use in private houses. In other words, about one-half the domiciles in Philadelphia have baths, and more than one-quarter have water-closets. Furthermore, it will be noted that all of the buildings constructed during the year, with the

REVENUES OF THE DEPARTMENT FOR THE SIX YEARS, 1880 TO 1885, INCLUSIVE.

YEAR.	Delinquent Water Rents.	Delinquent Penalties.	Water Rents.	Penalties.	Fractional Rents.	Water-pipe.	Searches.	Chief Engineer's Office.	City Solicitor's Office.	TOTALS.
1880	$112,728 37	$16,783 11	$1,218,925 66	$19,002 35	$48,038 07	$26,077 90	....	$4,786 07	$38,015 53	$1,484,357 06
1881	84,591 40	12,627 66	1,256,662 00	19,234 38	53,451 56	47,489 11	....	5,549 01	29,936 22	1,509,541 34
1882	78,543 01	11,479 18	1,295,419 87	18,016 23	49,529 90	34,979 52	....	7,515 88	21,421 05	1,516,904 64
1883	69,995 84	10,310 00	1,380,882 17	23,280 44	67,088 10	45,853 09	....	8,515 11	21,144 41	1,627,069 16
1884	19,837 72	2,492 97	1,566,027 57	22,797 76	77,557 40	71,542 00	461 50	10,670 89	21,098 20	1,792,486 01
1885	11,267 25	1,561 03	1,567,031 94	22,298 78	101,643 88	92,182 18	1,988 75	9,197 00	18,993 23	*1,826,164 04

* If reduction in horse-power charge be added, this amount would be $1,896,164.04.

exception of 106, were equipped with closets. There are, however, 7,357 dwellings and 13,623 "half" dwellings not supplied with water.

The number of stationary steam-engines in use in the city is 1,152, with a total horse-power of 16,227, and of steam-boilers 2,521, of 56,487 horse-power—in all 72,714 horse-power—the reduction in amount charged for which, from $3.00 to $2.00, occasioned a corresponding reduction in the Department revenues for 1885.

The 85 per cent. reduction of water-rents to certain charitable institutions involves a loss of revenue of $19,105, while the water supplied to the Public Buildings, Park, Schools, Fire and Police Stations, if charged for at the regular rates, would pay $30,203.

The Department likewise furnishes gratis all water used for the extinction of fire, whether through public or private apparatus, as well as what is used to clean the streets. For the last two years, also, as improvements in the water supply permitted, under permits given to the police authorities in each district the gutters in summer have been flushed on an average twice a week to prevent the accumulation of foul liquids and street rubbish.

The Water Department, therefore, is charged to a very large extent with the support of other departments, in addition to the surplus revenue which it has been made to yield.

To Mr. Hickman, the Chief Clerk, and Mr. Keithler, the Registrar, with their several assistants, inspectors, and clerks, the Department is indebted for assiduous, faithful, and efficient service throughout the year.

WATER CHARGES.

In my previous reports I have presented data tending to show the advantage of the method of direct measurement of water supplied to large consumers and the economical results both to water takers and to the city to be anticipated from the use of meters for the purpose of assessment of water charges. In my last Annual Report it is stated as follows:

"The table of Meter Charges is a most interesting exhibit. "Early in 1883 a preliminary investigation of the Registrar's "books showed marked inequalities in charges and in some "cases most singular disparities between those charges and the "amount of water consumed. Later, it became manifest also, "from both observation and computation, that a large propor- "tion of the total daily pumpage was wasted, thereby entailing "a heavy additional and unneces ary expense upon the City— "since the expenditure of fuel and the wear and tear of ma- "chinery are directly proportionate to the pumpage and have "no relation to the use or misuse of the water after delivery. "Furthermore, this waste, by diminishing in effect the capacity "of the basins and distributing mains, occasions an artificial "scarcity which impairs the effectiveness of the Fire Depart- "ment, hampers manufacturers, and interferes seriously with "domestic comfort; and these disadvantages must, perforce, "continue until either the means of distribution shall be greatly "increased or the waste prevented.

"No arrangement having been concluded for the instrumental "determination of domestic waste, the vigilance of the Depart- "ment Inspectors, aided by casual information from citizens, "had to be depended upon to correct the thousands of leaky "and flowing hydrants, water-closets and basins—quite inef- "fectively, it must be admitted, in the absence of any plumb- "ing regulations and supervision.

"For the large consumer the obvious means to systematize "and equalize water charges as well as restrict the waste, was "to measure the water drawn and charge for it.

"For this purpose, under the provisions of the joint resolu- "tion of Councils of May 18, 1870, authorizing the Chief Engi- "neer to apply meters when necessary to ascertain the amount "of water consumed, the establishments named on the meter "schedule were supplied with meters, and the records kept. "The result in many cases was quite unexpected both to the "Department and to the consumers, and a large body of fresh "and valuable information was rapidly obtained. The general "system of rating premises for water rents, under which the "Water Department, since its organization in 1854, has pro- "ceeded, is to make an inspection of the premises and base the "charges upon the number and character of the water appliances "in service, the charge for each appliance being regulated by "a schedule in force in the old City previous to consolidation "and re-enacted by ordinance thereafter. The charges against "the several appliances named in the schedule were presumably "proportioned originally in accordance with the average amount "of water which it was supposed would be drawn from them; "but as plumbing arrangements developed, and in especial as "manufacturing methods were altered, and new devices, labor- "saving and other, came into use, it was found necessary from "time to time to amend the schedule. This was done by the "joint action of the Chief Engineer and the Water Committee, "without resubmitting the matter to Councils; but notwith- "standing the changes, the schedule has failed to keep pace with "industrial modifications, and continues to bear indications of "its early origin. The record of the meters clearly brought "out these points, and has served as a valuable aid in the re- "adjustment of the details of charges, which is now under "consideration by the Water Committee.

"It was mainly upon this evidence that the Department re- "commended, and the Committee approved, a decrease in the "charge for steam-power from $3 to $2 per horse-power, which "is now the lowest charge in the United States. The old "charge was probably a lower one, when it was adopted, than "is the smaller charge now, since the introduction of con- "densing and compound engines, with other improvements in "mechanical engineering, has effected a marked economy in "both fuel and water, the latter being used over and over "again. As will be seen by reference to the Registrar's de-

"tailed Statement of Appliances the number of steam-engines "and boilers in service in the City exceeds three thousand, "with an aggregate horse-power in excess of sixty-five thou- "sand. The reduction of $1 in the horse-power charge corre- "spondingly relieves the steam-using industries and diminishes "the revenues of the Department. The change was made "early this year, in time to go into effect in making out the "bills for 1885. The meter further developed the fact that in "some establishments appliances were in use not named in the "schedule nor known to the Department, and therefore not "charged for, which, nevertheless, consumed large quantities "of water. It also showed that in many cases the amount "of water wasted was largely in excess of that usefully em- "ployed, as was evidenced by the rapid decrease of consump- "tion so soon as the meter readings were made, and the "managers saw that a proper and large economy could be "effected by requiring their employés to stop unnecessary "flow. The reduction in some instances was fifty per cent., "and even as high as seventy per cent. This result was, of "course, anticipated; since it is quite clear that, as a rule, "little if any care will be taken to restrict the flow of water "which is not charged for, nor even noted, and that even were "strict instructions given, employés will not take the trouble "to obey them so long as their dereliction could escape observa- "tion. A pipe would be used, for example, to fill a tub, and "the workman would throw the hose upon the floor and let the "water run until he again had occasion to use it. In other "cases a pipe in constant flow during the day would also be "allowed to run after shutting down the mill. Leaking pipes "were not repaired, nor were urinals and basins shut off. All "these sources of waste the meter readily controls to the "advantage of every interest.

"The establishments given in the Meter Statement are not "all of those to which meters were provisionally or experi- "mentally applied, but are selected as exhibiting the charac- "teristic results afforded by direct measurement. In some "the charges remain about the same by meter as by regular "schedule rates; in others the meters, after correction of the "waste, largely reduced the cost to the consumer; while in "still others the increase by meters was so great as to show "clearly the inadequacy and inequality of the schedule charges "as based upon assessment of appliances. In these cases, as "was natural, the meter was strenuously objected to; and, in "fact, it was made evident that in regard to certain industries "which are compelled to use immense quantities of water for "cleaning and similar purposes the City could well afford to "reduce the charge per thousand gallons below even the "moderate rate of eight cents.

"It would seem equitable, in considering these matters, that "consumers using over a certain quantity should be allowed a "reduced charge—either by a sliding scale, as has been "adopted in many other cities, or by the minimum draught "per day, or per annum, above which the reduced rate would "go into effect.

"It is in these two directions, of restricting waste and equal-"izing charges, that the meter exhibits its useful qualities; "and under favorable circumstances its application to all large "consumers would be attended with excellent results. This is "now done in many cities where the business of furnishing "water has been carefully and intelligently regulated, and in "several instances meters are universally applied even to "private houses. In Philadelphia it would be unadvisable to "so greatly enlarge the use of meters; and there are good "reasons, since our supply is only necessarily restricted by "the pumping and distributing facilities, for not putting meters "in private houses.

"The free use of water for bathing purposes is so desirable "that it should be in every way encouraged and nothing done "that would tend to restrict it. Furthermore, the number of "premises supplied with water is so great as to forbid consid-"eration of the general use of meters, certainly until at least "the extensive expenditures for most urgent and indispensable "improvements shall have been made.

"With our present arrangements, too, meters are at a dis-"advantage from the character of the supply. The city water "is frequently highly charged with sediment, and the meters "are thereby, to a certain extent, obstructed, so that they "register less than the amount passed through them. This "fact operates against the City by diminishing the apparent "consumption, although the consumer is correspondingly bene-"fited. In some cases, too, the meter became choked and "obstructed the flow, although this difficulty, under a proper "system, need not continue. Whether any extension of the "use of meters shall be hereafter made or not, the information "furnished by them has been most valuable in clearly indicat-"ing where revision of the schedule charges is needed and how "readily waste can be prevented."

I shall not seek to enlarge upon the views above expressed beyond the statement of a few facts in the same connection.

The primary objects sought to be attained by the direct measurement of the quantity of water supplied are, first, the proper and equitable regulation of the Department business; second, the equalization of charges to consumers; and third, the restriction of waste. It will not be contended, I presume, that the securing of these results is other than desirable. Useless waste cannot be defended; it benefits no one, injures those who are thereby deprived of a needful supply, and adds an item of superfluous cost to the maintenance of the Department. At a moderate estimate one-third of the water now pumped and distributed is wasted, passing into the sewers without having served any useful purpose whatever, and in most cases having done harm on its way. The pumping expenses for fuel for the year 1885 were in round numbers $90,000, and the waste of water therefore represented an unnecessary expenditure in this item alone of not less than $30,000, to which must be added that large but incomputable amount due to short supply occasioned by the non-utilization

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of that same waste, which dwellings, stores, and factories needed but had to go without, to the serious detriment of individuals and interests. Were Philadelphia situated as is Baltimore, with a gravity supply by conduit from a stream having a much larger flow than for the present can be utilized, the economical argument would be weakened; but even then it is manifest that in time the conduit would no longer suffice, and meanwhile the unnecessary draft upon the mains due to waste diminishes the available pressure in the city. To restrict waste, therefore, is to augment the supply, to reduce expense, and to improve sanitary conditions; and there is no way in which waste can be so effectually checked as by ascertaining and charging for it. The equalization of charges to consumers is certainly equitable and just. Of two establishments with the same appliances and equal requirements, why should one get from the city three times the quantity of water supplied to the other, when both pay the same water-rent? Or conversely, if both take the same quantity of water, why should one pay three times as much for it as the other? It is quite impossible to answer these questions in any manner consistent with the present method of dealing with the subject. The regular schedule of charges takes account of appliances only, and not of the water drawn and used or wasted. It is out of the question that equalization can be effected while this is the case, and the city is only encouraging wasteful and extravagant methods in certain cases at the expense of the community. It may be said that if the arrangement be good as regards large consumers it would also include small consumers and dwellings. This is not necessarily so. In the first place the charges to dwellings are much higher in proportion than to manufacturers, and the annual water-rent would cover considerable waste at the present meter price. Furthermore, the city has a right to consider her own interest; and if in a given case the cost of suppressing waste exceeded that of the waste itself it might be worth while to let it go or try another method.

From the administrative point of view, the regulation of the Department business is a matter of importance and especially is this the case since the Department is dealing pecuniarily in sums large and small through various agents with a very large number of people and the temptation to dishonestly economise payments and to influence the Department agents improperly should be as completely removed as possible. In other words the basis of Department accounts and bills rendered should be so simple and satisfactory as to be open to ready and clear determination and closed to dispute or dishonest avoidance. With the existing manufacturer's schedule this is not the case, nor are its incongruities and inequalities susceptible of correction, unless it can be determined by measurement how much water each appliance should be charged for; but this involves the use of the meter without which the correction cannot be made.

The main argument advanced against the use of meters is that the manufacturing interests upon which to so large a degree the prosperity of the city depends, must be protected against excessive charges, and that the effect of the meter would be to increase the charges now made. The obvious answer to this is that the meter is a mere instrument to measure the volume of water passing through it, and has nothing to do with regulating the price charged for that water. If the price is too large, nothing is simpler than to reduce it, but in the adjustment of matters of this sort it is essential that it be done "in the open" and in the general interest, not that of individuals however influential.

My efforts have been directed to the elimination from the Department business of this intolerable "personal equation," and the adoption of impartial and systematic regulations, but with the complicated machinery of the city government, as at present constituted, the task has hitherto proved impracticable. Examination of the comparative statement of schedule and meter charges, printed in the report for 1884, will indicate the gross inequalities of the so-called "regular" rates. Two typical illustrations will suffice. A sugar refinery was found to be charged $150 per annum, while the actual value of water used, if charged at the meter rate of eight cents per thousand gallons, would be $1,500. There are many cases of this sort in which the basis of charge is quite indeterminable. Of two large establishments, one a dye-house and the other a brewery, using the same quantity of water, viz.: about 430,000 gallons per day, one pays $4,872 water rent; the other $10,922. Now since the service performed by the city to these two customers is precisely the same in one case as in the other, it is manifest that if one is paying a just rate the other is getting his water supply at less than half rates, or if the latter's bills are equitable the former is being grossly overcharged. The fact probably is that the equitable rate, both to the city and the two consumers, lies intermediate between the two charges.

My own views upon the general question are that so far at least as the manufacturing interests are concerned, the city charges for water should exceed the actual cost of service, as determined by the average ma intenanceexpenses of the Department, by such amounts only as would suffice to meet the cost of renewals and additions to plant required to keep pace with the increase of growth and demand, in other words to maintain the service.

It was shown in the report of 1883 at page 70, that considering the entire period since consolidation and comparing the total quantity of water supplied with the gross expenditures, exclusive of interest on loans or plant, the cost of the service was at the rate of nearly 4 and 75-100 cents per thousand gallons delivered. If now this amount be increased by 25-100 of a cent to provide for needed enlargements, an equitable charge to large manufacturing industries would be at the rate, say of five cents per thousand gallons. The effect of this charge in the case of the dye-house and brewery already referred to would be to reduce the $10,922 water rent, and increase the $4,872 rent to $€,825 for each, an amount with which certainly neither one nor the other could justly find fault.

In opposition to the allegation that the use of meters would increase the burden to consumers, it can be conclusively shown that while certain partialities to individuals would be eliminated, in the greater number of cases the water charges would be reduced, even at the present price of eight cents per thousand gallons, but that the advantage of repressing useless waste and regulating the Department business would so nearly offset the loss of revenue that the application of the direct system of measurement would be found both to justify further reductions in the rate per thousand gallons, and to inure to the joint benefit of the city and the manufacturer.

As the system of water charges and the schedule now in force have not been acted upon by Councils since the Act of Consolidation, and as, in my judgment, it was important for reasons already given, and for the additional reason of legalizing the charges made, that authoritative action by Councils should be taken, I have sought to secure full and open consideration of the subject, but up to the present the Water Committee, to which my communication was referred, have submitted no report.

The meters in service have been reduced from 560 in 1884 to 305 in 1885, and are now used only where premises have both a public and private supply, and the rent cannot be otherwise determined than by measurement of city water taken.

THE PUMPING PLANT.

The character and work of the several Department pumping stations, nine in all, have been fully explained in my former reports, and no special description at this time is necessary. The additions heretofore made to the plant, of the two 15-million gallon Worthington engines in the new station at Spring Garden, the 7½-million Worthington at Roxborough, and the 10-million Corliss at Frankford, increasing the total pumpage capacity by 47 ½-millions gallons per day, with other improvements in the service of the stations, have enabled them to do their work with reasonable regularity and security, and usually to hold in reserve a certain proportion of power. This is manifestly a matter of importance in a service whose shortcomings or failure involve such serious consequences, and it is generally considered that the pumping capacity of a given station should exceed by 25 or 30 per cent. the expected demands, and under all circumstances have some power in reserve. This may now be said to be the case so far as engines are concerned, except at the Spring Garden Station to which point further reference will be made later.

The reports and tables of the Superintendent furnish the detailed information as to the work at the stations and the cost of operating them. The total quantity of water pumped was 25,165,020,072 gallons, a daily average of 68,945,260, which, estimating the population of the city for 1885 at 947,000, corresponds to a daily average of 72.8 gallons per head of population.

Owing to the fact that the Fairmount turbines were under repair for a considerable portion of the year its pumpage was less than usual, and in consequence additional work was thrown upon the Spring Garden station, which had also to take care of a considerable proportion of the Kensington pumpage, notwithstanding that the supply was restricted as much as possible.

While, therefore, the actual number of gallons pumped was less than in 1884, the total work represented by gallons raised 100 feet was greater. In this connection it is proper to state that the pumpage returns from the stations for years immediately preceding 1883, cannot be regarded as entirely reliable, inasmuch as it was ascertained that the employés at some of the stations, in order to make a better showing and record the expected number of strokes of the engines, opened the relief valves and in some cases worked the counters ahead by hand.

Taking the figures however as they appear in the published reports, the showing made in the following comparative table of operations and cost for the period 1881–1885 has some gratifying features.

CURRENT EXPENSES AND WORK OF THE PUMPING STATIONS FOR THE YEARS 1881-85.

Years.	Pay of employés at the stations.	Coal.		Lubricating Oils and Tallow.			Lighting Stations.			Repairs to boilers and machinery.	Packing and small stores.	Total expenses.	Percentage of decrease from 1882.	Total gallons pumped.	Gallons per capita.	Mean lift in feet.	Gallons pumped 100 feet high.	Percentage of increase from 1881.	Cost of raising one million gallons 100 feet high.	Percentage of decrease from 1881.
		Tons.	Cost.	Gallons.	Pounds.	Cost.	Gas.	Oil.	Electric light.											
1881...........	$61,821 54	28,348	$124,033 11	3,017	19,142	$2,643 83	$4,468 20	$401 23	....	$37,733 33	$4,510 40	$235,611 64	6.64	22,721,014,838	71.8	150.7	34,238,528,111	00.00	$6 88	00.00
1882...........	60,572 65	28,395	124,525 29	3,937	7,361	3,611 49	5,983 97	387 82	....	53,002 47	4,275 97	252,359 66	0.00	24,691,440,430	76.4	153.4	37,873,302,258	10.61	6 66	3.19
1883...........	64,410 46	27,486	117,873 88	3,536	1,302	3,082 83	5,267 94	525 68	....	52,640 84	3,112 13	246,913 76	2.16	25,284,957,251	76.5	150.0	37,949,320,701	10.84	6 51	5.38
1884...........	57,885 22	28,880	97,995 05	2,864	....	1,706 32	4,734 60	206 59	$885 95	48,374 63	4,383 15	215,895 72	14.45	25,495,179,353	75.2	152.2	39,001,865,294	13.91	5 54	19.47
1885...........	57,347 74	31,738	83,931 62	3,486	....	1,967 21	2,907 98	253 53	236 42	37,140 17	1,134 55	184,919 22	26.72	25,165,020,072	72.8	156.2	39,308,901,886	14.81	4 70	31.69

Notwithstanding the establishment of a complete new station of 30 millions capacity at Spring Garden, increase of compensation to certain employés, and increased pumpage, the reductions in expense appear in every column. The increase in amount of coal consumed is due to use of pea instead of egg. The total expense in 1882 was $252,359.66, and in 1885, $184,919.22, a reduction of $67,440.44, or 26¾ per cent. with increase in work amounting to 5 per cent., and the cost of raising a million gallons to the height of 100 feet was reduced from $6.66 in 1882 to $4.70 in 1885, or 28 $\frac{7}{10}$ per cent.

The economical results may be shown as follows:

The total cost of pumpage for the three years, 1883, 1884 and 1885, was $647,728.70. Had this work cost at the same rate as in 1882 the total would have been $774,292.18. The saving in cost for the three years is therefore $126,563.48.

Another result of the work of the Department is shown in the reduction, though slight, in the daily supply per head of population. As this reduction was effected cotemporaneously with a general increase in supply and pressure throughout the city and a corresponding decrease in complaints it is clearly due to the efforts made to prevent waste by the detection of leaks, repair of fixtures and the repression of the improper use of hydrants and the constant flow from horse-troughs and other appliances.

The improvement is slight, it is true, and yet gratifying as an indication of betterments which have even now an appreciable money value. Had the supply per capita been the same in 1884 and 1885 as in 1883 the additional cost for the two years would have been $12,916.19—a sum considerably greater than the total annual cost of either the Frankford or Kensington stations and more than sufficient to run the entire station at Fairmount with ordinary repairs only. Fairmount in 1883 with $3,000 repairs, etc., cost $14,217, and if once put in good order should not cost over $12,000.

The figures are significant as showing how the value of better administration inures at once to improvements in and decreased cost of service.

The percentage of work done at the principal stations is 44.57 for Spring Garden, 17.42 for Fairmount, 13.90 for Belmont and 13.04 for Roxborough.

Of the total supply 90.25 per cent. is taken from the Schuylkill and 9.75 per cent. from the Delaware at the two stations Frankford and Kensington.

The cost of pumping by turbines at Fairmount was $2.33 per hundred million foot gallons as compared with steam pumping at Spring Garden $4.96, Belmont $5.37 and Roxborough $4.27. The total average cost by steam and water being $4.70.

Excluding repairs to boilers and machinery costing $37,140.17, (about 20 per cent. of the total $184,919.22,) the average cost of pumping was $3.76 per hundred million foot gallons.

The entire suppression of the pumpage from Kensington, though very desirable by reason of the large admixture of sewage in the Delaware at that point, has not been practicable for two reasons. In order to accomplish this, it was necessary to impose additional work upon Spring Garden, and to increase the capacity of the mains from that station to the Fairhill basin. It was found that the development of the region northwest from Kensington was so rapid as to keep pace with the modifications made in the mains, and that the growth of the area north of Callowhill street, west of Broad, Jefferson, and Ninth streets, which, being without a reservoir, must be supplied by direct pumpage from Spring Garden, rendered it dangerous to augment too greatly the work of that station towards Kensington. I am inclined to believe that the purpose in view, until at least the proposed Cambria basin can be constructed, will be most satisfactorily accomplished by a new main from the Wentz Farm basin to the Fairhill basin, and to impose upon the Lardner's Point station the additional duty of maintaining the Kensington supply. This station has two 10-million gallon engines, while the average daily pumpage is under three millions. Either engine, therefore, could send seven millions daily to Fairhill, which would much more than suffice, and leave Spring Garden to attend to its own large and increasing responsibilities. The alternative is to put a new 20-million-engine at Spring Garden in the place of the old No. 4, next to the Cramp, and to lay new mains, also.

There are important reasons for this increased power at Spring Garden other than the above. Fairmount cannot be depended upon in summer during low stages of river for more than five or six millions a day, and often less. The deficiency has to be met by increasing the burden upon Spring Garden which during the period of maximum pumpage is fully employed. The total capacity of the station is sixty-eight or seventy millions, and it often happens in summer that every one of its engines is running. If the mains were capable of taking or the reservoirs of holding the water, the station would be driven to its limit without any reserve power at all. This condition of affairs at the largest and most important station in the Department—upon which, too, depend for their supply, by the constant and direct action of the pumps, the large population above Callowhill and west of Broad and Ninth streets—is too dangerous to be permitted to continue. With all the engines running and nothing in reserve, it may readily be seen how serious the stoppage for any reason of one of them would be to the region depending upon direct pumpage. The cost of the new engine in place would be about $65,000, and of additional boilers, say $40,000. New boilers in any case are needed, both at Spring Garden and Belmont, to take the place of old ones which have been fifteen or twenty years in service, and can no longer be relied upon. One battery at Spring Garden, in fact, is entirely useless.

The new boilers for Belmont, including removal of old plant, would cost say $30,000, making the total expenditure needed for new engines and boilers, $135,000.

West Philadelphia took nearly 500,000 gallons per day more in 1885 than in 1884, and with the new 36-inch main in service the requirements for the present year will be still

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greater. As the case now stands the boilers at Belmont cannot be depended upon for any additional duty nor even to continue their present work, and the new plant is urgently needed both at Belmont and Spring Garden.

THE DISTRIBUTING PLANT.

The general features and defects of the distribution system have been fully explained in previous reports. The provision for storage is quite insufficient, and for subsidence almost entirely lacking. There are no appliances for filtering or clarifying the water. West Philadelphia, which in many respects is better served than other districts, has but five days' storage in the Belmont Basin, and this is diminishing as the population and consumption increase. For the city generally the Fairmount, Spring Garden, Corinthian and Fairhill Basins, with a combined capacity of less than 100,000,000 gallons, have only two days' supply on hand for a population of, say 650,000, exclusive of the direct pumpage area and the outlying districts. Germantown, supplied from the Mt. Airy Basin, is no better off, and the Wentz Farm Basin, supplying Frankford and Bridesburg and the vicinity, from defective construction will contain only about one-third its intended store. These are matters of too serious a nature to warrant their neglect.

The East Park Reservoir was designed as a storage Basin for all that extensive area, say from Spring Garden street southward and from Broad and Ninth streets eastward, which its projected surface elevation of 133 feet would enable it to reach. Work upon it has been suspended since 1875, and the expenditure of about $1,250,000 has so far been rendered useless by the failure to complete the work. To put it in service will cost about $1,250,000 more, and require two or three years time. When completed it will not only furnish an opportunity to get rid of a considerable proportion of the weightier sediment with which the Schuylkill water is frequently charged, but will be

BASINS.

Name.	When built.	Capacity, gallons.	Elevation. Feet above city datum. Surface.	Elevation. Feet above city datum. Bottom.	Depth, feet.	No. of divisions.	District supplied.	Population, 1880.
Fairmount	1815–1836	26,443,140	94	82	12	5	Old city, or 5th, 6th, 7th, 8th, 9th, and 10th Wards.	113,043
Spring Garden	1844	9,800,000	120	104	16	2	1st, 2d, 3d, 4th, 11th, 12th, 13th, 14th, 15th, 20th, 26th, 29th, 30th, 31st, and parts of 25th and 28th Wards.	445,467
Corinthian	1850–1852	37,312,000	120	93	27	1		
Lehigh or Fairhill	1852–1871	25,757,720	114	96	18	3	16th, 17th, 18th, 19th, and part of 25th Ward.	121,512
Belmont	1866–1870	40,000,000	212	187	25	2	West Philadelphia alone—24th and 27th Wards.	69,340
Wentz Farm	1876–1877	35,750,000	167	144	23	1	Frankford and Bridesburg—23d and part of 25th Ward.	36,675
Roxborough	1865–1866	11,771,700	366	347	19	1	Germantown and Manayunk, or 21st, 22d, and part of 28th Ward.	61,505
Mount Airy	1855–1857	4,390,000	363	348	15	2		
East Park	Commenced 1871	700,000,000	133	108	25	3		847,542
Cambria	Proposed	210,000,000	166	135	31	2	Population, 1884.	931,886

a valuable safeguard against failure of the pumps or bursting of mains.

The Cambria Basin exists only in name. The site was secured by Ordinance of Councils nearly three years ago but has not yet been paid for, nor has any appropriation been made looking towards beginning its construction. It will cost in round numbers $1,000,000 and require say three years to construct. If in service it would contain at an elevation of 166 feet, double the daily maximum summer pumpage of the entire City, viz.: 210,000,000 gallons one-third the contents of the East Park and five times that of the Belmont Basin. The especial utility of the Cambria Basin would be that from its altitude it would serve the greater part of that extensive and populous area covering the Twenty-eighth, Twenty-ninth and adjacent wards which is now dependent solely upon direct pumpage into the mains, and which could not be reached even by the East Park Reservoir. Furthermore, as is stated in the annual report of 1883, whether the future supply be derived from a reformed Schuylkill, from the Delaware or Perkiomen, the Cambria Basin will constitute a convenient terminal and distributing point whence the other basins may draw their supply.

The much needed enlargement of the Mt. Airy Basin which was also surveyed and reported upon in 1883, will cost about $250,000, and the required partial reconstruction of the Wentz Farm Basin, to enable it to retain water to its full capacity, will cost perhaps $25,000 or $30,000 more. Omitting from consideration a new Basin for Manayunk, which has been recommended, and a possibly needed new Basin at Twelfth and Olney road, the completion and enlargement of existing works which are imperatively required for present service will aggregate $2,500,000.

The pipe system is defective to a considerable extent by reason of the age and small dimensions of many of the mains, but principally by reason of the insufficient number and dimensions of the supply or trunk mains to conduct the water from the basins to the service mains, with which house and other connections are made. The reason for this it may be assumed was the injudicious restriction of expenditures by which the Department was forced to extend too greatly the use of small mains and compelled to omit the laying of the trunk mains needful to keep the service mains charged at the proper pressure when water is drawn from them.

The pipe map shows that in some considerable areas, for example the Nineteenth, Twentieth, and Thirty-first Wards, there are nearly no trunk mains at all. The result is that the pressure and flow which even were the pipe system properly constructed would be less than is desirable, from the low elevation of the basins, are largely reduced below what the elevation calls for and at times fail entirely. The results secured by laying new trunk mains last year clearly illustrate this.

West Philadelphia was dependent entirely upon a 20-inch supply main from the Belmont Basin, and the pressures and flow were quite insufficient over a considerable area of higher elevation than the average, although the height of the basin above these areas was ample to give an excellent supply. The capacity of the main, however, had become entirely insufficient to deliver the needful amount of water.

I presented this matter in the report for 1883, and last year a new 36-inch main was appropriated for and laid in Fifty-second street from the basin to Walnut street, and a 20-inch connection on Lancaster avenue put in between the old and new supply mains. The effect was very marked. The pressure and supply were about doubled and in several localities trebled. This result, it will be of course understood, was reached without any increase in the height of the basin or other change in the static head.

The capacity of a pipe to deliver water depends upon its diameter, length and interior condition and the hydraulic gradient, and is quite independent of the needs of the population drawing from it. When it has reached the limit of its capacity there is nothing to do but to lay another main—the wiser course in the first place being to exercise such intelligent and judicious prevision of the growth and requirements of the future as to forestall the disadvantages and danger of an inadequate supply.

Similar effects to those in West Philadelphia were shown in connection with the other new mains. The 20-inch main on Gray's Ferry road gave 10 lbs. pressure where formerly in Summer it was nothing. In Germantown the 16-inch main raised the pressure at the Town Hall from 20 to 40 lbs. Tioga depended upon a 6-inch main and if a fire-hydrant were opened the pressure fell very low. The new 12-inch pipe nearly doubled the static pressure from 50 to 90 lbs. and furnishes an ample quantity.

The work of replacing the old mains of small dimensions and in use for one or two generations, reported in 1883, was begun with an appropriation of $100,000. The work was pushed during the Fall with great success and the Fifth and Sixth wards and a portion of territory adjacent were nearly cleaned up and some work done in Chestnut Hill. Three hundred and forty-eight feet of 1½-inch pipe, 60 of 2-inch, 22,694 of 3-inch and 11,079 feet of 4-inch were replaced with 6-inch; the 4-inch on Fourth street from Market to Walnut was abandoned and a new 16-inch laid. On Walnut street a 12-inch pipe was laid from Front to Twelfth and from Fifteenth to Twenty-second streets. The pipe from Twelfth to Fifteenth was already 12-inch. The total amount of small and unserviceable pipe replaced was about one-twentieth of the entire amount, and about $1,500,000 will be needed to complete the work. The matter is fully stated in the report for 1883. It is obvious that this condition of affairs, imperiling valuable property and crippling the Fire Department, should not have been permitted to continue, and that the replacing of unserviceable plant is a clearly expectable requirement and simply constitutes part of the maintenance of the Department.

The new hydrant, designed to meet the needs of modern fire apparatus, proved very successful and has met the approbation of the Fire Department. From the old hydrant with a single $2\frac{1}{4}$-inch nozzle but one stream could be taken, and that often a feeble one. The new hydrants are of three sizes or numbers, the principal one having three openings, two 4 inches in diameter and one of $2\frac{1}{2}$ inches. Three steamers can couple to this and throw five streams of water of full force. The immense advantage of taking water near the fire and saving great lengths of hose is obvious. The hydrants were formerly placed midway between the streets. They are now as often as possible placed near the street corners, by which they command two sides of a square, are visible from four directions, and usually illuminated by a lamp post on an opposite corner. The steamer at the corner is also less liable to obstruct traffic than when compelled to take position in the middle of a square.

The report of the Assistant Engineer-in-Charge gives the detailed account of work during the year, which, as has been observed, is much larger than ever before done by the Department.

Following is a general exhibit of work during the past six years:

Table of work in connection with the Distribution for the years 1880–85.

Years.	New pipe laid, feet.	Relays and repairs, feet.	Total handled.		New stops.	New hydrants.	Number of new attachments.	Meters in use.
			Feet.	Pounds.				
1880...	23,085	9,557	32,642	1,107,772	138	70	2,943	34
1881...	56,616	3,832	60,448	3,032,272	249	144	3,483	42
1882...	56,860	7,740	64,600	5,880,257	312	120	3,484	45
1883...	63,215	12,605	75,880	3,724,065	281	131	4,877	63
1884...	83,862	18,079	101,941	8,516,219	324	148	5,945	560
1885...	137,967	93,783	231,850	15,499,611	539	324	7,285	305

The Department accounts show that the average total cost of pipe in place for the years 1880, 1881, and 1882, was $4.41 per hundred pounds, and for 1883, 1884, and 1885, $3.65, a reduction of 17 per cent. This decrease in cost is due in part to somewhat lower prices for material, and in part to the considerable quantity of mains of large dimensions, but after making proper allowance for these the Department must be credited with a large reduction due to the active pushing of work, much of it late in the Fall, and under great disadvantage from stormy and freezing weather and heavy rains. Had the pipe laid during the past three years cost the same per hundred pounds as during the preceding three years, the additional expense would have amounted to over $200,000.

As the distribution system is now arranged, the old city, between Vine and South streets, takes its supply from the Fairmount Basin whose altitude, 94 feet, is but little above the roofs of many of the buildings within that area. For this reason and the insufficiency of trunk mains the supply is nearly always defective on the upper floors, and at times, when the draught is largest, fails altogether. The city south of South street takes its supply from the Corinthian Basin, passing directly through the old city down Broad street. This 30-inch Broad street main alone is unable to deliver the amount of water needful to meet the large and rapidly increasing requirements of the lower wards, owing to its length and insufficient diameter, and the average pressure is about ten or eleven pounds only. It is proposed to improve the condition of affairs in both districts, by increasing the capacity of the trunk mains and making an exchange of Basins, transferring the old city proper to the Corinthian Basin having an elevation of 120 feet, and letting the southern district draw directly from Fairmount through a new 48-inch main down Twenty-second to South street. As the construction of the Baltimore and Ohio Railroad on Twenty-fourth street past the Fairmount Basin cuts off temporarily all the mains leading from it and compels extensive alterations in their position to enable them to cross the tunnel with sufficient cover, advantage has been taken of the opportunity to arrange the work with reference to the proposed redistribution, and this is now in progress.

In preparing the estimates for 1886, the entire subject was considered and the cost of the most urgently-needed mains was included in the sum asked for this purpose. In brief these are as follows: The 48-inch from Twenty-fourth and Pennsylvania avenue to South street *via* Wood and Twenty-second; on South street a 30-inch from Twenty-second to Broad and thence to Front a 20-inch; a 20-inch on Dickinson from Front to Broad; cost of above about $240,000. These mains are for the supply of the city below South street. Others will be required, in order to furnish intersecting trunk mains, of larger dimensions than the regular 6-inch service mains. In providing for these, 12-inch and 20-inch should be put in every three to six squares. For the old city, between South and Vine streets, changed from Fairmount to Corinthian, the following: The Broad street main, now supplying below South, to be connected to supply the old city; a 30-inch main on Twenty-fourth street, from Fairmount avenue to Pennsylvania avenue. A 48-inch main is also needed from the Spring Garden Pumping Station to Callowhill *via* Pennsylvania avenue and Twenty-fourth street. The uses of this main, which has not heretofore been projected, are important. It will enable the Spring Garden Station to pump either to Fairmount or Corinthian, or, in case of need, to supply either the Old City or the Southern District by direct pumpage. Market street should have a 20-inch main from Broad to the Schuylkill, in place of two 6-inch; and also in West Philadelphia, from Thirty-eighth to Fifty-second, to connect the two trunk mains from the Belmont Basin. The cost of the above will be about $200,000. For a proper supply to the heavy manufacturing area, including the Sixteeenth, Seventeenth, Eighteenth, Nineteenth, Twenty-fifth, and Thirty-first Wards, numerous large mains are absolutely necessary. The water requirements are not only large and important, but rapidly increasing, and the district is practically without trunk mains unless two 18-inch mains can be called such.

In planning new mains upon the city map, it has been sought to take the best advantage of the existing arrangements and provide for two sources of supply, in case of accident to one. Twelve-inch mains are projected for the following-named streets; Emerald, Amber, Tulip, Girard avenue, Front, and Gaul; 20-inch mains for Girard avenue, from Front to Otis; Filmore, from Lehigh avenue to Cumberland; Cumberland, from Filmore to the canal; Frankford avenue, from Foulkrod to Kensington avenue, and Kensington to Lehigh avenue; Jefferson street, from Front to Ninth; Front street, from Girard to York; and Kensington to Lehigh. The above will cost say $240,000. There should be a 48-inch pumping-main from the Spring Garden Station to Lehigh avenue, near the proposed Cambria Basin, *via* Thirty-third and Hunting Park, and thence to Ninth street; a 36-inch on Lehigh from American to Kensington, and a 30-inch thence to Cedar street. The above will cost $400,000. The difficulty in delivering an adequate amount of water to the Twenty-eighth Ward and eastward is increasingly large, and considerable expenditures for supply and distributing mains are already urgent, and will shortly become imperative. The pumping main up Hunting Park avenue to Lehigh can hereafter be used to fill the Cambria Basin when completed, and meanwhile its prolongation eastward on Lehigh avenue will furnish a large body of water at a high elevation for the supply of the direct pumpage area.

The total amount asked for mains in the estimates for 1886 is $1,050,000. This by no means includes all the mains that are needful, nor even those which are now required. Selection has merely been made of the most urgent. The quite desirable main from Wentz Farm basin to Kensington has been elsewhere referred to.

In the proposed distribution last year of the surplus of Gas Loan No. 9, the necessity for these mains was overlooked, and such sums as were allotted to the Water Department, provided for beginning the construction of the Cambria basin, renewing work on the East Park reservoir, and replacing more of the old small mains now in the ground. It is manifest that without mains the Basins would be of little service; that the mains are needed in any event, and their laying would be at once productive of benefit, while at the rate at which funds were proposed for reservoir construction at least three years would elapse before any improvements could be realized. Meanwhile the existing shortage would continue and augment in severity. I therefore recommended that the mains be first provided for, and the reservoir construction deferred until larger appropriations could be made.

A partial re-arrangement of the Purveyors' Districts is desirable. At present the First District covers the pipe sytem below South street with its office at Twelfth and Wharton. The Second District includes the old city and West Philadelphia, with its office at Ninth and Cherry. This is an arrangement of long standing and should be changed. West Philadelphia has now a large population covering an extensive area, and its own practically independent water system; it should therefore constitute a Purveyor's District by itself and be no longer an appendage to the old city with the Purveyor's office so far removed.

To effect this without increase of cost to the Department, it is only necessary to transfer the old city to the First District, which would then include the city south from Vine street between the two rivers, and make West Philadelphia the Second District. Even thus enlarged the area of the First District would be much smaller and less difficult to administer than any of the others, and the withdrawal of the Purveyor's office from joint use of the Department shop at Ninth and Cherry, would add greatly to the value of the shop for Department purposes, by affording needful space.

Another matter of minor but considerable importance is that of providing suitable Purveyors' yards for the storage and protection of pipes and other material. In none of the Purveyors' Districts are the yards of proper accommodation, and the Fourth District in particular, the most important of all and handling the largest amount of material, has been moved from pillar to post by the repeated sale or other disposition of the ground occupied—until for the past year it has almost been literally in the street. I have pressed this upon the attention of the committee for a year or more, and the situation is become such as to cause serious inconvenience and disadvantage to the service. Unless some provision can be made it may become a matter of consideration to convert the Spring Garden Basin into a yard for the Fourth Purveyor. It would make a very good yard, and is of little use as a Basin as it contains less than 10 millions of gallons and can be pumped full in half a day by the Cramp engine at the Spring Garden Station.

THE SHOP.

The operations and work of the Department Construction and Repair Shop will be found in the report of the Superintendent. Its service is of great value and in fact indispensable to the Department, by enabling special work and repairs to be carried on without loss of time by instructed men. I have nothing to add to my previous recommendations beyond the statement that the growth of the Department business is adding increased urgency to the need for less limited facilities than at present exist. This can be readily accomplished if as I have recommended, the Second Purveyor's office be removed and the shop enlarged to meet present requirements. An expenditure of about ten thousand dollars would accomplish this. Suggestions to establish the shop elsewhere have been considered, but my judgment is that the present location is as convenient and favorable to its special work as any other, and the transfer elsewhere of the Purveyor's office and yard would leave ample room for the needful enlargement.

As will be seen from the report, the amount of work done during 1885, as in the other branches of the Department, largely exceeded that of previous years; and Mr. Courtney, who was for many years foreman under the late Superintendent —now Magistrate Neall—and who received his promotion upon the retirement of the latter, has shown himself to be a worthy successor to a valuable and efficient officer.

IMPROVEMENT OF THE PRESENT SUPPLY.

Supplementing the efforts elsewhere referred to, to increase the quantity of water delivered to individual consumers for their several needs by effecting such improvements as were practicable in the pumping and distributing appliances and the general methods of administration, earnest endeavor has been made to suppress or at least mitigate the most immediate and serious causes tending to affect injuriously the potability and wholesomeness of the water supply.

The pumpage from the Delaware River, at the Kensington Station (Otis street wharf), was bettered by extending the intake from the head of the wharf to the channel, and the situation has been perhaps still more improved by limiting as much as possible the amount of water taken at this point.

For the Lardner's Point supply little could be done, and in fact it has been conclusively shown by the analyses and reports of Prof. Leeds, confirmed by those of Professors Mallet, Wormley and Greene, that the Delaware water at Lardner's Point though taken from the tidal section into which is poured the entire sewage of Philadelphia, Camden, and the up-river towns to Trenton, contains less unoxidized sewage and is a better water than the Schuylkill—even at its most favorable point whence the Philadelphia supply is pumped, viz.: the Roxborough Station above Flat Rock dam.

As 90 per cent. of the water used in Philadelphia comes from the Schuylkill and nearly 80 per cent. from the three principal stations, Fairmount, Spring Garden, and Belmont, at points affected by numerous local sources of contamination, attention was directed to the betterment of these conditions so far at least as the most detrimental pollutions were concerned. Full statements of all facts determined, after careful investigation, were printed in the Annual Reports of 1883 and 1884, and need not here be repeated.

It was shown that apart from the general impairment of quality due to the large and increasing population and industries of the valley using the river as a conduit for waste matters of every sort, the grossest and most obvious contaminations—and, from their propinquity, the most dangerous, also—were occurring within the city limits, and in the Fairmount Pool itself, under the very eyes and noses of the public.

It was further shown that among the most objectionable and obtrusive of all were public sewers, with which the neighboring mills, breweries and domiciles had been either permitted or required to connect. In other words, that the great receiving basin of the city—to wit, the Fairmount pool, whence 80 per cent. of the entire supply is taken—was used in effect as a general cesspool for the riddance of the foulest and most deleterious waste matters; and that the city itself by permitting and participating in this violation of law and decency had in effect constituted itself the chief sinner.

The publication of these facts albeit familiar to many, naturally attracted attention and aroused discussion, much of it intelligent and discriminating, but some strangely enough acrimoniously directed not against the abuse itself but against the publicity given it, on the ground of the alleged possible injury to the general repute and interests of the city. It is somewhat difficult to understand the reasoning that regards the knowledge of an evil a greater evil than the evil itself, and would substitute for the suppression of a dangerous nuisance of great magnitude and long standing the suppression of public information of facts which the public is clearly entitled to have, and particularly when this information is indispensable to the abatement of the nuisance—but there is no difficulty whatever in determining what should be the course of an executive officer charged with the special duty and responsibility of maintaining and improving the water supply when such facts come into his possession. Whatever is needful to abate the evil must be done; and in a community so varied and extensive as this, where private and public interests by no means necessarily coincide, the opposition to remedial measures will invariably prevail until the latent power of public opinion is evoked. Such in fact has been the history of this matter.

The enactments of 1824 1828 and 1832, devised to guard the Fairmount pool from pollution, forbade under penalties the throwing or deposit in that part of the river Schuylkill which is between the dam at Flat Rock and the dam at Fairmount, any carrion or carcass any excrement or filth any offal or noxious matter or any matter or liquid from any dye-house or manufactory calculated to render the water of said river impure.

These judicious enactments for the protection of the public health have remained dead letters upon the statute books, and when in 1868, it was sought to revive them with increased penalties and enlargement of scope from Flat Rock to Norristown, the manufacturing interests affected united in a successful effort to prevent it. The arguments and statements then made are still of interest. It was represented that nearly 100 manufactories, with invested values of $36,000,000, producing annually $24,000,000, employing 10,000 people and supporting 40,000, would be threatened with destruction to the great loss of the city itself.

"The committee" (of manufacturers) "are fully persuaded "there is no other river in the world one hundred miles in "length, that drains a country so supplied with all the re-"sources essential to the development of a great manufacturing "district," which "would if undisturbed, make the Schuylkill "Valley second to none in the Union in wealth and pros-"perity."

The Committee "assert without hesitation that no artificial "drainage can ever be efficiently substituted for the natural "bed of the Schuylkill River, and that from the sewers of "Manayunk, from the tow-paths and roads along its shores, "from the drainage of the vast cemeteries on its banks and "from the gutters of city streets, there is a vastly greater "amount of filthy animal matter thrown into the river than "from all the operations of the manufacturing establishments."

The Committee therefore urge the retention of the river as the natural drain, deprecate the construction of an intercepting sewer as costly and uncertain, and suggest instead the laying of a main from Flat Rock to Fairmount.

They earnestly "appeal to the Legislature to protect them "in the pursuit of their avocations, and to forbid any inter-"ference therewith by doubtful experiments to purify the "Schuylkill river instead of securing a supply of pure water "free from the possibility of contamination.

"In conclusion the Committee leave the question of an in-"creased supply of water to be determined as the necessities "and development of the city may require, without detriment "to the industry of the Schuylkill valley, which is as essential "to the growth and prosperity of the city as the supply of "pure water to the health of its inhabitants."

It must be admitted that the case of the manufacturers was ably stated and that their arguments are such as to entitle them to consideration, although the requirements of the situation have since far outgrown the means of amelioration they suggest. Their reasoning upon the general subject is just and strong. The Schuylkill is an industrial valley, whose prosperity and development are vital to those of the State and city and should not be hampered or destroyed. The construction of intercepting sewers throughout its length would be costly beyond possibility of contemplation; and the obvious conclusion to be drawn is that ultimately the Schuylkill must be abandoned as a source of water supply. The objections however against an intercepting sewer between Flat Rock and Fairmount are not so well taken. Its cost need not be excessive nor its usefulness doubtful. Even were our water supply no longer taken from the Fairmount pool, it is too valuable a portion of the Park to be abandoned altogether to base uses. Furthermore, since the securing of a new and more distant supply would in any case involve large expenditures and some years of construction, it was of the utmost importance that during the necessary interval the public health should be protected by the rigorous exclusion of dangerous matters.

The proposition to lay a water conduit from Flat Rock to Fairmount, which has since been revived from time to time, would be of no avail. In order to supply the two stations, Spring Garden and Fairmount only, it would have to be of greater dimensions and cost than the sewer, and in addition involve compensatory damages to the Flat Rock water power, would continue the Fairmount pool as a cesspool and force the Belmont Station to supply West Philadelphia with worse water than before. But in fact, the water from Flat Rock is not so much superior to that at Fairmount as to justify such sacrifices to secure it. The general contamination above Flat Rock is clearly manifested in the analyses, and even as shown in the Chemists' Reports, procured for the purpose of establishing its purity, is inferior to water taken from the Delaware river at Lardner's Point, one mile above Bridesburg, and past which, on the flood tide, pours the diluted sewage of the entire city. This comparison, established by unquestioned authority, is conclusive against the proposition. It also constitutes a caution against anticipating too much from the completion of the intercepting sewer. As originally planned, this sewer was to be 7 feet in diameter and capable of receiving and transporting below Fairmount Dam the entire waste flow from the eastern shore of the river from above Manayunk. Although designed primarily for the betterment of the water supply, the Water Department was not in any wise consulted as to its plan or dimensions, and as now under construction its diameter has been reduced, injudiciously as I believe, to 4½ feet at its lower terminus and 3 feet at the upper, so that a portion only of the drainage of Manayunk and points below can be received and diverted from the pool. To the extent to which it shall be made to intercept sewage and mill waste, it will undoubtedly be of advantage, but it will be unable to intercept large amounts of deleterious matter, and by no means be capable of doing all that is needful for the purification of the river.

The measures taken to purify the supply during the year 1885 were as follows:

In consequence of the public agitation of the snbject Councils adopted a resolution on January 29, directing the Chief Engineer of the Water Department to serve personal notice upon all persons dumping refuse or discharging water-closet drainage into the river to cease doing so within 30 days upon penalty of legal proceedings against them. It will be observed that the prohibition was limited to water-closet drainage and the dumping of refuse, thereby leaving the entire volume of factory and other waste untouched. The results are given in the appended report from the Assistant Engineer, from which it may be seen what very moderate measures it was possible to take under the authority given.

It is also proper to state that upon the discovery that the Department was including premises having connection with the sewers which themselves discharged into the Pool, Councils, upon the recommendation of the Water Committee, came within an ace of withdrawing the notifications upon the ground that the owners had already incurred the expense of making the connection.

In all, full or partial compliance with the notifications was secured in 130 cases—3 in West Philadelphia, 4 on the Wissahickon, and the rest in Manayunk and the Falls of Schuylkill—mainly in the interception of water-closet drainage only. In several cases manufacturers employing a large number of hands, protested against the interference with their arrangements, although it was shown them that the necessary interception of urine and excrement could be effected at slight expenditure and even be made profitable by utilizing the material. The opposition to changes was almost universal and few acted with any willingness. As usual the city was among the most stubborn. The Manayunk Fire Station had a special drain into the canal, which was cut off and a vault built, but the two police stations at Manayunk and the Falls—the former having connection with the public sewer—failed to comply with the requirements of the resolution of Councils.

In addition to the cases reported by Mr. Barber, the Park Commission, of which the Chief Engineer of the Water Department is a member, instructed the Superintendent to see that the drainage from the Park restaurants and buildings did not reach the river but was intercepted in cesspools which should be cleaned from time to time.

The case of the old sewer discharging under the Girard Avenue Bridge is instructive as illustrating the difficulty of dealing with such matters and securing results.

In 1882 Councils ordered the abandonment of this sewer, which drained Brewerytown and had its outlet into the river in close proximity to the Spring Garden Station, and which for years had been protested against as a dangerous and indefensible nuisance. No effective action having been taken by the Survey and Law Departments I reported the matter to the Board of Health, which after inspection, promptly ordered its abatement. As some of the users of the sewer paid no attention to the order the Board had the sewer closed by interior bulkheads. These did not entirely prevent flow, as the walls of the sewer were so open that the sewage passed out and in again around the bulkhead, but as the contents were partially backed up into the cellars of certain premises continuing to use the sewer, the owners secretly sent men in and had the bulkheads broken down, thus restoring the former conditions and clearing their premises of the accumulated sewage.

WELLS AND PUMPS.

While endeavoring to mitigate the pollution of the public supply investigation was also made by means of the Department Inspectors into the number of pumps and wells from which other than city water was taken in the built-up portions of the city and within the reach of city water pipes.

The results were communicated in March, 1885 to the Board of Health in the accompanying letter, with detailed statements. The synopsis shows that in 19 wards the ground water was drawn from over a thousand pumps, wells, etc., for the domestic supply of nearly 1,500 premises, 1,320 of which were within reach of the city mains—and these figures by no means include all.

The circular of the Board of Health dated April 28th, contains in the report of its Sanitary Committee, so concise and clear a statement of the fundamental facts relating to the use of city wells as to warrant its reproduction.

The Board declared nuisances all pumps and wells taking ground water within the built-up portions of the city, and ordered that they be abandoned and filled with clean earth. In these cases also much opposition was developed—so difficult is it to convince people that their safety requires them to abandon the use of a cool, clear and attractive fluid which they have been accustomed to regard as far superior to the tepid and cloudy water of the public supply. So far as I am advised, about thirty wells supplying fifty or sixty families, have been closed and the health officer proposes to continue the work.

Philadelphia Water Department.

March 28, 1885.

To the Board of Health
of the City of Philadelphia:

GENTLEMEN:—I present herewith a list of the pumps, wells, and other sources from which other than city water for domestic purposes is derived, as compiled from reports by the Department inspectors.

The tables include figures from nineteen wards, the remaining wards having been returned as furnishing no data of this kind. The position of each pump, well or other source of supply is given, followed by the number and location of properties dependent upon each pump, etc., and a note whether they are within reach of the city pipes or upon a street in which there is no pipe.

The recapitulation shows in nineteen wards (excluding, as explained above, the 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 13th and 14th,) a total of 1,478 properties whose occupants seem to rely wholly or in part upon other than city water for domestic use, drawing their supply from 1,066 pumps, 13 wells and nine so-called "springs," etc. Of these pump-users, 1,320 houses are upon streets in which city pipes have been laid, 158 upon streets in which there are at present no city pipes.

A noticeable feature of this exhibit is the very large percentage of premises relying upon the pumps on streets where public pipes are accessible. There is, besides, a large number of families, in summer especially, who resort to the pumps for a cooler or more attractive beverage than the city water.

In a few cases a marginal remark is quoted from the inspectors' reports touching the quality of the water, but inspection by your Board will doubtless develop the fact that owing to their surroundings, most, if not all of these wells are nuisances prejudicial to the public health.

Respectfully,

WILLIAM LUDLOW,

Chief Engineer.

Pumps in the built-up portions of Philadelphia:—Recapitulation from reports of Inspectors of the Water Department, March, 1885.

Wards.	Pumps.	Wells.	Streams, "springs," rain water, canal, etc.	Houses dependent on said pumps, etc.	Accessible to pipe in street.	No pipe in street.
First	2	....	....	2	1	1
Second	None	None	None	None		
Third	"	"	"	"		
Fourth	"	"	"	"		
Fifth	"	"	"	"		
Sixth	"	"	"	"		
Seventh	"	"	"	"		
Eighth	"	"	"	"		
Ninth	"	"	"	"		
Tenth	"	"	"	"		
Eleventh	"	"	"	"		
Twelfth	1	....	....	15	15	
Thirteenth	None	None	None	None		
Fourteenth	"	"	"	"		
Fifteenth	12	1	....	27	17	10
Sixteenth	1	....	....	1	1	
Seventeenth	1	....	....	2	2	
Eighteenth	14	....	....	21	14	7
Nineteenth	21	....	....	24	22	2
Twentieth	6	....	....	7	7	
Twenty-first	77	7	9	255	180	75
Twenty-second	41	....	....	40	35	5
Twenty-third	308	....	....	310	306	4
Twenty-fourth	277	....	....	386	363	23
Twenty-fifth	156	3	....	173	161	12
Twenty-sixth	14	....	....	14	9	5
Twenty-seventh	58	1	....	88	85	3
Twenty-eighth	57	1	....	90	84	6
Twenty-ninth	14	....	....	17	13	4
Thirtieth	1	....	....	1	1	
Thirty-first	5	....	....	5	4	1
Totals—nineteen wards	1,066	13	9	1,478	1,320	185

Order of the Board of Health in relation to Wells in built-up portions of the City.

Office of the Board of Health.
Philadelphia, April 28, 1885.

Report of the Sanitary Committee on the polluted water of pump-wells, draw-wells, etc., and the action of the Board of Health, declaring such wells nuisances, prejudicial to public health, and ordering their removal.

"Beneath the surface of the ground, at variable depths, there exists a body of water, the so-called 'ground water,' derived from the rainfall, which soaks into the ground and collects in a deposit of gravel or other pervious material overlying a bed of rock or other impermeable stratum. From this subterranean sheet of water, pump-wells and draw-wells receive their supply, and the quality of the water obtained will depend on the quality of the ground water. The ground water beneath a town or city is always more or less polluted by the foul soakings from cesspools or privy-wells, from sewers and drains, from graveyards, etc. The most dangerous source of contamination is the leaching cesspool or privy-well. These receptacles of filth are usually constructed with porous sides and bottom, so that the liquid sewage shall escape into the surrounding soil. This liquid matter passes down, like the rainfall, and mixes with the main body of underground water, from which pump-wells obtain their supply. At a very low estimate, there are at least 50,000 cesspools or privy-wells in this city, and these, together with miles of leaking sewers and drains, and numerous graveyards, are constantly discharging foul organic matter into the bed of water underlying the city, which, under these circumstances, cannot be otherwise than polluted, and therefore no precautions that may be taken in sinking wells will enable a safe supply of water to be obtained. It is no argument in favor of the wholesomeness of water derived from city pumps, that people have used this water without, apparently, any disastrous results. It is an undeniable fact, that very impure water may be used for an indefinite period without such consequences. But should the seeds of disease, the so-called 'disease germs' gain access to the water —an occurrence which may take place at any time from infected matter discharged into the soil—a local outbreak of disease would be inevitable, as may be inferred from the examples in point, of the celebrated Broad street pump in London, and the Van Brunt street well in Brooklyn, in both of which cases a local outbreak of cholera was caused by people drinking the water of the well, which had become infected by cholera excretions."

"There can be no doubt that each of the very many wells reported to your Board may at any time become a focus for the spread of disease, and therefore all wells situated within the built up portions of the city should be regarded as dangerous to the public health, and should be removed without delay. Your committee would therefore respectfully recommend the adoption of the following resolution:"

"'*Resolved*, That all pumps and wells from which other than city water for domestic purposes is derived, located within the built-up portions of the city, be, and they are hereby declared nuisances, having a tendency to endanger the health of citizens, and that notice be served on the owners or agents of premises on which such pumps or wells are located, or of premises on the sidewalks of which such pumps or wells are located where the city water pipes are accessible, to abandon the same within thirty days, by filling them with clean earth; and on failure to comply with this order of the Board, the Health Officer be, and he is, hereby directed to abate the nuisances in the manner indicated, and in conformity with law and the rules of the Board.'"

By order of the Board of Health,

WM. P. TROTH,

Chief Clerk.

AËRATION.

The results of the application of the aëration process to the supply of West Philadelphia are of great interest. This process is effected by pumping air into the rising main at the station, whence the intimately commingled air and water pass to the basin under the pressure due to the diminishing head. The injection of 20 per cent. by volume at atmospheric pressure of air into the mains produced a surcharge of oxygen which did not succeed altogether in freeing itself in the open basin but passed into the distributing mains and made itself manifest at the faucets in the houses. In some cases a freshly drawn goblet of water was as white as milk for a minute or two—the globules snapping off the surface and crowding the sides of the glass. This phenomenon occasioned apprehension as to its cause in some instances until explained.

The chemical effect of the aëration, as ascertained by comparing the water at the intake and the upper mouth of the main, was to reduce the Free Ammonia 76 per cent., the Albuminous Ammonia 40 per cent., eliminate the Nitrous Acid, diminish the total solids, and increase the total gases 22 per cent.

I regret that it has not been practicable to operate aërating plant at all the other stations, but the pumping in of a surcharge of air might endanger the stability of a weak or badly laid main or get it air-bound at summits where no provision had been made to relieve the pipe. The operation would be of greatest advantage at Spring Garden, but to pump air into the distributing mains and thence to the service-pipes would introduce complications and possibly cause disaster. Until some reforms are effected in this direction full use of the aërating system cannot be made, but an air-compressor might be put in at Roxborough with great advantage to the Germantown and Mt. Airy supply.

Filtration.

The elimination from the present supply of the large amount of sediment which it bears would be advantageous for many reasons. The mud and silt clog the mains and pipes, destroy the appearance of the water, injure it for domestic and numerous industrial uses, and tend to the formation of scale in boilers.

To accomplish this however would involve a heavy outlay, whether for filtering machinery or basins. The plant to filter ten million gallons per day would cost $100,000, with large operating expenses in addition.

London, with an average supply double that of Philadelphia, has fifty-four subsiding reservoirs and ninety-three filter-beds of large capacity. The completion of the East Park Reservoir, the construction of the Cambria Basin, and the enlargement of the Mt. Airy Basin, would be of great benefit; and until these and other important expenditures for mains, etc., shall have been made, provision for filtering appliances is out of the question.

Report of the Assistant Engineer on Suppression of Pollution.

Philadelphia Water Department.
January 13, 1886.

Col. William Ludlow,
Chief Engineer:

Sir:—I have the honor to submit the following report of the operations of the Department during the year 1885, in connection with the suppression of the pollution of the Schuylkill by water-closet drainage and solid refuse.

By resolution of Councils passed January 29, 1885, the Chief Engineer of the Water Department was authorized and directed to serve personal notices upon all parties guilty of discharging water-closet drainage into the river Schuylkill, and to parties dumping refuse into the river that if the same were not stopped within thirty days of said notice legal proceedings would be instituted against them.

In accordance with this resolution I was directed to report the names and addresses of all persons guilty of such offenses within the city limits between Fairmount and Flat Rock dam. My previous investigations of pollution had been chiefly confined to manufactories and other sources whence waste matters were discharged directly into the river or a tributary, or a short private sewer, and no examinations had been made to determine how many and what dwellings had connection with the public sewers.

The latter proved somewhat difficult especially in dwellings occupied by tenants, since the connections were almost always with a leaching cesspool or vault; unless the connection had been made within the occupancy of the tenant he was often ignorant of the fact and inspection was difficult. To facilitate the investigation the Mayor, at your request, granted me the assistance of the police, who were of much service at Manayunk and Falls of Schuylkill on account of their intimate knowledge of the locality and acquaintance with the people.

On February 13 I submitted a list of one hundred and two owners of one hundred and twenty one properties to which the resolution applied. Subsequently thirteen more owners of nineteen properties were reported, making a total of one hundred and forty premises. Seven were mistakes and suspected cases which could not be proved without great expense, leaving one hundred and thirty-three—all in Manayunk or Falls of Schuylkill except four on the Wissahickon and three in West Philadelphia. Of this number eighty-three were dwellings, twenty-eight manufactories, four hotels, nine stores and shops (independent of dwellings), one school, two offices, two halls, one railroad station, two police stations, and one fire-engine house.

Of the twenty-eight manufactories nineteen were discharging water-closet drainage into the river, five were dumping solid refuse into it, and four were doing both. The dwellings and all other classes were charged with water-closet drainage only.

Of the 83 dwellings 30 had direct connection with the public sewers, 25 with a culvert discharging into a public sewer, 21 with culverts or brooks discharging into the river or canal, three with the canal directly and four with the river directly.

Of the four hotels one had direct connection with the river and the rest with Wissahickon Creek—all in Fairmount Park.

The school was a Catholic academy for young ladies, above Chestnut Hill, having drainage into the Wissahickon.

Of the nine stores and shops, eight were discharging fæcal matter directly into the canal at Manayunk and one into a culvert at the Falls.

The two offices were connected with the public sewers of Manayunk. The two halls were the Odd Fellows' at the Falls, having privies beside a culvert near the river, and the Masonic at Manayunk having water closet connection with the public sewer.

The Railroad Station was that of the Philadelphia and Reading Railroad at Manayunk, having drainage by sewer to the river.

The police stations were the sub-station at the Falls, occupying the Odd Fellows' Hall building, and the Manayunk station having connection with the public sewer.

The fire engine house was in the upper part of Manayunk and had a special drain to the canal.

The notices were served personally on the owners or their representatives by an inspector of the Department, beginning February 20.

Thirty days after the notice was served I reinspected each place to ascertain if it had been complied with, with this result:

All the manufactories which had been dumping solid refuse into the river had apparently complied for the time being. Of the 23 manufactories discharging water closet drainage into the river, 17 had complied and four more expressed an intention of doing so shortly, having found it inconvenient for one reason or another, to make the change in the 30 days allowed.

Of the 83 dwellings, 43 had complied—13 being of the class which had direct connection with the public sewer and 20 of the class connected with culverts discharging into public sewers—and five more had promised. The school had not satisfactorily complied but promised to do so.

The notice had been complied with at three of the nine stores and shops and one of the offices. At the two halls, the Railroad Station, and the two police stations the required correction had not been made. At the fire engine house the notice had been complied with.

The most common excuse for non-compliance in the specified time was the difficulty of digging vaults in the deeply frozen earth, as that was the most common resort of those having privies over a stream or water closet connections with a sewer, and having no vault or cesspool. Yet many did proceed in spite of the frost to construct vaults. Others having privies over vaults in the yard in addition to direct connection from water closets in the house to the sewer, could comply more easily by cutting off the latter connection. The most common method however among houses connected with the sewer was by a drain from a privy vault into which was discharged the domestic waste-water. In this case it was necessary to divert the water to the sewer direct and close the outlet of the vault.

Those who had not complied at the end of thirty days and manifested an intention to do so as soon as the severity of the weather abated or some other hindrance was removed, were asked to name a day when it would be completed. I then re-inspected the place again, and if still unfinished made a new appointment. Thus many places were visited several times. Gradually it became apparent who intended to comply and who were not inclined to; and when none but the latter remained, I submitted a list of twenty-one names, covering thirty-four premises of persons who evinced no disposition to comply with the notice.

These were referred on May 2 to the City Solicitor, who on May 7 sent notices to each, threatening that unless the nuisances complained of should be wholly abated within one week he would cause warrants to issue for their arrest or place the matter in the hands of the Board of Health for summary action by them. Later two more names were referred and like notices sent on May 19.

Sixteen of these notices were heeded and the nuisances abated within one week. Three others were begun within the week and completed shortly after; and one person made the correction a few days later, leaving three nuisances not abated and still in the City Solicitor's hands.

In the majority of cases the correction was not properly made though complying, perhaps, with the letter of the law, inasmuch as leaching cesspools within a few feet of the river, canal, culvert, or brook, were generally substituted for direct drainage into the same.

In six cases (five stores, belonging to one man and a mill to another) the privies were securely fastened up and the tenants and employés told to go elsewhere. In these cases especially it will be an easy matter to return to the old practice unless the places are closely watched.

Very respectfully,

DANA C. BARBER,

Assistant Engineer.

Report upon the Water Supply by Professors Mallet, Wormley and Greene.

This report constitutes so important a contribution to the work of the year and the literature of the subject as to warrant its incorporation herewith. Its value is the greater that it was specially procured, independently of the Department investigations (which the authors were instructed to disregard), for the purpose if practicable of securing a clean bill of health for the Schuylkill River and of supporting the statements of those who for business reasons loudly maintained its purity and were indignant that its excellence should be questioned.

Under these circumstances, it was fortunate for the community that the judgment of the gentlemen to whom the investigation was entrusted could not be warped by the manifest purpose of its promoters. And yet there was an element of uncertainty by which the advocates hoped to profit and to which reference will be made later.

It should be understood that in making chemical analyses of water, it is first carefully filtered and thereby purified of its visible sedimentary and a portion of its invisible foreign matters. What remains therefore are the dissolved and permanent ingredients, and these it is that the chemist reports upon. It is also understood that the sediment in the Schuylkill water (which is never entirely clear and is frequently extremely turbid), is one of the principal sources of complaint and indeed popularly the main one—as it affronts the eye, soils clothing and befouls vessels. But with this element of dissatisfaction the chemical analysis does not deal. It simply examines the filtered water, and if comparisons are desired compares one filtered water with another.

Even under these circumstances the investigation in question so far from establishing the purity of the Schuylkill, found that the evidence of pollution going on within the city limits was very apparent from the progressive degradation of the water taken at successive points. The report adverts to the importance of excluding sewage and foul drainage of any kind, and points out how such matters furnish pabulum for germs of noxious organisms. The spread of cholera by this means is referred to in tones of earnest warning. In comparing the several samples examined, the report distinctly finds the best of the Schuylkill waters, viz.: at Roxboro, even after partial oxidation in the basin, inferior to the water taken from the Delaware River at Lardner's Point and pumped into the Wentz Farm Basin. Comparing Philadelphia water with that of other cities as analyzed some years since, the Philadelphia average appears inferior to those of Chicago and Baltimore, in some respects better than those of Boston and New Orleans, and not very far removed from the Croton of New York.

With regard to these comparisons, the following is of importance. The water of Lake Michigan barring an outpour of sewage from Chicago is probably the same the year round. This is also in great measure true of the Mississippi river whence New Orleans supplies herself. It is less true of the Croton of New York, and the Gunpowder of Baltimore; but nevertheless these streams are but slightly contaminated and are generally clear as well as wholesome. One of the most prominent characteristics of the Schuylkill is its marked and extreme variability. The minimum flow is less than one-sixth of its average flow while the maximum is several times greater. It follows that the sources of pollution being at their maximum in summer when the flow is at its minimum, the varying proportion of the two intensifies the natural variability in quality due to changes in volume. For this reason the water supply of the city varies with meteorological conditions and the seasons of the year, from very good to very bad with every sort of intermediate condition independent of sediment altogether. This is where the element of uncertainty previously referred to comes in. Any single analysis might furnish reasons for highly commending, or entirely condemning, the water; and averages, if such can be considered of any value, could only be secured by frequent and systematic analyses continued during at least one year and covering one entire cycle of changes. It so happened that when the samples analyzed by the Professors were taken, the river from recent rains was in fuller flow and better condition than usual in summer, and therefore the chemical results gave indications more favorable to the quality of the water than would have been found a few weeks later.

As a matter of fact it does not appear that a stream which is objectionable in quality for several months in the year is improved by a calculation of what its condition would be if averaged for the entire year. As the weakest link measures the strength of a chain, and as the rainfall of a minimum year must be taken as the estimate of water obtainable from a given area, so the worst condition of a water supply, unless this can be materially modified, must be accepted as the value of that supply.

It is obvious moreover, that other supplies being better or worse than the one under consideration is quite immaterial. It does not in the least benefit Philadelphia that some other city is worse off, nor improve the Schuylkill to establish the greater pollution of another stream, any more than the river can be purified by protestations, or sewage and mill waste gotten rid of by denying their existence. In these matters thorough ascertainment of the facts, clear comprehension of the requirements of the situation and candid acceptance of the duty imposed thereby, are worth all the tinsel patriotism and provincial declamation that can find utterance and auditors. What it is evidently essential to each city to do is to set itself resolutely to the solution of its own individual problem, and having accomplished this to the best of its ability, congratulations may ensue, and complacency and comparisons be in order.

REPORT BY PROFESSORS MALLET, WORMLEY AND GREENE IN RELATION TO THE WATER SUPPLY, WITH LETTER OF TRANSMITTAL BY CHIEF ENGINEER.

Philadelphia Water Department,
September 17, 1885.

To the Select and Common Councils
of the City of Philadelphia.

GENTLEMEN:—The report by Professors Mallett, Wormley and Greene in relation to the water supply of the city, which will be presented to Councils to-day from the Water Committee, so clearly indicates the necessity of protecting the Schuylkill River and in especial the Fairmount pool from pollution, and so strongly supports the several representations by this Department to the same effect, that it seems a fitting opportunity to invite the renewed attention of Councils to this vital matter.

The report is prepared by able men, and written with caution, as would naturally be the case in a question of such importance, especially when the conclusions must be derived from single analysis of a variable stream. The samples analyzed were taken between June 13 and 23 when the Fairmount dam, from June 1 to 20, showed an average of about twenty inches of water—the low water stage being about eight or nine inches. The samples therefore exhibit more nearly an average condition of the water than exists during the summer, when the pollution is at its greatest and the fresh water supply the least.

The main points of the report are, first, that chemical analysis alone cannot be relied upon to establish the character of a water supply, as disease germs may exist and quite elude possibility of discovery by this means; secondly, the progressive deterioration of the Fairmount pool from Flat Rock dam to Fairmount, due to the very apparent pollution going on within the limits of municipal authority; thirdly, the vital importance of excluding all sewage and foul drainage of any kind, and fourthly, the inferiority of the Shawmont (Roxborough) water to that taken from the Delaware at Lardner's Point. These conclusions, with the exception of the last, have been frequently and fully set forth in the Department reports, although the exhaustive investigations which have been in constant progress during the past two years have not warranted me in asserting that the Schuylkill at its best point, viz: Shawmont, must be regarded as distinctly inferior to the Delaware, above Bridesburg.

Nevertheless the comparative qualities of the Delaware water, as stated in the report, even though charged with the entire drainage of Philadelphia, Camden, and the towns above to Trenton, tend to confirm the views of this Department that an excellent supply could be taken from the Delaware above the influence of this pollution.

The recommendations of the report are mainly summed up in the following paragraph:

"A suggestion of practical value is furnished by the comparison of water from the lower or down stream pumping stations (as, for instance, Nos. V and VII) on both the Schuylkill and Delaware, with that taken from these rivers higher up. The evidence is very apparent of pollution going on within the limits of municipal authority. The importance of providing for the exclusion from the rivers, of sewage and foul drainage water of any kind, lies not merely in the direct consequent reduction in the amount of impurities in the water people drink, but to a much greater extent in reducing the chance of the living germs of noxious organisms finding their way into the water, there to be nourished by and render dangerous *dead* organic matter which of itself might be harmless enough. In the event of such an epidemic as one of cholera gaining but a first foot-hold in some parts of the city, this consideration would at once acquire a degree of importance scarcely to be overestimated."

The condition of affairs at Manayunk and the Falls of Schuylkill is such that no remedies are so practical and effective as the immediate completion of the intercepting sewer. During this year much less local pollution has occurred than usual, owing to the closing of numerous mills and the action taken by this Department to diminish the quantity of water closet drainage, but unless the health and convenience of the citizens are to be disregarded and the important local industries hampered or suspended altogether, it is incumbent upon the city at once to make provision for the proper drainage of these localities and intercept the torrents of foul matters which for a generation and more have been discharging into the Fairmount pool.

I therefore beg leave to renew the recommendation heretofore made, that out of any funds which may be, or become available for this purpose, the sewer be completed at the earliest possible date. Were this accomplished and other similar points covered, the city might rest in comparative security during the inevitable interval which must occur while the ways and means for a more ample and reliable supply for the future are preparing.

Respectfully,

WILLIAM LUDLOW,

Chief Engineer.

TO JOHN BARDSLEY, ESQ.,

Chairman of Sub-Committee of the Committee on Water of the Councils of Philadelphia.

SIR:—The undersigned, having been requested by you to examine carefully, by the best known chemical methods, samples of water from certain designated points of supply, have completed this work during the last few weeks, and now beg leave to report briefly and plainly as follows:

1°—Drinking water may be classed under three heads, as regards purity and wholesomeness.

First. That which is so pure that, as the result of a chemical and biological examination, it may be confidently pronounced *absolutely* wholesome and safe.

Using these words with their full force of meaning, it may be said that such water is practically not obtainable in such quantity as to furnish the supply needed by a large city.

Second. That which is so impure that, as the result of a like examination, it may be with certainty declared *absolutely* unwholesome and dangerous.

Usually such water gives warning of its character by easily observable signs, such as smell and taste, and is practically not found in use by large numbers of people, since it would soon attract attention by its marked effect upon health.

Third. That of intermediate character as to purity, in regard to which, in the present state of chemical knowledge, it is only possible, and will probably always remain but possible, to say, after an examination, that it is *comparatively* more or less open to suspicion, more or less likely to prove wholesome in use than some other water which has been examined in the same way. Practically the water supplied to the population of every large city falls under this third head.

2°—There is strong reason for believing that chemistry helps us in judging of the character of a water only in this imperfect and comparative way, because there is rarely present any substance which, by its nature and quantity, behaves as an ordinary chemical poison, as a noxious drug would. The progress of knowledge of late years points strongly to the real source of danger, consisting in the presence of certain exceedingly minute, even in the microscopic sense, exceedingly minute, living organisms, whose development and reproduction seem to be closely connected with the propagation of disease.

Precisely the same quantity of organic matter, as found by chemical analysis, may be perfectly harmless if mere *dead* organic matter, or may be highly dangerous if present in living form. Chemistry gives us no means of deciding whether the organic matter found is in the one or the other condition. Nor has our knowledge of these minute organisms, even when they are known to be present and living, advanced as yet far enough to allow of positively approving or condemning a particular water on the basis of microscopical examination and biological experiments with it. We know that many of the minute living forms found in ordinary water are practically quite harmless, including many of the largest and most conspicuous objects easily detected by the microscope. We know too little of the distinction of species, and too little of the different stages of development of the most probably dangerous, simplest, and most minute of these organisms, to be able to draw with any certainty the line between safety and danger. A water may be wholesome at one time, and at another become dangerous to health, without having perceptibly changed in composition, but having received from some source the germs of a noxious organism. Not only so, but probably the same water may even be wholesome at one time and dangerous at another, without either change of composition or introduction of new forms of life, the organisms already present having simply passed from a harmless to a noxious stage of development, as the moth itself, and the egg which it deposits, do not injure a piece of cloth, but in the grub or caterpillar stage, the same insect attacks the fabric.

3°—Assuming that the chief source of danger in drinking water is the presence, development, and reproduction of certain minute organisms, chemical examination may nevertheless help us to some extent, in determining whether or not in a particular water there be present in large or small amount suitable material for the nourishment of such organisms, and in proving whether or not there be present in large or small amount certain substances, especially the nitrites and nitrates, the production of which is known to be brought about by the presence of such organisms of at least highly suspicious character.

Ample proof of the above general statements may be found in a Report by one of the undersigned to the U. S. National Board of Health, on the methods in use for the examination of drinking water, contained in the annual report of the Board for the year 1882. Especially may evidence there be found that we cannot at present, on the basis of the most elaborate chemical, microscopical, and biological examination, pronounce *absolutely* upon the wholesomeness or unwholesomeness of a sample of such water as is actually used by large city populations, and also evidence of the frequent occurrence in more than usual amount of nitrites and nitrates* in water known or strongly believed to have caused disease, although in the largest quantity in which these salts have been found they are of themselves undoubtedly quite harmless, their presence being in all likelihood significant only as pointing to the presence at the time, or previously, of living organisms concerned in their production.

4°—If, then, the examination of the water of a city is to be of use, since we can discuss the results *comparatively* only, with what standard shall we compare them?

For such a standard perfectly pure water is plainly useless, since no such water is obtainable anywhere for the practical supply of a city.

We may adopt as the basis of comparison the purest water which *can* be obtained in sufficient quantity for any given city; but this opens up great questions of cost of procurement, distance to be overcome by aqueducts or other engineering works, possibility of preserving the water all along its course from future pollution, and other such considerations. We have neither been furnished with already determined facts of this kind, nor have we been asked to investigate the general question of water supply for Philadelphia from other sources

* The former of these may fairly be regarded with more suspicion than the latter, because representing the intermediate stage of change, whether nitrates are being formed by oxidation or destroyed by removal of oxygen, and therefore furnishing more probably evidence of changes actually in progress and connected with the presence of living organisms.

than those at present in use. Some chemical work has, we know, already been done in this direction for the Water Department of the City by Professor Leeds, of Hoboken, N. J.; but, as we have understood that an entirely impartial and unbiased report is desired from us, we have neither examined his results during the progress of our own work, nor referred to them in discussing the results we have ourselves obtained.

We may use as the standard of comparison such of the water in actual use in a city as is drawn from points where it is least likely to be contaminated by known sources of pollution, and so may be fairly supposed to be the best and most wholesome water attainable under the existing conditions of supply. Such a standard has been furnished us by the expressed desire of one of your Committee, that we base our comparison of the other samples examined upon that taken directly from the Schuylkill River at Shawmont, above the Flat Rock dam, and before passage through the pumps, reservoir or pipes.

Lastly, some use may be made of a comparison between the results obtained for the water of a given city, as here of Philadelphia, and those derived from the examination in exactly the same way of such water as is regularly supplied to the people of other large cities. The Report to the National Board of Health, which has been already referred to furnishes the means for this comparison in reference to the water supply of several of the principal cities of the United States.

5°—We have examined samples of water carefully collected at the following points :—

I. Directly from the Schuylkill River at Shawmont Water Works, before entering the pumps.

II. The same—a second sample, taken in consequence of there being a notable amount of suspended matter in the water on the day the first sample was obtained. It was supposed that this might cause the usual condition of the water to be misrepresented, though it turns out that some of the *dissolved* constituents were present in larger amounts on the second occasion than the first.

III. A hydrant in Manayunk, connected with and supplied from the Roxborough reservoir.

IV. A hydrant in the Medical Department building of the University of Pennsylvania, supplied from the Belmont reservoir, on which West Philadelphia depends.

V. A hydrant on Twenty-first street, supplied from the Fairmount reservoir.

VI. A hydrant in Frankford, supplied from the Wentz Farm reservoir.

VII. A hydrant in Kensington, supplied from the Lehigh Avenue reservoir.

Of the above samples, the first five came from the Schuylkill River and the last two from the Delaware.

6°—In the examination of these specimens of water we have applied *all* the well-known and carefully-tested methods, desiring to make the investigation as thorough and complete as possible, and, for greater security, nearly all the experiments have been made in duplicate. The action of potassium permanganate was applied at ordinary temperature, as practiced by Tidy. The exact details of the methods employed may be found in the report on such methods to the National Board of Health, which has been already referred to. These details have there been very fully investigated, and by adhering strictly to them it becomes possible to compare results directly with those of a long series of other analyses included in the report in question, amongst which are those of the water supply of other American cities. Bearing in mind the possibility of contamination of the Philadelphia water by traces of poisonous metals from certain geological sources or from manufacturing refuse, lead, copper, arsenic and mercury were tested for, but not a trace could be found of any of these.

As influencing the fitness of the water for cooking and laundry use, the "hardness," both before and after boiling, was determined.

7°—In Table I. are presented, in successive columns, the results we have obtained, the figures expressive of weights representing in each case the number of parts of each constituent in one million parts of the water, and the figures expressing volumes of gas representing cubic centimetres in one litre (or one thousand cubic centimetres) of the water.

For the convenience of those who may prefer to look upon a gallon as the standard quantity of water, and to use English instead of French metric weights and volumes, Table II. has been calculated from Table I., and gives the quantities by weight expressed as grains per gallon (of 70,000 grains), and the quantities by volume as cubic inches per gallon.

In Table III. are quoted, for comparison, the figures (expressed as in Table I.) quoted from the 1882 Report of the National Board of Health for the examination of the water supplies of Boston, New York, Baltimore, Washington, Richmond, New Orleans and Chicago, respectively.

8°—On looking over these results it will be seen that there has been found no inorganic or mineral substance which, of itself and in the quantity present, can be considered in any way harmful or seriously objectionable. The slight degree of hardness, due mainly to the sulphates of calcium and magnesium, can scarcely be looked upon as requiring notice in exception to this statement.

9°—As regards organic matter, or matter of organic origin, it is to be remembered that a minute proportion of such matter is normally present in all river water, and is not of itself necessarily injurious to health. This examination does not show the presence in any of the samples of Philadelphia water of so large a proportion of such matter as to be incompatible with the water being normal and wholesome. But it should not be forgotten that, as has already been stated, the organic matter in a water, though not necessarily of itself unwholesome, may become a source of real danger by furnishing the conditions for the development of disease-producing organisms, and this may be the case with a proportion of organic matter smaller than we have here found.

10°—Comparing the results for the water from the several reservoirs with those for the water in the Schuylkill river at Shawmont, assumed as the standard, and comparing the results for the different reservoir samples with each other, there is some difficulty in coming to a general decision, in view of the fact that the same water sometimes appears to better advantage in reference to one constituent and to worse in regard to another. But, balancing as well as we can these points of advantage and disadvantage, and interpreting the results in the light of the best knowledge attainable at present, we consider two of the samples as representing water of *better* quality than that of the Schuylkill at Shawmont, namely, No. III., originating from this same Shawmont pumping station, but having stood in and passed through the Roxborough reservoir; and No. VI., being Delaware water from the higher or up-stream of the two points of supply on that river, and furnished from the Wentz Farm reservoir. Of these two we consider the water from the Wentz Farm reservoir as the better. It may be questioned whether the superiority of the Roxborough reservoir water over that taken directly from its point of supply on the Schuylkill, is due to the reservoir having on the average been filled with water from the river when the latter was in better condition than on either of the days when samples I. and II. were taken, or is to be attributed to purification going on by the action of oxygen in the water while standing in the reservoir, but there is some reason to think that the latter is the true explanation.

On the other hand, we consider three of the samples as representing water *inferior* in quality to that of the assumed standard (Schuylkill river at Shawmont), namely, No. IV., from the Belmont reservoir, No. V., from the Fairmount reservoir, and No. VII., Delaware river water from the Lehigh avenue reservoir, these standing in the order in which they have just been named; No. IV. (Belmont) as least below the standard, and No. VII. (Lehigh avenue) as most objectionable.

11°—Comparing the results now obtained for the different samples of the Philadelphia water supply with those, quoted in Table III., for the regular or principal water supply of seven other important cities, we find that the figures of the former fall within the limits of those for the best and worst of the latter, though not holding a very high position on the whole. Thus the general conclusion, balancing advantages and disadvantages on particular points, would be more favorable for the water of Chicago and probably Baltimore (both as supplied in 1881), than for that of Philadelphia; but the contrary would be true for the water of Boston and New Orleans. The Croton supply of New York is not very far removed from the average of the Philadelphia supply; the best of the latter being rather above, while the worst is below the New York standard. Perhaps the water of Philadelphia presents itself least favorably in connection with the suspicious nitrites and nitrates, though the quantity of these is not very large.

12°—A suggestion of practical value is furnished by the comparison of water from the lower or down stream pumping stations (as, for instance, Nos. V. and VII.), on both the Schuylkill and Delaware, with that taken from these rivers higher up. The evidence is very apparent of pollution going on within the limits of municipal authority. The importance of providing for the exclusion from the rivers of sewage and foul drainage water of any kind lies, not merely in the direct consequent reduction in the amount of impurities in the water people drink, but to a much greater extent in reducing the chance of the living germs of noxious organisms finding their way into the water, there to be nourished by and render dangerous *dead* organic matter which of itself might be harmless enough. In the event of such an epidemic as one of cholera gaining but a first foothold in some parts of the city, this consideration would at once acquire a degree of importance scarcely to be overestimated.

13°—Finally, in relation to expansion of the present system of water supply for this city, it is worthy of note that, both on the score of inorganic and organic matter present, the water from the upper pumping station on the Delaware contrasts very favorably with that from the upper pumping station on the Schuylkill. Whether this superiority is always maintained, or merely represents a difference of condition on the particular days when our samples were taken, it would require further examination to decide, though it is not likely that the difference, on most points at any rate, is one of temporary character only.

We remain, sir,

Very respectfully, your obedient servants,

J. W. MALLET, M. D.,
Professor of Chemistry, University of Virginia.

T. G. WORMLEY, M. D.,
Professor of Chemistry, University of Pennsylvania.

WM. H. GREENE, M. D.,
Professor of Chemistry, Philad'a Central High School,
Member of Franklin Institute.

TABLE I.

Number of samples	I.	II.	III.	IV.	V.	VI.	VII.
Date of collection	June 16.	June 24.	June 20.	June 13.	June 23.	June 27.	June 30.
Collected at	Pumping Station, Shawmont.	Pumping Station, Shawmont.	Hydrant in Manayunk.	University of Pennsylvania.	Hydrant, on Twenty-first street.	Hydrant, in Frankford.	Hydrant, in Kensington.
Source of water	Direct from Schuylkill River.	Direct from Schuylkill River.	Roxborough Reservoir.	Belmont Reservoir.	Fairmount Reservoir.	Wentz Farm Reservoir.	Lehigh Avenue Reservoir.
Temperature of water	29.5°C.	27°	23.3°	22°	24°	22.5°	23.5°
Temperature of air	35°	28°	29°	25°	23°	29.5°	22°
Clearness or turbidity, as seen in two-foot tube	Distinctly turbid; comparatively coarse, suspended particles, consisting to large extent of fragments of vegetable debris, some living infusoria in active motion.	Slightly turbid; notably less so than I; suspended matter for most part finely divided; some coarse particles, as in I; some living infusorial organisms.	Slightly turbid; much more slightly than II, with suspended particles like those in II.	Very nearly clear.	Distinctly, though not very turbid; mainly finely divided matter; some coarser suspended particles, including a few infusorial forms.	Slightly turbid: suspended matter mostly in state of fine division, but visibly granular.	*Very faintly* turbid; suspended matter all in state of fine division.
Color, in two-foot tube	Light yellowish brown; between suspended particles nearly colorless.	Light brownish yellow.	Color much as in I, but lighter.	Very faint brownish.	Light brownish yellow.	Brownish.	Yellowish.
Odor when collected	Marshy on river; none in bottles.	Possibly less marshy on river than I.	None.	None.	None.	None.	None.
Odor after standing thirty-six hours	Marshy.	None.	Slightly marshy.	Slight, if any.	Resembling sea-beach.	None.	Feeble, resembling decayed wood.
Total solids	127	130	124	113	159	56.5	97

Table I—*Continued.*

Number of samples	I.	II.	III.	IV.	V.	VI.	VII.
Date of collection	June 16.	June 24.	June 20.	June 13.	June 23.	June 27.	June 30.
Loss on ignition	22	31	25.5	15	65.5	26	33.5
Phenomena on ignition	Blackens; charred wood odor; dull gray when cold.	Blackens; odor of charred wood, and possibly slightly nitrogeneous; gray when cold.	Blackens only for moment; same odor as I; residue gray when cold.	Brown; then black; faint nitrogeneous odor in charring; gray when cold.	Brown; then black; charred wood odor, somewhat like caramel; gray when cold.	Blackens; odor of charring; white when cold.	Brown; then black; odor of charring; grayish white when cold.
Chlorine	4	5	4.5	5	6.5	3	6.3
Sulphuric acid (as SO^4)	31.49	39.87	30.24	42.92	44.53	8.22	19.57
Combustion process. Organic carbon	3.78	3.51	2.54	2.37	4.26	3.77	4.06
Combustion process. Organic nitrogen	.88	.79	.55	.69	1.08	.65	.94
Combustion process. Sum of carbon and nitrogen	4.66	4.30	3.09	3.06	5.34	4.42	5.00
Combustion process. Ratio of carbon to nitrogen	4.3 : 1	4.4 : 1	4.6 : 1	3.4 : 1	3.9 : 1	5.8 : 1	4.3 : 1
"Albuminoid" ammonia process. Free ammonia	.050	.060	.026	.024	.026	Trace.	.095
"Albuminoid" ammonia process. Nitrogen of free ammonia	.041	.049	.021	.019	.021	Trace.	.078
"Albuminoid" ammonia process. "Albuminoid" ammonia	.220	.210	.120	.146	.160	.114	.120
"Albuminoid" ammonia process. Nitrogen of "albuminoid" ammonia	.178	.173	.099	.120	.132	.094	.099
Nitrogen of nitrites	.012	.012	None.	.002	.014	None.	.051
Nitrogen of nitrates	.278	.318	.400	.648	.346	.170	.031
Total inorganic nitrogen (NH^3, NO^2, NO^3)	.331	.379	.421	.669	.381	.170	.160
Total combined nitrogen (organic + NH^3, NO^2, NO^3)	1.211	1.169	.971	1.359	1.461	.820	1.100

Table I—*Continued.*

			I.	II.	III.	IV.	V.	VI.	VII.
Number of samples			1.	II.	III.	IV.	V.	VI.	VII.
Date of collection			June 16.	June 24.	June 20.	June 13.	June 23.	June 27.	June 30.
Permanganate process.		Oxygen consumed in one hour	.528	.696	.372	.384	.496	1.136	.840
		Oxygen consumed in three hours	.724	.904	.445	.552	.780	1.520	1.136
		Oxygen consumed in twenty hours	1.224	1.532	.668	.780	1.348	2.088	1.632
		Oxygen in one hour, as percentage on three	72.9	76.9	83.6	69.5	63.5	74.7	73.9
		Oxygen in three hours, as percentage on twenty	59.1	59.0	66.6	70.7	57.7	72.8	69.5
Dissolved gases.	By volume.	Carbon dioxide, c. c. per litre	1.99	2.80	3.33	3.03	3.94	1.59	3.06
		Oxygen, " "	4.34	5.93	3.37	4.91	5.04	5.29	4.49
		Nitrogen, " "	13.25	12.30	14.00	11.96	12.78	12.19	11.84
		Total volume, c. c. per litre	19.58	21.03	20.70	19.90	21.76	19.[illegible]7	19.39
		Oxygen as percentage on O+N	24.7	32.5	19.2	29.1	28.3	30.2	27.5
	By weight.	Carbon dioxide	3.94	5.53	6.57	5.98	7.78	3.14	6.04
		Oxygen	6.24	8.51	4.84	6.91	7.24	7.59	6.45
		Nitrogen	16.64	15.45	17.59	15.02	16.05	15.31	14.87
		Total by weight, mgr. per litre	26.82	29.49	29.00	27.91	31.07	26.04	27.36
Hardness before boiling ($CaCO^3$ mgr. per litre)			58.60	55.70	54.30	60.00	54.30	27.30	41.60
Hardness after boiling, " "			50.00	47.10	52.90	52.90	48.60	27.30	41.60
Poisonous metals: lead, copper, arsenic, mercury			None.	None.	None.	None.	None.	None.	None.

Table II.

Number of sample	I.	II.	III.	IV.	V.	VI.	VII.
Date of collection	June 16.	June 24.	June 20.	June 13.	June 23.	June 27.	June 30.
Collected at	Pumping Station, Shawmont.	Pumping Station, Shawmont.	Hydrant in Manayunk.	University of Pennsylvan'a.	Hydrant on Twenty-first St.	Hydrant in Frankford.	Hydrant in Kensington.
Source of water	Direct from Schuylkill River.	Direct from Schuylkill River.	Roxborough Reservoir.	Belmont Reservoir.	Fairmount Reservoir.	Wentz Farm Reservoir.	Lehigh Ave. Reservoir.
Temperature of water	85.1° F.	80.6°	74.9°	71.6°	75.2°	72.6°	74.3°
Temperature of air	95°	82.4°	84.2°	77°	73.4°	85.1°	71.6°
Clearness or turbidity, as seen in two-foot tube.							
Color in two-foot tube.							
Odor when collected.							
Odor after standing thirty-six hours.							
Total solids, grains per gallon	8.890	9.100	8.680	7.91	11.130	3.955	6.790
Loss on ignition, grains per gallon	1.540	2.170	1.785	1.05	4.585	1.820	2.345
Phenomena on ignition.							
Chlorine	.28	.35	.315	.35	.455	.21	.441
Sulphuric acid (as SO^4)	2.2043	2.7909	2.1168	3.0044	3.1171	.5754	1.3699
Combustion process. Organic carbon	.2646	.2457	.1778	.1659	.2982	.2639	.2842
Combustion process. Organic nitrogen	.0616	.0553	.0385	.0483	.0756	.0455	.0658
Combustion process. Sum of carbon and nitrogen	.3262	.3010	.2163	.2142	.3738	.3094	.3500
Combustion process. Ratio of carbon to nitrogen	4.3 : 1	4.4 : 1	4.6 : 1	3.4 : 1	3.9 : 1	5.8 : 1	4.3 : 1
"Albuminoid" ammonia process. Free ammonia	.00350	.00420	.00182	.00168	.00182	Trace.	.00665
"Albuminoid" ammonia process. Nitrogen of free ammonia	.00287	.00343	.00147	.00133	.00147	Trace.	.00546
"Albuminoid" ammonia process. "Albuminoid" ammonia	.01540	.01470	.00840	.01022	.01120	.00798	.00840
"Albuminoid" ammonia process. Nitrogen of "Albuminoid" ammonia	.01246	.01211	.00693	.00840	.00924	.00658	.00693

Table II—*Continued.*

		I.	II.	III.	IV.	V.	VI.	VII.
Number of sample		I.	II.	III.	IV.	V.	VI.	VII.
Date of collection		June 16.	June 24.	June 20.	June 13.	June 23.	June 27.	June 30.
Nitrogen of nitrites		.00084	.00084	None.	.00014	.00098	None.	.00357
Nitrogen of nitrates		.01946	.02226	.02800	.04536	.02422	.01190	.00217
Total inorganic nitrogen (NH^3, NO^2, NO^3)		.02317	.02653	.02947	.04683	.02667	.01190	.01120
Total combined nitrogen (organic + NH^3, NO^2, NO^3)		.08477	.08183	.06797	.09513	.10227	.05740	.07700
Permanganate process.	Oxygen consumed in one hour	.03696	.04872	.02604	.02688	.03472	.07952	.05880
	Oxygen consumed in three hours	.05068	.06328	.031 5	.03864	.05460	.10640	.07952
	Oxygen consumed in twenty hours	.08568	.10724	.04676	.05460	.10436	.14616	.11424
	Oxygen in one hour, as percentage on three	72.9	76.9	83.6	69.5	63.5	74.7	73.9
	Oxygen in three hours, as percentage on twenty	59.1	59.0	66.6	70.7	57.7	72.8	69.5
Dissolved gases. By volume.	Carbon dioxide, cubic inches per gallon	.5508	.7750	.9216	.8368	1.0905	.4401	.8469
	Oxygen cubic inches per gallon	1.2002	1.6412	.9327	1.3589	1.3949	1.4641	1.2427
	Nitrogen, cubic inches per gallon	3.6672	3.4043	3.8748	3.3102	3.5371	3.3738	3.2770
	Total volume, cubic inches per gallon	5.4182	5.8205	5.7291	5.5059	6.0225	5.2780	5.3666
	Oxygen as percentage on O + N	24.7	32.5	19.2	29.1	28.3	30.2	27.5
Dissolved gases. By weight.	Carbon dioxide, grains per gallon	.2758	.3871	.4599	.4186	.5446	.2198	.4228
	Oxygen, " "	.4368	.5957	.3388	.4837	.5068	.5313	.4515
	Nitrogen, " "	1.1648	1.0815	1.2313	1.0514	1.1235	1.0717	1.0409
	Total, by weight	1.8774	2.0643	2.0300	1.9537	2.1749	1.8228	1.9152
Hardness before boiling ($CaCO^3$) grains per gallon)		4.102	3.899	3.801	4.200	3.801	1.911	2.912
Hardness after boiling " " "		3.500	3.297	3.703	3.703	3.402	1.911	2.912
Poisonous metals, lead, copper, arsenic, mercury		None.	None.	None.	None.	None.	None.	None.

TABLE III.

Number of sample	I.	II.	III.	IV.	V.	VI.	VII.
Date	September 7, 1881...	July 25, 1881.	July 22, 1881.	August 19, 1881.	July 15, 1881.	June 30, 1881.	October 12, 1881.
Source of water	Cochituate Supply, Boston, Mass.	Croton Supply, New York City.	Lake Roland Supply Baltimore, Md.	Potomac Supply, Washington, D. C.	James River Supply, Richmond, Va.	Mississippi Supply, New Orleans (from reservoir).	Lake Mich. Supply, Chicago, Ill.
Clearness or turbidity as seen in two-foot tube	Slightly turbid.	Very slightly turbid	Somewhat turbid.	Turbid.	Turbid.	Very turbid.	Very slgtly turbid.
Color in two-foot tube	Greenish-yellow.	Yellowish.	Yellowish.	Yellowish.	Yellowish.	Yellowish.	Blue.
Odor	None.	None.	None.	None.	None.	None, or very faint.	None.
Total solids	60	90	110	165	105	340	160
Loss on ignition	10	20	35	95	20	50	60
Phenomena on ignition	Small black patches and rings, odor slight, no fumes.	Dark lines and spots, no fumes, odor slight.	Fawn color, no fumes, odor faint.	Dark brown, but no fumes nor odor.	Fawn-colored rings on mineral film no fumes, little odor.	Dark layer, with tendency to concentric lines; no fumes, odor slight	Black rings, with slight odor.
Chlorine	3.6	.67	2.33	1.1	1.17	14.5	2
Sulphuric acid	Not determined.	Not determined.	Not determined.	Not determined.	Not determined.	Not determined.	Not determined.
Combustion process. — Organic carbon	7.20	3.96	1.67	2.20	1.41	6.14	1.40
Organic nitrogen	.66	.62	.39	.44	.33	.76	.31
Sum of carbon and nitrogen	7.86	4.58	2.06	2.64	1.74	6.90	1.71
Ratio of carbon to nitrogen	10.9 : 1	6.4 : 1	4.3 : 1	5 : 1	4.3 : 1	8.1 : 1	4.5 : 1
"Albuminoid" ammonia process. — Free ammonia	.070	.020	.010	.05	.055	.04	.095
Nitrogen of free ammonia	.058	.016	.008	.041	.045	.033	.078
"Albuminoid" ammonia	.255	.150	.110	.127	.15	.325+	.09
Nitrogen of "albuminoid" ammonia	.210	.123	.091	.105	.124	.268+	.074

Table III—*Continued.*

	I.	II.	III.	IV.	V.	VI.	VII.
Number of sample	I.	II.	III.	IV.	V.	VI.	VII.
Date	September 7, 1881.	July 25, 1881.	July 22, 1881.	August 19, 1881.	July 15, 1881.	June 30, 1881.	October 12, 1881.
Nitrogen of nitrites	Trace.	.018	Trace.	Trace.	Trace.	None.	None.
Nitrogen of nitrates	Trace.	Trace.	.37	.23	Trace.	.08	Trace
Total inorganic nitrogen (NH^3, NO^2, NO^3)	.058	.034	.378	.271	.045	.113	.078
Total combined nitrogen (organic + NH^3, NO^2, NO^3)	.718	.654	.768	.711	.375	.873	.388
Permanganate process. — Oxygen consumed in one hour	4.008	1.799	.520	.864	.512	2.398	.264
Permanganate process. — Oxygen consumed in three hours	5.213	2.163	.684	1.016	.636	3.142	.400
Permanganate process. — Oxygen in one hour as percentage on three	77	84	91	85	80	76	66
Dissolved gases. By volume. — Carbon dioxide c.c. per litre	2.09	1.89	4.93	3.14	3.58	8.16	4.27
Dissolved gases. By volume. — Oxygen " "	4.73	4.67	2.97	5.27	4.48	3.73	6.35
Dissolved gases. By volume. — Nitrogen " "	10.62	11.25	11.39	11.29	10.63	10.99	12.41
Dissolved gases. By volume. — Total volume " "	17.44	17.81	19.29	19.70	18.69	22.88	23.03
Dissolved gases. By volume. — Oxygen as percentage on O+N	30.81	29.33	20.68	31.82	29.64	25.34	33.80
Dissolved gases. By weight. — Carbon dioxide	4.12	3.72	9.72	6.19	7.06	16.08	8.42
Dissolved gases. By weight. — Oxygen	6.76	6.67	4.25	7.54	6.41	5.33	9.08
Dissolved gases. By weight. — Nitrogen	13.34	14.13	14.30	14.18	13.35	13.80	15.59
Dissolved gases. By weight. — Total by weight, mg. per litre	24.22	24.52	28.27	27.91	26.82	35.21	33.09

THE CHEMICAL REPORT.

The report of Dr. Leeds, bearing upon the questions both of present and future supply, will be read with great attention in view of the large and exhaustive labor of the past three years in the systematic gathering of information upon which the final expression of his views is based. The large number of samples taken and analyzed, and the care and accuracy with which the analyses were made, free the subject of uncertainty so far as chemistry is prepared to enlighten it and must be accepted as establishing the fundamental analytical facts. The report should be read in conjunction with those of 1883 and 1884, which it briefly reviews.

The great purity of the flow from the Blue Mountain region, the high rank of the Upper Delaware waters, and the varying character and progressive deterioration of the Schuylkill are clearly established. The flow from the Perkiomen water-shed is shown to be inferior to that of the Schuylkill itself at Phœnixville where the main stream is found in its best condition. The increasing contamination of the water thence downward is attributable in part to the unfavorable character of the Perkiomen drainage and in part to the inflow of the drainage of 150,000 people and their varied industries from Phœnixville to Fairmount. The character of the pollution below Flat Rock is clearly shown by comparison of the Roxborough water with that of Spring Garden. The free ammonia has increased 67 per cent., the albuminoid ammonia 7 per cent., and the chlorine, already large in quantity and the recognized permanent non-oxidizable constituent of sewage, has increased 51 per cent., or from 0.346 parts per 100,000 at Roxborough to 0.523 parts at Spring Garden. To any one who has inspected the banks of the river from the upper end of Manayunk downward this degradation of the stream will be no mystery. Notwithstanding this increase in unfavorable chemical constituents the amount of these present in the Roxborough sample is so large that relatively there is but little superiority over the Spring Garden samples, and were the intercepting sewers completed the conditions would be reversed, and Spring Garden make a better showing than Flat Rock.

The summing up is, that there is no point in the Schuylkill river from Phœnixville to Fairmount, where sewage in a more or less decomposed and noxious condition is not revealed by analysis to be ordinarily present in the water. That the present supply is therefore unsatisfactory as regards quality, and that unless it can be materially benefited by the exclusion of sewage, and aëration, subsidence, and filtration, it ought to be abandoned.

Of the two stations, Lardner's Point on the Delaware, and Roxborough on the Schuylkill, the averages of 17 analyses in one case and 21 in the other, show that the latter station has 25 per cent. more Free Ammonia, 6 per cent. less Albuminoid Ammonia, 1,400 per cent. more Nitric Acid, 33 per cent. more Nitrous Acid, 5 per cent. more Chlorine, and 53 per cent. more total solids. These data fully establish the inferiority of the water pumped to the Roxborough Basin to that pumped to the Wentz Farm Basin.

THE FUTURE SUPPLY.

During the past three years, cotemporaneously with the endeavor to improve the existing supply, has proceeded the systematic and careful gathering of all information bearing upon the solution of the problem which for a generation has vexed the public mind, viz.: that of the future water supply of the city.

The increasing contamination of the Schuylkill due to the development of industries and growth of population in its valley, the marked diminution in its volume at low stages and corresponding inability to effect digestion of extraneous matters—its frequent overcharge of polluting elements, chronic disposition to turbidity after rains, and recurring fits of nauseousness—have for a long time attracted public attention and claimed serious consideration from those charged with special supervision of the subject. It was however with extreme reluctance that the public mind could bring itself to contemplate the thought of abandoning a stream to which the sentiment of generations was wedded, and of transferring to another source the multiplied associations that clustered about the Fairmount Works.

It is true that the river itself, like the faithful servant it had in so many ways proved itself to be, had no disguises and made open confession of its inability longer to bear its burden and discharge the duty that had endeared it to the community—but such is the power of sentiment that until recently it has seemed preferable to overlook its aberrations and even refuse to recognize the truth of its own confessions. But this could not endure. Sentiment like its object may become unwholesome, and when the public interest is clearly shown to require a change it must sooner or later get itself accomplished.

In 1865 the first coherent and rational project was advanced by Mr. Birkinbine then Chief Engineer of the Water Department. Upon a sound basis of reasoning, though an insufficient array of reliable data, he advocated the procuring of a supply by gravity by impounding the rainfall of the Perkiomen Valley, and until 1883 when organized surveys were instituted, this proposition held its own through all the desultory and interminable discussions of the subject that accompanied the growing dissatisfaction of the public and the indifference or inability of the local authorities to grapple with the problem. These surveys, having been in constant progress for the past three years, are now practically complete. They have been made with such care and thoroughness as to leave no element of uncertainty, and directed with such discrimination of needful data as to have been secured at an extremely moderate cost. With the completion of some compilation and tabulation the material prepared can be presently formulated into a final report for permanent record, but with the exception of some minor data relating to estimates, which will not seriously affect the result, the essential facts are contained in the Annual Reports for the successive years 1883 and 1884, and in the present Report for 1885.

The investigation has progressed on three lines co-operating with each other—Topographical, including hydrology and geology, Chemical and Sanitary. In all essential respects the information is complete and as prepared has been submitted to Councils in annual installments, of which this is the final one. It only remains, after consideration of the data collected, to decide upon the plan of action and proceed with its execution without further delay.

The basis of estimate for supply is that with a present population of nearly 1,000,000, and a maximum demand of 100,000,000 gallons per diem, a generation hence the population will be 2,000,000 and the demand 200,000,000. The conduits and other works that have been projected therefore have a daily delivering capacity of 210,000,000 gallons per diem due to a diameter of 12 feet and a slope of 1 in 6,000. These dimensions are modified in the conduit from the Perkiomen to the Lehigh, which augments the supply from the Perkiomen and makes up the full amount.

The general map accompanying this Report presents at a glance the topographical features of the situation, which will be briefly described. Philadelphia lies at the confluence of two water-sheds from one or the other of which its water supply must be taken. The Schuylkill has heretofore discharged this service, but the accumulated evidence proves that it cannot even for the present any longer be relied upon unless, by either great engineering constructions or the rigid enforcement of legislative enactments which in the end would prove even more costly, the conditions can be radically and permanently altered. There remains the water-shed of the Delaware, and here two alternatives are presented; one the Perkiomen-Lehigh project, an enlarged modification of the original proposition of Mr. Birkinbine; the other the Point Pleasant-Water-

Gap project, now for the first time shown by these surveys to be practicable and comparable in cost with the other.

The former plan impounds the Perkiomen water at Green Lane and draws the additional amount needed from the Eastern slopes of the upper Lehigh between Aquanchicola Creek and White Haven. The latter proceeds directly to the Delaware River at PointPleasant, impounds the Tohickon, with auxiliary pumping from the main stream, and ultimately extends the conduit to near the Water Gap for a full gravity supply.

It will be seen at once that both these projects stretch out towards the Blue Mountain region as the future gathering ground for the water supply of Philadelphia, and in fact, as was stated in my report of January 9 upon the South Mountain proposal, this is the ultimate solution of the problem.

It is from the pure and unpolluted rainfall of these elevated and desert regions that the community will hereafter drink; but meanwhile, and until increase of population shall have too seriously impaired the character of gathering grounds nearer at hand, the great expenditures needful to draw the entire supply from those distant sources is shown by the surveys to be unnecessary for the present and for a period in the future not definitely determinable.

The projects examined and estimated for other than the ones above outlined need not here be described. The statement and details of each are tabulated with Mr. Hering's report, and while, for the sake of covering the possibilities with thoroughness and security, attention was given to each, it requires but brief consideration of their several features to show that they are inferior in several marked respects to the two which challenge comparison and decision. While Philadelphia might well be satisfied with either of these projects, my judgment, after full consideration, is clear as to the advisability of selecting the Point Pleasant route.

Without going into specific details which are now unnecessary and will be more conveniently discussed in the final compiled report, the general considerations controlling my opinion are these:

For a satisfactory and reliable supply of 200,000,000 gallons per day the difference in cost of the two projects will not constitute any considerable percentage of the cost of either.

The Tohickon is equal in flow and quality to the Perkiomen above Green Lane. To supplement the upper Perkiomen it is needful to go beyond into the Lehigh Valley and nearly double the length of the conduit. To supplement the Tohickon the Delaware river is at hand with its minimum flow on October 3, 1885, of over 1,500 million gallons. The full amount required for generations hence can therefore be drawn from this point, while in the case of the Lehigh, as the needful amount augments, its several affluents must be intercepted and in the end the upper Lehigh itself be taken. I apprehend that before this result is reached the question of compensating damages for water withdrawn from other communities will have assumed considerable complexity and importance, while this is scarcely to be anticipated in the case of the Delaware river.

By the Delaware route the works are conveniently accessible by rail and canal at nearly all points. The Perkiomen route is less advantageous in this respect.

The Delaware river above Point Pleasant is quite free from pollution, having no large towns nearer than 25 miles. The rocky bed and turbulent flow of the stream are favorable to the oxidation and elimination of sewage reaching the stream beyond that distance. It is largely for these reasons that the analyses of the Point Pleasant water are so uniformly good.

But aside from this the entire population of the Delaware water-shed above Point Pleasant, including the relatively populous Lehigh valley, is less than 59 to the square mile, which may *en passant* be compared with the 176 to the square mile in the water-shed of the Schuylkill. Unless unexpected developments shall occur in the Delaware valley it appears unlikely that its population will so augment as to seriously impair the purity of the water within any clearly assignable period; and when this shall occur, and it become needful to reach at last the Blue Mountain elevations beyond possibility of contamination, the Delaware route is more favorable than the other by reason of convenience of access, with little to choose in the end between the final gathering ground in the two cases. In fact if it be desired branch aqueducts can readily be constructed to intercept the flow from both.

The following is the result of the prolonged chemical investigation of the subject, as given in Dr. Leeds' final report:

"In the selection of a new water supply for the City of "Philadelphia, the Blue mountain tributaries of the Delaware "and Lehigh rivers are to be preferred before all others. And "whilst of the Delaware river waters that of the Water "Gap is entitled to the first place, that gathered at Point "Pleasant is uniformly wholesome, and of satisfactory purity "and quality."

These opinions, derived from the alchemy of the laboratory, are fully confirmed by the topographical and sanitary data.

I have thus briefly discussed the subject, and indicated what, in my judgment, the facts justify as the best conclusion. In the final compilation of all the reports to be submitted for record, the full data will be tabulated, but the general facts will not be altered thereby.

In closing this portion of my report, I may be permitted to express a hope that in the future Philadelphia will better understand her actual rank among modern communities, and more fully accept the moral responsibilities attaching thereto, than has been indicated in the past by her indifference to and neglect of several aspects of civilization which are imperatively demanding recognition. Her adherence to a muddy and befouled water supply, retention of cobble-stone pavements, indifference to a proper system of sewerage and neglect of the laws of sanitation, constitute, in effect, moral misdemeanors unworthy of a community which, in intelligence and true worth, and the wide distribution of means of comfortable living, is without a superior.

The following comparative table is appended to give a general view derived from numerous analyses in each case of the qualities of the water examined:

Comparative Table of Analyses of Delaware and Schuylkill Waters, in parts per 100,000.

	Point Pleasant.	Frankford.	Roxborough.	Spring Garden.	Green Lane, Upper Perkiomen.	Phœnixville.
Number of samples....	44	17	21	59	13	17
Free ammonia..........	.0028	.00385	.0048	.008	.0043	.0035
Albuminoid ammonia	.00988	.01490	.014	.015	.015	.0097
Nitrous acid..............	.000022	.00004	.0006	.0006	.000176	.00012
Nitric acid................	.2543	.328	.435	.39	.36	.369
Required oxygen.......	.315	.308	.229	.22	.293	.188
Chlorine....................	.266	.329	.346	.523	.390	.324
Total solids................	6.88	8.30	12.67	11.95	9.88	13.32

SOUTH MOUNTAIN WATER COMPANY.

In seeking to comply with the instructions of Councils to prepare a report for their information upon the proposal of the South Mountain Water Company submitted to Councils in October last to lease the water plant of the city for a period of fifty years, and to construct certain works designed to secure an ample and satisfactory supply, it was manifestly necessary to form some estimate of what would be the future population of Philadelphia and the requirements of the water service for half a century in advance. For this purpose recourse was had to the data contained in the report of the United States Census for 1880, and the results are given in the tables accompanying the report.

The immediate result of this inquiry as tabulated in the columns of population and supply per diem was to demonstrate the fact that the proposed conduit from Philadelphia to the

Delaware River at Point Pleasant, with a daily delivering capacity of 210,000,000 gallons, would become inadequate to meet the requirements of the City long before the expiration of the period named in the Company's proposal.

By 1920 upon the moderate computation of demand, an average supply of 215 or 220 millions would be needed, with maximum in summer considerably in excess of this, so that from about 1910, on an increasing shortage would probably be experienced.

This in fact was to have been anticipated, for the reason that the Department in deciding upon the data for the future supply had gone no further than an estimated doubling of the population in say 30 years—and the work projected, the published plans of which the South Mountain Company borrowed, made provision for this period only.

I therefore recommended that if the lease be made, additional constructions should be provided for, and that the Company should be required to construct a second conduit before the first should prove unable to meet the demand.

I also recommended that inasmuch as the City at the termination of the lease, in about 1940, with a population of nearly 3,000,000, would then require a daily supply of say 400,000,000 gallons, the condition be made that before conveying the works back to the City the Company should construct from Point Pleasant to near the Water Gap, a conduit capable of transmitting by gravity the amount above named, and by this means turn over to the City a complete gravity supply in satisfactory and adequate condition.

In the discussion of the proposal before the Water Committee I also called attention to the desirability of securing a satisfactory guarantee from the Company as to the *quality* of the water, and a stipulation that should it, for any at present unforeseen cause, be impaired in purity below a proper standard of wholesomeness, the Company should be required to take such measures as might be requisite to restore and maintain its satisfactory condition.

The figures that must be considered in an estimate of half a century's growth for an American city, are so formidable as to bring clearly before the mind the magnitude of the questions at issue and the importance of the utmost vigilance in making provision for the future.

As this investigation, involving considerable labor, covers a much longer period than, so far as I am aware, has hitherto been attempted, and as the data relating thereto may be found of interest in other directions, they are briefly summarized in the following tables.

The figures in the several columns are the percentages of increase in population during successive decades, these percentages being computed upon the basis of the population in the initial year of each decade as shown by the census of that year. Selection was naturally made of those communities having certain geographical and business relations with Philadelphia and whose statistics therefore would be useful for comparison. The data for the seaboard States are given for the last decade, and those for Chicago and Cincinnati are included as of interest—the former in particular exhibiting the most phenomenal growth known to history.

The first fact apparent from this table is that the population of the United States at large has increased at a quite uniform rate in each decade, with the exception of that covering the war of 1860–1864, the average for the whole being nearly 33 per cent. In other words, the population of the country has much more than doubled in each generation of thirty years.

The urban population, on the other hand, exhibits greater variation in rate, and on the whole, has an average increase of 66 per cent.—double the general one. The result of this tendency to concentration, as manifested from the beginning, is illustrated in another way by the statement that whereas, in 1800, but 4 per cent. of the population lived in cities, the percentage increased so that, in 1820, 5 per cent. of the population was urban; in 1830, 6 per cent.; 1840, 8 per cent.; 1850, 12 per cent.; 1860, 16 per cent.; 1870, 20 per cent.;

Table showing increase in population during successive decades, by percentages on population of initial year of each decade, compiled from Census Report 1880.

	1800 to 1810.	1810 to 1820.	1820 to 1830.	1830 to 1840.	1840 to 1850.	1850 to 1860.	1860 to 1870.	1870 to 1880.	Average.
United States	36	33	34	33	36	36	23	30	33
Urban population	69	33	82	68	99	76	59	40	66
Pennsylvania	34	29	29	28	34	26	21	22	28
Philadelphia	37	24	40	54	58	38	19	26	37
New York State	63	43	40	26	27	25	13	16	32
New York City	59	28	65	50	65	58	16	28	46
Brooklyn	....	40	99	130	190	100	47	43	93
New Jersey	16	13	16	17	31	37	35	25	22½
Jersey City	....	....	....	....	130	186	105	46	117
Newark	....	....	....	....	66	34	46	32	44
Massachusetts	12	11	17	21	35	21	18	22	20
Boston	14	29	42	54	51	33	40	43	38
Maryland	11	7	10	5	24	18	14	20	13½
Baltimore	....	....	....	....	....	....	26	24	25
Ohio	....	....	61	62	30	18	14	20	34
Cincinnati	....	....	65	53	95	38	20	20	48½
Illinois	....	....	185	202	79	101	48	21	106
Chicago	....	....	....	....	330	235	142	73	195
Rhode Island	....	....	....	....	....	....	....	27	
Connecticut	....	....	....	....	....	....	....	16	
Delaware	....	....	....	....	....	....	....	17	
Virginia	....	....	....	....	....	....	....	23	
North Carolina	....	....	....	....	....	....	....	31	
South Carolina	....	....	....	....	....	....	....	41	
Georgia	....	....	....	....	....	....	....	30	
Florida	....	....	....	....	....	....	....	43	

and in 1880, 22½ per cent. of the whole population—or nearly thirteen millions out of fifty millions—were living under municipal rule.

As a corollary, it follows that cities increase more rapidly than the States to which they belong.

The figures for the five principal eastern cities for the decade 1870–1880 are—Boston 43, New York 28, Brooklyn 43, Philadelphia 26, and Baltimore 24; and, for the States, Massachusetts 22, New York 16, Pennsylvania 22, and Maryland 20. The average rate for these cities for the last decade is 33 per cent., and for their States 20 per cent.

It will be observed that the rate of increase in these seaboard centres is greater than that of the United States at large in the same decade; and this growth has occurred notwithstanding the predominant agricultural interest, the westward tide of emigration and the enormous development of the western areas. As the statistics of other countries exhibit the same rapid increase of urban as compared with rural populations, it is manifest that the concentration of people into closely-packed communities is taking place in compliance with a general politico-economical law, which it is foreign to the present purpose to discuss, but which must be recognized as a continuing and permanent influence, suggesting the vital importance of wise and provident anticipation of the future and its, as yet, scarcely comprehended requirements.

If the rate of increase for the last decade (which is less than the average) be continued, the country will contain in 1910 over one hundred millions of people, of which some thirty-five millions will be residents of cities.

It is obvious that while the problem of Federal and State Governments will assume formidable proportions, that of providing for the practical administration of the extremely complex interests and relations of municipalities will offer still greater and more rapidly increasing difficulties, with the disadvantage that no satisfactory system or model has yet endured the test of practical operation, or even been determined upon. It is likewise clear that the regulation of the intricate business interests of an aggregation of one or two millions of people should no longer be controlled by haphazard or confused methods, or entrusted to incapable and unfaithful hands; and that in future, the services of the most competent and trustworthy men that can be procured, untrammeled by considerations other than those of their special charge and responsibilities, will be found indispensable to the safe conduct of the enormous interests concerned.

The State of Pennsylvania has steadily held its own and occupied the second place in the list of States with the exception of 1810 and 1820, when Virginia was falling from the head of the column and New York was taking her place. Philadelphia has shared the prosperity of the State, and between 1800 and 1880 exhibited an average increase of 37 per cent. against 28 per cent. for the State.

The population of Pennsylvania for the successive census years is given in the following table, with the estimated population of Philadelphia for comparison:

Pennsylvania.		Increase, per cent.		Philadelphia, estimated.		Increase, per cent.	
1800	602,365	34		1880	847,170	25	
1810	810,091	29		1890	1,059,427	24	
1820	1,047,507	29		1900	1,313,689	23	
1830	1,348,233	28		1910	1,615,837	22	
1840	1,724,033	34	Average. 26	1920	1,971,321	21	Average. 21
1850	2,311,786	26		1930	2,385,298	20	
1860	2,906,215	21		1940	2,862,357	19	
1870	3,521,951	22		1950	3,406,215	18	
1880	4,282,891			1960	4,019,322		

The State acquired one million population in 1820 and four millions in 1880—a period of 60 years with an average rate of increase of 26 per cent. The City, according to the estimate, will have one million in 1890 and four millions in 1960—a period of 70 years with an average allowed increase per decade of 21 per cent.

As Pennsylvania possesses a greater store of natural wealth in coal, iron, oil and gas than any other State, and as Philadelphia is her commercial metropolis with exceptionally favorable conditions of accessibility, climate, geographical position, varied industries and ample room for expansion, it is evident that the estimate of her future population and needs errs, if at all, on the side of conservatism and moderation, and that in all probability the actual requirements of the future will be in excess of those—large as they appear to be—which the estimate calls for.

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COMMUNICATION BY THE CHIEF ENGINEER TO THE CHAIRMAN OF THE WATER COMMITTEE ON THE PROPOSAL OF THE SOUTH MOUNTAIN WATER COMPANY.

Philadelphia Water Department.

Philadelphia, January 9, 1886.

THOMAS GREEN, ESQ.,
Chairman of the Water Committee:

SIR:—The proposal of the South Mountain Water Company for the future supply of the City, heretofore presented to Councils, was by resolution referred to the Water Committee for consideration and report, with the further requirement that the Chief Engineer of the Water Department prepare a statement with regard thereto for the information of Councils. In compliance with this requirement, I beg to submit the following:

The investigation antecedent to the consideration of this or any other project for the future supply of the city involves the determination—

First—Of the condition of the present supply as to quantity and quality.

Second—Whether the present supply is capable of such modification as to enable it to meet future requirements; and,

Third—What are the possible projects fulfilling these requirements from among which selection can be made of the most favorable.

The Water Department since the spring of 1883 has been actively engaged in gathering information upon these points from every available source, the conduct of the work and the methods employed being such as to ensure accurate ascertainment of fact, and constitute the basis of a secure judgment and reliable action in the future. The results of this investigation as it progressed have been submitted to Councils in the Annual Reports of the Department for the years 1883 and 1884, and the continued work of the last year, 1885, tends only to confirm the information therein contained. I assume therefore, that no elaborate discussion or repetition of these statements is called for in this paper, and the present condition of affairs may briefly be summed up as follows:

It is unnecessary to enlarge upon the defects of the present supply. They have been fully set forth in the Department reports, and are matters of everyday experience, general dissatisfaction, and serious detriment to public interests of great value. In respect both of quantity and quality, improvements are imperatively demanded in the interest of the common prosperity, safety and convenience. While certain outlying districts such as West Philadelphia, Frankford, Manayunk and part of Germantown, have sufficient for their needs, the city generally is badly served. Throughout the compact and wealthy region south of Vine street the pressure is light, the supply inadequate, and the basins hold but two days' storage. For the extensive and rapidly developing area from Vine street northward to Lehigh avenue, bounded by Broad, Jefferson, and Ninth streets, there is no storage whatsoever, and the supply to thousands of dwellings and hundreds of manufactories is wholly dependent upon the continuous action of the pumps drawing directly from the river at the Spring Garden Station. The heavy manufacturing district of which Kensington is the focus draws its supply through miles of 6-inch pipes and is quite insufficiently served.

For the amendment of these defects, so far as quantity is concerned, the construction of adequate storage basins, the laying of new mains, the renewal of old and the procurement of new plant would suffice for the present, but the defects of quality would still remain.

A good water should be soft, clear, cool and sparkling, and without deleterious matters in solution or suspension; but aside from the intrusion of sewage and other waste matters, the Schuylkill is hardly ever clear, and is frequently turbid by reason of the freshets which bring down large quantities of mud and silt in suspension. This sediment destroys the appearance of the water, discourages its proper uses, clogs the pipes, interferes seriously with industrial processes requiring clear water, and generally causes great public dissatisfaction and disgust. To remedy this evil, extensive subsidence and filtering basins, or rather appliances, of some sort, are indispensable if the pipes are to be kept free of deposits and the water delivered in an acceptable condition, and the cost of such plant, even with the present limited supply, would be a heavy item.

In addition to these objections however, there are general considerations which are decidedly adverse to future dependence upon the Schuylkill. The Schuylkill Valley is an industrial region destined to contain a dense population, and the river is the natural carrier of all of its fluid and much of its solid waste matters. To exclude these, legislative enactments would in all probability be entirely futile, and engineering constructions, such, for example, as capacious intercepting sewers along both banks and up each affluent, would be necessary. Another important fact is that the low water flow of the Schuylkill has seriously diminished in the last sixty years. It is now less than double the summer supply to Philadelphia, and in the absence of costly storage dams in the valley, will presently prove insufficient. For all these reasons the engineers who have investigated the subject, have concluded that ultimately the abandonment of the Schuylkill as a source of supply will be imperative.

Speaking generally, Philadelphia must look to the mountainous region constituting the upper drainage areas of the Lehigh and Delaware Rivers for its source of supply, and the investigations by the department in 1883, 1884, and 1885, tend to show that on the whole, two projects may be regarded as fairly adequate and practicable: one, to connect the upper Lehigh by conduit—down the Lehigh Valley and thence across to Green Lane—with the upper Perkiomen and so secure a gravity supply of undoubted purity and probably sufficient quantity; the other, to strike across from Philadelphia to the Delaware River at Point Pleasant, establish there a provisional pumping station with a storage basin in the Tohickon Valley, and ultimately extend the conduit upward for a gravity supply from near the Water Gap.

The final comparative analysis of these two projects cannot at present be made, as the land damages are not as yet fully determined. The Delaware project has the advantage of less distance, greater simplicity of detail and directness of result, with ample capacity for future enlargement, drawing from the living waters of the Delaware while in full flow. The Lehigh-Perkiomen project will impound the pure and unpolluted rainfall of the mountains, far above the possibility of contamination, while the dams and conduit will be of greater length and complexity of construction, with perhaps less security of maintenance. The cost in the two cases will probably not differ by any large percentage of the total of either.

The South Mountain Water Company was originally projected to take its supply from the Perkiomen Valley, but the facts set forth in the Department reports indicate that ultimately the Perkiomen water-shed alone will prove inadequate, and the Company has therefore shifted its ground and boldly adopted the Delaware project as outlined in the Department reports.

The proposal of the Company, so far as the engineering features are concerned, make these reports the basis of its project and estimates, and there is no reason to doubt that if the works are properly constructed and managed they will furnish an ample and satisfactory supply for a generation to come. The estimated cost and time of construction of the works as proposed are approximately correct.

The $5,000,000 to be expended for reservoirs, new mains, replacing old mains, etc., if properly applied, will suffice to complete the East Park reservoir, the Cambria basin, enlarge the Mt. Airy Basin, equip the city with proper pumping and supply mains, and in general place the pumping and distributing plant within the city limits in a satisfactory condition. All these works are now needed, and will be necessary, whatever may be the source of supply.

The stipulations as to the time of payment of the $5,000,000 make the last installment payable two years and eight months after delivery of lease, while the Company undertakes the completion of the conduit, etc., within two years and a half from the same date. It would be well to secure the completion of all these works at the same time, and safer to estimate a period of three years from delivery of lease for completing the new basins and conduit.

So far as the engineering questions for the present and immediate future are concerned, I have no further suggestions to make, and I do not suppose that Councils require me to discuss questions of city finance nor to advise as to the general policy of making the lease as proposed or modified. Unless specially called for, these matters lie outside my functions as the Chief Engineer of the Water Department; but in order to aid the Committee in the consideration of the subject, I have prepared the accompanying tables embodying the results of careful study of official records and much computation.

Table I.

	Year.	Population.	Per Cent. of Increase.	Daily Supply per head. Gallons.	Per Cent. of Increase.	Average Daily Consumption U. S. Gallons.	Per Cent. of Increase.	Year.	Total Annual Revenue.	Per Cent. of Increase.	Revenue per Head, per Annum.	Per Cent. of Increase.
	1	2	3	4	5	6	7	8	9	10	11	12
Actual.	1800	70,287	37									
	1810	96,287	24	7	123	669,071	174					
	1820	119,325	40	15½	3	1,834,836	46					
	1830	167,080	54	16	22	2,676,164	89					
	1840	258,037	58	19½	8	5,004,099	73					
	1850	408,762	38	21	71	8,697,534	134					
	1860	565,529	19	36	53	20,398,197	80	1860	$558,531	70	$0 98	43
	1870	674,022	26	55	24	36,720,030	57	1870	947,330	57	1 40	25
	1880	847,170	25	68	18	57,707,082	47	1880	1,484,357	46	1 75	16
Estimated.	1890	1,059,427	24	80	12½	84,754,160	40	1890	2,167,000	39	2 04	12
	1900	1,313,689	23	90	11	118,232,010	37	1900	3,000,000	37	2 28	11
	1910	1,615,837	22	100	10	161,583,700	34	1910	4,111,000	34	2 54	10
	1920	1,971,321	21	110	9	216,845,310	32	1920	5,500,000	32	2 79	9$\frac{7}{10}$
	1930	2,385,298	20	120	8⅓	286,235,760	30	1930	7,300,000	30	3 06	8½
	1940	2,862,357	19	130	7$\frac{7}{10}$	372,106,410	28	1940	9,500,000	28	3 32	7½
	1950	3,406,205	18									
	1960	4,019,322	17									

TABLE II.

Year.	Population of Philadelphia, as Estimated by Board of Engineers in 1876.
1880	880,000
1890	1,175,000
1900	1,500,000
1910	1,840,000

TABLE III.

Year.	Population of London.
1801	959,000
1884	4,000,000
	Rate of Increase, 20 to 16 per cent. per Decade.
1884	Actual Increase 70,000
	Rate per Decade 17½ per cent.

TABLE IV.

Daily Supply, per Head, from Annual Report, Water Department, 1884.	Gallons.
Boston	90
Buffalo	130
Chicago	121
Detroit	144
Milwaukee	106
New Haven	100
New York	90
Pittsburgh	186
Troy	100
Washington	165
Wilmington	103

TABLE V.

Total Expenditures, per 1,000 gallons	5 cts.
Total Receipts, " "	7 cts.
Interest on Loans, " "	1 ct.
Profits on Business, " "	1 ct.

Table VI.

	Philadelphia. 1884.	London. 1884.
Population	956,000	4,000,000
Daily Supply, per Head. Average	73 gals.	$37\frac{1}{2}$ U. S. gals.
Total Daily Supply. Average	69,658,969	150,000,000
Total Expenditures per Annum	$1,072,000	$2,450,000
Expenditures per Thousand Gallons	$4\frac{2}{10}$ cents	$4\frac{1}{2}$ cents
Expenditures, per Head	$1 12	61 cents
Total Receipts, per Annum	$1,792,486	$7,000,000
Receipts, Less Expenditures	$720,000	$4,450,000
Receipts per Thousand Gallons	7 cents.	$12\frac{1}{4}$ cents
Receipts per Head	$1 87	$1 75
Profits per Thousand Gallons	$2\frac{8}{10}$ cents	$7\frac{2}{3}$ cents.
Profits per Head	75 cents	$1 14
Pumping Engines. Number	25	143
Filter Beds. "	None	93
Subsiding Reservoirs. "	None	54
Service " "	9—Area 37.7 A	49
Capacity of " U. S. Gallons	195,524,522	1,733,000,000
Capital Invested	$15,000,000	$66,000,000

Table VII.

Estimated Income of City, Under Proposition to Divide Excess Over $2,000,000.

Year.	Revenue.	City's Income.
1886	$1,900,000	
1887	1,966,750	
1888	2,033,500	$16,750
1889	2,100,250	50,125
1890	2,167,000	83,500
1900	3,000,000	500,000
1910	4,111,000	1,055,500
1920	5,500,000	1,750,000
1930	7,300,000	2,650,000
1940	9,500,000	3,750,000

The data of the future as to water supply depend primarily upon population, and Table I therefore, begins with a carefully considered estimate. The first column gives the initial year of each decade; column 2, the population of that year; and column 3, the percentage of increase for the ensuing decade. The average rate of increase between 1800 and 1880 is 37 per cent. per decade; the greatest being 58 per cent., for 1840 to 1850, and the least 19 per cent., for the period of the war—1860 to 1870.

In estimating the increase for the period following 1880, I have taken into consideration the preceding average rate and made allowance for the gradual diminution in the rate of increase as the population augments. The estimate is conservative and will, I think, be found fairly reliable. For comparison, Table II gives the estimate made by the Board of Engineers in 1876, whose figures are somewhat larger than mine. As an additional check, comparison is made with the data of London, in Table III, a city resembling Philadelphia in many material characteristics. London quadrupled its population from one to four millions between 1800 and 1884, with an average rate of increase per decade of from 20 to 16 per cent., and in 1884 the increase was 70,000 for the year—a rate of 17½ per cent. per decade. It will be observed that Philadelphia has now the population of London in 1801, will attain her two millions in 1920 and her four millions in 1960, and be then increasing at the rate of 17 per cent.

Column 4, of Table I, gives the daily supply per head of population, which rapidly augments from decade to decade. This increase has in Philadelphia taken place notwithstanding that for many years the supply has been deficient, and indicates the absolute necessity for extensive betterments of the water service if the public demands are to be met. The increasing consumption per capita, as I have indicated in the Department reports, arises largely from a desirably freer use in the household, and, in especial, from the establishment of numerous industries such as breweries, morocco factories, dye-houses and others to which an ample flow of good water is indispensable. For the future, on the assumption that the useless waste of water will be controlled, I have allowed a moderate gradual increase of 10 gallons per head in successive decades. That these amounts, though far beyond our present means, are not excessive, Table IV is given to show the supply to several cities for the years 1883 and 1884, which in some cases have been since increased. Boston and New York furnish 90, Troy and New Haven 100, Wilmington 103, Milwaukee 106, Chicago 121, Buffalo 130, and Detroit 144 gallons per head. Washington has little business, but uses water freely for flushing and ornamental purposes at the rate of 165 gallons, while Pittsburgh takes it gluttonously at the rate of 185 gallons per head. Philadelphia in 1884 furnished 73 gallons per head.

Even with proper provision for the restriction of waste, Philadelphia will need in 1910 not less than an average of 100 gallons per head per day, and in 1940, 130 gallons with maxima 25 or 30 per cent. greater. As this year closes the decade during which the South Mountain Water Company's lease, if made, would terminate, I have stopped the computation at that point.

Column 6, Average Daily Consumption, is derived from Population and Supply per head, and owing to the increase of both, shows a percentage of increase greater than either.

In 1920 the city will need an average daily supply of not less than 215 or 220 million gallons, an amount in excess of the capacity of the proposed conduit to furnish, and before that date it will be necessary to make provision for increasing the plant. I therefore recommend that, since the lease, if made as proposed for a term of 50 years, would in 1920 still have 16 or more years to run, additional stipulation be made therein for the duplication of the conduit from Point Pleasant to the city before the demand shall have outrun its capacity and for the final extension thereof to the Gap, with sufficient capacity to supply both the new and old conduits, or a total of at least 400,000,000 gallons per day, which amount will not be much in excess of the probable demand at the expiration of the lease.

With regard to the annual revenues to be anticipated there is naturally considerable uncertainty, but it is found from examining the records of the Department that a remarkable correlation has heretofore existed between total supply and total collections.

Whether the calculation be made for the entire period since consolidation, for separate decades or even for individual years, the gross collections average as nearly as may be 7 cents per thousand gallons furnished. Assuming that what has been true of the past generation may be used as a basis of calculation for the ensuing one, the figures of Column 9, Annual Revenue, are readily obtained, and the receipts being considered by this method as a direct function of the supply the percentage of increase is the same for both.

These data however cannot be accepted as furnishing an absolute calculation of revenue. They are obtained by allowing 7 cents uniformly for every thousand gallons delivered; but it is quite certain that Philadelphia, which now makes little public use of water for sanitary purposes, will be compelled in the future to use considerable quantities in flushing sewers and other much needed requirements of a similar character, and the receipts per thousand gallons used will be correspondingly diminished, although to what extent it is useless to speculate. I am of opinion, also, that a special manufacturers' rate should be made for all consumers above a certain amount, such rate to be less than the average general one, or say 5 cents per thousand gallons.

The essential fact, of course, remains that the water will be needed and must be had in any event, and can be procured only by large expenditures.

Enthusiastic people have asserted that water should be as bountiful and free as air. This is now, in fact, the case, if one choose to go and get it; but the important difference between the two fluids is that air penetrates everywhere, and delivers itself at all elevations free of charge, while water seeks the lowest level and has hitherto refused to flow up hill except upon compulsion. This involves expenditure of power and consequently expenditure of money, which some one must pay.

Column 11 is added to give the revenue per annum per head of population and to show how the growth of population and industries furnishes a large income at a small cost to the individual.

As the total daily supply increases in a higher ratio than the population itself, the cost per head naturally augments; but this average cost does not involve increased cost to individuals, and arises only from distributing the large payments by wholesale users.

Table VII is a calculation of the income to the city under the arrangement proposed by the Company of dividing the surplus revenue over $2,000,000. It depends upon Column 8, of Table I, and is of course subject to any changes that may be made therein.

Table VI furnishes some comparative statistics of the Philadelphia and London water supplies for 1884. Our allowance per day was 73 gallons against $37\frac{1}{2}$ in London. The expenditures per thousand gallons were for Philadelphia $4\frac{2}{10}$ cents; London, $4\frac{1}{2}$ cents. Receipts per thousand gallons: Philadelphia, 7 cents; London, $12\frac{1}{4}$ cents. Gross profits: Philadelphia, $2\frac{8}{10}$ cents; London, $7\frac{3}{4}$ cents. London has $66,000,000 invested in water plant; Philadelphia, $15,000,000, approximately distributed as follows:

For pipes, valves, stops, etc.	$8,000,000
For reservoirs, buildings, and grounds	5,000,000
For machinery, etc.	2,000,000

Table V is a summary of the average operations of the Water Department since 1854, to include 1884. Comparing total expenditures, for all purposes, with total pumpage, the cost of the service, as heretofore managed and controlled by the city, has been about 5 cents per thousand gallons, which added to the interest charge on water loans, estimated at 1 cent, makes a total cost of about 6 cents, and compared with the average receipts of 7 cents, shows an apparent profit of about 1 cent per thousand gallons delivered, omitting interest upon the original cost of the plant.

The total receipts since consolidation, to include 1884, were	$28,762,807
Total expenditures	19,052,009
Showing an apparent profit of	$9,710,798

in thirty years, all of which has been turned into the City Treasury to the general account.

As a matter of public policy, I am convinced that the revenues of the Water Department should not have been taken from it and expended for other purposes, and since my induction into office and close acquaintance with the needs of the service, I have earnestly contended that there should be no excess of receipts over expenditure so long as need existed for betterments. With a completely satisfactory service established, and this the city has really never known, there would still remain the inevitable necessity for anticipating future needs, in order that the prosperity of the city, from that cause at least, should not be checked.

In my report for 1883, pages 29 and 30, I stated as follows:

"Whatever may have been the causes of the extraordinary "and prolonged neglect and consequent dangerous decadence "of a service established for the benefit of the citizens, and "holding such intimate relation to the comfort, health, and "prosperity of the entire community, the above statements, "from the records of the Department, make it sufficiently evi-"dent that a lack of funds, properly and equitably applicable "to its necessary support and enlargement in proportion to "the growth and requirements of the city, was not among "them. It is probable that investigation would, without "much or any difficulty, discover these, and establish their "close connection with certain erroneous principles, misdi-"rected economies, and radical defects of administration.

"The business of supplying water to the citizens is no "necessary municipal function or obligation. It might, with "entire propriety, have been relegated, as in many large "cities, to a chartered company, with careful stipulations as "to the percentage of profits, and rigid provisions for penal-"ties in case of inadequate or unsatisfactory service.

"The city, however, has voluntarily chosen to engage in "this business on its own account, and by ordinance has "created a monopoly by forbidding others to compete therein. "This assumption of an extraneous function cannot, however, "relieve the city from the natural and equitable obligations "thereby incurred, but, on the contrary, imposes additional "and weighty responsibilities. As a vital need, whether for "daily domestic uses, for manufacturing purposes, for protec-"tion against losses by fire, or for the conservation of the "public health, there is no requirement which approaches in "urgency the demand for an ample supply of wholesome "water, and yet, as has been shown, the city has permitted "the service to languish, until not only is the quality of the "water unsuitable and its quantity insufficient, but there was "danger that a large portion of the city would be deprived of "its supply altogether.

"The appropriations for necessary improvements were with-"held year after year, while the heavy annual surplus collected "from citizens was used for other and less important improve-"ments.

"It would seem clear that until the water supply of Phila-"delphia is such as a city of one million souls—the second in "population and the first in manufacturing importance in the "United States—should have, there can be no application of "the water revenues so just and so judicious as their expenditure for the imperative requirements of a service upon which "the well-being, comfort and prosperity, individually and collectively, of the community, is wholly and without alternative dependent."

In the report of 1884, pages 79 and 80, I stated:

"The creation and maintenance of a system of water supply "to a great modern community is practically a never-ending "problem. The needs of each generation so largely transcend "not alone those of the preceding one, but even the estimates "which could then have been formed of the future requirements, as almost invariably to exceed reasonable anticipations and far outrun the capacity of the existing constructions, even with considerable additions from time to time.

"The real difficulty due to this cause is the unceasing "watchfulness and prevision needful to give timely warning "of the approaching inadequacy of the existing plant, and the "resolution and persistence demanded from those charged "with the special responsibility in constantly presenting and "urging the requisite modifications and enlargements.

"The intimate relation of water supply to the public health "and other material as well as moral interests of the very first "importance, need not be enlarged upon. It is second only, "if second at all, to the protection of life and property, with "both of which, in fact, its connection is of the closest. The "adequacy and satisfactory service of the Water Department "must therefore be regarded as a municipal obligation and "responsibility not exceeded in importance by any other, and "its neglect and insufficiency cannot be defended upon any "grounds, even those of financial embarrassments and inability "to raise the necessary funds for improvements.

"Even these excuses disappear when, as is the case in "Philadelphia, the Water Department, so far from being a "burden and expense, is in reality a source of generous rev-

"enue which pays a heavy interest upon the total cost of the "plant, and in the past thirty years, upon an expenditure of "$19,000,000, has collected $28,750,000, and turned into the "City Treasury a net profit of nearly $9,750,000."

As a matter of fact, the diversion of this large sum has been no real profit whatsoever, but, on the contrary, has involved loss. It was obtained by starving the Department, robbing it of its earnings, and refusing to return them in sufficient amount ot keep body and soul together. Instead of being a wholesome and vigorous stimulant to growth, the water service has been a clog and a nuisance, always behind the daily need, never ready to meet it, depressing and endangering property, imperiling health, hampering development, restricting manufactures, and dulling local enterprise. Judicious and timely expenditures by the city for the needful enlargement and extension of the water service are a municipal obligation of the highest order, and to stint or withhold them is not to save but to lose money. The profits should have been looked for in the promotion of prosperity, the development of industries, the increase of values, and the accumulation of wealth. It is doubtful, even if the surplus revenues of the Department had been properly applied, whether the needs of to-day could have been adequately met; but it is perfectly safe to say that the city has lost in the last thirty years, from the deficiencies and unsatisfactoriness of her water supply, far more than the $325,000 a year she took from it, and, after all, now find herself confronted with the absolute necessity of restoring the misapplied millions, and, having spent them, does not in the least know how they are to be obtained.

Very respectfully,

WILLIAM LUDLOW,

Chief Engineer.

THE ADDRESS TO THE COUNTY MEDICAL SOCIETY.

The Water Supply of a city is a vital function of municipal life, indispensable not only to material and moral interests of the greatest importance but to the very existence of the community.

With no other one department of the local administration is the citizen and tax payer so intimately concerned as that regulating the quantity and quality of the water delivered to him for domestic and business uses— and upon none other, from its direct bearing upon matters of health and business interests and his absolute dependence, is he more entitled to demand and receive the fullest and most accurate information. This constitutes in my judgment the basis of the relation of the Head of the Water Department to the community which it is his honor to serve—but it imposes weighty responsibilities. His duties are not limited to the technical details of pumping and distributing the water, important as these are, nor even to the judicious and economical use of the sums entrusted to him for expenditure. These constitute the elementary work of his office, but he is bound further to inform himself in the fullest measure as to all material facts bearing upon the water supply, and be prepared at any time to render account to the public of the exact condition of the service and its needs, present and prospective.

It is perhaps unnecessary to say that, holding this view, I have not hesitated when called upon for information to furnish it, after the facts in the case had been fully investigated, especially when the information was requested in the public interest by professional and other associations of recognized standing and authority. The effect of this has been to give wide and wholesome publicity to certain facts relating to the water supply, which had long existed in clear violation of law and public right, and were far from being commendatory of the service or creditable to those who were responsible for their continuance, and who, therefore, took great offense at what they condemned as injurious and inconsiderate disclosures. This view however appears to involve an identification of themselves with the community, which, notwithstanding their official relation thereto, must on the whole be regarded as insufficiently established. In a few other cases the belief seemed to be honestly entertained that since the publication of damaging facts must to a certain extent be injurious to the business interests of the city, particularly those relating to the water supply about which modern communities are becoming more sensitive in proportion as its importance is intelligently realized, it would be better to proceed by more tolerant methods and withhold from the public the knowledge of the situation, in order to guard them against undue apprehension of results and the city against loss of repute.

This view however ignores the possibility of still greater injury from the results themselves, and the further consideration that since the evils known to exist had been the outgrowth of many years of neglect and concealment, and were maintained by powerful interests, the continuance of the same policy could only result, as it had always done, in failure to effect any substantial remedy. In fact it is obvious that a department officer, however conscientious and determined, could accomplish nothing in such a matter without the co-operation of Councils, and that the city legislature, representing theoretically the public interest, could only be moved to action in the face of active opposition by the urgent expression of public judgment and insistance.

But one city department, viz.: the Fairmount Park Commission, whose fundamental purpose was the purification from sewage and mill waste of the Fairmount pool, had ever attempted to do anything in that direction. Two methods had been tried: one by outright purchase of offending properties, which, with the exception of the cemeteries, cleared the banks to the Falls of Schuylkill, but had a severe set-back when a mill owner, bought out near the Wissahickon, at heavy cost, used the money to construct a still larger establishment still nearer the pumping stations, and failed altogether when it came to buying out Manayunk and the opposite bank. The money was not all wasted, since a noble park has been established to the great advantage both of the city and the citizens; but the original purpose was practically as far from accomplishment as at the beginning.

The second method was by suits in equity against individual properties which in flat defiance of the statute laws, were discharging deleterious waste matters into the pool. These proceedings dragged through pleadings and hearings interminable, and when finally about to conclude, were promptly annulled by the refusal of Councils to authorize the action. In contrast with these failures, partial and total, the appeal to public opinion made by publication of the facts in 1883 and 1884 stimulated Councils to authorize the Water and Law Departments to abate the nuisances, and the immediate result of the energetic action of the City Solicitor was the procuring of indictments against three typical cases of dangerous pollution and their conviction in court of maintaining a common nuisance. Judge Thayer, in his charge to the jury, formulated an admirable statement of the law relating to the pollution of river water used for drinking purposes, which is printed in the Water Department Report of 1884, and the fact was thus summarily and for the first time effectively established that any dangerous pollution of the pool could be promptly abated without regard to other considerations than the protection of the public health. This result could not possibly have been reached without the support of that public opinion which when aroused to due energy of impulse and expression, can compel or forbid the practical enforcement of any law however opposed by selfish and powerful individual interests.

It is true the situation had some embarrassing aspects. The action was nominally taken by the Commonwealth, and in the view of the law the city corporation was as liable for its infraction as an individual mill or tavern owner. By her own action in procuring the prosecutions the city was likewise shown to be in default and subject to like condemnation as the individuals against whom she proceeded, by the proof that city sewers were maintained side by side with private drains. As nothing is so useful to direct the judgment as a clear view of the situation, it is probable that this condition of affairs was not without its weight in indicating to Councils the imperative need of complete remedial measures—which it may be hoped will ultimately be taken.

An interesting episode which is of record in the official journals of Councils was the action taken in consequence of an address delivered by the Chief Engineer of the Water Department at the request and for the information of the County Medical Society, a numerous and active body including in its membership many of the most prominent leaders in medical thought and public interest in the city. The address, an unassuming one enough, was entitled "Water supply in relation to Sanitation," and while using certain known public facts relating to the water supply of Philadelphia as well as of other cities in illustration of the principles and importance of sanitary requirements, was calculated simply to enlarge the popular knowledge and appreciation of the subject and did not as a matter of fact, contain a single word or assertion to which any reasonable person could take exception.

The opportunity was however seized upon by certain persons more anxious to attract public attention than judicious in their selection of means to accomplish that purpose, and in consequence the paper caused a stir quite out of proportion to its merit or importance and was thus fortunately enabled to be the means of doing much more good than would have been possible without such assistance. The resolution of Councils, my letter in response thereto, and the address itself are appended as part of the official record. The action of Councils was promptly repudiated by the entire newspaper press of the city and the public at large, and by special resolution of such representative bodies as the Franklin Institute, the Committee of 100, and the County Medical Society, and was widely commented upon by the journals of other cities in terms less complimentary to Philadelphia even than the allusions to its water supply had been. It is needless to say that the passage of this resolution conveys less reflection upon the individual members of Councils who voted for it (with the exception of its few active advocates), than upon the hasty action of a numerous body led astray by misrepresentation and misuse of opportunity, as is illustrated by the fact that an effort made to return my communication as disrespectful found but twelve supporters, and was withdrawn and the entire matter ordered printed in the journal.

The similar failure and collapse of a further attempt to controvert the official statements of the Department by endeavoring to procure analyses of the water more favorable to the quality of the Schuylkill than those printed by the Department, are elsewhere recorded—after which the subject was permitted to drop, and appropriations for completing the Manayunk sewer were quietly made at the first opportunity.

It seemed superfluous at the time to make any argument as to the implied relation of a head of a Department to Councils, as their subordinate merely who should speak or be silent as permitted or directed, or that in the exercise of the duties of his office his responsibility and discretion were confined to the narrow channels of routine, and any expansion thereof or recognition of the community as his employer and principal, was illegitimate. I have already stated my opinion on this point, to which in any event I proposed to adhere as fully founded in fact and reason. It is the vice of the present system of government in Philadelphia that notwithstanding members of the legislative bodies, whether as individuals or committees, are distinctly forbidden to exercise any executive functions whatsoever, the prohibition is entirely disregarded and the interference with and attempted dictation to the responsible executive officers are incessant, to the great detriment of the service and enormous disadvantage of the citizens—for whose interests alone both legislative and executive offices are supposed to have been created.

As the point has been frequently made by those who, for one reason or another, have been opposed to practical improvements, that the general health of the city is good and the death rate low for cities of the population of Philadelphia, the appended table of population, deaths and death rates, for the period 1860—1885, has been prepared:

Year.	Population.	Deaths.	Rate per thousand.
Census, *1860	565,529		
1861	571,879	13,540	23.68
1862	579,229	13,364	22.21
1863	587,579	14,220	24.20
1864	596,929	15,875	26.61
1865	607,279	15,633	25.74
1866	618,629	15,362	24.83
1867	630,979	12,660	20.06
1868	644,329	13,391	20.78
1869	658,679	13,428	20.38
Census, *1870	674,022	15,317	22.72
1871	689,087	15,485	22.48
1872	704,652	18,987	26.94
1873	720,717	15,224	21.12
1874	737,282	15,238	20.67
1875	754,347	17,805	23.59
1876	771,912	18,892	24.47
1877	789,977	16,004	20.26
1878	808,542	15,743	19.47
1879	827,607	15,473	18.69
Census, *1880	847,170	17,711	20.91
1881	866,000	19,515	22.52
1882	885,500	20,059	22.65
1883	905,500	20,076	22.17
1884	926,000	19,999	22.60
1885	947,000	21,392	22.70

* The average rate for the decade 1860–'70, was 23.12; for 1870–'80, 21.86; for 1880–'85, 22.53; and for the entire period, 1860–'85, 22.50.

It thus appears that but twice during twenty-five years has the death-rate fallen below 20; that it has risen during the past six years four in the thousand, and that the average of the past five years is greater than that of the past twenty-five years. These distinct intimations of increasing mortality point to neglect of sanitary improvements as the proximate cause. Nor do the comparisons so often made with other cities avail to remove the reproach.

The death-rate of a city depends upon many considerations of climate, topography, modes of life, occupations, etc. Among these a prominent one is the expansion or crowding together of the population, which is a much more important factor than the actual number of people themselves. Now in these respects there is no city in the world, great or small, more happily circumstanced, and in none, unless in certain exceptional cases, should the death-rate be lower than in Philadelphia. As a matter of fact however, there are many cities with lower rates, and those with which it is sometimes sought to make more favorable comparison are in every case vastly more crowded. Paris, for example, with 2,250,000, and a death-rate of 26.3, has on the average 29 people in every house. Berlin, with 2,000,000, and death-rate the same, has 63 persons to the house. New York, with 1,500,000, and death-rate 30, has an immense tenement population, and an average of 13 to the house. Of the cities having over a million London in this respect more nearly resembles Philadelphia.

That ancient metropolis has a population fourfold that of Philadelphia, with an average of 8 persons in a house to less than 6 in Philadelphia; but the improvements made in water supply and sewerage have, since the works were completed, in 1871, steadily reduced the mortality until it is now much lower than with us. For the decade 1840–50 the London death-rate was 24.8; for 1850–60, 23.7; 1860–70, 24.4; and 1870–80, 22.5. For 1882 it was 21.4, and for 1883, 20.4.

Other things being equal, London, with her greater and more compact population, must of necessity have a higher death-rate than Philadelphia, and the conclusion is inevitable that with proper engineering constructions to secure good water, improved pavements, a scientific system of drainage, and the abolition of cess-pools and other relics of barbarism, the death-rate in Philadelphia could readily be reduced to 20, and in all probability brought down to 18 in the thousand. But a reduction from say 22.70 (the rate of 1885) to 20, means, with the present population of Philadelphia, the annual saving of over 2,500 lives and an immense and unrecorded amount of unnecessary illness, privation, and distress. It must be observed also that the crushing burden of this superfluous suffering and loss inevitably falls in larger measure upon the very class of our population whose perpetual struggle for existence, heavily handicapped by comparative ignorance and poverty, renders them easy victims, and constitutes them the natural wards of those whose more ample means and superior intelligence and information should in the common interest be directed, in part at least, to the amelioration of the conditions investing their fellow-citizens of the laboring classes. This view of the matter, obvious as it is, does not seem to have occurred to those responsible for injudicious economies which have consulted merely the pockets of the property-owner at the cost of the lives and health of the laborer and the mechanic, whose rented habitations, modest as they are, return larger interest to the owners than any other class of buildings in Philadelphia.

It is possible that when these classes shall have been adequately advised as to the situation, and sufficiently informed as to the importance to them and their families of relief from the imposition of such painful and unnecessary burdens in addition to those which they must in any case bear, the suggestions that will reach the city authorities will produce greater result than those which have heretofore emanated from other and less influential sources.

(Resolution introduced in Common Council by John J. Ridgway, March 31. Adopted by both Chambers same day.)

RESOLUTION

Of request to the Chief Engineer of the Water Department to cease publicly agitating the condition of the water supply of the city.

WHEREAS, The Chief Engineer of the Water Department has been giving public lectures on the injurious qualities to health of the present water supply and the extreme probability of an epidemic arising from the use of said water, which statements are widely circulated in our own and other newspapers, as will appear from the following extract taken from the *Philadelphia Inquirer* of this morning:

"Colonel Ludlow said that the remedy would be to have large subsidiary reservoirs, and then to filter the water. This, however, would involve considerable expense, as it would require an acreage of filter beds as large as the present basins. A survey had shown that at Point Pleasant, on the Delaware, water nearly as good as at the Water Gap could be obtained at a cost of about $7,500,000. He regarded the Delaware as the scheme of the future. The sewer system should be investigated. There should be no baby talk about it or fears of frightening the public. The simple and effective means of preventing cholera is to thoroughly guard the water supply from pollution. Leaving out of consideration the misery and suffering they entail, epidemics are costly.

"In St. Louis, in 1866, out of a population of 200,000 3,527 people died of cholera, a death-rate from that cause alone of nearly 2 per cent. St. Louis, though well supplied with wholesome water, permits the existence of over 7,000 wells, from which over half the houses take their polluted water. The outbreak of cholera in Europe last Summer was traced beyond question to pollution of the water supply in Marseilles, Toulon, in Genoa and Naples. The small-pox epidemic in

Philadelphia, in 1870 and 1872, cost the community over $20,000,000.

"The number of people inhabiting the drainage area above Philadelphia is over 350,000. It is within the city limits themselves, and under the direct control of the city authorities that the gravest and most dangerous pollution exists. No less than four city sewers, about 2 miles in length, have for a generation and more, poured their foul fluids into the pool, contaminating the drinking supply of 900,000 people with the waste matter. There are thousands of wells in use in the city, some 2,000 of which have been reported to the Board of Health for examination. Not less than 1,200 of these exist along the lines of city water-pipes. The importance of closing these wells and pumps can hardly be overestimated."

AND WHEREAS, It is impossible for the great mass of our citizens not to use this water for themselves and their families, and no arrangements can be made altering the present supply until some years have elapsed, even if his suggestions be entirely adopted.

AND WHEREAS, Such statements are calculated to seriously injure the business prosperity of the city, by driving or keeping away strangers, and to alarm a community already greatly excited by the fear of cholera.

AND WHEREAS, Notwithstanding all that is said, the general health of the city does not indicate such direful results from the use of the water as are suggested by the Chief Engineer, but on the contrary the analysis, as made by the Department, shows our water supply to be the best given to any city in the Union except Chicago. Therefore be it,

Resolved, by the Select and Common Councils of the City of Philadelphia, That the Chief Engineer be requested to refrain at present from the public agitation of the subject, which is being carefully considered by Councils, and will not be facilitated by the above course.

Reply of the Chief Engineer to above Resolution of Councils.

Philadelphia, April 2, 1885.

To the Select and Common Councils
of the City of Philadelphia.

Gentlemen:—I am in receipt of the resolution passed at the meeting of Councils on Tuesday last, requesting me to refrain from public agitation of the condition of the water supply.

I should always be prepared to receive with respectful consideration what might appear to represent the judgment of Councils upon any matter affecting the Department of which I am in charge, but in the present instance, apart from the unusual nature of the request, there are two aspects of the case which render it incumbent upon me to make reply, both in my own behalf and the interests of the community.

The resolution is based upon a lengthy preamble containing numerous serious misstatements and grave errors of fact and inference which should not go on record without correction. The newspaper quotation which constitutes the greater part of the first "whereas," is an imperfect abstract of an address recently delivered by me at the request of the County Medical Society. In this report various unrelated matters are thrown together, so that statements under one head are made to appear as referring to another.

To amend this, I beg to transmit herewith printed copies of my address as delivered, examination of which will serve to point out the numerous errors of the preamble.

The address was upon the relation of water supply to sanitation. It did not dwell upon the injurious qualities of the present supply, but pointed out what may be hereafter a danger from its local pollution. There is no intimation of probability of an epidemic from the present use of the water; on the contrary, it is stated that there need be no danger whatever of this kind, even in the future, if certain precautions therein distinctly set forth shall be taken.

The second "whereas" states that it is impossible to avoid the use of this water, and that years will be required to make the necessary amendments.

The address states that all that is necessary is to cut off the local sewage pollution of Fairmount pool, and to close the numerous wells in the built-up parts of the city from which drinking water is taken. All this could be readily accomplished in a month or two at most, by temporary use of privy wells, thousands of which now exists throughout the city, and by filling up the polluted drinking wells. This done, the danger of an epidemic of cholera would be reduced to the minimum.

In the discussion which followed the address, it was further stated that the simple expedient of thoroughly boiling the water, even should it contain disease germs, would probably suffice to render it innocuous.

The third "whereas" deprecates an alleged loss of business and popular alarm. It is inconceivable how the formulation of simple measures for the prevention of an epidemic, and the advocacy of their practical application, can arouse undue apprehension. It would appear, on the contrary, that nothing could be more reassuring than an explanation of their entire effectiveness and facility of application.

The fourth "whereas" suggests the singular argument that the present general health of the city being satisfactory, there will be no danger in drinking water which may hereafter become the source of disease unless certain matters are excluded; but the general health of the city cannot be regarded as satisfactory, and in this connection I make the following quotation from my annual report for 1883, pages 59 and 60:

"With all its fortunate conditions, climatic and local, the expansion of its population and the intelligence and good conduct of its citizens, Philadelphia has a higher death-rate than London, notwithstanding the greater age of the latter, its population of four millions to Philadelphia's one and the average of eight persons to each house against less that six in Philadelphia. To a great extent this relatively high death-rate is chargeable to the diseases known as zymotic, and classed as preventable, viz.: typhoid fever, diphtheria, scarlet fever, *et al.* Philadelphia kills one person in a thousand more than London. In all, the lives of more than one thousand persons are uselessly sacrificed every year, and the health of thousands more impaired. The causes of this are a sewage polluted soil, bad water, defective sewerage, defective highways, and defective plumbing. The responsibility for these things does not rest with the people, who cannot be expected to fully appreciate or understand them; but upon those whose business it is to know and whose duty it is to make them plain, and to indicate and provide the proper remedies."

The final statement that analyses made by the Department show our water supply to be the best of any city in the Union except Chicago, is the most remarkable of all. There is no basis for this statement, and no analysis can establish it. Several cities have a purer supply, and the exception made of Chicago is not fortunate, since the drifting lakeward of the city sewage has at times caused serious pollution at the intake and compelled the consideration of an extension of the conduit.

The address itself states that, notwithstanding the pollution above, the water as it reaches Flat Rock Dam is often in a very satisfactory condition.

But aside from any question of the quality of Schuylkill water in general, the fact remains that the most serious pollution takes place within the city limits, and that were the water at Flat Rock Dam drawn from the purest mountain lake, the local pollution would still remain a source of danger and disgust.

The statements in relation to our water supply are based upon thoroughly ascertained data, which have been communicated to Councils in official reports during the past year. The greater number of these were published a year ago in the annual report of the Department for 1883, and can be fully corroborated by any one who chooses to make the necessary investigation.

The second aspect of the case to which I have referred, is the character of the discussion preceding the passage of the resolution. This, from the evidence of witnesses, was marked by the unrebuked indulgence of some of its prominent advocates in a brutal intemperance of language unbecoming a legislative assembly, and in personal abuse and misrepresentation of an executive officer who should have been protected therefrom both by his absence and by the dignity of the Chamber itself.

In the broad view I am persuaded, that while a general and needful movement of our citizens is making to improve the sanitary condition of the city, no aid can be extended so reasonable and effective as the promulgation of the exact facts, and the indication of the most direct and effective means of amendment.

Panic is born of a vague terror of the unknown, and has no relationship to that clear comprehension of a source of possible danger and of the means of avoiding it, which promotes calmness and justifies confidence.

Very respectfully,

WILLIAM LUDLOW,

Chief Engineer.

WATER SUPPLY IN RELATION TO SANITATION.

An address to the County Medical Society of Philadelphia, by Col. William Ludlow, delivered March 30, 1885.

MR. CHAIRMAN, LADIES AND GENTLEMEN:

The subject upon which I have undertaken to address you this evening, in compliance with the request of the Committee, is that of "Water Supply in Relation to Sanitation."

Considering the grave importance of this subject, its intimate connection with the welfare of the community, and in particular the technical character of its relation to the great question of public health, I may well be pardoned for entertaining some misgivings as to the wisdom of assigning me so responsible a task; but my practical connection with the actual supply, and, in particular, the urgent need that exists of an expansion of information, professional as well as popular, forbade hesitation in undertaking what might be regarded as a public duty, and an opportunity, perhaps, to discharge in some slight measure a public service.

Composed, chemically, of two gaseous elements of great subtlety, which, so far as we can ascertain, exists throughout the universe,—water, like a protean spirit, under numerous and constantly changing forms, pervades earth and sky, and is an almost invariable constituent of the materials of our sphere, as well as a nearly universal solvent.

Under its ordinary aspect it controls the physical features of the globe, forming seas, lakes, and rivers, bounding continents, regulating climates, and furnishing that pleasing diversity of view that makes the world so agreeable a habitation.

Born of the ocean, under the benign influence of solar warmth, it rises into the atmosphere in the form of aqueous vapor, conserving that moderate range of temperature which is needful to our existence, protecting us both from blazing heat and cosmic cold, painting the scenery of the sky, the glories of the sunset, and the pure beauty of the rainbow, and in the form of mist and rain refreshing the earth with its grateful influence and taking its course again to the sea.

Aside from his daily physical need of it, man early recognized the beneficial character of water, and with that persistence and ingenuity which have given him the mastery of the globe, developed the means of making it useful to him. The waterfall turned his wheel and ground his corn. The river floated his raft and transported his products; but it was when he discovered the potency of the spirit which could be evolved by applying heat to water in captivity, that steam became at once the most powerful and docile of his servants. By the aid of this force he traverses earth and sea with incredible speed, and multiplies the centres of industry everywhere; but with a careless ignorance and reckless absorption in the present, he failed to perceive that in some respects he has been sowing the seeds of his own destruction. Air, water, and food are the imperative necessities of our existence, and without a suitable and timely supply of all three, we presently perish. Of one, we inhabit the depths of an enveloping ocean, and its inhalation goes on unceasingly and almost unconsciously day and night throughout our lives. Absorption of the others, though less frequent, is likewise indispensable. But the conditions of our earthly sojourn are somewhat more arduous in this respect, and require that we shall procure them for ourselves. It follows that man, in common with all other animals, is impelled to constant effort to procure his daily supply of food and drink, of which water constitutes by far the greater proportion. The almost universal presence of water has made its procurement a matter of no great difficulty. The spring, the lake, and the flowing stream are of ready access; or, if absent, a shaft sunk to a moderate depth in the earth, or a cistern to store the rain, furnishes the needful supply.

Unfortunately, as the world became older, as populations and industries increased, as modern organized communities sprang up and grew, and the complexity and artificiality of vital conditions increased, the twin sciences of physiology and hygiene failed of corresponding development, and in consequence the beneficial element became in part converted into a deadly enemy.

The farmer dug his cesspool and his well in convenient propinquity, deposited in one the waste and effete matters of his household, and contentedly drew from the other his supply of water, boasting of its purity and sparkle, and failing to suspect its dangerous quality. If typhoid invaded his home the village physician was summoned, who lent his best skill and exhibited his accustomed drugs. If death came, all heads were bowed to what were assumed to be the stern dictates of an overruling Providence, and the old oaken bucket continued its journeyings.

The village pump, drawing water from a permeable stratum, to which numerous adjacent cesspools had access, as well as the surface drainage from neighboring roads and pig-pens, was resorted to both for water and gossip, and a suggestion to remove its handle would arouse the greatest opposition, even were a pestilence prevailing.

Towns and cities on the banks of rivers, took thence their supply, and constructed elaborate provision for furnishing every house lavishly with baths, wash stands, and all the recognized conveniences of modern civilization. But the outflow thence went again to the river to be again pumped and distributed; and the pipes that brought the water, and the drains that carried it off, conjoined in the dwelling to make it the battle-ground of the contending principles of life and death. In consequence, fatal plagues fell upon men, especially those herded in cities; but it was long before the true cause was even suspected. People shuddered under the mysterious and fatal finger of death and fled from the scene, abandoning their homes and even their dying; but, by a fatality that was apparently needed to clearly indicate the source of danger, sent back from a distance for the water to which they were accustomed, and thereby likewise perished.

Before pursuing this important line of thought, let us devote a few moments to the consideration of the physiological aspects of water.

In the first place, it is the universal sustainer of Life. Without it no form of living organism with which we are acquainted can exist. It is an essential part of all tissues; constitutes a large proportion of all foods and beverages, and is the normal carrier of nutritive material, as well as of waste products.

Water composes over 70 per cent. of our bodies by weight; and a man weighing 150 pounds will, therefore, be about 109 pounds water. In vegetable food the percentage of water varies from 5 to 96; in animal food from 10 to 86, with an average for both of about 55 per cent.

The total daily amount of meat and drink needed to maintain the vital functions, on an average dietary, is about 7 pounds, of which 80 per cent., or $5\frac{1}{2}$ pounds, is water, and 20 per cent., or $1\frac{1}{2}$ pounds only, is dry food—or in the proportion of 4 to 1. As food, in its ordinary condition, is over half water, the proportion, by weight, of food to drink in practice becomes about 3 to 2. An average man will, therefore, take into his system in every month at least his own weight of water, and during a year nearly a ton, leaving out of account the sometimes very considerable amount absorbed beyond what is really needful or beneficial. Deprived of it, he dies of thirst before he perishes from lack of food.

The daily waste, of course, is in corresponding amount. We exhale it in our breath, lose it by transpiration, and discharge it by means of the appropriate organs; and it is in this condition, as the carrier of waste products, that water ceases to be the preserver of life, and assumes the character of a positive danger and a possible destroyer.

To understand clearly how this may be, it it necessary to have recourse to the considerable body of facts that have been gathered by those acute and ardent students of natural science, who devote themselves to exploring the mysteries of pathogenesis—the causation of disease. The study is surrounded with most formidable difficulties, which long baffled the most persistent investigation; but, of late years, improved methods and appliances have secured valuable results, and indicated the lines of exploration for further successes.

Bacteria are microscopic plants, occupying the lowest place in the scale of living things. For convenience of designation, they are divided into two general classes, according to their form and mode of propagation, viz., the micrococci, of spheroidal shape, and reproducing themselves by fission, and the bacilli, which are rod-shaped or spiral, and throw off minute spores or seeds.

The function of bacteria, in the scheme of nature, is apparently to pull apart the more complex tissue of higher organisms and resolve it into its original elements. They are the invariable accompaniments of decomposition, and are extremely persistent of life; multiplying, too, under favorable circumstances, with an incredible rapidity, and requiring the presence of moisture, with a not too great range of temperature. A great variety of these organisms is known; not all of them, perhaps a few only, harmful. In fact, it is evident that, so long as they are engaged in decomposing matter which is effete or no longer living, they are serving a useful and, indeed, an indispensable purpose. It is when they exhibit or develop a capacity to operate upon living tissue, especially in beings of a high type, so as to endanger vital processes, that they become the most insidious and, as experience has shown, the most deadly of foes.

Now, it has been clearly proven, in the case of certain diseases, that the bacterium peculiar to this or that disease is the cause of it: that is to say, the disease can be reproduced in a healthy subject by inoculating it with that particular and readily distinguishable bacterium. Experiments of this kind have naturally been made mainly upon the lower animals; but in certain cases it is no longer doubtful that man himself is the frequent victim of the invisable and swarming myrmidons. It seems probable, in fact, though it cannot yet be positively asserted, that all or nearly all of the infectious diseases are disseminated by this means; but it has been shown by all the data carefully gathered and studied, that the epidemic intestinal diseases, the choleraic diseases, and typhoid fever, are communicated by means of the specific poison or special disease-germ being absorbed in drinking water. The physical and sanitary data on this point are entirely conclusive, and although the microscopic proof is not yet complete, the fact is hardly longer in doubt.

Numerous thoroughly authenicated cases are of record, proving that water which has been polluted, though but slightly, with discharges from a person ill with cholera or typhoid fever, is the most direct and certain, and probably the sole vehicle for the transmission of those diseases. A few illustrations of this may be given:

Up to twenty-five years ago Glasgow drew water from the Clyde, which received the sewage of the city, and the successive cholera epidemics of 1832, 1849, and 1854, showed bills of mortality of from 10 to 15 per thousand of population. In 1859, the source of supply was changed to Loch Katrine, one of the purest waters in the world, and in the next cholera epidemic of 1866, the mortality was $\frac{1}{100}$ only of the former rates.

London is supplied by several private companies—some of which formerly took water from that portion of the Thames into which the sewers emptied. In the epidemic of 1849, it was found that the mortality within the jurisdiction of these companies, varied from $\frac{8}{10}$ to $16\frac{3}{10}$ per 1,000, precisely in proportion to the degree of pollution of the source. Previous to the next epidemic one of the companies moved its source up the river, and in consequence diminished its propagation of poison, as shown by the death rate, over two-thirds, the other conditions remaining unchanged. One side of a street, for example, was decimated, while the other, supplied from a purer source, escaped.

These observations were made on a large scale, and in the absence of our present precise knowledge of the existence and action of disease germs.

But more dramatic cases of dissemination can be cited, as, for example, the famous one of the Broad Street Pump. In London, in 1854, a case of cholera occurred in a crowded district, and it was shown that the alvine discharges had been thrown into a drain which passed within a short distance of the pump. The subsequent outbreak was of great intensity, and over six hundred people lost their lives; and it was clearly proven that those who escaped did not use the water, while those who suffered did, including a number of people living at a distance, who were in the habit of sending to that particular pump.

Another striking case is furnished by the town of Caterham, England. The supply derived from deep wells in the chalk, was of a high order of purity. The company had occasion to sink a new well and connect it with the others at a depth of over four hundred and fifty feet. While the work was in progress, an epidemic of typhoid fever broke out, affecting over three hundred and fifty people, and killing twenty-one. By the most thorough investigation, this outbreak was clearly traced to a workman employed at the foot of the well, who, being ill of the fever, took all the precautions he could to prevent an offense, but some portion of the alvine discharges reached the water, and was thence distributed.

I will not weary you with multiplied instances. My time is brief, and I do not seek to prove a case which the instructed sanitarian admits, so much as clearly to bring before you the essential facts.

While, however, there is little or no dispute that infected water may be a common carrier of disease, and that the continuous propagation, especially of intestinal epidemics, is effected by its means, it has been contended that polluted water, by artificial filtration or its flow in natural channels, will free itself of dangerous matters, and become again pure and wholesome.

The advocates of this theory depend mainly upon negative evidence, while the positive evidence all points unmistakably in the opposite direction. It is true that many towns and cities drink more or less sewage—perhaps most of them do—without causing a serious epidemic to prevail constantly. It is true, also, that a flowing stream exposed to sun and air will gradually effect, to a considerable extent, the elimination of matters which to the eye and nostril are offensive. The oxygen of the water, no doubt, tends to effect the destruction of nitrogenous compounds, and convert them into innocuous residua. But how shall it be shown that the living germs of disease, which are proved to have been transported for many miles in an open stream, are to be destroyed? Chemistry is helpless to discriminate between living organic matter and dead organic matter in such a state of diffusion. An admixture of what might be called "healthy" sewage—however it might disgust the sensibilities—can, no doubt, be absorbed without inevitable injury; but how is it possible to assert that the sewage is "healthy" or diseased, and knowing what we do of the fatal character of certain diseases, and of the mode of their propagation and transmission, what safe or decent course is there other than the rigid exclusion from our water supply of all those foul waste matters which the instinctive impulse of every animal rejects, and which, over and over again, have been proven to convey the seeds of death—whose vitality is persistent, and whose presence or absence could only be positively determined by actual tests upon living beings.

Filtration is highly advantageous, and indeed indispensable, for waters lacking clearness and transparency, or loaded with sediment; but with regard to protection from disease, the evidence of its ineffectiveness is conclusive. A crucial illustration of this is the noted case of Lausen, a small Swiss mountain hamlet much resorted to for health. The water is taken from a spring flowing from the heart of the mountain above the village, received in a covered reservoir, and thence distributed. Six houses only had a separate supply. In 1872 typhoid broke out, and not a house escaped but the six.

Patient investigation disclosed the cause. In a neighboring valley the fever had existed, and it was found that at a certain place the water from a small stream escaped into the mountain which separated the two villages. It was proved that the escaping water had been contaminated with discharges from typhoid cases. It remained to connect the Lausen spring with the polluted water. For this purpose a quantity of salt was dissolved and the solution poured in where the water had disappeared. On the next day the Lausen spring was salty. A quantity of flour was then tried, but the spring remained perfectly clear, and not even a chemical reaction of starch could be obtained.

It was manifest in this striking case, first, that the fever was brought from the adjacent valley by the water flowing under the mountain; and, secondly, that this water was so thoroughly filtered that, although the salt solution was found to appear, no trace whatever of the existence of the flour could be discovered, even by the aid of a refined chemical analysis.

The typhoid germs, however, had passed through the most minute interstices, without loss of vitality, and fastened upon the intestines of their healthy victims with deadly virulence. How, in fact, is it to be expected that bacteria can be intercepted by a filter? The smallest possible drop of water would be a home and nidus for millions of them, and they would pass thousands abreast through the pores of any filter adapted to the flow of water.

We may say, therefore, that a satisfactory drinking water must, as nearly as may be, comply with the following requirements: It should be transparent, without color, odor, or taste, cool and sparkling, with but a small amount of mineral matter in solution, the least possible quantity of organic matter, animal or vegetable, and be absolutely free from excremental pollution. In a community so happily provided for, cholera could not endure.

Sporadic and imported cases might occur from time to time, but could be completely isolated, and the infection exterminated. There should be no more danger of cholera and typhoid fever in a well regulated community than of small pox; and the existence of any of these filth diseases, as they are appropriately termed by sanitarians, is simply a disgrace and a blot upon civilization.

We do not know how to cure cholera. It claims about as large a proportion of deaths to seizures, with medical treatment, as without it; but we are armed with a better knowledge still, viz.: how to *prevent* it; and the simple and effective means of doing this is to thoroughly guard the water supply from pollution by matters which have been derived from the patient, and may contain the specific poison of the disease.

It is the same with typhoid fever. It may, very possibly, be the same with some other diseases. And with this knowledge in our possession, is it not evident that the Sanitary Engineer must be called upon to plan and direct the construction of the necessary works?

The matter of the protection of the public health, from those epidemics at least which owe their continuance and propagation to contaminated drinking water, must therefore be regarded as one of the most important branches of municipal control; second only, if second at all, to the suppression of crime.

Leaving out of consideration the misery and suffering they entail, epidemics are costly. I was in St. Louis in 1866, when out of a population of 200,000, 3,527 people died of cholera—a death rate from this cause alone of over 17¼ per thousand. The trade of the city was completely crushed for the entire summer; and I well remember the dread and anxiety depicted on every face, and the deadly pall that hung over the city, which the gutters, reeking with the pungent odor of chloride of lime, and the black smoke of the blazing tar barrels converted into a veritable Gehenna.

The time has long since gone by when remedies such as these are recognized; nevertheless, so slow are people to act, and so urgent the need of sanitary information, that, to-day, St. Louis, though well supplied with wholesome water, permits the existence of over seven thousand wells, from which over half the houses take their polluted water for domestic uses. St. Louis is simply insisting upon another epidemic.

The outbreak of cholera in Europe last summer was traced beyond question to pollution of the water supply in Marseilles and Toulon, in Genoa and Naples, while neighboring cities supplied beyond contagion escaped. The cost to the victimized communities in actual loss of money could not have been less than $100,000,000, and was perhaps twice that amount. Dr. Benjamin Lee, President of the American Academy of Medicine, proved that the small-pox epidemic in Philadelphia, in 1870 and 1872, cost the community over $20,000,000. There were 20,000 cases and 4,500 deaths. In 1849 the cholera in Philadelphia killed over 1,000 people, a rate equivalent to about three deaths per thousand of population. Were a similar epidemic to occur again, the death roll would be, with our present population, about 3,000, and the actual loss to the city would be equal to or even greater than that incurred in 1870–72.

How, then, does Philadelphia stand, with reference to its water supply? A few data will show. The average daily pumpage is 70,000,000 gallons,—70 gallons to every man, woman, and child. About 300,000 tons of water raised by the huge pumps, working night and day, to the height of the city basins, a quantity equivalent to the contents of a reservoir fifty feet deep and the size of a city square filled and emptied daily.

The quantity is ample, even lavish. About forty gallons per day per head of population is all that under existing circumstances could be really used. We have few fountains and no sewer-flushing arrangements; about thirty gallons each, then, is wasted. Philadelphia is gluttonous of water, but never has enough, because she wastes it. The great East Park reservoir itself, capable, were it finished, of holding 700,000,000 of gallons, would contain ten days' supply only, at this rate of draught, if the whole city should draw from it.

With the waste stopped, the water would rise to bathrooms and tanks which have long been dry and dusty. Of course new mains and distributing pipes are needed also.

The water is taken from both rivers; a small part only from the Delaware, at Lardner's Point, above Bridesburg; the remainder from the Schuylkill at several points above Fairmount Dam. It is drawn from the stream and sent to the basins, which hold only about two or three days' supply, and the water is therefore delivered to consumers pretty much in the condition in which the river furnishes it, without subsidence or filtration; and if so, what is this condition?

The Schuylkill drains its valley, and receives the waste products of its industries and population. The number of people inhabiting the drainage area above Philadelphia is over 350,-000. Nevertheless, the water is often in apparently good condition when it reaches Flat Rock Dam, above the city. It is within the city limits themselves, and under the direct control of the city authorities that the grossest and most dangerous pollutions exist. No less than four city sewers, about two miles in length, have for a generation and more poured their foul fluids into the pool, contaminating the drinking supply of 900,000 people with the waste matter and excremental pollution of 7,000 or 8,000, in addition to the discharge of dye-stuffs, wool-washings, and foul refuse from the mills which line the banks and overhang the stream.

Suppose, now, that in some of the purlieus of Manayunk, or the Falls of Schuylkill, or among the operatives in the mills, some of which are indescribably filthy, an intestinal epidemic disease should effect a lodgement. There is absolutely no chance that the discharges shall not reach the river, and if they do, they will, beyond question, be taken up by the pumps at the stations and thence distributed.

Steps have been taken during the past year by Councils and the Departments of Law, Health, and Water, to amend this dangerous condition of affairs: but the city has put herself in the wrong by failing to make proper arrangements for drainage, and the force of inertia and selfish resistance are difficult to overcome. It will be accomplished, but only by great insistence in the face of constant opposition.

In addition to the danger from the pollution of the Fairmount pool, which is, in effect, the reservoir whence our main supply is drawn, is an equally obvious but less general peril. There are thousands of wells in use in the city, some two thousand of which have been reported to the Board of Health for examination. Not less than twelve hundred of these exist along the lines of city water-pipe; and only the ignorance of the occupants and the selfishness of the owners, interfere to prevent attaching to the city mains and thereby reducing the risk of infection. The importance of closing these wells and pumps can hardly be over-estimated. The water is often superior in clearness and coolness to the city supply, and has a sparkling appearance which makes it attractive to those who are ignorant that its pleasing aspect is due to the dangerous qualities which it conceals. A case in point:

A gentleman of prominence, dissatisfied with the inferior quality and deficient quantity of the supply to his extensive offices on Walnut street, sunk a well and found a stratum of water which highly commended itself for its excellent appearance. It seemed as though certainly a source had been reached which was beyond criticism; but at my earnest request, before using the water, he submitted samples of it to a competent chemist for examination. He later sent me a copy of the chemist's report, and abandoned the well. The report said:—"For boiler purposes the water is useless, and for drinking purposes absolutely poisonous."

If this was the condition of a well eighty feet in depth, penetrating through a clay stratum and reaching a layer of water-bearing gravel, what are we to assume of some others, sunk into a soil polluted with generations of accumulated excremental poisons, and tapping strata which drain an unknown number of the privy wells and cesspools with which the city abounds. The Board of Health will no doubt abolish them.

But this local view of the question even does not suffice. The most important water-supply to a class of our population the most helpless and the most cherished, and at the same time that among which the greatest mortality takes place, is milk. I refer, of course, to infants. Nothing is more certain than that an impure milk supply is one of the most serious causes of sickness. It has been shown, beyond possibility of question, that typhoid fever, cholera and the diarrhœal diseases to which young children are especially subject, have been transmitted in milk. Cow's milk is eighty-six per cent. water, and it is sufficient that in the farm-yard which it inhabits the cow shall have access to a pond or trough or be watered from a well which has been contaminated with the specific poison of disease, to transmit that disease to all those to whom her milk is served. If therefore, we would adequately protect our people, it is manifest that the jurisdiction of our health inspectors must, by some means, reach the points whence fatal infection may come.

I have sought, in this imperfect manner, to touch upon the leading points of a most vitally important and intensely interesting subject—which opens up the whole field of hygiene. "An ounce of prevention is worth a pound of cure." Medicine may save a sick man's life—sanitation will preserve his health.

Health is at least as valuable to us as our pocketbook. It will come to pass that we shall have as much right to insist upon health as upon honesty. There are diseases which are crimes. The filth diseases are such, since they are preventable. The community is punished; but, unfortunately the rod falls alike upon the guilty and the innocent individual. It is the community that is guilty, and the community must reform itself.

I have sought to confine my remarks to those points which had the most direct and obvious bearing upon the matter of water supply; but, gentlemen, it occurs to me, in indicating how far our city falls short of being in a satisfactory sanitary condition, to inquire how happens it that this should be the case.

Philadelphia is, in this country, the mother of medical science, educating yearly in the art of healing, and sending out to the world, hundreds of bright young minds infused with professional enthusiasm, and ambitious, not only for success, but for that greater crown, the laurel wreath of the benefactor. Can it be that in this city of science and culture these things that lie before us, patent to every sense, have escaped all observation, or is it that the fatalism of the East has seized upon the intellects that should have grasped the situation so that, instead of sending out the cry of warning they have shrouded their heads and awaited the inevitable coming of the destroyer? Among the general public, I grant, it is customary to lay the blame upon the city authorities; and should misfortune befall, to heap execrations upon those whom they themselves have selected to represent them, forgetting that the fountain may not rise higher than its source, and that as an analogical hydraulic fact, it cannot rise even so high, owing to the friction and duration of the passage.

It is not to be expected that people occupied in daily toil, and chiefly concerned with the primal duty of providing for their families, have time or opportunity to investigate abstruse matters, or to undertake the responsibility of pointing out the measures that should be taken to provide for the public welfare. To rest upon an unformed and uninstructed public opinion to eventually work out these problems, is simply to do nothing but to lag behind civilization in its efforts to drag the world upward to a higher plane of existence and thought. Upon whom, then, does this responsibility rest—the answer is inevitable—upon those who have the knowledge, the means, and the opportunity.

The average citizen does not ride over the barbarous cobble pavement. He goes in a street car and is ignorant of the disadvantages and loss due to a noisy pavement, destructive to traffic and prejudicial to health from its permeability to street fluids and the impossibility of cleaning it. If the water be only tolerably muddy he does not complain, unconscious that the ailments that have weakened his strength and lost him many a week's wages, are due thereto. If his child sicken, he grieves, but fails even in his mind to charge the doctor's and undertaker's bills to the farmer who furnished the milk, and whose own child had died with the same disease two weeks earlier. His wife is pale and languid, failing in health and spirits, and no longer adequate to the care of her house; but the sympathizing husband does not think to fill up the cesspool in the yard or to tear out the pump which sucks from an infected soil the source of her pallor and waning strength.

Let us look a little higher. How many of the comfortable and cheerful homes for which Philadelphia is famous are in good sanitary condition? In how many is the soil surrounding the house dampened and rotted with the leaking hydrant? How many unventilated closets are there from which the sewer gases steal out at night to poison the sleeper? How many pipes from which water is drawn for drinking purposes, have secret and unsuspected connection with the drains? How many sewer outlets underlie the cellar floor, and leaking, unperceived, are forming a pestilential lake of unspeakable filth, which emits upward through the moistened floor the most repulsive though unobserved vapors? Be it remembered that the most fatal sewer gases are not apparent to the senses. It is evident that not only the homes of the honest and industrious artisan, but those of the well-to-do and rich are in need of examination. I have mentioned no illustrations of which I am not personally cognizant. Philadelphia has bitter need of the immediate and stringent application of the laws of sound sanitation. She has no sanitary engineer in her official employ; no plumbing regulations or inspection; few building regulations, and those inefficiently applied; no proper system of sewerage: no inspection or flushing of sewers; a host of privy wells and cesspools, never cleansed and only emptied in part when the attention of the Board of Health is called to them; practically no inspection of food or sanitary inspection of houses. With the population and interests of a city of the front rank, possessing undoubted superiority over her sisters in many most important respects, mental and moral—in the matter of physical existence, we see this ancient and honorable city wallowing in the mire and incompleteness of a town of fifty years ago.

It seems almost incredible that with all the pride of citizens in their birthplace, their devotion to her name, and resentment of any imputation upon her fair fame, that these things should be as they are. It must be that some false principle, some malign influence has been at work to hold the city down these many years, and forbid her to rise to that sense of responsibility both to the world at large and to her own offspring which is clearly hers. But whatever may have been the errors and shortcomings of the past, whatever the lack of the present, the future of Philadelphia is in the hands of her sons and daughters, and upon their heads must rest the blame if ignorance and apathy shall control her fate and continue to demean her in the eyes of the world.

GENERAL AND MISCELLANEOUS REMARKS.

THE PLYMOUTH EPIDEMIC.

Several matters relating to water supply of much importance and interest can receive but passing mention.

The Plymouth Epidemic of typhoid fever which broke out with dramatic suddenness in April, and proved to be one of the worst on record in medical annals, furnished a most striking illustration of the necessity of the observance of the rules of sanitation, and in particular of guarding the water supply against possibility of contamination by the germs of communicable diseases. The prompt and well judged action of the Mayor in dispatching Drs. Shakespeare and French to investigate the cause of the outbreak resulted in establishing the fact that the epidemic that created such frightful havoc among a careless and unsuspecting community was due to the poison contained in the discharges from a single typhoid patient—which had reached the reservoir whence the water supply was taken and been distributed by the mains—so highly diluted as to be entirely inappreciable in amount, but charged with an appalling intensity of virulence that smote down almost at a blow 1,200 out of 8,000 people—and either as victim or mourner carried the entire community to the grave. It is thus that nature punishes criminal neglect and ignorance of her common laws, and to disregard such merciless instruction is but to invite fierce repetition of the lesson. Upon the State at large it had its effect, and the establishment of the State Board of Health followed with immense possibilities of usefulness to the Commonwealth. It is worth noting perhaps that the epidemic broke out within ten days after the passage of the resolution by Councils, designed to forbid further agitation of the question of protecting the water supply of the city from sewage pollution, but the warning was scarcely heeded, for in the subsequent proposed distribution of the gas surplus—although a million was allotted to the construction of an extravagant bridge of stone across the Schuylkill, not a dollar was appropriated to complete the Manayunk Intercepting Sewer.

Plumbing Regulations.

The State enactment directing the preparation and enforcement of suitable plumbing regulations in Philadelphia for the protection of the public as well as of the reputable part of the plumbing fraternity, was the final result of prolonged effort. The Department Reports for 1883 and 1884 contain somewhat extended representations of the importance of this matter, and it is a subject of congratulation that rules long since in force in other cities will shortly go into effect in Philadelphia. As a mere question of administration I am of opinion that the jurisdiction of the matter should have been vested in the Water Department instead of in the City Board of Health, but the absence of any legal status for the Water Department no doubt was an obstacle. The relations of the Department with the plumbing work of the City are extremely intimate, and by providing for a suitable person to supervise and correct the plumbing plans of new buildings and direct the amendment of the old, the services of the Department inspectors could have been used to enforce the execution of the law with but little additional expense. As it is, however, the new legislation which, it is creditable to the Master Plumbers of the City to say, was largely due to their efforts, will without doubt be productive of great good. The actual amount of defective and vicious plumbing in Philadelphia is very large, and years of resolute and persistent effort will be required to eradicate it. This is due in part to the fact that plumbing has heretofore been done by persons ignorant of its elementary principles and entirely without supervision, and in part to the general fact that the systems of plumbing in vogue ten years ago and then practised even by the best instructed plumbers, are no longer recognized as scientific or safe.

The Water Loan.

An interesting effort was made by several prominent citizens, under the lead of the late Hon. John Welsh, to secure funds for improving the water supply by procurance of legislation to authorize the issuance of a water loan, at $3\frac{1}{2}$ per cent., to the amount of $3,000,000, which sum was estimated as sufficient to secure a moderate increase in the storage and distribution facilities. Notwithstanding the opposition of the lower branch of the City legislature, the bill was passed by the State Legislature, but vetoed by the Governor—mainly on the ground of doubt as to its strict conformity with the constitutional limitations regulating the increase of municipal indebtedness.

Use of Frontage Collections.

From time to time, as occasions justified, I have recommended certain city legislation, which I believed to be of more or less importance to the Department. Among other measures which seemed advisable but did not apparently approve themselves to the legislating bodies, was a suggestion with reference to the use of collections of pipe frontage, *i. e.*, the refund to the City at the rate of two dollars per lineal foot of the expense of laying water-pipe.

This work is done out of a general appropriation made at the beginning of each year and the sum available is nearly always less than the amount required to lay the pipe authorized by ordinance in any one year. In consequence there is an increasing accumulation of work of this sort upon the Department books and in many cases undue and disadvantageous delay in laying pipe when required. The greater part of the pipe frontages is paid promptly and deposited in the Treasury, whence it cannot again be drawn without further appropriation. It occurred to me as an advantageous arrangement that the frontage charges so collected and deposited, if again made available for expenditure by a general ordinance could, in great part be used over and over during the year—enabling the Department with a limited appropriation to secure the laying of pipe costing in the end much more than the original appropriation—and yet so arrange matters as to leave the full amount in the Treasury at the end of the year. I consulted the City Solicitor on the question of the legality of this proposition and got his official opinion that as frontage charges were merely refunds and not moneys derived from taxation, Councils had full control of the disposal of them during the year for any legitimate purpose, and that the suggested arrangement was entirely proper and practicable. I have never quite understood why this proposition which seemed to me very advantageous and business-like—and would have much increased the practical value of the pipe-laying appropriation, failed of adoption—as with say $50,000 the Department in the course of the year would be enabled to lay say $150,000 worth of pipe and still have the original $50,000 on hand in the Treasury at the close of the year.

Department Offices.

I have urgently represented the advisability and justice both to the public and the Department officials, of adequate and proper accommodation for the transaction of the large and increasing business of the Department, but have entirely failed to secure favorable action. In the interest of those who continue in the service and must suffer from the numerous and serious disadvantages of inadequate space, impure air and physical discomfort, I renew my recommendation that without further delay such decent and suitable facilities for the transaction of the Department business be procured as shall serve the public interest, and conserve the health and well-being of the public servants. To one who has visited the headquarters of the Water Department and seen the long lines of old people, cripples and children exposed to every inclemency of weather, and the crowded condition of the Registrar's clerks who with every discouragement seek to perform their duties, no argument seems necessary. In many respects the situation on the third floor is little better, and it seems unworthy of the city that a department of such large transactions and which has been made to return so large an unearned revenue, should be provided with quarters so contracted and be subject to such unsanitary and unwholesome influences.

There are likewise to be recorded two other facts of an unpleasant nature: The Belmont main, repaired in the spring of 1883, and from time to time during the summer of that year used to bring water from the Belmont basin to the east side of the river, failed again late in the fall. As described in the Report for 1884, it was again repaired during that summer at a large cost, and as was supposed upon reports submitted, in a permanent and reliable manner, but late in 1885, when the reduced stock of coal at the Spring Garden station suggested the desirability of lessening the work of that station and increasing that of Belmont, the main was brought into requisition, and almost as soon as the pipe was filled, though the operation was conducted with great care by the Superintendent and Fourth Purveyor, it was found to be leaking so badly as to forbid its use. Subsequent investigation showed that a length of pipe which had been banded to close cracks, but was insufficiently secured, had given way. As the season was far advanced and the water at freezing temperature, no attempt was made to repair it, and I was therefore compelled to that extent to leave to my successor the legacy which I inherited in 1883.

The second circumstance to which allusion is made was the discovery in October last that a considerable apparent indebtedness had been created upon the private order of a Department subordinate, without the authority or knowledge of the Department, and in contravention of its well understood regulations, and of the law forbidding the incurring of obligations in excess of the appropriations by Councils applicable to the purpose.

The services of the employé in question were at once dispensed with, and the bills investigated. It was found that these were of such a character as to make their validity more than doubtful, aside from the question of their illegality. Those which were ascertained to be equitable were paid, and the remainder thrown out, leaving the owner to establish his claim for compensation for such portions of them as he might be able to show by legal procedure to represent actual service rendered the City, which could then make appropriation to pay them in part or not at all, as she chose.

CONCLUDING REMARKS.

In concluding my connection with a service which for three full years has engrossed my thoughts and activities I may be permitted a few words of final comment.

To furnish the present and future Philadelphia with such a water supply as her large and hereafter imperial needs will call for, is a labor demanding the exercise of all the professional skill, the forethought, sincerity, and wisdom that can be brought to bear upon it. While so much remains to be done that it may be said that only a beginning has yet been made, and while much more could have been accomplished had it been possible to procure the necessary sums in larger amounts than it was practicable to place at the disposal of the Department, and while I recognize too that much that has been done might have been better done could I have brought to its service a closer preliminary acquaintance with the needs and conditions of a business of such magnitude and complexity, I may nevertheless be permitted to look back upon the labor of the past three years with a certain sense of satisfaction, inasmuch as I have not knowingly spared any effort to accomplish useful results, or to meet the full measure of the duties and responsibilities of the office without reference to personal or other considerations foreign to the advantage and benefit of the community.

The results are shown generally in the rehabilitation of the Department into a fairly effective organization of men and material so far as that could be accomplished, operating at leastwith order and economy—in a considerably augmented water supply for large portions of the city, adding to the comfort, health and security of the citizens and the prosperity of dependent industries—a diminution of waste, which co-exists with scarcity and is in part the cause of it—a partial suppression of the more dangerous contaminations entering the supply within the jurisdiction of the city—large reductions in current expenses—and a heavy increase in the Department revenues without any material increase in the rates and in some particulars with reductions to certain important interests.

But in addition to these and aside from that marked general increase in public information on matters of sanitation to which I have been glad to contribute, I regard as perhaps most important of all the thorough investigation of the entire situation as regards both the present and the future, and the recording of those facts in permanent form upon which as a secure basis the work of the future can be planned with certainty, and entered upon without fear of failure. So far as I am aware no field of information has been left unexplored, and while the facts gathered could have been greatly amplified with more time and means, the essential features of the situation have been ascertained and recorded in the annual reports of the Department for the past three years. I am glad to believe that in this respect my services have been of some value to the community which it has been alike my honor and pleasure to serve, and I cannot avoid expression of recognition of the almost uniform consideration by which my work has been supported and encouraged in every quarter of any value, and which I am gratified to say has endured to the end.

The situation in 1883 was such as no community could afford to maintain, and unless remedied could only culminate in disaster. The Department had for years been run as a political machine in the interest of individuals, and made the harboring-place of henchmen who were quartered upon the City by the score and maintained at the public expense, although in many cases their services were entirely valueless, and in all cases political service and work of some sort were demanded as the price of appointment and retention. Honeycombed with intrigue and inefficiency, destitute of discipline or recognition of authority, disorder and waste prevailing, "politics" had truly brought the service into a perilous condition, and the Chief Engineer, harassed by his responsibilities but unable to shake off the bondage that paralyzed his usefulness, proclaimed the danger and announced an impending water famine.

The Department has been rescued from this condition by the application of methods the reverse of former ones. I accepted office upon the distinct condition that no personal or political consideration should influence my judgment or control my action. The Department was taken out of "politics" and called upon to devote itself to its legitimate work. Every employé of the Department was protected in the free exercise of his rights as a man and a citizen; no interference was attempted with his political opinions nor the proper and temperate expression of them, but undue political activity or conduct calculated to make him obnoxious to his fellow-citizens and impair his usefulness was forbidden. Personal solicitation was discouraged and appointments made only upon written applications supported by testimonials of character and qualifications from responsible business sources. It is by such means as these, and by these alone, that a service such as that of the Water Department can be maintained in fit or even respectable condition. To the extent to which it is used for so-called political purposes it is corrupted and demoralized.

While there is a large amount of technical work required, the most important duties of the head of the Department are administrative, and unless he can keep himself aloof from political entanglements and control, his usefulness must be seriously impaired if not entirely destroyed. The principles above mentioned steadily adhered to, purified the service and rescued it from the slavery that owns a master and dreads nothing so much as the withdrawal of his favor.

When it became a question of electing my successor the political conditions surrounding the Department had greatly changed from those of 1883. At that time the persistent efforts of large numbers of good citizens to purify the administration of city affairs had borne good fruit in the repression of former political potentialities, and the establishment in Councils of an unusually large number of men of intelligence, probity, disinterestedness, and freedom of judgment in matters of city business. In 1886 this so-called reform or independent element had disappeared and the regular political machinery had resumed full control. Even thus I was gratified to find that the integrity of my position was recognized. The situation was fully explained to me, with kindly insistence that I should accept the change in circumstances, and by suitable modification of past methods of administration be enabled to continue in charge of the Department. It was urged that this might be done with entire propriety, looking at the matter from a purely business point of view; that the Department had been kept out of politics for the past three years and could no longer be spared, since the loss of the Federal patronage had closed the doors of several former strongholds. I appreciated the logic of the situation, as well as the personally friendly sentiments expressed, but finding myself unable to accept the conditions the negotiation was closed. It is a matter of congratulation that the management of the Department has been entrusted to an officer whose prolonged connection therewith in positions of increasing labor and responsibility has made him thoroughly familiar with its numerous and intricate details.

In conclusion I beg to express my sincere thanks to the members of the Councils of 1883 for the honor of their selection to a difficult and responsible post, wherein I have earnestly sought to justify that exercise of their judgment, and to make due acknowledgment to the Councils of 1886 that in permitting me to withdraw from the service of the city their action was frankly based upon the ground of an alleged incompatibility of my political views with those of the majority, which it was not sought formally to establish, and was unaccompanied by any expressions of dissatisfaction with my administration.

In particular is recognition due to all those employés of the Department who gave it loyal and faithful service, cheerfully accepting the greatly increased labor imposed upon them by the strenuous effort to render it more efficient, and conforming in good faith to that disinterested co-operation with the head of the Department which is essential to the common interest, and which elevates the relation of subordinate and superior to that of mutual esteem and personal confidence without disturbance of the official organization.

The newspapers of a city are charged with great powers for good or evil, and in proportion to the intelligence and sincerity of their public discussion of men and measures is their usefulness to the community developed. It will be through their teaching alone that the public can be brought to feel that the city corporation is a business organization like any other, that every resident and taxpayer is one of its members, and that its affairs, closely affecting the domestic and business interests of every citizen, must be managed in the public behalf simply upon sound business principles.

This broad departure from the common acceptation of city office and employment will find no favor with those who, by the contrary view, use it for selfish purposes and are enabled to maintain themselves in power through an army of adherents whose service is paid primarily to their patrons, and secondarily, if at all, to the city which supports them. When it shall be clearly apprehended that this view of the public service is essentially servile and degrading, and inevitably fatal to economy and efficiency, and when the newspaper press will consistently and without equivocation or deflection maintain the proper attitude, all branches of the public service of the city will be rendered honorable in the community, and be prepared to command the employment and retention of men of adequate attainments and character.

APPENDIX

TO THE

CHIEF ENGINEER'S REPORT.

REPORT ON THE BOILERS AT THE BELMONT PUMPING STATION.

PHILADELPHIA WATER DEPARTMENT,
February 16, 1886.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—The following results were obtained from the test of the eight cylinder boilers at the Belmont Pumping Station. The test was commenced at 8 A. M. February 10, and finished at 8 A. M. February 11.

The City Boiler Inspector allows a pressure of 45 pounds per square inch by the gauge. The safety valves all lifted before the pressure reached 43 pounds per square inch. The steam escaped freely into the atmosphere in addition to running the Worthington pumps Nos. 1 and 2, each delivering at the rate of 6,000,000 gallons per 24 hours into the Belmont reservoir.

These boilers have been in use about fourteen years and run continuously night and day.

Particular attention was given to the steam pressure. Four steam gauges were attached to the boilers, two of which were known to be correct—the other two varied two pounds. The water and coal used by the boilers were both carefully weighed on scales prepared for the purpose, and all observations were checked at the end of each hour. Temperature of the outside air, fire-room, escaping gases and feed-water were all noted at regular intervals. Moisture in the coal was obtained by drying a sample and weighing it. The quality of the steam was ascertained by taking 16 calorimetric tests at regular intervals, using 300 pounds of water and 20 pounds of steam each time. Temperature of the escaping gases was taken with a pyrometer and registered at times as high as 1,100 degrees Fahrenheit. The economic evaporation from and at 212 degrees Fahrenheit is 2.93 pounds less than the result obtained from the Marine boilers at the Frankford Pumping Station.

Respectfully,
JOHN E. CODMAN,
Chief Draughtsman.

Results of the Trial of 8 Cylinder Boilers at the Belmont Pumping Station, Philadelphia Water Department, to determine their evaporative efficiency. Date of trial, 8 A. M., February 10, to 8 A. M., February 11, 1886. Duration of trial, 24 hours.

Dimensions and Proportions.

Type of boiler: externally fired, plain cylinder.	
Number in use	8
Diameter of boiler	54 inches.
Length of boiler	30 feet.
Number of furnaces	8
Diameter of drums (2—mud drums)	28 inches.
Length of drum	22 feet.
Heating surface in one boiler	500 sq. ft.
Total heating surface in 8 boilers	4,000 sq. ft.
Height of stack	100 feet.
Area of stack at base	25 sq. ft.
Grate surface, 5 feet wide, 5 feet long	25 sq. ft.
Water heating surface	4,000 sq. ft.
Ratio of water heating surface to grate surface	20 to 1

Average Pressures.

Steam pressure in boiler by gauge	41.6 lbs.
Absolute steam pressure	56.53 lbs.
Atmospheric pressure, per barometer, mean for 24 hrs.	30.421 ins.
Force of draught, in inches of water	0.784 ins.

Average Temperatures.

Of external air	40 °8 F.
Of fire room	56.°3 F.
Of steam	288.°78 F.
Of escaping gases	950.°7 F.
Of feed water	113.°62 F.

Fuel.

Total amount of coal consumed	75,499 lbs.
Moisture in coal, $=2\frac{63}{100}$ per cent	1,986 lbs.
Dry coal consumed	73,513 lbs.
Total refuse, dry $=13\frac{8}{10}$ per cent	10,144 lbs.
Total combustible (dry weight of coal, less refuse)	63,369 lbs.
Dry coal consumed per hour	3,063 lbs.
Combustible consumed per hour	2,640 lbs.

Results of Calorimetric Tests.

Percentage of moisture in steam	4.05 per cent.

WATER.

Total weight of water pumped into boiler and apparently evaporated....	471,763 lbs.
Water actually evaporated, corrected for quality of steam..........	452,657 lbs.
Equivalent water evaporated into dry steam from and at 212° F....	510,144 lbs.
Equivalent total heat derived from fuel in British thermal units....	492,617,560
Equivalent water evaporated into dry steam from and at 212° F. per hour....	21,256 lbs.

ECONOMIC EVAPORATION.

Water actually evaporated per pound of dry coal from actual pressure and temperature....	6.158 lbs.
Equivalent water evaporated per pound of dry coal from and at 212° F....	6.94 lbs.
Equivalent water evaporated per pound of combustible from and at 212° F....	8.05 lbs.

COMMERCIAL EVAPORATION.

Equivalent water evaporated per pound of dry coal, with one-sixth refuse, at 70 pounds gauge pressure, from temperature of 100° F.(=last item, "Economic Evaporation," multiplied by 0.7249)....	5.83 lbs.

RATE OF COMBUSTION.

Dry coal actually burned per square foot of grate surface per hour....		15.32 lbs.
Consumption of dry Coal per hour, coal assumed with one-sixth refuse.	Per sq. ft. of grate surface......	15.84 lbs.
	Per sq. ft. of water heating surface....	1.026 lbs.
	Per sq. ft. of least area for draught....	195.5 lbs.

RATE OF EVAPORATION.

Water evaporated from and at 212° F. per square foot foot of heating surface per hour....		6.88 lbs.
Water evaporated per hour from temperature of 100° F. into steam of 70 pounds gauge pressure.	Per sq. ft. of grate surface....	92.44 lbs.
	Per sq. ft. of water heating surface....	5.99 lbs.
	Per sq. ft. of least area for draught....	1,141 lbs.

COMMERCIAL HORSE-POWER.

On a basis of thirty pounds of water per hour evaporated from temperature of 100° F. into steam of 70 pounds gauge pressure (=34½ lbs. from and at 212° F.)....	616
Horse-power, builders' rating at 10 square feet per horse-power....	400
Per cent. developed above rating....	54

REPORT ON TEST OF MARINE BOILERS AT FRANKFORD PUMPING STATION.

PHILADELPHIA WATER DEPARTEENT,
February 17, 1886.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—The following results were obtained from the capacity test of the two Marine boilers at the Frankford Pumping Station, June 1st and 2d, 1885, the unit of measurement for capacity being the standard unit of evaporation as recommended by the Committee of Mechanical Engineers, May, 1884. The coal used was a good quality of bituminous coal from Cambria County, Pennsylvania.

The manhole plates were all removed from the top of the boilers, stop and safety valves opened, and a free vent given to the vapor to escape. All coal and water used by the boilers were carefully weighed upon scales prepared for the purpose, and all observations checked each hour. The fires were drawn out of the furnaces and new fires started with wood at the beginning of the test.

The amount of coal furnished was consumed in 22½ hours, when the fires were burned out and ashes and clinker drawn from the furnace and weighed.

Respectfully,

JOHN E. CODMAN,
Chief Draughtsman.

Results of the trial of two Marine Boilers at the Frankford Pumping Station, to determine the capacity of the boilers. Date of trial, June 1 and 2, 1885. Duration of trial, 22½ hours.

DIMENSIONS AND PROPORTIONS.

Type of Boiler: Marine-tubular, arranged in pairs, with one foot space from shell to shell, each pair connected to one steam drum, which is supported on the boilers in such a manner that the supports, bottom of drum and sides of boilers, form the connections to the smoke-flue leading to the stack.

Number in use	2
Diameter of boiler	11 ft., 6 in.
Length of boiler	10 ft., 10 in.
Number of furnaces in each boiler	2
Type of furnaces: Fox's Pat. Corrugated.	
Diameter of furnace	3 ft., 7 in.
Length of furnace	8 ft.

Number of tubes in each boiler	188
Diameter of tubes	3 in.
Length of tubes	8 ft.
Diameter of drum	3 ft., 6 in.
Length of drum	12 ft., 6 in.
Heating surface in one boiler:	
Heating surface of furnaces	136 sq. ft.
Back box	134 sq. ft.
Tubes	1,180 sq. ft.
Front of boiler	45 sq. ft.
Side and back	56 sq. ft.
Total heating surface in one boiler	1,551 sq. ft.
Total tube cross section area	7.7 sq. ft.
Ratio of tube cross section to grate surface	1 to 5.5
Height of stack	100 ft.
Area of stack at base	25 sq. ft.
Grate surface, 3′ 6′′ wide; 6′ 0′′ long; (2 furnaces)	42 sq. ft.
Water heating surface	1,551 sq. ft.
Superheating surface	46 sq. ft.
Ratio of water heating surface to grate surface	37 to 1

Average Pressures.

Steam pressure in boiler by gauge	0 lbs.
Absolute steam pressure	14.64 lbs.
Atmospheric pressure per barometer, mean for 24 hours,	29.8 in.

Average Temperatures.

Of external air	71.6° F.
Of fire room	79° F.
Of steam	212° F.
Of escaping gases	441.5° F.
Of feed water	116° F.

Fuel.

Total amount of coal consumed and equivalent wood	26,715 lbs.
Moisture in coal	None.
Dry coal consumed	26,715 lbs.
Total refuse dry (11½ per cent.)	3,075 lbs.
Total combustible (dry weight of coal, less refuse)	23,640 lbs.
Dry coal consumed per hour	1,187.3 lbs.
Combustible consumed per hour	1,050.7 lbs.

Water.

Total weight of water pumped into boiler and apparently evaporated	236,054 lbs.
Water actually evaporated, corrected for quality of steam	236,054 lbs.
Equivalent water evaporated into dry steam from and at 212° F.	259,730 lbs.
Equivalent total heat derived from fuel, in British thermal units	250,830,980
Equivalent water evaporated into dry steam from and at 212° F. per hour	11,543.5 lbs.

Economic Evaporation.

Water actually evaporated per pound of dry coal from actual pressure and temperature	8.836 lbs.
Equivalent water evaporated per pound of dry coal from and at 212° F.	9.722 lbs.
Equivalent water evaporated per pound of combustible from and at 212° F.	10.986 lbs.

Commercial Evaporation.

Equivalent water evaporated per pound of dry coal, with one-sixth refuse, at 70 pounds gauge pressure, from temperature of 100° F. (=last item "Economic Evaporation" multiplied by 0.7249)	7.956 lbs.

Rate of Combustion.

Dry coal actually burned per square foot of grate surface per hour		14.135 lbs.
Consumption of dry coal per hour—coal assumed with one-sixth refuse	Per sq. ft. of grate surface	15.00 lbs.
	Per sq. ft. of water heating surface	0.406 lbs.
	Per sq. ft. of least area for draught	81.9 lbs.

Rate of Evaporation.

Water evaporated from and at 212° F. per square foot of heating surface per hour		3.721 lbs.
Water evaporated per hour from temperature of 100° F. into steam of 70 pounds gauge pressure	Per sq. ft. of grate surface	119.05 lbs.
	Per sq. ft. of water heating surface	3.236 lbs.
	Per sq. ft. of least area for draught	652 lbs.

Commercial Horse-Power.

On a basis of thirty pounds of water per hour evaporated from temperature of 100° F. into steam of 70 pounds gauge pressure (=34½ lbs. from and at 212° F.)	335.
Horse-Power, Builders' Rating— 10 sq. ft. fire surface per H. P.; 15 sq. ft. tube surface " " "	226.
Per cent. developed above rating	48.

REPORT BY THE CHIEF CLERK

OF THE DETAILED EXPENDITURES OF THE DEPARTMENT, DURING 1885.

PHILADELPHIA WATER DEPARTMENT.

February 1, 1886.

COL. WILLIAM LUDLOW,
Chief Engineer.

SIR:—I have the honor to submit herewith a detailed statement of the expenditures of this Department for the year 1885; also a statement showing the total amounts available during the year, the sub-divisions of expenditures and the balances remaining to the credit of the Department at the close of the year.

The following table will show the increase in the business transactions during the past six years:

1880, Number of warrants drawn, - -	4,789
1881, Number of warrants drawn, - -	5,420
1882, Number of warrants drawn, - -	6,880
1883, Number of warrants drawn, - -	11,199
1884, Number of warrants drawn, - -	12,737
1885, Number of warrants drawn, - -	14,258

The erection of a storehouse enables the Department to purchase supplies in larger quantities than heretofore, consequently the number of bills audited was a fraction less than in the year previous. The number of pay rolls prepared was three hundred and forty-eight (348), the same as in 1884.

Respectfully,

J. T. HICKMAN,
Chief Clerk.

Detailed Expenditures of the Department for 1885.

General Appropriation.	Amount appropria'd.	Amount expended.	Balance merging.
An Ordinance to make an appropriation to the Water Department for the year 1885, approved December 31, 1884 ... $894,298 00			
Diminished by ordinance of February 3, striking out appropriation to Item 11, for new mains ... $220,000 00			
Transferred to special appropriations for refunds, Ordinances of April 4 and June 22 ... 2,524 80			
Transferred to special appropriation for Mt. Airy engines, Ordinance May 12 ... 1,610 81 — $224,135 61			
Increased by transfer from surplus, for new mains, Ordinance March 24 ... 200,000 00			
Net reduction ... 24,135 61			
Net appropriation ...	$870,162 39		
Item 1. Salaries ... $173,798 00			
Diminished by transfer to special appropriations to refund twice-paid water rents, Ordinance April 4 ... $716 15			
Ordinance June 22 ... 1,808 65			
To Item 7, Ordinance Dec. 18 ... 500 00			
To Item 8, Ordinance Dec. 18 ... 1,300 00			
Net reduction ... 4,324 80			
Net appropriation to Item 1 ...	$169,473 20		
Salary of chief engineer ...	$7,000 00	$7,000 00	
" general superintendent ...	3,500 00	3,500 00	
" assistant engineers ...	5,500 00	4,638 64	
" draughtsmen ...	4,150 00	4,150 00	
" chief clerk ...	2,000 00	2,000 00	
" assistant clerks ...	1,980 00	1,980 00	
" janitor Spring Garden hall ...	675 00	675 00	
" watchmen Spring Garden hall ...	675 00	675 00	
" lineman ...	720 00	720 00	
" telephone operator ...	720 00	720 00	
" foreman of laborers ...	675 00	675 00	
" watchmen (reservoirs) ...	6,750 00	6,750 00	
" policemen, with $40 each for uniforms ...	2,860 00	2,860 00	
" river watchmen ...	750 00	746 89	
" general storekeeper ...	800 00	800 00	

Detailed Expenditures of the Department for 1885.

Salaries of Employés at Pumping Stations.	Engineer in charge.	First engineer.	Second engineer.	Assistant engineers.	Oilers.	Firemen.	Coal passers.	Watchmen.	Storekeepers.	Amount appropria'd.	Amount expended.	Balance merging.
Fairmount		1	1		4				1	$5,600 00	$5,573 79	
Spring Garden	1			4	6	14	4		1	23,860 00	23,835 98	
Belmont	1			2	2	4	4		1	10,800 00	10,770 71	
Roxborough	1			2		4	2	2		8,320 00	7,569 99	
Mt. Airy				2			2			2,850 00	2,835 89	
Chestnut Hill				1			1			1,410 00	1,410 00	
Frankford	1				1	2		1		3,925 00	3,916 00	
Kensington					2					1,500 00	1,435 48	
Salary of foreman carpenter										900 00	900 00	
" " bricklayer										950 00	950 00	
" " stonemason										900 00	900 00	
" " rigger										900 00	900 00	

Detailed Expenditures of the Department for 1885.

General Appropriation.	Amount appropria'd.	Amount expended.	Balance merging.
Item 1, continued.			
Salary of correspondence clerk	$1,000 00	$1,000 00	
" clerk to general superintendent	900 00	900 00	
" assistant clerk to general superintendent	850 00	850 00	
" pipe recording clerks	2,000 00	1,316 64	
" assistant clerk	850 00	850 00	
" time clerk	900 00	900 00	
" messenger	600 00	600 00	
" pipe inspector	1,200 00	1,200 00	
" registrar	3,000 00	3,000 00	
" " chief clerk	1,350 00	1,350 00	
" cashier	1,300 00	1,300 00	
" permit clerk	1,080 00	1,080 00	
" assistant clerk	900 00	900 00	
" registering clerk	1,080 00	1,080 00	
" assistant clerk	900 00	900 00	
" entry clerks	2,000 00	2,000 00	
" bill clerk	1,300 00	1,300 00	
" general clerks	5,400 00	4,875 00	
" chief inspector	950 00	950 00	
" inspectors	17,100 00	17,100 00	
" messenger	800 00	800 00	
" purveyors	9,000 00	9,000 00	
" clerks to purveyors	3,600 00	3,559 35	
" general foremen	6,573 00	6,213 05	
" foremen of repairs	3,120 00	3,120 00	
" watchmen district yards	2,025 00	2,025 00	
" superintendent of shop,	1,500 00	1,500 00	
" clerk to superintendent of shop	850 00	836 31	
Totals	$169,473 20	$169,393 72	$79 48
Item 2. Regular supples, including fuel, oil, gas, and small stores ... $95,000 00			
Increased by transfer from surplus, December 18 ... 5,000 00			
	$100,000 00		
Net appropriation to Item 2, deficiencies for coal of 1884:			
Fairmount, 184 tons egg, at ... $4 95 ... $910 80			
Kensington, 100 tons egg, at ... 4 52 ... 432 00			
Spring Garden, 781.04 tons pea, at $2 95 ... 2,304 54			
Roxborough, 463.16 tons pea, at ... 2 90 ... 1,345 02			
	...	$4,992 36	
Blocks, etc	...	266 63	
Chandlery	...	1,089 39	
Galvanized wire	...	395 38	
Gum goods	...	2,069 84	
Hauling coal	...	591 51	
Hardware	...	1,232 55	
Iron fittings	...	188 26	
Paints, etc	...	986 55	
Wood	...	7 75	
GAS.			
Purveyor's office, Third District ... $4 51			
City repair shop ... 71 11			
Fairmount station ... 1,871 00			
Mount Airy ... 235 85			
Kensington ... 801 13			
	...	2,983 60	

Detailed Expenditures of the Department for 1885.

General Appropriation.		Amount appropria'd.	Amount expended.	Balance merging.
Item 2, continued.				
COAL FOR OFFICES AND DISTRICTS.				
42 tons stove, at $5 90	$247 80			
21½ tons bituminous, at 5 75	117 88			
20 tons nut, at 5 75	115 00			
5 tons stove, at 6.50	$19 50			
15 tons stove, carried to third floor, at 1.50	22 50			
		....	$522 68	
COAL FOR STATIONS.				
Fairmount, 148 tons egg, at $4 50	$666 00			
Spring Garden, 16,388.14 " pea, at 2 58	42,282 85			
Belmont, 5,852.06 " pea, at 2 43	14,221 10			
Roxborough, 5,073.16 " pea, at 2 68	13,597 78			
Chestnut Hill, 909.01 " pea, at 3 15	2,863 51			
Frankford, 1,184.14 " pea, at 2 51	2,973 60			
Kensington, 2,428.05 " pea, at 2 43	5,851 59			
		....	82,456 43	
OIL.				
46½ gals. black, at 10½c.	$4 88			
98 " Castor, at $1.35	132 30			
934½ " Colzaline, at 40c.	373 80			
153 " Cylinder, at 75c.	114 77			
1,812½ " " at 49c.	888 15			
1,515½ " Gasoline, at 16c.	242 48			
911 " Headlight, at 11c.	100 21			
599 " Lard, at 60c.	359 70			
		....	2,216 29	
Totals		$100,000 00	$99,999 22	78
Item 3. Repairs to machinery	$35,000 00			
Increased by transfer: From Item 6, July 24	5,000 00			
		$40,000 00		
Net appropriation to Item 3.				
Brass fittings	$646 54			
Indicator springs	11 00			
Iron fitting	143 84			
Machine work	9 57			
Pulleys and shaft	55 85			
Transportation	920 60			
Water-tight tanks	250 00			
		....	$2,037 40	

Detailed Expenditures of the Department for 1885.

MATERIAL.	General Appropriation.								Amount appropria'd.	Amount expended.	Balance merging.
Item 3, continued.	Fairmount.	Spring Garden.	Belmont.	Roxborough.	Mt. Airy.	Chestnut Hill.	Frankford.	Kensington.			
Alteration of engine					$626 21					$626 21	
Boiler inspection			$66 00							66 00	
Brass fittings	13 85	1,559 15	184 34			9 05				1,766 39	
Covering steam pipe		779 62					19 20			798 82	
Damper regulator		150 00								150 00	
False heads		166 00								166 00	
Fire bricks		199 75	259 95	48 00				78 80		586 50	
Hardware		26 19	77 94							104 13	
Iron fittings	16 50	668 10	107 85			12 00				804 45	
Iron shaft	745 00									745 00	
Leather washers		7 00								7 00	
Packing		260 51	9 12				50 00			319 63	
Repairs to boilers	55 20	1,673 87	1,647 04	27 05		4 47	27 00	28 00		3,462 63	
Repairs to engines		6,808 96					981 26			7,790 22	
Repairs to turbines	5,098 75									5,098 75	
Steam trap		55 00								55 00	
Totals	$5,929 30	$12,354 15	$2,352 24	$75 05	$626 21	$25 52	$1,077 46	$106 80			

Detailed Expenditures of the Department for 1885.

General Appropriation.										Amount appropria'd.	Amount Expended.	Balance merging.
Item 3, continued.												
WAGES.	Fairmount.	Spring Garden.	Belmont.	Roxborough.	Mt. Airy.	Chestnut Hill.	Frankford.	Kensington.	Totals.			
Bricklayers	....	$1,864 86	$640 50	$418 55	....	$94 50	....	$318 50	$3,336 61			
Carpenters	$423 00	610 50	78 00	....	....	....	....	....	1,111 50			
Hauling	....	....	34 50	44 00	....	....	....	....	78 50			
Laborers	30 00	482 50	328 75	....	....	....	$64 75	17 50	923 50			
Machinists	1,511 61	3,784 76	1,226 69	192 29	$118 29	208 56	379 65	440 48	7,862 33			
Painters	....	1,281 00	....	....	....	....	....	....	1,281 00			
Total	$1,964 61	$8,023 62	$2,308 44	$654 54	$118 29	$303 06	$444 40	$776 48	....	$40,000 00	$39,177 57	$822 43

Detailed Expenditures of the Department for 1885.

General Appropriation.		Amount appropria'd.	Amount expended.	Balance merging.
Item 4. Repairs to buildings, grounds and reservoirs	$30,000 00			
Increased by transfer:				
From Item 6, June 24 ... $1,000				
From Item 5 A, December 18 ... 3,000	4,000 00			
Net appropriation to Item 4		$34,000 00		
Bricks, Lime and cement			$1,592 75	
Cleaning Cess-pool			35 50	
Chandlery			143 23	
Electric lamps			192 75	
Fire-hose			508 35	
Forage			656 60	
Grass-seed and plants			46 05	
Gum goods			169 45	
Hardware			614 34	
Harness			18 65	
Horse shoeing			87 40	
Hauling ashes, Frankford Station	$204 00			
Hauling ashes, Kensington Station	357 00			
Hauling ashes, Roxborough Station	300 00			
			861 00	
Iron railing			676 85	
Lumber			3,940 76	
Plumbing and gas fitting			110 28	
Repairs to automatic regulator	$69 80			
" cart	5 30			
" electric plant	43 67			
" gas machine	3 90			
" roofs	409 49			
" scales	35 00			
" tracks	225 13			
" wagon	21 30			
" wharf	835 21			
			1,648 80	
Shear poles			27 00	
Scales			144 80	
Steam heaters			82 50	
Shingling roof of coal shed, Belmont			769 00	
Telephone rental and supplies			1,270 70	
Wagon			125 00	
Window glass			56 00	
Wages, bricklayers			80 50	
" carpenters			3,997 50	
" engineers			46 12	
" Hauling			1,096 35	
" laborers			12,496 03	
" painters			1,371 00	
" riggers			233 25	
" stonemasons			831 00	
Totals		$34,000 00	$33,929 51	$70 49
Item 5. Maintenance and improvement of the distribution		$135,000 00		
Block tin			$13 00	
Blocks and ropes			11 08	
Brass fittings			3,249 57	
Bricks, lime, and cement			339 04	
Changing pumping mains (Frankford)			2,367 86	
Chandlery			433 52	
Cobble stone			45 00	
Covering pipe			45 90	
Coke			253 65	

Detailed Expenditures of the Department for 1885.

General Appropriation.		Amount appropria'd	Amount expended.	Balance merging.
Item 5, continued.				
Coal (10 tons stove at $5.90)			59 00	
Drain-pipe			8 09	
Demurrage			2 00	
Fence (Fourth Purveyor's yard)			50 00	
Glass and glazing			5 60	
Gravel			18 00	
Gum goods			736 89	
Hauling pipe			4,539 15	
Hardware			1,155 61	
Iron fittings			130 53	
Iron pipe, 1,340,652 lbs. at 01$\frac{28}{100}$	$17,160.33			
Less deduction for pipes purchased in the open market	454 45			
			16,705 88	
Iron specials, 261,509 lbs. at 02$\frac{2}{10}$	$5,753 19			
" 129,256 " at 02$\frac{3}{10}$	2,972 86			
			8,726 05	
Lead pipe			12 62	
Lumber			2,802 02	
Lead (pig), 150,069 lbs. at 03$\frac{71}{100}$			5,567 56	
Manure			3 00	
Measuring over pipe			2,594 67	
Oil			27 44	
Plumbing			212 15	
Powder (blasting)			419 55	
Paving hammers			36 00	
Rent			75 00	
Repairs to building	$6 45			
" gauge	4 95			
" jacks	7 38			
" meters	10 00			
" pumps	5 50			
" pavement	23 50			
" stand-pipe	75 68			
" tools	115 10			
" tool-boxes	23 84			
" torches	31 44			
			303 84	
Steel			2 28	
Shop castings, 21,294 lbs. at .01$\frac{69}{100}$			359 87	
Stop valves, 25 at $70			1,750 00	
Stove			18 00	
Supporting tracks			3 47	
Spars			24 00	
Tallow			3 56	
Tapping machines			238 00	
Water meters			63 00	
Wharfage			116 60	
Wood			113 00	
Wages, First District			9,117 68	
" Second "			9,207 12	
" Third "			11,041 27	
" Fourth "			20,013 98	
" Fifth "			7,127 43	
" Sixth "			11,729 26	
" improvement to distribution			9,913 29	
" buildings, grounds, and reservoirs			3,150 11	
Totals		$135,000 00	$134,941 19	$58 81

Detailed Expenditures of the Department for 1885.

General Appropriation.	Amount appropria'd.	Amount expended.	Balance merging.
Item 5 A. For replacing small pipe.... $100,000 00			
Diminished by transfer to Item 4, December 18.................. $3,000 00			
Diminished by transfer to Item 4, December 18.......... 200 00			
3,200 00			
Net appropriation to Item 5 A..........................	$96,800 00		
Bricks, lime, and cement..........................		$618 36	
Brooms..........................		65 00	
Hauling pipe..........................		2,191 08	
Hardware..........................		305 47	
Iron pipe, 4,896 lengths—6-inch—1,959,690 pounds, at $.01\frac{28}{100}$..........................		25,084 02	
" 755 lengths—6-inch—281,015 pounds, at $30.50 per ton..........................		3,826 32	
" 169 lengths—8-inch—81,185 pounds, at $.01\frac{28}{100}$..........................		1,039 16	
" 250 lengths—10-inch—170,534 pounds, at $.01\frac{249}{1000}$..........................		2,129 97	
" 275 lengths—12-inch—247,365 pounds, at $28 per ton..........................		3,092 07	
" 499 lengths—12-inch—453,826 pounds, at $.01\frac{249}{1000}$.......................... $5,668 28			
Less difference in price for 12-inch purchased in open market.......................... 2 52		5,665 76	
Iron specials, 76,324 pounds, at $.02\frac{2}{10}$....... $1,679 12			
" 50,903 pounds, at $.02\frac{3}{10}$....... 1,170 76		2,849 88	
Lead pipe..........................		13 92	
Lead (pig), 107,789 pounds, at $.04\frac{46}{100}$..........................		4,807 39	
Lumber..........................		1,013 81	
Paving hammers..........................		24 00	
Plumbing..........................		45 80	
Shop castings, 237,208 pounds, at $.01\frac{69}{100}$..........................		4,008 80	
Wharfage..........................		77 15	
Wood..........................		43 75	
Wages, First District..........................		6,297 85	
" Second "		16,813 99	
" Fourth "		13,272 61	
" Sixth "		3,355 68	
Totals..........................	$96,800 00	96,641 84	**$158 16**
Item 5 B. For new three-way fire plugs..........................	$6,000 00		
Brass castings, 92½ pounds, at 11 cents....... $10 17			
" " 296½ pounds, at 14 cents..... 41 51		$51 68	
Gum valves..........................		1,750 00	
Hardware..........................		90 07	
Shop castings, 97,625 pounds, at $.01\frac{69}{100}$..........................		1,649 84	
Wages, Second District..........................		377 25	
" shop..........................		2,074 25	
Totals..........................	$6,000 00	$5,993 09	**$6 91**
Item 6. For supplies and labor at the city repair shop.......................... $50,000 00			
Diminished by transfer:			
To Item 3, July 6.................. $5,000 00			
To Item 4, June 24................ 1,000 00			
Net reduction.......................... $6,000 00			
Net appropriation to Item 6..........................	$44,000 00		

Detailed Expenditures of the Department for 1885.

General Appropriation.		Amount appropria'd.	Amount expended.	Balance merging.
Item 6, continued.				
Alcohol			$40 88	
Brass castings, 11,379 pounds @ 11 cents	$1,251 68			
Brass castings, 12,029½ pounds @ 14 cents	1,684 13			
Brass castings, 44½ pounds @ 20 cents	8 90			
			2,944 71	
Bronze castings			14 76	
Brass fittings			365 99	
Chandlery			549 89	
Coal, 49 tons of nut @ $5.75	$281 75			
Coal, 100 tons of bituminous @ $5.75	575 00			
			856 75	
Coke			13 60	
Drilling machine			825 00	
Drills, reamers, and taps			108 00	
Galvanizing			320 84	
Gum goods			361 08	
Hardware			1,138 35	
Iron, bolts, and nuts			1,445 71	
Iron fittings			42 27	
Lathe			1,225 00	
Listing			7 50	
Lumber			607 25	
Machine tools			383 00	
Machine work			116 20	
Malleable castings			29 45	
Oil			90 47	
Planer			1,825 00	
Pulleys and shaft			68 25	
Repairs to gear wheel	$4 41			
Repairs to roof	52 32			
			56 73	
Shop castings, 425,068 pounds @ $1\frac{69}{100}$ cents			7,283 66	
Steel (cast)			372 75	
Tallow			24 94	
Testing scales	$40 00			
Testing screws	25 00			
			65 00	
Window frames			31 85	
Wages			22,371 99	
Totals		$44,000 00	$43,586 87	$413 13
Item 7. For general and incidental expenses, including keep of horses for chief engineer, superintendent, and assistant engineer	$12,000 00			
Increased by transfer:				
From Item 1, December 18	500 00			
Net appropriation to Item 7		$12,500 00		
Advertising			$715 70	
Brooms, brushes, etc			43 75	
Carriage hire			52 00	
Clocks			23 00	
Coal			44 40	
Engineers' supplies			589 13	
Furniture			234 50	
Glass			12 15	
Gum goods			43 11	
Ground-rent			26 66	
Hardware			82 61	
Ice			73 73	

Detailed Expenditures of the Department for 1885.

General Appropriation.	Amount appropria'd.	Amount expended.	Balance merging.
Item 7 continued.			
Incidentals		347 46	
Keep of horse		1,368 75	
Meals		399 70	
Plumbing		41 60	
Printing notices		69 45	
Rent		125 00	
Repairs to telephone and type-writer		44 10	
Stationery		4,873 14	
Subscriptions		78 94	
Telegraph and messenger service		179 41	
Text-books and binding		620 45	
Transportation		1,951 25	
Traveling expenses (pipe inspector)		382 56	
Washing towels		77 00	
Totals	$12,500 00	$12,499 55	45
Item 8. For surveys and expenses connected therewith for a future water supply..$20,000 00			
Increased by transfer:			
From Item 1, December 18.....$1,300 00			
" " 5, December 18...... 200 00			
Net increase........ 1,500 00			
Net appropriation to Item 8	$21,500 00		
Engineers' supplies		$293 87	
Gum goods		21 20	
Incidentals		1,911 03	
Services of assistant engineers, analyst and rodmen		19,273 00	
Totals	$21,500 00	$21,499 10	90
Item 9. Contingent expenses..........$10,000 00			
Diminished by transfer:			
To special appropriation for engines at Mt. Airy, Ordinance May 12........ 1,610 81			
Net appropriation to Item 9	$8,389 19		
Deficiencies of 1884:			
Cement........ $117 00			
Engineers' supplies........ 46 37			
Hauling ashes........ 39 15			
Hauling coal........ 64 06			
Ice........ 73 02			
Incidentals........ 369 97			
Iron fittings........ 165 91			
Measuring over pipe........ 239 57			
Maintenance of tracks........ 173 62			
Repairs to boilers........ 387 38			
Scales........ 258 40			
Telegraph and messenger service........ 29 58			
		$1,964 03	
Atlas		35 00	
Advertising		6 24	
Horse		225 00	
Ice		146 83	
Professional services (veterinary surgeon)		55 80	
Professional services (experts testing engines)		1,174 65	

Detailed Expenditures of the Department for 1885.

General Appropriation.	Amount appropria'd.	Amount expended.	Balance merging.
Item 9, continued.			
Repairs to boilers		3,110 15	
Repairs to electric plant		394 43	
Stationery		334 75	
Subscription		25 26	
Telegraph and messenger service		16 21	
Vertical engine		150 00	
Washing towels		14 00	
Wages		736 75	
		$8,389 10	$0 09
Item 10. For aërating the water supply	$7,500 00		
Air compressors and condensors for air compressors		$6,940 00	
Freight		12 70	
Wages		543 50	
		$7,496 20	$3 80
Item 11. Surplus, for new mains, transferred from surplus 1880 and 1881; Ordinance March 24 .... $200,000 00			
Diminished by transfer:			
To Item 2, supplies 5,000 00			
Net appropriation to Item 11	195,000 00		
Hauling pipe		$2,667 48	
Iron pipe:			
2,929 lengths 6″, 1,053,157 lbs., at $.01\frac{28}{100}$ per pound.		$13,480 40	
741 lengths 6″, 275,854 lbs., at $30.50 " ton		3,756 04	
250 lengths 10″, 64,646 lbs., at $.01\frac{249}{1000}$ " pound.		2,138 75	
684 lengths 12″, 612,981 lbs., at $.01\frac{249}{1000}$ " "		7,656 13	
5 lengths 12″, 4,515 lbs., at $28.00 " ton		56 44	
200 lengths 16″, 271,317 lbs., at $.01\frac{35}{100}$ " pound.		3,662 78	
1,124 lengths 20″, 1,923,531 lbs., at $.01\frac{17}{100}$ " "		22,505 33	
313 lengths 30″, 1,254,287 lbs., at $.01\frac{17}{100}$ " "		14,675 16	
934 lengths 36″, 4,182,698 lbs., at $.01\frac{14}{100}$ " "		47,682 87	
270 lengths 48″, 2,217,405 lbs., at $.01\frac{14}{100}$ " "		25,278 42	
21 breeches pipes, 87,282 lbs., at $.04\frac{47}{100}$ per lb		3,901 50	
Iron specials:			
Small specials, 87,340 lbs., at $.02\frac{2}{10}$ per pound		1,921 47	
Large specials, 23,772 lbs., at $.02\frac{3}{10}$ " "		546 76	
Lead (pig), 150,068 lbs., at $.03\frac{71}{100}$ " "		5,567 52	
Rotary pump		500 00	
Services of experts, analysis of the Schuylkill water		1,473 77	
Valve, 48″		770 00	
Wages, First District (Gray's Ferry road)		7,292 69	
" Second " (Lancaster ave.) $3,562 87			
" " " (Fifty-second st.) 4,070 99			
		7,633 86	
" Fourth " "		13,753 88	
" Sixth " (Tioga)		5,340 63	
Totals	$195,000 00	$192,261 88	$2,738 12

Detailed Expenditures of the Department for 1885.

Special Appropriations.	Balance Jan. 1, 1885.	Amount expended.	Balance not merging
FOR THE EXTENSION OF WORKS.			
Surplus of 1880 and 1881.			
Ordinances June 21, 1882, and March 24, 1883......	$23,470 64		
Retained percentage due for pumping engines at the Spring Garden Station..............................	....	$16,200 00	
Retained percentage due for pumping engine at the Roxborough Station..............................	....	7,200 00	
		$23,400 00	$70 64
FOR THE EXTENSION OF WORKS.			
Surplus of 1882.			
Ordinance March 24, 1883..............................	8,826 34		
Retained percentage due for pumping engines at the Frankford Station..............................	....	8,800 00	26 34
Item 19 of appropriation for 1883. For the purchase of pipes and special castings. Transferred from surplus 1882, Ordinance October 20, 1883.....	315 16	....	315 16
Item 9½. For the payment in full of the balance due on two pumping engines at Mt. Airy Station. Transferred from Item 9, Ordinance of May 12..............................	1,610 81		
Pumping engines, Mt. Airy Station..............................	....	1,610 81	
REFUNDS.			
For the purpose of refunding certain twice-paid, overpaid, and paid-in-error water rent and pipe-laying bills:			
Ordinance December 31, 1880..............................	155 57	....	155 57
Ordinance June 16, 1881..............................	502 25	....	502 25
Ordinance March 10, 1882..............................	100 75	....	100 75
Ordinance December 11, 1882..............................	216 65	14 00	202 65
Ordinance December 30, 1882..............................	146 35	....	146 35
Ordinance November 12, 1883..............................	412 95	18 00	394 95
Ordinance September 9, 1884..............................	362 41	78 25	284 16
Ordinance October 4, 1884..............................	972 75	496 00	476 75
	Amount appropria'd.		
Ordinance April 4, 1885. Transferred from Item 1	$716 15	461 97	254 18
Ordinance June 22, 1885. Transferred from Item 1	1,808 65	1,243 62	565 03

Detailed Expenditures of the Department for 1885.

RECAPITULATION.

Available for 1885.					
Special appropriations:					
Balance January 1, 1885, from Annual Report of 1884		$38,074 56			
Less balance of Item 21, appropriation of 1882, for Mt. Airy engines, improperly merged		2,592 74			
		$35,481 82			
Transferred from annual to special appropriation:					
Mt. Airy engines	$1,610 81				
Refunds	2,524 80				
		4,135 61		$39,617 43	
Annual appropriation				870,162 39	
					$909,779 82
Expended from Annual appropriation:					
For new three-way fire plugs			$5,993 09		
For deficiencies of 1884			6,956 39		
For aërating the water supply			7,496 20		
For surveys for a future water supply			21,499 10		
For replacing small pipe			96,641 84		
For new mains			192,261 88		
For maintenance			534,960 34		
				$865,808 84	
Expended from special appropriations:					
For pumping engines at Mt. Airy Station			$1,610 81		
For refunds			2,311 84		
For pumping engines at Roxborough Station			7,200 00		
For pumping engines at Frankford Station			8,800 00		
For pumping engines at Spring Garden Station			16,200 00		
				36,122 65	
Total expenditures				$901,931 49	
Amount merging			$1,615 43		
Amount not merging			6,232 90		
				7,848 33	
					909,779 82
Balance on hand January 1, 1886		$6,232 90			

REPORT BY THE REGISTRAR.

PHILADELPHIA WATER DEPARTMENT,
REGISTRAR'S OFFICE,

February 27, 1886.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—I respectfully submit the following Report of the Operations of this Office for the year 1885:

The total receipts derived from all sources (paid daily as received into the office of the City Treasurer) were - - - - - .	$1,826,164 04
This is an increase over the previous year of -	33,678 03
and over 1882 of - - - . - - -	309,259 40
The collection of water rents and penalties for the year 1885 amounted to - - -	1,589,330 72
an increase over the previous year of - -	505 39
and over 1882 of - - - - - - -	275,894 62

The small increase in this item over 1884 is by reason of the reduction in horse-power from three to two dollars, amounting in the aggregate to sixty thousand dollars.

The receipts from delinquent rents and penalties amounted to - - - - - -	$12,828 28
a decrease from 1884 of - - - - -	9,502 41
and from 1882 of - - - - - -	77,193 91

The decrease in this item continues by close collections and prompt payments.

The receipts from fractional rents and other sources amounted to - - - - -	$101,643 88
an increase over the year 1884 of - -	24,086 48
and over 1882 of - - - - - - -	52,113 98

The receipts from water-pipe charges amounted to - - - - - - - - -	$92,182 18
an increase over the year 1884 of - -	20,640 18
and over 1882 of - - - - - -	57,202 66
The receipts from search fees amounted to -	1,988 75
an increase over the year 1884 of - -	1,527 25
Receipts through the Chief Engineer's Office for old material, fire connections, etc., amounted to - - - - - - -	9,197 00
a decrease from 1884 of - - - - -	1,473 89
an increase over 1882 of - - - - -	1,681 12
The amount collected through the City Solicitor's Office for pipe frontage, and certified to this Department, amounted to - -	18,993 23
a decrease from 1884 of - - - - -	2,104 97
and from 1882 of - - - - - -	2,427 82
Water-pipe bills to the amount of - - were returned to the City Solicitor's Office for lien.	24,598 63
The receipts of the Department in full for the year 1885, as previously estimated by the Chief Engineer to the City Controller, were	1,800,000 00
Actual receipts for the year 1885 - -	1,826,164 04
Increase over estimate of - - - - -	26,164 04

The annexed itemized tables contain full information of the detailed work of this office.

Very respectfully,

A. N. KEITHLER,

Registrar.

TOTAL RECEIPTS OF THE WATER DEPARTMENT FOR THE YEAR 1885.

MONTHS.	Delinquent Rents.	Penalties.	Rents for 1885.	Penalties.	Fractional Rents.	Water-pipe.	Searches.	Totals.
January	$1,114 75	$144 73	....	....	$9,043 21	$3,373 55	$55 75	$13,731 99
February	904 00	124 80	$158,692 75	....	2,494 12	1,353 29	64 50	163,633 46
March	902 00	127 74	305,904 72	....	6,428 62	3,837 16	139 75	317,339 99
April	2,149 75	241 03	892,826 00	....	11,500 16	5,071 21	184 00	911,972 15
May	296 50	44 53	35,318 00	$1,761 68	10,955 18	7,958 86	199 50	56,534 25
June	929 75	136 38	52,857 58	2,627 87	11,210 06	6,042 66	203 50	74,007 80
July	354 00	53 10	13,036 75	1,845 94	13,803 87	8,247 31	173 25	37,514 22
August	226 50	34 00	18,625 73	2,792 08	7,144 06	7,170 34	125 50	36,118 21
September	975 50	146 43	49,241 60	7,233 60	6,548 92	14,575 04	179 25	78,900 34
October	1,398 00	206 20	29,909 38	4,473 86	10,915 00	16,697 73	229 00	63,829 17
November	1,356 50	202 97	8,634 93	1,271 39	8,012 75	11,807 32	229 75	31,515 61
December	660 00	99 12	1,984 50	292 36	3,587 93	6,047 71	205 00	12,876 62
Totals	$11,267 25	$1,561 03	$1,567,031 94	$22,298 78	$101,643 88	$92,182 18	$1,988 75	$1,797,973 81

Total receipts through the Chief Engineer's office for the year 1885	$9,197 00
Total receipts through the office of the City Solicitor for the year 1885	18,993 23
Total receipts of the Water Department for the year 1885	$1,826,164 04
Receipts as previously estimated by the Chief Engineer	$1,800,000 00

ITEMS OF RECEIPTS UNDER HEAD OF "FRACTIONAL RENTS."

YEAR.	Rents.	Ferrules.	Repairs.	Totals.
1885	$85,491 13	$14,674 00	$1,478 75	$101,643 88
1884	64,492 90	11,842 00	1,222 50	77,557 40
Increase	$20,998 23	$2,832 00	$256 25	$24,086 48

RECEIPTS THROUGH THE CHIEF ENGINEER'S OFFICE FOR THE YEAR 1885.

January 10	Warrant	Overdrawn	$8 44
" 10	"	"	10 12
" 14	Baldwin Locomotive Works	Fire attachment	76 47
" 14	" " "	Removing fire hydrant	45 86
" 16	Pennsylvania Railroad Co	Laying pipe	282 57
" 16	" "	Raising and shifting fire hydrant	29 70
" 16	" "	Raising 20-inch main	849 84
" 16	" "	Repairing pipe	114 82
" 16	" "	Construction of bridge	155 81
" 16	" "	Water connection	52 77
" 16	" "	Removing fire plug	28 17
" 16	" "	Removing pipe	93 85
" 16	" "	Relaying pipe	214 24
" 16	" "	Repairing pipe	45 23
" 16	" "	Shifting main	110 41
" 16	" "	Removing fire plug	42 48
" 16	" "	Relaying pipe	83 89
" 16	" "	Cutting out main	10 50
" 16	" "	Supply connection	123 21
" 16	" "	Disconnecting stand pipe	8 58
" 16	" "	Water connection	98 72
" 22	Edwin Peters	For penalty	50 00
" 22	C. Kennedy & Son	Powder	36 75
February 3	R. S. Peabody	Stone	16 00
" 21	Joseph H. McClure	Old material	83 98
" 24	Folwell & Bros	Fire connection	55 02
March 2	A. Purves & Son	Old material	41 50
" 6	John H. Dearnley	Fire connection	73 87
" 7	M. Dolan & Bro	Old material	465 44
" 9	Bussenius, Cunliffe & Co	" "	400 87
" 23	John J. Dawson & Bro	" "	60 56
" 23	Warrant	Overdrawn	75
" 24	D. P. S. Nichols	Horse	55 80
" 30		Conscience money	3 00

RECEIPTS THROUGH THE CHIEF ENGINEER'S OFFICE FOR THE YEAR 1885—*Continued.*

April 1	George W. Blabon	Supply connection	$27 10
" 1	" "	" "	95 65
" 8	Henry Snyder	Rent at Fairmount	450 00
May 21	M. Loughran	For penalty	5 00
June 6	Charles Lafferty	" "	10 00
" 6	Midvale Steel Works	Repairing pipe	3 38
" 9	Russell Thayer	For penalty	103 00
" 11	John Welsh	Stone	114 40
" 15	James Ewing	For penalty	5 00
" 15	John Kernan	" "	5 00
" 15	Charles McCoy	" "	5 00
" 24	B. L. Collum	Stone	10 00
" 29	James F. Orne	For penalty	5 00
" 30	M. Klemm	" "	5 00
July 3	Joseph Ladley	Stone	23 60
" 15	Charles Bartol	"	44 80
" 21	A. Purves & Son	Old material	183 72
" 25	M. Dolan & Bro	" "	973 90
" 27	John F. Betz	For penalty	50 00
" 29	William A. Welsh	" "	50 00
" 31	J. Solis Cohen	Ashes	1 30
August 17	John McDonald	Stone	10 00
" 17	Bussenius, Cunliffe & Co	Old material	357 77
" 21	George B. Newton & Co	Removing fire hydrant	52 31
September 7	Joseph H. McClure	Old material	409 09
" 7	B. L. Collum	Stone	10 00
" 7	Henry Snyder	Rent at Fairmount	225 00
" 12	W. L. Craven & Sons	Removing fire hydrant	29 01
" 16	Girard Estate	Repairing stop	6 00
" 28	R. W. Peterson & Co	For penalty	10 00
" 28	J. Johnson & Co	" "	10 00
" 30	George Barnes	Stone	8 00
October 6	John and James Dobson	Supply connection	71 53
" 14	Philadelphia Traction Co	Water connection	8 04

RECEIPTS THROUGH THE CHIEF ENGINEER'S OFFICE FOR THE YEAR 1885—*Continued.*

October 14	Philadelphia Traction Co	Altering stops	$43 96
" 14	" "	" "	104 38
" 14	" "	Removing plug	26 93
" 14	" "	Removing stop	25 43
" 14	" "	Altering connections	149 50
" 14	" "	Altering stop	70
" 14	West Jersey Ferry Company	Removing fire hydrant	21 55
" 23	United States Naval Asylum	Water connection	79 74
" 26	St. Mary's P. E. Church	Supply connection	2 69
" 26	William Thornton	Fire connection	58 04
" 27	J. and F. Elkinton	" "	66 73
" 29	Girard Estate	Raising valve and packing stop	17 70
" 29	Samuel Hart	Moving fire hydrant	38 52
" 29	Emlen & Cope	Fire connection	75 82
November 3	Charles Bartol	Stone	3 20
" 3	George Righter	"	2 50
" 3	Dornan Bros. & Co	Fire connection	63 68
" 4	Workingmen's Club, Germantown	" "	36 41
" 6		Gravel	4 25
" 12	Stafford & Co	Fire connection	58 89
" 16	F. A. Poth	Supply connection	65 31
" 16	Boston Steamship Company	Repairing stop	4 80
" 18	Harrison, Havemeyer & Co	Fire connection	71 64
" 20	Clough & Carson	" "	60 38
" 20	Allison Car Works	Repairing fire connection	8 33
" 24	J. B. Stetson & Co	Altering fire connection	26 43
" 28	German Hospital	Supply connection	67 76
" 28	Joseph Ladley	Stone	180 80
December 7	Quaker City Croquet Club	Rent, corner Twenty-second and Brown streets	10 00
" 7	E. P. and H. M. Almy	Fire attachment	64 04
" 12	M. C. Hong	Moving water pipe	4 14
" 12	Butcher's Ice and Coal Co	Cutting ice	100 00
" 15	George H. Wilson	Stone	2 80

RECEIPTS THROUGH THE CHIEF ENGINEER'S OFFICE FOR THE YEAR 1885—*Continued.*

December 18......	William B. Bement & Sons....	Fire connection....................	$42 37
" 18......	William Sellers & Co............	Changing location of fire hydrant..............................	43 04
" 22......	Stewart, Ralph & Co.............	Fire connection......................	6 47
" 26......	John Welsh.........................	Stone....................................	135 20
" 26......	Philadelphia Traction Co......	Laying water pipe................	114 27
" 26......	William H. Johnson.............	For penalty...........................	50 00
" 29......	George H. Wilson................	Stone....................................	3 60
" 30......	A. Purves & Son..................	Old material..........................	5 14
" 31......	H. H. Houston.....................	Supply connection................	42 39
" 31......	Warrant	Overdrawn	65
		Total..............................	$9,197 00

COMPARATIVE STATEMENT OF RECEIPTS FOR THE YEARS 1884 AND 1885.

Year.	Delinquent Rents.	Delinquent Penalties.	Water Rents.	Penalties.	Fractional Rents.	Water Pipe.	Searches.	Chief Engineer's Office.	City Solicitor's Office.	Totals.
1885	$11,267 25	$1,561 03	$1,567,031 94	$22,298 78	$101,643 88	$92,182 18	$1,988 75	$9,197 00	$18,993 23	$1,826,164 04
1884	19,837 72	2,492 97	1,566,027 57	22,797 76	77,557 40	71,542 00	461 50	10,670 89	21,098 20	1,792,486 01
Increase	....	....	$1,004 37	....	$24,086 48	$20,640 18	$1,527 25	....	....	$33,678 03
Decrease	$8,570 47	$931 94	....	$498 98	....	....	....	$1,473 89	2,104 97	....

SCHEDULE OF CHARGES AGAINST PUBLIC BUILDINGS AT THE REGULAR RATES.

Wards.	Name.	Location.	Amount.
Fifth	Mayor's office		$ 15 00
"	Telegraph Department		13 00
"	Office Clerks of Councils		5 00
"	Court of Common Pleas, No. 1		32 00
"	Sheriff's office		4 00
"	Common Pleas, No. 3		18 00
"	Independence Hall	Independence Hall	21 00
"	Council Chambers		6 00
"	Prothonotary's office		20 00
"	Common Pleas, No. 4		6 00
"	" " No. 2		21 00
"	Old Court House		9 00
"	New "	Sixth street, below Chestnut	87 00
Ninth	Basement		662 00
"	West end, first floor		85 00
"	Superintendent's office	New City Hall, Broad and Market streets	10 00
"	City Treasurer		18 00
"	City Controller		8 00

SCHEDULE OF CHARGES AGAINST PUBLIC BUILDINGS AT THE REGULAR RATES—(*Continued*).

Ward.	Name.	Location.	Amount.
Ninth	City Commissioners		$4 00
"	Southeast corner, first floor		48 00
"	Headquarters National Guards		4 00
"	Commissioner of City Property		6 00
"	Commissioners of Fairmount Park		8 00
"	Board of Revision		4 00
"	Tax Assessor's office	New City Hall, Broad and Market streets	2 00
"	Delinquent Tax office		4 00
"	Northeast corner, first floor		48 00
"	Receiver of Taxes		16 00
"	Northeast corner, second floor		48 00
"	Survey Department		13 00
"	Highway Department		6 00
"	Southeast corner, second floor		27 00
"	Architect's office	New City Hall, Broad and Market streets	6 00
"	Supreme Court		33 00
"	Board of Guardians' office	42 North Seventh street	12 00

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SCHEDULE OF CHARGES AGAINST PUBLIC BUILDINGS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
Tenth	Cherry street shops	918 Cherry street	$53 00
"	Armory State Fencibles	East side Broad, south of Race street	65 00
Eleventh	City Morgue	Northwest corner Noble and Beach streets	14 00
Fourteenth	Spring Garden Hall	Thirteenth and Spring Garden streets	41 00
Seventeenth	Purveyor's office	Frankford avenue and Master street	5 00
Twenty-second	Town Hall	Northwest corner Germantown avenue and Lafayette street	29 00
Twenty-third	Gas office	Southeast corner Frankford avenue and Ruan street	24 00
Twenty-sixth	Water Department office, stable, and storage yard	Wharton street, east of Twelfth street	16 00
"	County Prison	West side Passyunk avenue, from Reed to Dickinson streets	1,294 00
Twenty-seventh	Philadelphia Almshouse		3,333 00
Twenty-ninth	Purveyor's office	Northeast corner Master and Twenty-sixth streets	5 00
		Total	$6,208 00

SCHEDULE OF CHARGES AGAINST FAIRMOUNT PARK AT THE REGULAR RATES.

Name.	Location.	Amount.
West Park	Belmont, including sprinklers for entire Park	$1,148 24
" "	Belmont Mansion	83 00
" "	British Building	18 00
" "	Ohio Building	7 00
" "	Memorial Hall	250 00
" "	Horticultural Hall	98 00
" "	Green-house adjoining Horticultural Hall	20 00
" "	Outside grounds	128 00
" "	Sweet Brier Mansion	15 00
" "	Rhode Island Building	9 00
" " jet fountain	Lake west of Belmont avenue, near Elm avenue	6,500 00
" " " "	Catholic Total Abstinence Society, near Elm avenue	1,000 00
East Park, drinking fountain	North front Lemon Hill Mansion	168 00
" " " "	Northeast from Lemon Hill Mansion	112 00
" " " "	Northeast of Sedgley Guard-house	10 00
" " jet fountain	" " "	560 00
" " " "	East side forebay	560 00
" " " "	Green street entrance	756 00

SCHEDULE OF CHARGES AGAINST FAIRMOUNT PARK AT THE REGULAR RATES—*Continued.*

Name.	Location.	Amount.
East Park, jet fountain	On lawn east of steamboat landing	$735 00
" " " "	On lawn northeast of steamboat landing	735 00
" " trefoil fountain	East of Lincoln Monument	2,205 00
" " fish pond	Main drive, near Brown street entrance	1,984 00
" " large fountain	West of Thirty-third street, south side Dauphin street	1,003 00
	Total	$18,104 24

SCHEDULE OF CHARGES AGAINST POLICE STATION HOUSES AT THE REGULAR RATES.

Wards.	Name.	Location.	Amount.
First	Station house, Seventeenth District	South side of Taylor street, east of Passyunk avenue	$62 00
Third	" " Second "	Second street above Christian street	97 00
Fifth	Central Station	Mayor's office, Independence Hall	70 00
"	Station house, Third District	Union street below Fourth	63 00
Sixth	" " Fourth "	Fifth street above Race	65 00
Seventh	" " Nineteenth District	734 Lombard Street	60 00
Eighth	" " Fifth "	Fifteenth street, east side, south of Walnut street	61 00
Ninth	" " Twentieth "	1519 Filbert street	51 00
Tenth	" " Sixth "	235 South Eleventh Street	65 00
Eleventh	" " Seventh "	St. John street below Green street	30 00
Fourteenth	" " Eighth "	1012–14 Buttonwood street	55 00
Fifteenth	" " Ninth "	Northwest corner Twenty-third and Brown streets	48 00
Seventeenth	" " Tenth "	Front street above Master street	58 00
Eighteenth	" " Eleventh "	Girard avenue above East Montgomery avenue	31 00
Twentieth	" " Twelfth "	Northeast corner Tenth and Thompson streets	71 00
Twenty-first	" " Thirteenth "	Station-house alley, between Mechanic and Cotton streets	36 00
Twenty-second	" " Sub "	Northwest corner Twenty-seventh and Highland avenue	23 00

SCHEDULE OF CHARGES AGAINST POLICE STATION HOUSES AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount,
Twenty-second	Station house, Fourteenth District	North side Lafayette street	$52 00
Twenty-third	" " Fifteenth "	Southwest corner Ruan street and Paul street	52 00
Twenty-fourth	" " Sixteenth "	Southwest corner Lancaster avenue and Thirty-ninth street	64 00
Twenty-fifth	" " Twenty-fourth District	Southwest corner Clearfield and Belgrade streets	19 00
"	" " Sub "	Northwest corner Kirbride and Richmond streets	40 00
"	" " " "	3883 Germantown avenue	33 00
Twenty-seventh	" " Twenty-first "	Southeast corner Woodland avenue and Spruce street	63 50
Twenty-eighth	" " Twenty-second "	Northwest corner Park and Lehigh avenues	94 50
Twenty-ninth	" " Twenty-third "	Southwest corner Twentieth and Jefferson streets	57 00
Thirtieth	" " First "	Fitzwater street below Twentieth street	60 00
Thirty-first	" " Eighteenth "	2028 Trenton avenue	53 00
		Total	$1,534 00

SCHEDULE OF CHARGES AGAINT FIRE STATIONS AT THE REGULAR RATES.

Wards.	Name.	Location.	Amount.
First	Fire Station, No. 10	818 Morris street	$25 00
Fifth	Truck D Company	319 Union street	21 00
"	Fire Station, No. 22	Levant street, below Third street	20 00
Sixth	" " No. 8	143 Race street	18 00
"	Truck E Company	321–323 Branch street	23 00
Seventh	Fire Station, No. 11	1035 Lombard street	15 00
"	" " No. 1	South street, below Nineteenth street	19 00
Tenth	" " and Shops, No. 17	Race street, south side, west of Thirteenth st	142 00
Eleventh	" " No. 21	826 New Market street	27 00
Fourteenth	" " No. 26	Hamilton street, between Tenth and Eleventh streets	36 00
Fifteenth	" " No. 18	1903 Callowhill street	15 00
"	Truck A	2132 Fairmount avenue	17 00
Eighteenth	Fire Station, No. 16	1106–1108 Montgomery avenue	20 00
Nineteenth	" " No. 15	Howard street and Columbia avenue	15 00
Twenty-first	" " No. 12	4541–4545 Main street	17 00
Twenty-third	" " No. 7	22 East Church street	16 00
"	" " No. 14	4612 Frankford avenue	24 00
Twenty-fifth	" " No. 28	Belgrade street, twenty feet south of Clearfield street	23 00
Twenty-seventh	" " No. 5	Southeast cor. Thirty-seventh and Ludlow streets	24 00
Twenty-ninth	" " No. 27	2202–2204 Columbia avenue	26 00
		Total	$543 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES.

Wards.	Name.	Location.	Amount.
First	Grammar School	Southeast corner Seventh and Dickinson streets	$27 00
"	Weccacoe Primary School	Second and Reed streets	13 00
"	Tasker School	Ninth and Tasker streets	13 00
"	Levin Handy Smith School	Fifth street and Snyder avenue	20 00
"	William Welsh School	Thirteenth and Jackson streets	26 00
"	Henry Clay School	Lancaster avenue, above Reed street	13 00
"	Morris School	Morris street, below Second street	13 00
"	Colored Consolidated School	Dickinson street, below Seventh street	18 00
"	Calhoun School	Tenth street and Snyder avenue	20 00
Second	George W. Nebinger School	Carpenter street, above Sixth street	18 00
"	Wharton "	Fifth street, below Washington avenue	29 00
"	Washington "	Carpenter street, above Ninth street	26 00
"	Watson "	Mary street, below Second street	15 00
"	John Hockdale "	Thirteenth and South Marshall streets	16 00
Third	Mt. Vernon "	Catharine street, above Third street	42 00
"	Fletcher "	Christian street, above Front street	14 00
"	Thomas B. Florence School	Catharine street, below Eighth street	32 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount.
Third	Lyons School	Catharine street, above Tenth street	$13 00
Fourth	Ringgold "	Northeast corner Eighth and Fitzwater streets	18 00
"	Fagen "	Twelfth and Fitzwater streets	21 00
"	William M. Meredith "	Fifth street, above German street	35 00
"	Ralston "	Northeast corner Guilford and Bainbridge streets	15 00
"	Ronaldson "	Fitzwater street, above Sixth street	13 00
Fifth	Horace Binney Grammar School	Spruce street, below Sixth street	77 00
"	James Forten School	Sixth street, above Lombard street	15 00
"	George W. Wharton School	Third street, above Lombard street	26 00
Sixth	No. 1. Primary School	New street, below Second street	9 00
"	Northeast Boys' Grammar School	Northwest corner of Crown and Race streets	29 00
"	N. E. Secondary School	Crown street, above Race street	10 00
Seventh	Secondary, No. 1, School	409 South Twenty-third street	8 00
"	Secondary, No. 3, "	1119 Pine street, northeast corner Quince street	17 00
"	Southwest School	Northeast corner Seventeenth and Pine streets	22 00
"	Secondary, No. 4, School	415 South Nineteenth street	13 00
"	O. V. Catto "	2028 Lombard street	18 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount.
Eighth	Hollingsworth School	Locust street, south side, west of Broad street	$26 00
"	Locust Street "	Northeast corner Locust and Twelfth streets	29 00
"	James A. Garfield "	Southwest corner Locust and Twenty-second streets	10 00
Ninth	Zane Street "	711–717 Filbert street	28 00
"	Filbert Street "	2015 Filbert street	13 00
"	Keystone "	Nineteenth street, west side, north of Chestnut street	37 00
Tenth	Edward Shippen "	Cherry street, north side, west of Nineteenth street	21 00
"	John Agnew "	Cherry street, south side, west of Eleventh street	20 00
"	Cherry Street "	Cherry street, south side, west of Fifteenth street	8 00
"	Northwest "	Race street, north side, west of Broad street	24 00
"	Sergeant "	920 Sergeant street	9 00
Eleventh	Shunk Primary, No. 1, School	East side New Market street, above Brown street	9 00
"	Madison Secondary School	East side New Market street, above Noble street	19 00
"	Northern Liberties "	Third street, below Green street	19 00
"	Biedeman Primary "	St. John street, below Buttonwood street	19 00
Twelfth	Saunders "	Northwest corner Dillwyn and Callowhill streets	16 00
"	Mifflin "	Third property west of 18 North Third street	26 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount.
Twelfth	Rovoudt School	432–436 Maria street	$17 00
"	E. M. Paxton "	Noble street, below Sixth street	26 00
Thirteenth	Wyoming "	Northwest corner Sixth street and Fairmount avenue	23 00
"	Adams "	Garden street, below Buttonwood street	23 00
"	Warner "	Perth street, north of Parrish street, west side	28 00
Fourteenth	Roberts Vaux "	Wood street, between Eleventh and Twelfth streets, north side	29 00
"	Monroe "	Wood street, east of Twelfth street	32 00
"	John M. Ogden "	Northeast corner Twelfth and Wistar streets	26 00
"	Bobert T. Conrad "	Melon street, east of Twelfth street	25 00
"	Hancock "	Fairmount avenue, west of Twelfth street	41 00
"	Spring Garden School	Southeast corner Twelfth and Ogden streets	30 00
"	Central High "	Southeast corner Broad and Green streets	63 00
Fifteenth	Girls' Normal "	Northeast corner Spring Garden and Seventeenth streets	119 00
"	Boys' School of Practice	1619 and 1621 Spring Garden street	41 00
"	Hoffman School	Northeast corner Seventeenth and Wood streets	19 00
"	Thaddeus Stevens School	Northwest corner Seventeenth and Grayson streets	31 00
"	Lincoln "	Southeast corner Twentieth street and Fairmount avenue	71 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount.
Fifteenth	A. D. Bache School........................	Northeast corner Twenty-second and Brown streets..	$17 00
"	Livingston "	Northeast corner Twenty-third and Shamokin streets..	21 00
Sixteenth	Wm. A. Lee "	Howard street, below Girard avenue.......	30 00
"	Martin Landenberger "	Fourth street, above George street..	27 00
"	George Wolfe "	Charlotte street, above Poplar street..	20 00
"	Jefferson "	Fifth street, above Poplar street.........................	38 00
Seventeenth	Harrison "	South side of Master street, above Second street..	19 00
"	James R. Ludlow "	Northeast corner Master and Lawrence streets..	25 00
"	Webster School......	East side Hancock street, above Girard avenue..	16 00
Eighteenth..........	Douglas "	Southeast corner Edgemont and Huntingdon streets..	13 00
"	Primaries, Nos. 7 and 8.............................	Southwest corner Belgrade and Otis streets..	13 00
"	T. K. Finletter School....................	Montgomery avenue, northeast corner Gaul street..	29 00
"	Morris "	Palmer street, above Thompson street..	16 00
"	George Chandler "	Montgomery avenue, above Richmond street..	36 00
"	Vaughan "	Marlborough street, above Thompson street..	26 00
Nineteenth..........	Price "	East side Howard street, north of Diamond street..	21 00
"	Wm. Adamson "	East side Fourth street..	25 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount.
Nineteenth.........	Franklin School..................	East side American street, north of Columbia avenue........................	$12 00
"	Colored consolidated "	West side Cadwallader street (rented)..	....
"	Wm. H. Hunter "	Southeast corner Dauphin and Mascher streets..	16 00
"	Cohocksink "	Northwest corner Montgomery avenue and Fourth street..	15 00
"	Cumberland "	Southwest corner Cumberland and Hancock streets..	19 00
Twentieth	Park Avenue "	Park avenue, above Thompson street..	61 00
"	Daniel Webster School.....	Eleventh street, below Thompson street..	21 00
"	Penn "	Southeast corner Eighth and Thompson streets..	20 00
"	Rutledge "	Northwest corner Seventh and Norris streets..	27 00
"	James Todd "	Northwest corner Franklin and Norris streets..	27 00
"	Primary No. 7 "	1523 and 1531 Mervine street..	10 00
"	James Lynd "	Twelfth street, above Columbia avenue...	40 00
Twenty-first........	Manayunk Grammar "	South side Green lane, below Wood street..	17 00
"	Fairview "	Manayunk avenue, below Green lane..	47 00
"	Schuylkill Secondary "	Washington street and Jefferson avenue...	17 00
"	Roxborough "	Ridge avenue, west side, below Parker street..	6 00
"	Washington Primary "	Shurs' lane, south side, first house east of Cresson street..................................	13 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount.
Twenty-first	Levering School	West side Ridge avenue, below Martin street	$7 00
Twenty-second	Chestnut Hill "	South side Highland avenue	19 00
"	Germantown "	Northeast corner Adams and Lafayette streets	30 00
"	C. W. Scheaffer "	Germantown avenue and Wyoming street	24 00
"	Central Primary School	North side Centre street	13 00
"	Bringhurst "	Bringhurst street	16 00
"	Rittenhouse "	South side Rittenhouse street	13 00
Twenty-third	Marshall "	Northwest corner Franklin and Sellers streets	11 00
"	Henry Herbert Grammar School	Frankford avenue, 100 feet from the southeast corner Foulkrod street	25 00
"	White Hall "	Southwest corner Pratt and Tacony streets	19 00
"	Wilmot Public "	One hundred and thirty feet from the southwest corner of Mulberry street	8 00
Twenty-fourth	Norris J. Hoffman "	Northeast corner Fifty-fifth and Vine streets	28 00
"	Jesse George "	Hamilton street, above Sixty-third street	28 00
"	Martha Washington "	Forty-fourth and Huron streets	36 00
"	Belmont Grammar "	Forty-first and Oregon streets	28 00
"	Warren "	Thirty-eighth street, below Warren street	35 00
"	Mantua "	Thirty-eight street, below Mount Vernon street	29 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount.
Twenty-fourth	Haverford School.........	3415 Haverford street..........	$28 00
Twenty-fifth	Sherman "	Northeast corner Somerset street and Frankford avenue..........	17 00
"	Boudinot School..........	Southwest corner Indiana avenue and "D" street..........	21 00
"	Henry W. Halliwell Grammar School.....	Frankford and Allegheny avenues..........	31 00
"	Geo. B. McClellan, No. 1, School..........	Northwest corner Edgemont and Neff streets..........	13 00
"	Geo. B. McClellan, No. 2, "	Northeast corner Neff and Thompson streets..........	30 00
"	Carroll School..........	1528 Salmon street..........	14 00
"	Irving "	Bridesburg..........	13 00
"	Barton "	Frankford avenue and Buckius street..........	13 00
"	Bayard Taylor School..........	Sixth and Venango streets..........	16 00
"	Asa Packer "	Broad and McFerran streets..........	22 00
Twenty-sixth.......	Jackson "	Southeast corner Twelfth and Federal streets..........	40 00
"	Jeremiah Nichols School..........	Northeast corner Sixteenth and Wharton streets..........	34 00
"	James Alcorn "	Thirty-fourth and Wharton streets..........	25 00
"	Landreth Federal "	Southeast corner Twenty-third and Federal streets..........	17 00
"	James Logan "	Northwest corner Nineteenth and Reed streets..........	16 00
Twenty-seventh...	Newton Grammar "	Southwest corner Thirty-eighth and Spruce streets..........	34 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount.
Twenty-seventh...	Newton Secondary School	3438 Chestnut street	$28 00
" ...	Newton Primary "	3459 Ludlow street	16 00
" ...	Price "	Southwest corner Forty-seventh and Locust streets	19 00
Twenty-eighth.....	Oakdale "	Eleventh street and Huntingdon avenue	24 00
"	Camac "	Corner Thirteenth street and Susquehanna avenue	43 00
"	Kenderton "	Fifteenth street below Tioga street	28 00
"	T. H. Powers "	Southwest corner Susquehanna avenue and Woodstock street	30 00
"	Bellevue "	Twenty-sixth street and Cumberland avenue	32 00
"	Glenwood Primary "	Ridge avenue above Thirty-second street	16 00
"	James L. Claghorn "	Seventeenth street and Susquehanna avenue	43 00
Twenty-ninth......	Reynolds "	Southwest corner Twentieth and Jefferson streets	36 00
"	Edward Gratz "	Southeast corner Twenty-third and Jefferson streets	24 00
"	Morris City "	Southwest corner Twenty-sixth and Thompson streets	10 00
"	Muhlenberg "	Southeast corner Master and Forty-seventh streets	22 00
"	Elisha Kent Kane "	Southeast corner Jefferson and Twenty-sixth streets	31 00
"	George G. Meade School	Eighteenth and Oxford streets	49 00
Thirtieth	William S. Pierce "	Twenty-fourth and Christian streets	26 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—*Continued.*

Wards.	Name.		Location.	Amount.
Thirtieth	Curtin	School........................	Southwest corner Twentieth and Catharine streets......	$16 00
"	James Pollock	"	Southwest corner Birch and Fitzwater streets..	16 00
"	Edwin M. Stanton	"	Southeast corner Seventeenth and Christian streets...	23 00
Thirty-first	John S. Hart	"	York and Memphis streets................................	29 00
"	Adams	"	Adams street above Amber street..	21 00
"	Lucretia Mott	"	Huntingdon avenue and Sepviva street..	28 00
			Total..	$3,814 00

LIST OF CHARITABLE INSTITUTIONS

Which, under the provisions of the Ordinance of June 21, 1878, and June 16, 1881, are charged fifteen per cent. of the regular rates.

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
First	Sisters of St. Francis	595 Reed street	June 7, 1883	$22 00	$5 00
Second	St. Ann Widows' Asylum	906 Moyamensing avenue	June 21, 1878	24 00	5 00
"	Ridgway Library	Broad street, southeast corner Christian street	January 21, 1882	107 00	16 05
Third	Maternity Hospital	730-32-34 South Tenth street	December 21, 1883	12 00	5 00
"	Industrial Home	762 South Tenth street	June 21, 1878	50 00	7 50
"	Southern Home for Destitute Children	Southeast corner Fitzwater and Twelfth streets	June 21, 1878	154 00	23 10
"	Philadelphia Society for Employment and Instruction of the Poor	714-718 Catharine street (Special ordiance)	March 23, 1878	76 75	5 00
Fourth	Institute for Colored Youth	915-919 Bainbridge street	April 17, 1883	28 00	5 00
"	Bedford Street Mission	619 Alaska street	June 2, 1879 June 11, 1879	30 50	5 00
Fifth	City Mission	411 Spruce street	April 10, 1883	16 00	5 00
"	Philadelphia Dispensary	127 South Fifth street	April 19, 1881	31 50	5 00
"	Newsboys' Aid Society	251 South Sixth street	September 29, 1881	62 90	9 43
Sixth	National Guards' Hall	518-520 Race street	April 26, 1884	54 00	8 10
"	Apprentices' Library	500 Arch street, southwest corner Fifth street	June 21, 1878	23 00	5 00
Seventh	Howard Hospital	1518-20 Lombard street.	April 10, 1883	22 50	5 00

LIST OF CHARITABLE INSTITUTIONS—*Continued.*

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
Seventh	Pennsylvania Hospital	Southwest corner Eighth and Spruce streets		$520 50	$78 18
"	Western Soup Society	1613–15 South street	June 21, 1878	21 00	5 00
"	Clinton Street Boarding House	913–15 Clinton street	June 21, 1879 Sept'mb'r 30, 1879	80 00	12 00
"	Deaf and Dumb Asylum	1025 Clinton street	October 22, 1885	8 00	5 00
"	" " "	317 South Eleventh street	October 22, 1885	67 00	10 05
"	" " "	Broad street, northwest corner Pine street	June 21, 1878	658 00	98 70
"	Day Nursery	2218 Lombard street	October 3, 1882	12 00	5 00
"	Lincoln Institute	324 Eleventh street (Special ordinance)	March 23, 1873	106 00	5 00
Eighth	Midnight Mission	919 Locust street	December 21, 1883	23 00	5 00
"	Philadelphia Library	Northwest corner Juniper and Locust streets	January 31, 1882	66 00	9 90
"	Jefferson Hospital	Sansom street, south side, above Tenth street	June 21, 1878	483 00	73 45
"	Union Benevolent Association	701 Sansom street	February 13, 1883	61 00	9 15
"	Jefferson College	Tenth street, west side, below Sansom street	June 21, 1878	136 00	20 40
"	Childrens' Hospital	207 South Twenty-second street	June 21, 1878	95 00	14 25
"	St. James' School	151 South Twenty-fourth street	February 10, 1885	21 00	5 00
"	Historical Society	Southwest corner Thirteenth and Locust streets	February 28, 1884	20 00	5 00
Ninth	Womens' Christian Association	1605 Filbert street	June 21, 1878	23 00	5 00

LIST OF CHARITABLE INSTITUTIONS—*Continued.*

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
Ninth	Homœpathic Hospital	1116–18 Cuthbert street		$29 00	$5 00
Tenth	Central Soup Society	709–11 Cherry street	June 13, 1881	103 00	15 45
"	Indigent Widows' and Single Women's Society	North side Cherry street, E. of Eighteenth street	June 21, 1878 June 18, 1879	61 00	9 15
"	Catholic Home for Destitute Children and Orphan Girls	1718–20 Race street	June 21, 1882	42 00	6 30
"	Wills' Eye Hospital	1810–24 Race street	June 21, 1878	121 00	18 15
"	Academy of Natural Sciences	1900 Race street, S. W. corner Nineteenth street	June 21, 1878	109 00	16 35
"	Presbyterian Historical Society	1227–29 Race street	June 20, 1882	17 00	5 00
"	Pennsylvania Institute for the Instruction of the Blind	Northeast corner Race and Twentieth streets	June 21, 1882	451 00	67 65
"	Orthopædic Hospital	1701 Summer street, N.W. cor. Seventeenth street	June 21, 1878	53 00	7 95
"	Academy of Fine Arts	Northwest corner Broad and Cherry streets	June 21, 1878	276 00	41 40
"	Magdalen Society of Philadelphia	Northeast corner Twenty-first and Race streets	June 21, 1878	67 00	10 05
Twelfth	Northern Soup Society	817 North Fourth street	June 21, 1878	40 50	6 07
"	Home Association	505 North Sixth street	June 21, 1878	18 00	5 00
Thirteenth	Northern Dispensary	606–08–10 Fairmount avenue	June 21, 1878	41 50	6 23
"	Sheltering Arms	717 Franklin street	September 16, 1885	29 00	5 00
Fourteeenth	Spring Garden Institute	1349–51–53 Spring Garden street	October 22, 1883	45 00	6 75

LIST OF CHARITABLE INSTITUTIONS—*Continued.*

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
Fifteenth	Preston Retreat	N. W. corner Twentieth and Hamilton streets	June 21, 1878	$121 00	$18 15
"	Home Infirmary	2208 Brown street	July 27, 1878	23 00	5 00
"	Northern Home for Friendless Children	N. E. corner Twenty-third and Brown streets	June 21, 1878	110 00	16 50
"	Soldiers' Orphans' Home	N. E. cor. Twenty-third and Brown streets (rear)	June 21, 1879	85 00	12 75
"	House of Refuge	N. W. cor. Twenty-second and Parrish streets	March 18, 1879	1,050 42	157 57
"	" " (colored)	" " " " "	March 18, 1879	400 00	60 00
"	Howard Institute	1610 Poplar street	June 7, 1883	13 00	5 00
"	" "	1612 " "	June 7, 1883	16 00	5 00
"	Jewish Foster Home	S. W. corner Twenty-fourth and Poplar streets	June 21, 1878	49 00	7 35
"	C. Morrison	2426 Hare street	June 24, 1879	5 00	0 00
"	St. Vincent Home for Destitute Infants	N. W. corner Wood and Eighteenth streets	June 21, 1878	109 00	16 58
"	Northern Home Infirmary	826 North Twenty-third street	November 16, 1880	$11 00	$5 00
"	Home for Aged Couples	1721–23 Francis street	December 5, 1883	14 00	5 00
"	Charity Hospital	1832 Hamilton street	February 5, 1885	17 00	5 00
Sixteenth	Day Nursery	1008 North Fifth street	July 31, 1885	29 00	5 00
Eighteenth	St. Mary's Hospital	N. E. cor. Palmer street and Frankford avenue		56 00	8 40
Nineteenth	Episcopal "	S. E. corner Front street and Lehigh avenue		649 00	97 35

LIST OF CHARITABLE INSTITUTIONS—*Continued.*

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
Nineteenth.........	Northeastern Soup Society....................	1940 North Front street................................	....	$8 00	$5 00
Twenty-second.....	Women's Christian Association.............	4781 Germantown avenue................................	January 31, 1885..	15 00	5 00
"	Young Men's Christian Association.......	5019 " "	January 25, 1882..	71 00	10 65
"	Lutheran Orphans' Home.......................	5576 " "	June 21, 1878..	67 00	10 05
"	" Asylum for Aged.....................	5580 " "	June 21, 1878..	84 00	12 60
"	Jewish Hospital..................................	Cottage avenue..	....	194 50	29 50
"	Germantown Hospital..........................	East Penn street, west of Chew street............	....	92 00	13 80
"	Pauline Home......................................	" " second house east of Ross st...	March 4, 1883..	39 00	5 85
"	Little Sisters of the Poor.......................	Mill street, fourth house east of Ross street......	June 21, 1878..	140 00	21 00
"	Jewish Foster Home.............................	" first house west of Chew street.........	June 7, 1881..	132 00	19 80
"	Germantown Poor House.......................	Rittenhouse street..	June 21, 1878.	57 00	8 55
Twenty-fourth.....	Working Home for Blind Men...............	3518 Lancaster avenue....................................	June 21, 1878..	100 00	15 00
"	Union Home for Old Ladies...................	N. W. cor. Lancaster and Girard avenues.........	June 21, 1878..	15 00	5 00
"	Presbyterian Hospital...........................	S.W. cor. Powelton avenue and Saunders ave.....	June 21, 1878..	290 00	43 50
"	Pennsylvania Home for Blind Women...	N. E. " " " " ..	June 18, 1881..	73 00	16 95
"	Old Men's Home...................................	N.W. " " " " ..	June 18, 1881..	170 00	25 50
"	Pennsylvania Hospital for Insane(femal's)	Haverford street, south side..............................	June 21, 1878.. February 17, 1879..	880 00	132 00

LIST OF CHARITABLE INSTITUTIONS—*Continued.*

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
Twenty-fourth.....	Pennsylvania Hospital for Insane (males).	Southeast cor. Haverford and Fiftieth streets...	June 21, 1878.. February 17, 1879..	$933 50	$140 03
"	Colored Home..	S. W. cor. Forty-fourth street and Girard ave...	June 21, 1878..	118 00	15 45
"	House of Good Shepherd........................	Fairmount avenue, west of Thirty-fifth street...	June 21, 1878..	516 00	77 40
"	Philadelphia Home for Infants...............	Westminster ave., S. E. corner Markoe street.....	June 21, 1878..	88 00	13 20
"	St. John's Orphan Asylum.....................	" " north side..........................	June 21, 1878..	105 00	15 75
"	Western Home for Poor Children...........	S. E. cor. Forty-first and Baring streets...........	April 18, 1882..	44 00	6 60
"	Pennsylvania Homœopathic Hospital for Children..	S. W. cor. Forty-third and Brown streets..........	June 21, 1878..	37 00	5 55
"	Colored Orphans' Home........................	S. W. corner Forty-fourth and Wallace streets. (Special Ordinance)...	March 23, 1878..	74 50	11 17
"	Baptist Orphanage.................................	S. W. cor. Forty-fifth and Fairmount avenue....	June 21, 1878..	26 00	5 00
Twenty-fifth........	Old Ladies' Home..................................	Frankford ave., fifth house north of cemetery...	May 31, 1881..	11 00	5 00
Twenty-sixth	Third Regiment Armory........................	N. E. cor. Twelfth and Reed streets.................	May 16, 1882..	50 00	7 50
Twenty-seventh...	University of Pennsylvania.	N. E. cor. Thirty-sixth and Spruce streets.........	June 21, 1878..	1,323 50	198 50
" ...	University of Pennsylvania, Veterinary Department	S. W. corner Thirty-sixth and Pine streets.......	June 21, 1878..	127 00	19 05
" ...	University of Pennsylvania, Biological Department	S. side Pine, bet. 37th and Cleveland streets.......	June 21, 1878..	95 00	14 25
" ...	West Philadelphia Industrial School.......	N. W. cor. Thirty-ninth and Pine streets.........	June 21, 1878..	118 00	17 70

LIST OF CHARITABLE INSTITUTIONS—*Continued.*

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
Twenty-seventh...	Home for Colored Children.....................	Woodland avenue, east of Forty-sixth street......	April 15, 1885..	$32 00	$5 00
" ...	Home for Incurables............................	" " east of Forty-eighth street...	January 1, 1883..	129 00	19 35
" ...	Divinity School....................................	" " S. E. cor. Fiftieth street.........	....	160 00	24 00
" ...	Presbyterian Orphans' Home..................	" " bet. Fifty-eighth and Fifty-ninth street............	July 18, 1878..	128 00	19 20
" ...	Educational Home................................	Woodland avenue and Forty-ninth street. (Special Ordinance)...	March 23, 1878..	179 50	5 00
Twenty-eighth.....	Baptist Home..	North Seventeenth street, cor. Norris street......	June 21, 1878..	223 00	33 45
"	Odd Fellows' Home................................	" " " S. E. cor. Tioga street..	June 21, 1878..	97 00	14 55
"	Methodist Episcopal Home.....................	N. E. cor. Thirteenth street and Lehigh ave......	June 21, 1878..	178 00	26 70
"	Women's Homœopathic Hospital...........	2135-37 North Twentieth street........................	October 1, 1884..	40 00	6 00
Twenty-ninth......	Homœopathic Hospital for Children.......	914 North Broad street........................	December 21, 1883..	61 00	9 15
"	School of Design for Women..................	1346 " " "	June 21, 1878..	129 00	19 35
"	Little Sisters of the Poor........................	Eighteenth street, E. side, N. of Jefferson st......	June 21, 1878..	192 00	28 80
"	German Hospital...................................	S. W. cor. Corinthian and Girard avenues.........	June 21, 1878..	743 00	111 45
"	House of Refuge...................................	N. W. cor. Twenty-second and Poplar streets....	June 21, 1878..	439 00	65 85
"	St. Joseph's Hospital.............................	S. E. cor. Seventeenth street and Girard ave......	June 21, 1878..	485 00	72 75
"	Women's Medical College.......................	N. W. cor. 21st street and North College avenue..	June 21, 1878..	110 00	16 50

STATEMENT OF PERMITS ISSUED DURING THE YEAR 1885 BY WARDS.

APPLIANCES.	WARDS.																														Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Aquaria				1*																												1
Bakeries	1				1						1			1	2		2		4				1	1	3	2		1	4		1	25
Barber shops	8	2		1	1	2	1		2		3	2	2		3	4		5	6	4	2	3	2	2	5	1	1	4	5	1	5	77
Bars	10	1		6	4	2	1	2	4	3	13	2	11	6	8	7	2	5	18	9	7	7	3	7	22	15	4	13	22	5	4	223
Basins and sinks in dwellings	5	3	5		19	28	39	69	35	31	2	8	35	24	192	4	6	10	41	110	24	132	9	128	23	32	199	344	140	10	18	1,725
Basins and sinks in offices, stores, factories, hotels, etc.	9	8	2		79	71	5	6	195	18	7	6	17	10	8	1	8	13	11	6	1	1		9	13	13	17	20	7	2	1	564
Baths in dwellings	180	22	12	4	10	6	27	40	20	14	6	6	24	18	231	13	22	41	373	78	70	286	64	378	434	389	192	493	312	47	45	3,857
Baths in public buildings																	3															3
Bidets								4	3											1							4		2			14
Bottling establishments	2											1			1		1	1					1		1				1			9
Building purposes, number	23	1	4	1	5	3	5	9	3	2		2	4	4	31	1	8	15	90	9	61	143	35	99	137	56	50	124	53	9	17	1,004
Carriages and wagons								3	27				12		14					1	1	15			4		2	10			1	90
Cut-offs	60	40	24	13	36	59	42	41	32	47	11	22	38	40	96	8	15	46	79	112	36	17	5	91	40	108	23	52	67	78	84	1,462
Half dwellings				5										1			8					4			21							39
Drug stores	1										1					1	1		2	1		1		1	2	2	1	4	1		1	20
Ferrules, number	392	62	39	17	56	89	80	82	66	75	14	30	54	64	449	18	40	80	629	219	148	439	160	647	734	927	208	692	496	133	170	7,309
Fountains, counter	2					1			3	3		1		1	1				4	6	1	2	1	1		2	1	1	3	1		35
Fountains, garden								2		1					3				1	1				1					2			11
Forges													2							2							8					12
Greenhouses	1																				2	2		7	8	1	9	2				32
Hydrants (new buildings)	291	15	15	6	11	18	22	37	21	12	4	3	17	29	262	12	28	48	443	69	156	443	148	482	487	640	263	552	345	28	78	4,985
Ice cream saloons					1						1									1				1								4
Laundries	3			1				2		1		4	3	1	2	1			7	3				1	1	1	5	2	4	3		45
Machines for scouring, washing, bleaching, and rinsing		1													2						1	1			5							10
Milk houses	6				1		2				2	1	6			2	2		2	7						3	3		1			38

STATEMENT OF PERMITS ISSUED DURING THE YEAR 1885, BY WARDS—*Continued.*

APPLIANCES.	WARDS.																															Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Motors, beer					2	3	2	1	4	1	2	1	4	1	3		2		2	4	1	4		4	3	1	1	2	6	1		55
Motors, organ								1	1													1					1	1		1		6
Photograph galleries										1									1					1							1	4
Plug permits	1		1				1		1									1			3			2	3	4	1	3	3	1	1	26
Pools in churches													1											1	1							3
Restaurants and eating saloons	3	1			1	2		4	1	2	1	2	5			2	1		3													28
Screw nozzles	2				1		1			1				1								2			1	3	1			1		14
Slaughter-houses																1			1		1				2			1				6
Stalls in stables	27	10				4	3	30			24		4	17	22	4	5	1	98	35	4	197	5	55	46	28	14	81	26	15	5	760
Steam boilers, number	4	2	1		8	9	8		11	5	2	4	3	2	4	4	6	2	12	6	4		3	7	21	3	2	4	3	1	10	151
Steam boilers, horse power	102	42	4		280½	182	134		244	196	17	42	66	41	71	98	105	25	321	49	73		60	76	512	56	4	60	20	5	240	3,125½
Steam engines, number	1	1	1		4	17		5	8	4		1	2	5	4	2	1		4	5	1	1	1	4	1	3	2	2	1		2	83
Steam engines, horse power	2	10	3		47	122		266	319	44		20	2	75	56	15½	10		107	23	14	18	16	90	6	73	13	17	250		13	1,631½
Street sprinklers																																101
Shower-baths, public															11																	11
Tubs, vats, and tanks		2	2			1					4	12				1	17	2	1						2	4		2			1	51
Urinals in dwellings								7	1	4	3		3		10				2	4		3		2			4	8	2	1		54
Urinals in stores, offices, factories, hotels, etc	1			1	14	15		6	70	4		2	14	8						5				3		1	3		2			149
Urinal troughs		1							1			1																	1			4
Wash-paves	82	5	7	3	6	7	7	33	20	9	6	2	19	12	181	9	17	18	298	90	28	121	42	178	199	163	133	364	257	24	31	2,371
Wash-paves for watering horses	13	3	3	3	8		2	1	4	4	2	1	2	3	5	2	4	9	12	7	3	3	2	10	18	13	1	6	10	3	13	170
Wash-tubs, stationary					4	4	18	28	18	8	3		7		27				2	9		45	3	59		6	53	113	23		3	433
Water-closets in dwellings	32	26	24	9	69	100	67	118	62	117	20	32	96	158	616	30	29	19	318	307	8	213	23	539	104	57	319	592	692	41	42	4,879
Water-closets in stores, offices, factories, hotels, etc	6	7	3		66	111	4	13	190	37	20	12	18	22	11	3		26	13			4	1	9	14	8	26	17	6	1	12	660
Watering vessels	18	97	12	6							4												2		1							140

STATEMENT BY WARDS OF THE NUMBER AND KIND OF PREMISES AND APPLIANCES ON THE GENERAL BOOKS OF THE WATER DEPARTMENT, JANUARY 1, 1886.

	WARDS.																															Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Aquaria	1			1		5			4		1		1		2				5	1		1							6			28
Bakeries	63	48	41	31	30	21	43	29	22	22	33	24	35	36	56	45	41	40	69	61	15	21	10	33	40	56	16	50	60	39	48	1,178
Barber shops	47	34	14	29	51	35	23	33	52	16	25	22	25	25	41	25	28	34	62	49	24	19	24	36	34	27	14	26	42	31	43	990
Bars	213	158	111	234	277	267	147	161	197	167	212	149	161	146	262	161	162	174	388	236	144	79	86	207	240	264	92	201	204	170	233	5,903
Basins and sinks in dwellings	141	44	135	59	237	251	2,139	3,241	1,366	1,860	40	534	986	794	6,176	117	94	121	339	2,548	277	1,632	154	1,923	123	294	2,424	3,316	5,190	148	122	36,825
" " offices, factories, hotels, and public buildings	62	66	44	37	2,395	3,098	144	1,985	2,003	721	227	197	295	312	475	110	85	101	358	230	89	268	47	400	77	71	471	157	458	135	138	15,226
Baths in dwellings	4,034	1,456	925	622	907	475	2,674	2,727	1,185	2,282	456	1,023	2,066	2,155	5,308	761	760	1,723	5,169	6,241	824	2,824	703	5,621	2,643	4,155	2,335	5,884	7,541	2,832	2,462	80,773
" public buildings			19		13	52	67	191	53	60	4	7	3		29	1	3		20	5	4	54		94			46	15	68	28		836
" foot							1						1											2	2		1					7
Beam houses		1									8	3		2														2				16
Bidets					1	1	41	169	45	24			10		80	1				18	4	29		25		3	20	1	19			491
Bottling establishments	3	3		2	2	5	1		1	2	1	4	2	3	3	2	4	4	2	4	3		1	1	4			2	5	2	1	67
Brick-yards, gangs of men																				1					12	21	16	14				64
Breweries	1		3	2		2			1		4	4		1	5	7	10	2	8	7	1	1	3	1	5	1		5	14	1	2	91
Cars, steam and horse							30								33			33	40					133	23		28	157	80		129	688
Carriages and wagons	64	47	31	94	52	26	97	299	276	254	41	111	263	245	495	52	62	112	359	365	236	227	110	350	50	107	193	174	233	92	61	5,178
Coloring-rooms											5	5				3																13
Condensers									1															1								2
Dash wheels						2						1				1														1		5
Dwellings without water	124	253	130	182	49	359	68	19	32	25	127	64	44	860	23	203	17	593	49	1	767	208	995	550	799	17	150	465	98	1	85	7,357
Half dwellings without water	214	860	863	969	475	268	769	302	167	578	684	539	396	420	757	962	1,314	555	542	385	186	45	82	124	327	86	92	82	87	225	268	13,623
Drug stores	26	16	12	14	12	13	20	23	23	18	7	10	19	22	30	9	12	18	35	37	10	16	9	24	11	24	15	32	36	23	17	593
Dry docks			1																													1
Engines on railroads		5			1										31				43	18		1			6		2				7	114
Filterers															1													1				2
Fountains, counter	4	1	4	1		7	9	7	10	12		3	6	6	5	3	2	2	8	15	3	6	3	9	2	4	8	7	19	6	1	173
" garden	3	2	3		3	3	7	21	12	8	1	5	8	8	50	2		8	5	17	9	32	5	31	5	3	36	9	30	11	4	341
Forges	5	7	8	3	9	27			13	3	6	5	7	5	237	7		87	8	42	15	7	27	8	44	11	71	15	7	5	17	706
Furnaces	8			4			1		22		4	9	2	2	10		8		6		9			4						2		91
Gas works									1						1	1					2				1	1						7
Glass works																		3	3						1					1	1	9
Greenhouses	18						1	13	1			1			3	2	1	5	3	8	36	103		42	67	30	136	44	23	13	1	551
Grindstones					5	11				2				1		22			11									2				54
Hatters' planks	8				12	9		4	2	2	1	11	3			4	3														2	61
Hydrants	9,446	4,649	2,623	2,398	2,937	2,750	4,749	3,535	2,519	3,696	1,945	2,123	3,271	3,122	8,612	2,575	2,886	5,001	9,588	8,498	3,073	4,730	2,086	9,518	6,399	8,477	3,239	6,424	9,061	5,554	6,359	151,853
Hydraulic elevators						2		1	5	3									2			1										14
Ice cream saloons	5	8	1	5	3	1	6	7	7	6	5		4	1	10	9		10	14	5	18	2	2	6	1	1	3	2	3	1	1	147
Ice machines															1					1						1			3			6
Laboratories								1		1		1					1											1		1		6
Laundries	20	6	6	9	13	5	13	6	18	11	3	10	10	10	11	2	4	2	12		3	2	3	7	3	5	5	3	8	7	7	224
Lawn sprinklers																				1	65	60	4				33	58	6			227
Machines for scouring, washing, bleaching, and rinsing		2	1		2	2		4		3	2					8	5	16	16						55	4	2				28	150

STATEMENT BY WARDS OF THE NUMBER AND KIND OF PREMISES AND APPLIANCES ON THE GENERAL BOOKS OF THE WATER DEPARTMENT, JANUARY 1, 1886—*Continued.*

	WARDS.																															Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Malt houses											1	1			1		1	1	3	2						1			4			15
Milk-houses	18		1	1	1		3				2	1	11	2	1	2	2		8	13	3			2		3	4	3	4		1	86
Motors, beer	3	1	5	7	17	21	12	16	11	5	4	9	10	3	9	3	9	10	17	20	14	7		11	3	4	3	9	18	31	3	295
" organ							1	5	2	1				1	1	2			1	1	1	6		1			4	1	1	1		30
Photograph galleries		2		3	4	3	1	10	19	4	7	1	7	1	7	1	4	1	6	5	1	3	2	2	2		3		2		3	104
Pools in churches		1	1		2			1	1	3			2	2	2	1		3		4	2	3		5	2		2	2	6		3	48
Premises with water	9,446	4,649	2,623	2,398	2,937	2,750	4,749	3,535	2,519	3,696	1,945	2,123	3,271	3,122	8,612	2,575	2,886	5,001	9,588	8,498	3,073	4,730	2,086	9,518	6,399	8,477	3,239	6,424	9,061	5,554	6,359	151,853
" without water	338	1,113	993	1,151	524	627	837	321	199	603	811	603	440	1,280	780	1,165	1,331	1,148	591	386	953	253	1,077	674	1,126	103	242	547	185	226	353	20,980
Rectifying establishments				1		1													1						1							4
Restaurants and eating saloons	16	7	3	10	28	80	7	29	61	14	24	7	24	13	7	10	8	6	20	24	3	1	2	16	1	9	9	13	7	7	9	475
Screw nozzles	134	58	53	47	179	265	127	232	160	165	138	103	135	134	327	146	148	249	230	278	269	198	114	385	108	63	214	219	280	90	162	5,410
Shot-towers		1																														1
Slaughter-houses	18										2	1	1	6	1	2	6		12	12	7	3	3	23	16	3		1	6	1	10	134
Soap-boiling establishments	2		1								1									1											1	6
Standpipes for watering engines									1		2		3	1	1			2						2	2					2		16
Stalls in stable	1,600	721	190	433	146	357	840	901	980	1,088	185	451	515	810	2,357	531	522	1,632	2,372	1,375	733	1,032	540	2,355	1,000	1,222	1,025	1,385	1,408	737	1,705	31,148
" in market			144		80	235	209		1,076		289			146	388				208	175	50			293		222			1,071	152	50	4,788
" country	4		14	114	97	27	10	32	98	32	238	127	108	28	152	129	12		101	347	135		147	12	76	13		66	206		12	2,337
" fish			1		9	3	1		6		3				2				2	2				3			1		13	2		48
Steam boilers, number	62	45	10	14	86	221	224	85	123	56	59	31	29	35	160	83	61	61	166	53	58	62	59	44	113	58	35	35	70	25	113	2,336
" " horse-power	1,879	1,216	218	389	1,841½	3,539	1,242	1,232	2,722	978	967	815	388	1,001	5,077	2,095	2,162	1,735	4,742	1,275	2,835	1,373	1,378	759½	3,316	1,550	546	467	2,621	757	3,082	54,198
" " heating, number				4	36	27	5	17	32	5			6	1	15	3			3	4		10	1	12	3	3	8	3	8	3		205
" " " horse-power					359	254	254	237	214	207			464	24	3				140					50	50			33				2,289
" engines, number	48	21	9	5	55	149	7	37	88	30	30	18	16	30	45	38	23	26	92	67	1	53	27	33	31	27	22	21	29	23	51	1,152
" " horse-power	645	411	182	45	535	1,379	151	620	2,457	519	224	399	76	428	736	655½	387	467	1,824	605	1	469	262	261	571	479	228	169	447	179	426	16,227½
" saws, number								4																			3					7
Swimming baths								2	1																							3
Tubs, vats, and tanks	19	18	4		88	69	41	9	51	21	176	398	302		107	165	383		168	42	59	70	51	31	76	22	2	49	11	28	159	2,619
Turbine wheels								1																								1
Urinals in dwellings				3	3	2	13	62	9	10	3		4	7	21	3	2		3	11	1	26		7		1	13	21	19	1		245
" stores, offices, factories, hotels, and public buildings	10	9	4	6	567	669	23	331	465	96	20	31	68	63	94	17	7	7	51	34	14	47	10	55	2	14	50	10	86	26	9	2,895
Urinal troughs	2	1			3	1		1	2		1	2		1				1			1											16
Vats, lime											18						25															43
" tan											18	3																				21
Vinegar establishments											1						1															2
Wash-paves	1,452	638	481	261	577	387	1,383	1,622	871	1,447	226	627	1,303	1,467	3,915	437	427	867	3,067	4,452	406	1,209	529	2,770	1,098	1,610	1,572	4,471	5,595	1,659	1,256	48,112
" for watering horses	34	11	11	6	21	4	13	3	20	12	17	8	5	14	29	11	33	46	63	23	19	14	15	36	60	31	23	37	22	12	37	690
Wash-tubs	4	13	24	6	51	4	640	1,556	415	497	181	3	3		1,020	396	78	10	55	535	63	773	7	636	12	54	866	376	969	54	13	9,314
Water-closets in dwellings	324	176	194	140	408	312	1,969	3,058	1,022	1,961	89	645	1,616	1,489	5,819	216	125	148	1,031	3,345	186	2,140	109	3,730	327	426	3,003	5,121	5,550	673	216	45,568
" offices, stores, factories, hotels, and public buildings	19	77	46	18	1,965	3,319	98	1,436	2,040	677	206	165	260	282	628	87	91	74	415	182	63	277	42	318	46	68	260	91	589	151	141	14,131
Wool washers		1		1			1											1	5			4			1	7		1				22

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LIST OF CHARITABLE INSTITUTIONS—*Continued.*

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
Twenty-ninth......	Women's Hospital..................................	N. E. cor. 22d street and N. College avenue........	June 21, 1878..	$282 50	$42 38
"	Girard College..	South College avenue, north side.......................	June 3, 1879..	5,235 28	788 30
"	Union Temporary Home for Children.....	1525 Poplar street...	June 21, 1878..	69 00	10 35
"	Northwest Soup Society.........................	1300 North Nineteenth street...........................	June 21, 1879..	11 00	5 00
				$22,395 35	$3,290 04
		Loss of revenue to the city...	....	$19,105 31	

REPORT

OF THE

GENERAL SUPERINTENDENT

OF

WORK DONE DURING 1885 TO BUILDINGS, GROUNDS AND RESERVOIRS, AND BOILERS AND MACHINERY OF THE DIFFERENT PUMPING STATIONS.

PHILADELPHIA WATER DEPARTMENT,
OFFICE OF THE GENERAL SUPERINTENDENT.

February 27, 1886.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—The following report of the operations of the Pumpage branch of the Department during the year 1885 is respectfully submitted:

The care of the machinery and buildings, grounds, and reservoirs was placed under my charge on October 15. Owing to the exhaustion of the appropriation, very little work was done after this date, except at Fairmount, where needed repairs to the turbines and pumps were completed, and the buildings and grounds put in shape for the winter.

At the other stations the employés were required to keep their machinery in order, and men from other branches of the Department were detailed to perform such work as could not be postponed until the following year.

The accompanying tables and description of the repairs and alterations made have been compiled from records on file in the office.

Respectfully,

JOHN L. OGDEN,
General Superintendent.

FAIRMOUNT.

BUILDINGS AND GROUNDS.

Space formerly occupied by the old No. 6 breastwheel fitted up as a dressing-room for oilers, a new floor being laid, doorway cut, walls plastered, and woodwork painted. A girder (wood) was placed under the floor to support it, the old supports having been washed away. A ventilator was built in the ceiling of the dressing-room, and carried up through the roof of the carpenter shop. New platforms were laid around turbines Nos. 1, 4, and 5. Platform and steps partially repaired in north wheel-house. Heater in oil-room repaired, and heater connections made in north wheel-house. New pipe connections made from mains of turbines Nos. 8 and 9 to boiler and wash room. Trap-doors made in platform around turbine No. 5. Trap-doors in platform around No. 7 repaired. Old steam-pipe taken down in north wheel-house, and connections made to heaters with one-inch pipe, the old pipe being too large for the purpose. Piers built under heaters. New doors made for wheel-house. Floors cemented around turbines Nos. 3, 4, 5, 7, 8, and 9. In the police station a new floor was laid, closets painted and grained, and door repaired. Blind-door built for No. 1 wheel-room. New woodwork in wheel-house and floor of mansion-house painted.

Forebay railing painted. Foundations built for sphinxes and wooden female figure near forebay. Figure painted and placed in position. Stone work of spring on north side of reservoir repaired. New floor laid in carpenter shop. Flagstone reset at Callowhill street entrance to garden. Railing along river front partially repaired. Necessary glazing done to sashes and lamps. Flash-boards replaced on dam.

RESERVOIRS.

Outlet-house of reservoirs rebuilt. Wooden frames made for screens at outlet-house. Derrick erected and wooden conduits built for cleaning reservoirs Platform built for pump and engine on bank. Old cap-logs removed from central reservoir. Reservoir banks cleaned and dirt hauled away; grass cut and washouts on walks repaired. Brick lining of reservoir No. 3 on south bank repaired, and angle-iron fitted to keep brick lining in place.

The reservoirs at this station, with the exception of Nos. 1 and 3, were cleaned in the following manner:

The reservoirs, with the exception of the central sections, which were kept partially filled by a wooden conduit thrown across reservoir No. 2, were emptied, and the mud, in a liquid form, was washed and shoveled into section 3 of reservoir No. 4, through a break in the dividing wall. A centrifugal pump, driven by a small steam-engine, pumped this liquid mud into No. 2 reservoir, where it was allowed to flow back through the pumping main of No. 1 turbine into the river below the dam.

MACHINERY.

Turbine No. 1.—Indicator connections made. Valves removed from pumps in order to drain reservoirs. New wooden screen built. New wedges placed under step and upright shaft raised. New iron keys fitted to backs of one set of suction and delivery valves on north side of pump. Guides of suction valve on north side bored out and bushed. Oil-ways cut in caps of main shaft. The fly-wheel, having worked loose, was forced back on shaft and keys secured in place. New tail-gates built and hung in position.

Turbine No. 3.—Pump cylinders rebored from $22\frac{1}{32}$ inches to $22\frac{11}{32}$ inches on the south side, and from $22\frac{1}{16}$ inches to $22\frac{7}{16}$ inches on the north side. Guides planed and lined up. Brass rings shrunk on plungers to increase the diameters, and turned off to fit the bores of the cylinders. Stop-valves disconnected and overhauled, new screws fitted to brass nuts, faces scraped, and new lead joints made. Cross-heads, bearings, and journals have been turned up true, new brasses on cross-heads, and new crank-pin brasses on north side. Indicator connections made on both pumps. All old valves taken out and replaced by new ones. The broken main shaft drilled out from both crank and spur wheels. Drain-valve placed on air-chamber. Main journals bored out on north side, and new shaft placed in position. New crank-pins ground in, and brasses scraped to fit. New lignum-vitæ gib blocks fitted to cross-head. New step fitted to vertical shaft. New tail-gates built, and painted and hung in position. Side boxes adjusted, and main shaft forced into line; brasses keyed up; plunger tightened on rod, and step overhauled. Two-inch fire-hose connection made on pumping main.

Turbine No. 4.—Brasses of cross-heads overhauled; indicator connections made. Threads of jam screws filed on quarter pieces of main journals. Repairing stop on pumping main, unfinished. Tail-gate removed and new one made, painted, and put in place. New wooden keys made for spur-wheel.

Turbine No. 5.—New cogs made for spur and bevel wheels, but not fitted in place. Indicator connections made. Scraped and filed brasses, and draw-filed crank-pin, north side. New studs screwed in stuffing-box of upright shaft. Main drilled for two-inch fire-hose connection. Quarter pieces of main journal for spur-wheel side rebored. Journal of main shaft of spur-wheel side turned up. Cogs of spur-wheel repaired. New tail-gates built, painted, and hung in position. Brasses of cross-heads and crank-pins overhauled. New lignum-vitæ gib blocks fitted. New lead joints made on stop-valves. Drain-valves overhauled.

Turbine No. 7.—Bed-plate and brace to counter-shaft broken on February 4, at 9 P.M. New wrought-iron bed-plate (box girder) placed in position. Space between plate and foundation filled with lead and

Jonval Turbines—Double Acting Horizontal Plunger Pumps.—Total capacity 33,200,000 gallons per day.

FAIRMOUNT STATION.

Capacity No. 1.—2,000,000 gallons per day.
" Nos. 3, 4, and 5.—5,300,000 gallons per day.
" Nos. 7, 8, and 9.—5,100,000 " "

1885.	Running Time of each Turbine in Hours.							Gallons Pumped by each Turbine.							Total Gallons Pumped each Month.	Average Pumpage per Day.	Oil.	
																	Castor.	Engine.
	No. 1.	No. 3.	No. 4.	No. 5.	No. 7.	No. 8.	No. 9.	No. 1.	No. 3.	No. 4.	No. 5.	No. 7.	No. 8.	No. 9.			Quarts.	Quarts.
January	723	......	724	724	665	696½	703	68,800,680	......	188,876,310	175,798,662	124,717,125	126,765,925	134,380,350	819,339,052	26,430,292	2	130
February	631½	......	630½	629	101	636	638½	57,209,460	......	152,638,483	145,278,157	19,381,050	104,752,050	116,682,150	595,941,350	21,283,619	2	102
March	742	......	740	726	279½	724½	710½	65,177,280	......	178,072,314	171,964,986	45,794,450	112,990,800	128,456,900	702,456,730	22,659,895	10	159
April	703	......	685	689½	689	633½	719	61,751,520	......	162,185,332	155,644,664	115,405,550	109,302,375	121,734,275	726,023,716	24,200,790	33	148
May	......	......	388½	476½	742	614½	704	......	......	88,098,944	98,137,680	112,376,225	105,239,875	103,680,525	507,533,249	16,372,040	90	144
June	......	136	590½	6	385½	420½	450	......	17,730,060	129,242,733	247,557	70,661,500	72,434,700	81,434,925	371,751,475	12,391,716	98	101
July	169	553½	633	......	......	46½	36½	14,844,960	97,503,805	128,521,729	......	......	8,655,400	6,512,025	256,037,919	8,259,288	122	65
August	664	716½	718½	33	......	677	672	57,798,720	134,786,258	151,203,390	2,112,302	......	110,507,800	109,532,150	565,940,620	18,256,149	42	207
September	19	281½	544½	48	......	366½	356½	1,668,960	54,097,889	115,179,006	6,272,366	......	60,374,925	59,418,775	297,011,921	9,900,397	10	63
October	323½	601	736	332	......	490½	501½	28,416,240	116,613,177	154,802,878	36,947,767	......	81,591,250	86,209,500	504,580,812	16,276,800	21	103
November	671	48	718	716	290	720	720	58,940,640	9,675,929	164,799,202	132,967,152	40,581,125	123,245,200	122,857,800	653,067,048	21,768,902	45	156
December	649	449	741	720½	739	659	772	57,008,160	96,571,202	174,424,882	142,266,905	126,167,600	116,461,150	134,763,200	847,663,099	27,343,971	42	197
Totals	5,295	2,785½	7,849½	5,100½	3,891	6,685	6,983½	471,616,620	526,978,320	1,788,045,203	1,067,638,198	655,084,625	1,132,321,450	1,205,662,575	6,847,346,991	18,759,855	517	1,575

caulked. Foundation repaired and capstones dressed. Pedestal block replaced and lined up. Hole drilled in bottom of housing of counter-shaft to get clearance for nuts of foundation bolts. Housings fitted on bed-plate and holes chipped; lead joint made between housings and bed-plate; counter-shaft replaced and lined up. New castings drilled and fitted to bed-plate. Keys fitted to pedestal block, to shaft, and to pinion of gate-racks. Holes drilled in pedestal block, and keys fitted in position. Wrought-iron plate fitted to bed-plate, to fasten old and new portions together. A two-inch drain-valve fitted on No. 7's main. Quarter pieces repaired. Connections made for indicator. Tail-gates removed, and new ones painted and hung in position. Valves removed, and wooden bonnets placed in cylinders and suction-pipes, in order to run liquid mud through from the Corinthian avenue reservoir. These bonnets were afterwards removed and the pump connected up, as the reservoir was not cleaned. Crank-pins, cross-heads, and brasses removed for repairs; main shaft blocked up, in order to turn up journal. New crank-pins fitted to crank-disks; new brass gibs made; new crank-pins ground in. Journals of main shaft turned off. Quarter pieces filed to fit journals of main shaft. New keys fitted to crank-pins, brass gibs fitted to cross-head, and pump connected. Valve overhauled in east forward end. Brasses of crank-pins and cross-heads overhauled. Spider of valve-chamber repaired.

Turbine No. 8.—Capstones of foundation dressed. New bracket, pinion, and rack, fitted to inside tail-gate. Plunger repaired. New drain-valves placed on mains. Step under upright shaft faced off, grooves cut, and step wedged in place. Indicator connections made. Tail-gates removed; new ones built, painted, and hung in position. Brasses of cross-heads and crank-pins overhauled. Spider of valve-chamber overhauled on north side, back end.

Turbine No. 9.—Fifteen new oak keys fitted in bevel wheel. Bolts put in bed-plate to strengthen it where it cracked. Cogs removed from spur-wheels and repaired and replaced, and new liners and wedges fitted. Indicator connections made. Tail-gates removed, and new ones built, painted, and hung in position. Quarter pieces adjusted.

SPRING GARDEN.

BUILDINGS AND GROUNDS.

Old Station, No. 6's *Room.*—Wainscoting repaired. Electric-light machinery painted. Cellar under engine-room whitewashed. Floor repaired and painted. Heater repaired. Sashes under engine-room painted and glazed.

No. 7's *Room.*—Dressing-room for engineers and telephone office built, painted and glazed. Woodwork and beams painted and grained. Steps

No. 6.—Simpson Rotary Compound.—Capacity 8,000,000 gallons per day.
No. 7.—Marine Rotary Compound.—Capacity 20,000,000 gallons per day.
No. 8.—Worthington Duplex.—Capacity 10,000,000 gallons per day.

Total capacity.—38,000,000 gallons per day.

OLD SPRING GARDEN STATION.

1885.	Running Time of each Engine in Hours.			Gallons Pumped by each Engine.			Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil. Cylinder.	Oil. Engine.	Mean Water Pressure and Mean Suction Lift in lbs. per sq. inch.			Gallons raised 100 feet per pound of coal.
	No. 6.	No. 7.	No. 8.	No. 6.	No. 7.	No. 8.	Gallons.	Gallons.	Tons.	Lbs.		Qts.	Qts.	No. 6.	No. 7.	No. 8.	
January	....	....	....	....	....	....	....	....	54	537	19.2	6½	1				
February	....	....	....	....	....	....	....	....	49	1,397	19.0	11½	6				
March	....	....	88¾	....	....	38,881,920	38,881,920	1,254,255	94	1,111	19.8	31½	12	......	......	50	219.9
April	....	9	390	....	5,219,010	175,168,000	180,387,010	6,012,901	301	793	20.3	87¼	26¾	......	64	52	321.7
May	....	414¼	412¼	....	297,281,930	197,482,880	494,764,810	15,960,155	653	1,925	20.0	211	189	......	62	55	460.0
June	¾	673⅚	$413\frac{7}{12}$	181,500	525,908,750	181,372,800	707,463,050	23,582,102	914	1,661	20.0	236	161	55	66	69	530.2
July	163½	677	565¼	59,661,500	526,686,460	248,235,680	834,586,640	26,922,150	1,041	2,202	19.9	238½	174¾	52	60	77	530.3
August	$718\frac{1}{12}$	[illegible]50½	399	262,809,000	183,161,910	157,858,969	603,829,870	19,478,383	823	1,238	20.0	248½	186¼	49	57	92	471.8
September	39½	681½	363¼	14,042,000	534,690,150	125,653,920	674,386,070	22,479,536	778	2,165	20.0	201¾	136½	50	56	88	589.8
October	13	598½	361	5,113,000	423,267,630	104,118,560	532,499,190	17,177,393	681	1,216	20.0	158½	119¾	49	56	87	497.4
November	....	429¾	279	....	316,136,210	87,102,960	403,239,170	13,441,306	516	1,658	20.0	156¾	101¾	......	54	88	491.6
December	....	288½	91½	....	206,196,900	32,428,480	238,625,380	7,697,593	351	527	20.4	93¾	57¼	......	54	86	407.3
Totals and averages.	934⅚	4,022⅚	$3,363\frac{7}{12}$	341,810,000	3,018,548,980	1,348,304,160	4,708,663,140	12,900,447	6,262	1,080	19.9	1,684½	1,175	51	59	74	451.1

and wainscoting repaired. Holes drilled and cut for brackets of main steam-pipe and girders for air-compressors. Lining of roof repaired. New floor laid under No. 7's room. Alterations made for air-compressors. Sashes glazed. Pipe built in wall. Railing erected, painted, and bronzed. Combing fitted on floor.

No. 8's Room.—Floor repaired and grating fitted over hatch. Ceiling and caps painted. Cellar underneath whitewashed. Two sphinxes removed from roof and sent to Fairmount.

Steps extended in No. 4's boiler-room, woodwork painted, and bolts cut off in walls.

New floor-plates fitted in front of boilers Nos. 12 to 21, inclusive. Boiler-house shed repaired. Slat work of boiler-house enclosed. Hose connections made. Foundations built for coal track. Track-shed built and painted. Railing erected at side of coal-shed. Addition built to machine shop, and shop partially fitted up. Windows walled up in oil-house. Bath-room and closets painted.

Railing put up in general store-house. Stalls repaired, slat door made, and quarters built for stableman in stable. Doors of store-room replaned and storekeeper's office painted.

Forebay walls repaired and holes drilled for grating. Railing around forebay leaded. Two fountains fitted in forebay. Cement roof over stop-house painted. Manhole on top of conduit repaired. Steam heater fitted in machine shop and oil-room. Flagstones dressed and laid over No. 7's main. Pavement repaired in front of No. 7's engine-room. Wall rebuilt around stop of No. 8's main. Pavement repaired in front of No. 8's engine-room. Foundation of standpipe repaired, and ten-inch relief pipe, 128 feet high, fitted inside. Iron bridge built over forebay. Ground in front of coal-shed graded and sodded. Concrete pavement laid in front of forebay. Ash-pit built. Coping of wall dressed and set.

New Station.—Closets built in boiler-house. Feed-pump room wainscoted, steps built, and holes plastered. Railing fitted outside of engine-house. Floor of engine-room planed. Door of engine-room repaired. New floor-plates laid, and drain built under floor in boiler-house. Concrete and cement foundation laid between and around tracks in front of boiler-house. Drain-pipe laid from boiler-house to inlet. Pavement laid and cemented under marine boilers. Hot and cold water-pipes connected to bath-tub in new engine-house. Wall repaired around blow-off pipe under marine boilers. Floor of engine-house painted around engines. Holes drilled and gauges fitted in wall of new engine-house, in order to show the pressures in the pumping mains of engines Nos. 9 and 10. Heater put up in engine-house.

East Park Reservoir.—Stop-house covered with planking over iron girders.

NEW SPRING GARDEN PUMPING STATION.

Total capacity, 30,000,000 gallons per day.

No. 9, Worthington Duplex.—Capacity 15,000,000 gallons per day.
No. 10, Worthington Duplex.—Capacity 15,000,000 gallons per day.

1885.	Running Time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. in.		Gallons raised 100 feet per pound of coal.
										Cylinder.	Engine.			
	No. 9.	No. 10.	No. 9.	No. 10.	Gallons.	Gallons.	Tons.	Lbs.		Quarts.	Quarts.	No. 9.	No. 10.	
January	320⅓	485 7/12	196,459,282	306,470,492	502,929,774	16,223,541	820	2,164	20.0	157½	78½	70	72	447.9
February	309	672	179,997,548	416,803,805	596,801,353	21,311,334	913	426	20.9	179	80½	52	73	496.2
March	494½	473 7/12	303,296,558	297,754,368	639,932,846	20,642,995	897	106	20.0	197½	106	61	68	443.5
April	632½	82½	386,525,282	49,671,983	436,197,265	14,539,909	693	1,088	20.0	169¾	86½	73	74	471.9
May	21	721¼	13,217,997	453,782,575	467,000,572	15,064,534	706	127	19.9	162½	94	59	67	453.5
June	466¼	360½	287,990,358	197,978,969	485,969,327	16,198,977	693	1,564	20.0	184½	95	53	81	463.3
July	651¾	566	408,259,245	283,456,527	691,715,772	22,313,412	970	1,505	20.0	253	99¾	54	86	491.1
August	381	744	226,013,704	385,121,653	611,135,357	19,714,044	936	432	20.0	234½	66½	54	85	492.9
September	584 7/12	711½	322,204,761	390,456,957	712,661,718	23,755,391	1,067	2,157	20.0	253	94½	56	83	485.7
October	428	738	242,800,905	384,437,920	627,238,825	20,233,510	987	1,310	20.0	239	98½	56	83	473.1
November	245½	715½	134,688,673	360,326,450	495,015,123	16,500,501	835	2,120	19.88	209	107½	55	82	453.9
December	35¾	737¾	21,524,554	409,364,319	430,888,873	13,899,641	734	770	20.00	185½	71¾	52	80	473.6
Totals and averages.	4,570⅙	7,008⅙	2,722,978,867	3,935,626,018	6,658,604,885	18,242,753	10,257	329	20.	2,424¾	1,079	58	78	470.5

ENGINES AND BOILERS.

Engine No. 6.—Poppet valves overhauled and ground in, and valve-stems repaired at the shop. Lifting-toes overhauled. Steam-pipe disconnected from engine and replaced by a copper steam-pipe. Main brasses chipped and filed, and oil-grooves cut in boxes of main bearings. New pin and brasses fitted to air-pump rod. New liners fitted to arms of fly-wheel and arms keyed up. Cylinders lagged. Wooden stairway built alongside of engine. Drip-pans attached. Lost motion of valve gear taken up.

Engine No. 7.—Engine painted. Holes drilled for drain-pipe in fly-wheel pit. Steam-pipe taken down and replaced by a copper steam-pipe. All steam stop-valves ground in, and steam-pipe covered with Hanmore's covering. New liners placed under links. New trap fitted to steam-pipe. New railing and steps fitted to engine. Crank-pit repaired. New pressure gauge attached. Crank-shaft bearings and bearings on low-pressure beam overhauled.

Work done by men from Cramp & Sons to Engine No. 7.—Bottom bearing removed from low-pressure beam and new liners fitted underneath. Braces, connecting cylinder with bed-plate, tightened. New joints made on high-pressure cylinder head. Lost motion taken up on the different links. Valve-stems and piston-rods packed with metallic packing.

Pumps overhauled, lost motion taken up on link and connecting rod, low-pressure side. Low-pressure slide valve reset. Liners removed from crank-pin bearing, low-pressure side, and three liners from links on high-pressure side. Two liners removed from low-pressure rod on beam bearing; liners removed and lost motion taken up on the low-pressure beam-rod. Holes drilled in caps of connecting rods for dowel-pins to steady the motion of the rods.

Engine No. 8.—Low-pressure cylinders rebored. Low-pressure cylinder heads bored out and fitted with stuffing boxes. Piston rods fitted to centers of low-pressure pistons for the purpose of giving steadiness to the motion of the engine. These additional rods fit in the stuffing boxes on the back-heads. Finished cast-iron false-heads fitted to low-pressure cylinder heads. Old steam pipe replaced by a new copper one. Indicator connections made. Steam cylinders covered with Hanmore's covering and lagged with oiled and polished walnut. Drip-pans fitted under guides. New valves and springs fitted to air pumps. A new section of pipe fitted between No. 8 pump and the check valve to replace a cracked section.

Engine No. 9.—Steam end lagged with oiled and polished walnut, pumps and discharge pipe painted. Drip-pans fitted to the discharge pipes to prevent the moisture from dripping on the floor which condenses on the uncovered surface of the discharge mains. All valve seats caulked. Engine revolution counter repaired. New iron steps fitted, and floor-plates fitted between the pumps.

Engine No. 10.—Steam end lagged with oiled and polished walnut, pumps and discharge pipe painted. New iron steps fitted and floor-plates laid between the pumps. Strap of air-pump rod repaired. Foundation bolts of air-pumps tightened.

BOILERS.

No. 6's Boilers, Nos. 7 *to* 11 *Inclusive.*—Furnaces of boilers Nos. 8, 9, 10 and 11 torn out and relined. Wall rebuilt around steam domes of boilers Nos. 8, 9, 10 and 11. All safety valves overhauled and set. Joints made on steam drum and seams caulked. New fire doors and frames fitted to boilers Nos. 10 and 11. Steam drums of boilers Nos. 7 and 10 repaired (new rivets.) Arch repaired in main flue back of No. 6's boiler. Front removed from boiler No. 7 to allow the boiler makers to cut out the tubes and put in a new sheet to replace one that was burnt. New sheets put in Nos. 7 and 8, and new tubes in No. 7. Steam pipe connected to drums of boilers Nos. 7 and 8. Furnace of No. 7 repaired, feed pipe removed and safety-valve ground in. Caps removed from check valves, and joints made on flanges of stop valves of boilers Nos. 8 and 9. Brick piers in fronts of this set of boilers repaired. Thirty-two new tubes put in boiler No. 8.

No. 7's Boilers, Nos. 12 *to* 21, *inclusive.*—Two new pilasters built in fronts of boilers Nos. 17 and 20. Steam-drum connected by a new copper pipe, all check valves ground in, and all bottom blow-valves repaired. All boilers scaled and cleaned. The crown sheet of boiler No. 17 was caulked. The crown sheet of boiler No. 19 was patched. A cracked plate was cut from the crown sheet of No. 12 and a new sheet put in, and two patches also. Seams of boiler No. 10 caulked. Arches turned in fronts of boilers Nos. 19, 20, and 21. Feed-pipe connections made to boilers Nos. 19 and 21. New fourteen-inch wrought-iron steam-pipe fitted and connected to No. 7 engine. Crown sheet of boiler No. 21 patched. Upper row of tubes in boilers Nos. 12 to 16, inclusive, plugged up. Bands fitted around steam-domes of boilers Nos. 7 to 11, inclusive. Drip-pipe connections made from steam-pipe to hot well. Joints made on stop-valve of boiler No. 15. Plugs caulked in boiler No. 12. New joints made on steam-pipe leading to steam-drum of boiler No. 19. Stop-valve of boiler No. 19 repaired. Feed-valves of boilers Nos. 14, 15, and 16 repaired at shop. Joints made on stop-valves of boilers Nos. 14 to 21, inclusive. Band fitted around copper steam-pipe in No. 7's room.

Marine Boilers Nos. 22 *to* 27 *and* 30 *to* 33, *inclusive—New Station.*—New joints made on water columns of boilers Nos. 22 and 23. One new globe-valve placed on pipe leading from steam-drum to water column of boiler No. 26. Bottom blow-valve of boiler No. 22 repaired. Albany steam-trap connected to boilers Nos. 22 and 23, and wooden box built over it. Bottom blow-pipe fitted to boilers Nos. 30 and 31. Water column connections overhauled on boiler No. 31. Water gauges overhauled and valves ground in on boilers Nos. 28 and 29. Hat-flanges caulked on blow-off pipe of boilers Nos. 30 and 31. Bottom blow-pipes fitted to boilers Nos. 22 to 27, inclusive. Wooden platform built over all boilers. Covering of all boilers painted. Leaks caulked on boilers Nos. 22 and 23. Hat-flanges on boilers Nos. 22 to 27, inclusive, caulked. Bottom blow-pipe connected on boilers Nos. 22 to 27, inclusive. Joints made on steam pipes of boilers Nos. 30 to 33, inclusive. Boiler covering patched. New joints made on water columns of boilers Nos. 22 to 27, inclusive. Bridge walls of all boilers repaired. Boilers Nos. 22 to 27, inclusive, sealed. Valves of boilers Nos. 24 and 25 overhauled. Hat-flanges fitted to air receiver of air compressor. Electric-light plant painted, steam connections made, and a broken valve-stem on the electric-light engine at the old station repaired.

Feed-pumps.—False heads of No. 9 feed-pump repaired, and the pump connected with No. 9 engine's steam-pipe. Two new piston-rods fitted to pumps in new boiler-house. New valves put in suction end of feed-pump in No. 4's boiler-room. Two air compressors erected for the purpose of aerating the water under pressure in the mains. An independent jet condenser attached to the air compressors.

A small machine shop, partially fitted up, for light work at the station.

BELMONT.

BUILDINGS AND GROUNDS.

Track shed built over coal shed, and shingled by contract. Bumper built at end of shed, and shed painted. Walls of shed repaired and coping stone dressed. New floor laid over forebay and steps built. Gallery torn out and wood-work altered to make room for air compressor.

Arch turned over spring. Ground around station graded and partially sodded. Ceiling lined under engineers' office.

Steps built to river-front. Track bridge extended for footway. Stone roof of oil house repaired. Tin roof of engine and boiler house repaired. Track repaired. Pipe built in for air compressor. Railing in engine-room bronzed and painted. Doors and frame of oil cellar painted. New cords fitted to ventilator sashes. Track and turntable repaired.

RESERVOIR.

Watch-box built, glazed, painted and fitted with a tin roof.

ENGINES AND BOILERS.

Engine No. 1.—Steam and water ends overhauled, pistons examined and joints made on high-pressure cylinder heads. New valves put in pumps. New joints made on cushion valves.

Total capacity.—18,000,000 gallons per day.

BELMONT PUMPING STATION.

No. 1.—Worthington Duplex.—Capacity 5,000,000 gallons per day.
No. 2.—Worthington Duplex.—Capacity 5,000,000 gallons per day.
No. 3.—Worthington Duplex.—Capacity 8,000,000 gallons per day.

1885.	Running Time of each Engine in Hours.			Gallons Pumped by each Engine.			Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil. Cylinder.	Oil. Engine.	Mean Water Pressure and Mean Suction Lift in lbs. per sq. inch.			Gallons raised 100 ft. per pound of coal.
	No. 1.	No. 2.	No. 3.	No. 1.	No. 2.	No. 3.	Gallons.	Gallons.	Tons.	Lbs.		Qts.	Qts.	No. 1.	No. 2.	No. 3.	
January	425	150	150½	96,217,200	35,725,560	59,119,415	182,062,175	5,872,973	427	474	20.2	64¾	26¾	94	94	94	411.3
February	505	3½	151	116,959,200	820,560	51,017,635	168,797,395	6,028,478	395	799	15.8	58	21	94	94	94	412.8
March	221	339	159½	50,704,500	80,679,144	52,509,495	183,893,139	5,932,037	404	369	15.1	64¾	26¾	94	94	94	439.1
April	12	617	98	2,708,100	143,108,784	33,198,735	179,015,619	5,967,187	364	792	15.0	60½	23¼	94	94	94	474.2
May	99½	364½	252⅓	22,884,300	87,488,232	85,172,790	195,545,322	6,307,913	406	596	19.3	62	27	94	94	94	464.6
June	92	138	488½	20,539,200	32 745,648	162,161,690	215,446,538	7,181,551	450	1,615	19.8	65½	24½	94	94	94	461.3
July	76¾	319¾	488½	15,457,200	79,256,424	162,380,425	257,094,049	8,293,356	551	855	19.9	81¾	32¼	94	94	94	450.0
August	....	145½	672½	....	34,518,120	203,463,805	237,981,925	7,676,836	517	728	20 0	70¾	31¾	94	94	94	444.0
September	24	85½	595¼	5,384,700	20,574,216	204,699,160	230,658,016	7,688,600	496	913	19.0	61¼	30½	94	94	94	448.5
October	73½	247	472	16,494,900	61,831,224	164,178,320	242,504,444	7,822,724	520	213	20.0	65¾	28¾	94	94	94	450.0
November	42	215	465	9,636,300	51,627,888	152,603,310	213,867,498	7,128,917	491	563	20.1	62½	30¾	94	94	94	420.2
December	161¼	266½	338	37,645,500	65,280,696	116,899,065	219,825,261	7,091,137	540	369	17.5	78¾	39¾	94	94	94	392.9
Totals and averages.	1,732	2,921¼	4,331 1/12	394,631,100	693,656,496	1,438,403,785	2,526,691,381	6,922,442	5,564	1,566	18.4	799¼	343	94	94	94	438.3

Engine No. 2.—Copper joints made on low-pressure cylinder heads. Pump plunger, left side, taken out and new key put in. Pistons of high-pressure cylinders examined, both sides. New joints made on cushion valves. Air-pump connections repaired.

Engine No. 3.—New valve springs put in air-pumps and new valves in pumps. High-pressue piston examined on right-side. New joints made on cushion valves.

New cylinder-head made for large donkey pump.

New top made for Worthington donkey pump (water end.)

BOILERS.

Cylinder Boilers, Nos. 1 *to* 8 *inclusive.*—New valves (Ludlow) fitted to all feed and blow-off pipes. All boilers scaled and cleaned Nos. 1 to 8 inclusive after a careful inspection by experts, were extensively repaired. New fire sheets and front-heads put on all boilers of this set, and the furnaces rebuilt.

Tubular Boilers Nos. 9 *to* 15, *inclusive.*—A heater and purifier attached to boilers Nos. 9 to 12, inclusive. New iron caps put on ends of blank flues of boiler No. 15. All boilers scaled and shields fitted to all fire-doors. Fire-room scales repaired.

An air compressor was erected and connected with the main, for the purpose of aerating the water.

ROXBOROUGH.

BUILDINGS AND GROUNDS.

Holes in walls of engine-room plastered up, and the walls cement-washed and blocked. Oil-house and cellar whitewashed. Boiler-house whitewashed inside. Track scales reset. Thirty-inch main built in foundation.

ENGINES AND BOILERS.

Engine No. 1.—Useless.

Engine No. 2.—Brickwork torn out from under high-pressure cylinders, and an iron column fitted under each cylinder. Leak repaired in passover valve of No. 2's main.

Engine No. 3.—Detroit lubricator fitted to steam-pipe of this engine. New joints made on pump cylinder-heads, and three broken studs replaced. Brasses filed on right-hand air-pumps. Plunger taken out right-hand side, and eight stud-bolts replaced in diaphragm. Left-hand diaphragm also secured. Dowel-pins fitted to each pump-head, for the purpose of keeping them steady under pressure.

Donkey-pumps repaired; indicator motion made. Water connection made for wetting down ashes. Brass numbers fitted to boilers and engines.

Total capacity—14,750,000 gallons per day.

ROXBOROUGH PUMPING STATION.

No. 1.—Cornish Overhead Beam.—Capacity 2,250,000 galls. per day.
No. 2.—Worthington Duplex.—Capacity 5,000,000 galls. per day.
No. 3.—Worthington Duplex.—Capacity 7,500,000 galls. per day.

1885.	Running Time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. inch.		Gallons raised 100 feet per pound of coal.
										Cylinder.	Engine.			
	No. 2.	No. 3.	No. 2.	No. 3.	Gallons.	Gallons.	Tons.	Lbs.		Qts.	Qts.	No. 2.	No. 3.	
January	...	379½	...	105,494,247	105,494,247	3,403,040	370	266	23.9	101	43¾	...	153	447.8
February	...	476	...	99,526,116	99,526.116	3,551,504	330	53	25.2	121	24	...	153	473.8
March	...	446½	...	106,852,602	106,852,602	3,446,822	369	1,858	23.9	101½	27	...	153	453.9
April	...	420½	...	107,804,478	107,804,478	3,593,482	354	610	25.6	90	23¼	...	153	478.0
May	...	438½	...	112,403,157	112,403,157	3,625,908	369	1,708	24.4	102¼	28¼	...	153	477.6
June	...	493½	...	124,108,437	124,108,437	4,136,948	398	1,012	24.5	117½	37¼	...	153	489.3
July	...	652½	...	159,058,233	159,058,233	5,130,911	505	1,211	20.9	126¾	51¼	...	155	500.8
August	32	526½	7,759,680	133,580,754	141,340,434	4,559,369	455	1,813	22.4	120¾	50¼	157	157	4[illegible]9.9
September	190½	358	45,105,795	85,071,657	130,177,452	4,339,248	436	1,075	24.7	116½	48¾	157	157	480.8
October	...	525	...	122,182,110	122,182 110	3,951,036	406	1,659	26.4	113¾	44½	...	157	485.4
November	...	466	...	112,569,612	112,569,612	3,752,320	387	491	25.3	104½	43¼	...	157	468.6
December	...	474½	...	116,471,646	116,471,646	3,757,149	380	218	27.2	103¼	43	...	157	493.9
Totals and averages	222½	5,657	52,865,475	1,385,423,049	1,438,288,524	3,940,517	4,764	774	24.5	1,318¾	464½	157	155	479.1

Total Capacity.—785,000 gallons per day.

ROXBOROUGH AUXILIARY STATION.

No. 1.—Knowle's.—Capacity 500,000 gallons per day.
No. 2.—Knowle's.—Capacity 285,000 gallons per day.

1885.	Running Time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil. Cylinder.	Mean Water Pressure.	
	No. 1.	No. 2.	No. 1.	No. 2.	Gallons.	Gallons.	Tons.	Lbs.		Quarts.	No. 1.	No. 2.
January	....	25	....	297,000	297,000	9,581	9	598	20.4	3	....	36
February	....	48	....	671,308	671,308	23,975	10	1,826	18.4	4¾	....	36
March	....	26	....	308,880	308,880	9,964	7	1,906	16.4	3½	....	36
April	....	33	....	469,040	469,040	15,634	7	663	20.0	4	....	36
May	....	35	....	415,800	415,800	13,413	4	1,600	16.8	3½	....	36
June	....	59	....	824,109	824,109	27,470	5	1,147	18.5	6	....	36
July	13	92	387,000	1,153,680	1,540,680	49,699	6	98	18.4	20½	36	36
August	....	80½	....	1,129,711	1,129,711	36,442	6	271	21.1	9½	....	36
September	23½	30	493,500	356,400	849,900	28,330	4	1,188	18.5	5¾	36	36
October	....	71	....	981,970	981,970	31,677	6	1,135	20.3	7½	....	37
November	17	21	78,540	113,400	191,940	6,398	6	21	21.9	4½	36	36
December	....	53½	....	751,421	751,421	24,239	7	1,475	20.0	6	....	36
Totals and averages	53½	574	959,040	7,472,719	8,431,759	23,101	82	728	19.2	78½	36	36

Boilers, Marine, Nos. 1 *to* 4, *inclusive.*—Saddles bricked up. Bridge walls rebuilt. One-inch pieces bolted to bearing bars of boilers Nos. 3 and 4, to support grate bars. Boiler covering whitewashed and fronts painted. Blow-off pipe under No. 3 boiler replaced by a new one.

Tubular Boilers, Nos. 5, 6, *and* 7.—All furnaces relined. Outside walls repaired. Leaky rivets and seams caulked. Steam-trap attached. Pipe to steam-gauge of boiler No. 5 repaired. Broken buck-stay of boiler No. 7 repaired. New steam damper placed in main flue. Brick fronts of boilers Nos. 5 and 6 rebuilt.

Roxborough Auxiliary Station.

A second safety valve was placed on the boiler at this station, to comply with the regulations of the official boiler inspector. Ten feet additional height added to supply main at reservoir, in order to force more water to Mt. Airy.

MT. AIRY.

New composition valve-seats, with rubber valves fitted to No. 2 pump. Air-pump of No. 2 pump rebored and made double acting. New leather washers fitted to plunger of this pump.

CHESTNUT HILL.

Dry wall repaired.

No. 1 pump torn out and air compressor put in its place.

No. 1 engine connected to new Wilbraham rotary pump. Indicator connections made on No. 1 engine.

No. 3 pump. Soft gum valves substituted for hard rubber ones. Indicator connections made.

Globe valve fitted to feed-pipe of boiler No. 2 and a new pressure gauge attached. New joints made on steam-dome and safety valve ground in. Furnaces of cylinder boilers repaired.

FRANKFORD.

Inside of roof stained and oiled. Steam-pipes and boiler fronts painted. Brick wall between forebay and engine-room rebuilt. Floor of engine-room repaired. Forebay and inside of coal-shed whitewashed. Ground around station graded and partially sodded. Conduit repaired. Scales placed on top of coal-shed. Wall around pumping main repaired. Coal-derrick repaired. Wharf extended at river front to adjoining property and ground graded. Stop-house built. Hardwood in engine-room oiled

Total capacity.—2,000,000 gallons per day.

MOUNT AIRY PUMPING STATION.

No. 1.—Davidson, Rotary.—Capacity 1,000,000 gallons per day.
No. 2.—Davidson, Rotary.—Capacity 1,000,000 gallons per day.

1885.	Running Time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per square inch.		Gallons raised 100 ft. per pound of coal.
										Cylinder.	Engine.			
	No. 1.	No. 2.	No. 1.	No. 2.	Gallons.	Gallons.	Tons.	Lbs.		Quarts.	Quarts.	No. 1.	No. 2.	
January	3	741	108,825	27,323,200	27,432,025	884,581	50	187	31.2	30¾	15½	45	45	253.1
February	15	657	535,950	24,061,050	24,597,000	878,464	46	268	31.2	28	14	45	44	241.7
March	26	718	962,500	26,339,450	27,301,950	880,708	50	2,081	30.9	17	15½	45	45	247.7
April	18	702	684,700	25,828,025	26,512,725	883,757	56	1,109	27.6	21½	15¼	57	55	265.3
May	14	730	515,475	26,231,375	26,746,850	862,802	61	504	25.9	34	16	60	60	269.1
June	16	689	580,000	24,710,475	25,290,475	843,016	69	312	24.5	26	15½	60	60	225.4
July	240	486	10,805,000	19,422,050	30,227,050	975,066	82	1,871	22.8	32	21¾	66	62	237.7
August	54	690	2,219,250	26,550,275	28,769,525	928,049	70	1,450	22.4	33½	16¼	65	62	260.2
September	4	716	161,250	27,434,250	27,595,500	919,850	65	1,228	19.5	38½	15	63	62	268.0
October	163	581	6,120,750	21,614,750	27,735,500	894,693	72	1,867	19.1	38½	16	60	61	237.7
November	6	714	225,000	25,924,000	26,149,000	871,633	64	1,061	18.4	33	15	60	60	249.9
December	23	721	849,500	26,105,250	26,954,750	869,508	69	2,169	20.0	52	15¾	60	60	237.4
Totals and averages	582	8,145	23,768,200	301,544,150	325,312,350	891,267	760	667	24.5	384¾	191½	57	56	249.4

Total Capacity—1,500,000 gallons per day.

CHESTNUT HILL PUMPING STATION.

No. 1.—Wilbraham Rotary.—Capacity 750,000 gallons per day.
No. 2.—Knowles.—Capacity 250,000 gallons per day.
No. 3.—Worthington Duplex.—Capacity 500,000 gallons per day.

1885.	Running Time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. inch.		Gallons raised 100 feet per pound of coal.
										Cylinder.	Engine.			
	No. 1.	No. 3.	No. 1.	No. 3.	Gallons.	Gallons.	Tons.	Lbs.		Qts.	Qts.	No. 1.	No. 3.	
January	....	744	....	6,940,440	6,940,440	223,885	26	1,465	14.8	15½	15½	....	53	141.7
February	....	672	....	6,456,060	6,456,060	239,574	23	1,678	14.4	14	14	....	53	147.9
March	....	744	....	7,146,360	7,146,360	230,528	26	748	14.0	15½	15½	....	53	147.7
April	84	636	921,600	5,889,780	6,811,380	227,046	25	540	14.7	15	15	54	53	147.2
May	408	324	4,615,200	3,072,420	7,687,620	247,988	25	1,399	16.0	15½	15½	54	54	166.3
June	581	150	6,454,100	1,927,380	8,381,480	279,383	26	409	16.0	15	15	54	54	177.4
July	238¾	96	3,832,675	1,450,800	5,283,475	170,435	24	906	16.5	10½	10½	53	54	118.4
August	180	276	2,095,200	1,917,240	4,012,440	129,433	19	220	15.9	12¾	12¾	54	54	116.5
September	360	360	4,348,800	2,138,240	6,487,040	216,235	25	146	15.9	22½	22¼	54	54	143.5
October	356½	366	4,187,850	2,275,000	6,462,850	208,479	24	2,079	17.1	22¾	22¾	54	54	143.7
November	360	360	3,978,000	2,190,500	6,168,500	205,617	25	635	19.3	22½	22½	54	54	135.3
December	152	477	1,669,950	3,606,720	5,276,670	170,215	24	1,894	18.7	24½	24½	54	54	117.8
Totals and averages	2,720¼	5,205	32,103,375	45,010,940	77,114,315	211,272	297	919	16.1	206	205¾	54	54	141.9

Total capacity.—20,000,000 gallons per day.

FRANKFORD PUMPING STATION.

No. 1.—Marine Compound Rotary.—Capacity 10,000,000 galls. per day.
No. 2.—Corliss Compound Rotary.—Capacity 10,000,000 galls. per day.

1885.	Pumping time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. in.		Gallons raised 100 feet per pound of coal
										Cylinder.	Engine.			
	No 1.	No. 2.	No. 1.	No. 2.	Gallons.	Gallons.	Tons.	Lbs.		Quarts.	Quarts.	No. 1.	No. 2.	
January	....	151	....	56,648,748	56,648,748	1,827,353	97	1,978	19.3	66	11½	....	81	481.4
February	....	163	....	56,811,435	56,811,435	2,028,979	99	340	25.1	50	10½	....	80	470.7
March	....	169	....	62,449,665	62,449,665	2,014,505	100	2,151	21.1	44	21	....	80	508.1
April	....	182½	....	65,552,613	65,552,613	2,185,087	107	235	20.9	45	23	....	79	496.5
May	....	178	....	63,091,812	63,091,812	2,035,219	104	1,945	20.9	44	21½	....	79	488.0
June	127½	105½	43,369,683	36,716,022	80,085,705	2,669,523	133	1,087	21.9	55	27½	80	79	489.9
July	9	227	2,828,877	78,079,512	80,908,389	2,609,948	146	1,367	23.7	58	29	80	79	447.9
August	....	216½	....	73,599,489	73,599,489	2,374,177	138	1,395	23.0	52	26	....	78	425.2
September	....	219½	....	72,183,618	72,183,618	7,218,360	133	1,209	21.8	50	25	....	76	421.8
October	....	227⅙	....	74,358,207	74,358,207	2,398,652	113	1,077	22.9	53	26½	....	78	524.8
November	....	207	....	68,699,298	68,699,298	2,289,977	108	1,840	21.1	36½	13¼	....	78	505.6
December	....	214	....	70,442,922	70,442,922	2,272,352	118	188	21.7	39	13½	....	78	477.7
Totals and averages	136½	2,260⅙	46,198,560	778,633,341	824,831,901	2,259,813	1,402	1,372	21.9	592½	248¼	80	79	478.1

and roof painted. Doors of coal-shed repaired. Privy built. Boiler-house roof overhauled, sashes reglazed, doors and frames puttied, oiled, and shellaced. Heater erected.

No. 1 Engine.—Eight-inch globe valve fitted to steam-pipe.

No. 2 Engine.—Air-chamber fitted to suction-pipe. Joints made on steam-pipe. Pumps partially painted.

KENSINGTON.

BUILDINGS AND GROUNDS.

Skylights and sashes glazed. Portion of pavement relaid around standpipe. Standpipe removed and bonnet secured over opening. Wharf repaired. Gate repaired.

Engine No. 3.—Air-pumps frequently repaired. Drip-pipe fitted to low-pressure cylinder.

BOILERS.

Bearing bars reset in furnaces. Tubes caulked in boilers Nos. 1, 2, and 3. Blank-flange put on steam-dome. Feed and blow-off valves ground in. Steam-pipe taken down and connection made with steam-damper of boilers Nos. 1 and 2. Furnaces of boilers Nos. 1, 2, 6, and 7 repaired. Blow-off pipe for boilers repaired. Old donkey-pump removed, and another old one, in better condition, put in its place. New joints made on stop-valve of engine.

FAIRHILL RESERVOIR.

Top of brick lining on south side repaired where it had been damaged by the ice. Curbstone reset and sidewalk repaired.

1885.
January
February
March
April
May
June
July
August
September
October
November
December
Totals and averag[e]
Increase over 188[4]
Decrease from 188[4]

TOTAL GALLONS PUMPED DURING 1885.

1885.	Fairmount.	Spring Garden.	Belmont.	Roxborough	Roxborough Auxiliary.	Mount Airy.	Chestnut Hill.	Frankford.	Kensington.	Totals.	Average per Day.	Percentage of Pumpage.	Maximum Gallons for one Day.	Minimum Gallons for one Day.	Total Steam Pumpage.
January	819,339,052	502,929,774	182,062,175	105,494,247	297,000	27,432,025	6,940,440	56,648,748	132,163,899	1,833,307,360	59,138,947	7.28	75,228,364	42,177,042	1,013,968,308
February	595,941,350	596,801,353	168,797,395	99,526,116	671,308	24,597,000	6,456,060	56,811,435	125,305,572	1,674,907,589	59,818,128	6.66	75,028,889	49,020,586	1,078,966,239
March	702,456,730	639,932,846	183,893,139	106,852,602	308,880	27,301,950	7,146,360	62,449,665	139,735,155	1,870,077,327	60,325,075	7.43	70,201,930	50,600,747	1,167,620,597
April	726,023,716	616,584,305	179.015,619	107,804,478	469,040	26,512,725	6,811,380	65,552,613	127,782,081	1,856,555,957	61,885,199	7.38	69,849,427	50,213,808	1,130,532,241
May	507,533,249	961,765,382	195,545,322	112,403,157	415,800	26,746,850	7,687,620	63,091,812	149,140,320	2,024,329,512	65,300,952	8.04	81,473,243	54,821,157	1,516,796,263
June	371,751,475	1,193,432,377	215,446,538	124,108,437	824,109	25,290,475	8,381,480	80,085,705	201,079,536	2,220,400,192	74,013,338	8.82	87,563,814	62,600,117	1,848,648,657
July	256,037,919	1,526,302,412	257,094,049	159,058,233	1,540,680	30,227,050	5,283,475	80,908,389	208,481,931	2,524,934,138	81,449,488	10.04	102,191,679	65,636,675	2,268,896,219
August	565,940,620	1,214,965,227	237,981,925	141,340,434	1,129,711	28,769,525	4,012,440	73,599,489	168,371,910	2,436,111,281	78,584,235	9.68	90,259,720	61,493,525	1,870,170,661
September	297,011,921	1,387,047,788	230,658,016	130,177,453	849,900	27,595,500	6,487,040	72,183,618	166,009,284	2,318,020,519	77,267,351	9.21	84,551,476	66,374,159	2,021,008,598
October	504,580,812	1,159.738,015	242,504,444	122,482,110	981,970	27,735,500	6,462,850	74,358,207	140,048,958	2,278,892,866	73,512,673	9.06	80,429,846	62,480,357	1,774,312,054
November	653,067,048	898,254,293	213,867,498	112,569,612	191,940	26,149,000	6,168,500	68,699,298	107,271,360	2,086,238,549	69,541,285	8.29	77,015,733	58,845,766	1,433,171,501
December	847,663,099	669,514,253	219,825,261	116,471,646	751,421	26,954,750	5,276,670	70,442,922	84,344,820	2,041,244,842	65,846,608	8.11	71,736,251	52,397,314	1,193,581,743
Totals and averages.	6,847,346,991	11,367,268,025	2,526,619,381	1,438,288,524	8,431,759	325,312,350	77,114,315	824,831,901	1,749,734,826	25,165,020,072	68,945,260	100.00	....	....	18,317,673,081
Increase over 1884	....	2,027,129,149	160,501,245	85,285.261	....	6,132,625	5,450,247	....	....	....	....	....	6,505,235	....	1,397,601,322
Decrease from 1884	1,727,760,603	....	....	....	628,259	....	....	13,495,632	872,773,314	330,159,281	713,709	....	....	3,986,016	

CURRENT EXPENSES AND WORK OF THE PUMPING STATIONS FOR THE YEAR 1885.

Stations.	Pay of employés at the stations.	Coal.			Lubricating Oils.		Lighting Stations.			Repairs to boilers and machinery.	Packing and small stores.	Total expenses.	Total gallons pumped.	Lift, in feet, including suction and friction.	Gallons pumped 100 feet high, suction and friction included.	Cost of raising one million gallons 100 feet.	Percentage of work done at each station.	Height of surface of basins above Pumps, in feet.
		Tons.	Price per ton.	Cost.	Gallons.	Cost.	Gas.	Oil.	Electricity.									
Fairmount	$5,573 79	....	....	....	523	$410 55	$1,871 00	....	....	$7,893 91	$197 64	$15,946 89	6,847,346,991	100.0	6,847,346,991	$2 33	17.42	90.00 115.00
Spring Garden	20,835 98	16,520	$2 68	$44,273 60	1,591	841 10	....	....	$136 00	20,377 77	505 67	86,970 12	11,367,268,025	154.1	17,516,960,027	4 96	44.57	102.00 †179.00 102.00
Belmont	10,770 71	5,565	2 43	13,522 95	286	149 60	....	....	100 42	4,660 68	157 69	29,362 05	2,526,691,381	216.2	5,462,706,765	5 37	13.90	198.14
Roxborough	....	4,764	2 68	12,767 52	446	231 30	....	$192 48	....	....	....	....	1,438,288,524	356.5	5,127,498,588	....	13.04	317.00
	7,569 99									729 59	148 19	21,932 00				4 27		
Roxborough auxiliary*	....	82	3 43	281 26	19	9 31	....	2 36	....	....	....	....	8,431,759	80.0	6,745,407	....	0.02	80.00
Mount Airy*	2,835 89	760	3 85	2,926 00	144	75 84	235 85	....	....	744 50	12 02	6,830 10	325,312,350	128.8	419,002,307	16 30	1.06	†128.80
Chestnut Hill	1,410 00	297	3 15	935 55	103	56 68	....	8 69	....	328 58	2 73	2,742 23	77,114,315	124.2	95,775,979	28 63	0.24	128.65
Frankford	3,916 00	1,403	2 51	3,521 53	210	109 72	....	50 00	....	1,521 86	67 39	9,186 50	824,831,901	181.7	1,498,719,564	6 13	3.81	168.63
Kensington	4,435 38	2,347	2 43	5,703 21	164	83 11	801 13	....	....	883 28	43 22	11,949 33	1,749,734,826	133.4	2,334,146,258	5 12	5.94	107.75
Totals and averages deduced from totals.	$57,347 74	31,738	$2 65	$83,931 62	3,486	$1,967 21	$2,907 98	$253 53	$236 42	$37,140 17	$1,134 55	$184,919 22	25,165,020,072	156.2	39,303,901,886	$4 70	100.00	

* Repumpage from Roxborough.

† On distribution.

DESCRIPTION OF PUMPING MACHINERY OF THE PHILADELPHIA WATER DEPARTMENT IN 1885.

STEAM ENGINES AND PUMPS.

Pumping Station.	Designated number of Engine or Turbine.	Type of Engines.	Designated capacity.—Million gallons per day.	High Pressure Cylinder. Number of Cylinders.	Bore (inches).	Stroke (feet).	Number of Revolutions.	Speed (feet per minute).	Diameter of Rod (inches).	Low Pressure Cylinder. Number of Cylinders.	Bore (inches).	Stroke (feet).	Number of Revolutions.	Speed (feet per minute).	Diameter of Rod (inches).	Air Pumps. Number of Air Pumps.	Bore (inches).	Stroke (feet).	Number of Revolutions.	Diameter of Rod (inches).	Type.—Single[S] or Double[D].
Spring Garden (Old Station)	6	Simpson Compound Rotary	8	1	35	5.2	11	113⅔	4	1	57	8	11	176	5	1	30	4	11	....	S.
	7	Marine Compound Rotary	20	1	45	6	17	204	8	1	80	6	17	204	8	1	40	3	17	....	S.
	8	Worthington Duplex	10	2	38	4	12½	100	4½	2	66 3/16	4	12½	100	2 rods 4	2 2	29¾ 27	2	12½	....	S.
(New Station)	9	Worthington Duplex	15	2	38	4	12½	100	4½	2	66	4	12½	100	2 rods 4	2 2	29¾ 27	2	12½	....	S.
	10	Worthington Duplex	15	2	38	4	12½	100	4½	2	66	4	12½	100	2 rods 4	2 2	29¾ 27	2	12½	....	S.
Belmont	1	Worthington Duplex	5	2	29	4	12	96	4	2	50¼	4	12	96	4	2 2	....	2	12	....	S.
	2	Worthington Duplex	5	2	29	4	12	96	4	2	50¼	4	12	96	4	2 2	....	2	12	....	S.
	3	Worthington Duplex	8	2	33¾	4	12	96	4½	2	58¼	4	12	96	4½	2 2	29¾ 23¾	2	12	....	S.
Roxborough	1	Cornish Overhead Beam	2¼	....	....	....	....	....	....	1	72	10	10	200	6	1	34	5	10	3	S.
	2	Worthington Duplex	5	2	36	4	12	96	4½	2	58	4	12	96	4½	2 2	29¾ 23¾	2 2	12	....	S.
	3	Worthington Duplex	7½	2	38	4	12½	100	4½	2	66	4	12½	100	2 of 4	2 2	29¾ 27	2 2	12½	....	S.
Roxborough Auxiliary	1	Knowles' Pump	½	1	24	2	20	80	....	....	....	....	....	....	....	....	....	....	....	....	....
	2	Knowles' Pump	....	1	14	1⅓	18	48	1 11/16	....	....	....	....	....	....	....	....	....	....	....	....
Mount Airy	1	Davidson Pump	1	1	20	1⅔	60	200	2¼	....	....	....	....	....	....	....	....	....	....	....	....
	2	Davidson Pump	1	1	20	1⅔	60	200	2¼	....	....	....	....	....	....	....	....	....	....	....	....
Chestnut Hill	1	Wilbraham Baker Rotary	¾	1	11½	2½	100	500	2¼	....	....	....	....	....	....	....	....	....	....	....	....
	2	Knowles' Pump	¼	1	24	1¾	11	38.5	3⅝	....	....	....	....	....	....	....	....	....	....	....	....
	3	Worthington Duplex	½	2	14	⅞	....	....	1¾	2	10	10¼	....	....	1¾	....	....	....	....	....	....
Frankford	1	Marine Compound Rotary	10	1	40	5	21	210	6¾	1	69	5	21	210	6¾	1	24	2½	21	3¾	S.
	2	Corliss Compound Rotary	10	1	28	3	37	222	3 15/16	1	56	3	37	222	4 15/16	1	30	1⅙	37	Trunk 6	S.
Kensington	....	Worthington Duplex	6	2	21	4	12	96	3½	2	36⅜	4	12	96	3½	4	18	1.59	12	....	S.
Fairmount (New House)	1	Turbine Wheels	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	3	....	5⅓	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	4	....	5⅓	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	5	....	5⅓	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
(Old House)	7	....	5 1/10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	8	....	5 1/10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	9	....	5 1/10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Forcing Pumps.

Pumping Station.	Designated number of Engine or Turbine.	Type.—Single[S], Double[D], Bucket[B], Plunger[P].	Number of Pumps.	Bore (inches).	Area (square inches), A.	Stroke (feet).	Number of Single Strokes per minute.	Diameter of Pump Rod (inches).	Displacement Per Stroke, Theoretical (Gallons).	Displacement Per Stroke, Actual (Gallons).	Diameter Suction Pipe (inches).	Diameter Discharge Pipe (inches).	Number of Suction Valves (on each end).	Lift of Suction Valves (inches).	Aggregate Area of Suction Valves (square inches).	Number of Discharge Valves.	Lift of Discharge Valves (inches).	Aggregate Area, B. (square inches).	Relative Speed of Water, A : B (through Valves).	Speed (feet per second) through Valves.	Mean Pressure on Pumps at Pressure Gauge (pounds per square inch).	Corresponding Head (feet).	Lift (feet) from Surface of Water to centre of Gauge.	Total Lift (feet).
Spring Garden (Old Station)	6	B. P.	2	B. 28½ P. 20⅛	638 318	8	22	....	125⅝	125	None.	36	16	1½	424	Check.	....	....	1.50	4.4	45	104.6	22	126.6
	7	D. P.	2	30	707	6	34	8	218½	207½	2 of 30	48	18	1	631	18	1	631	1.12	3.8	66 45	153.5 104.6	20	173.5 124.6
	8	D. P.	2	30	707	4	25	4½	147½	140	30	30	8	1	280½	8	1	280½	2.50	4.2	86 45	200 104.6	16.5	216.6 121.2
(New Station)	9	D. P.	2	37	1,075	4	25	5	221¼	210¼	36	36	12	1	300¾	12	1	300¾	3.58	5.97	66 45	153.5 104.6	16.4	169.9 121
	10	D. P.	2	37	1,075	4	25	5	221¼	210¼	36	36	12	1	300¾	12	1	300¾	3.58	5.97	86 45	200 104.6	16.4	216.4 121
Belmont	1	D. P.	2	22 1/16	382	4	24	4	78	75	30	30	8	1	....	8	1	....	....	....	88	204.6	14.6	219.2
	2	D. P.	2	22½	397	4	24	4	8[illegible]¼	78	30	30	8	1	....	8	1	....	....	....	88	204.6	14.6	219.2
	3	D. P.	2	28	615	4	24	4½	126½	121¼	30	30	8	1	248	8	1	248	2.47	3.96	88	204.6	14.6	219.2
Roxborough	1	S. P.	1	20¼	322	10	10	....	167	159	26	24	1	2½	338	1	2½	338	0.95	3.17	....	....	....	....
	2	D. P.	2	22	380	4	24	4½	77½	73¾	30	30	8	1	....	8	1	....	....	....	....	....	21	365.4
	3	D. P.	2	26	531	4	25	5	108	102¾	30	30	8	1	280	8	1	280	2.50	4.2	148	344	21.4	365.4
Roxborough Auxiliary	1	Piston.	1	....	....	2	40	3 15/16	....	25	12	10	2	....	....	2	....	....	....	....	36	83.7	....	....
	2	Piston.	1	10	78.5	1⅓	36	1 11/16	6.8	5½	6	6	2	....	....	2	....	....	....	....	36	83.7	....	....
Mount Airy	1	D. Pist'n	1	10	78.5	1⅔	120	2¼	6⅝	6¼	12	10	6	⅝	87	6	⅝	87	0.90	3.00	60	140	....	....
	2	D. Pist'n	1	10	78.5	1⅔	120	2¼	6⅝	6¼	12	10	6	⅝	87	6	⅝	87	0.90	3.00	60	140	....	....
Chestnut Hill	1	Rotary.	1	....	....	Per	revolution 5	....	....	....	10	8	....	....	....	....	....	....	....	....	54	125.5	....	....
	2	Piston.	1	18	254.5	1¾	22	3⅜	26	25	10	8	2	⅝	34	2	....	34	7.4	4.74	53	123.2	....	....
	3	....	....	....	....	....	....	1¾	6.9	6.5	....	....	....	....	....	....	....	....	....	....	53	123.2	....	....
Frankford	1	D. P.	2	21	346	5	42	6¾	85¼	81¾	2 of 20	30	10	1	350⅝	10	1	350⅝	0.98	3.45	73	170	17.4	187.5
	2	D. P.	2	20	314	3	74	3 11/16	48	45¾	30	30	12	¾	420¾	12	¾	420¾	0.75	2.77	73	172	15.4	187.5
Kensington	....	D. P.	2	24	452	4	24	3½	93½	89¼	30	30	8	1	248	8	1	248	1.82	2.91	52	121	14.5	135.5
Fairmount (New House)	1	Piston.	2	16	201	6	24	3⅝	61 1/20	61 1/20	18	16	2	....	240	2	....	240	0.88	2.11				
	3	Piston.	2	22⅜	394.3	6	16	5	119 13/16	115⅖	22½	36	6	....	528	1	2	441	0.90	1.44				
	4	Piston.	2	22	380.1	6	16	5	115⅖	115⅖	22½	36	6	....	528	1	2	441	0.86	1.37	56	130	....	130
	5	Piston.	2	22	380.1	6	16	5	115⅖	115⅖	22½	36	6	....	528	1	2	441	0.86	1.37	56	130	....	130
(Old House)	7	Piston.	2	18 11/16	274.3	6	22	4	83½	80 97/100	20	30	1	2	264	1	2	264	1.04	2.29	56	130	....	130
	8	Piston.	2	18⅝	272.4	6	22	4	82 9/10	80 97/100	20	30	1	2	264	1	2	264	1.04	2.29	56	130	....	130
	9	Piston.	2	18 11/16	274.3	6	22	4	83½	80 97/100	20	30	1	2	264	1	2	264	1.04	2.29	56	130	....	130

STEAM BOILERS.

Pumping Station.	Type of Boilers.	Number of Boilers.	Diameter of Shell (inches).	Length of Shell (feet).	Thickness of Shell (inches).	Number of Flues.	Diameter of Flues (inches).	Thickness of Flues (inches).	Length of Flues (feet).	Number of Tubes.	Length of Tubes (feet).	Diameter of Tubes (inches).	Diameter of Steam Drum (inches).	Length of Steam Drum (feet).	Length of Grate (feet).	Area of Grate (square feet).	Area of Heating Surface (square feet).	Estimated horse power, at 10 square feet for Shell and Fire Flues, 15 square feet for Tubes, and 12 square feet for Drums.	Height of Stack (feet).	Section of Stack (square feet).
	2 mud drums on each boiler, 28 inches x 22 feet.																			
Spring Garden	Cylinder	6	54	30	....	0	....	....	....	0	....	....	0	....	6	30	510	47	95	
	Tubular	10	72	12	½	....	....	....	....	92	12	4	48 2 domes.	14	6	40½	1,371	95.9	95	25
	Tubular	5	72	15	7/16	....	....	....	....	75	15	4	40	5	5	33¾	1,305	93	....	25
	Marine, Steel	10	138	10⅝	9/16	Fox corrugated. 2	43	⅜	8	188	8	3	42	12½	6⅙	42	1,551	113	100	49
	2 mud drums, 28 inches x 22 feet, on each boiler.																			
Belmont	Cylinder	8	54	30	⅜	0	....	....	....	0	....	....	....	....	5	26¼	510	47	100	25
	Tubular	7	72	12	½	....	....	....	....	92	12	4	48	14	5½	36	1,371	95.9	100	25
Roxborough	Tubular	3	72	15	⅜	....	....	....	....	67	15	4	1 dome. 36	4	5	33¾	1,215	87	100	20¼
	Marine	4	11½ 9½ oval.	9⅝	9/16	2	37½	⅜	7	138	7	3	42	11½	6⅙	37½	....	....	100	
Mount Airy	Tubular	3	48	10	5/16	....	....	....	....	48	10	3	1 dome.	....	4	16⅔	455	33	50	7 9/16
	Connected by 1 drum in the flue and 1 on top.																			
Chestnut Hill	Cylinder	2	30	30	....	0	....	....	....	0	....	....	30	7½	5	13¾	175	16½		
	Tubular	1	48	14	5/16	0	....	....	....	44	14	3	24	24	5	22½	....	44		
Frankford	Marine, Steel	4	138	10⅝	¾	Fox corrugated. 2	43	⅜	8	188	8	3	42	12½	....	42	1,551	113	100	33
Kensington	Tubular	2	72	15	⅜	....	....	....	....	67	15	4	1 dome. 36	4	5	33¾	1,215	87	....	9
	Tubular	5	72	15	⅜	....	....	....	....	75	15	4	2 domes. 36	4	5	33¾	1,305	93	....	9

KENSINGTON PUMPING STATION.

No. 3.—Worthington Duplex.—
Capacity 6,000,000 gals. per day.

1885.	Running Time in Hours.	Gallons Pumped.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per square inch.	Gallons raised 100 ft. per pound of coal.
							Cylinder.	Engine.		
	No. 3.	No. 3.	Gallons.	Tons.	Lbs.		Quarts.	Quarts.	No. 3.	
January	462½	132,163,899	4,263,351	183	365	25.0	39	6⅛	58	429.7
February	440½	125,305,572	4,475,199	183	56	25.8	32½	7⅜	59	414.7
March	503	139,735,155	4,410,811	207	1,428	25.0	52½	7	58	400.8
April	455½	127,782,081	4,259,402	193	1,342	24.9	45	6⅝	58	393.1
May	503½	149,140,320	4,810,978	209	204	24.9	46	8⅛	58	424.8
June	694	201,079,536	6,702,651	242	1,954	25.2	60	7½	58	493.1
July	724	208,481,931	6,725,223	254	298	25.3	62	8⅛	58	488.5
August	579	168,371,910	5,431,352	204	1,136	25.3	55½	7½	58	490.3
September	578¼	166,009,284	5,533,643	201	900	25.5	51	7¼	58	490.9
October	469½	140,048,958	4,517,708	187	141	25.0	47½	12⅝	58	445.9
November	356¼	107,271,360	3,575,712	146	1,019	24.9	36½	11⅝	58	436.2
December	288½	84,344,820	2,720,801	133	979	24.9	28	10⅜	58	376.4
Totals and averages	6,054½	1,749,734,826	4,793,794	2,346	892	25.1	558½	100¼	58	440.3

REPORT

ON THE

OPERATIONS IN CONNECTION WITH THE

DISTRIBUTION SYSTEM

DURING 1885.

PHILADELPHIA WATER DEPARTMENT.

March 29, 1886.

COL. WILLIAM LUDLOW,

Chief Engineer:

SIR:—The operations in connection with the distribution system will be found detailed in the accompanying tables.

One hundred and thirty-seven thousand nine hundred and sixty-seven feet or over 26 miles of new mains and service pipes have been laid, making a total of 826 miles and 4,944 feet now in use.

Forty-four thousand one hundred and forty-three feet of pipes have been relaid principally in the Third, Fourth, Fifth and Sixth Wards.

Thirty-seven thousand and sixty-four feet of small pipes mostly laid previous to 1854, and useless on account of the accumulation of rust and sediment, have been taken up.

Twelve thousand five hundred and seventy-six feet of pipes of various sizes have been used for repairs, lowered, raised, etc., making the total of pipes handled 231,850 feet or 15,499,611 pounds.

MAINS.

A 36-inch main was laid in Fifty-second street for an additional supply for West Philadelphia. Commencing at the George's Hill reservoir it extended south to Walnut street. It was completed September 7, 1885.

The 20-inch main on Lancaster avenue from Forty-fourth to Fifty-second street was completed about the middle of June. On July 31, the water was turned on through these mains, more than doubling the water supply of West Philadelphia and increasing the pressure at the high points from 10 to 27 pounds, and the average pressure throughout that district from 22 to 36 pounds.

The 20-inch main on South street and Gray's Ferry road from Twenty-second to Thirty-sixth street was completed and water passed through on June 25. The pressure in the southwestern section of the city was increased from 0 to 10 pounds. At some hydrants in this section no water would flow during the day.

The 16-inch main on Green street, Germantown, for the supply of the Twenty-second and part of the Twenty-eighth Wards was completed and water passed through on July 9. The pressure at the Purveyor's office, at the Town Hall, was increased from 15 to over 40 pounds during the day and correspondingly throughout the lower portion of these wards.

The 12-inch main on Ridge avenue west of Thirty-fourth street was completed and water turned on June 18. People living on the high ground in the vicinity who previously could get very little water now have a pressure of 10 pounds.

The 12-inch pipe for the supply of Tioga was completed and water turned on November 2. The supply to this district was previously ample except in case of fire or a break in the 6-inch pipe through which it was furnished with water. The ordinary pressure was 50 pounds before and 90 pounds after the completion of the new main.

RELAYS.

The work of replacing the old and small service pipes with larger ones was continued during the year as fast as the material could be procured. Three hundred and forty-eight feet of 1½-inch, 60 feet of 2-inch, 22,694 feet of 3-inch and 11,079 feet of 4-inch were replaced, mostly with 6-inch pipe. A 16-inch main was laid in Fourth street from Market to Walnut street, and the old 4-inch pipe abandoned. A 12-inch pipe was laid in Walnut street from Front to Twelfth street and from Fifteenth to Twenty-second.

In some cases where the old pipes were laid under car tracks they were cut off and left in the ground.

FIRE-HYDRANTS.

Three hundred and seven fire-hydrants were placed in new locations during the year, 271 of which were of the new styles adopted during the previous year.

DRILLS.

Seven thousand two hundred and eighty-five attachments have been made for house service which, with very few exceptions, were corporation cocks screwed into the mains.

METERS.

The appended table shows the number of meters in use and in stock. Those in use are principally on establishments having wells or motors and whose water rents cannot be determined by assessment.

On December 21, 1885, the district supplied by direct pumpage at Spring Garden station was extended from Spring Garden street to Callowhill street west of Broad. The work was commenced at 8 A. M., by filling the old No 6, 36-inch pumping main in Master street from the Spring Garden station to the Spring Garden reservoir and the two 16-inch supply mains on North College and Ridge avenues to Poplar street. The

20-inch main on Sixteenth street from Poplar to Callowhill street, and the 12-inch main on Twenty-second street from Poplar to Spring Garden street were then opened to direct pumpage. The valves on the supply pipes on the west side of Broad street and the north side of Callowhill street were then closed and the valves along the north side of Spring Garden street opened. Gauges were placed on the fire hydrants in that district in charge of men who noted the pressures every half hour, as shown in the accompanying table. The work of enclosing this district commenced at 8 A. M., and was completed at 4.30 P. M.

The pressure at Nineteenth street above Callowhill having fallen from 30 to 16 pounds, it was thought proper to extend the district to Vine street west of Broad, which was done on the following day, December 22, at 8 A. M.

Respectfully,
JOHN L. OGDEN,
Assistant Engineer.

IRON SERVICE AND SUPPLY MAINS LAID IN 1885.

First District,

Comprising the First, Second, Third, Fourth, Twenty-sixth, and Thirtieth Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply Pipes.		
Annin street, from Twentieth to Twenty-first	6	548
Broad street, east side, from Reed to Dickinson	6	448
Carpenter street, from Gray's Ferry road east	12	8
Chadwick street, from 6 feet south of north house line of Morris to north house line of Tasker	6	450
Cymro street, from Dickinson to Tasker	6	450
Daly street, from Seventh to Eighth	6	439
Dorrance street, from Tasker north	6	14
Dove street, from Third to Fourth	6	401
Donnagana street, from Fifteenth to Sixteenth	6	447
Eighth street, from Jackson to Moyamensing avenue	6	552
Federal street, from Clarion to east side Broad	6	456
Fernon street, from 193 feet 4 inches east of Twentieth to Twenty-first	6	719
Flora street, from Reed to Scott	6	309
Hicks street, from McKean to Mifflin	6	438
Hilliary street, from Wharton to Reed	6	450
Lambert street, from Dickinson south	6	275
Long lane, from 128 feet southwest of McKean to Tasker	6	2,328
Manton street, from Long lane west	6	355
Manton street, from 228 feet east of Twenty-second west	6	558
Mifflin street, from Long lane west	6	215
Mountain street, from Nineteenth to Twenty-first	6	952
Moyamensing avenue, from Eighth east	6	19
Oakford street, from 257 feet 6 inches east of Twenty-second west	6	558
Siebold street, from 403 feet south of south house line of Jackson to centre Jackson	6	428
Siegel street, from Ninth west	6	193
Sober street, from Dickinson south	6	275
Stanley street, from 135 feet west of Third to Fourth	6	317
Stow street, from Long lane west	6	219
Tasker street, from Ward to Caernarvon	6	575
Tasker street, from Centre of Twentieth east	6	21
Thirty-sixth street, from Gray's Ferry road south	12	12
Tree street, from Seventh to Eighth	6	439
Twentieth street, from Morris to Dickinson	6	887
Twenty-second street, from Latona to Federal	12	487
Wheat street, from Wharton to Reed	6	441
Winton street, from Eighth to Ninth	6	448
Washington av., south side, from Gray's Ferry road east	6	24
Woodstock street, from Tasker to Dickinson	6	438
Total		16,493

Street. Location.	Size in inches.	Distance in feet.
Supply Mains.		
South street, from west house line of Twenty-second to Gray's Ferry road	20	219
Gray's Ferry road, from South to Thirty-sixth street	20	6,846
Total	....	7,065
Cross connections.		
Thirtieth street and Gray's Ferry road	6	8
Thirty-third street and Gray's Ferry road	6	13
Thirty-fifth street and Gray's Ferry road	6	17
Washington av., north side, from Gray's Ferry road east	6	27
Total	....	65
Fire-hydrant connections	4	8
" "	6	472
Total	....	480
Supply connections (private) extended.		
Gray's Ferry road, 174 feet south of Fitzwater	6	19
Grays Ferry road, 188 feet north of north house line of Catharine	6	20
Total	....	39
Drains.		
Christian street, north side, from Gray's Ferry road east	4	11
Repairs, general	3	10
" "	4	48
" "	6	263
" "	8	17
" "	10	3
Total	....	341

Street.	Location.	Size in inches.	Distance in feet.
	Repairs, new stops put in.		
Carpenter street, east house line of Sixth		6	3
Eighth street, north house line of Wharton		6	3
Eleventh street, north house line of Morris		6	3
Front street, south house line of Almond		8	2
Long lane, north house line of Wharton		6	3
Marriott street, east house line of Sixth		4	2
Passyunk avenue, south house line of Reed		6	6
Tenth street, north house line of Tasker		6	3
Total			25
	Pipe taken up.		
Alaska street, from Fifth to Seventh		3	893
Annapolis street, from Bainbridge to South		3	299
Bainbridge street, south side, from Third to Passyunk av.		3	816
Barrow street, from Bainbridge to Trout (or Pine alley)		4	170
Baker street, from Spafford to Seventh		3	270
Carpenter street, from Front to Second		3	500
Charles street, from Monroe to south side Bainbridge		4	220
Charles street, north side, from Bainbridge to South		3	296
China street, from Front to Second		3	461
Congress street, from Front to Second		4	457
Concord street, from Second to Third		3	553
Hallowell street, from Sixth to Seventh		3	450
Marriott street, from Moyamensing av. to Passyunk av.		3	1,146
		4	883
Mary street, from Front to Second		3	500
Mead street, from Front east		4	32
Paul street, from Sixth to Seventh		4	452
Penn street, from South to Bainbridge		4	300
Senate street, from Front to Second		3	403
Stanley street, from Third street west		3	140
Spafford street, from Fitzwater to Bainbridge		3	415
Trout street, from Barrow to Fourth		4	165
Total			9,821

Street. Location.	Size in inches.	Distance in feet.
Relaid.		
Alaska street, from Fifth to Seventh	6	897
Annapolis street, from Bainbridge to South	6	321
Bainbridge street, south side, from Third to Passyunk av.	6	867
Barrow street, from Bainbridge to Trout	6	171
Baker street, from Spafford to Seventh	6	305
Carpenter street, from Front to Second	6	444
Charles street, from Monroe to south side of Bainbridge	6	232
Charles street, north side, from Bainbridge to South	6	326
China street, from Front to Second	6	454
Congress street, from Front to Second	6	461
Concord street, from Second to Third	6	597
Hallowell street, from Sixth to Seventh	6	453
Marriott street, from Moyamensing av. to Passyunk av.	6	2,111
Mary street, from Front to Second	6	444
Mead street, from Front street east	6	32
Paul street, from Sixth to Seventh	6	453
Penn street, from South to Bainbridge	6	308
Senate street, from Front to Second	6	460
Stanley street, from Third street west	6	135
Spafford street, from Fitzwater to Bainbridge	6	402
Trout street, from Barrow to Fourth	6	309
Total	....	10,182
Relaid fire-hydrant connections	6	307
Lowered.		
Moyamensing avenue, from east house line of Eighth east	6	24

Recapitulation of First District.

	Purposes for which used.	Size—Inches. 3	4	6	8	10	12	20	Totals in feet and pounds.
New pipe or feet added.	Supply pipes			15,986			507		16,493
	" mains							7,065	7,065
	Cross connections			65					65
	Fire hydrant connections		8	472					480
	Supply connections (private)			39					39
	Drains		11						11
	Total... feet		19	16,562			507	7,065	24,153
	Total... pounds		361	546,546			36,504	1,123,335	1,706,746
Pipe used, but adding nothing to feet in the ground.	Repairs, general	10	48	263	17	3			341
	" new stops put in		2	21	2				25
	Taken up	7,142	2,679						9,821
	" relaid			10,182					10,182
	Fire hydrant connections relaid			307					307
	Lowered			24					24
	Total... feet	7,152	2,729	10,797	19	3			20,700
	Total... pounds	107,280	51,851	356,301	798	165			516,395
	Total handled feet	7,152	2,748	27,359	19	3	507	7,065	44,853
	Total handled pounds	107,280	52,212	902,847	798	165	36,504	1,123,335	2,223,141

Second District,

Comprising the Fifth, Sixth, Seventh, Eighth, Ninth, Tenth, Twenty-fourth, and Twenty-seventh Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply Pipes.		
Arch street, from 5 feet east to 5 feet west of 36-inch pipe in Fifty-second	6	10
Brown street, from Markoe to Dyson	6	135
Cathedral avenue, from Fifty-second east	6	18
Cherry street, from 6 feet 7 inches west of west house line of Eighteenth, to 1 foot 10 inches east of east house line of Nineteenth	6	386
Chester avenue, from 200 feet west of Forty-eighth to Forty-ninth	6	234
Columbia avenue, from Fifty-second west	6	32
Dyson street, from 10 feet south of north curb line of Brown north	6	184
Fairmount avenue, from west curb line of Thirty-third to Thirty-fourth	6	396
Fifty-second street, west side, from 95 feet south of south house line of Supplee to 6 feet 6 inches north of centre of Girard avenue	6	484
Forty-fifth street, from Lancaster to 7 feet north of centre of Marion	6	302
Forty-ninth street, from 2 feet 11 inches southeast of southeast house line of Chester avenue northwest	6	482
Forty-ninth street, from Woodland avenue southeast	6	455
Fourth street, east side, from Walnut to Chestnut	16	572
Greenway avenue, from Seventy-first to 2 feet east of east house line of Seventy-second	6	472
Jefferson street, from Fifty-second west	6	32
Haverford avenue, from west house line of Thirty-first to Thirty-second	6	266
Lombard street, from Sixtieth west	6	132
Manning street, from 125 feet east of east house line of Twenty-fourth west	6	60
Master street, from Fifty-second west	6	34
Orion street, from Fairmount avenue north	6	209
Powelton avenue, from Warren to Lancaster avenue	6	378
Race and Fifty-second streets, connection east and west with 36-inch main	6	10
Seventy-first street, from Woodland avenue to 116 feet north of Greenway avenue	6	640
Seneca street, from east curb line of Fifty-second west	6	12
Summer street, from Thirty-second to 3 feet 9 inches west of east house line of Keffer	6	280

Street. Location.	Size in inches.	Distance in feet.
Supply Pipes—Continued.		
Supplee street, from 10 feet west of east curb line of Fifty-second west	6	6
Trotters alley, from 75 feet west of west house line of Second to Strawberry	6	68
Thirtieth street, from 1,139 feet north of Market to south curb line of Spring Garden	6	2,219
Thirty-seventh street, from 231 feet north of north house line of Aspen to south house line of Brown	6	133
Walnut street, south side, from Second to Eighth	12	2,700
" " " from Tenth to 9 feet 6 inches east of centre of Twelfth	12	896
Walnut street, south side, from Fifteenth to Twenty-second	12	3,206
Wyalusing avenue, from Fifty-third to Fifty-fifth	6	999
Total		16,442
Supply Mains.		
Fifty-second street, from 30 feet south of Walnut to Belmont Reservoir	36	10,939
Haverford avenue, east and west of 36-inch pipe in Fifty-second	20	42
Juniper street, from Market to Filbert. Filbert street, from Juniper to Broad. Broad street, from Filbert to 45 feet 10 inches north of north house line of Arch	20	1,105
Lancaster avenue, from 36 feet west of Forty-fourth to west house line of Fifty-second	20	5,253
Market street, north side, from east curb line of Fifty-second west	20	25
Westminster avenue, from east curb line of Fifty-second west	12	44
Total		17,408
Cross connections.		
Forty-ninth and Lancaster avenue	6	10
Fifty-second and Lancaster avenue	6	12
Forty-seventh and Lancaster avenue	6	7
Forty-sixth and Lancaster avenue	6	5
Markoe and Lancaster avenue	6	12
Paschall and Lancaster avenue	6	6
Wyalusing and Lancaster avenues	6	5
Total		57

Street. Location.	Size in inches.	Distance in feet.
Fire hydrant connections	6	1,882
Fire connections (private).		
South street, north side, 116 feet east of east house line of Twenty-fifth, N. C. Mitchell's Rubber Works	4	16
Chestnut street, north side, 184 feet 6 inches west of west house line of Seventh, Temple Theatre	4	9
Total	....	25
Supply connections (private).		
Forty-ninth street, 2 feet south of south house line of Chester avenue (Belmont Cricket Club)	4	13
Spruce street, south side, 238 feet west of Thirty-second (Public Bath)	4	24
Juniper street, southwest corner of Filbert (City Hall)	12	38
Total	....	75
Drains.		
Fiftieth street and Lancaster avenue	6	7
Lancaster avenue, 68 ft. 6 in. east of centre of Forty-eighth	6	17
Belmont Reservoir and Fiftieth street, to drain stop-house	4	38
Fifty-second street, east side, 91 feet north of Wyalusing av.	6	8
Total	....	70
Repairs, general	3	5
" "	4	88
" "	6	603
" "	8	27
" "	10	54
" "	12	12
Total	....	789
Repairs, new stops put in.		
Chestnut street, south side, 3 feet east of east house line of Fourth	10	3
Chestnut street, south side, 3 feet 6 inches west of west house line of Fourth	10	3
Chestnut street, north side, 3 feet east of east house line of Fourth	10	3

Street. Location.	Size in inches.	Distance in feet.
Repairs, new stops put in—Continued.		
Chestnut street, north side, 3 feet 6 inches west of west house line of Fourth	10	3
Pine street, at intersection of Seventh, "Four-way Barton stop"	6	9
Sansom street, west house line of Ninth	6	2
Wallace street, west house line of Thirty-fifth	6	3
Wallace street, east curb line of Thirty-fifth	6	2
Total	....	28
Pipe taken up.		
Appletree alley, from Fourth to Fifth street	3	396
Balch street, from New to Vine	3	176
Bank street, from Chestnut to Market	3	480
Barron street, from South to Gaskill	3	200
Black Horse alley, from Front to Second	3	400
Branch street, from Third to Fourth	3	421
Branner's alley, from Mulberry alley north	1½	114
Chancery lane, from Coombes to Arch	2	60
	3	200
Cherry street, from Third to Sixth	4	1,371
Church street, from Front to Third	3	941
Clyde alley, from Cresson to Cherry	3	120
Commerce street, from Fourth to Seventh	3	1,492
Coombes street, from Front to Second	3	396
Craven street, from Front to Second	3	396
Cresson street, from Fifth to Nicholson	3	711
Drinker street, from Front to Second	3	396
Elbow lane, from Bank to Third	3	100
Elfreth's alley, from Front to Second	3	396
Fetter's lane, from Bread to Third	3	225
Filbert street, from Sixth to Seventh	3	421
Forty-first street, from 71 feet south of south house line of Haverford avenue south	6	77
Fourth street, from Chestnut to Market	4	481
Gaskill street, from Third to Fifth	4	950
George street, from Sansom north	3	130
Haverford street, from 10 feet west of east curb line of Fifty-second east	6	14
Heston street, from Fifty-second west	6	14
Hillsdale street, from Cherry to Race	3	331
Kempton street, from Sixth east	1½	138
Kenyon street, from New to Vine	3	174
Kershaw street, from Fifty-second east	6	20
Lagrange street, from Second west	3	292
Ledger place, from Second to Lagrange	3	338
Locust street, from Fourth to Sixth	4	881
Mayland street, from Race to Mulberry alley	3	300

Street. Location.	Size in inches.	Distance in feet.
Pipe taken up—Continued.		
Merchant street, from Fourth to Fifth	3	446
Minor street, from Fifth to Sixth	3	396
Mulberry alley, from Fifth to Sixth	3	416
Neville street, from Mulberry alley to Vine street	3	300
New street, from Front to Fourth	3	456
	4	1,000
Nicholson street, from Cherry to Race	3	275
North street, from Fifth to Sixth	3	396
Paschal street, from Fifty-second east	6	18
Quarry street, from Second to Third	3	475
Relief street, from Front to Second	3	390
Sansom street, from Sixth to Seventh	3	453
Sansom street, from Seventh to Eighth	3	501
Second street, east side, from South to Pine	4	731
Second street, west side, from South to Lombard	4	376
Strawberry street, from Chestnut to Market	3	481
Swanwick street, from Walnut to Sansom	3	240
Torr avenue, from Fifty-second east	6	24
Thirty-second street, between Ludlow and Chestnut	4	24
Trotter's alley, from Second west	$1\frac{1}{2}$	96
Walnut street, from Front to Second	6	451
Walnut street, from Eighth to Tenth	6	897
Belmont Reservoir connections	30	159
Belmont Reservoir connections	20	40
Total	....	22,693
Fire hydrant connections taken up	6	26
Relaid.		
Appletree alley, from Fourth to Fifth	6	451
Balch street, from New to Vine	6	192
Bank street, from 5 feet 6 inches north of centre of Chestnut to 23 feet south of centre of Market	6	520
Barron street, from South to Gaskill	6	188
Blackhorse alley, from Front to Second	6	454
Branch street, from Third to Fourth	6	445
Branner's alley, from Mulberry alley north	6	164
Chancery lane, from Coombes to Arch	6	200
Cherry street, from Third to Sixth	6	1,350
Church street, from Front to Third	6	1,003
Clyde alley, from Cresson to Cherry	6	166
Commerce street, from 5 feet west of centre of Fourth to Seventh	6	1,265
Coombes street, from Front to Second	6	480
Craven street, from Front to Second	6	544
Cresson street, from Fifth to Nicholson	6	776

Street. Location.	Size in inches.	Distance in feet.
Relaid—Continued.		
Dr.nker street, from Front to Second	6	518
Elbow lane, from Bank to Third	6	225
Elfreth's alley, from Front to Second	6	507
Elm avenue, from east curb line of Fifty-second west	10	32
Fetter's lane, from 18 feet west of centre of Bread to Third	6	264
Filbert street, from Sixth to Seventh	6	445
Fourth street, from Chestnut to Market	16	575
Gaskill street, from Second to Fifth	6	1,421
George street, from Sansom street north	6	129
Girard avenue, from east curb line of Fifty-second west	6	18
Hillsdale street, from Cherry to Race	6	327
Heston street, from Fifty-second west	6	14
Haverford street, from 5 feet east and west of 36-inch main in Fifty-second	12	12
Haverford street, from 4 feet east of east curb line to 36-inch main in Fifty-second	6	14
Kempton street, from Sixth east	6	224
Kenyon street, from New to Vine	6	193
Kershaw street, from Fifty-second east	6	20
Lagrange street, from Second west	6	436
Ledger place, from Second to Lagrange	6	350
Locust street, from Fourth to Sixth	10	881
Mayland street, from Race to Mulberry alley	6	341
Merchant street, from Fourth to Fifth	6	443
Minor street, from Fifth to Sixth	6	446
Mulberry alley, from Fifth to 5 feet east of centre of Sixth	6	438
Nicholson street, from Race to Cherry	6	320
Neville place, from Mulberry alley to Vine	6	342
New street, from Front to Fourth	6	1,544
North street, from Fifth to Sixth	6	449
Paschal street, from Fifty-second east	6	18
Quarry street, from Second to Third	6	512
Relief street, from Front to Second	6	372
Seventh street, west side, intersection of Sansom	6	43
Sansom street, north side, from Sixth to 6 feet 6 inches west of centre of Eighth	6	897
Second street, east side, from South to Pine	10	731
Second street, west side, from South to Lombard	6	376
Strawberry street, from 5 feet north of centre of Chestnut to 23 feet south of centre of Market	6	534
Swanwick street, from 8 feet 6 inches north of centre of Walnut to Sansom	6	252
Torr avenue, from Fifty-second east	6	24
Thirty-second street, from Ludlow to Chestnut	6	253
Trotter's alley, from Second west	6	100
Walnut street, from Front to Second	12	452
Walnut street, from Eighth to Tenth	12	897
Total		24,587

Street. Location.	Size in inches.	Distance in feet.
Relaid at Belmont Reservoir.		
No. 1 connection	30	33
No. 2 connection	30	38
No. 3 connection	30	43
No. 4 connection	30	48
Nos. 1 and 3 connection, from reservoir to 20-inch supply main	30 20	29 25
No. 1 connection, from reservoir to 30-inch pumping main	30	36
Connection 36-inch pumping main to two 30-inch reservoir connections	30 36	97 14
Connection 36-inch pumping main to overflow southeast corner of reservoir	36	24
Connection 36-inch supply main to Nos. 2, 3, and 4, reservoir connections	36	47
Total	....	434
Relaid fire hydrant connections	6	340
Lowered.		
Twenty-second street, east side, centre of Filbert street	6	5
Raised.		
Belmont reservoir connections	20	36
Belmont reservoir connections	30	86
Belmont reservoir connections	36	100
Total	....	222
Shifted.		
Forty-first street, south of Haverford, moved 10 feet east from centre, between 71 and 148 feet south of Haverford	6	89
Ninth and Market	6	27
Total	....	116
Cut off and abandoned.		
Cherry street, east of Sixth	4	49
Commerce street, east of Sixth	3	36
Total	....	85

Recapitulation of Second District.

Purposes for which used.		Size—Inches. 1½	2	3	4	6	8	10	12	16	20	30	36	Totals in feet and pounds.
New pipe, or feet added.	Supply pipes					9,068			6,802	572				16,412
	Supply mains								44		6,425		10,939	17,408
	Cross connections					57								57
	Fire hydrant connections					1,882								1,882
	Fire connections, private				25									25
	Supply connect's, private				37				38					75
	Drains				38	32								70
	Total feet				100	11,039			6,884	572	6,425		10,939	35,959
	Total pounds				1,900	361,287			495,648	62,920	1,021,575		1,616,258	6,562,588
Pipe used, but adding nothing to feet in the ground.	Repairs general			5	88	603	27	54	12					789
	Rep'rs, new stops put in					16		12						28
	Pipe taken up	348	60	14,757	5,811	1,541					40		159	22,719
	Relaid					21,007		1,644	1,361	575	25	324	85	25,021
	Fire hyd'nt con., relaid					340								340
	Lowered					5								5
	Raised										36	86	100	222
	Shifted					116								116
	Cut off and abandoned			36	49									85
	Total feet	348	60	14,798	5,951	23,628	27	1,710	1,373	575	101	410	344	49,325
	Total pounds	2,436	600	221,970	113,069	779,724	1,134	94,050	98,856	63,250	16,059	136,120	145,168	1,672,436
Total handled	feet	348	60	14,798	6,051	34,667	27	1,710	8,257	1,147	6,526	410	11,283	85,284
	pounds	2,436	600	221,970	114,969	1,144,011	1,134	94,050	594,504	126,170	1,037,634	136,120	4,761,426	8,235,024

THIRD DISTRICT,

Comprising the Eleventh, Twelfth, Sixteenth, Seventeenth, Eighteenth, Nineteenth, Twenty-third, Thirty-first, and part of the Twenty-fifth Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply pipes.		
Adalena street, from Emerald southeast	6	244
Amber street, from Westminster avenue north	6	582
Butler street, from Turner east	6	21
Cambria street, from Third to 13 feet east of west house line of American	6	286
Cambria street, from Fourth to Fifth	6	519
Cherry street, from Foulkrod to Harrison	6	568
Clifton street, from Neff southwest	6	283
Coral street, from Wheat Sheaf lane southwest	6	565
Darien street, from 250 feet north of north house line of Huntingdon to Somerset	6	838
Eighth street, from Huntingdon to Lehigh avenue	6	554
Erie avenue, south side, from Fifth to Sixth	10	564
Fairhill street, from Indiana avenue to Clearfield	6	555
Firth street, from 120 feet 9 inches west of Eighth west	6	48
Fourth street, from Somerset north	6	456
Fourth street, from Cambria to Indiana avenue	6	553
Franklin street, from Unity southwest	6	148
Franklin street, from Lehigh avenue to Huntingdon	6	558
Hope street, from Cambria north	6	210
Indiana avenue, from Fourth to Fifth	6	527
Lawrence street, from Cambria to 145 feet north of north house line of Indiana avenue	6	751
Leithgow street, from Cambria south	6	400
Marshall street, from Venango to Erie	6	552
Ninth street, from Cumberland to Huntingdon	6	550
Ninth street, from 12 feet north of north house line of Huntingdon north	6	242
Orianna street, from Cambria to 12 feet north of north house line of Indiana avenue	6	535
Orkney street, from Cambria north	6	779
Seventh street, from Huntingdon north	6	138
Seventh street, from Venango to 4 feet north of south house line of Erie avenue	6	530
Tioga street, from 12 feet east of east house line of Frankford avenue to Waterloo	6	490
Turner street, from 22 feet north of north house line of Tioga to Venango	6	503
Turner street, from 126 feet south of Erie avenue to Butler	6	754
Total		14,303
Fire hydrant connections	6	371

Street. Location.	Size in inches.	Distance in feet.
Fire connections (private).		
Bodine street, east side, 150 feet north of Oxford, for A. M. Collins & Co.	4	9
Fairhill street, east side, 42 feet 6 inches north of Cumberland, for Schofield, Mason & Co.	4	19
Kensington avenue, east side, 92 feet north of Huntingdon, for E P. & H. N. Almy	4	14
Somerset street, north side, 37 feet east of Eighth, for John H. Dearnley	4	20
Wildey street, north side, 83 feet east of Frankford avenue, for Morse, Williams & Co.	4	17
Total	....	79
Connections at Pumping Stations.		
Kensington Station, blow-off pipe	4	21
Repairs general	4	48
" "	6	195
" "	8	3
" "	10	16
Total	....	262
Repairs, new stops put in.		
Alleghany avenue, south side, west house line of Salmon.	6	4
Fox street, north house line of Cumberland	4	4
Front street, " " " "	6	4
Hancock street, " " " "	6	4
Lee street, " " " "	4	4
Somerset street, east " " Howard	6	5
Total	....	25
Pipe taken up.		
Fire hydrant connections	4	80
Relaid.		
Sixth street, over Reading Railroad bridge	10	84
Relaid fire hydrant connections	6	106

Street. Location.	Size in inches.	Distance in feet.
Lowered.		
Lawrence street, south of Cambria	6	50
Lawrence street, west side, south of Cambria	4	14
Orthodox street, west of Richmond	6	647
Orthodox street, south side, 6 feet west of Salmon	4	10
Wheatsheaf lane, between Frankford road and Pennsylvania Railroad	12	250
Total		971
Cut off and abandoned.		
Belgrade street, northeast corner of Earl	4	14

Recapitulation of Third District.

	Purpose for which used.		Size—Inches. 4	6	8	10	12	Totals in feet and pounds.
New pipe, or feet added.	Supply pipes			13,739		564		14,303
	Fire hydrant connections			371				371
	Fire connections (private)		79					79
	Connections at Stations		21					21
	Total	Feet	100	14,110		564		14,774
		Pounds	1,900	465,630		31,020		498,550
Pipe used, but adding nothing to feet in the ground.	Repairs general		48	195	3	16		262
	" new stops put in		8	17				25
	Pipe taken up		80					80
	" relaid					84		84
	Fire hydrant connections relaid			106				106
	Lowered		24	697			250	971
	Cut off and abandoned		14					14
	Total	Feet	174	1,015	3	100	250	1,542
		Pounds	3,306	33,495	126	5,500	18,000	60,427
Total handled		Feet	274	15,125	3	664	250	16,316
		Pounds	5,206	499,125	126	36,520	18,000	558,977

Fourth District,

Comprising the Thirteenth, Fourteenth, Fifteenth, Twentieth, part of the Twenty-eighth, and part of the Twenty-ninth Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply Pipe.		
Carlton street, from Tenth to Eleventh	6	441
Croskey street, from Diamond to Norris	6	547
Dakota street, from Thirtieth to Duhring	6	1,197
Diamond street, south side, from Broad to Carlisle	6	252
Dubree street, from Wylie to Vineyard	6	360
Duhring street, from Dakota to Ridge avenue	6	135
Esher street, from Thompson north	6	154
Fontain street, from Twenty-third to Croskey	6	206
Gold street, from Twenty-third west	6	38
Harper street, from Twenty-ninth to Thirtieth	6	476
Lemon street, from Twelfth to Andress	6	226
McClellan street, from Pennock to Twenty-eighth	6	204
Marston street, from Columbia avenue to Maud	6	391
Master street, from Twenty-eighth to Thirty-first	6	1,380
Maud street, from Twenty-seventh to Twenty-eighth	6	401
Norris street, from Twenty-second to Twenty-fourth	6	942
Page street, from Twenty-third to Croskey	6	203
Pennock street, from Swain south	6	54
Pennock street, from Brown to Poplar	6	873
Poplar street, from Ringgold to West College avenue	6	427
Poplar street, from Thirtieth west	6	172
Potts street, from Thirteenth to Ridge avenue	6	586
Ringgold street, from Poplar to Parrish	6	437
Scott street, from 199 ft. 6 in. west of Twenty-seventh west	6	30
Seybert street, from Seventeenth to Eighteenth	6	443
Sixteenth street, from Dauphin to Cumberland	6	1,083
Sixteenth street, from Herbine north	6	68
Shamokin street, from 200 feet west of Twenty-second west	6	127
Sheridan street, from Montgomery to Berks	6	516
Sommerville street, from Germantown road to Warnock	6	192
Swain street, from Twenty-seventh to Pennock	6	202
Taylor street, from Parrish to Poplar	6	451
Taylor street, from Montgomery to Berks	6	557
Thirtieth street, from Master south	10	35
Thirty-second street, from Dauphin to Dakota	6	125
Twenty-fourth street, from Berks to Norris	6	543
Twenty-fifth street, from Brown to Poplar	6	862
Twenty-third street, from Norris south	6	14
West College avenue, from Brown to Parrish	6	409
West College avenue, from 3 feet south of north curb line of Poplar north	6	9
Willow street, south side, from Eleventh west	6	325
Wright street, from 226 feet east of Twenty-sixth to 5 feet west of east house line of Twenty-sixth	6	236
York street, from Twenty-third to Sedgeley	6	198
York street, from Twenty-fourth to Twenty-sixth	6	904
Total	....	17,431

Street. Location.	Size in inches.	Distance in feet.
Supply Mains.		
Fairmount avenue, 168 feet west of Twenty-fifth	30	31
Master street, 67 feet east of Twenty-seventh	20 16	13 64
Poplar street, from Broad to Ridge avenue	20	1,411
Poplar street and Ridge avenue	16	44
Thompson and Taney streets	16	45
Thompson street, from Taney to West College avenue	30	460
Twenty-second street, from 30 feet south of south curb line of Poplar north	12 20	83 12
Total	....	2,163
Pumping Mains.		
Fairmount Station, extension of 16-inch main in forebay to Schuylkill river	10	86
Fairmount Station, connection between No. 7 and 48-inch main	30	80
Fairmount Station, connection between No. 7 and 48-inch main	48	11
Spring Garden Station, No. 6. connection to No. 7 main	36	90
Spring Garden Station, connection between No. 7 and No. 9 main	36	107
Spring Garden Station, connection between No. 7 and No. 10 main	36	57
Spring Garden Station, connection between No. 6 and No. 9 main	36	104
Spring Garden Station, connection between No. 8 and No. 10 main	30	120
Spring Garden Station, near standpipe connecting No. 8 to Belmont main	30	85
Spring Garden Station, on Belmont connection from No. 8 main north to cross Reading Railroad	30	154
Spring Garden Station, No. 7 main crossing Reading R.R.	48	193
Thirty-third street, south side of Reading Railroad to north side of Thompson	36	138
Total	....	1,225
Cross Connections.		
Twenty-ninth and Master	6	16
Fire hydrant connections	6	350

Street. Location.	Size in inches.	Distance in feet.
Connections at Pumping Stations.		
Belmont, connection to air engines	4	17
Belmont, connection to No. 1 main	4	12
Belmont, connection to No. 1 main	8	4
Spring Garden, drain on No. 7 engine	6	7
Spring Garden, drain on southwest side Reading Railroad	10	92
Spring Garden, drain from 18-inch main	10	200
Spring Garden, drain from 18-inch main	16	7
Spring Garden, drain from 18-inch main	12	9
Spring Garden, drain from coal sheds	6	24
Spring Garden, drain from new engine-house	4	73
Spring Garden, drain from Fourth District office	4	23
Spring Garden, No. 6 blow-off	4	4
Spring Garden, No. 6 blow-off	6	3
Total		475
Repairs general	3	1
" "	4	64
" "	6	745
" "	8	4
" "	10	6
" "	12	2
" "	16	8
" "	18	4
" "	20	4
Total		838
Repairs, new stops put in.		
Twenty-second street, south of Seybert	20	4
Twenty-second street, west side, and Hamilton	6	1
Twenty-first street, north side, and Sharswood	10	3
Total		8
Taken up.		
Fairmount Park, across Reading Railroad bridge	30	144
Spring Garden Station, No. 4 main	30	20
Spring Garden Station, No. 5 main	36	146
Spring Garden Station, No. 6 main	36	54
Spring Garden Station, No. 8 main	30	170
Spring Garden Station, old mains	18	15
Spring Garden Station, old mains	20	50
Thirty-third street, south of Master	36	312

Street. Location.	Size in inches.	Distance in feet.
Taken up—Continued.		
Thirty-third street, south of Thompson	36	60
Thompson street and West College avenue	16	172
Twenty-fourth street, east side, 66 feet south of Hamilton.	4	12
York street, south side, 76 feet east of Twenty-second	4	12
York street, south side, 15 feet east of Twenty-first	4	10
Total	....	1,177
Relaid.		
Twenty-seventh and Parrish	6	61
Twenty-seventh and Brown	6	60
Thirty-third and Thompson	6	24
Fairmount Park, across Reading Railroad bridge	30	144
Total	....	289
Relaid fire hydrant connections	6	308
Lowered.		
Sharswood street, from Twenty-third to Twenty-fourth	6	380
Twenty-second street, south of Seybert	20	90
York street, from Twenty-second west	6	319
Total	....	789
Raised.		
Twenty-eighth and Master	48	36
Shifted.		
Ridge avenue and Poplar	16	72

Recapitulation of Fourth District.

Purposes for which used.		Size—Inches. 3	4	6	8	10	12	16	18	20	30	36	48	Total in feet and pounds.
New pipe, or feet added.	Supply pipes			17,396		35								17,431
	Supply mains						83	153		1,436	491			2,163
	Pumping mains					86					439	496	204	1,225
	Cross connections			16										16
	Fire hydrant connections			350										350
	Connections at station		129	34	4	292	9	7						475
	Total { feet		129	17,796	4	413	92	160		1,436	930	496	204	21,660
	Total { pounds		2,451	587,268	168	22,715	6,624	17,600		228,324	308,760	209,312	119,340	1,502,562
Pipe used, but adding nothing to feet in the ground.	Repairs, general	1	64	745	4	6	2	8	4	4				838
	Repairs, new stops put in			1		3				4				8
	Pipe taken up		34					172	15	50	334	572		1,177
	Pipe relaid			145							144			289
	Fire hydr't connect'ns relaid			308										308
	Lowered			699						90				789
	Raised												36	36
	Shifted							72						72
	Total { feet	1	98	1,898	4	9	2	252	19	148	478	572	36	3,517
	Total { pounds	15	1,862	62,634	168	495	144	27,720	2,660	23,532	158,696	241,384	21,060	540,370
Total handled { feet		1	227	19,694	8	422	94	412	19	1,584	1,408	1,068	240	25,177
Total handled { pounds		15	4,313	649,902	336	23,210	6,768	45,320	2,660	251,856	467,456	450,696	140,400	2,042,932

Germantown District,

Comprising the Twenty-second and parts of the Twenty-fifth and Twenty-eighth Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply pipes.		
Baird street, from Penn to Coulter	6	316
Baynton street, from 631 feet southeast of Wistar southeast	6	137
Boyer street, from Mt. Airy avenue northwest	6	718
Bristol street, from Sixteenth west	6	150
Bruner street, from Germantown avenue to Wayne	6	550
Chelten avenue, from Cedar to southwest house line of Boyer	6	1,763
Chew street, from Mill to Locust	6	504
" from 225 feet southeast of Haines to centre of Haines	6	225
Chew street, from Chelten avenue southeast	6	8
Cliveden street, from Germantown avenue to Nash	6	1,121
Coulter street, from Germantown avenue to Cumberland	6	761
Duval street, from Green northeast	6	12
Fifteenth street, from Tioga to Erie avenue	6	1,097
Franklin street, from 6-inch pipe on Green northeast	6	9
Gorgas lane, from Germantown avenue to Chew	6	1,051
Green street, from Franklin northwest	6	384
Haines street, from 186 feet 8 inches northeast of Cedar to Chew	6	1,142
Jefferson street, from 100 feet northeast of northeast house line of Mercer northeast	6	389
Lincoln avenue, from 5 feet east of 16-inch pipe on Green west	10	11
Morris street, from School to Chelten avenue	6	771
Mt. Pleasant avenue, from Germantown ave. to McCallum	6	3,918
Mill street, from centre of Chew southwest	3	12
Miller street, from Wisteria avenue northwest	6	24
Mt. Airy avenue, from southwest side of Chestnut Hill R. R. to east side of Sullivan	6	765
Mechanic street, from Morton to Cedar	6	630
Mechlin street, from Germantown avenue to Wakefield	6	915
Philellen street, from 5 feet 6 inches northeast of 16-inch pipe in Green southwest	6	9
Ruscomb street, from East Logan east	6	421
Sedgwick street, from McCallum southwest	6	15
Sixteenth street, from Bristol north	6	246
Smedley street, from Venango to Erie avenue	6	525
Sprague street, from Mt. Airy avenue southeast	6	452
Stenton avenue, from southwest side of Evergreen avenue northwest	6	20
Twenty-seventh street, from Southampton to Union ave	6	477
Upsal street, from Germantown avenue to Nash	6	854
" " from Green southwest	6	4

Street. Location.	Size in inches.	Distance in feet.
Supply pipes—Continued.		
Venango street, from Smedley to Seventeenth..................	6	224
Washington lane, from 138 feet southwest of Germantown avenue southwest..	4	85
Wayne street, from West Logan to southeast side of Seymour..	6	491
West Logan street, from 230 feet northeast of Wayne to centre of Wayne...	6	267
Westview avenue, from Germantown avenue southwest...	6	729
Wisteria avenue, from northeast house line of Baynton to Miller..	6	366
Total..	....	22,568
Supply mains.		
Green street, from 200 feet 6 inches south of south house line of Upsal to north house line of Franklin..........	16	1,760
Hunting Park avenue, from Cottage to Pulaski avenue....	12	1,665
Manheim street, from Green to Pulaski avenue.............	12	1,712
Pulaski avenue, from south side of Nicetown lane to 32 feet north of southeast house line of Seymour..........	12	5,375
Total..	....	10,512
Cross connections.		
Apsley street and Pulaski avenue................................	6	3
Hunting Park avenue and Cottage................................	6	5
Wayne street, southeast of Seymour............................	6	18
Total..	....	26
Fire hydrant connections..	6	875
Connections at Pumping Stations		
Chestnut Hill, connection to pump..............................	4 6 10	6 6 6
Mt. Airy, from Boiler House...	4	70
Mount Airy lane, from west end of 4-inch pipe, 13 feet north of north curb line of Allen's lane southwest to Chestnut Hill Railroad..	6	308
Connections at stations..	3	135
Total..	....	531

Street. Location.	Size in inches.	Distance in feet.
Drains.		
Alleghany avenue, northwest corner of Sixth	3	16
Cliveden street, west house line of Nash	6	4
Green street, northeast side, 36 feet north of Upsal	6	3
" " southwest side, 56 feet 6 inches northwest of Lincoln	6	11
Pulaski avenue, northeast side, 663 feet north of Hunting Park avenue	6	31
Pulaski avenue, northeast side, northeast side of Roberts avenue	6	23
Pulaski avenue, northeast side, 16 feet 6 inches south of Apsley	6	8
Pulaski avenue, southwest side, 58 feet 6 inches northwest of Bristol avenue	6	3
Total		99
Repairs, general	3	10
" "	4	26
" "	6	91
" "	10	42
" "	12	12
Total		181
Repairs, new stops put in.		
Hancock street, south side of High	6	3
Wayne street, south side of Walnut	3	
" " south side of Tulpehocken	6	
" " south side of Harvey	3	
Wissahickon avenue, northwest side of Hunting Park avenue	6	2
Total		5
Taken up.		
Manheim street, from 225 feet southwest of Green southwest	4	36
Manheim street, from 261 feet southwest of Green southwest	3	186
New street, from southwest side of Prospect avenue southwest	3	279
Prospect avenue, from 68 feet southeast of Evergreen	3	27
" " from 150 " " "	3	36
" " from 250 " " "	3	167
" " from 15 feet northwest of south house line of Evergreen northwest	4	29

Street. Location.	Size in inches.	Distance in feet.
Taken up—Continued.		
Queen street, from Green to Knox	4	1,006
Rex avenue, from Germantown avenue southwest	3	100
Summit street, from Springhouse pike northeast	4	1,131
Union avenue, from 45 feet northeast of prospect avenue northeast	4	270
Total		3,267
Relaid.		
Johnson street, from Germantown avenue to southwest house line of Adams	6	1,561
New street, from Prospect avenue to Springhouse pike	6	486
Prospect avenue, from Union avenue to 20 feet north of south house line of New	6	1,697
Queen street, from Green to Wayne	6	1,006
Rex avenue, from Germantown avenue to 60 feet southwest of Twenty-eighth	6	1,334
Summit street, from Spring House pike to 171 feet 8 inches northeast of northeast house line of Prospect avenue	6	1,634
Union avenue, from Stenton avenue southwest	6	270
Wayne street, from Walnut lane to near Tulpehocken	6	657
Total		8,445
Cut off and abandoned.		
Johnson street, from 4-inch dead end west	3	448
" " from Germantown avenue west	4	1,032
Manheim street, from 20 feet east of Green	4	245
New street, from Spring House pike east	3	202
Prospect avenue, from Evergreen to 20 feet north of New	4	1,446
Rex avenue, from 100 feet southwest of Germantown avenue southwest	3	1,234
Summit street, from Chestnut Hill avenue west	4	62
" " under Chestnut Hill Railroad	4	86
" " northeast of Chestnut Hill Railroad	4	347
Wayne street, from Tulpehocken to Walnut lane	3	654
Total		5,756

Recapitulation of Germantown District.

	Purposes for which used.	Size—Inches. 3	4	6	10	12	16	Total in feet and pounds.
New pipe, or feet added.	Supply pipe	12	85	22,460	11			22,568
	" mains					8,752	1,760	10,512
	Cross connections			26				26
	Fire hydrant connections			875				875
	Connections at stations	135	76	314	6			531
	Drains	16		83				99
	Total.... Feet	163	161	23,758	17	8,752	1,760	34,611
	Total.... Pounds	2,445	3,059	784,014	935	630,144	193,600	1,614,197
Pipe used, but adding nothing to feet in the ground.	Repairs, general	10	26	91	42	42		181
	" new stops put in			5				5
	Pipes taken up	795	2,472					3,267
	Relaid			8,445				8,445
	Cut off and abandoned	2,538	3,218					5,756
	Total.... Feet	3,343	5,716	8,541	42	12		17,654
	Total.... Pounds	50,145	108,604	281,853	2,310	864		443,776
Total handled...	Feet	3,506	5,877	32,299	59	8,764	1,760	52,265
	Pounds	52,590	111,663	1,065,867	3,245	631,008	193,600	2,057,973

Manayunk District,

Comprising the Twenty-first and part of the Twenty-eighth Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply Pipes.		
Cresson street, northeast side, from Fairview to Queen......	6	257
Fairview street, from Cresson northeast........................	6	12
Fountain street, from 450 feet southwest of Ridge avenue southwest..	6	456
Jefferson street, from Ridge avenue to Selig..................	6	1,018
Leverington street, from Mansion avenue northeast.........	6	203
Linden street, from Jefferson northwest........................	6	325
Mansion avenue, from Leverington to Ripka.................	6	303
Markle street, 124 feet northeast of Terrace, northeast 37 feet, then southeast 223 feet................................	6	260
Parker avenue, from 300 feet southwest of Ridge avenue southwest..	12	48
Ridge avenue, from Woodford to 136 feet north of Thirty-fifth..	12	3,171
Terrace street, from East to Markle............................	6	196
Terrace street, from 156 feet 8 inches northwest of Markle to Shur's lane..	6	291
Total..	....	6,540
Cross connections.		
Ridge avenue, at centre of Nicetown lane.....................	6	21
Fire-hydrant connections..	4	36
" "	6	139
Total..	....	175
Supply connections (private).		
Ridge avenue, 448 feet north of Scott's lane, for Dobson & Son..	4	24
Connections at Pumping Station.		
Roxborough	6	50
Repairs, general..	4	22
" "	6	22
Total..	....	44

Street.	Location.	Size in inches.	Distance in feet.
Relaid.			
Abbotsford avenue, over Pennsylvania Railroad bridge		4	122
Lowered.			
Leverington avenue, from Pechin to Mitchell		6	425
Leverington avenue, for plug connection		4	24
Monastery avenue, from east house line of Ridge avenue		6	250
Mitchell street, from Kram's avenue northwest		6	180
Total		....	879

Recapitulation of Manayunk District.

	Purposes for which used.		Size—Inches. 4	6	12	Totals in feet and pounds.
New pipe or feet added.	Supply pipes		....	3,321	3,219	6,540
	Cross connections		....	21	....	21
	Fire hydrant connections		36	139	....	175
	Supply connections (private)		24	....	....	24
	Connections at stations		....	50	....	50
	Total	feet	60	3,531	3,219	6,810
		pounds	1,140	116,523	231,768	349,431
Pipe used, but adding nothing to feet in the ground.	Repairs, general		22	22	....	44
	Relaid		122	....	....	122
	Lowered		24	855	....	879
	Total	feet	168	877	....	1,045
		pounds	3,192	28,941	....	32,133
	Total handled	feet	228	4,408	3,219	7,855
		pounds	4,332	145,464	231,768	381,564

RECAPITULATION BY DISTRICTS.

Districts.		Sizes—Inches.														Total.	
		1½	2	3	4	6	8	10	12	16	18	20	30	36	48	Feet.	Pounds.
New pipe or feet added.	First	....	....	....	19	16,562	....	....	507	....	....	7,065	....	....	....	24,153	1,706,746
	Second	....	....	....	100	11,039	....	....	6,884	572	....	6,425	....	10,939	....	35,959	6,562,588
	Third	....	....	....	100	14,110	....	564	....	....	....	....	....	....	....	14,774	498,550
	Fourth	....	....	....	129	17,796	4	413	92	160	....	1,436	930	496	204	21,660	1,502,562
	Germantown	....	....	163	161	23,758	....	17	8,752	1,760	....	....	....	....	....	34,611	1,614,197
	Manayunk	....	....	....	60	3,531	....	....	3,219	....	....	....	....	....	....	6,810	349,431
	Total.. feet	....	....	163	569	86,796	4	994	19,454	2,492	....	14,926	930	11,435	204	137,967	
	Total.. pounds	....	....	2,445	10,811	2,864,268	168	54,670	1,400,688	274,120	....	2,373,234	308,760	4,825,570	119,340	....	12,234,074
Pipe used, but adding nothing to feet in the ground.	First	....	....	7,152	2,729	10,797	19	3	....	....	....	....	....	....	....	20,700	516,395
	Second	348	60	14,798	5,951	23,628	27	1,710	1,373	575	....	101	410	344	....	49,325	1,672,436
	Third	....	....	....	174	1,015	3	100	250	....	....	....	....	....	....	1,542	60,427
	Fourth	....	....	1	98	1,898	4	9	2	252	19	148	478	572	36	3,517	540,370
	Germantown	....	....	3,343	5,716	8,541	....	42	12	....	....	....	....	....	....	17,654	443,776
	Manayunk	....	....	....	168	877	....	....	....	....	....	....	....	....	....	1,045	32,133
	Total.. feet	348	60	25,294	14,836	46,756	53	1,864	1,637	827	19	249	888	916	36	93,783	
	Total.. pounds	2,436	600	379,410	281,884	1,542,948	2,226	102,520	117,864	90,970	2,660	39,591	294,816	386,552	21,060	....	3,265,537
Total handled	feet	348	60	25,457	15,405	133,552	57	2,858	21,091	3,319	19	15,175	1,818	12,351	240	231,850	
	pounds	2,436	600	381,855	292,695	4,407,216	2,394	157,190	1,518,552	365,090	2,660	2,412,825	603,576	5,212,122	140,400	....	15,499,611

RECAPITULATION OF WORK ON THE WATER PIPES.

Purposes for which used.		Size—Inches. 1½	2	3	4	6	8	10	12	16	18	20	30	36	48	Total in feet and pounds.
New pipe, or feet added.	Supply pipe			12	85	81,970		610	10,528	572						93,777
	Supply mains								8,879	1,913		14,926	491	10,939		37,148
	Pumping mains							86					439	496	204	1,225
	Cross connections					185										185
	Fire hydrant connections				44	4,089										4,133
	Fire connections, private				104											104
	Supply connections, private				61	39			38							138
	Connections at stations			135	226	398	4	298	9	7						1,077
	Drains			16	49	115										180
	Total { feet			163	569	86,796	4	994	19,454	2,492		14,926	930	11,435	204	137,967
	Total { pounds			2,445	10,811	2,864,268	168	54,670	1,400,688	274,120		2,373,234	308,760	4,825,570	119,340	12,234,074
Pipe used, but adding nothing to feet in the ground.	Repairs, general			26	296	1,919	51	121	26	8	4	4				2,455
	Repairs, new stops put in				10	60	2	15				4				91
	Pipe relaid				122	39,779		1,728	1,361	575		25	468	85		44,143
	Fire hydrant connec., relaid					1,061										1,061
	Pipe taken up	348	60	22,694	11,079	1,541				172	15	90	334	731		37,064
	Pipe lowered				48	2,280			250			90				2,668
	Pipe raised											36	86	100	36	258
	Pipe cut off and abandoned			2,574	3,281											5,855
	Pipe shifted					116				72						188
	Total { feet	348	60	25,294	14,836	46,756	53	1,864	1,637	827	19	249	888	916	36	93,783
	Total { pounds	2,436	600	379,410	281,884	1,542,948	2,226	102,520	117,864	90,970	2,660	39,591	294,816	386,552	21,060	3,265,537
Total handled { feet		348	60	25,457	15,405	133,552	57	2,858	21,091	3,319	19	15,175	1,818	12,351	240	231,850
Total handled { pounds		2,436	600	381,855	292,695	4,407,216	2,394	157,190	1,518,552	365,090	2,660	2,412,825	603,576	5,212,122	140,400	15,499,611

NEW FIRE HYDRANTS SET IN 1885.

First District.

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Annin street, north side, 158 feet 7 inches east of east house line of Twenty-first	26	6		7 ft. 2 in.		1		
Broad street, east side, 5 feet north of north house line of Washington avenue	2	10		5 ft.		1		
Chadwick street, west side, 95 feet 9 inches south of south house line of Tasker	26	6		7 ft.		1		
Cymro street, east side, 14 feet south of south house line of Dickinson	26	6		7 ft. 6 in.		1		
Daly street, south side, 182 feet 7 inches west of west house line of Seventh	1	6		7 ft. 6 in.		1		
Dickinson street, north side, 63 feet 6 inches east of east house line of Seventeenth	26	6		11 ft.		1		
Doneganna street, north side, 7 feet 6 inches east of east house line of Sixteenth	26	6		7 ft. 10 in.		1		
Dove street, south side, 115 feet 6 inches east of Fourth	2	6		6 ft. 7 in.		1		
Eighth street, east side, 5 feet south of south house line of Jackson	1	6		13 ft.		1		
Eighth street, east side, 9 feet 4 inches south of south house line of Wolf	1	6		13 ft.		1		
Eleventh street, east side, 10 feet 5 inches north of Mountain	1	6		11 ft.		1		
Federal street, north side, 14 feet 6 inches east of east house line of Broad	26	6		13 ft. 6 in.		1		
Fernon street, south side, 111 feet east of east house line of Twentieth	26	6		8 ft. 10 in.		1		
Gray's Ferry road, southeast side, 16 feet northeast of northeast house line of Catharine	30	20		5 ft. 6 in.		1		
Gray's Ferry road, southeast side, 38 feet 7 inches southeast of Twenty-fifth	30	20		3 ft. 10 in.		1		

New Fire Hydrants—First District—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Gray's Ferry road, southeast side, 27 feet northeast of Washington avenue	30	20	....	3 ft.	....	1		
Gray's Ferry road, south side, 9 feet west of west house line of Twenty-eighth	26	20	....	7 ft. 5 in.	....	1		
Gray's Ferry road, south side, 18 feet west of west house line of Thirtieth	26	20	....	6 ft, 8 in.	....	1		
Gray's Ferry road, south side, 13 feet east of east house line of Patton	26	20	....	13 ft.	....	1		
Gray's Ferry road, south side, 11 feet west of west house line of Thirty-third	26	20	....	4 ft. 6 in.	....	1		
Gray's Ferry road, south side, 23 feet east of east house line of Thirty-fifth	26	20	....	4 ft. 6 in.	....	1		
Gray's Ferry road, north side, 18 feet 6 inches east of east house line of Thirty-sixth	26	20	....	18 ft. 8 in.	....	1		
Hicks street, east side, 92 feet 7 inches south of south house line of Mifflin	26	6	....	6 ft. 10 in.	....	1		
Jackson street, north side, 122 feet west of west house line of Thirteenth	1	6	....	17 ft.	....	1		
Lambert street, west side, 14 feet south of south house line of Dickinson	26	6	....	7 ft.	....	1		
Long lane, southeast side, 207 feet southwest of Tasker	26	6	....	9 ft. 6 in.	....	1		
Long lane, southeast side, 130 feet northeast of Moore	26	6	....	9 ft. 6 in.	....	1		
Long lane, southeast side, 75 feet northeast of Mifflin	26	6	....	9 ft.	....	1		
Long lane, southeast side, 183 feet southwest of Mifflin	26	6	....	5 ft.	....	1		
Long lane, southeast side, corner southwest of McKean	26	6	....	14 ft.	....	1		
Manton street, south side, 71 feet east of east house line of Twenty-second	26	6	....	10 ft. 6 in.	....	1		

NEW FIRE HYDRANTS—FIRST DISTRICT—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Mifflin street, north side, 170 feet west of west house line of Long lane	26	6	....	37 ft.	....	1		
Mifflin street, south side, 50 feet west of west house line of Long lane	26	6	....	3 ft.	....	1		
Mountain street, south side, 86 feet 3 inches east of east house line of Twentieth	26	6	....	8 ft. 10 in.	....	1		
Oakford street, north side, 71 feet east of east house line of Twenty-second	26	6	....	13 ft.	....	1		
Sidmouth street, west side, opposite centre of Wyatt	2	4	8	....	1			
Seibold street, west side, 299 feet south of south house line of Jackson	26	6	....	7 ft. 10 in.	....	1		
Seventh street, east side, 10 feet north of Paul	2	6	....	12 ft. 6 in.	....	1		
Siegel street, north side, 149 feet 6 inches west of west house line of Ninth	1	6	....	7 ft. 6 in.	....	1		
Sober street, west side, 14 feet south of south house line of Dickinson	26	6	....	8 ft.	....	1		
South street, south side, 57 feet east of Gray's Ferry road	30	20	....	3 ft. 8 in.	....	1		
Stowe street, south side, 14 feet west of west house line of Long lane	26	6	....	7 ft. 6 in.	....	....	1	
Tasker street, south side, 132 feet 8 inches east of east house line of Nineteenth	26	6	....	13 ft.	....	1		
Tree street, south side, 182 feet 6 inches west of Seventh	1	6	....	7 ft. 6 in.	....	1		
Twentieth street, east side, 14 feet south of south house line of Tasker	26	6	....	13 ft. 10 in.	....	1		
Twentieth street, east side, 15 feet south of south house line of Dickinson	26	6	....	13 ft.	....	1		
Twenty-second street, west side, 15 feet north of north curb line of Oakford	26	12	....	13 ft.	....	1		

New Fire Hydrants—First District—*Continued.*

Street.	Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Webster street,	north side, 110 feet west of west house line of Twenty-first	30	4	....	7 ft.	1			
Wheat street,	east side, 42 feet 4 inches south of south house line of Wharton	1	6	....	4 ft. 5 in.	....	1		
Winton street,	north side, 183 feet 6 inches west of west house line of Eighth	1	6	....	6 ft. 3 in.	....	....	1	
Woodstock street,	west side, 14 feet south of south house line of Dickinson	26	6	....	7 ft. 10 in.	....	1		
Totals		......	....	8	472 ft.	2	47	2	

New Fire Hydrants Set in 1885—Continued.

Second District.

Street.	Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Arch street,	northwest corner of Delaware avenue	6	6	....	4 ft. 6 in.	....	1		
Arch street,	north side, west house line of Front	6	8	....	19 ft. 8 in.	....	1		
Arch street,	south side, 5 feet west of west house line of Chancery	6	6	....	22 ft. 6 in.	....	1		
Arch street,	north side, east house line of Second	6	8	....	16 ft. 2 in.	....	1		
Arch street,	south side, 36 feet west of west house line of Third	6	30	....	10 ft.	....	1		
Arch street,	southeast corner of Fourth	6	30	....	11 ft.	....	1		
Arch street,	southeast corner of Fifth	6	30	....	10 ft.	....	1		
Arch street,	southeast corner of Sixth	6	30	....	11 ft.	....	1		
Arch street,	southeast corner of Seventh	6	30	....	10 ft.	....	1		
Arch street,	southeast corner of Eighth	9	30	....	6 ft. 1 in.	....	1		
Arch street,	southwest corner of Ninth	9	30	....	11 ft. 8 in.	....	1		
Broad street,	west side, north house line of Arch	10	20	....	12 ft. 3 in.	....	....	....	1
Broad street,	west side, north house line of Arch	10	20	....	18 ft. 4 in.	....	....	....	1
Broad street,	west side, 252 feet south of south house line of Vine	10	20	....	32 ft. 6 in.	....	....	....	1
Broad street,	east side, 252 feet south of south house line of Vine	10	20	....	32 ft. 6 in.	....	....	....	1

NEW FIRE HYDRANTS—SECOND DISTRICT—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 4.
Broad street, west side, 4 feet south of south house line of Race	10	20	....	16 ft.	....	....	....	1
Broad street, west side, north house line of Cherry	10	20	....	16 ft.	....	....	....	1
Broad street, east side, 4 feet south of south house line of Race	10	20	....	54 ft.	....	....	....	1
Broad street, east side, 3 feet south of south house line of Cherry	10	20	....	54 ft.	....	....	....	1
Branch street, north side, 74 feet east of east house line of Fourth	6	6	....	13 ft. 6 in.	....	1		
Cherry street, north side, 165 feet 7 inches west of west house line of Eighteenth	10	6	....	10 ft.	1			
Chestnut street, northwest corner of Delaware avenue	6	6	....	3 ft. 4 in.	....	1		
Chestnut street, south side, 6 feet east of east house line of Second	5	10	....	7 ft.	....	....	1	
Chestnut street, northwest corner of Second	6	10	....	9 ft.	....	....	1	
Chestnut street, south side, 3 feet 6 inches west of west house line of Front	5	10	....	3 ft. 2 in.	....	1		
Chestnut street, northwest corner of Seventeenth	9	16	....	15 ft. 6 in.	....	....	1	
Chestnut street, northwest corner of Eighteenth	9	16	....	15 ft. 6 in.	....	....	1	
Dock street, north side, west of Delaware avenue	5	6	....	6 ft.	....	1		
Dyson street, east side, 155 feet 6 inches north of north house line of Brown	24	6	....	6 ft. 6 in.	1			
Fairmount avenue, south side, west house line of Thirty-third	24	6	....	16 ft. 10 in.	....	1		
Fifty-second street, east side, 5 feet 6 inches north of north house line of Walnut	27	36	....	6 ft.	....	....	....	1

NEW FIRE HYDRANTS—SECOND DISTRICT—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Fifty-second street, east side, north house line of Chestnut	27	36	....	6 ft.	....	....	....	1
Fifty-second street, east side, 3 feet 6 inches south of south house line of Market	27	36	....	6 ft.	....	....	....	1
Fifty-second street, west side, 61 feet south of Columbia avenue	24	36	....	8 ft.	....	....	....	1
Fifty-second street, west side, 68 feet north of Paschal	24	36	....	21 ft.	....	1		
Fifty-second street, east side, 3 feet north of Girard avenue	24	36	....	11 ft.	....	1		
Fifty-second street, west side, 159 feet north of Lancaster avenue	24	36	....	7 ft.	....	....	....	1
Fourth street, east side, 5 feet south of south house line of Chestnut	5	16	....	6 ft. 10 in.	....	....	1	
Fourth street, west side, north house line of Ranstead	6	16	....	5 ft. 12 in.	....	1		
Fourth street, west side, south house line of Cherry.	6	6	....	9 ft. 10 in.	....	1		
Fourth street, west side, south house line of Race	6	6	....	21 ft. 6 in.	....	....	....	1
Front street, northwest corner of Church.	6	6	....	12 ft. 5 in.	....	1		
Front street, southwest corner of Black Horse alley	6	6	....	5 ft. 7 in.	....	1		
Greenway avenue, south side, 221 feet east of east house line of Seventy-second	27	6	....	23 ft.	....	....	....	1
Greenway avenue, north side, 3 feet east of east house line of Seventy-second	27	6	....	23 ft.	....	....	....	1
Gaskill street, north side, 172 feet 8 inches west of Third	5	6	....	12 ft.	....	1		
Gaskill street, north side, 232 feet 5 inches west of Fourth	5	6	....	12 ft.	....	1		

New Fire Hydrants—Second District—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Gaskill street, southeast corner of Barron	5	6	....	10 ft.	....	1		
Haverford avenue, north side, 1 foot west of west house line of Thirty-first	24	6	....	17 ft. 6 in.	....	1		
Haverford avenue, north side, 5 feet west of west house line of Ludwig	24	6	....	22 ft. 6 in.	....	1		
Lancaster avenue, northwest corner of Kershaw	24	20	....	11 ft. 6 in.	....	....	1	
Lancaster avenue, north side, 73 feet east of east house line of Fifty-second	24	20	....	9 ft.	....	....	1	
Locust street, north side, 225 feet west of Fourth	5	10	....	11 ft.	....	1		
Locust street, north side, 216 feet west of Fifth	5	10	....	10 ft.	....	1		
Lombard street, south side, 102 feet west of Sixtieth	24	6	....	16 ft	1			
Market street, north side, 11 feet 6 inches west of west house line of Delaware avenue	6	6	....	4 ft. 4 in.	....	1		
Market street, northeast corner of Front	6	6	....	9 ft.	....	1		
Market street, southeast corner of Front	6	6	....	10 ft.	....	1		
Market street, south side, 5 feet east of east curb line of Letitia	6	6	...	10 ft.	....	1		
Market street, southeast corner of Strawberry	6	6	....	7 ft. 3 in.	....	1		
Market street, southeast corner of Second	6	6	....	11 ft.	....	....	....	1
Market street, southeast corner of Third	6	6	....	15 ft.	....	....	....	1
Market street, northwest corner of Fifth	6	6	....	14 ft.	....	1		

New Fire Hydrants—Second District—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Market street, southwest corner of Fifth	6	6	....	8 ft.	....	1		
Market street, north side, 7 feet east of east house line of Sixth	6	6	....	7 ft. 7 in.	....	1		
Market street, southwest corner of Sixth	6	6	....	8 ft.	....	1		
Market street, south side, 3 feet east of east house line of Seventh	6	6	....	8 ft.	....	1		
Market street, north side, 12 feet west of Seventh	9	6	....	12 ft.	....	1		
Market street, southwest corner of Eighth	9	6	....	9 ft.	....	1		
Market street, southwest corner of Ninth	9	6	....	10 ft. 3 in.	....	....	1	
Market street, northeast corner of Ninth	9	6	....	9 ft.	....	1		
Ninth street, west side, 21 feet north of Chestnut	9	6	....	15 ft. 9 in.	....	1		
Ninth street, west side, 10 feet north of north curb line of Vine	13	12	....	17 ft. 1 in.	....	1		
Orion street, west side, 202 feet north of north house line of Fairmount avenue	24	6	....	8 ft.	1			
Powelton avenue, north side, 383 feet west of west house line of Forty-second	24	6	....	10 ft. 4 in.	1			
Pine street, southeast corner of Front	5	6	....	15 ft.	....	1		
Pine street, northwest corner of Second	5	6	....	14 ft.	....	1		
Pine street, northeast corner of Third	5	6	....	15 ft.	....	1		
Pine street, southeast corner of Fourth	5	6	....	20 ft.	....	1		

NEW FIRE HYDRANTS—SECOND DISTRICT—*Continued.*

Street.	Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Pine street,	southwest corner of Fifth	5	6	....	16 ft.	....	1		
Pine street,	northwest corner of Sixth	5	6	....	18 ft.	....	1		
Pine street,	northeast corner of Seventh	7	6	....	20 ft.	....	1		
Pine street,	northeast corner of Eighth	7	6	....	19 ft.	....	1		
Pine street,	northwest corner of Ninth	7	6	....	15 ft.	....	1		
Race street,	southwest corner of Delaware avenue	6	6	....	8 ft. 4 in.	....	....	....	1
Race street,	north side, 11 feet west of west house line of Front	6	6	....	13 ft. 5 in.	....	....	....	1
Race street,	north side, east house line of Second	6	6	....	22 ft. 6 in.	....	....	....	1
Race street,	northeast corner of Third	6	6	....	14 ft.	....	....	....	1
Race street,	southwest corner of Fifth	6	10	....	15 ft.	....	....	....	1
Race street,	north side, 2 feet west of west house line of Sixth	6	6	....	15 ft. 9 in.	....	....	....	1
Race street,	north side, 7 feet east of east house line of Seventh	6	6	....	13 ft.	....	....	....	1
Race street,	southeast corner of Eighth	10	6	....	17 ft. 4 in.	....	....	....	1
Race street,	north side, 2 feet west of west house line of Ninth	10	6	....	13 ft.	....	....	....	1
Sansom street,	south side, 2 feet east of east house line of Seventh	5	6	....	10 ft. 6 in.	....	1		
Second street,	southwest corner of Trotter's alley	6	6	....	6 ft. 3 in.	....	1		

NEW FIRE HYDRANTS—SECOND DISTRICT—*Continued.*

Street.	Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Seventy-first street	east side, 12 feet south of Lloyd	27	6	....	18 ft.	1			
Seventy-first street	west side, 22 feet south of south house line of Greenway avenue	27	6	....	18 ft.	1			
Seventy-first street	east side, 72 feet 6 inches north of north house line of Greenway avenue	27	6	....	18 ft.	1			
Sixth street	east side, 239 feet south of south house line of Chestnut	5	6	....	14 ft.	....	1		
South street	south side, 32 feet 4 inches east of Second	5	10	....	5 ft.	....	1		
Spruce street	southwest corner of Delaware avenue	5	6	....	7 ft.	....	1		
Spruce street	southeast corner of Front	5	6	....	16 ft.	....	1		
Spruce street	northeast corner of Second	5	6	....	14 ft.	....	1		
Spruce street	north side, 6 feet east of east house line of Third	5	10	....	10 ft.	....	1		
Spruce street	northeast corner of Fourth	5	10	....	12 ft.	....	1		
Spruce street	northwest corner of Fifth	5	10	....	10 ft. 7 in.	....	1		
Spruce street	northwest corner of Sixth	5	10	....	14 ft. 4 in.	....	1		
Spruce street	northeast corner of Seventh	5	10	....	12 ft. 9 in.	....	1		
Spruce street	northwest corner of Eighth	8	10	....	12 ft. 10 in.	....	1		
Spruce street	northeast corner of Ninth	8	12	....	11 ft. 2 in.	....	1		
Summer street	north side, east house line of Keffer	24	6	....	8 ft.	....	....	....	1

New Fire Hydrants—Second District—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Third street, northeast corner of Church	6	6	....	9 ft. 7 in.	....	1		
Thirtieth street, west side, 1,584 feet north of north house line of Market	24	6	....	21 ft.	1			
Thirtieth street, west side, 843 feet south of south curb line of Spring Garden	24	6	....	21 ft.	1			
Thirtieth street, west side, south curb line of Spring Garden	24	6	....	22 ft.	1			
Vine street, southwest corner of Delaware avenue	6	6	....	5 ft.	....	....	....	1
Vine street, north side, 17 feet 6 inches west of west house line of Front	11	10	....	13 ft. 4 in.	....	....	....	1
Vine street, northwest corner of Second	11	10	....	11 ft. 7 in.	....	1		
Vine street, southeast corner of Third	6	10	....	15 ft.	....	1		
Vine street, northwest corner of Fourth	12	10	....	13 ft.	....	1		
Vine street, northwest corner of Crown	12	10	....	13 ft.	....	1		
Vine street, northwest corner of Fifth	12	12	....	13 ft.	....	1		
Vine street, northwest corner of Sixth	13	12	....	12 ft.	....	....	1	
Vine street, northeast corner of Franklin	13	12	....	9 ft.	....	1		
Vine street, northeast corner of Eighth	13	12	....	9 ft. 2 in.	....	1		
Walnut street, southeast corner of Second	5	12	....	11 ft.	....	....	....	1
Walnut street, southeast corner of Third	5	12	....	9 ft.	....	....	....	1
Walnut street, northwest corner of Fifth	5	12	....	16 ft.	....	....	....	1

New Fire Hydrants—Second District—*Continued.*

Street.	Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Walnut street,	south side, 1 foot west of west house line of Sixth	5	12		9 ft.				1
Walnut street,	south side, 2 feet 6 inches west of centre of Seventh	5	12		9 ft.				1
Walnut street,	south side, east house line of Duponceau	8	12		7 ft. 6 in.				1
Walnut street,	south side, 3 feet west of west house line of Ninth	8	12		6 ft. 6 in.				1
Walnut street,	south side, 7 feet 6 inches west of west house line of Tenth	8	12		9 ft.				1
Walnut street,	south side, 3 feet west of west house line of Eleventh	8	12		9 ft.				1
Walnut street,	north side, 4 feet 6 inches east of east house line of Twelfth	8	12		17 ft.				1
Walnut street,	southwest corner of Fifteenth	8	12		4 ft. 6 in.		1		
Walnut street,	southeast corner of Sixteenth	8	12		10 ft. 6 in.		1		
Walnut street,	southwest corner of Seventeenth	8	12		10 ft.		1		
Walnut street,	southwest corner of Eighteenth	8	12		8 ft.		1		
Walnut street,	southeast corner of Nineteenth	8	12		8 ft.		1		
Walnut street,	south side, west house line of Twentieth	8	12		12 ft.		1		
Walnut street,	southwest corner of Twenty-first	8	12		12 ft.		1		
Wyalusing avenue,	south side, 62 feet 6 inches east of east house line of Fifty-fifth	24	6		20 ft. 2 in.		1		
Wyalusing avenue,	south side, 14 feet 8 inches east of east house line of Fifty-fourth	24	6		21 ft. 6 in.		1		
Total					1,882 ft.	11	84	9	40

New Fire Hydrants Set in 1885—Continued.

THIRD DISTRICT.

Street.	Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Amber street	east side, 500 feet north of Westmoreland	25	6	....	14 ft. 4 in.	....	1		
Belgrade street	northeast corner of Earl	18	6	....	14 ft.	....	1		
Cambria street	north side, 7 feet 7 inches west of Leithgow	25	6	....	14 ft.	1			
Cambria street	north side, southwest corner of American	25	6	....	14 ft.	....	1		
Cherry street	southeast corner of New	23	6	....	16 ft. 6 in.	....	1		
Clifton street	southeast side, 233 feet southwest of Neff	25	6	....	7 ft.	....	1		
Coral street	southeast side, 533 feet southwest of Wheat Sheaf lane	25	6	....	14 ft. 6 in.	....	1		
Darien street	east side, 124 feet north of north house line of Lehigh avenue	25	6	....	8 ft.	1			
Eighth street	east side, 188 feet north of Huntingdon	19	6	....	14 ft. 6 in.	1			
Fairhill street	west side, 116 feet south of south house line of Clearfield	25	6	....	14 ft. 3 in.	1			
Fourth street	east side, 265 feet north of north house line of Cambria	25	6	....	14 ft. 9 in.	1			
Fourth street	west side, 119 feet north of north house line of Somerset	25	6	....	14 ft.	1			
Franklin street	southeast side, 122 feet southwest of southwest house line of Unity	23	6	....	14 ft. 10 in.	1			
Franklin street	west side, 159 feet south of Lehigh avenue	19	6	....	12 ft.	....	1		
Hope street	east side, 174 feet north of north house line of Cambria	25	6	....	8 ft. 6 in.	1			

New Fire Hydrants—Third District—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection 4 in.	Connection 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Indiana avenue, northeast corner of Leithgow	25	6		17 ft. 4 in.		1		
Lawrence street, west side, 50 feet south of south house line of Indiana avenue	25	6		14 ft. 6 in.	1			
Marshall street, west side, 18 feet south of Erie avenue	25	6		14 ft. 3 in.	1			
Ninth street, west side, 14 feet north of north house line of Cumberland	19	6		14 ft. 3 in.		1		
Orkney street, east side, 184 feet south of south house line of Indiana avenue	25	6		8 ft.	1			
Otis street, southwest side, 3 feet 3 inches southeast of east house line of Front	31	6		16 ft. 9 in.		1		
Oxford street, southwest corner of Worth	23	6		14 ft.			1	
Seventh street, east side, 304 feet north of Venango	25	6		15 ft.		1		
Tioga street, north side, 2 feet east of west house line of Waterloo	25	6		27 ft.		1		
Turner street, west side, 258 feet south of south house line of Venango	25	6		14 ft.		1		
Turner street, east side, 242 feet north of north house line of Erie avenue	25	6		14 ft. 6 in.			1	
Wellington street, south side, 2 feet east of east house line of Fisher	25	6		6 ft. 3 in.	1			
Total				371 ft.	12	13	2	

New Fire Hydrants Set in 1885—Continued.

Fourth District.

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Croskey street, east side, 164 feet south of Diamond	28	6	....	13 ft.	....	1		
Dakota street, south side, 172 feet west of west house line of Thirtieth	28	6	....	12 ft.	1			
Dakota street, south side, 36 feet east of Duhring	28	6	....	12 ft.	1			
Maud street, north side, 180 feet east of Twenty-eighth	29	6	....	10 ft.	1			
Norris street, north side, 176 feet east of east house line of Twenty-fourth	28	6	....	19 ft.	....	1		
Norris street, southeast corner of Eighth	20	6	....	20 ft.	....	1		
Pennock street, west side, 42 feet south of Swain	15	6	....	10 ft.	1			
Pennock street, west side, 290 feet south of Parrish	15	6	....	12 ft.	....	1		
Pennock street, southeast corner of Poplar	15	6	....	18 ft.	....	1		
Poplar street, south side, 123 feet west of Thirtieth	15	6	....	16 ft.	....	1		
Potts street, south side, east house line of Ridge avenue	14	6	....	4 ft.	....	1		
Ridge avenue, 53 feet northwest of South College avenue	29	6	....	4 ft.	....	....	....	1
Ringgold street, east side, 196 feet south of south house line of Poplar	15	6	....	10 ft.	....	1		
Seybert street, north side, 100 feet east of Eighteenth	29	6	....	8 ft.	....	1		
Sixteenth street, east side, 205 feet north of north house line of York	28	6	....	13 ft.	....	1		

New Fire Hydrants—Fourth District—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Taylor street, east side, 58 feet south of Berks	28	6	....	7 ft.	....	1		
Thirty-first street, southeast corner of Jefferson	29	6	....	13 ft.	....	1		
Thirty-first street, east side, south house line of Master	29	6	....	11 ft.	....	1		
Twelfth street, east side, 250 feet south of Master	20	6	....	14 ft.	....	1		
Twenty-fifth street, east side, 177 feet north of Brown	15	6	....	13 ft.	....	1		
Twenty-fifth street, east side, 132 feet south of Poplar	15	6	....	15 ft.	....	1		
Twenty-fourth street, east side, 168 feet north of Berks	28	6	....	13 ft.	....	1		
Twenty-third street, northwest corner of Gold	15	6	....	16 ft.	....	1		
Uber street, east side, south house line of Berks	28	6	....	11 ft.	....	1		
West College avenue, east side, 55 feet north of Brown	15	6	....	9 ft.	....	1		
York street, southwest corner of Twenty-fifth	28	6	....	22 ft.	....	1		
Total	....	....	....	350 ft.	4	21	....	1

New Fire Hydrants Set in 1885—Continued.

GERMANTOWN DISTRICT.

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Baynton street, southwest side, 42 feet northwest of Wisteria avenue	22	6	....	12 ft.	....	1		
Boyer street, southwest side, 455 feet northwest of Mt. Airy avenue	22	6	....	14 ft.	....	1		
Bruner street, east side, 14 feet northeast of Wayne	28	6	....	10 ft.	1			
Chelten avenue, east side, 13 feet northeast of Cedar	22	6	....	24 ft.	....	1		
Chelten avenue, northwest side, 462 feet southwest of Chew	22	6	....	24 ft.	....	1		
Chelten avenue, northwest side, 144 feet southwest of Boyer	22	6	....	22 ft.	....	1		
Chew street, southwest side. 148 feet southeast of Locust	22	6	....	18 ft.	....	1		
Chew street, northeast side, 200 feet southeast of Haines	22	6	....	25 ft.	....	1		
Coulter street, southeast side, 211 feet northeast of Germantown avenue	22	6	....	12 ft.	....	1		
Clivedon street, south side, 337 feet northeast of Germantown avenue	22	6	....	16 ft. 3 in.	1			
Clivedon street, northwest side, 195 feet northeast of Morton	22	6	....	14 ft.	....	....	1	
Fifteenth street, east side, 269 feet south of Venango	28	6	....	13 ft.	....	1		
Fifteenth street, west side, corner of Venango	28	6	....	13 ft.	1			
Gorgas lane, southeast side, 127 feet northeast of Musgrove	22	6	....	12 ft.	....	1		
Gorgas lane, southeast side, 13 feet southwest of Chew	22	6	....	12 ft.	....	1		
Green street, northeast side, 256 feet northwest of Franklin	22	16	....	12 ft.	....	1		

NEW FIRE HYDRANTS—GERMANTOWN DISTRICT—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New. No. 4.	Style. New, No. 5.
Green street, northeast side, 40 feet south of Upsal	22	16	....	4 ft.				
Green street, northeast side, 20 feet 6 inches south of Lincoln avenue	22	16	....	4 ft. 6 in.				
Haines street, southeast side, 694 feet northeast of Cedar lane	22	6	....	13 ft.	....	1		
Haines street, southeast side, 17 feet southwest of Chew	22	6	....	13 ft.	....	1		
Hunting Park avenue, northwest side, 26 feet southwest of Logan	28	12	....	9 ft. 9 in.	....	1		
Hunting Park avenue, northwest side, 296 feet southwest of Nineteenth	28	12	....	9 ft.	....	1		
Johnson street, northwest side, 500 feet southwest of Germantown avenue	22	6	....	14 ft.	....	1		
Johnson street, southeast side, 14 feet southwest of Jefferson	22	6	....	14 ft.	....	1		
Johnson street, northwest side, 11 feet northeast of Adams	22	6	....	14 ft.	....	1		
Mt. Airy avenue, northwest side, 338 feet southwest of Sullivan	22	6	....	9 ft.	1			
Mt. Airy avenue, northwest side, 13 feet southwest of Sullivan	22	6	....	9 ft.				
Mt. Pleasant avenue, northwest side, 975 feet northeast of Cresheim	22	6	....	12 ft.	1			
Mt. Pleasant avenue, southeast side, 500 feet northeast of Cresheim	22	6	....	14 ft.	1			
Mt. Pleasant avenue, northwest side, 39 feet northeast of Cresheim	22	6	....	12 ft.	1			
Mt. Pleasant avenue, southeast side, 21 feet northeast of Quincy	22	6	....	14 ft.	....	1		
Mt. Pleasant avenue, northwest side, 232 feet southwest of Quincy	22	6	....	14 ft.	....	1		
Mt. Pleasant avenue, southeast side, 183 feet southwest of Emlen	22	6	....	14 ft.	....	1		

NEW FIRE HYDRANTS—GERMANTOWN DISTRICT—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Mt. Pleasant avenue, northwest side, 111 feet southwest of Jefferson	22	6	....	12 ft.	....	1		
Manheim street, northwest side, 487 feet southwest of Green	22	12	....	8 ft.	....	1		
Mechanic street, southeast side, 350 feet northeast of Morton	22	6	....	11 ft.	....	1		
Mechlin street, northwest side, 12 feet northeast of Germantown avenue	22	6	....	13 ft.	....	1		
Mechlin street, southeast side, 491 feet northeast of Germantown avenue	22	6	....	13 ft.	....	1		
Mechlin street, southeast side, 62 feet southwest of Wakefield	22	6	....	13 ft.	1			
Morris street, northeast side, 143 feet 4 inches southeast of Bexley	22	6	....	16 ft.	1			
New street, southeast side, 220 feet west of Prospect	22	6	....	12 ft.	....	1		
Pulaski street, northeast side, 11 feet northwest of Hunting Park avenue	28	12	....	24 ft. 6 in.	....	1		
Pulaski street, southwest side, 229 feet 6 inches southeast of northwest house line of Bristol	28	12	....	15 ft. 6 in.	....	1		
Pulaski street, southwest side, 27 feet southeast of Berkley	22	12	....	11 ft.	....	1		
Pulaski street, southwest side, 16 feet southeast of Logan	22	12	....	12 ft.	....	1		
Pulaski street, southwest side, 13 feet northwest of Seymour	22	12	....	11 ft.	....	1		
Pulaski street, southwest side, 14 feet 6 inches southeast of Manheim	22	12	....	11 ft.	....	1		
Prospect street, southwest side, 170 feet north of Evergreen	22	6	....	6 ft.	....	....	1	
Prospect street, southwest side, 345 feet south of New	22	6	....	12 ft.	....	1		
Rex street, southeast side, 130 feet northeast of Twenty-seventh	22	6	....	10 ft.	....	1		

NEW FIRE HYDRANTS—GERMANTOWN DISTRICT—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Rex street, southeast side, 316 feet southwest of Twenty-seventh	22	6		10 ft.		1		
Ruscomb street, south side, 10 feet west of Philadelphia and Germantown Railroad	22	6		18 ft.	1			
Sixteenth street, west side, 220 feet north of Bristol	22	6		11 ft.		1		
Smedley street, west side, 255 feet north of Venango	28	6		8 ft. 6 in.		1		
Sprague street, northeast side, 416 feet south of south house line of Mount Airy avenue	22	6		14 ft. 3 in.			1	
Summit street, northwest side, 455 feet northeast of Spring House pike	22	6		10 ft.		1		
Summit street, northwest side, 94 feet southwest of Chestnut avenue	22	6		9 ft.		1		
Twenty-seventh street, southeast corner of Southampton	22	6		15 ft.			1	
Upsal street, southeast side, 16 feet southwest of Morton	22	6		17 ft.	1			
Upsal street, southeast side, 37 feet 8 inches southwest of Nash	22	6		17 ft.	1			
Wayne street, southwest side, 342 feet 6 inches northwest of Walnut lane	22	6		25 ft. 3 in.	1			
Wayne street, northeast side, 32 feet 6 inches northwest of West Logan	22	6		16 ft. 6 in.	1			
West View street, southeast side, 284 feet southwest of Germantown avenue	22	6		12 ft.			1	
West View street, southeast side, southwest of Germantown avenue	22	6		14 ft.			1	
Wisteria street, northwest side, 148 feet southwest of Miller	22	6		13 ft.	1			
Wissahickon avenue, southwest side, 7 feet northwest of Queen	22	6		11 ft.			1	
Total				875 ft.	15	41	7	

New Fire Hydrants Set in 1885—Continued.

Manayunk District.

Street. Location.	Ward.	Size of Main in inches.	Connection. 4 in.	Connection. 6 in.	Style. Old.	Style. New, No. 3.	Style. New, No. 4.	Style. New, No. 5.
Fifty-one feet northwest of Roxborough station	21	4	9 ft.	....	1			
Fountain street, northwest side, 857 feet southwest of Ridge avenue	21	6	....	12 ft.	1			
Jefferson street, southeast side, 205 feet southwest of Shalkop	21	6	....	14 ft.	....	1		
Jefferson street, northwest side, 110 feet 3 inches northwest of Shalkop	21	6	....	14 ft.	....	1		
Jefferson street, southeast side, 13 feet 9 inches southwest of Selig	21	6	....	14 ft.	....	1		
Leverington avenue, northwest side, 172 feet northeast of Mansion	21	6	10 ft.					
Linden street, east side, 300 feet north of Jefferson	21	6	....	9 ft.	1			
Mitchell street, southwest side, 12 feet northwest of Roxborough avenue	21	6	....	13 ft.	1			
Mansion street, southwest side, 135 feet 6 inches northwest of Leverington avenue	21	6	....	14 ft.	1			
Markle street, northwest side, 221 feet northeast of Terrace	21	6	....	14 ft.	1			
Parker street, northwest side, 325 feet southwest of Ridge avenue	21	12	....	14 ft.	....	1		
Ridge avenue, southwest side, 542 feet northwest of Hunting Park avenue	28	12	....	7 ft.	1			
Ridge avenue, southwest side, 524 feet northwest of Woodford	28	12	17 ft.	....	1			
Terrace street, west side, 182 feet northwest of Markle	21	6	....	14 ft.	1			
Total	....	....	36 ft.	139 ft.	9	4		

FIRE HYDRANTS RENEWED.

First District.

Street. Location.	Ward.	Size of Main in inches.	Connection. 6 in.	Style. Old, removed.	Replaced by New, No. 3.	Replaced by New, No. 4.	Replaced by New, No. 5.
Alaska street, south side, 9 feet east of east house line of Sixth	4	6	9 ft.	1	1		
Alaska street, north side, east of east house line of Seventh	4	6	9 ft.	1	1		
Annapolis street, west side, 63 feet north of north house line of Bainbridge	4	6	13 ft. 6 in.	1	1		
Bainbridge street, south side (in market), 93 ft. 8 in. east of east house line of Passyunk ave.	4	6	9 ft.	1	1		
Bainbridge street, south side (in market), 146 feet west of west house line of Third	4	6	9 ft.	1	1		
Baker street, north side, 131 feet east of east house line of Seventh	4	6	6 ft. 7 in.	1	1		
Broad street, east side, 194 feet south of Federal	26	6	2 ft. 6 in.	1	1		
Charles street, west side, 93 feet 6 inches north of north house line of Bainbridge	4	6	8 ft.	1	1		
Charles street, east side, 46 feet 7 inches north of north house line of Monroe	4	6	7 ft.	1	1		
Carpenter street, north side, 131 feet east of east house line of Second	2	6	8 ft.	1	1		
Carpenter street, north side, 121 feet west of west house line of Sixth	2	6	15 ft. 5 in.	1	1		
Concord street, north side, 150 feet east of east house line of Third	3	6	4 ft.	1	1		
Congress street, north side, 13 feet east of east house line of Second	4	6	5 ft.	1	1		

Fire Hydrants Renewed—First District—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 6 in.	Style. Old, removed.	Replaced by New, No. 3.	New, No. 4.	New, No. 5.
Christian street, north side, 19 feet 6 inches east of east house line of Seventeenth	30	12	19 ft.	1	1		
Front street, west side, 123 feet south of south house line of Queen	2	8	14 ft. 8 in.	1	1		
Front street, east side, 20 feet south of south house line of Catharine	3	8	15 ft.	1	1		
Front street, west side, 210 feet 8 inches north of north house line of Catharine	3	8	14 ft. 8 in.	1	1		
Front street, east side, 137 feet 8 inches south of south house line of Almond,	4	8	15 ft.	1	1		
Front street, west side, 78 feet north of north house line of Bainbridge	4	8	15 ft. 4 in.	1	1		
Marriott street, north side, 49 feet 9 inches east of east house line of Third	2	6	10 ft.	1	1		
Marriott street, north side, 28 feet east of east house line of Fourth	2	6	10 ft.	1	1		
Marriott street, south side, 20 feet 4 inches east of east house line of Fifth	2	6	3 ft. 3 in.	1	1		
Marriott street, north side, 13 feet west of west house line of Fifth	2	6	3 ft. 6 in.	1	1		
Marriott street, north side, 12 feet west of west house line of Sixth	2	6	3 ft. 6 in.	1	1		
Mary street, north side, 8 feet east of east house line of Second	2	6	11 ft. 8 in.	1	1		
Paul street, south side, 104 feet west of west house line of Sixth	2	6	7 ft. 6 in.	1	1		
Penn street, east side, 46 feet north of north house line of Bainbridge	4	6	13 ft.	1	1		

FIRE HYDRANTS RENEWED—FIRST DISTRICT—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 6 in.	Style. Old, removed.	Replaced by New, No. 8.	New, No. 4.	New, No. 5.
Spafford street, west side, 127 feet south of south house line of Bainbridge	4	6	6 ft. 10 in.	1	1		
Senate street, north side, 68 feet 6 inches east of east house line of Second	4	6	3 ft.	1	1		
Sixth street, east side, 87 feet north of Fitzwater	4	6	13 ft. 6 in.	1	1		
Stanley street, north side, 104 feet 6 inches west of west house line of Third	4	6	10 ft. 6 in.	1	1		
Trout street, north side, 74 feet west of west house line of Barrow	4	6	4 ft. 6 in.	1	1		
Tenth street, west side, 153 feet south of south house line of South	4	6	13 ft. 7 in.	1	1		
Washington avenue, south side, 16 feet east of east house line of Fifth	2	16	2 ft.	1	1		
Total			307	34	34		

Fire Hydrants Renewed—Continued.

Second District.

Street. Location.	Ward.	Size of Main in inches.	Connection. 6 in.	Style. Old, removed.	Replaced by New, No. 3.	New, No. 4.	New, No. 5.
Broad street, northwest corner of Filbert	9	6	18 ft. 4 in.	1	....	....	1
Broad street, northeast corner of Filbert	9	6	12 ft. 8 in.	1	....	....	1
Cherry street, north side, 148 feet west of west house line of Fifth	6	6	13 ft. 8 in.	1	1		
Chestnut street, south side, 55 feet west of west house line of Fifth	5	10	6 ft.	1	....	1	
Chestnut street, south side, 51 feet east of east house line of Sixth	5	10	7 ft.	1	....	1	
Commerce street, north side, 218 feet west of west house line of Fourth	6	6	8 ft.	1	....	....	1
Commerce street, north side, 175 feet west of west house line of Sixth	6	6	9 ft.	1	1		
Eighteenth street, east side, 33 feet 6 inches north of north house line of Delancy	7	12	12 ft.	1	....	....	1
Eleventh street, east side, 190 feet north of north house line of Spruce	8	10	13 ft.	1	....	....	1
Elm avenue, south side, 138 feet west of Belmont avenue	24	10	5 ft.	1	....	....	1
Fairmount Park, opposite Rhode Island building	24	36	21 ft.	1	....	....	1
Juniper street, east side, 18 feet north of north house line of Market	9	20	7 ft. 6 in.	1	....	....	1
Lombard street, north side, 8 feet 6 inches west of west house line of Wetherell	7	6	13 ft.	1	1		

Fire Hydrants Renewed—Second District—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 6 in.	Style. Old, removed.	Replaced by New, No. 3.	Replaced by New, No. 4.	Replaced by New, No. 5.
Minor street, south side, 179 feet east of east house line of Sixth	6	6	9 ft. 3 in.	1	1		
Merchant street, south side, 222 feet 6 inches west of west house line of Fourth	6	6	17 ft. 10 in.	1	....	1	
Market street, south side, 7 feet east of east house line of Thirty-ninth	27	12	1 ft. 6 in.	1	1		
New street, south side, 216 feet west of west house line of Front	6	6	6 ft. 7 in.	1	1		
New street, north side, 182 feet 8 inches east of east house line of Third	6	6	9 ft. 6 in.	1	1		
New street, north side, 177 feet east of east house line of Fourth	6	6	12 ft. 9 in.	1	1		
North street, north side, 301 feet west of west house line of Fifth	6	6	8 ft. 6 in.	1	1		
Pine street, south side, 16 feet west of west house line of Delaware avenue	5	6	6 ft. 2 in.	1	1		
Sansom street, north side, 120 feet east of east house house line of Eighth	8	6	12 ft.	1	....	....	1
Sansom street, northeast corner of Fortieth	27	6	17 ft.	1	....	....	1
Second street, west side, 6 feet north of north house line of Church	6	6	13 ft. 3 in.	1	1		
Second street, east side, south house line of Coomb's alley	6	6	13 ft. 4 in.	1	1		
Second street, east side, north house line of Lombard	5	10	5 ft.				
Torr street, south side, 77 feet west of west house line of Forty-ninth	24	6	12 ft.	1	....	....	1

Fire Hydrants Renewed—Second District—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 6 in.	Style. Old, removed.	Replaced by New, No. 3.	New, No. 4.	New, No. 5.
Twenty-first street, east side, 28 feet south of south house line of Winter	10	6	12 ft. 6 in.	1	....	....	1
Vine street, south side, 164 feet 4 inches west of west house line of Broad	10	16	17 ft. 2 in.	1	....	....	1
Walnut street, north side, 17 feet west of west house line of Delaware avenue.	5	6	6 ft. 6 in.	1	1		
Walnut street, north side, 182 feet 6 inches west of west house line of Tenth	8	6	13 ft.	1	....	....	1
Total	......	....	340 ft.	30	13	3	14

Fire Hydrants Renewed—Continued.

Third District.

Street. Location.	Ward.	Size of Main in inches.	Connection. 6 in.	Style. Old, removed.	Replaced by New, No. 3.	New, No. 4.	New, No. 5.
Almond street, east side, 2 feet south of south house line of Adam	31	6	14 ft. 10 in.	1	1		
Ann street, south side, 27 feet west of west house line of Jasper	31	6	18 ft.	1	1		
E street, east side, 213 feet south of south house line of Indiana avenue	25	6	12 ft. 10 in.	1	1		
Firth street, north side, 140 feet 5 inches west of Amber	31	6	9 ft. 8 in.	1	1		
Gaul street, northeast corner of Townsend	31	6	13 ft.	1	1		
Germantown avenue, southwest corner of second	16	6	25 ft.	1	....	1	
Thompson street, east side, 58 feet 10 inches north of Monmouth	25	6	12 ft. 8 in.	1	1		
Total	......	....	106 ft.	7	6	1	

Fire Hydrants Renewed—Continued.

Fourth District.

Street. Location.	Ward.	Size of Main in inches.	Connection. 6 in.	Style. Old, removed.	Replaced by New, No. 3.	Replaced by New, No. 4.	Replaced by New, No. 5.
Amboy street, 194 feet south of Columbia avenue	20	4	6 ft.	1	1		
Broad street, west side, 27 feet north of Parrish	15	12	36 ft.	1	1		
Broad street, west side, 190 feet south of Girard avenue	29	12	3 ft.	1	1		
Columbia avenue, north side, 26 feet west of Fawn	20	6	18 ft.	1	1		
Fairmount avenue, south side, 47 feet west of Ridge avenue	15	10	2 ft.	1	....	....	1
Fairmount avenue, north side, 48 feet east of Sixteenth	15	10	24 ft.	1	....	....	1
Fairmount avenue, north side, 4 feet west of Seventeenth	15	10	25 ft.	1	....	....	1
Franklin street, west side, 90 feet south of Wallace	13	6	16 ft.	1	1		
Franklin street, west side, 224 feet south of Poplar	13	6	12 ft.	1	1		
Green street, south side, 168 feet east of Eighteenth	15	6	16 ft.	1	1		
Lehigh avenue, south side, 144 feet west of Eleventh	28	6	11 ft.	1	1		
Marshall street, west side, 145 feet south of Jefferson	20	6	14 ft.	1	1		
Master street, north side, 18 feet west of Warnock	20	6	14 ft.	1	1		

FIRE HYDRANTS RENEWED—FOURTH DISTRICT—*Continued.*

Street. Location.	Ward.	Size of Main in inches.	Connection. 6 in	Style. Old, removed.	Replaced by New, No. 3.	Replaced by New, No. 4.	Replaced by New, No. 5.
Master street, north side, 230 feet west of Thirty-first	29	6	6 ft.	1	1		
Mervine street, front of No. 1740	20	6	14 ft.	1	1		
Ninth street, west side, 15 feet north of Diamond	20	6	14 ft.	1	1		
Spring Garden street, north side, 75 feet west of Seventh	13	6	10 ft.	1	1		
Susquehanna avenue, south side, 22 feet west of Twelfth	28	6	16 ft.	1	1		
Thirty-first street, west side, 7 feet north of Master	29	6	9 ft.	1	1		
Twelfth street, east side, 15 feet south of Berks	28	6	3 ft.	1	1		
Twenty-fourth street, west side, 66 feet south of Hamilton	15	6	10 ft.	1	1		
Twenty-second street, east side, 6 feet south of Fairmount avenue	15	12	10 ft.	1	1		
Twenty-sixth street, west side, 33 feet south of Hare	15	6	13 ft.	1	....	....	1
Warnock street, front of No. 1540	20	4	5 ft.	1	1		
York street, south side, 15 feet east of Twenty-first	28	6	14 ft.	1	1		
York street, south side, 76 feet east of Twenty-second	28	6	12 ft.	1	1		
Total	......	....	308 ft.	26	22	....	4

Fire Hydrants Renewed—Continued.

GERMANTOWN DISTRICT.

Street. Location.	Ward.	Size of Main in inches.	CONNECTION. 6 in.	STYLE. Old, removed.	Replaced by New, No. 3.	New, No. 4.	New, No. 5.
Broad street, east side, north of Rising Sun lane	28	6		1	1		
Fifteenth street, east side, 231 feet north of Tioga	28	6		1	1		
Queen street, southeast side, 5 feet southwest of Green	22	6		1	1		
Queen street, southeast side, northeast corner of Wayne	22	6		1	1		
Sixteenth street, west side, 220 feet north of Bristol	25	6		1	1		
Summit street, northwest side, 177 feet southwest of Stenton avenue	22	6		1	1		
Total				6	6		

Recapitulation of Fire Hydrants Set and Removed.

	Districts.	Old Style.	Three Nozzles. No. 3.	Three Nozzles. No. 4.	Three Nozzles. No. 5.	Total.	Old Style Taken up.	Total added during 1885.
New Fire Hydrants.	First	2	47	2	....	51	2	49
	Second	11	84	9	40	144	10	134
	Third	12	13	2	....	27	3	24
	Fourth	4	21	....	1	26	2	24
	Germantown	15	41	7	....	63	....	63
	Manayunk	9	4	....	....	13	....	13
	Totals	53	210	20	41	324	17	307
Fire Hydrants removed.	First	......	34	....	....	34	34	
	Second	......	13	3	14	30	30	
	Third	......	6	1	....	7	7	
	Fourth	......	22	....	4	26	26	
	Germantown	......	6	....	....	6	6	
	Manayunk	......						
	Totals	......	81	4	18	103	103	
Total New Style Fire Hydrants		......	291	24	59	374		

FIRE HYDRANTS, BY PURVEYORS' DISTRICTS,

And the diameter of the pipes to which they are connected.

Purveyors' Districts.	Sizes of Pipes in Inches. 3	4	6	8	10	12	16	18	20	30	36	Total.
First	60	251	787	15	33	11	4	......	13	......	......	1,174
Second	59	68	975	154	146	163	29	......	18	13	8	1,633
Third	1	238	975	4	124	12	2	4	5	......	3	1,368
Fourth	1	174	837	1	88	33	12	......	5	11	1	1,163
Germantown	32	66	891	14	34	27	16	......	2	......	......	582
Manayunk	....	21	228	....	10	7	3	......	5	......	......	274
Totals	153	818	4,193	188	435	253	66	4	48	24	12	6,194

FIRE HYDRANTS BY WARDS,

And the diameter of the pipes to which they are connected.

Wards.	Sizes of Pipes in Inches.											Total.
	3	4	6	8	10	12	16	18	20	30	36	
First	5	105	195	3	....	....	1	......	......	......	......	309
Second	28	39	103	5	4	1	2	......	1	......	......	183
Third	10	7	69	5	15	....	......	......	......	......	......	106
Fourth	11	9	68	2	11	....	......	......	......	......	......	101
Fifth	6	10	65	36	33	7	1	......	......	......	......	158
Sixth	1	....	109	11	13	....	1	......	......	7	......	142
Seventh	11	5	104	....	8	16	14	......	......	......	......	158
Eighth	11	2	96	....	13	31	8	......	2	......	......	163
Ninth	5	4	94	....	17	11	5	......	2	5	......	143
Tenth	11	10	80	3	13	11	......	......	9	1	......	138
Eleventh	....	14	44	1	18	....	......	......	......	......	......	77
Twelfth	....	13	39	....	26	2	2	......	......	......	......	82
Thirteenth	....	18	72	....	16	6	......	......	......	......	......	112
Fourteenth	....	14	64	....	19	5	1	......	......	2	......	105
Fifteenth	1	56	183	....	27	5	2	......	3	2	......	279
Sixteenth	....	21	41	....	22	....	......	......	......	......	......	84
Seventeenth	1	25	54	....	8	2	......	......	......	......	......	90
Eighteenth	....	36	77	....	22	....	......	......	......	......	......	135
Nineteenth	....	64	189	....	9	....	......	4	......	......	1	267
Twentieth	....	60	145	....	5	7	......	......	......	2	......	219
Twenty-first	....	21	194	....	10	4	3	......	5	......	......	237
Twenty-second	32	66	303	14	32	18	16	......	2	......	......	483
Twenty-third	....	3	110	....	....	....	......	......	5	......	......	118
Twenty-fourth	14	21	314	20	26	49	......	......	5	......	5	454
Twenty-fifth	....	20	300	3	19	9	......	......	......	......	2	353
Twenty-sixth	3	57	223	....	1	6	......	......	8	......	......	297
Twenty-seventh	....	16	112	84	21	32	......	......	......	......	3	268
Twenty-eighth	....	2	299	....	2	25	......	......	2	1	......	331
Twenty-ninth	....	24	168	1	19	2	9	......	......	4	1	228
Thirtieth	3	35	129	....	2	4	1	......	4	......	......	178
Thirty-first	....	42	150	....	4	....	......	......	......	......	......	196
Totals	153	818	4,193	188	435	253	66	4	48	24	12	6,194

STATEMENT OF THE NUMBER OF FIRE-HYDRANTS, BY DISTRICTS AND WARDS,

During 1885, and total previous thereto.

	First District.					Second District.												Third District.						Fourth District.						Germantown.			Manayunk.			Total.
	Wards.				Total.	Wards.											Total.	Wards.					Total.	Wards.					Total.	Wards.		Total.	Wards.		Total.	
	1	2	26	30		5	6	7	8	9	10	11	12	13	24	27		18	19	23	25	31		14	15	20	28	29		22	28		21	28		
Prior to 1885	...	...	...	...	1,125	...	...	...	...	...	...	...	...	...	...	...	1,499	...	...	...	...	...	1,344	...	...	...	...	...	1,139	......	......	519	......	......	261	5,887
During 1885	9	4	33	5	51	31	40	3	14	9	11	2	3	4	19	8	144	1	3	3	19	1	27	1	9	2	9	5	26	55	8	63	11	2	13	324
Totals	...	...	...	...	1,176	...	...	...	...	...	...	...	...	...	...	...	1,643	...	...	...	...	...	1,371	...	...	...	...	...	1,165	......	......	582	......	......	274	6,211
Taken out in 1885	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	10	...	...	...	...	...	3	...	...	...	...	...	2	......	......	......	......	......	......	17
Total in city	...	...	...	...	1,174	...	...	...	...	...	...	...	...	...	...	...	1,633	...	...	...	...	...	1,368	...	...	...	...	...	1,163	......	......	582	......	......	274	6,194

Number of attachments for fire purposes previously reported........................ 278

Made during 1885,
- First District..
- Second " 2
- Third " 5
- Fourth " ....
- Germantown District...
- Manayunk " ....

Total.. 285

ATTACHMENTS, ETC., MADE BY THE PURVEYORS.

In accordance with permits issued by the Registrar, arranged by months.

Months.	Service Attachments.						Shut-offs by Permit.					Miscellaneous.					Re-driven.
	Size.					Total.	For repairs.	To re-drive.	To discontinue.	To transfer.	Total.	Leak.	Delinquent.	Duplicate.	Discontinued and abandoned.	Total.	
	½ inch.	⅝ inch.	¾ inch.	1 inch.	2 inch.												
January	81	2	2	4	1	90	12	16	2	....	30	20	....	....	5	25	9
February	28	3	1	1	....	33	39	10	....	....	49	11	....	....	4	15	3
March	132	4	3	4	....	143	60	20	2	2	84	46	....	1	7	54	12
April	500	27	8	9	1	545	120	48	4	7	179	43	....	....	11	54	25
May	507	24	16	29	....	576	90	24	....	5	119	24	....	....	5	29	16
June	650	10	10	14	....	684	83	19	1	7	110	11	....	....	3	14	17
July	646	22	24	15	1	708	70	15	3	6	94	10	....	....	5	15	44
August	667	20	12	15	1	715	44	17	4	6	71	14	....	1	7	22	98
September	854	30	14	15	1	914	65	28	4	6	103	8	....	....	9	21	220
October	1,079	41	12	27	3	1,162	62	22	17	7	108	13	6	4	25	44	398
November	1,097	51	14	20	4	1,186	61	29	17	7	114	13	2	....	22	37	648
December	493	20	5	7	4	529	50	30	11	2	93	36	23	....	11	70	56
Total	6,734	251	121	160	16	7,285	756	278	65	55	1,154	249	31	6	114	400	1,546

ATTACHMENTS, ETC., MADE BY THE PURVEYORS,

In accordance with permits issued by the Registrar, arranged by Purveyors' Districts.

Districts.	Service Attachments. Size. ½ inch.	⅝ inch.	¾ inch.	1 inch.	2 inch.	Total.	Shut-offs by Permits. For repairs.	To re-drive.	To discontinue.	To transfer.	Total.	Miscellaneous. Leak.	Delinquent.	Duplicate.	Discontinued and abandoned.	Total.	Re-driven.
First	1,438	7	8	21	1	1,475	115	4	....	7	126	29	11	....	31	71	493
Second	988	105	56	82	7	1,238	149	89	11	17	266	48	6	....	32	86	960
Third	1,674	18	15	28	4	1,739	229	93	30	16	348	67	14	2	11	94	70
Fourth	1,878	105	35	20	3	2,041	213	77	17	2	309	94	....	4	19	117	13
Germantown	579	17	7	8	....	611	35	9	....	8	52	4	....	....	14	18	4
Manayunk	177	2	....	1	1	181	15	26	7	5	53	7	....	....	7	14	6
Totals	6,734	254	121	160	16	7,285	756	278	65	55	1,154	249	31	6	114	400	1,546

Account of New Stops for 1885.

Districts.	Two-way.	Four-way, Barton.	Four-way, Viney.	Total.
First	73	....	....	73
Second	189	....	2	191
Third	60	1	2	63
Fourth	80	1	....	81
Germantown	113	....	....	113
Manayunk	18	....	....	18
Totals	533	2	4	539

Repairs to Mains, Stops, and Fire Hydrants, and Stops Taken Out During 1885

Districts.	Repairs to Mains.	Stops.		Fire Hydrants.	
		Repaired.	Taken out.	Repaired.	Taken out.
First	79	600	....	684	2
Second	54	1,967	7	1,128	10
Third	158	612	....	606	3
Fourth	234	461	....	779	2
Germantown	52	290	....	394	....
Manayunk	61	372	....	700	....
Totals	638	4,302	7	4,291	17

Number of Complaints Received and Examined during 1885.

Hydrants	4,768
Service-pipes	1,314
Wash-paves	420
Spigots	6
Water-closets	9
Horse-troughs	7
Surface water, etc. (not leaks)	1,060
Total	7,584

NUMBER OF VALVES RAISED IN THE DIFFERENT DISTRICTS DURING THE YEAR 1885.

Also in each year since 1873.

DISTRICTS.	8-inch Barton.	3-inch.	4-inch.	6-inch.	8-inch.	10-inch.	12-inch.	16-inch.	20-inch.	30-inch.	36-inch.	Totals.
First	....	....	1	4	1	......	......	......	......	......	......	6
Second	....	11	3	26	......	2	......	2	......	......	......	44
Third	....	....	7	13	......	3	......	......	......	......	......	23
Fourth	....	....	13	54	......	4	......	......	......	1	......	72
Totals for 1885	....	11	24	97	1	9	......	2	......	1	......	145
" " 1884	....	7	13	71	1	4	2	1	3	6	1	109
" " 1883	....	4	27	88	......	8	......	1	......	1	1	130
" " 1882	1	14	25	58	1	5	1	......	......	1	......	106
" " 1881	....	15	44	90	......	5	7	......	......	......	......	161
" " 1880	....	7	23	47	......	8	1	......	......	1	......	87
" " 1879	....	9	16	60	1	3	2	......	......	1	1	93
" " 1878	....	27	22	100	......	3	1	......	1	1	......	155
" " 1877	....	12	6	50	......	1	......	......	1	......	......	70
" " 1876	....	3	17	49	......	3	......	......	1	......	......	73
" " 1875	....	17	55	120	4	12	2	4	1	2	......	217
" " 1874	....	13	32	111	6	6	3	3	......	......	......	174
Totals for 12 years..	1	139	304	941	14	67	19	11	7	14	3	1,520

TABULAR STATEMENT OF WORK CONNECTED WITH THE DISTRIBUTION,

For the six years 1880 to 1885, inclusive.

Years.	Pipe.										Additional stops.	Additional fire hydrants.	Fire hydrants in use.	Meters in use.	Service Attachments.					
	Extensions.		Repairs and relays.		Total pipe handled.		Total amount in use.		Total amount handled.											
	Feet.	Pounds.	Feet.	Pounds.	Feet.	Pounds.	Feet.	Pounds.	Feet.	Pounds.					½ in.	⅝ in.	¾ in.	1 in.	2 in.	Total.
1880......	23,085	844,946	9,557	262,826	32,642	1,107,772	3,927,623	192,816,906	4,164,768	200,136,708	138	70	5,358	34	2,687	118	49	89	....	2,943
1881......	56,616	2,832,623	3,832	199,649	60,448	3,032,272	3,984,239	195,649,529	4,225,216	203,168,980	249	144	5,502	42	3,166	137	59	121	....	3,483
1882......	56,860	5,396,165	7,740	484,092	64,600	5,880,257	4,041,099	201,045,694	4,289,816	209,049,237	312	120	5,622	45	3,169	110	76	129	....	3,484
1883......	63,215	3,048,645	12,605	675,420	75,880	3,724,065	4,104,314	204,094,339	4,365,696	212,773,301	281	130	5,752	63	4,576	97	71	133	....	4,877
1884......	83,862	7,135,948	18,079	1,380,271	101,941	8,516,219	4,188,176	211,230,287	4,467,637	221,289,520	324	147	5,887	560	5,529	185	84	140	7	5,945
1885......	137,967	12,234,074	93,783	3,265,537	231,850	15,499,611	4,326,143	223,464,361	4,699,487	236,789,131	539	307	6,194	305	6,734	254	121	160	16	7,285

GENERAL SUMMARY OF METER OPERATIONS DURING 1885.

Size.	In use January 1, 1885.							In stock January 1, 1885.						Totals.	In use January 1, 1886.							In stock January 1, 1886.						Condemned.					Totals.
	Crown.	Worthington.	Union.	Keystone.	Marsland.	Equitable.	Total.	Crown.	Worthington.	Union.	Keystone.	Equitable.	Total.		Crown.	Worthington.	Union.	Keystone.	Marsland.	Equitable.	Total.	Crown.	Worthington.	Union.	Keystone.	Equitable.	Total.	Worthington.	Union.	Marsland.	Equitable.	Total.	
½ inch	18	......	......	......	......	......	18	15	......	......	......	10	25	43	2	......	......	......	......	......	2	31	......	......	......	......	31	......	......	......	10	10	43
¾ "	72	......	......	13	......	2	87	8	1	......	12	9	30	117	25	......	......	2	......	......	27	55	......	......	23	......	78	1	......	......	11	12	117
1 "	120	17	......	......	4	3	144	14	8	2	......	7	31	175	51	9	......	......	......	1	61	83	16	......	......	1	100	......	2	4	8	14	175
1½ "	86	2	23	2	4	......	117	6	......	2	2	......	10	127	57	2	9	......	1	......	69	35	......	16	4	......	55	......	......	4	......	4	128
2 "	128	1	......	......	4	......	133	8	1	......	......	......	9	142	103	1	......	......	......	......	104	33	1	......	......	......	34	......	......	3	......	3	141
3 "	32	3	......	......	8	......	43	10	......	......	......	......	10	53	22	3	......	......	......	......	25	20	......	......	......	......	20	......	......	8	......	8	53
4 "	14	......	......	......	......	......	14	5	......	......	......	......	5	19	13	......	......	......	......	......	13	6	......	......	......	......	6	......	......	......	......	......	19
6 "	4	......	......	......	......	......	4	......	......	......	......	......	......	4	4	......	......	......	......	......	4	......	......	......	......	......	......	......	......	......	......	......	4
Totals	474	23	23	15	20	5	560	66	10	4	14	26	120	680	277	15	9	2	1	1	305	263	17	16	27	1	324	1	2	19	29	51	680

Table showing changes in pressure at different points due to change in distribution from Corinthian Avenue Basin to direct pumpage, in the district west of Broad street, between Spring Garden and Vine streets.

Location of Gauges.	Poplar and Twentieth Sts.			Spring Garden and 20th Streets.			Carlton and 19th Streets.		Lehigh Av. and Sixth Street.	
	December.			December.			December.		December.	
Time.	11th.	21st.	22d.	11th.	21st.	22d.	21st.	22d.	21st.	22d.
8 A.M.	....	....	....	....	....	38	....	21	....	....
8.30 "	....	....	....	....	....	36	....	25	....	10
9 "	15	....	27	12½	....	33	....	25	....	9
9.30 "	15	....	26	12½	....	29	....	37	....	9
10 "	15	....	28	12½	....	34	....	41	....	10
10.30 "	16	....	28	12½	....	34	....	42	....	8
11 "	13	....	28	12	....	34	....	45	....	8
11.30 "	16	....	29	12	....	36	....	47	....	9
12 "	16	20	31	14	10	39	24	52	12	10
12.30 P.M.	17	26	32	13½	15	42	30	54	11	13
1 "	....	25	30	....	15	36	27	47	10	11
1.30 "	....	25	29	....	12	35	25	45	8	10
2 "	....	25	28	....	14	38	26	49	10	9
2.30 "	....	23	29	....	15	32	28	50	9	9
3 "	....	28	30	....	20	35	31	46	9	9
3.30 "	....	32	30	....	33	37	20	45	9	10
4 "	....	35	30	....	35	36	16½	48	11	11
4.30 "	....	30	28	....	39	36	16	47	12	12
5 "	....	30	28	....	....	39	....	50	....	11

REPORT

ON THE

OPERATIONS OF THE SHOP

DURING 1885.

PHILADELPHIA WATER DEPARTMENT,
CHERRY STREET SHOP,

January 18, 1886.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—I submit the following report of the operations of the Department Construction and Repair Shop, for the year 1885.

Respectfully,
W. F. COURTNEY,
Superintendent.

MERCHANDISE.	DR.
To Stock on hand January 1, 1885	$10,964 93
Blocks and ropes	3 34
Bolts and nuts	1,069 91
Bricks and lime	21 92
Brass fittings	244 62
Brass castings, 23,519 lbs	3,011 15
Chandlery	131 95
Castings, iron, 787,172 lbs	13,302 18
Coke, 400 bush	34 00
Coal, 175 tons	1,006 25
Gas	71 11

MERCHANDISE.	DR.
Galvanizing	$320 84
Hardware	306 61
Hauling	95 40
Ice	36 35
Lumber, 14,434 ft	574 81
Machinery	4,525 46
Malleable iron castings, 453 lbs	31 71
Miscellaneous	93 83
Paints and oils	87 59
Gum goods	2,161 56
Steel, 4,744 lbs	400 40
Tickets	100 00
Wrought iron fittings	38 78
Wrought iron, 50,298 lbs	1,203 28
Oils and tallow	148 84
Packing (gasket)	338 30
Distribution	65 00
Wages	26,680 93
	$67,071 05

MERCHANDISE.	CR.	
By repairs and supplies, First District	$11,997 54	
" " " Second "	14,521 47	
" " " Third "	4,091 76	
" " " Fourth "	17,178 48	
" " " Fifth "	1,511 30	
" " " Sixth "	5,844 97	
		$55,145 52

FAIRMOUNT STATION.		
By Repairs to machinery	$1,366 44	
Repairs to buildings and grounds	336 85	
Pumping water	6 00	
		1,709 29

SPRING GARDEN STATION.		
By Repairs to machinery	$1,880 97	
Repairs to boilers	1,744 03	
Repairs to buildings and grounds	1,051 54	
Pumping water	127 50	
Store-house	44 43	
		4,848 47

Belmont Station.

Merchandise.	Cr.	
By Repairs to machinery	$644 70	
Repairs to boilers	257 30	
Repairs to buildings and grounds	434 83	
		$1,336 83

Roxborough Station.

By Repairs to machinery	$379 55	
Repairs to boilers	38 81	
Repairs to buildings and grounds	17 62	
Pumping water	27 00	
		462 98

Chestnut Hill Station.

By Repairs to machinery	$228 22	
Repairs to boilers	11 20	
Pumping water	27 00	
		266 42

Mount Airy Station.

By Repairs to machinery	$301 97	
Repairs to boilers	27 61	
		329 58

Frankford Station.

By Repairs to machinery	$265 43	
Repairs to boilers	45 28	
Repairs to buildings and grounds	170 33	
Pumping water	27 00	
		508 04

Kensington Station.

By Repairs to machinery	$513 97	
Repairs to boilers	47 56	
Repairs to buildings and grounds	9 27	
Pumping water	96 00	
		666 80

Main Office.

By Supplies and repairs	$391 05	
		391 05

Cherry Street Shop.

By Supplies and repairs	$1,117 83	
Extension	861 22	
		1,979 05

General Buildings and Grounds.

Merchandise.	Cr.	
By Supplies (Corinthian Reservoir)	$13 52	
		$13 52

Water Meters.

By Supplies and repairs	$265 70	
		265 70

Fixed Patterns.

By Supplies and repairs	$947 21	
		947 21

Distribution.

By Supplies and labor	$466 73	
		466 73

Ferrules.

By Labor (on corporation cocks)	$46 95	
		46 95

Old Metals.

By Sales	$671 66	
		671 66

Machinery.

By Supplies, repairs and labor (for shop)	$4,913 69	
		4,913 69
		$74,969 49
By Stock on hand January 1, 1886		6,936 19
Cr.		$81,905 68
Dr.		67,071 05
Balance to Cr.		$14,834 63

INVENTORY, JANUARY 1, 1886.

3	6-inch stop cocks, at $25 00	$75 00	
5	12-inch stop cocks, at 45 00	225 00	
			$300 00
2	3-inch square-top screws, O. S., at $2 25	$4 50	
2	4-inch " " " " 2 25	4 50	
2	6-inch " " " " 2 50	5 00	
13	10-inch " " " " 4 50	58 50	
21	16-inch " " " " 6 50	136 50	
10	20-inch " " " " 8 25	82 50	
3	36-inch " " " " 22 00	66 00	
			357 50

33 4-inch square-top screws, N. S., at $2 25	$74 75	
5 6-inch “ “ “ “ 2 50	12 50	
6 8-inch “ “ “ “ 3 25	19 50	
13 10-inch “ “ “ “ 4 50	58 50	
9 12-inch “ “ “ “ 5 00	45 00	
4 16-inch “ “ “ “ 6 50	26 00	
2 20-inch “ “ “ “ 8 25	16 50	
7 30-inch “ “ “ “ 10 25	71 75	
1 36-inch “ “ “ “ 22 00	22 00	
8 Barton stop screws, at $3.75	30 00	
		376 50
28 3-inch socket screws, at $1 50	$42 00	
25 4-inch “ “ “ 1 50	37 50	
57 6-inch “ “ “ 1 75	99 75	
42 8-inch “ “ “ 2 00	84 00	
13 10-inch “ “ “ 2 25	29 25	
25 12-inch “ “ “ 2 50	62 50	
		355 00
25 3-inch spindles, at $1 50	$37 50	
13 4-inch “ “ 1 50	19 50	
47 6-inch “ “ 1 75	82 25	
3 8-inch “ “ 2 00	6 00	
15 10-inch “ “ 2 25	33 75	
25 12-inch “ “ 2 50	62 50	
		241 50
6 4-inch iron bands, at $2 15	$12 90	
28 6-inch “ “ “ 2 15	60 20	
21 12-inch “ “ “ 7 50	157 50	
10 16-inch “ “ “ 9 00	90 00	
5 20-inch “ “ “ 10 50	52 50	
		373 10
36 pairs single stop monkey legs, w. i., at $1 50	$54 00	
22 pairs double stop monkey legs, c. i., at 3 25	71 50	
76 cross heads and nuts, at $2 50	190 00	
283 wood plugs, at 50 cts	141 50	
Finished parts of stop valves	89 40	
“ “ “ 6-inch three-way fire hydrants	50 21	
		596 61
3 4-inch fire hydrants, O. S., at $28.00	$84 00	
3 4-inch fire hydrant cases, O. S., at $7.50	22 50	
35 plug monkeys, complete, at $3.25	113 75	
100 4-inch plug nuts, at 25 cts	25 00	
2 valve rods for three-way fire hydrants, at $1.50	3 00	
2 “ “ “ O. S., “ “ “ 80 cts	1 60	

92	pure gum joint rings for 3-way fire hydr., at 65 cts.	$59 80	
3	" " valves " " " " " $5.00.	15 00	
121	" " " " O. S., " " " $2.25.	272 25	
			$596 90
778	lbs. iron forgings, at 10 cts	$77 80	
2,039	lbs. finished brass castings, at 30 cts	611 70	
8	hydrant keys, at $2.25	18 00	
120	caulking irons, at 50 cts	60 00	
3	gasket irons, at 50 cts	1 50	
28	flat and cape chisels, at 35 cts	9 80	
22	handled cutters, at 60 cts	13 20	
15	handled diamond point cutters, at 75 cts	11 25	
60	hand diamond point cutters, at 35 cts	21 00	
25	hand round nose cutters, at 35 cts	8 75	
53	doz. S. hooks, at 75 cts	39 75	
75	lbs. malleable castings, at 7 cts	5 25	
2	sets gearing for derrick	75 00	
12	stub end straps, at $8.00	96 00	
237	brass ferrule plugs, at 50 cts	118 50	
			1,167 50
1,025	ft. lumber	$75 37	
14,114	lbs. wrought iron, at $2\frac{1}{4}$ cts	317 57	
1,756	lbs. cast steel, at 9 cts	158 04	
715	lbs. machinery steel, at 5 cts	35 75	
4,419	lbs. brass castings (unfinished), at 14 cts	618 66	
24,788	lbs. iron castings, at $1\frac{69}{100}$ cts	418 92	
547	lbs. round rod brass, at 21 cts	114 87	
60	lbs. brass spring wire, at 30 cts	18 00	
1,620	lbs. pig lead, at 5 cts	81 00	
125	lbs. Babbitt metal, at 35 cts	43 75	
Bolts and nuts, washers, rivets, etc		518 28	
Hardware		138 09	
Paints and oils		17 67	
Oils and tallow		15 61	
			2,571 58
			$6,936 19

ARTICLES MANUFACTURED DURING 1885.

18	4-inch	stop cocks, at $22.00	$396 00
558	6-inch	" " " 25.00	13,950 00
12	10-inch	" " " 40.00	480 00
35	12-inch	" " " 45.00	1,575 00

22	20-inch " " " 95.00	$2,090 00	
12	30-inch " " " 189.00	2,268 00	
10	36-inch " " " 360.00	3,600 00	
64	4-inch screws, O. S., at $1.50	96 00	
92	6-inch " " " 1.75	161 00	
18	10-inch " " " 2.25	40 50	
2	20-inch " N. S., " 8.25	16 50	
			$24,673 00
58	6-inch spindles, at $1.50	$87 00	
26	10-inch " " 2.25	58 50	
			145 50
37	cross heads, at 75 cts	$27 75	
200	stop monkey keys, at 25 cts. per dozen	4 16	
50	" " legs, c. i., at $1.50	75 00	
30	" " " w. i, at $3.25	97 50	
633	frames and covers, 12,600 lbs., at .0169	2,138 54	
41	extra covers, at $1.95	79 95	
			2,422 90
5	hat flanges, 4 x 20 inches, at $1.50	$7 50	
62	" " 6 x 20 " " 2.80	173 60	
16	" " 6 x 30 " " 2.80	44 80	
6	" " 8 x 36 " " 1.50	9 00	
6	" " 10 x 36 " " 1.75	10 50	
8	" " 12 x 16 " " 5.00	40 00	
5	" " 12 x 20 " " 5.00	25 00	
6	" " 12 x 36 " " 5.00	30 00	
4	" " 20 x 36 " " 8.00	32 00	
			372 40
106	O. S. 4-inch fire hydrants, at $28.00	$2,968 00	
310	No. 3—6-inch 3-way fire hydrants, at $34.25	10,617 00	
25	No. 4— " " " " " $42.00	1,050 00	
10	No. 5— " " " " " $44.50	445 00	
220	O. S. fire hydrant castings, at $7.50	1,650 00	
75⅔	doz. S. hooks, at 75 cts. per doz	56 75	
38⅙	doz. clevises, at 75 cts. per doz	28 63	
88	plug monkeys, at $3.25	286 00	
55⅙	doz. plug monkey keys, at 25 cts. per doz	13 80	
25	plug risers, at $2	50 00	
33	" valve rods, at 75 cts	24 75	
18	" frost " " 75 cts	13 50	
18	wrenches, at $1.25	22 50	
			17,225 93

48	flushing nozzles	$80 00	
41	Jones couplings, at $4 00	164 00	
32	fish traps, at $5.25	168 00	
			$412 00
23	4-inch bands, at $2 15	$49 45	
155	6-inch " " 2 15	333 25	
13	10-inch " " 5 00	65 00	
15	12-inch " " 7 50	112 50	
17	16-inch " " 10 00	170 00	
15	20-inch " " 10 50	157 50	
9	36-inch " " 20 00	180 00	
			1,067 70
48	crow bars, at $1.15	$55 20	
31	caulking and gasket irons, at 60 cts	18 60	
91	cutting chisels, at 60 cts	54 60	
154	flat and cape chisels, at 35 cts	53 90	
150	handled diamond point chisels, at 75 cts	112 50	
100	hand " " " " 35 cts	35 00	
50	handled gouges, at 60 cts	30 00	
800	wood plugs, at 50 cts	400 00	
9	large lead pots, at $4.00	36 00	
20	medium lead pots, at $2.50	50 00	
6	small lead pots, at $1.35	8 10	
20	hydrant keys, at $2.25	45 00	
5	stop keys, at $5.25	26 25	
372	brass ferrule plugs, at 50 cts	186 00	
6	furnaces, at $16.25	97 50	
12	striking hammers, at $1.75	21 00	
18	caulking " " 1.00	18 00	
6	sledge " " 2.25	13 50	
			1,261 15
			$47,580 58

PURCHASED ARTICLES SUPPLIED TO DISTRICTS.

270	gallons headlight oil, at 11 cts	$29 70
139	" lubricating oil, at $10\frac{1}{2}$ cts	14 60
13	" lard oil, at 60 cts	7 80
58	bales gasket	349 75
$328\frac{1}{6}$	doz. bolts and nuts, at 75 cts. per doz	246 13
612	lbs. washers, at $5\frac{1}{4}$ cts	32 13
3	doz. sledge handles, at 90 cts. per doz	2 70

$6\frac{7}{12}$	doz. pick handles, at $1 30 per doz.	....	$8 56
$1\frac{1}{2}$	" maul " " 90 cts. "	....	1 35
$\frac{1}{2}$	" axe " " $1.50 "	....	75
4	" hammer " " 60 cts. "	....	2 40
$1\frac{3}{4}$	" shovels, at $8.92 per doz.	....	15 61
$\frac{1}{4}$	" red lamps, at $19.00 per doz.	....	4 75
$\frac{1}{4}$	" axes, at $9.75 per doz.	....	2 44
505	joint rings, at 50 cts.	....	252 50
576	case bolts, at 2 cts.	....	11 52
78	lbs. plug rivets, at $7\frac{1}{2}$ cts.	....	5 85
49	plug valves, at $2.25	....	110 25
6	frost valves, at 30 cts.	....	1 80
224	gland bolts, at 11 cts.	....	24 64
			$1,125 23

Stop-cocks, Frames and Covers, Fire-hydrants, Cases, etc., delivered from Cherry Street Shop during 1885, to the Purveyors' Districts.

Districts.	4-inch stop cocks.	6-inch stop-cocks.	10-inch stop-cocks.	12-inch stop-cocks.	20-inch stop-cocks.	30-inch stop-cocks.	36-inch stop-cocks.	Frames and Covers.	Extra covers.	4-inch fire-hydrants.	6-inch fire-hydrants, 3-way, No. 1.	6-inch fire-hydrants, 3-way, No. 2.	6-inch fire-hydrants, 3-way, No. 3.	4-inch cases, O. S.	Brass ferrule plugs.	Furnaces.	Lead pots.	Plug monkeys.
First..........	4	112	12	7	8	......	......	163	35	28	1	3	71	53	84	1	2	19
Second........	4	154	......	14	4	......	3	149	......	39	38	7	67	55	114	1	8	12
Third.........	6	78	......	......	......	......	......	......	......	12	2	4	21	66	84	1	2	5
Fourth.......	2	125	......	10	12	12	7	196	1	4	19	4	104	30	78	1	6	15
Fifth..........	2	18	......	......	......	......	......	50	......	11	......	......	6	13	21	1	1	2
Sixth..........	......	85	......	......	......	......	......	75	5	20	......	7	41	5	39	1	4	......
	18	572	12	31	24	12	10	633	41	114	60	25	310	222	420	6	23	53

Stop-cocks, Frames and Covers, etc.—*Continued.*

Districts.	4-inch iron bands.	6-inch iron bands.	10-inch iron bands.	12-inch iron bands.	16-inch iron bands.	20-inch iron bands.	36-inch iron bands.	6 x 20 in. hat flanges.	6 x 30 in. hat flanges.	12 x 20 in. hat flanges.	12 x 16 in. hat flanges.	4 x 20 in. hat flanges.	8 x 36 in. hat flanges.	20 x 36 in. hat flanges.	Wood plugs.	Chisels.	Stop keys.	Hydrant keys.
First	......	......	......	......	......	2	......	28	......	3	......	......	......	......	201	87	1	4
Second	3	11	......	3	......	3	......	17	10	......	......	......	......	2	199	210	2	3
Third	16	39	5	......	......	......	......	......	......	......	......	......	......	......	151	6	......	......
Fourth	2	38	2	1	4	10	7	8	6	2	8	3	4	1	127	159	4	4
Fifth	......	......	......	2	......	......	......	......	......	......	......	......	......	......	30	6	......	......
Sixth	......	42	6	......	3	......	2	......	......	......	......	......	......	......	80	27	......	......
Main Office	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	6
	21	133	13	6	7	15	9	53	16	5	8	3	4	3	788	495	7	17

List of Articles delivered Purveyors' Districts, 1885—*Continued.*

Districts.	Gasket irons.	Caulking irons.	Handled gouges.	S hooks.	Clevises.	Monkey keys.	Valve rods.	Frost rods.	Wrenches.	Risers.	Striking hammers.	Caulking hammers.	Sledge hammers.	Crowbars.	Hammer handles.	Sledge handles.	Pick handles.	Axe handles.
First	3	15	......	144	96	142	8	5	4	......	6	5	5	24	7	6	......	......
Second	10	61	6	180	72	128	9	1	3	18	......	6	1	24	34	20	29	......
Third	......	25	......	344	170	168	2	6	3	......	......	......	......	12	......	......	......	......
Fourth	4	30	17	180	96	154	9	4	1	......	6	7	......	24	3	27	48	......
Fifth	......	15	12	24	24	30	......	1	......	......	......	......	......	......	......	......	......	6
Sixth	4	......	15	36	......	40	2	1	3	......	......	......	......	......	......	......	......	......
	21	146	50	908	458	662	30	18	14	18	12	18	6	84	44	53	77	6

SURVEYS

FOR THE

FUTURE WATER SUPPLY

OF THE

CITY OF PHILADELPHIA.

ANNUAL REPORT OF PROGRESS

DURING 1885,

BY RUDOLPH HERING, C. E.,

Engineer in Charge.

PHILADELPHIA WATER DEPARTMENT,
March 27, 1886.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—I have the honor to present to you the following Annual Report of Progress of the Surveys for Future Water Supply for the City of Philadelphia:

The topographical work covering the water-sheds of the Perkiomen, Tohickon and Neshaminy creeks, and that for the proposed aqueduct lines has been completed.

The sanitary surveys have likewise been finished, comprising an examination of the entire Lehigh valley and of the Delaware valley above Yardleyville, the lowest point from which it would be feasible to obtain a good water supply.

The hydrographic work comprising rainfall observations and stream gauging has been continued in the Perkiomen, Tohickon and Neshaminy valleys. Low water gaugings were made of the Delaware river at the Water Gap and at Point Pleasant, and of the Lehigh river at White Haven, as during the previous years.

The office work has consisted in plotting the surveys, field notes and observations, and in compiling and arranging the information collected. The large topographical maps of the Perkiomen, Tohickon and Neshaminy water-sheds, and those showing the numerous projected lines for aqueducts, are finished excepting a few of their titles and some tinting.

The rainfall over the area investigated has been tabulated and plotted on large charts in such a way as to allow of ready comparison. The daily stream flow in the various creeks under consideration has also been plotted, together with the rainfall and temperature, to show their relation to it.

A general map has been prepared showing the locations of the proposed aqueducts; also a map of the drainage areas of the Lehigh and Schuylkill rivers, and of the Delaware river above Philadelphia, showing the density of population distributed over the same; also profiles of the proposed aqueducts to Point Pleasant, to the Perkiomen, to the Delaware Water Gap and to the Upper Lehigh river.

I can report with pleasure that the persons engaged in the above work have exhibited much zeal and industry, and special mention is due to Mr. F. L. Paddock and Mr. H. W. Sanborn, who very efficiently conducted respectively the topographical and hydrographic branches of the investigation.

The following is a detailed account of the work done and of the conclusions reached during the year:

AQUEDUCTS.

The previous Annual Reports contain a detailed account of the projected lines to the Perkiomen, to Point Pleasant, and to

Portland near the Delaware Water Gap. During the present year the remaining projects have been worked up. They comprise the following lines:

PHILADELPHIA TO YARDLEYVILLE.

Setting aside any future scheme that would depend on the use of the tidal water of the Delaware river below Trenton, because of the prospective if not present pollution from Trenton to Philadelphia, the river at Yardleyville, four miles above Trenton, is the first point which presents favorable conditions for a water intake. It is above tide water and above any serious source of pollution even for a long future, as far as we can judge at present, and the distance from the city is no greater than to Trenton.

The elevation of the Delaware river at this point is but 10 feet above tide. The entire quantity of water must therefore be raised by pumps. It would be difficult and very expensive to build an aqueduct of masonry parallel with the river, and for a considerable distance necessarily below the level of the same, in order to bring the water from Yardleyville and to pump it into the basins at Philadelphia. Such a scheme has therefore not been considered—the water must be raised at Yardleyville. The territory between this village and Philadelphia lies too low for an aqueduct of masonry that would deliver into the city basins at the desired elevations. The only feasible scheme therefore is to lay a pipe line which would run full under pressure.

No topographical surveys existed of the country over which the line passes. As it required more funds and time than were available, to make a survey similar to those previously made, only a careful reconnoissance was undertaken, the leveling being done with Aneroid barometers. An excellent vertical base line was furnished by the Delaware and Bound Brook Railroad which runs nearly parallel to the proposed pipe line, and the map used was one published by the State Geological Survey to a scale of $1\frac{1}{2}$ inches to the mile. Thirty-five square miles of area were thus surveyed within five and a half days. Readings were taken with sufficient frequency to allow of ten feet contours to be drawn over the territory. Every two or three hours a check was obtained by driving back to the railroad, noting the time and error of the barometer, and then distributing the same by an interpolating diagram according to the times of observation. Use was also made of the Abney level.

The alignment was so arranged that but one summit and two depressions are necessary between the stand pipe at Yardleyville Hill, and the Wentz Farm Basin. The summit is about six miles from the latter and near Walter's Run. The depressions are at the crossings of Pennypack and Neshaminy creeks. The line is therefore a very favorable one. Its total length is 20.76 miles.

In order to find the most economical number of pipes and height of pumping, several trial estimates were made with different gradients and sizes of pipes, and it was found that four pipes, each five feet in diameter, would deliver the desired quantity most economically, and that the water should be raised at Yardleyville to an elevation of two hundred and twenty-eight feet above City Datum.

The length of force main is 2.22 miles, that of the delivery main 18.54 miles, making the total length to the Wentz Farm Basin 20.76 miles, with a mean hydraulic gradient of 0.0654 foot per hundred feet.

The cost* of the aqueduct, delivering 210,000,000 gallons per day is $8,845,565, to which should be added the cost of the pumping plant, and, to compare with the gravity schemes, also the capitalized cost of pumping the water into the aqueduct.

Estimating the cost of pumping 1,000,000 gallons one hun-feet high at $5.00, the yearly cost of pumping would be $873,810: representing a sum if capitalized at four per cent. for forty years of $17,294,954. To this should be added

*See detailed estimate, Appendix No. 2.

$1,250,000, the estimated final cost of the pumping plant, etc., making a total of $27,390,519.

Among the advantages of this project could be mentioned the fact that it would be necessary to lay no more pipes at first than needed at once, and to increase their number as desired, thus saving the interest on a large portion of the investment. A pipe line can also be more quickly built than a brick aqueduct, and water could probably be had from Yardleyville in less than two years after beginning the construction.

Among the disadvantages may be reckoned, besides the great expense, also the fact that this project allows of no extension. In case the water at Yardleyville becomes impure the entire line would have to be abandoned.

Philadelphia to New Hope.

Following up the Delaware river, we find New Hope to be the next convenient place from which a water supply could be obtained, the river having quite a fall at this point. Two projects have been suggested, as follows:

1. *Open Canal Scheme.*—The required quantity of water can be turned from the river into *the Delaware Division Canal* and flow in it to Bristol. From this point to Frankford a new channel would have to be dug, and the entire quantity of water pumped at the terminus near Lardner's Point. A profile and sections were made of the present canal, based on data kindly furnished to the department by Joseph S. Harris, Esq., President of the Lehigh Coal and Navigation Company.

Estimates were made for supplying 100 and 210 million gallons daily at gradients of one foot and of one-half foot per mile. The long levels on the present canal, one of which is over ten miles, require considerable regrading to obtain the fall necessary for the delivery of the above quantities. Widening would also be necessary, which requires a reconstruction of the bridges and locks, and an entirely new channel would have to be built from Bristol to Lardner's Point, a distance of about 14 miles.

The total length of the aqueduct would be 37.5 miles. The cost* of this project is estimated as follows: (a) for supplying 100 million gallons per day, $4,994,664, to which must be added $6,710,041, representing the capitalized cost of pumping into the Wentz Farm Basin, including the plant, making a total of $11,704,705; (b) for supplying 210 million gallons per day $6,232,953, to which must be added $13,766,085, representing the capitalized cost of pumping, including the plant, and making a total of $19,999,038.

To both of these estimates it is still necessary to add the cost of purchasing the present canal, and the land damages between New Hope and Philadelphia.

Among the projects that have been investigated, this one has no marked advantages over the others. Its disadvantages are as follows:

The artificial banks are liable to be broken from numerous causes, thereby cutting off the supply. The shallow depth of the open channel is liable to cause the water to become very warm during the summer months on its long course of over 37 miles, thereby facilitating the development of low organic life. The flat gradient and consequent slow velocity would not permit of the aëration secured in natural creeks or in large rivers. An extreme cold winter might by the formation of ice seriously decrease the ordinary capacity of the channel.

2. *Closed Aqueduct Scheme.*—From Philadelphia to a point near Pineville, the aqueduct would be identical with the one running to Point Pleasant, as described in my last report. It there takes a northerly direction to near Ingham's Spring, passes through a gap between Buckingham and Solebury mountains, and continuing in a northeasterly direction reaches the Delaware river about one mile above New Hope. This branch line has 3,100 feet of tunneling, 4,000 feet of inverted siphons, and 5,700 feet of pumping mains. It passes about fifty feet above Ingham's Spring, and has a stand-pipe about one mile

*See detailed estimate, Appendix No. 2.

and a half northwest of New Hope, to which the water would have to be pumped.

The total length of the aqueduct from the proposed basin at Twelfth street and Olney avenue, in Philadelphia, is 28.54 miles. The cost* is estimated at $6,367,224, to which must be added the cost of the pumping plant and the capitalized cost of pumping 210 million gallons daily, amounting to $14,752,201. The total cost of this project is therefore $21,119,425.

This project allows the water from the Neshaminy creek to be collected and delivered into the aqueduct by gravity. The cost of collecting the same, and the available amount have not yet been ascertained. It is therefore impossible at present to state how much it would reduce the total cost.

There are no marked advantages to be gained by adopting this scheme over others. A disadvantage exists in the fact that a considerable portion of the aqueduct would have to be abandoned when an extension to a point further up the river is found to be necessary.

Philadelphia to Lumberville.

Above New Hope the next practicable point from which the Delaware water may be taken is at Lumberville. The aqueduct to this point was described in my last report. Its location has since been revised and slightly altered. Its length from the proposed basin at Olney avenue and Twelfth street, in Philadelphia, is now 30.57 miles, and its cost* is $6,720,147.

The cost of the pumping plant and the capitalized cost of pumping 210 million gallons per day are $13,538,520; the total cost of the project is therefore $20,258,667.

This project likewise allows the water from the Neshaminy creek to be collected into the aqueduct. When the cost of storing the same has been determined, it will be possible to

*See Appendix No. 2.

state the reduction which might be made from the above figures in case this water is to be used.

The principal advantage of Lumberville as a point from which a future water supply may be obtained, lies in the circumstance that the aqueduct to this point would be useful for all time, as it is on the direct line to the Blue Mountains, whence the supply for Philadelphia must ultimately be taken, and in the fact that it is the nearest point on this line where a satisfactory supply may be obtained at present.

No objections can be made to this scheme except that it is more expensive than others yet to be named.

Philadelphia to Point Pleasant.

By continuing the aqueduct just described, a few miles further up the Delaware river, we gain the advantage of reducing the height of pumpage from 162 to 145 feet, and also of securing the water from the Tohickon creek, which may be stored and made to flow into the aqueduct by gravity, as mentioned in previous reports. If we do not make use of the latter, but pump the entire quantity of water required from the river, we obtain the following figures:

The length of the aqueduct would be 32.9 miles, starting at the proposed basin at Olney avenue. The cost* is estimated at $7,373,559. The cost of the pumping plant and and the capitalized cost of pumping 210 million gallons per day, is $12,248,984. The total cost would therefore be $19,622,543.

If the Tohickon water is utilized this cost may be considerably reduced, and another reduction would be possible, if the Neshaminy water is also stored and turned into the aqueduct. In neither case however have the necessary data yet been obtained to enable the amount of this reduction to be stated. The aqueduct would be slightly lengthened to 33.9 miles, and its cost* would be increased to $7,386,009.

The advantages are the same as those given for the Lum-

* See Appendix No. 2.

berville scheme, with the additional one that it is less expensive owing to the decreased height of pumping, and also that the Tohickon water could be used. On the other hand there are no objectionable features, unless it be found, in a final comparison which is made after the cost of storage has been computed, that it is more expensive than other projects.

POINT PLEASANT TO THE BLUE MOUNTAINS.

When the Delaware water at Point Pleasant has become sufficiently polluted to demand an extension of the aqueduct, it would probably be best to go at least as far as Portland, near the Delaware Water Gap, at which point the aqueduct reaches the level of the river and can receive its water without requiring pumping. In the last report this aqueduct was fully described. A revision of the line has determined its length to be 47.20 miles, and its cost $11,142,052.

When this extension is desired, or at some period thereafter, it might be found that the sewage entering the Delaware river from cities and settlements above Portland, such as Stroudsburg, Port Jervis, etc., is sufficiently suspicious to warrant an additional expense to guard against any danger therefrom; then a final project presents itself, namely, the continuation of the aqueduct to the streams of the mountainous region of Monroe and Pike Counties, which have an exceedingly sparse population, and offer no inducements to its future increase, from the absence of mineral wealth and of facilities for agriculture. The territory available for furnishing the city with water by means of this aqueduct, which would run as far as Bushkill, is about 440 square miles, and with the aid of a sufficient number of storage dams, could supply the city with as much as 400,000,000 gallons per day.

The cost* of the aqueduct from Portland to the Water Gap, with extensions to beyond Stroudsburg and Bushkill, furnishing 210,000,000 gallons per day, is estimated at $2,954,497, their aggregate lengths being 22.79 miles.

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*See Appendix No. 2.

The advantage of this extension to beyond the Blue Mountains is to be found in the excellence of the water which can be secured by it. No better source of supply can be found in Eastern Pennsylvania. The objections are, the great cost of the necessary aqueducts and dams.

PHILADELPHIA TO PERKIOMEN CREEK.

The Blue Mountains can be reached with about the same length of aqueduct by a line passing through the valley of the Perkiomen Creek to the Lehigh River. And several schemes present themselves in connection with this line. In my previous reports a detailed account was given of the aqueduct lines run between Philadelphia and the Perkiomen. During the year further studies were made with the following results:

No more time was spent in making either a location or an estimate for an aqueduct by the way of Evansburg, for which a survey had previously been made and plotted, because it became evident that the line would be much more expensive than the one adopted. The Wissahickon alternate, via Gwynedd, was also laid aside on account of its expense, if built at the gradient adopted.

The projected terminus near Salford's Station was abandoned as it was found that a dam at this point would not be economical. It was placed near Frederick Station instead, on the assumption that a dam be built at the gorge above Schwenksville to store the water both of the Perkiomen and of West Swamp Creek.

The length of the aqueduct from the Cambria basin in Philadelphia to this point is 26.69 miles, and the cost* is estimated at $6,534, 230. The detailed location of almost the entire line is already described in the report for 1883.

The results of the topographical surveys and compilation of statistics show that the water of the West Swamp and Macoby creeks and of the North-East Branch was not as desirable,

* See Appendix No. 2.

although fairly good, as the water from the main Perkiomen and East Swamp creeks.

It was therefore thought well to estimate for an extension of the aqueduct to Green Lane, limiting the supply to the latter two creeks only. The length from the Cambria basin to Green Lane is 32.29 miles, and the cost* is estimated at $7,164,458.

The advantage of the Perkiomen scheme lies in the fact that all the water is received into the aqueduct by gravity. Whether the cost of storing the water in sufficient quantities to furnish the required supply, will be greater than the cost of securing the same amount by pumping at other points, is still to be ascertained. Among the disadvantages might be reckoned the dependency upon stored water alone, which under certain conditions does not preserve its original purity. This objection could perhaps be made to the storing of water in the lower areas of the West Swamp Creek and North-East Branch, draining large agricultural areas; but not to the higher reservoirs fed from the southern slope of the South Mountain and from a territory which to a large extent is uncultivated and wooded.

Perkiomen Creek to the Blue Mountains.

The amount of water available from the entire Perkiomen water shed has not yet been definitely ascertained, yet it will not fall far short of 200 million gallons per day. The amount at Green Lane including the East Swamp Creek would probably give about 100 million gallons per day. The remaining quantity, on the basis of a supply of 210 million gallons per day, would have to be obtained elsewhere, and the only suitable locality lies in the Lehigh Valley north of the Blue Mountains.

As mentioned in my last report a survey and reconnaissance were made to determine the feasibility and cost of an aqueduct connecting the Perkiomen with the upper Lehigh Valley. During the present year the notes were plotted, the location for an aqueduct determined and an estimate of cost made.

* See Appendix No. 2.

At Treichlersville, a small village situated on the Perkiomen Creek at the foot of the southern slope of the South Mountain, and at an elevation of four hundred feet above city datum, it was found that an aqueduct could be started which would discharge the water from the upper Lehigh river into the Perkiomen Creek. A tunnel through the South Mountain leads at once into the Lehigh water shed. On a comparatively direct line the aqueduct passes near Millerstown and Crackersport to a point near Ironton, where two alternates diverge, the better one of which has not yet been determined; one takes a northeasterly direction towards Whitehall and follows the Lehigh River, crossing it at Kuntz's Dam. The other takes an almost direct northerly course, crossing the river about a mile below Slatington; from this point the aqueduct follows the eastern side, and after passing the Lehigh Gap crosses the Aquanchicola Creek, and four and three quarter miles further up, near Weissport, also the Big Creek. These two affluents of the Lehigh river, lying between the Pocono and Blue Mountain ranges, and together having a water shed of about 170 square miles could furnish, with the aid of storage reservoirs, at least 130 million gallons per day of excellent water.

The length of an aqueduct from Treichlersville to Big Creek is 33.47 miles, and the cost* is estimated at $5,837,757.

The capacity of the aqueduct is assumed to be 130 million gallons per day, intended to supplement the supply from the upper Perkiomen. The gradient from Treichlersville to Big Creek is one foot in two thousand feet, and the size is 8 feet in diameter. Should this aqueduct be built, it would of course be more economical to make it larger, and provide for a correspondingly larger supply from further up the river. The above size was assumed simply for the purpose of a fair comparison.

An extension of the aqueduct up the river from Big Creek to White Haven is quite feasible, and it would enable water to

*See Appendix No. 2.

be drawn from a still better territory. An estimate of cost shows that an aqueduct, 22.15 miles long and 8 feet in diameter, with a capacity of 130 million gallons per day, would cost $4,786,844.*

The entire quantity of water available from the head waters of the Lehigh River, north of the Blue Mountains and east of the river, can, by establishing storage reservoirs, be increased to over 450 million gallons per day.

The advantages of obtaining a supply from this source would be the same as those mentioned in connection with a supply from the upper Delaware. The water is most excellent, and from the fact that there are no inducements to either manufacture or agriculture, it is bound to remain so indefinitely. The disadvantages of the scheme are mainly the damages resulting from a serious diminution in the flow of the river.

I have appended a table giving the principal dimensions of the different aqueducts, their capacity, and cost; also, one giving the cost of pumping for the projects depending on the water from the Delaware River, below the Water Gap. The capitalized cost of pumping, given in the last column, added to the cost of the pumping plant, is to be compared with the cost of storing the necessary quantity of water in the smaller water sheds under consideration, in order to furnish a uniform supply of the desired quantity. This cost is to be ascertained during the present year.

The estimates were based on a careful calculation of the respective quantities of material and amount of labor required.

The prices were assumed at present rates for similar work. In adding a percentage for contingencies a different assumption was made for different lines, depending on the degree of accuracy of the data available in each case. The cost of the inverted syphons was based on a supply of 100 million gallons per day, this being the quantity probably required at first; the additional pipes would be laid as needed.

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*See Appendix No. 2.

TOPOGRAPHY OF GENERAL WATER-SHEDS.

During the past year the Surveys of the Perkiomen, Tohickon and Neshaminy Water Sheds were completed. It was thought desirable to have also a reconnaissance made with Aneroid barometers of the entire mountainous region north of the Blue Mountains and between the Lehigh and Delaware Rivers. But there was insufficient time left for the purpose. The only section surveyed in this manner was a portion of the Upper Lehigh Valley, which was reported upon in 1883.

The topography of the Perkiomen and adjoining water sheds was plotted on large maps in the manner previously mentioned. During the year they were tinted to show their features with more distinctness. The roads were colored yellow, the timbered areas received a green tint, the buildings were shown in red and the streams in blue. They are at present finished excepting a few of the titles. These maps cover over 446 square miles of territory in Bucks, Montgomery and Lehigh Counties. They are plotted to a scale of 400 feet to one inch, contain contours ten feet apart and show all roads, buildings, etc., with considerable accuracy. They will therefore form a valuable contribution to the survey of the State. The maps of the Geological Survey, covering a portion of the Perkiomen Valley, were mounted and tinted to correspond with our own. The scale of these is only 1,600 feet to one inch.

All these maps were reduced by photography to the scale of 1½ inches per mile, preparatory to making a general topographical map extending from Philadelphia to the northern part of Bucks County, and measuring about six feet square. A preliminary map was made by simply mounting the photographic prints and carefully adjusting them to the lines of latitude and longitude, to avoid errors from irregular shrinking.

A map has been started to show the available collecting areas north of the Blue Mountains. The existing maps and surveys were found to be so erroneous that considerable difficulty was experienced in joining them. The map as at present laid out is based upon the best attainable data. The Aneroid survey over a portion of the territory will enable contour lines to be drawn upon the same.

From the large maps the desirable statistics have been collated. The areas were divided into such as were cultivated and improved, including the roads, villages, etc., and into such as were untillable and covered with forests. The highest and lowest elevations were noted and a mean elevation for the water shed computed. The U. S. Census enumeration for the Counties and Townships was used to get the average population per house, and by counting the number of buildings in each water shed the distribution of the population residing thereon was estimated.

It is probable that the results obtained from the maps of the Geological Survey, covering the Upper Perkiomen Valley, give a slight excess of population, because no distinction had been made between houses and barns, which probably caused the latter to be sometimes counted in with the former. The villages and their separate population were recorded, as well as the length of railroads and public roads, and the number and kind of manufactories on each water shed.

A recapitulation from these tables is appended. The percentage of the untillable and wooded areas allows of a deduction regarding the quality of the water. It is clearly shown why such streams as the Upper Perkiomen and Tohickon, having a large percentage of untillable ground do not get very turbid after storms, and clear up much quicker than the others. The population also varies, as might be expected, directly with the percentage of cultivated and improved areas. A judgment of the relative superiority of the different water sheds, from a sanitary point of view, is therefore materially aided by a comparison of the results given in these tables.

Another compilation is being made, in which the features governing the relation of rainfall and stream flow have been grouped. The water sheds were divided into belts, the first one comprising all the territory between 0 and 200 feet above city datum, the second, that between 200 and 400 feet above the same, the third, that between 400 and 600 feet and so on. On each one the topographical characteristics were noted, such as the areas of roads from which the water flows off most rapidly, and the areas cultivated as well as those wooded or untillable. A division was also made separating these areas into such as have an average slope of less than two feet per hundred, into such as have one between two feet and twenty feet per hundred and finally into such as have a slope of more than twenty feet per hundred. By means of this compilation a more definite relation between rainfall and stream-flow may be obtained than would otherwise be possible, a question which comes into prominence when a large number of storage basins are contemplated, such as would be required for the use of the water from the areas under consideration.

During the past year but little time was available for the final part of the investigation, namely, the cost of storing water in the different water sheds. The calculations for the stream-flow had not been completed, and any conclusion before such completion, must necessarily have been based on assumptions. The stream-flows are now nearly computed, and the storage capacity of the various proposed sites for reservoirs, and the cost of storage, are being determined.

SANITARY SURVEY.

The investigation of the sanitary features of the water sheds was continued by Mr. Barber, whose report is appended. It covers the whole Delaware Valley above Point Pleasant, and thus completes this branch of the investigation. It includes also a description of the valley between Point Pleasant and Yardleyville, in consideration of the scheme for pumping from the latter point. There are but few notable sources of contamination in this portion of the valley, yet the amount of pollution is considerable from Lambertville, only nine miles above Yardleyville, having a population of over 4,000 and also extensive manufactories. Trenton takes its supply from the Delaware River four miles below Yardleyville, and the water is generally considered very satisfactory, though in the spring of 1883, and at the same season in several preceding years, there was general complaint of a fishy taste and smell, quite offensive to many. No satisfactory investigation of this trouble was ever made.

Mr. Barber's work consisted chiefly of an investigation of the pollution of the streams, especially by manufactory refuse and the domestic sewage of towns. The report follows the river up from Point Pleasant, and goes back into the country to almost all villages having a population of over 500, and many smaller ones, gives their present estimated population, and states their location and other peculiarities affecting the extent of the river pollution caused by them. At the end is a list of all villages and towns of over 200 population, with their distance above the nearest proposed point of supply.

A map has also been prepared to accompany this report, and is appended, showing the distribution of population throughout the entire area drained by the Schuylkill and Delaware above Philadelphia.

The whole population of the Delaware water shed above Point Pleasant, including the Lehigh, as compiled by Mr. Barber (from the United States Census, corrected by local estimates and consideration of the causes affecting an increase or decrease since the last enumeration), is 399,150, of which 58,365 are in New Jersey and 79,400 in New York. The area being 6,793 square miles, the number of inhabitants per square mile is less than 59, against 176 per square mile in the Schuylkill water shed.

The report shows the river to be quite free from gross pollution for 25 miles above Point Pleasant, having no large towns near it, and none in that portion of its water-shed, except Hackettstown, N. J., 46 miles above Point Pleasant, and

Washington, N. J., 35 miles above—too far distant to produce any perceptible effect in the quality of the water at the proposed point of supply. Moreover the character of the river is such as to secure extensive purification of sewage received above, in its flow of 25 miles over a broad rocky bed, with a fall of 84 feet.

The lower Lehigh river is the source of the most extensive pollution by domestic and manufactory sewage in the whole Delaware water-shed, chiefly from the towns of Easton, Bethlehem and Allentown, having a total population of about 50,000. Although these towns are as yet almost entirely without sewers, their natural facilities for surface and under drainage are so good that a great amount of organic waste must necessarily reach the river. Manufacturing villages continue at frequent intervals all the way to Mauch Chunk, 45 miles above the mouth of the Lehigh, a town of nearly 4,000 inhabitants, most of whom have complete sewerage to the river. At and above Mauch Chunk several tributaries from the coal regions enter the Lehigh, bringing sulphuric acid from the mines and considerable sewage from the mining population, which is quite dense in several places. The tributaries from the west continue unsuitable for domestic water supply to above White Haven, 68 miles from the mouth of the Lehigh. Above that point the whole water-shed is not surpassed by any territory available as a source of supply for Philadelphia, having almost no population except in a few scattered hamlets, being unfit for agriculture or even grazing, and having no mineral resources or other inducements. Without doubt this region will remain for generations essentially in its present condition. The tributaries from the east below White Haven as far down as the Blue Ridge are also of excellent character, affording in all an area of about 542 square miles, with a population of only 10,000, or about 18 to the square mile.

Although the Lehigh river below White Haven is polluted to such an extent as to make it an undesirable supply of itself, its water becomes so purified by its long flow and the frequent accessions of purer tributaries, and again to a much greater degree after mixing with the larger volume of the Delaware River and flowing in its broad and shallow channel between Easton and Point Pleasant, that the water at the latter point is of great purity and would probably prove satisfactory in quality for many years. Moreover when the volume of the Lehigh river is smallest and the amount of sewage proportionately largest, the Delaware canal receives probably fully one-third of the water of the Lehigh, and of this third carries about one-half past Point Pleasant.

But the lower Lehigh Valley is bound to increase rapidly in population on account of being one of the most important pathways to the coal regions, and the time will come sooner or later when the Delaware river below the Lehigh will become unfit for a domestic water supply.

Between Point Pleasant and the Water Gap Mr. Barber's report shows but little pollution except in the towns of Belvidere, N. J., and Bangor, Pa. The former is decreasing in population (now 1750) but the latter (population 2500) has had a rapid growth, and seems likely to increase, being one of the principal centres of the slate quarrying industry.

With the exception of Stroudsburg and a few miles around it the Delaware for more than forty miles above the Blue Mountains drains a water-shed as fine as that of the Upper Lehigh, and with the further exception of the town of Honesdale and the aggregation of population about it, the whole remaining portion of the water-shed in Pennsylvania is exceedingly well fitted for the supply of water of a high degree of purity.

In New York State the only town giving any considerable pollution to the Delaware, is Port Jervis, 50 miles above the lowest proposed terminus of the gravity aqueduct. The 2,623 square miles in New York have an average population of less than 31 each, or without Port Jervis less than 27 per square mile. The upper portion of the water shed in New York, being a tolerably good farming country, is destined to increase in population, and the time may come when the water of the Delaware, at the Water Gap, will be unsatisfactory for domestic purposes. There will still remain, however, as already mentioned, an area of about 440 square miles of mountainous country in Monroe and Pike Counties, Pa., having at present a population of only 11,000, or 25 per square mile, which could be utilized for a supply sufficient for domestic purposes when the Delaware river itself at that point becomes unfit. This area possesses little, if any inducements to any considerable increase of population, especially the higher part drained by Bushkill Creek.

HYDROGRAPHIC WORK.

The Hydrographic work was continued in charge of Mr. H. W. Sanborn. It consisted in measuring the amount of rainfall on the areas to be investigated, the daily flow of the creeks traversing them, also the minimum flows of the Delaware and Lehigh rivers and the amount of rain water from storms flowing off small areas having different surface characteristics, all of which was a continuation of the work of the previous year.

Rain Fall.

No changes were made during the year in the location or number of rain gauges. The observations were continued without interruption, and furnish at present a continuous series extending over a period of more than two years. Appended is a table giving the monthly precipitations up to December 1885, in Philadelphia and in the Schuylkill, Perkiomen, Delaware, Tohickon, and Neshaminy Valleys. The localities are grouped in a manner showing, as nearly as possible, the amount of rain falling on each water shed. All of the observations are compared with those taken by the United States signal officer in Philadelphia, a column of differences being added for every station.

Annual Totals are given showing both the actual amounts in inches that fell and also the percentages as compared with the amounts recorded at the United States Signal Service Station in Philadelphia. At the bottom of the table the observations of the three years ending December 1885 are averaged, the results being given in inches and percentages. The continuation of these observations for a greater number of years will of course vary these averages and show the relation of the rain fall at the different stations with more and more accuracy. Already the present results show with some definiteness that, for instance, while in the Perkiomen water shed the rain fall is materially greater than at the Signal Service Station in Philadelphia, yet it is not as great as estimated for the Perkiomen project by the Commission of Experts in their report in 1875.

There is also appended a table showing the results obtained by the automatic gauges during a few of the most violent storms of the year, similar to the one appended to my last report.

The rain fall observations of the previous years have all been plotted on large charts in a manner which facilitates a comparison with regard to the amounts that fell in neighboring localities and with regard to the duration, extension and intensity of the storms.

The observations taken for the purpose of ascertaining the amounts of rainwater flowing off areas having different surface characteristics were discontinued in the fall. The deductions from the same have not yet been made.

Stream Flow.

During the year gaugings were made at the following points, according to the methods specified in previous reports. The Perkiomen Creek was gauged at Frederick, the West Swamp Creek at Zieglersville, the North East Branch near Schwenksville. The observations were taken by Mr. George W. Wood.

The Big and Little Neshaminy Creeks were gauged at the Forks and the Mill Creek above Rush Valley by Mr. J. G. Hilsman. The Tohickon was gauged at Point Pleasant by Mr. R. C. Stover.

During the summer months weir measurements were made at the West Swamp, Big Neshaminy, Mill and Tohickon Creeks.

Numerous meter measurements were made on all the streams under observation.

Early in the fall meter measurements were also made of the minimum flows in the Delaware River at the Water Gap and at Point Pleasant and of the Lehigh River at White Haven, the results of which are given in the appended table.

Owing to a decided change in the bed of the Tohickon Creek at the gauge, it was found necessary to select a new location for the same. The importance of the Tohickon in connection with a supply from Point Pleasant, made it advisable to establish a permanent gauge, at a point where no changes in the bed would be likely to occur. The automatic gauge is placed at this point when the weir is not used.

The observations made on the streams since the beginning of the work, have been compiled and the daily flows are nearly all computed, excepting the Little Neshaminy, the West Swamp, North East Branch and Macoby Creeks. It is not yet possible therefore to give the final results for any stream. As far as calculated they are plotted upon large charts, the ordinates representing the daily flows in million gallons per day and cubic feet per second. Each chart contains the annual record for one stream.

In order to better understand the relation of the flows to the rain fall and temperature, the former as deduced from the nearest points of observation, and the average daily temperature at Philadelphia, are plotted immediately under the same. The effects both of a long period of hot weather on the amount of water flowing off after a sudden rain fall and of a thaw during the winter, are clearly indicated and the relations can be measured.

PARTIES ENGAGED ON THE WORK.

The following is a list of the persons engaged during 1885, with time of service:

Engineering Work.

Mr. F. L. Paddock, Principal Assistant, whole year.
Mr. Harvey Linton, Assistant, whole year.
Mr. H. W. Sanborn, Assistant, whole year.
Mr. George B. Mifflin, Assistant, whole year.
Mr. W. H. Forsythe, Assistant, until December 1.
Mr. Kenneth Allen, Assistant, until December 1.
Mr. W. E. Parker, Sub-Assistant, whole year.
Mr. C. E. Taylor, Sub-Assistant, until December 1.
Mr. G. S. Cheyney, Sub-Assistant, until November 1.
Mr. H. A. Schofield, Rodman, whole year.
Mr. Amasa Ely, Rodman, until November 1.
Mr. William S. Gleim, Rodman, until June 1.
Mr. A. E. Miller, Rodman, whole year.
Mr. J. G. Hilsman, Stream Gauger, whole year.
Mr. George W. Wood, Stream Gauger, from May 1.
Mr. R. C. Stover, Stream Gauger, whole year.

Special Work.

Mr. Dana C. Barber, Sanitary Surveyor.

Rain-Gauge Observers.

Dr. J. A. Roth, Seisholtzville, Pa., whole year.
Mr. J. H. Steltz, Green Lane, Pa., whole year.
Mr. Edwin Heavner, Ottsville, Pa., whole year.
Dr. C. D. Fretz, Sellersville, Pa., whole year.
Mr. H. L. Shull, Lansdale, Pa., whole year.
Mr. Thomas Walton, Doylestown, Pa., whole year.
Mr. Manassas Bean, Frederick, Pa., until May 1.
Mr. George W. Wood, Frederick, Pa., from May 1.
Mr. J. G. Hilsman, Rush Valley, Pa., whole year.

In addition to these paid observers, we are indebted to the following persons who have kindly furnished us with rain-fall records:

General W. B. Hazen, Chief Signal Officer, Washington.

Sergeant C. M. Kitchell, U. S. Signal Service, Philadelphia.

Sergeant L. M. Dey, U. S. Signal Service, Philadelphia.

Mr. E. F. Smith, Chief Engineer Canals, Reading, Pa.

Mr. Thomas J. Beans, Burlington, N. J.

Mr. Charles Moore, Pottstown, Pa.

Mr. S. B. Lehman, Lebanon. Pa.

Mr. Milnor Gillingham, Falsington, Pa.

Mr. M. McNeill, Princeton, N. J.

Mr. H. H. Heacock, Quakertown, Pa.

Miss Emily Kent, Phillipsburg, N. J.

Prof. S. J. Coffin, Easton, Pa.

Dr. J. C. Green, West Chester, Pa.

Mr. Thomas Meehan, Germantown, Pa.

Pennsylvania Hospital, Philadelphia, Pa.

WORK REMAINING TO BE DONE.

To complete the investigation as marked out in the previous reports, the following work still remains to be done:

Completion of the computations, etc., for the stream flows in the Perkiomen, Tohickon, and Neshaminy Valleys.

Computation of the storage capacities in each valley and estimation of the cost of storage, including dams, land damages, etc.

Final report, including maps, charts, recapitulations, and tables to accompany the same.

Respectfully,

RUDOLPH HERING,

Engineer in Charge of Surveys.

LIST OF TABLES, MAPS, ETC., ACCOMPANYING THIS REPORT.

APPENDIX II.

ESTIMATED COST OF AQUEDUCTS.

PUMPING SUPPLY.

Estimated cost of Delaware Aqueduct, from Wentz Farm Basin, Philadelphia, to Yardleyville, Delaware River; four iron pipes, each 5 feet in diameter; length, 20.76 miles; capacity, 210,000,000 gallons per day.

1,272,935	cubic yards excavation, at 50 cents	$635,467 50
100,802	cubic yards borrowed material, at 50 cents	50,401 00
391,248,610	pounds iron in pipes, at 1½ cents	5,868,729 15
438,400	lineal feet pipe laid, at $1.48	648,832 00
856.4	cubic yards cut stone masonry, at $40	34,256 00
9,095.1	cubic yards rubble stone masonry, at $7	63,665 70
180.5	cubic yards brick laid, at $11	1,985 50
233.2	cubic yards concrete, at $5.50	1,282 60
28,170	pounds iron in buckle plate, at 4 cents	1,126 80
138,943	pounds iron I beams, at 4 cents	5,557 72
2	stand pipes,	60,000 00
		$7,371,303 97
	Add 20 per cent. for contingencies	1,474,260 79
		$8,845,564 76
	Pumping plant	1,250,000 00
	Capitalized cost of pumping	17,294,954 33
		$27,390,519 09
	Land damages	....

PUMPING SUPPLY.

Estimated cost of Delaware Division Canal Project from Receiving Basin at Lardner's Point, Philadelphia, to Limestone Rift (above New Hope), Delaware River; length, 37.5 miles; capacity of new canal, 100,000,000 gallons per day.

	New Receiving Basin at Lardner's Point......	$500,000 00
	Diversion of Wissinoming Creek.......	25,000 00
438,400	cubic yards rock excavation, at $1..............	438,400 00
1,717,926	cubic yards earth excavation, at 40 cents......	747,170 40
365,000	cubic yards borrowed material, at 50 cents....	182,500 00
89,874	cubic yards masonry, at $7.........................	629,118 00
36,500	cubic yards paving, at $2..........................	73,000 00
8	aqueduct bridges over streams.....................	454,837 00
22	bridges to convey streams over new canal......	143,115 00
1	drop..	4,480 00
95	road and farm bridges...............................	237,000 00
	Intercepting sewers....................................	195,000 00
1,000	lineal feet canal covering..........................	500,000 00
	Additional masonry...........................	12,600 00
	Dam across Delaware River at Limestone Rift	20,000 00
		$4,162,220 40
	Add 20 per cent. for contingencies..............	832,444 08
		$4,994,664 48
	Pumping plant...	750,000 00
	Capitalized cost of pumping.......................	5,960,040 65
		$11,704,705 13
	For purchase of present canal.....................	....
	For purchase of additional land, from Lardner's Point to Bristol, 14½ miles..............	....
	For additional land between Bristol and New Hope......................	....

Pumping Supply.

Estimated cost of Delaware Division Canal Project from Receiving Basin at Lardner's Point, Philadelphia, to Limestone Rift (above New Hope) Delaware River; length, 37.5 miles; capacity of new canal, 210,000,000 gallons per day:

	New Receiving Basin at Lardner's Point......	$500,000	00
	Diversion of Wissinoming Creek................	25,000	00
775,000	cubic yards rock excavation, at $1.00..........	775,000	00
2,239,066	cubic yards earth excavation, at 40 cents......	895,626	40
404,000	cubic yards borrowed material, at 50 cents....	202,000	00
127,443	cubic yards masonry, at $7........................	892,101	00
52,200	cubic yards paving, at $2.........................	104,400	00
8	bridges over streams................................	526,200	00
22	bridges to convey streams over new canal......	155,300	00
1	drop..	5,000	00
95	road and farm bridges	285,900	00
	Intercepting sewers.................................	195,000	00
1,000	lineal feet canal covering (through towns)....	600,000	00
	Additional masonry to support same...........	12,600	00
	Dam across Delaware River at Limestone Rift	20,000	00
		$5,194,127	40
	Add 20 per cent. for contingencies..............	1,038,825	48
		$6,232,952	88
	Pumping plant.......................................	1,250,000	00
	Capitalized cost of pumping......................	12,516,085	37
		$19,999,038	25
	For purchase of present canal.....................	....	
	For additional land between Bristol and New Hope..	....	
	For additional land from Lardner's Point to Bristol, 14½ miles..................................	....	

PUMPING SUPPLY.

Estimated cost of Delaware Aqueduct from proposed basin at Twelfth street and Olney avenue, Philadelphia, to New Hope, Delaware River; length, 28.541 miles; diameter, 12 feet; capacity, 210,000,000 gallons per day.

222,425	cubic yards rock excavation, at 80 cents........	$177,940	00
589,847	cubic yards rock excavation, at $1..............	589,847	00
569,500	cubic yards earth excavation, at 35 cents......	199,325	00
309,022	cubic yards borrowed material, at 50 cents....	154,511	00
60,700	cubic yards soiling, at 40 cents................	24,280	00
132,216	cubic yards tunnel excavation, at $6...........	793,296	00
2	shafts, 177 lineal feet, at $175....................	30,975	00
207,818	cubic yards brick masonry, at $11..............	2,285,998	00
469	cubic yards concrete, at $5.50.....................	2,579	50
10,577	cubic yards concrete lining in tunnels, at $6..	63,462	00
2,826	cubic yards cut stone masonry, at $40..........	113,040	00
17,547	cubic yards rubble stone masonry, at $7........	122,829	00
95,681	cubic yards rubble stone masonry, at $5........	478,405	00
949	cubic yards paving, at $2.............................	1,898	00
37,651,530	pounds iron in pipes, at 1½ cents..................	564,772	95
258,550	pounds iron in special work, at 5 cents.........	12,927	50
1,700	lineal feet piles driven, at 50 cents..............	850	00
12,000	feet B. M. timber placed, at $35..................	420	00
168	lineal feet 15-inch tile pipe, at $1.15............	193	20
53	lineal feet 18-inch tile pipe, at $1.25............	66	25
65,595	lineal feet pipe laying, trenching, etc., at $1.50	98,392	50
20	stop cocks, at $400....................................	8,000	00
20	chamber gates, at $200..............................	4,000	00
1	reservoir near New Hope..............................	40,000	00
94	man holes, at $12.......................................	1,128	00
172.5	acres right of way, at $100..........................	17,250	00
40	acres clearing, at $50..................................	2,000	00
		$5,788,385	90
	Add 10 per cent. for contingencies.............	578,838	59
		$6,367,224	49
	Pumping plant..	1,250,000	00
	Capitalized cost of pumping........................	13,502,201	19
	Total...	$21,119,425	68

Pumping Supply.

Estimated cost of Delaware Aqueduct from proposed basin at Twelfth street and Olney avenue, Philadelphia, to Lumberville, Delaware River; length, 30.568 miles; diameter, 12 feet; capacity, 210,000,000 gallons per day.

368,293	cubic yards rock excavation, at 80 cents	$294,634	40
343,045	cubic yards rock excavation, at $1	343,045	00
571,864	cubic yards earth excavation, at 35 cents	200,152	40
223,088	cubic yards borrowed material, at 50 cents	111,544	00
74,600	cubic yards soiling, at 40 cents	29,840	00
202,344	cubic yards tunnel excavation, at $6	1,214,064	00
4	shafts, 442 lineal feet, at $175	77,350	00
238,363.8	cubic yards brick masonry, at $11	2,622,001	80
411	cubic yards concrete, at $5.50	2,260	50
16,127	cubic yards concrete lining in tunnels, at $6	96,762	00
15,657	cubic yards rubble stone masonry, at $7	109,599	00
138,810	cubic yards rubble stone masonry, at $5	694,050	00
1,028	cubic yards paving, at $2	2,056	00
2,773	cubic yards cut stone masonry, at $40	110,920	00
8,902,740	pounds iron in syphon pipes, at 1½ cents	133,541	10
207,008	pounds iron in special castings, at 5 cents	10,350	40
1,700	lineal feet piles, at 50 cents	850	00
12,000	feet B. M. timber, placed at $35	420	00
168	lineal feet 15-inch tile drain, at $1.15	193	20
53	lineal feet 18-inch tile drain, at $1.25	66	25
15,510	lineal feet pipe laying, trenching, etc., at $1.50	23,265	00
15	stop cocks, at $400	6,000	00
19	chamber gates, at $200	3,800	00
105	manholes, at $12	1,260	00
190.5	acres, right of way, at $100	19,050	00
43	acres of clearing, at $50	2,150	00
		$6,109,225	05
	Add 10 per cent. for contingencies	610,922	50
		$6,720,147	55
	Pumping plant	1,250,000	00
	Capitalized cost of pumping	12,288,520	18
	Total	**$20,258,667**	**73**

Gravity Supply.

Estimated cost of Delaware Aqueduct from proposed basin at Twelfth street and Olney avenue, Philadelphia, to dam on the Big Neshaminy Creek; length, 18.07 miles; capacity, 210,000,000 gallons per day. Amount of water available from Neshaminy Creek, 100,000,000 gallons per day.

87,970	cubic yards rock excavation, at 80 cents.......	70,368	00
206,951	cubic yards rock excavation, at $1..............	206,951	00
413,061	cubic yards earth excavation, at 35 cents......	144,571	35
200,363	cubic yards borrowed material, at 50 cents....	100,181	50
44,300	cubic yards soiling, at 40 cents..................	17,720	00
130,391	cubic yards tunnel excavation, at $6...........	782,346	00
2	shafts, 177 lineal feet, at $1.75...................	30,975	00
143,138.5	cubic yards brick masonry, at $11...............	1,574,523	50
275	cubic yards concrete, at $5.50.....................	1,512	50
10,431	cubic yards lining, at $6............................	62,586	00
11,475	cubic yards rubble stone masonry, at $7........	80,325	00
83,975	cubic yards rubble stone masonry, at $5........	419,875	00
538	cubic yards paving, at $2...........	1,076	00
1,606	cubic yards cut stone masonry, at $40..........	64,240	00
2,086,490	pounds iron in siphon pipes, at $1\frac{1}{2}$ cents........	31,297	35
132,370	pounds iron in special work, at 5 cents.........	6,618	50
1,700	lineal feet piles driven, at 50 cents..............	850	00
12,000	B. M. feet timber, placed at $35..................	420	00
168	lineal feet 15-inch tile pipe, at $1 15............	193	20
53	lineal feet 18-inch tile pipe, at $1.25............	66	25
3,635	lineal feet pipe laying, trenching, etc., at $1.50	5,452	50
10	stop cocks, at $400	4,000	00
10	chamber gates, at $200..............................	2,000	00
62	manholes, at $12.......................................	744	00
109.5	acres right of way, at $100........................	10,950	00
28	acres of clearing, at $50............................	1,400	00
		$3,621,242	65
	Add 10 per cent. for contingencies..............	362,124	26
	Total..	$3,983,366	91

PUMPING SUPPLY.

Estimated cost of Delaware Aqueduct from proposed basin at Twelfth street and Olney avenue, Philadelphia, to site of pumping station near Point Pleasant, Delaware River; length, 32.9 miles; diameter, 12 feet; capacity, 210,000,000 gallons per day, to be pumped from the Delaware River:

354,716	cubic yards rock excavation, at 80 cents....	$283,772	80
373,755	cubic yards rock excavation, at $1..............	373,755	00
16,380	cubic yards rock excavation, at 1.25...........	20,475	00
577,264	cubic yards earth excavation, at 35 cents......	202,042	40
223,263	cubic yards borrowed material, at 50 cents...	111,631	50
78,000	cubic yards soiling, at 40 cents..................	31,200	00
223,724	cubic yards tunnel excavation, at $6...........	1,342,344	00
4	shafts 442 lineal feet, at $175...........	77,350	00
256,038.6	cubic yards brick masonry, at $11...............	2,816,424	60
678	cubic yards concrete, at $5.50.....................	3,729	00
17,898	cubic yards concrete lining in tunnels, at $6..	107,388	00
23,148	cubic yards rubble stone masonry, at $7.......	162,036	00
147,270.6	cubic yards rubble stone masonry, at $5.......	736,353	00
3,566	cubic yards cut stone masonry, at $40..........	142,640	00
1,345	cubic yards paving, at $2..........................	2,690	00
13,107,290	pounds iron in siphon pipes, at 1½ cents......	196,609	35
339,380	pounds iron in special work, at 5 cents........	16,969	00
1,700	lineal feet piles driven, at 50 cents.............	850	00
12,000	feet B. M. timber in place, at $35...............	420	00
168	lineal feet 15-inch tile pipe, at $1.15...........	193	20
53	lineal feet 18-inch tile pipe, at $1.25...........	66	25
22,835	lineal feet pipe laying, trenching, etc., at $1.50	34,252	50
25	stop cocks, at $400..................................	10,000	00
29	chamber gates, at $200.............................	5,800	00
112	manholes, at $12.....................	1,344	00
205.5	acres in right of way, at $100...................	20,550	00
47	acres of clearing, at $50..........................	2,350	00
		$6,703,235	60
	Add 10 per cent. for contingencies..............	670,323	56
		$7,373,559	16
	Pumping plant..	1,250,000	00
	Capitalized cost of pumping	10,998,984	11
	Total..	$19,622,543	27

Alternate Lines.

Taking Water from Neshaminy Creek.

Estimated cost of Delaware Aqueduct from Station 870 to Station 1090, on main line across storage dam for Big Neshaminy Creek; length, 3.36 miles; capacity, 210,000,000 gallons per day:

116,200	cubic yards rock excavation, at $1	$116,200 00
58,100	cubic yards earth excavation, at 35 cents	20,335 00
42,674	cubic yards tunnel excavation, at $6	256,044 00
7,900	cubic yards soiling, at 40 cents	3,160 00
3,414	cubic yards concrete lining, at $6	20,484 00
26,871.2	cubic yards brick masonry, at $11	295,583 20
120	cubic yards rubble masonry, at $7	840 00
3,250	cubic yards rubble masonry, at $5	16,250 00
34	cubic yards paving, at $2	68 00
20	acres, right of way, at $100	2,000 00
1	acre clearing, at $50	50 00
		$731,014 20
	Add 10 per cent. for contingencies	73,101 42
	Total	$804,115 62

Not taking Water from Neshaminy Creek.

Estimated cost of Delaware Aqueduct from Station 870 to Station 1090, on main line; length, 4.17 miles; capacity, 210,000,000 gallons per day:

158,311	cubic yards rock excavation, at $1	$158,311 00
20,000	cubic yards earth excavation, at 35 cents	7,000 00
9,954	cubic yards soiling, at 40 cents	3,981 60
33,277	cubic yards brick masonry, at $11	366,047 00
1,171	cubic yards rubble masonry, at $7	8,197 00
11,750	cubic yards rubble masonry, at $5	58,750 00
119	cubic yards cut masonry, at $40	4,760 00
168	cubic yards paving, at $2	336 00
25	acres right of way, at $100	2,500 00
5	acres clearing, at $50	250 00
	Crossing Neshaminy by syphon	168,817 00
		$778,949 60
	Add 10 per cent. for contingencies	77,894 96
	Total	$856,844 56

Pumping and Gravity Supply.

Estimated cost of Delaware Aqueduct from proposed basin at Twelfth street and Olney avenue, to site of pumping station near Point Pleasant;* length 33.09 miles; capacity 210,000,000 gallons per day; to utilize Tohickon flow; balance pumped from Delaware River.

354,716	cubic yards rock excavation, at 80 cents	$283,772 80
381,182	cubic yards rock excavation, at $1	381,182 00
16,380	cubic yards rock excavation, at $1.25	20,475 00
571,864	cubic yards earth excavation, at 35 cents	200,152 40
229,998	cubic yards borrowed material, at 50 cents	114,999 00
78,500	cubic yards soiling, at 40 cents	31,400 00
233,131.4	cubic yards tunnel excavation, at $6	1,398,788 40
4	shafts, 442 lineal feet, at $1.75	77,350 00
258,556.9	cubic yards brick masonry, at $11	2,844,125 90
526	cubic yards concrete, at $5.50	2,893 00
18,651	cubic yards concrete lining in tunnels, at $6	111,906 00
18,126	cubic yards rubble stone masonry, at $7	126,882 00
151,079	cubic yards rubble stone masonry, at $5	755,395 00
3,034	cubic yards cut stone masonry, at $40	121,360 00
1,257	cubic yards paving, at $2	2,514 00
10,725,190	pounds iron in siphon pipes, at 1½ cents	160,877 85
273,194	pounds iron in special work, at 5 cents	13,659 70
1,700	lineal feet piles driven, at 50 cents	850 00
12,000	feet B. M. timber in place, at $35	420 00
168	lineal feet 15-inch tile pipe, at $1.15	193 20
53	lineal feet 18-inch tile pipe, at $1.25	66 25
18,685	lineal feet pipe laying, trenching, etc., at $1.50	28,027 50
20	stop cocks, at $400	8,000 00
24	chamber gates, at $200	4,800 00
112	manholes, at $12	1,344 00
207.2	acres right of way, at $100	20,720 00
48	acres of clearing, at $50	2,400 00
		$6,714,554 00
	Add 10 per cent. for contingencies	671,455 40
		$7,386,009 40
	Pumping plant	....
	Storage reservoirs	....

Capitalized cost of pumping cannot be determined until average supply from Tohickon is known.

* This location passes to the west of Lumberville by tunnel, and crosses Tohickon Creek at proposed site of storage reservoir dam.

Gravity Supply.

Estimated cost of extension of Delaware Aqueduct from near Point Pleasant to one-half mile below Portland; length 47.197 miles; diameter 12 feet; capacity 210,000,000 gallons per day.

84,308	cubic yards rock excavation, at 80 cents........	$67,446	40
1,194,793	cubic yards rock excavation, at $1..............	1,194,793	00
295,639	cubic yards earth excavation, at 35 cents......	103,473	65
550,000	cubic yards borrowed material, at 50 cents.....	275,000	00
100,000	cubic yards soiling, at 40 cents..................	40,000	00
22,806	cubic yards tunnel excavation, at $6...........	136,836	00
145,188.5	cubic yards tunnel excavation, at $7...........	1,016,319	50
4	shafts 1,218 lineal feet, at 1.75 per foot.........	213,150	00
360,982	cubic yards brick masonry, at $11..............	3,970,802	00
2,547	cubic yards concrete, at $5.50.....................	14,008	50
13,472	cubic yards concrete lining, at $6................	80,832	00
4,897	cubic yards cut stone masonry (arches, trimmings, etc.), at $40..............................	195,880	00
37,273¾	cubic yards rubble stone masonry (bridges and culverts), at $7..............................	260,916	25
297,755¾	cubic yards rubble stone retaining walls and cradling, at $5....................................	1,488,778	75
1,547	cubic yards paving, at $2...........................	3,094	00
30,033,300	pounds iron in siphon pipes, at 1½ cents........	450,499	50
595,674	pounds iron in special work, at 5 cents.........	29,783	70
2,550	lineal feet 15-inch pipe, at $1.15.................	2,932	50
45	stop cocks, at $400....................................	18,000	00
45	chamber gates, at $200...............................	9,000	00
160	manholes, at $12.......................................	1,920	00
286	acres right of way, at $100..........................	28,600	00
145	acres clearing, at $50.................................	7,250	00
52,950	lineal feet pipe laying, trenching, jointing, etc., at $1.50...	79,425	00
		$9,688,740	75
	Add 15 per cent. for contingencies.............	1,453,311	11
		$11,142,051	86
	Dam across Delaware River near Portland and land damages..	....	

Gravity Supply.

Estimated cost of extension of Delaware Aqueduct from one-half mile below Portland, Delaware River, to Broadhead Creek above Stroudsburg and to Bushkill Creek, Delaware River;* aggregate length 22.791 miles; capacity 210,000,000 gallons per day.

381,110	cubic yards rock excavation, at $1	$381,110	00
70,800	cubic yards earth excavation, at 35 cents	24,780	00
90,000	cubic yards borrowed material, at 50 cents	45,000	00
55,600	cubic yards soiling, at 40 cents	22,240	00
18,579	cubic yards tunnel excavation, at $6	111,474	00
1,487	cubic yards concrete lining, at $6	8,922	00
118,091	cubic yards brick masonry, at $11	1,299,001	00
18,277	cubic yards rubble stone masonry, at $7	127,939	00
29,253	cubic yards rubble stone masonry, at $5	146,265	00
500	cubic yards cut stone masonry, at $40	22,400	00
66	cubic yards paving, at $2	132	00
3,151,260	pounds iron in syphon pipes, at 1½ cents	47,268	90
132,372	pounds iron in special work, at 5 cents	6,618	60
50	lineal feet 15 inch pipe, at $1.15	57	50
5,490	lineal feet pipe laying, trenching, etc., at $1.50	8,235	00
10	stop cocks, at $400	4,000	00
10	chamber gates, at $200	2,000	00
139	acres, right of way, at $100	13,900	00
9	acres clearing, at $50	450	00
	Bridging or syphoning Pocono and McMichael's Creeks	140,000	00
	Extras in small culverts, clearing, manholes, and incidentals	50,288	00
		$2,462,081	00
	Add 20 per cent for contingencies	492,416	20
		$2,954,497	20
	Storage reservoirs	....	

* This project to utilize the western affluents of the Delaware River betwen Water Gap and Bushkill.

Gravity Supply.

Estimated cost of Perkiomen Aqueduct from Cambria Basin, Philadelphia, to a point near Frederick Station, in the lower Perkiomen Valley; length 26.69 miles; diameter 12 feet; capacity 210,000,000 gallons per day.

4,109	cubic yards ringstones for arch culvert, at $40	$164,360 00
35,364	cubic yards masonry, at $7	247,548 00
4,283	cubic yards masonry in foundations, at $6	25,698 00
3,334	cubic yards paving, at $2	6,668 00
29,883	cubic yards excavation in foundation, at 50 cts.	14,941 50
1,178	lineal feet terra cotta pipe (18 in.), at $1.25	1,472 50
159,975	cubic yards tunnel excavation, at $6	959,850 00
379	lineal feet tunnel shafts, at $175	66,325 00
12,798	cubic yards tunnel lining, at $6	76,788 00
464,253	cubic yards earth excavation, at 35 cents	162,488 55
350,420	cubic yards rock excavation (shale and sandstone), at 80 cents	280,336 00
150,488	cubic yards rock excavation (sienite, slate and limestone), at $1	150,488 00
497,851	cubic yards borrowed material, at 50 cents	248,925 50
56,840	lineal feet 48 inch cast iron pipe, at $10.11	574,652 40
55,960	lineal feet trenching, jointing and laying, at $1.50	83,940 00
7	pairs siphon chambers, at $21,894	153,258 00
9,312	cubic yards retaining wall, at $5	46,560 00
195,699	cubic yards brickwork, at $11	2,152,689 00
95,325	cubic yards cradling, $5	476,625 00
182	cubic yards concrete, at $5.50	1,001 00
82	manholes, at $12	984 00
150	acres, right of way, at $100	15,000 00
1.66	acres land damages in Philadelphia, at $3,000	5,000 00
52,275	cubic yards soiling, at 40 cents	20,910 00
25	acres, clearing, at $50	1,250 00
1	conduit for mill race	1,951 00
	Removing house	500 00
		$5,940,209 45
	Add 10 per cent for contingencies	594,020 95
		$6,534,230 40
	Storage reservoirs and compensation for loss of water below Schwenksville Dam	....

Gravity Supply.

Estimated cost of Perkiomen Aqueduct from Cambria Basin, Philadelphia, to Green Lane, in the Perkiomen Valley; length, 32.29 miles; diameter, 12 feet; capacity, 210,000,000 gallons per day.

5,295	cubic yards ringstones for arch culverts, at $40....	$211,800	00
45,511	cubic yards masonry, at $7..........................	318,577	00
5,282	cubic yards masonry in foundations, at $6.......	31,692	00
4,418	cubic yards paving, at $2..........................	8,836	00
25,275	cubic yards excavation in foundations, at 50 cts...	12,637	50
1,608	lineal feet terra cotta pipe (18-inch), at $1.25...	2,010	00
165,239	cubic yards tunnel excavation, at $6..............	991,434	00
379	lineal feet shafts, at $175........................	66,325	00
13,240	cubic yards tunnel lining, at $6..................	79,440	00
433,862	cubic yards earth excavation, at 35 cents.........	151,851	70
312,643	cubic yards rock (shale and sandstone), at 80 cts.	250,114	40
238,681	cubic yards rock (sienite, slate, and limestone), at $1..	238,681	00
56,000	cubic yards trap rock, at $1.25....................	70.000	00
513,672	cubic yards borrowed material, at 50 cents.......	256,836	00
56,840	lineal feet 48-inch cast-iron pipe, at $10.11......	574,652	40
55,960	lineal feet trenching, jointing, and laying, at $1.50...	83,940	00
7	pairs siphon chambers, at $21,894.................	153,258	00
9,812	cubic yards retaining wall, at $5..................	49,060	00
219,553	cubic yards brick work, at $11.....................	2,415,083	00
98,000	cubic yards cradling, at $5........................	490,000	00
235	cubic yards concrete, at $5 50......................	1,292	50
94	man-holes, at $12....................................	1,128	00
184	acres, right of way, at $100.......................	18,400	00
1.66	acres, land damages, at $3,000.....................	5,000	00
61,440	cubic yards soiling, at 40 cents....................	24,576	00
30	acres clearing, at $50................................	1,500	00
	Conduit for mill-race..................................	1,951	00
	Removing house..	500	00
1	drop (13 feet)...	2,568	00
		$6,513,143	50
	Add 10 per cent. for contingencies.................	651,314	35
		$7,164,457	85
	Storage reservoirs and compensation for loss of water below Green Lane..........................		

GRAVITY SUPPLY.

Estimated cost of Aqueduct from Treichlersville, in the upper Perkiomen Valley, to Aquanchicola Creek, in the Lehigh Valley; length, 28.7 miles; diameter, 8 feet; capacity, 130,000,000 gallons per day:

7,077	cubic yards arch culvert masonry, at $10	$70,770 00	
1,532	cubic yards rect. culvert masonry, at $7	10,724 00	
1,660	cubic yards foundation masonry, at $6	9,960 00	
1,000	cubic yards paving, at $2	2,000 00	
3,186	cubic yards foundation excavation, at 50 cents	1,593 00	
377	lineal feet drain tile, at $1.25	471 25	
			$95,518 25
10,000	cubic yards retaining wall, at $5	$50,000 00	
75	cubic yards concrete, at $5.50	412 50	
1,000	cubic yards masonry to support siphons, at $7	7,000 00	
48,410	cubic yards cradling, at $5	242,050 00	
			299,462 50
82,800	cubic yards tunnel excavation, at $8	$662,400 00	
117	lineal feet tunnel shafts, at $175	20,475 00	
6,624	cubic yards tunnel lining (concrete), at $5,50	36,432 00	
			719,307 00
170,250	cubic yards earth excavation, at 35 cts.	$59,587 50	
545,682	cubic yards rock excavation, at $1	545,682 00	
126,116	cubic yards borrowed material, at 75 cents	94,587 00	
			$699,856 50
139,717	cubic yards brickwork, at $12		1,676,604 00
6	pairs siphon chambers, at $25,000	$150,000 00	
36,160	lineal feet 48-inch cast iron pipe, at $10.11	365,577 60	
35,904	lineal feet trenching, jointing, and laying, at $1.50	53,856 50	
			569,433 60
80	manholes, at $12		960 00
174	acres right of way, at $75		13,050 00
40	acres clearing, at 50		2,000 00
6	pipes at Kuntz dam siphon		19,810 00
2,000	cubic yards masonry, Jordan Creek Dam		14,000 00
58,575	cubic yards soiling, at 60 cents		35,145 00
			$4,145,146 85
	Add 20 per cent. for contingencies		829,029 37
	Total		$4,974,176 22
	Storage reservoirs and compensation for loss of water		....

Gravity Supply.

Estimated cost of Aqueduct in the Lehigh Valley, from Aquanchicola Creek to Big Creek ; length, 4.77 miles ; diameter, 8 feet ; capacity, 130,000,000 gallons per day.

4,600	cubic yards arch culvert masonry, at $10...	$16,000 00	
120	cubic yards rect. culvert masonry, at $7....	840 00	
1,320	cubic yards foundation masonry, at $6.....	7,920 00	
660	cubic yards paving, at $2.....................	1,320 00	
1,400	cubic yards excavation in foundations, at 50 cents..	700 00	
270	lineal feet drain tile, at $1.25	337 50	
			$57,117 50
660	cubic yards retaining wall, at $5...........	$3,300 00	
7	cubic yards concrete, at $5.50................	38 50	
680	cubic yards masonry to support siphons, at $7..	4,760 00	
10,100	cubic yards cradling, at $5...................	50,500 00	
			58,598 50
1,350	cubic yards tunnel excavation, at $8.......	$10,800 00	
108	cubic yards tunnel lining (concrete), at $5.50................	594 00	
			11,394 00
27,731	cubic yards earth excavation, at 35 cents..	$9,705 85	
79,025	cubic yards rock excavation, at $1..........	79,025 00	
106,000	cubic yards borrowed material, at 75 cts...	79,500 00	
			168,230 85
18,693	cubic yards brick work, at $12.......		224,316 00
2	pairs siphon chambers, at $25,000.........	$50,000 00	
14,784	lineal feet 48-inch cast iron pipe, at $10.11..	149,466 24	
14,592	lineal feet trenching, jointing, and laying, at $1.50...	21,888 00	
			221,354 24
19	man-holes, at $12......		228 00
29	acres, right of way, at $75................................		2,175 00
10	acres clearing, at $50..		500 00
11,710	cubic yards soiling, at 60 cents..............................		7,026 00
			$750,940 09
	Add 15 per cent. for contingencies........................		112,641 01
			$863,581 10
	Storage reservoirs and compensation for loss of water.........................		....

Gravity Supply.

Estimated cost of Aqueduct in the Lehigh Valley, from Big Creek to White Haven; length 22.15 miles; capacity 130,000,000 gallons per day.

9,521	cubic yards arch culvert masonry, at $10	$95,210 00	
6,348	cubic yards rect. culvert masonry, at $7	44,436 00	
882	cubic yards foundation masonry, at $6...	5,292 00	
1,540	cubic yards paving, at $2..................	3,080 00	
9,538	cubic yards excavation in foundations, at 50 cents....................................	4,769 00	
250	feet 18 inch drain tile, at $1.25...........	312 25	
			$153,099 25
14,340	cubic yards retaining wall, at $5..........	$71,700 00	
18	cubic yards concrete, at $5.50..............	99 00	
320	cubic yards masonry to support siphons.	2,240 00	
21,960	cubic yards cradling, at $5.................	109,800 00	
			$183,839 00
78,150	cubic yards tunnel excavation, at $8......	625,200 00	
6,252	cubic yards tunnel lining (concrete) at $5.50..	34,386 00	
			$659,586 00
52,019	cubic yards earth excavation, at 35 cents	$18,206 65	
458,822	cubic yards rock excavation, at $1........	458,822 00	
92,172	cubic yards borrowed material, at 75 cts	69,129 00	
			$546,157 65
123,894	cubic yards brickwork..		1,486,728 00
2	pairs siphon chambers........................	$50,000 00	
82,256	lineal feet 48 inch cast iron pipe, at $10.11..	831,608 16	
81,744	lineal feet trenching, jointing and laying, at $1.50..............................	122,616 00	
			$1,004,224 16
79	shafts (in drops), at $700.................	55,300 00	
1,730	lineal feet of aqueduct between shafts, at $17.2788..................................	29,892 32	
			85,192 32
64	manholes, at $12..		768 00
134	acres, right of way, at $75............................		10,050 00
50	acres clearing, at $50...		2,500 00
2	coffer dams..		5,000 00
42,215	cubic yards soiling, at 60 cents.........................		25,329 00
			$4,162,473 38
	Add 15 per cent. for contingencies....................		624,371 01
			$4,786,844 39
	Storage reservoirs and compensation for loss of water..		....

APPENDIX III.

Miscellaneous Tables.

Extent, Elevation, and Density of Population of the several Collecting Areas Examined.

	Areas in Sq. Miles.			Elevations in Feet.			Population.	
Delaware Areas.	Cultivated and Improved.	Untillable and Wooded.	Total.	Highest.	Lowest.	Mean.	Total.	Per Sq. Mile.
Tohickon	76.08 (74.35%)	26.25 (25.65%)	102.33	960	120	497	*9,843	*96
Neshaminy	82.28 (93.05%)	6.15 (6.95%)	88.43	670	135	362	†9,628	†109
Little Neshaminy	37.90 (95.04%)	1.98 (4.96%)	39.88	490	150	304	4,325	108
Mill Creek	9.26 (83.20%)	1.87 (16.80%)	11.13	550	200	344	1,086	98
Totals	205.52 (85.01%)	36.25 (14.99%)	241.77	960	120	410	24,882	103
Perkiomen Areas.								
Perkiomen above, and including West Branch	47.39 (70.24%)	20.08 (29.76%)	67.47	1,190	260	619	6,940	103
Perkiomen, between West Branch and Schwenksville Dam	13.62 (74.43%)	4.68 (25.57%)	18.30	640	140	332	1,916	105
Macoby Creek	14.78 (84.75%)	2.66 (15.25%)	17.44	850	210	451	2,566	147
East Swamp Creek	35.57 (72.77%)	13.31 (27.23%)	48.88	920	180	517	5,312	109
West Swamp Creek	45.35 (92.99%)	10.41 (7.01%)	55.76	1,110	140	397	7,255	130
North East Branch	54.36 (81.33%)	4.10 (18.67%)	58.46	670	160	395	8,638	148
Totals	211.07 (79.26%)	55.24 (20.74%)	266.31	1,190	140	474	32,627	122

† Not including Quakertown (population in 1880, 1,769) or Doylestown† (population in 1880, 2,070), the drainage of which can be diverted into other water-sheds.

Population on Proposed Collecting Areas.

	Collecting area, square miles.	Population.	Population per square mile.
Perkiomen creek	266.3	32,600	122
Tohickon creek	102.3	11,600	113
Neshaminy creek	139.4	17,100	123
Lehigh river, above White Haven, and eastern tributaries, above Lehigh Gap	542.5	10,000	18.4
Western tributaries of Delaware river, from Water Gap to Bushkill	440.5	11,000	25

Minimum Flow of Delaware and Lehigh Rivers at Points Named, During the Years 1883 to 1885, in Gallons Per Twenty-four Hours.

Delaware, at Water Gap.		Delaware, at Point Pleasant.		Lehigh, at White Haven.	
Sept. 20, 1883	697,000,000			Sept. 19, 1883	76,000,000
Sept. 23, 1884	1,050,000,000	Sept. 24, 1884	1,662,000,000	Oct. 2, 1884	127,000,000
Oct. 2, 1885	873,000,000	Oct. 3, 1885	1,582,000,000	Sept. 30, 1885	62,000,000

Rain-storms of Greatest Intensity, as Recorded by Automatic Gauges during 1885.

Station—Water Department, Philadelphia.

Date, 1885.	Total Fall.			Heavy Fall.			Maximum Fall.		
	Amount Inches.	Duration Hrs.	Duration Min.	Amount Inches.	Duration Hrs.	Duration Min.	Amount Inches.	Duration Min.	Rate per Min. Inches.
May 7..........	1.956	15	12	1.381	3	30	0.30	25	0.012
July 7..........	1.0[illegible]0	4	38	0.900	0	29	0.40	9	0.044
August 3......	3.861	13	24	2.800	1	25	0.50	8	0.062
August 25.....	1.677	10	30	1.154	0	56	0.50	20	0.025
November 2..	1.618	13	00	1.400	6	10	1.07	228	0.005

Station—Doylestown, Bucks County, Pa.

Date, 1885.	Total Fall.			Heavy Fall.			Maximum Fall.		
	Amount Inches.	Duration Hrs.	Duration Min.	Amount Inches.	Duration Hrs.	Duration Min.	Amount Inches.	Duration Min.	Rate per Min. Inches.
February 9...	2.110	21	30	1.067	2	56	0.110	12	0.009
February 16..	1.852	10	00	0.700	1	38	0.200	5	0.040
August 3......	5.893	15	00	4.400	1	43	1.500	20	0.075
October 21....	1.243	11	20	0.630	2	00	0.300	36	0.008

Station—Frederick, Montgomery County, Pa.

Date, 1885.	Total Fall.			Heavy Fall.			Maximum Fall.		
	Amount Inches.	Duration Hrs.	Duration Min.	Amount Inches.	Duration Hrs.	Duration Min.	Amount Inches.	Duration Min.	Rate per Min. Inches.
January 6.....	1.328	16	00	0.400	1	20	0.147	21	0.007
February 10..	1.584	15	40	1.000	3	40	0.100	12	0.008
August 3......	5.043	16	30	3.270	4	08	1.000	24	0.042
October 21....	1.084	11	30	0.720	2	32	0.250	15	0.017

MONTHLY PRECIPITATION ON SUNDRY WATER-SHEDS,

COMPARED WITH U. S. SIGNAL SERVICE OBSERVATIONS AT PHILADELPHIA.

PHILADELPHIA WATER DEPARTMENT.
WILLIAM LUDLOW, Chief Engineer.

SURVEYS FOR A FUTURE WATER SUPPLY.
RUDOLPH HERING, Engineer in Charge.

DATE.		PHILADELPHIA.							SCHUYLKILL SERIES.									
		U. S. Sig. Service.	Philada. Water Department.		Pennsylvania Hospital.		Germantown.		Lebanon.		Schuylkill Haven.		Reading.		Pottstown.		Browers.	
Year.	Month.	Monthly precip. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.
1883	January	4.13	......	......	3.78	−0.35	......	......	4.35	+0.22	4.00	−0.13	4.42	+0.29	2.82	−1.31	3.83	−0.30
	February	5.04	......	......	4.79	−0.25	......	......	4.22	−0.82	3.60	−1.44	4.23	−0.81	3.32	−1.72	4.28	−0.76
	March	2.02	......	......	2.43	+0.41	......	......	3 70	+1.68	3.13	+1.11	3.09	+1.07	1.33	−0.69	1.92	−0.10
	April	2.44	......	......	2.98	+0.54	......	......	2.89	+0.45	2.34	−0.10	3.05	+0.61	3.45	+1.01	3.30	+0.86
	May	1.91	......	......	1.95	+0.04	......	......	2.98	+1.07	3.55	+1.64	1.81	−0.10	2.80	+0.89	1.84	−0.07
	June	5.91	......	......	5 96	+0.05	......	......	8.54	+2.63	5.24	−0.67	6.05	+0.14	5.65	−0.26	8.31	+2.40
	July	1.78	......	......	2.04	+0.26	......	......	2.96	+1.18	2.87	+1.09	3.83	+2.05	4.29	+2.51	3.07	+1.29
	August	3.40	......	......	4.11	+0.71	......	......	2.68	−0.72	1.28	−2.12	2.99	−0.41	4.89	+1.49	4.85	+1.45
	September	4.26	......	......	4.43	+0.17	......	......	4.46	+0.20	3.34	−0.92	3.80	−0.46	4.80	+0.54	2.68	−1.58
	October	4.18	3.37	−0.81	4.11	−0.07	......	......	5.93	+1.75	4.59	+0.41	4.20	+0.02	4.64	+0.46	3 91	−0.27
	November	1.34	1.22	−0.12	1.56	+0.22	......	......	1.42	+0.08	1.48	+0.14	0.81	−0.53	1.88	+0.54	1.70	+0.36
	December	2.76	2.71	−0.05	3.15	+0.39	......	......	3.28	+0.52	2.99	+0.23	2.73	−0.03	1.10	−1.66	3.50	+0.74
	Totals	39.17	For 3 7.30	months. −0.98	41.28	2.12	......	......	47.41	8.24	38.41	−0.76	41.01	1.84	40.97	1.80	43.19	4.02
	Percentages	100	88	......	105	......	......	......	121	......	98	......	105	......	105	......	110	......
1884	January	5.46	5.47	+0.01	5.02	−0.44	......	......	3.95	−1.51	4.15	−1.31	5.25	−0.21	5.42	−0.04	6.24	+0.78
	February	5.70	5.11	−0.59	5.82	+0.12	......	......	4.59	−1.11	5.19	−0.51	5.52	−0.18	5.93	+0.23	5.95	+0.25
	March	4.70	4.25	−0.45	5.41	+0.71	4.17	−0.53	4.88	+0.18	4.07	−0.63	5.44	+0.74	5.00	+0.30	5.20	+0.50
	April	1.63	1.78	+0.15	2.02	+0.39	2.02	+0.39	2.92	+1.29	2.32	+0.69	3.30	+1.67	2.76	+1.13	2.62	+0.99
	May	3.39	4.28	+0.89	3.90	+0.51	3.25	−0.14	3.96	+0.57	2.91	−0.48	3.96	+0.57	4.00	+0.61	3.54	+0.15
	June	3.00	3.05	+0.05	4.55	+1.55	4.52	+1.52	4.02	+1.02	2.90	−0.10	3.78	+0.78	6.53	+3.53	5.52	+2.52
	July	3.83	4.55	+0.72	4.67	+0.84	4.44	+0.61	6.15	+2.32	5.73	+1.90	6.22	+2.39	7.08	+3.25	4.23	+0.40
	August	4.30	4.39	+0.09	3.76	−0.54	4.02	−0.28	4.56	+0.26	4.32	+0.02	2.77	−1.53	1.83	−2.47	3.20	−1.10
	September	0.20	0.19	−0.01	0.27	+0.07	0.14	−0.06	0.94	+0.74	1.25	+1.05	0.68	+0.48	0.60	+0.40	0.39	+0.19
	October	1.54	1.46	−0.08	1.99	+0.45	2.22	+0.68	3.85	+2.31	2.58	+1.04	2.77	+1.23	3.64	+2.10	2.84	+1.30
	November	2.31	2.98	+0.67	4.01	+1.70	3.50	+1.19	3.13	+0.82	2.45	+0.14	2.79	+0.48	3.77	+1.46	3.79	+1.48
	December	3.28	3.78	+0.50	4.76	+1.48	5.05	+1.77	5.82	+2.54	5.98	+2.70	6.22	+2.94	5.94	+2.66	6.25	+2.97
	Totals	39.34	41.29	1.95	46.18	6.84	For 10 33.33	months. 5.15	48.77	9.43	43.85	4.51	48.70	9.36	52.50	13.16	49.77	10.43
	Percentages	100	105	......	118	......	118	......	124	......	112	......	124	......	134	......	127	......
1885	January	2.92	3.37	+0.45	3.84	+0.92	4.85	+1.93	5.25	+2.33	4.34	+1.42	4.41	+1.49	3.69	+0.77	3.91	+0.99
	February	2.79	3 39	+0.60	3.28	+0.49	5.25	+2.46	3.30	+0.51	2.98	+0.19	3.66	+0.87	5.05	+2.26	5.07	+2.28
	March	0.69	0.71	+0.02	0.26	−0.43	1.20	+0.51	1.32	+0.63	0.69	0.00	1.08	+0.39	1.12	+0.43	0.98	+0.29
	April	2.54	2.52	−0.02	2.27	−0.27	2.70	+0.16	3.02	+0.48	2.22	−0.32	2.73	+0.19	2.63	+0.09	1.98	−0.56
	May	3.76	3.07	−0.69	4.00	+0.24	3.65	−0.11	4.48	+0.72	3.39	−0.37	3.15	−0.61	5.11	+1.35	3.39	−0.37
	June	0.74	0.91	+0.17	1.07	+0.33	0.96	+0.22	1.46	+0.72	0.81	+0.07	1.30	+0.56	1.35	+0.61	1.16	+0.42
	July	2.39	2.22	−0.17	2.42	+0.03	1.49	−0.90	3.03	+0.64	1.61	−0.78	2.03	−0.36	2.03	−0.36	2.11	−0.28
	August	6.80	7.90	+1.10	10.08	+3.28	8.80	+2.00	5.48	−1.32	7.46	+0.66	7.09	+0.29	5.92	−0.88	5.24	−1.56
	September	1.17	1.05	−0.12	1.08	−0.09	0.83	−0.34	0.81	−0.36	0.42	−0.75	0.50	−0.67	1.07	−0.10	2.28	+1.11
	October	3.33	3.67	+0.34	4.85	+1.52	5.58	+2.25	8.20	+4.87	4.39	+1.06	5.47	+2.14	4.62	+1.29	4.18	+0.85
	November	3.35	3.53	+0.18	4.30	+0.95	3.86	+0.51	4.64	+1.29	3.48	+0.13	4.50	+1.15	4.62	+0.86	4.57	+1.22
	December	2.87	2.91	+0.04	3.24	+0.37	3.33	+0.46	3.10	+0.23	3.16	+0.29	3.21	+0.34	3.40	+0.53	3.31	+0.44
	Totals	33.35	35.25	1.90	40.69	7.34	42.50	9.15	44.09	10.74	34.95	1.60	39.13	5.78	40.20	6.83	38.18	4.83
	Percentages	100	106	......	122	......	127	......	132	......	105	......	117	......	120	......	114	......
Yearly averages	Inches	37.25	35.29	−0.96	42.72	5.43	41.25	4.00	46.72	9.47	39.03	1.78	42.91	5.66	44.52	7.27	43.68	6.43
	Percentages	100	95	......	115	......	123	......	125	......	105	......	115	......	119	......	120	......

DATE.		PERKIOMEN SERIES.								DELAWARE SERIES.											
		Siesholtzville.		Pennsburg.		Green Lane.		Frederick.		Easton.		Phillipsburg.		Princeton.		Fallsington.		Moorestown.		West Chester.	
Year.	Month.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.
1883	January	......	......	......	......	......	......	......	......	......	......	......	......	3.73	−0.40	4.07	−0.06	4.05	−0.08	4.52	+0.39
	February	......	......	......	......	......	......	......	......	......	......	......	......	4.40	−0.64	4.60	−0.44	4.77	−0.27	5.48	+0.44
	March	......	......	......	......	......	......	......	......	......	......	......	......	1.65	−0.37	2.60	+0.58	2.33	+0.31	3.62	+1.60
	April	......	......	......	......	......	......	......	......	......	......	......	......	2.46	+0.02	3.88	+1.44	3.08	+0.64	3.52	+1.08
	May	......	......	......	......	......	......	......	......	......	......	......	......	2.40	+0.49	3.34	+1.43	4.70	+2.79	2.71	+0.80
	June	......	......	......	......	......	......	......	......	......	......	......	......	6.32	+0.41	5.04	−0.87	4.51	−1.40	5.72	−0.19
	July	......	......	......	......	......	......	......	......	......	......	......	......	1.57	−0.21	2.05	+0.27	1.57	−0.21	2.54	+0.76
	August	......	......	......	......	3.20	−0.20	4.00	+0.60	......	......	......	......	3.60	+0.20	5.36	+1.96	4.07	+0.67	5.20	+1.80
	September	......	......	5.24	+0.98	6.51	+2.25	3.96	−0.30	......	......	......	......	3.26	−1.00	3.64	−0.62	4.77	+0.51	3.64	−0.62
	October	......	......	5.27	+1.09	5.20	+1.02	4.77	+0.59	......	......	......	......	3.34	−0.84	4.02	−0.16	5.22	+1.04	4.45	+0.27
	November	......	......	1.93	+0.59	1.69	+0.35	1.75	+0.41	......	......	......	......	1.48	+0.14	1.56	+0.22	1.48	+0.14	2.30	+0.96
	December	......	......	3.31	+0.55	4.21	+1.45	5.76	+3.00	......	......	......	......	2.75	−0.01	3.31	+0.55	3.25	+0.49	4.63	+1.87
	Totals	......	......	For 4 15.75	months. 3.21	For 5 20.81	months. 4.87	For 5 20.24	months. 4.30	......	......	......	......	36.96	−2.21	43.47	4.30	43.80	4.63	48.33	9.16
	Percentages	......	......	126	......	130	......	127	......	......	......	......	......	95	......	111	......	112	......	123	......
1884	January	......	......	5.14	−0.32	5.28	−0.18	6.02	+0.56	4.48	−0.98	4.37	−1.09	4.72	−0.74	4.90	−0.56	4.36	−1.10	7.32	+1.86
	February	......	......	5.04	−0.66	5.84	+0.14	5.36	−0.34	4.49	−1.21	5.01	−0.69	4.56	−1.14	5.04	−0.66	5.33	−0.37	7.29	+1.59
	March	......	......	5.04	+0.34	4.35	−0.35	4.70	0.00	4.70	0.00	3.99	−0.71	4.10	−0.60	4.79	+0.09	4.64	−0.06	6.09	+1.39
	April	......	......	2.63	+1.00	2.30	+0.67	2.25	+0.62	2.22	+0.59	3.13	+1.50	2.08	+0.45	2.25	+0.62	2.03	+0.40	2.94	+1.31
	May	......	......	2.72	−0.67	3.06	−0.33	3.48	+0.09	2.18	−1.21	3.11	−0.28	2.75	−0.64	4.48	+1.09	3.29	−0.10	3.64	+0.25
	June	4.64	+1.64	......	......	5.24	+2.24	5.59	+2.59	2.70	−0.30	4.22	+1.22	3.58	+0.58	5.30	+2.30	3.81	+0.81	7.52	+4.52
	July	7.44	+3.61	......	......	7.32	+3.49	6.21	+2.38	4.93	+1.10	5.64	+1.81	3.35	−0.48	4.24	+0.41	3.78	−0.05	5.27	+1.44
	August	3.16	−1.14	......	......	3.72	−0.58	2.43	−1.87	5.57	+1.27	3.79	−0.51	4.49	+0.19	4.58	+0.28	5.08	+0.78	2.12	−2.18
	September	0.77	+0.57	......	......	0.40	+0.20	0.44	+0.24	0.95	+0.75	0.47	+0.27	0.24	+0.04	0.22	+0.02	0.16	−0.04	0.42	+0.22
	October	3.99	+2.45	......	......	3.97	+2.43	3.41	+1.87	3.74	+2.20	1.79	+0.25	2.33	+0.79	2.30	+0.76	2.29	+0.75	2.56	+1.02
	November	3.19	+0.88	......	......	3.12	+0.81	3.40	+1.09	3.05	+0.74	3.12	+0.81	3.14	+0.83	3.12	+0.81	3.40	+1.09	4.36	+2.05
	December	6.73	+3.45	......	......	6.03	+2.75	5.92	+2.64	5.70	+2.42	4.60	+1.32	6.16	+2.88	6.00	+2.72	5.37	+2.09	7.05	+3.77
	Totals	50.49	11.15	......	......	50.63	11.29	49.21	9.87	44.71	5.37	43.24	3.90	41.50	2.16	47.22	7.88	43.54	4.20	56.58	17.24
	Percentages	128	......	......	......	129	......	125	......	114	......	110	......	106	......	120	......	111	......	144	......
1885	January	4.71	+1.79	......	......	3.79	+0.87	3.73	+0.81	4.40	+1.48	4.16	+1.24	3.78	+0.86	4.23	+1.11	3.43	+0.51	4.65	+1.73
	February	3.84	+1.05	......	......	4.09	+1.30	4.73	+1.94	4.18	+1.39	4.34	+1.55	5.06	+2.27	4.91	+2.12	4.23	+1.44	6.39	+3.60
	March	1.59	+0.90	......	......	0.80	+0.11	1.12	+0.43	0.97	+0.28	0.95	+0.26	1.31	+0.62	1.19	+0.50	1.08	+0.39	1.34	+0.65
	April	2.79	+0.56	......	......	2.54	0.00	2.42	−0.12	2.40	−0.14	2.33	−0.21	1.57	−0.97	2.30	−0.24	2.82	+0.28	2.20	−0.34
	May	3.98	+0.22	......	......	2.36	−1.40	2.62	−1.14	2.29	−1.47	2.22	−1.54	1.86	−1.90	1.51	−2.25	2.84	−0.92	4.07	+0.31
	June	0.75	+0.01	......	......	1.18	+0.44	1.75	+1.01	2.74	+2.00	2.19	+1.45	3.37	+2.63	1.02	+0.28	2.57	+1.83	1.26	+0.52
	July	1.10	−1.29	......	......	2.48	+0.09	2.29	−0.10	2.63	+0.24	2.51	+0.12	2.81	+0.42	4.05	+1.66	3.08	+0.69	0.93	−1.46
	August	7.82	+1.02	......	......	4.96	−1.84	7.39	+0.59	7.76	+0.96	7.35	+0.55	5.49	−1.31	7.56	+0.76	7.16	+0.36	9.51	+2.71
	September	0.96	−0.21	......	......	0.90	−0.27	0.84	−0.33	0.59	−0.58	0.57	−0.60	1.08	−0.09	1.07	−0.10	0.57	−0.60	1.49	+0.32
	October	5.49	+2.16	......	......	4.29	+0.96	4.46	+1.13	4.52	+1.19	4.22	+0.89	3.29	−0.04	4.23	+0.90	3.48	+0.15	6.25	+2.92
	November	5.03	+1.68	......	......	3.32	−0.03	4.45	+1.10	4.03	+0.68	3.88	+0.53	2.72	−0.63	3.58	+0.23	3.77	+0.42	4.71	+1.36
	December	3.79	+0.92	......	......	3.25	+0.38	3.11	+0.24	3.30	+0.43	3.19	+0.32	2.54	−0.33	3.26	+0.39	3.07	+0.20	4.18	+1.31
	Totals	41.85	8.50	......	......	33.96	0.61	38.91	5.56	39.81	6.46	37.91	4.56	34.88	1.53	38.71	5.36	38.10	4.75	46.98	13.63
	Percentages	126	......	......	......	102	......	117	......	119	......	114	......	105	......	116	......	114	......	141	......
Yearly averages	Inches	47.05	9.80	......	......	44.19	6.94	45.41	8.16	43.16	5.91	40.57	4.23	37.74	0.49	43.10	5.85	41.78	4.53	50.59	13.34
	Percentages	127	......	......	......	119	......	121	......	116	......	112	......	101	......	116	......	112	......	136	......

DATE.		TOHICKON AND NESHAMINY SERIES.											
		Ottsville.		Quakertown.		Doylestown.		Sellersville.		Lansdale.		Forks of Neshaminy.	
Year.	Month.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.	Monthly precip. Inches.	Diff. Inches.
1883	January	......	......	4.51	+0.38								
	February	......	......	4.04	−1.00								
	March	......	......	2.29	+0.27								
	April	......	......	2.65	+0.21								
	May	......	......	2.29	+0.38								
	June	......	......	6.78	+0.87								
	July	......	......	1.25	−0.53								
	August	......	......	2.25	−1.15								
	September	......	......	3.52	−0.74								
	October	4.71	+0.53	4.10	−0.08	3.80	−0.38						
	November	1.82	+0.48	1.47	+0.13	1.43	+0.09						
	December	4.05	+1.29	4.04	+1.28	3.06	+0.30						
	Totals	For 3 10.58	months. 2.30	39.19	0.02	For 3 8.29	months. 0.01						
	Percentages	128	......	100	......	100							
1884	January	5.92	+0.46	4.71	−0.75	5.58	+0.12						
	February	5.51	−0.19	5.38	−0.32	6.27	+0.57						
	March	5.40	+0.70	4.98	+0.28	5.20	+0.50						
	April	2.34	+0.71	2.70	+1.07	2.42	+0.79						
	May	3.54	+0.15	3.53	+0.14	3.37	−0.02	......	......	3.11	−0.28		
	June	6.32	+3.32	6.54	+3.54	5.42	+2.42	5.92	+2.92	4.39	+1.39		
	July	6.07	+2.24	7.92	+4.09	5.92	+2.09	3.85	+0.02	4.89	+1.06		
	August	4.24	−0.06	3.76	−0.54	5.13	+0.83	3.07	−1.23	2.53	−1.77		
	September	0.40	+0.20	0.53	+0.33	0.21	+0.01	0.39	+0.19	0.47	+0.27	0.18	−0.02
	October	3.79	+2.25	4.38	+2.84	3.47	+1.93	3.37	+1.83	3.09	+1.55	2.55	+1.01
	November	3.49	+1.18	3.53	+1.22	3.67	+1.36	3.74	+1.43	3.70	+1.39	3.68	+1.37
	December	6.07	+2.79	6.46	+3.18	6.07	+2.79	6.51	+3.23	5.27	+1.99	5.80	+2.52
	Totals	53.09	13.75	54.42	15.08	52.73	13.39	For 7 26.85	months. 8.39	For 8 27.45	months. 5.60	For 4 12.21	months. 4.88
	Percentages	135	......	138	......	134	......	145	......	126	......	167	
1885	January	4.17	+1.25	4.52	+1.60	3.71	+0.79	3.96	−1.04	3.62	+0.70	3.93	+1.10
	February	5.38	+2.59	4.28	+1.49	5.30	+2.51	5.02	+2.23	4.31	+1.52	5.07	+2.28
	March	1.92	+1.23	1.28	+0.52	1.24	+0.55	1.51	+0.82	0.85	+0.16	1.03	+0.34
	April	2.60	+0.06	2.79	+0.25	2.23	−0.31	2.21	−0.33	2.55	+0.01	1.96	−0.58
	May	2.01	−1.75	2.32	−1.44	2.46	−1.30	2.72	−1.04	2.63	−1.13	2.24	−1.52
	June	0.86	+0.12	0.81	+0.07	1.40	+0.66	1.39	+0.65	1.35	+0.61	2.29	+1.55
	July	3.12	+0.73	1.47	−0.92	1.40	−0.99	1.82	−0.57	1.11	−1.28	4.08	+1.69
	August	7.58	+0.78	8.34	+1.54	7.85	+1.05	5.69	−1.11	5.81	−0.99	5.50	−1.30
	September	0.50	−0.67	0.52	−0.65	1.17	0.00	1.11	−0.06	1.05	−0.12	1.24	+0.07
	October	5.36	+2.03	4.29	+0.96	5.38	+2.05	5.25	+1.92	5.92	+2.59	5.36	+2.03
	November	5.10	+1.77	4.23	+0.88	4.27	+0.92	4.57	+1.22	5.25	+1.90	3.97	+0.62
	December	2.97	+0.10	3.15	+0.28	2.84	−0.03	2.88	+0.01	2.75	−0.12	3.04	+0.17
	Totals	41.57	8.22	37.93	4.58	39.25	5.90	38.13	4.78	37.20	3.85	39.71	6.36
	Percentages	125	......	114	......	118	......	114	......	111	......	119	
Yearly averages	Inches	48.04	10.79	43.81	6.56	45.83	8.58	45.57	8.32	42.92	5.67	45.68	8.43
	Percentages	130	......	118	......	124	......	125	......	117	......	148	

Table showing Dimensions, Capacity, and Cost of Aqueducts from City Termini to Water Intakes.

	Location.	Length in miles.	Size.	Gradient per 100 feet.	Capacity in gallons per day.	Cost per mile.	Total cost.
Delaware.	From Lardner's Point to Delaware River, above New Hope..	37.5	Open canal, 346 sq. ft. in section.	.00947	210,000,000	*$166,212 08	*$6,232,953 00
	From Wentz Farm Basin to Delaware at Yardleyville........	20.76	4 pipes, 5 feet in diameter........	Hydraulic gradient .0653	210,000,000	426,086 93	8,845,564 76
	From Basin, Twelfth street and Olney avenue, to Neshaminy Creek........	18.07	12 feet in diameter.	.01667	†210,000,000	220,410 88	3,983,366 91
	From Basin, Twelfth street and Olney avenue, to Delaware, above New Hope........	28.541	12 feet in diameter.	.01667	210,000,000	223,090 45	6,367,224 49
	From Basin, Twelfth street and Olney avenue, to Delaware at Lumberville........	30.568	12 feet in diameter.	.01667	210,000,000	219,842 56	6,720,147 55
	From Basin, Twelfth street and Olney avenue, to Delaware at Point Pleasant........	33.09	12 feet in diameter.	.01667	210,000,000	223,209 71	7,386,009 40
	From Point Pleasant to Delaware River near Portland........	47.197	12 feet in diameter.	.01667	210,000,000	236,075 42	11,142,051 86
	From Portland to Broadhead Creek, above Stroudsburg, and to Bushkill Creek........	22.791	9½, 8, and 6 feet diameters........	.05	210,000,000	129,634 38	2,954,497 20
Perkiomen.	From Cambria Basin to Dam near Frederick Station, Perkiomen Valley........	26.69	12 feet in diameter.	.01667	210,000,000	241,819 45	6,534,230 39
	From Cambria Basin to Dam at Green Lane Station, Perkiomen Valley........	32.29	12 feet in diameter.	.01667	210,000,000	221,878 53	7,164,457 85
	From Treichlersville, Perkiomen Valley, to Big Creek, Lehigh Valley........	33.47	8 feet in diameter...	.05	130,000,000	174,417 61	5,837,757 32
	From Big Creek, Lehigh Valley, to White Haven, Lehigh Valley........	22.15	8 feet in diameter...	.05	130,000,000	216,110 35	4,786,844 39

* The cost of existing canal, Bristol to New Hope, 23 miles, and additional land damages, are not included.
† The amount of water available is only about 100,000,000 gallons daily.

Cost of Pumpage from the Delaware River at the Several Points Named.

Station.	Cost of pumping one million gallons 100 ft. high (assumed.)	Computed lift.	Million gals. pumped per day.	Annual cost.	Capitalized cost at 4 per cent. for 40 yrs.
Lardner's Point	$5 00	165 ft.	100	$301,125 00	$5,960,040 65
			210	632,362 50	12,516,085 37
Yardleyville	5 00	228 ft.	100	416,100 00	8,235,692 54
			210	873,810 00	17,294,954 33
New Hope	5 00	178 ft.	100	324,850 00	6,429,619 61
			210	682,185 00	13,502,201 19
Lumberville	5 00	162 ft.	100	295,650 00	5,851,676 28
			210	620,865 00	12,288,520 18
Point Pleasant	5 00	145 ft.	100	264,625 00	5,237,611 48
			210	555,712 50	10,998,984 11

Estimated cost of plant (engines, boilers, buildings, grounds, etc.)

For pumping 100 million gallons, daily $750,000 00

" " 210 " " " 1,250,000 00

TOTAL COST OF PROJECTS FOR A SUPPLY FROM THE DELAWARE RIVER ALONE, BY PUMPING.

	Cost of Aqueduct.	Capitalized cost of pumping 210 million gallons per day, at 4 per cent. for 40 years.	Cost of pumping plant.	Total.
From Lardner's Point to New Hope—open canal*	$6,232,953 00	$12,516,085 37	$1,250,000	$19,999,038 37
From Wentz Farm basin to Yardleyville—four 5-feet iron pipes	8,845,564 76	17,294,954 33	1,250,000	27,390,519 09
From proposed basin at Twelfth street and Olney avenue, to New Hope—masonry conduit, twelve feet in diameter	6,367,224 49	13,502,201 19	1,250,000	21,119,425 68
From proposed basin at Twelfth street and Olney avenue, to Lumberville—masonry conduit, twelve feet in diameter	6,720,147 55	12,288,520 18	1,250,000	20,258,667 73
From proposed basin at Twelfth street and Olney avenue, to Point Pleasant—masonry conduit, twelve feet in diameter	7,373,559 16	10,998,984 11	1,250,000	19,622,543 27

* Excluding cost of existing canal and land damages.

APPENDIX No. 1

TO

REPORT ON FUTURE SUPPLY SURVEYS.

PART I.—SANITARY SURVEY OF PROPOSED FUTURE SUPPLY WATER-SHEDS.

By Dana C. Barber, *Assistant Engineer.*

Philadelphia Water Department,
February 25, 1886.

Mr. Rudolph Hering,
Engineer in charge of
Surveys for Future Supply:

Sir:—I have the honor to submit the following Report of a Sanitary Survey of the Delaware Valley above Point Pleasant, including the Lehigh, made by me, under your direction during the past year.

Although the cost of two schemes for taking the Delaware water below Point Pleasant—at New Hope and Yardleyville—has been estimated, I was not instructed to make a detailed survey of the valley below that point, since these schemes are not considered among the best. But the general features of the lower portion covering these additional schemes may be briefly stated, as follows:

The valley is narrow, especially on the Pennsylvania side, and contains but few towns or villages. The largest is Lambertville, about nine miles above Yardleyville, having a population of over 4,000, with public water supply and partial sewerage.

It contains some large manufactories, and is evidently the source of considerable pollution. On the other side of the river, opposite Lambertville, is New Hope, with a population of about 1,200, favorably situated in general for good surface drainage, while many houses on the line of the canal use that as a sewer. Just below the town is a large paper mill.

At Lumberville, 14 miles above Yardleyville, a village of perhaps 300 inhabitants, there is no notable pollution.

The supply of Trenton is taken from the Delaware about four miles below Yardleyville, which has a population of 900, and the water is generally considered of superior quality. In the latter part of the spring of

1883, however, and at the same season in previous years, the water had a fishy taste and odor, very offensive to some, lasting about ten days. No thorough investigation was made to ascertain the cause of this, but it is believed to have come from the river and to have had no connection with the reservoir.

The survey above Point Pleasant was made by following the principal streams nearly to their sources, visiting all the large towns, and most villages having a population of over 500 and also many smaller manufacturing hamlets, and investigating all special sources of pollution by examination and by interviewing manufacturers, town surveyors and others best acquainted with the streams and their pollution. Most of the field work was done in the months of August, September, and October, but a portion of that in the Upper Lehigh and Lackawaxen valleys was necessarily postponed until the present month.

The whole area drained by the Delaware river and tributaries above Point Pleasant (including the Lehigh) is about 6,793 square miles, of which about 795 are in the State of New Jersey and 2,623 in the State of New York. The drainage area of the Delaware above the Water Gap is about 4,446 square miles, and of the Lehigh Water Shed 1,373 square miles.

The population* of the whole area drained by the Delaware above Point Pleasant is about 399,150, of which 58,365 are in New Jersey and 79,400 in New York. The population of the Delaware watershed above the Water Gap is about 141,000 and of the Lehigh 164,000.

The sources of pollution will be considered in order going up stream.

Frenchtown, seven miles above Point Pleasant, on the New Jersey side, is a trading village of 1,060 inhabitants, situated on gentle slopes near the river. Half a dozen shops and houses discharge waste water directly into a small creek flowing through the village, which also drains a small cemetery. A few houses have privies near the bank of the creek. There are no manufactories of note, and the dwellings being scattered and having no drainage, but little of the domestic sewage reaches the river.

At Uhlerstown, a small hamlet opposite Frenchtown (on the Pennsylvania side), half a dozen houses have a little waste water drainage into the canal (flowing past Point Pleasant) with privies near the bank, and at a canal boat yard a few men—not over eight or ten—use a privy draining into the canal.

At Milford, on the New Jersey bank of the Delaware, 11 miles above Point Pleasant, about 40 houses are situated near a small creek flowing through the town, of which 25 have privies located favorably to indirect drainage into the stream. Twenty are favorably located for drainage of waste water into the stream over the ground and two or three for direct drainage. Nine small stables near the creek are partially drained into it.

* Estimated from comparison of Ninth and Tenth National Census, and local data.

There are a few small manufactories, but none have foul drainage. The village has a population of perhaps 300.

At the mouth of Durham creek, 17 miles above Point Pleasant, on the Pennsylvania side, are the Durham Iron Works, said to be the oldest in the country (founded in 1727). Five hundred men are employed here, of whom 40 use privies over the creek. The dwellings of the employés are not favorably situated for drainage into the stream. One-half of the ore used here is from mines near the works (red hematite). The Superintendent said that this was without doubt the only ore in the Delaware Valley, on the Pennsylvania side, excluding the Lehigh.

At Rieglesville, one mile above the preceding, the Musconetcong river, the first large tributary above Point Pleasant, enters the Delaware from the State of New Jersey, running for most of its course through a narrow belt of limestone formation. It rises in and about Lake Hopatcong, 40 miles from its mouth, and drains a narrow valley naturally well fitted for water supply. As yet there are few villages of any size in the valley, although the Morris canal (from Phillipsburg to Jersey City) and the Morris & Essex division of the Delaware, Lackawanna and Western Railroad traverse the upper portion of it, near the stream, and the Central Railroad of New Jersey ten miles of the lower portion. The only villages having a population of over 200 are Bloomsburg (600), Hackettstown (2,650), and Stanhope (700), of which Hackettstown, 28 miles from the Delaware, is the only one having a public water supply. This is a gravity supply from a mountain stream (tributary of the Musconetcong), giving an average pressure of about fifty pounds. The daily consumption is estimated at 100,000 gallons. There are no sewers (except a short culvert for surface drainage), and the houses are scattered at some distance from the stream, so that the pollution from domestic sewage is comparatively slight for a town of its size. There are no manufactories having foul drainage.

On the lower part of the stream are the following manufactories:

At Rieglesville, near the mouth, a paper mill, using three tons of jute butts per day, 25 bushels of lime, 600 lbs. of chloride of lime, 300 lbs. of alum, and 20 lbs. of soda ash.

At Finesville, one mile above the mouth, an edge tool works, employing thirteen men, who use privies over the raceway.

A large pottery, one and a half miles from the mouth, not in operation for several years.

A paper mill, four miles from the mouth, using ten tons of jute butts per day, 100 bushels of lime, 3,000 pounds of chloride of lime, and 1,000 pounds of alum. Sixty employés have water closet drainage to the stream.

The intervales and gentle slopes along the Musconetcong are generally cultivated, but the hillsides are for the most part wooded.

Pohatcong creek, entering the Delaware about 20 miles above Point Pleasant, drains a similar valley of about half the length of the Musconetcong. The only town of note in its watershed is Washington, on a short branch about 15 miles from the Delaware. It has a population of about 2,300, supported mainly by manufacturing, the principal products being organs and shoes. One of the principal hotels and a large office building have complete drainage to the creek by pipe sewer; with this exception there is no direct drainage other than from a tannery (using 1,000 cattle hides per year and a few sheep skins, also washing a little wool) and two or three small slaughter houses. A short section of the principal business street is frequently washed by hose in dry summer weather, and drained through the gutters to the creek. A few houses have gutter drainage for waste water. The town has a public water supply from springs three miles away, through a 12-inch main. About 120 private houses have water attachments, but the amount consumed could not be learned.

The Pohatcong Valley is quite free from manufactories (except in Washington, as above noted), is generally sparsely populated, and seems to possess small inducements to any considerable increase

The first large town on the Delaware is Phillipsburg, N. J., 25 miles above Point Pleasant. It has a population of about 7,600, made up largely of the employes of the several railroads terminating or passing through, and the canal starting there. There are some large iron works and a few other manufactories (none having foul drainage), but almost the whole town has (in the absence of sewers) no direct drainage to the river. Most of the houses are situated on high and nearly level ground, on which there are but few streets and no natural water courses to the river. The comparatively small population on the steep approach from Easton (on the opposite side of the river) has good surface drainage, but most of the domestic sewage from the greater portion in the rear is absorbed before reaching the stream. Water is now furnished to a portion of the town by the Easton Water Works through a six-inch pipe, but an independent supply is contemplated. The death rate in 1884 was about 18 per 1,000.

At a small village at the lower end of the town six or eight houses have privies on the bank of Lopatcong creek, and a dozen others throw slop water and garbage into the same. A beer brewery on the opposite side of the river (below South Easton), producing about 1,500 barrels a year, drains into the canal (from Easton to Bristol.)

The most notable pollution of the Delaware is from the towns of Easton, Allentown and Bethlehem, on the lower portion of the Lehigh, the largest tributary of the Delaware. Here, within a distance of seventeen miles, is a population of about 50,000 in towns favorably situated for good drainage. None of them, however, is sewered, and when the volume of the Lehigh is lowest and the amount of sewage proportionately largest, the Delaware canal receives probably fully one-third of the water of the Lehigh, and of this third it is estimated that one-half is carried past Point Pleasant.

Easton, on the north side of the Lehigh, at its confluence with the Delaware, 26 miles above Point Pleasant, is a town having a population of about 13,000. Bushkill creek borders the northern side, so that unusually good natural drainage facilities are afforded, especially as the population is for the most part quite dense. One public sewer (from the county jail—average population of 50) has a few connections with private houses, and one hotel, affording complete sewerage for about 200 people. There are besides three culverts for surface drainage, which may also have a few house connections for wash water only. I estimate that one-fifth of the population, or 2,600, have drainage for wash water through street gutters and culverts, of which perhaps one-sixth goes into the Lehigh.

In the dry weather of summer much water is used in washing the streets, and since the grades are quite steep much street dirt is carried to the river. The slopes are chiefly toward the Delaware and Bushkill creek, so that only about one-eighth of the area is drained into the Lehigh above the dam, comprising perhaps one-fourth of the population. The sewer above-mentioned discharges into the Delaware. The kitchen garbage collected is also dumped into the river (Delaware) at present, but it is intended soon to construct a furnace for cremating it. Privies are generally placed over leaching cesspools which also receive, from the better class of houses, water-closet sewage and kitchen and bath water. The most densely populated portion is on gravel formation where the cesspools seldom or never fill up. When they are cleaned the material is generally used in making fertilizers, but sometimes, when more convenient, is dumped into the Delaware.

The healthfulness of the town is considered good, but as no complete record of deaths is kept it is impossible to give exact figures. A prominent physician estimated the death rate at not over 15 per 1,000 annually, and said there were few cases of typhoid or other enteric diseases.

The public water supply is regularly from the Delaware just above the town. Formerly it was pumped from the Lehigh, just above the town, and this station remains as a reserve. The Delaware water was substituted for the Lehigh because softer and purer, though one of the leading physicians thinks that the Lehigh water caused no sickness when it was used. The Delaware water seems to be entirely satisfactory in quality, but gives some trouble in pumping on account of tan-bark and other small vegetable refuse which it contains at times. The total quantity supplied, including that to Pbillipsburg, averages about one million gallons per day. In addition to the above general supply about two hundred families have an independent supply of spring water.

Besides the pollution of the Delaware by street and domestic drainage, there are the following special sources in Easton proper:

On Bushkill creek near its mouth are several small butcher shops, which (in all) slaughter about 40 cattle, 30 calves, and 90 sheep and lambs per week, besides many hogs in winter, and drain directly into the creek. Near them is a stable containing six or seven horses, draining directly into the stream, and several others indirectly.

A calf kid manufactory on the Bushkill, half a mile from its mouth, treats 25 dozen skins per week and discharges the liquid waste directly into the creek; it is of the worst character but not large in amount.

About a mile from the mouth of the Bushkill are two privies over the stream, used by perhaps 15 people, and a stable on the bank for eight or ten horses.

A beer brewery, producing 10,000 barrels per year, drains into the Lehigh, and a smaller one (3,000 to 5,000 barrels) into the Bushkill. At the former place 15 men use a privy near the river bank and perhaps ten more use another belonging to an oil works near by.

From the town gas works, on the Bushkill, but little waste seems to escape int the stream, the tar being sold. From 50,000 to 75,000 cubic feet per day are produced from coal.

The Easton cemetery occupies a hill around which winds the Bushkill creek, affording excellent drainage for the greater portion of its area.

Bushkill creek, entering the Delaware at Easton, drains a considerable area of farming country containing a few small hamlets but no town of any size. At Wind Gap, however, a station on the railroad between Bangor and Bethlehem, slate quarries are now being opened, which seem likely to build up quite a town at that point.

South Easton, an independent borough on the other side of the Lehigh, has a population of about 5,000, wholly in the Lehigh water-shed, but on account of the entire absence of sewers and a public water supply and the scattered state of the population, comparatively little domestic sewage enters the river. Perhaps 50 houses near the river have partial drainage through street gutters for wash water. A water supply is contemplated from springs back of the town.

The principal pollution at this place is from the following manufactories along the river and canal:

At a cotton and woolen mill, draining partly into the river and partly into the canal, 30 lbs. of indigo, 40 lbs. of catechu and half a pound of aniline dyes are used per day. Two hundred operatives use water closets discharging directly into the stream.

At a wire mill, between the river and canal, 4,660 lbs. of oil of vitrol are used per day, and the waste discharged into the Lehigh. Water closet drainage from 250 men also goes into the river.

At another wire mill the waste from 900 lbs. oil of vitriol per day is discharged into the canal, and 35 men use privies over leaching cesspools from 30 to 40 feet from the canal.

At an iron furnace near the above, which had been idle for some time, the workingmen's privies were over the river.

At the shops of the Lehigh Valley Railroad Company 250 men use privies over cesspools from 50 to 100 feet from the canal. The urinals have direct drainage to the canal, as also the waste oil, etc., from the round-house. The privies of the Easton station (L. V. R. R.) are over a leaching cesspool about 100 feet from the canal. At Glendon, a borough of 700 or 800 population, two and a-half miles above Easton, 100 men in iron furnaces use privies over a raceway from the canal to the river. The dwellings are so situated as to have little or no direct drainage to the river.

At Redington, six miles from the mouth of the Lehigh, about 30 houses are within a hundred feet of the river, but contribute little direct drainage.

Freemansburg, on the left bank of the Lehigh, eight miles from its mouth, is a small village (of 630 inhabitants), containing no manufactories, in which nearly all the houses are located on one nearly level street parallel to the canal, which lies between it and the river. So situated but little direct pollution comes from this place.

With the above exceptions there is no notable pollution of the Lehigh between Easton and Bethlehem, ten miles from the Delaware and 36 from Point Pleasant.

Bethlehem proper, or old Bethlehem, is situated on the left bank of the Lehigh, just below Manockisy creek. Its present population is estimated at 5,800, the greater part of which occupies high ground having steep slopes to the streams There are no sewers except one culvert for surface drainage only. Fæcal matter and much domestic waste water are received by leaching cesspools in cavernous limestone, containing fissures which serve as drains, so that the cesspools seldom or never fill up. According to a local engineer they are sometimes dug as deep as 80 feet to secure this natural drainage. A considerable part of the domestic waste water is carried through the gutters to the streams, chiefly to the Manockisy.

The public water supply averages nearly 400,000 gallons per day. It is pumped from a spring beside the Manockisy, about 1,500 feet from the Lehigh. No record of deaths being kept I was unable to obtain the rate, or even any estimate.

West Bethlehem, on the other side of the Manockisy, has a population of about 2,000, much more scattered than Bethlehem proper, and with no water supply, so that it has but little domestic drainage to the stream.

The following are sources of special pollution on Manickisy creek:

Several small butcher shops, slaughtering perhaps 25 cattle per week, and a small establishment for utilizing a portion of the butchers' offal—all having direct drainage to the stream; two small breweries, a small dye-house, a small stable, and privies used by about 25 people. These are in Bethlehem proper and West Bethlehem. Above the town there is but little direct pollution of the Manockisy. A railroad runs up the stream to its source, and thence across to the Bangor slate quarries (to be referred to later), but the population is mostly scattered over a farming country.

Bath, a town of 700 inhabitants, ten miles above Bethlehem, is the source of no notable pollution except a small tannery and the domestic sewage, a large number of the houses being favorably situated for good surface drainage to the stream.

South Bethlehem, on the right bank of the Lehigh, has nearly or quite as large a population as Bethlehem proper (now estimated at 5,600), though not quite so favorably situated, on the whole, for natural drainage—the bulk of the population being on comparatively flat land.

The public water supply is from the Lehigh, at present from a point opposite the heart of the town, and below much pollution, but about to be taken from a new station above town. The new works will also supply West Bethlehem. It is expected that about 600,000 or 700,000 gallons per day will be required.

Six buildings of the Lehigh University, including a large chemical laboratory, situated on the hill-side back of the town have complete drainage into cesspools which overflow into public sewers discharging into Lehigh river above the intake of the present water supply. Two of them are occupied regularly by 35 persons, and over 300 more use the water-closets more or less. The sewers receive no other fæcal matter, but afford surface drainage for the most densely populated portion of the town taking much domestic waste water which is discharged into the street gutters.

A small brewery back of the university drains into a brook which is often dry in warm weather, so that much of the drainage is purified before reaching the river.

Besides these sewers, a culvert running through the town, open most of the way, receives the drainage of a public laundry, and more or less domestic waste water from about 20 houses. Twenty-five houses have privies near the wall of the culvert, while the water closets of a railroad office building, occupied by 20 or more persons, and the railroad station closet, used probably by more than 30 persons per day, have direct drainage into it.

The town has been built up and is chiefly supported by the extensive iron works of the Bethlehem Iron Company, on the river at the lower end of the village. About 2,600 men are employed here. Their bath waste runs direct to the river, but the privies are over cesspools, from which the contents are removed. An inspection of the river bank opposite the works, however, showed that many, perhaps hundreds, went there instead of to the privies.

There is also a large zinc works here, but no pollution from it was evident.

St. Luke's Hospital (30 to 50 patients), near the Lehigh, in the upper part of the town, drains its laundry water to the river by an open ditch in which much of the water is absorbed. All other drainage goes to a leaching cesspool.

On or near Saucon creek, entering a mile below South Bethlehem, are two small villages, Hellertown (700), and Coopersburg (400), but the stream receives little pollution from them.

The largest town in the Lehigh Valley is the city of Allentown, on the right bank, at the intersection of the Little Lehigh and Jordan creeks, 16 miles above the Delaware and 42 miles above Point Pleasant. The population is about 20,000, nearly all of whom live on slopes sufficiently steep to afford excellent surface drainage. The City Engineer estimates that one-third of the population drain all domestic sewage (including fæcal matter) into leaching cesspools in cavernous limestone. He also estimates that one-tenth of the population use privies the contents of which is removed to flats on an island overflowed by high water. Two public culverts assist in the removal of gutter drainage which includes considerable house waste water.

The water supply (1,500,000 gallons per day) is from springs near the Little Lehigh, on the outskirts of the town.

According to official returns the death rate in 1884 was 13.3 per 1,000. One-fourteenth of the total number of deaths was from typhoid fever, which "prevailed in various sections of the city to such an extent as to almost cause alarm."

The cemetery is located over cavernous limestone five feet below the surface.

In addition to domestic sewage there are the following manufactories having foul drainage into the Lehigh or its tributaries in and around Allentown:

Three small breweries, having an aggregate product of ten or twelve thousand barrels per year; two or three small slaughter houses on the Little Lehigh; a soap factory near the Lehigh discharging into it per day (on the average) the waste from 500 lbs. of scraps of hides (i. e. the solid part remaining after boiling them to recover the oil) and five or six gallons of spent lye; also 10 lbs. of refuse from refining tallow.

At the public gas works a local nuisance has been created by running all the liquid waste (except tar, which was sold,) to a large pool back of the works. It had no known outlet, but being near both the river and Jordan Creek, some of the liquid doubtless reached the streams after more or less thorough filtration. The Board of Health had just ordered this practice stopped, and the Superintendent did not know whether it would hereafter be sent directly into the creek or into a well. The daily product averages over 40,000 cubic feet, from coal.

Quite a large tannery on the Little Lehigh, on the outskirts of the town, had been idle for more than a year, and was not likely to resume work.

At a woolen mill near the preceding but little dyeing is done, but the operatives (80 to 100) use privies over the stream. Another large woolen mill near Jordan Creek had been idle for a long time.

At a silk mill near the Jordan creek, the water-closets, used by 600 operatives, discharge into a cesspool having an overflow to the stream.

At a pipe foundry on the Jordan creek, a hundred or more men use privies over the stream.

At a paint works and grist mill, near the mouth of the Little Lehigh, about a dozen men use privies on the banks of the stream.

A small furnace below the town, near the river, had been idle a long time; when in use perhaps 30 men use privies over a small stream.

There are extensive iron works on the river in the upper part of the town, but little pollution comes from them except the bath water of the employés, which, however, is not inconsiderable, as the number of men aggregates several hundred.

Three miles above Allentown, on Jordan creek, is a fertilizer factory having a capacity of 3,000 tons per year. The principal pollution is from boiling bones, the waste from which flows into a small land basin, said to have no outlet, and not reached by the creek except at times of freshet. Some of the deposit in the basin is sometimes taken out for manure.

The Lehigh County Poorhouse, situated on Cedar creek, a branch of the Little Lehigh, about three miles from Allentown, has direct water-closet drainage to the stream. The average population is about 300.

At East Allentown is a large tannery draining into the Lehigh, using 30,000 hides per year, 7,000 tons of bark, and 1,800 bushels of lime. It employs 50 workmen, half of whom use privies over the stream of waste water to the river. This stream, having an estimated flow of 20,000 gallons an hour at the time of my inspection, was very foul to the smell.

Catasauqua, 19 miles above the Delaware and 45 miles above Point Pleasant, is a manufacturing town of about 3,000 population, or, including suburbs and West Catasauqua, 4,500. It has a public water supply estimated at nearly 200,000 gallons per day, pumped from the river. The greater part of the population is favorably situated for surface drainage to the canal, including most of the domestic waste water. Cesspools receiving faecal waste are in cavernous limestone.

The special sources of pollution in Catasauqua are chiefly the privies of the large manufactories, used by over 300 men. The largest works, however, has tight cesspools. The same works wastes a barrel of oil per week from its iron rolls. A small gas works near the canal is probably the source of some pollution.

At Hockendauqua, a mile and a-half above Catasauqua, are two small furnaces, from which the most serious pollution is a privy over the river wall, used apparently by not more than 20 men. Below the furnaces a dozen houses on the bank have indirect drainage to the river.

Stemton, on the left bank, and Coplay on the right, about a mile above the preceeding, are small hamlets of scattered houses. At Coplay was a furnace not in operation, and at Stemton, car shops also idle at the time of my inspection. Above Coplay are two large cement works near the river, but giving no perceptible pollution.

Slatington, on the right bank of the Lehigh, 30 miles from the Delaware, has had a rapid growth within the last few years, due to the slate industry on which it is almost wholly dependent. The population is now estimated at over 2,000. About half the population has good surface drainage for domestic waste water by means of Trout creek, flowing through the town, and some 20 houses have privies over the stream. One livery stable also has partial drainage to the creek. In the upper part of this town a slaughter house, and a few water-closets drain into a small branch of Trout creek. This is the last town below the Blue Ridge.

Aquanchicola creek, the first tributary above the Blue Ridge (entering from the northeast, 34 miles from the Delaware) drains the northern slope of the Ridge, absolutely without population on one side, and a sparsely settled rough farming country on the other.

Pohopocho, or Big creek, entering five miles above the preceding, drains a broader valley, with a somewhat larger population. Parryville, a village at its mouth, has a population of about 700, mostly dependent on an iron works, where 100 men have water-closet drainage to the river; also some 50 more in shops and dwellings on the stream.

Above Parryville the valley is mostly rugged and wooded for 12 miles, with few inhabitants except along the stream where the land is cultivated, generally on one side only. The tributaries from the north drain extensive mountain districts which are within three or four miles of the main stream in the lower ten miles of its course (excepting the last two). The upper portion of the valley is more open, with better farming land, and consequently more thickly settled, though having less than 50 inhabitants to the square mile. The best portion of the valley is between five and fifteen miles from the river, where the population is only about 35 to the square mile. The lower five miles are somewhat more thickly settled on account of nearer markets and railroads, though the country is but little if any better suited for agriculture than that above.

Weisport, a village on the left bank of the Lehigh, two miles above the mouth of Big creek, has a population of about 500, but the dwellings are scattered—extending back from the river for more than a mile—and there are no manufactories with foul drainage.

Lehighton, just above Weisport on the opposite (west) side of the Lehigh, has a population of about 2,200, scattered over a large area, with no public water supply and but little direct drainage. It is a trading center for a large part of the surrounding country and the home of many of the workmen in the railroad car shops at Packerton, a mile above. There 1,000 men have water closet drainage to the river.

Next is Mauch Chunk, an important railroad and canal headquarters and summer resort, about 70 miles above Point Pleasant. Nearly the whole population has complete sewerage to the river, but there is no pollution from manufactories. The population of east Mauch Chunk (1,900) is quite scattered and has but little direct drainage.

West and northwest from Mauch Chunk are extensive coal mines in the mountains between the Lehigh and Susquehanna watersheds. This region was not visited and the following information regarding it was obtained from men acquainted there and from maps :

Hazleton, the largest town in this region, is partly in the Lehigh and partly in the Susquehanna watersheds. I estimate 4,000 of its 7,500 population as in the Lehigh drainage area. It is 13 miles from the Lehigh by way of Hazel and Black creeks and 90 miles above Point Pleasant. It is supported chiefly by the mining industry, but has also extensive manufactories of pianos and burial caskets.

Eight miles below, on the same stream (Black creek), is the borough of Weatherly, a town of over 2,000 inhabitants, having extensive car shops.

Three miles up Nesquehoning creek, entering from the west two miles above Mauch Chunk, is the village of Nesquehoning, having a mining population of about 900.

About eight miles southwest of Mauch Chunk is a large mining settlement on the summit between the Lehigh and Susquehanna watersheds, but little of the drainage from this population reaches the stream directly.

A considerable quantity of sulphuric acid enters the Lehigh from the coal mines northwest and southwest of Mauch Chunk, but I was unable to get any estimate of its amount.

The next town on the Lehigh is White Haven, 24 miles above Mauch Chunk and 94 above Point Pleasant. It has a population of about 1,500, scattered and at a short distance from the river, without a public water supply, so that but little direct pollution of the river from sewage results. There is no manufacturing except of lumber.

Above White Haven the watershed is almost wholly without population, or inducement thereto, the country being worthless for agriculture, with no mineral resources and but little valuable water power. The sources are in great swamps, from which the water acquires a brownish tinge, but the taste at the time of my visit to White Haven in September, was not unpleasant.

As has been seen, almost the whole area east of the Lehigh, above the Blue Ridge, is finely adapted for water supply while the tributaries from the west are unfitted by the coal mining industry until White Haven is reached. It is, therefore, proposed to intercept these streams from the east by the conduit which would tap the Lehigh above White Haven. The watershed thus utilized has an area of about 542 square miles and a population of about 10,000, or less than 19 to the square mile.

Returning to the Delaware, the first pollution of note above Easton is from Martin's creek, entering from Pennsylvania, 33 miles above Point Pleasant. With the exception of a small tannery near the mouth, no source of pollution was discovered on this stream below Bangor, seven miles from the Delaware and 40 above Point Pleasant. Quite a town (population 2,500) has been built up at this point within a few years by the slate quarrying industry. There are, however, no large manufactories having foul drainage, and in the absence of a public water supply, but little domestic sewage reaches the creek directly. The principal hotel has complete drainage to the stream and about a dozen houses have privies near the banks, half of which also cast in garbage.

Another slate quarrying town, situated on a branch of Martin's creek, about eight miles from the Delaware, is Pen Argyle, having a population of about 800. Both these last named towns are connected by rail with the Delaware and Lackawanna Railroad at Portland, and an extension has lately been constructed down the creek to connect with the Belvidere Division of the Pennsylvania Railroad, which will doubtless somewhat increase the population in this valley.

The first town above Easton is Belvidere, N. J., 40 miles above Point Pleasant, at the mouth of Pequest river. It is the seat of Warren county, a railroad junction and trading town, with some manufacturing, especially of flour, having a population of about 1,750. A public water works, pumping from the Delaware, supplies nearly 100,000 gallons per day on the average.

One public sewer drains the railroad station water-closets, one hotel and several private houses, while several grist and saw mills have privies over the stream. Water-closet drainage is thus afforded for perhaps 150 people. The dwellings are generally scattered so that comparatively little domestic sewage reaches the river directly. An old tannery on the Pequest was not in operation at the time of my inspection. A paper pail factory was also idle.

The Pequest valley is a limestone district, and contains extensive swamps about twelve miles back of Belvidere. These are being reclaimed by drainage, reducing the summer flow of this tributary.

Paulins' kill, draining a large area in New Jersey, enters about 49 miles above Point Pleasant. Newton, a town of about 2,000 inhabitants, is in its watershed, near its source, about 35 miles from its mouth, and several other quite large villages, nearly as far up, but they were not visited on account of their distance from the Delaware. There are no large villages in the Paulins' kill valley within 25 miles of its mouth.

Just above this, on the Pennsylvania side of the Delaware, is Portland, a village of 800 inhabitants, not very favorably situated for surface drainage. About a dozen houses have privies near the banks of the river or creek. A small tannery was not in operation, but was said to use about 50 hides per week when running. There are also several saw mills and a small foundry. This completes all notable pollution below the Water Gap.

Above the Blue Ridge, the Delaware watershed is remarkably free from pollution by manufacturing and domestic sewage. For more than 40 miles above the Water Gap it is almost wholly free from pollution incident to habitation (excepting a few large Summer hotels about the Gap, and the drainage area of a tributary entering two miles above, which contains the borough of Stroudsburg and considerable good farming country)—nearly the whole area being exceedingly rough and unattractive to any industry, seemingly destined to forever remain very sparsely populated. One township (Porter, Pike county) having an area of over 60 square miles, had a population of less than 100 in 1880.

At the Water Gap, at Stroudsburg, and at several other points on or near the river, are many hotels and boarding-houses which largely increase the population in the summer. Some of these drain directly into the river, as noted in detail below.

The Water Gap House, having accommodations for 300 guests, is generally full, or nearly so, for two months, and half full for four months more. It has a drain to the river taking all sewage except water closet waste, which is retained in a tight vault and used for a fertilizer.

The Kittatinny House, having about the same accommocations and patronage, has direct drainage for all sewage to the river; also the Central House, having about 30 occupants for four or five months.

A pulp and paper mill on Analomink creek, one-fourth mile from the Delaware, one mile above Water Gap Station, was being rebuilt at the time of my inspection. It was intended to consume twelve cords of wood per day, requiring probably about 7,000 lbs of lime, 4,000 lbs. of soda ash, and 1,400 lbs. of chloride of lime.

Stroudsburg, situated on McMichael's creek, just above its junction with Brodhead's creek, about four miles from the Delaware and six above the Gap, is a town of about 2,000 population, largely increased in summer by city boarders.

Pocono creek, a branch of McMichael's, borders the town on a third side, so that good natural drainage facilities are afforded, but the houses are scattered over flat ground at a distance from the streams, and only one house—the principal hotel, having about 50 boarders in summer—has a sewer.

A public water supply probably furnishes not more than a fourth of the population, as there are only 75 taps. The quantity consumed was not known.

At East Stroudsburg, on the other side of Brodhead's creek, is a tannery treating 510 hides per week with 100 tons of bark and 40 bushels of lime. Another, in Stroudsburg village, tans 300 hides per week, and one at Spragueville, six miles above, tans 250 per week. Formerly there were more tanneries in this upper Delaware country, but now nearly all are abandoned, or about to be, except those most favorably situated for shipment.

A woolen mill at Stroudsburg scours about 1,000 pounds of wool per day with 13 pounds of potash, 13 pounds of soda ash, and 33 pounds of sal soda, and colors 600 to 700 pounds per day, mostly with logwood and catechu. One hundred operatives use privies over the stream.

Excluding the pollution above-mentioned (in Stroudsburg and vicinity) there remains an excellent watershed of about 440 square miles, with a population of only 11,000, drained by Brodhead's, McMichael's, Cherry, Mrshall's and Bushkill creeks, entering the Delaware within a distance of 14 miles.

At Dingman's ferry, about 27 miles above the Water Gap, are a few summer boarding houses, but apparently little sewage reaches the river from them. The first town above Stroudsburg is Milford. It is the seat of Pike county, Pa., about 35 miles above the Water Gap, having a population of 1,200, mostly scattered and at a distance from the river, so that very little house drainage reaches it. It has no manufactories having foul drainage.

Port Jervis, N. Y., is the largest town in the Delaware valley above Easton. It is about 43 miles above the Water Gap, by way of the river. It was built up chiefly by the Erie Railroad when it had its terminus there, connecting with the Delaware and Hudson canal, and is still largely dependent on transportation interests, though also a trading town for the surrounding country. It has a population of about 9,000, mostly in scattered houses on flat ground at a distance from the river, and therefore not well drained. Only the business portion has good drainage, having a raceway in the rear of the principal street, with two connecting sewers, draining about 50 buildings. Perhaps 50 more have privies over or beside it, and 300 men in the Erie Railroad shops use privies over it, making, perhaps, 800 who have water-closet drainage to the river. The town has a public water supply from a mountain stream, with reservoir capacity of 280,000,000 gallons, 130 feet above the town. The quantity consumed is not known, but probably nearly all the inhabitants are supplied, as there are 2,500 attachments. Public gas works, producing 20,000 cubic feet per day from naphtha, drain into the river, but no other manufactory pollution was discovered.

Matamoras, a suburb on the Pennsylvania side, has a scattered population of about 1,000, on flat ground without water supply or good natural drainage.

Above Port Jervis there is little pollution from towns or manufactories except from Honesdale and vicinity on the Lackawaxen, the principal tributary from the west above the Lehigh. Extending for more than half the distance from the Delaware to the Lackawanna coal fields, it has naturally been one of the principal transportation routes. The Delaware and Hudson Canal follows the Lackawaxen from Honesdale to the Delaware, as also a branch of the Erie Railroad. Coal is brought over to the canal from Carbondale to Honesdale and formerly from Scranton to Hawley (nine miles below Honesdale) by rail. Thus towns have grown up at these points, Honesdale being the older and larger as the headquarters of the canal company. Formerly, before the railroad outlet was constructed and no coal could be removed in winter, it was the largest coal storing station in the world. It is about 24 miles from the Delaware and 91 above the Water Gap. The population of the borough proper is about 2,600, but including the outskirts and villages in the vicinity the total is about 6,000, increasing very slightly, if at all. One half of the borough (or a population of 1,300) has complete drainage by sewers to the stream, and a large part of the remainder has good surface drainage, while some 20 houses have privies on the banks of the river.

Hawley, nine miles below, has a very scattered population of nearly 2,000, or with immediate surroundings, nearly 3,000. Very little domestic sewage enters the stream from this town, but a large silk mill (500–600 operatives) has privy drainage to the Paupack, a tributary of the Lackawaxen at that point. There are large glass works here, also at Honesdale and at White Mills, between the two, but otherwise there is little manufacturing in the Lackawaxen Valley. A few tanneries remain but these are being gradually abandoned. The whole watershed of this tributary is finely adapted to water supply, except for the pollution above noted.

Above the Lackawaxen the Delaware watershed is almost entirely free of towns or manufactories having any considerable foul drainage. The largest town, Deposit (1,500), is nearly 130 miles above the Water Gap, and has no manufactories or direct drainage. Nearly all that portion of the watershed in New York state is sparsely settled farming country. The valley above Deposit was not surveyed but extensive inquiries revealed no sources of pollution.

Appended is a list of towns and villages having a population of 200 or over in the several watersheds, arranged in order of distance from the nearest proposed point of taking the supply. Possibly a few remote villages in New Jersey and some mining villages near the Susquehanna watershed northwest of Mauch Chunk, having a population slightly in excess of 200, may be wanting.

Respectfully,

DANA C. BARBER,

Assistant Engineer.

TOWNS AND VILLAGES IN THE DELAWARE VALLEY (EXCLUDING THE LEHIGH) BETWEEN POINT PLEASANT AND WATER GAP, HAVING A POPULATION OF 200 OR MORE.

	Estimated Population, 1885.	Miles above Point Pleasant.
Frenchtown, N. J	1,060	7
Milford, N. J	300 ?	11
Riegelsville, Pa	340	18
Bloomsbury, N. J	600	25
Phillipsburg, N. J	7,600	25
*Easton, Pa	9,750*	26
Stewartville, N. J	550	28
Broadway, N. J	200	31
†Nazareth, Pa	340†	34
Washington, N. J	2,300	35
Belvidere, N. J	1,750	40
Bangor, Pa	2,300	40
Pen Argyle, Pa	800	41
Hackettstown, N. J	2,650	45
Portland, Pa	800	48
Oxford Furnace, N. J	2,800	49
Hope, N. J	250	49
Williamsburg, N. J	340	51
Stanhope, N. J	700	55
Andover, N. J	400	66
Newton, N. J	2,000	84

TOWNS AND VILLAGES IN THE LEHIGH VALLEY HAVING A POPULATION OF 200 OR OVER.

	Estimated Population, 1885.	Miles above Point Pleasant.
‡Easton, Pa	3,250‡	25
South Easton, Pa	5,000	26
Glendon, Pa	1,100	28
Redington, Pa	370	31
Freemansburg, Pa	630	34
Bethlehem, Pa	5,800	36
South Bethlehem, Pa	5,500	36
West Bethlehem, Pa	2,000	37
Hellertown, Pa	700	38
Allentown, Pa	20,000	41
East Allentown, Pa	530	41
Catasauqua, Pa	3,500	44
West Catasauqua, Pa	560	44
Fullertown, Pa	500	45

* Three-fourths only; one-fourth of population drains into Lehigh.
† One-third only; two-thirds in Lehigh.
‡ One-fourth only; three-fourths of population drains into the Delaware direct.

Towns and Villages in the Lehigh Valley—*Continued.*

	Estimated Population, 1885.	Miles above Point Pleasant.
Coplay, Pa	800	46
Bath, Pa	700	46
Stemton, Pa	280	46
Siegfried's Bridge, Pa	240	47
Chapman, Pa	380	48
Coopersburg, Pa	400	48
*Nazareth, Pa	680*	49
Ironton, Pa	280	50
East Texas, Pa	240	52
Centerville, Pa	350	52
Macungie, Pa	700	52
Emaus	900	53
Alburtis	500	54
Slatington	2,000	56
Trexlertown, Pa	390	57
Franklin, Pa	220	59 ?
Fogelsville, Pa	390	60
Slatedale, Pa	350	61
Parryville, Pa	700	66
Weisport, Pa	500	67
Lehighton, Pa	2,200	68
Mauch Chunk, Pa	3,800	71
East Mauch Chunk, Pa	1,900	72
Nesquehoning, Pa	1,000	76
Weatherly, Pa	2,200	82
Beaver Meadow	500	85
Laurytown	550	86 ?
Beaver Meadow Mines	900	87 ?
Jeansville	500	88
Buck Mountain	700	89
†Hazelton	5,000†	90
Lehigh Tannery, Pa	300	91
Sandy Valley, Pa., ?	400	93 ?
White Haven, Pa	1,500	94
Middleburg, Pa	300 ?	95
Port Jenkins, Pa	300 ?	96
Highland, Pa	600	99

Upper Lehigh.

	Estimated Population, 1885.	Miles above White Haven.
Gouldsboro', Pa	250	13
Tobyhanna, Pa	600	25

* Two-thirds only; one-third in Delaware.
† A part only; remainder in Susquehanna water shed; estimate doubtful.

TOWNS AND VILLAGES IN THE DELAWARE VALLEY ABOVE WATER GAP HAVING A POPULATION OF 200 OR MORE.

	Estimated Population, 1885.	Distance in Miles above Water Gap.
Water Gap, Pa	200	2
Stroudsburg, Pa	1,850	5
East Stroudsburg, Pa	1,200	5
Dûtchbury, Pa	200	5?
Tannersville, Pa	330	15
Mountain Home, Pa	280	20
Milford, Pa	1,050	36
Port Jervis, N. Y	9,200	45
Matamoras, Pa	1,000	45
Wurtsboro, N. Y	500	57
Monticello, N. Y	950	67
Narrowsburg, N. Y	320	74
Liberty, N. Y	500	76
Hawley, Pa	2,000	83
Calicoon Depot, N. Y	320	87
Honesdale, Pa	2,600	95
Prompton, Pa	320	98
Waymart, Pa	500	103
Deposit, N. Y	1,500	121
Walton, N. Y	1,500	153
Andes, N. Y	500	159
Margaretville	450	162
Delhi	1,450	168
Bloomville	250	175
Hobart	400	182

APPENDIX No. 1—*Continued.*

PART II.—REPORT ON DAMAGE CAUSED BY RAIN STORM TO HYDROGRAPHIC WORK.

By H. W. Sanborn, *Assistant Engineer.*

Philadelphia Water Department,

February 25, 1886.

Mr. Rudolph Hering,

Engineer in charge of

Surveys for Future Supply:

Sir:—A report of the storm of February 11th and the damage it caused to the Hydrographic work is as follows: The rain began to fall at the different Gauge Stations at from 5 to 7 A. M., and continued through the day, ending at from 6 P. M. on the 11th until 7 A. M. on the 12th. The fall was about 2.60 inches.

The streams rose to an unusual height, reaching what is said to be the highest point since 1869. The unusual rise of water was caused by the melting of the large quantity of snow that fell on the 3d and 4th uniting with the rainfall. The quantity of water given off by the melting of the snow is somewhat uncertain, as the records of the snow-fall vary so much, due to its drifting. I should judge that it would be equivalent to one (1) or one-and-one-half ($1\frac{1}{2}$) inches of rain, which would make a total of 3.60 or 4.10 inches of rainfall.

There was a second fall of 0.80 or 0.90 inches of rain on the afternoon of the 12th, causing a second rise of the streams to nearly half the height of the first one.

The highest points that the streams reached are as follows:

Perkiomen, at Frederick, 17 feet.

Neshaminy, below the Forks, 17.75 feet.

Tohicon, at Point Pleasant, 11.00 feet.

The greatest damage done was at the Neshaminy below the Forks. The automatic stream gauge was carried away and the flooring on the meter bridge was torn off.

The cables and floor timbers are not apparently injured, yet they had a great strain to withstand, as the bridge at the centre must have been four feet under water, while the stream was running full of ice.

The automatic gauge-box was crushed by the ice, and the trees to which it was attached had all the bark torn off for two feet above the general height of the water. The pier lately built at the Tohicon, and upon which the automatic gauge is placed, showed scarcely a tremor when the ice was running.

The residents state that they never before saw so much ice go down the stream during a freshet.

The following is a list of the stream and maximum gauges washed away. Most of them need not be replaced, as sufficient results, generally, have been obtained:

Perkiomen, above Green Lane, 1 maximum gauge.
Macoby, 1 maximum gauge.
Macoby, 1 stream gauge.
E. Swamp at Perkiomenville, 1 maximum gauge.
West Swamp, 1 maximum gauge.
West Swamp, 1 stream gauge.
N. E. Branch, 1 stream gauge.
N. E. Branch, 2 maximum gauges.
Big Neshaminy, 1 maximum gauge.

Respectfully,

H. W. SANBORN,
Assistant Engineer.

FINAL REPORT

OF A

CHEMICAL INVESTIGATION

INTO THE

PRESENT AND PROPOSED FUTURE

WATER SUPPLY OF PHILADELPHIA.

MADE UNDER THE DIRECTION OF THE CHIEF ENGINEER OF THE WATER DEPARTMENT BY

ALBERT R. LEEDS, PH. D.

PHILADELPHIA WATER DEPARTMENT,

March 15, 1886.

COL. WILLIAM LUDLOW,

Chief Engineer:

SIR:—I have the honor to transmit herewith a final report upon the results of a chemical, and to a certain extent biological, investigation into the Present and Proposed Future Water Supply of the City of Philadelphia.

As introductory thereto, I desire briefly to point out the various steps which have been taken in the progress of this investigation, prior to the work summarized in this final report. The first step, you will remember, was made in January, 1883, when I was requested by the Water Commission and by Dr. Wm. H. McFadden, the Chief Engineer at that time, to determine the origin of the nauseous taste and smell affecting the water drawn from the Fairmount and Spring Garden Basins. The results of the first inquiry established:

First, The fact of a progressive deterioration in the quality of the water on its way down the river, this deterioration being made evident by the increase in the percentages of Albuminoid Ammonia, of Nitrous Acid and of Chlorine, and by the decrease in the percentage of dissolved Oxygen.

Second, The amounts of putrescible organic matters were so large, and the quantities of dissolved Oxygen so small (the river at that time being covered by a coating of ice), that adequate oxidation of the impurities did not take place. From the fact of the oxidation being arrested and only partial, it resulted that the gases arising from processes of putrefactive decay, kept accumulating in the water until at last the smell and taste originating from them, became unendurable.

The next step was made later in the year in connection with the preliminary surveys of the water-sheds in Eastern Pennsylvania, which in your judgment might be regarded as available sources of water supply for the City of Philadelphia. These preliminary surveys resulted in excluding from the necessity of future consideration a large number of streams, and in permitting future study to be concentrated on those which remained. Thus, of the streams included in the water-shed of Perkiomen River, the Skippack, the West Swamp Creek and the Northeast Branch, were found to be inferior, as regards quality of water, to the East Swamp Creek, and to the Perkiomen itself above Zieglersville and above Green Lane. The first three mentioned were also inferior to other available sources mentioned later on, so that for these reasons, future analyses of the Perkiomen water were restricted to samples taken above Zieglersville and Green Lane. An investigation of the upper waters of Lehigh River and of its affluent Tobyhanna Creek, showed that these were so pure, and so unexposed to future contamination, that their purity was established, and needed no further confirmation.

A preliminary analytical examination of the Schuylkill River waters, demonstrated that there would be no advantage in multiplying the points at which samples should be collected, but on the contrary there would be great gain in restricting these points to three, viz: the Phœnixville Pumping Station, the Roxborough Pumping Station, and the Spring Garden Pumping Station: the first as representing the best water obtainable from the Schuylkill, and the second and third, the relative amounts of deterioration at these two actual sources of the City's supply, respectively. By such restriction, the frequency and thoroughness of the comparison were greatly increased.

The preliminary surveys and analyses of the Delaware River, from the Water Gap down to the Kensington Pumping Station, showed that the difference in quality between the water at the two extreme points was great, and resulted in a recommendation to abandon the intake located at the latter point. Furthermore, whilst omitting the future study of the water at Kensington, for the reason mentioned, it was shown to be desirable to make systematic analyses of the Delaware at the Frankford Pumping Station, at Point Pleasant, and at the Delaware Water Gap, and also of certain tributaries of the Delaware of promising quality, more especially the Neshaminy, Tohickon and Mill Creeks.

The third step was the systematic weekly comparison of the waters of the Delaware River with those of the tributaries mentioned, and with those of the Schuylkill River and of the Perkiomen. The places from which the samples were taken were fourteen in number, and the comparison extended from the month of April, 1884, to the close of December in that year. These comparisons established the following points:

First. That the waters of the upper Delaware at the Water Gap and at Point Pleasant, those of the Schuylkill at Phœnixville, and those of Mill Creek, Tohickon and Neshaminy creeks, can all be placed in the category of wholesome and palatable waters, their relative quality being in the order mentioned. Apart from sanitary considerations, the Phœnixville water had the disadvantage, in common with the Schuylkill supply in general, that it is not so soft as the waters of the Delaware, the Perkiomen and their tributaries.

Second. That the Perkiomen waters are inferior in quality to those mentioned above.

Third. That the water supply from Spring Garden and Fairmount is very variable in quality, sometimes yielding favorable results on analysis, at other times showing gross pollution.

The conclusions above formulated have been confirmed by the work subsequently performed, this work being principally devoted to the following topics:

First. To the amount of deterioration of the Schuylkill River in the course of its flow from Phœnixville to the Spring Garden Pumping Station.

Second. To the degree of pollution of the Schuylkill River water at Spring Garden Pumping Station at various times and seasons.

Third. To discover whether the Delaware River at a point opposite Yardleyville had the same characteristics as to wholesomeness and purity as it exhibits at Point Pleasant.

Fourth. To certain simultaneous chemical and biological analyses of the waters of the Schuylkill, Perkiomen and Delaware rivers.

Fifth. To experiments upon the improvement of the present water supply.

I.

Amount of Pollution of the Schuylkill River in the Course of its Flow from Phœnixville to Fairmount.

No plan can be adopted, more liable to lead to erroneous results, than that of basing conclusions as to the character of waters in flowing streams, upon the testimony of a few isolated analyses. For this reason, the waters herein reported upon have been compared under the most dissimilar conditions with regard to volume, temperature, rainfall, etc. For purposes of comparison, it would have been somewhat more satisfactory to have the averages made out upon the same number of samples in every case, and to have had each set of samples collected simultaneously under identical conditions. But the latter achievement was practically impossible, and, even as they stand, these averages have great value. For, in the first place, they are computed upon the results of analyses of a large number of samples; and, in the second place, they represent a comparison extended through all seasons of the year—and that, too, for three consecutive years. As the labor of computing these averages was very considerable, only a limited number of the constituents which were determined in the course of analysis are represented in the accompanying table:

Schuylkill River. Average Results of Analyses.
(Parts per 100,000.)

	Phœnixville Pumping Station.	Roxborough Pumping Station.	Spring Garden Pumping Station.
Number of samples	17.	21.	59.
Free ammonia	0.0035	0.0048	0.008
Albuminoid ammonia	0.0097	0.014	0.015
Nitrous acid	0.00012	0.0006	0.0006
Nitric acid	0.369	0.435	0.39
Oxygen required to oxidize organic substances	0.188	0.229	0.22
Chlorine	0.324	0.346	0.523
Total solids	13.32	12.67	11.95

Along with the analyses of the waters of the Schuylkill I give the mean of 44 analyses of the Delaware river, at Byram or Point Pleasant:

Delaware River, at Byram (Point Pleasant). Average of 44 Samples. (Parts per 100,000).

Free ammonia	0.0028
Albuminoid ammonia	0.00988
Nitrous acid	0.00002
Nitric acid	0.254
Oxygen required to oxidize organic substances	0.315
Chlorine	0.266
Total solids	6.88

Now it will be noted that there is a sudden break or difference in the character of the Phœnixville samples as compared with those taken at the two lower points on the stream. The percentage of free ammonia rises abruptly 37 per cent., that of Albuminoid Ammonia 44 per cent., that of Nitrous Acid 400 per cent., that of Nitric Acid 18 per cent., of Oxygen required to effect the oxidation of organic substances 22 per cent., and of chlorine 7 per cent.

The origin of this abrupt alteration in character, is in part attributable to the impurities entering into the Schuylkill river from the population located upon its two banks, beginning with the 7,500 inhabitants of the Borough of Phœnixville, down to the Roxborough Pumping Station. But a potent factor in bringing about this change of character in the Schuylkill River waters, is the influence of the drainage from the Perkiomen water-shed. This is best seen by a comparison of the figures given below, which represent the composition of the Perkiomen waters at Zieglersville and Green Lane, and the general average of both.

Perkiomen Water-shed. (Parts per 100,000).

	Zieglersville.	Green Lane.	Mean.
Number of samples	11.	13.	24.
Free ammonia	0.003	0.0043	0.0037
Albuminoid ammonia	0.017	0.015	0.016
Nitrous acid	0.00009	0.000176	0.00013
Nitric acid	0.343	0.36	0.352
Oxygen required to oxidize organic substances	0.343	0.295	0.316
Chlorine	0.425	0.39	0.406
Total solids	10.31	9.88	10.08

It should be borne in mind that the average for the Perkiomen water-shed excludes the results obtained by the analysis of samples from the Skippack, the West Swamp Creek and the North East Branch, these streams having been previously set aside, on the testimony of the preliminary surveys, as unworthy of comparison with the Schuylkill at Phoenixville, the Delaware at Byram, and the Perkiomen at Zieglersville and Green Lane. And whilst the Perkiomen at the two points last mentioned is frequently limpid and exhibits little or no color, after it has received the drainage from its affluents, it pours a turbid tide into the Schuylkill, so that the junction of the two streams becomes very apparent to the eye.

Yet even without including the deterioration of the Perkiomen in the lower portion of its course, the averages given above show that its entrance into the Schuylkill river must necessarily bring about a considerable alteration in the composition of the latter. Thus, the amount of Albuminoid Ammonia in the Perkiomen waters, is usually relatively high. Its average quantity, (0.016 parts), is not very different from the average of this constituent at Roxborough, whilst it is considerably higher than the Phœnixville percentage, which is 0.0097 parts. Another characteristic of the Perkiomen waters is that the Oxygen required to effect the oxidation of the organic matters contained in them, is ordinarily greater than in the Schuylkill waters. In this respect we have an average in the Perkiomen of 0.316 parts, as against 0.188 parts at Phoenixville. This increment is largely due to decaying vegetable matters, and is markedly apparent, especially in the summer months and in autumn, in the waters of streams draining extensive areas of alluvial lands. In this respect the waters of the Perkiomen compare more closely with the Delaware river than they do with the Schuylkill, as will be seen by the inspection of the various analyses of these streams. But it would be absurd to suppose that such an increment in the gross amounts of oxidizable matters in the Perkiomen waters, was attended by any corresponding increment in the quantity of fresh sewage. And in this connection, the figures for the relative amounts of nitrous acid, which are indicative of the quantities of fresh sewage entering the streams, are eminently suggestive. For these amounts are about the same in the Perkiomen waters, as they are in the Schuylkill River just above Phœnixville, whilst below Phœnixville, at Roxborough, at Spring Garden, and at Fairmount, the average amounts of nitrous acid are more than twice as great.

Leaving now the comparison of the Roxborough samples with those of Phœnixville, let us pass to the comparison of the former with those of Spring Garden. It will be noted, in the first place, that the Free Ammonia is 67 per cent greater at Spring Garden than at Roxborough; the Albuminoid Ammonia only 7 per cent. greater; the quantities of Nitrous Acid are the same; the Nitric Acid and oxidizable organic matter are less. The most significant increase is found in respect of Chlorine, which is 0.175 parts more at Spring Garden than at Roxborough. The peculiar importance of this large absolute increase, is due to the fact that Chlorine is an invariable constituent of sewage. Furthermore, the compounds of Chlorine are mineral substances, and differ from the organic constituents of sewage, in being incapable of destruction by oxidation. Hence it is that every increment of sewage to the waters of a flowing stream is represented by a permanent increase in the percentage of Chlorine. On the other hand, such increments may not be represented by a permanent increase in the organic constituents, the latter being represented in the analyses by the ammonia, nitrogen acids, and oxidizable organic substances. Instead of an increase, the factors representing the organic constituents may actually diminish in amount. They increase when the processes of natural oxidization in a flowing stream are inadequate to cope with the burden of sewage, whilst they diminish (even though the absolute quantity of sewage added is very large), when the reverse is the case. But in either event, the percentage of Chlorine goes on steadily increasing.

These various phenomena are strikingly exemplified in the present instance. The Chlorine increases steadily, the increase between Roxborough and Spring Garden being 51 per cent. whilst the free Ammonia increases 67, and the Albuminoid Ammonia only 7 per cent. It may properly be objected to this explanation of the increase of the percentage of Chlorine, that this substance is contained in the form of common salt and other chlorides, in the refuse of many factories. But, whilst a portion of the increase is due to manufacturing establishments, yet another large portion is unquestionably due to sewage, for were it all due to factory waste, then the total amount of solids in solution would increase in the course of flow past Norristown, Manayunk, Falls of Schuylkill and other points. As a matter of fact, such is not the case; it is Chlorine, or the non-oxidizable constituent of sewage, which alone of all the other factors shows a considerable increase in flowing past these points.

The facts above stated are in harmony with those which the writer found to be true of the sewage-polluted water of the City of Albany, the investigation having been made during September and October of 1885, under instructions from the special Water Commission of that city. For whilst a considerable volume of sewage enters the Hudson river at Troy, which is located seven miles above Albany, and at a number of points below Troy, progressive oxidation and destruction of the organic constituents of this sewage occur in the course of its flow down the river, whilst *the percentage of chlorine goes on regularly increasing.* But inasmuch as the processes of oxidation under the conditions prevailing at Albany are inadequate to completely oxidize the sewage present in the Hudson river at that point, I recommended to the special Commission that the present method of supply, which is from an intake located on the Hudson river immediately above Albany, should be abandoned.

Certain conclusions of the greatest importance follow from the facts dwelt upon above; and whilst a portion of the evidence upon which they are based is connected with certain biological inquiries detailed later on, yet it is expedient to follow the preceding discussion with an immediate statement of the resulting conclusions. They are:

First.—There is no point on the Schuylkill river, from Phœnixville down to Fairmount, where incompletely oxidized sewage—that is to say, sewage in a more or less decomposed and noxious condition—is not revealed by analysis to be ordinarily present in the water.

Second.—The condition of the Schuylkill river at Roxborough cannot be taken as representing the composition of unpolluted Schuylkill river water. The composition of the water at Phœnixville is very different and very much superior; and whilst Phoenixville water is not at all times and seasons satisfactory, yet its average quality and purity are such that I have taken it throughout as the basis of comparison for the Schuylkill river samples. That its selection as a basis was justifiable and correct, is abundantly shown by the superiority evinced by the figures given for the average composition of the Schulkill river at this point, as contrasted with those at Roxborough.

Third.—The difference in regard to quality between the water at Roxborough and at Spring Garden is small, the superiority as a general rule being on the side of the Roxborough samples, so that the average quality of the Roxborough water is slightly better than that of the Spring Garden water. This is not always the case, for the following reason:

Fourth. Owing to the natural processes of oxidation in the course of flow, it sometimes happens that the water at Spring Garden shows a smaller quantity of non-oxidized sewage than at Roxborough. In fact, were the sewers so far completed as to intercept the sewage from Manayunk down, this occasional superiority of the Spring Garden water would be both natural and permanent.

For the detailed data upon which these conclusions are founded, not only tables I and II, which are given herewith, but all the tables in the preceding reports, are to be consulted.

TABLE I.

ANALYSES OF PRESENT AND PROPOSED WATER SUPPLIES OF PHILADELPHIA,

COMPLETING AN ENTIRE YEAR, BEGINNING APRIL 23, 1884. [See TABLE II, Annual Report for 1884.]

MADE UNDER DIRECTION OF COL. WILLIAM LUDLOW,

BY ALBERT R. LEEDS, PH. D.

Month.	Day.	LOCATION.	Laboratory number.	Free ammonia.		Albuminoid ammonia.		Nitrous acid.		Nitric acid.		Oxygen required to oxidize organic matter. [Permanganate.]		Oxygen required corresponding to silver reduced.		Gases in solution in 1,000 cubic centimeters.				Chlorine.		Hardness.		Total solids.		Color.	Taste.	Smell.	Temperature. Fahr.
				Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Oxygen.	Carbon dioxide.	Nitrogen.	Total.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.				
January	14	Schuylkill River, above Phœnixville	673	0.0035	0.00204	0.0065	0.0038	0.0002	0.00012	0.288	0.168	0.18	0.105	0.22	0.128	6.66	1.06	13.27	20.93	0.275	0.16	1.35	0.787	29.00	16.91	0.5	Pleasant	Vegetable	37.°3
	14	Schuylkill River, at Roxborough Pumping Station	668	0.007	0.0041	0.019	0.011	0.0002	0.00012	0.20	0.116	0.37	0.215	0.18	0.105	6.40	0.49	14.73	21.62	0.325	0.189	3.24	1.89	10.00	5.83	3.0	Pleasant	Slightly vegetable	38.°8
	14	Fairmount Reservoir, Basin No. 4	667	0.0085	0.005	0.02	0.0116	0.0004	0.00023	0.12	0.07	0.14	0.082	0.29	0.169	6.34	1.36	13.42	21.12	0.40	0.233	3.42	1.99	11.75	6.85	5.5	Woody	Slightly unpleasant	39.°0
January	21	Schuylkill River, above Phœnixville	676	0.0015	0.00087	0.0075	0.0044	0.0001	0.00005	0.288	0.168	0.11	0.064	0.19	0.11	7.31	1.08	14.64	23.03	0.20	0.116	5.61	3.27	9.20	5.36	0.0	Pleasant	None	32.°9
	21	Schuylkill River, at Spring Garden Forebay	674	0.0015	0.00087	0.0105	0.006	0.00015	0.00008	0.144	0.084	0.15	0.087	0.35	0.204	6.95	0.59	14.52	22.06	0.40	0.233	3.06	1.78	8.80	5.13	0.5	Slightly peaty	Slightly vegetable	33.°5
January	28	Schuylkill River, above Phœnixville	677	0.0125	0.0073	0.0065	0.0038	0.00013	0.00007	0.384	0.224	0.075	0.0437	0.14	0.082	6.71	1.00	15.60	23.31	0.225	0.131	4.68	2.72	10.70	6.23	0.0	Pleasant	None	32.°3
	28	Schuylkill River, at Roxborough Pumping Station	679	0.0025	0.0015	0.007	0.0041	0.00028	0.00016	0.768	0.448	0.09	0.052	0.22	0.128	6.60	1.13	15.40	23.13	0.325	0.189	5.14	3.00	9.95	5.802	0.25	Pleasant	None	32.°4
	28	Schuylkill River, at Spring Garden Forebay	678	0.0075	0.0044	0.0095	0.0055	0.0002	0.00012	0.768	0.448	0.23	0.134	0.23	0.134	6.71	2.03	14.16	22.90	0.35	0.204	5.14	2.99	10.00	5.83	0.25	Slightly unpleasant	None	33.°6
February....	4	Schuylkill River, above Phœnixville	682	0.005	0.0029	0.007	0.0041	0.0002	0.00012	0.48	0.28	0.11	0.064	0.14	0.082	7.67	1.31	17.34	26.32	0.20	0.12	5.85	3.41	11.8	6.88	0.0	Pleasant	None	32.°3
	4	Schuylkill River, at Roxborough Pumping Station	680	0.0065	0.0038	0.0075	0.0044	0.0001	0.00005	0.768	0.448	0.125	0.072	0.18	0.105	7.61	1.19	18.30	27.10	0.35	0.204	5.38	3.13	12.3	7.16	0.0	Pleasant	None	32.°6
	4	Schuylkill River, Spring Garden Forebay	681	0.007	0.0041	0.0085	0.005	0.0002	0.00012	0.24	0.14	0.18	0.105	0.17	0.099	7.61	1.08	17.16	25.85	0.375	0.218	5.85	3.41	12.1	7.04	0.25	Pleasant	None	32.°4
February....	11	Schuylkill River, above Phœnixville	690	0.016	0.0093	0.017	0.0099	0.0001	0.00005	0.192	0.112	0.28	0.163	0.23	0.134	7.38	1.31	17.28	25.97	0.25	0.145	5.61	3.27	11.4	6.64	1.75	Strong	Strong	32.°3
	11	Schuylkill River, at Roxborough Pumping Station	689	0.0135	0.0079	0.02	0.0116	Trace.	Trace.	0.192	0.112	0.37	0.215	0.319	0.186	7.25	1.44	18.00	26.69	0.175	0.102	2.7	1.57	6.0	3.5	2.25	Slightly earthy	Vegetable	32.°3
	11	Schuylkill River, Spring Garden Forebay	688	0.012	0.007	0.022	0.0128	0.0002	0.00012	0.192	0.112	0.35	0.204	0.297	0.173	7.65	1.31	18.48	27.44	0.175	0.102	2.43	1.41	6.70	3.90	1.50	Pleasant	Vegetable	32.°2
March.........	25	Schuylkill River, above Phœnixville	711	0.0045	0.0026	0.009	0.0052	0.0002	0.00012	0.576	0.335	0.11	0.064	0.187	0.109	5.68	0.84	19.38	25.90	0.325	0.189	5.85	3.41	11.30	6.59	0.0	Slight	None	32.°8
	25	Schuylkill River, above Roxborough Pumping Station	712	0.011	0.0064	0.018	0.0105	0.0002	0.00012	0.096	0.056	0.07	0.041	0.253	0.146	5.87	0.93	18.91	25.71	0.325	0.189	5.14	3.00	11.20	6.52	1.25	Slightly unpleasant	None	34.°1
	25	Schuylkill River, Spring Garden Forebay	713	0.0105	0.0061	0.0165	0.0096	0.0004	0.00023	0.384	0.224	0.185	0.107	0.385	0.224	5.40	0.93	19.85	26.18	0.45	0.262	5.38	3.13	11.70	6.82	1.25	Slightly earthy	None	35.°2
	25	Delaware River, at Point Pleasant	721	0.0035	0.002	0.011	0.0064	0.00005	0.000029	0.336	0.196	0.197	0.115	0.313	0.182	6.05	0.74	16.12	22.92	0.275	0.160	4.33	2.52	7.80	4.54	1.00	Slight	None	38.°2
April	1	Perkiomen Creek, at Zieglersville	726	0.007	0.0041	0.022	0.0128	Trace.	Trace.	0.336	0.196	0.336	0.196	0.45	0.262	6.20	0.49	18.56	25.25	0.325	0.189	3.15	1.83	6.35	3.70	3.00	Unpleasant	Vegetable	36.°4
	1	Delaware River, at Point Pleasant	727	0.01	0.0058	0.014	0.0082	Trace.	Trace.	0.336	0.196	0.185	0.107	0.363	0.211	5.73	0.88	18.27	24.88	0.25	0.145	2.97	1.73	5.85	3.41	2.5	Slightly earthy	None	41.°6
April	8	Schuylkill River, at Spring Garden Forebay	729	0.0075	0.0044	0.016	0.0093	0.0004	0.00023	0.288	0.168	0.185	0.107	0.319	0.186	6.32	0.68	16.95	23.95	0.30	0.175	4.68	2.72	6.00	3.50	1.25	Pleasant	None	47.°0
	8	Delaware River, above Water Gap	730	0.0045	0.0026	0.0125	0.0073	Trace.	Trace.	0.096	0.056	0.31	0.18	0.385	0.224	6.46	0.49	18.39	25.34	0.125	0.073	2.52	1.46	3.45	2.01	1.25	Slight	None	39.°8
	8	Delaware River, at Point Pleasant	731	0.003	0.0018	0.0105	0.0061	0.00023	0.00013	0.192	0.112	0.324	0.189	0.257	0.15	6.47	0.84	17.94	25.25	0.20	0.116	2.34	1.36	3.40	1.98	1.25	Pleasant	None	40.°0
	8	Delaware River, at Frankford Pumping Station	728	0.006	0.0035	0.018	0.011	0.0004	0.00023	0.192	0.112	0.406	0.236	0.385	0.224	6.15	0.82	17.82	24.79	0.20	0.116	2.43	1.41	3.40	1.98	1.75	Slight	Vegetable	41.°2
April	15	Schuylkill River, at Spring Garden Forebay	735	0.0095	0.0055	0.021	0.0122	0.0004	0.00023	0.384	0.224	0.14	0.082	0.242	0.141	5.68	0.74	16.87	23.29	0.375	0.218	3.78	2.20	9.30	5.42	1.0	Pleasant	Slightly unpleasant	44.°3
	15	Tohickon Creek, above Stover's mill, Point Pleasant	736	0.006	0.0035	0.02	0.0116	0.00005	0.00003	0.144	0.084	0.15	0.087	0.352	0.205	5.78	0.56	15.84	22.18	0.40	0.233	3.42	2.00	6.00	3.50	1.0	Pleasant	None	44.°1
	15	Neshaminy Creek, below Forks	738	0.007	0.0041	0.012	0.007	0.0004	0.00023	0.192	0.112	0.11	0.064	0.308	0.179	5.59	0.74	16.59	22.92	0.525	0.305	2.70	1.57	5.55	3.23	1.25	Unpleasant	Vegetable	46.°0
	15	Delaware River, at Point Pleasant	737	0.003	0.0018	0.0095	0.0055	Trace.	Trace.	0.144	0.084	0.18	0.105	0.286	0.167	5.78	0.68	16.28	22.74	0.15	0.087	2.52	1.46	3.60	2.10	1.0	Slight	None	41.°9

TABLE II.

ANALYSES OF SAMPLES COLLECTED EACH WEEK DURING THE YEAR BEGINNING JANUARY 21, 1885, AND ENDING JANUARY 20, 1886.

FROM THE SPRING GARDEN PUMPING STATION ON THE SCHUYLKILL RIVER.

MADE UNDER THE DIRECTION OF COLONEL WILLIAM LUDLOW,

By ALBERT R. LEEDS, Ph. D.

Month.	Day.	Laboratory number.	Free ammonia.		Albuminoid ammonia.		Nitrous acid.		Nitric acid.		Oxygen required to oxidize organic matter. [Permanganate.]		Oxygen required corresponding to silver reduced.		Gases in solution in 1,000 cubic centimeters.				Chlorine.		Hardness.		Total solids.		Color.	Taste.	Smell.	Temperature, Fahr.
			Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Oxygen.	Carbon dioxide.	Nitrogen.	Total.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.				
January	21	674	0.0015	0.00087	0.0105	0.0061	0.0001	0.00008	0.144	0.084	0.150	0.087	0.350	0.204	6.95	0.59	14.52	22.06	0.400	0.233	3.06	1.78	8.80	5.13	0.50	Slightly peaty	Slightly vegetable	33.°5
January	28	678	0.0075	0.00440	0.0095	0.0055	0.0002	0.00012	0.768	0.448	0.230	0.134	0.230	0.134	6.71	2.03	14.16	22.90	0.350	0.204	5.14	2.99	10.00	5.83	0.25	Slightly unpleasant	None	33.°6
February	4	681	0.0070	0.00410	0.0085	0.0050	0.0002	0.00012	0.240	0.140	0.180	0.105	0.170	0.099	7.61	1.08	17.16	25.85	0.375	0.218	5.85	3.41	12.10	7.04	0.25	Pleasant	None	32.°4
February	11	688	0.0120	0.00700	0.0220	0.0128	0.0002	0.00012	0.192	0.112	0.350	0.204	0.297	0.173	7.65	1.31	18.48	27.44	0.175	0.102	2.43	1.41	6.70	3.90	1.50	Pleasant	Vegetable	32.°2
February	18	694	0.0150	0.00870	0.0110	0.0064	0.0002	0.00012	0.240	0.140	0.370	0.215	0.253	0.147	6.06	1.11	12.77	19.94	0.300	0.175	2.97	1.73	6.30	3.67	1.00	Pleasant	None	32.°5
February	25	698	0.0100	0.00580	0.0100	0.0058	0.0004	0.00023	0.576	0.335	0.240	0.140	0.210	0.122	7.61	2.52	17.33	27.46	0.425	0.247	4.91	2.86	9.80	5.71	1.25	Unpleasant	None	32.°6
March	4	704	0.0140	0.00820	0.0140	0.0082	0.0005	0.00029	0.384	0.224	0.410	0.239	0.286	0.167	6.98	0.99	16.76	24.73	0.400	0.233	4.68	2.72	9.30	5.42	2.50	Slight	None	32.°7
March	11	705	0.0095	0.00550	0.0185	0.0107	0.0002	0.00014	0.265	0.155	0.310	0.180	0.264	0.154	6.48	1.08	14.04	21.60	0.375	0.218	4.68	2.72	9.50	5.54	2.25	Pleasant	None	34.°1
March	18	709	0.0085	0.00490	0.0130	0.0076	0.0004	0.00023	0.336	0.196	0.270	0.157	0.308	0.179	7.56	1.08	17.19	25.83	0.350	0.204	4.21	2.45	9.10	5.31	2.00	Pleasant	None	34.°3
March	25	713	0.0105	0.00610	0.0165	0.0096	0.0004	0.00023	0.384	0.224	0.185	0.107	0.385	0.224	5.40	0.93	19.85	26.18	0.450	0.262	5.38	3.13	11.70	6.82	1.25	Slightly earthy	None	35.°2
April	8	729	0.0075	0.00440	0.0160	0.0093	0.0004	0.00023	0.288	0.168	0.185	0.107	0.319	0.186	6.32	0.68	16.95	23.95	0.300	0.175	4.68	2.72	6.00	3.50	1.25	Pleasant	None	47.°0
April	15	735	0.0095	0.00550	0.0210	0.0122	0.0004	0.00023	0.384	0.224	0.140	0.082	0.242	0.141	5.68	0.74	16.87	23.29	0.375	0.218	3.78	2.20	9.30	5.42	1.00	Pleasant	Slightly unpleasant	44.°3
April	22	739	0.0060	0.00350	0.0130	0.0076	0.0004	0.00023	0.288	0.168	0.080	0.046	0.270	0.157	6.15	0.65	12.67	19.47	0.425	0.247	3.15	1.82	9.15	5.34	1.00	Sl'y chalky & earthy	Vegetable	63.°2
April	29	743	0.0095	0.00550	0.0160	0.0093	0.0003	0.00018	0.192	0.112	0.093	0.055	0.153	0.089	6.41	0.79	12.69	19.89	0.400	0.233	5.38	3.13	10.20	5.94	1.25	Unpleasant	Unpleasant	62.°8
May	6	744	0.0045	0.00260	0.0140	0.0082	None.	None.	0.408	0.237	0.134	0.078	0.166	0.097	6.02	1.86	12.80	20.68	0.450	0.262	4.86	2.83	10.05	6.12	0.50	Slight	None	63.°4
May	13	754	0.0030	0.00180	0.0110	0.0064	0.0003	0.00017	0.768	0.447	0.170	0.099	0.144	0.084	5.87	0.28	13.14	19.29	0.350	0.204	3.96	2.31	8.70	5.07	0.50	Slight	None	61.°1
May	20	756	0.0040	0.00230	0.0160	0.0093	0.0004	0.00023	0.696	0.406	0.180	0.105	0.189	0.110	5.78	0.95	13.53	20.26	0.425	0.247	4.68	2.72	10.25	5.97	1.00	Slightly unpleasant	Slightly vegetable	71.°3
May	27	757	0.0035	0.00204	0.0150	0.0087	Trace.	Trace.	0.576	0.335	0.110	0.064	0.210	0.122	4.19	1.21	12.11	17.52	0.475	0.277	5.25	3.05	10.50	6.12	1.00	Slightly earthy	None	70.°0
June	3	761	0.0130	0.00760	0.0140	0.0080	0.0008	0.00046	0.576	0.335	0.170	0.099	0.180	0.105	4.34	1.21	12.11	17.66	0.500	0.291	5.49	3.20	11.35	6.62	1.00	Unpleasant	Vegetable	76.°0
June	10	769	0.0125	0.00730	0.0180	0.0105	0.0004	0.00023	0.576	0.335	0.147	0.086	0.170	0.099	4.33	0.73	12.51	17.57	0.500	0.291	5.85	3.41	11.80	6.88	0.50	Earthy	Earthy	74.°4
June	17	771	0.0060	0.00350	0.0160	0.0093	Trace.	Trace.	0.576	0.335	0.140	0.082	0.227	0.132	4.40	1.28	11.56	17.24	0.550	0.320	5.25	3.05	12.00	7.00	0.50	Peaty	None	80.°2
June	24	776	0.0050	0.00290	0.0160	0.0093	Trace.	Trace.	0.432	0.252	0.110	0.064	0.160	0.093	3.88	0.68	8.15	12.71	0.625	0.364	4.91	2.86	13.00	7.58	0.00	Slight	Slight	79.°8
July	1	777	0.0160	0.00930	0.0140	0.0082	0.0032	0.00190	0.384	0.224	0.190	0.111	....	....	5.06	0.55	13.14	18.75	0.650	0.379	4.21	2.45	13.30	7.75	0.50	Slight	Of decay	77.°1
July	10	782	0.0160	0.00930	0.0150	0.0087	0.0032	0.00190	0.460	0.268	0.150	0.087	0.180	0.105	4.96	2.19	12.97	20.12	0.750	0.437	4.43	2.58	14.30	8.34	0.50	Slightly earthy	None	82.°0
July	15	789	0.0190	0.01110	0.0260	0.0152	0.0032	0.00190	0.432	0.252	0.200	0.116	0.296	0.173	3.20	1.51	11.49	16.20	0.650	0.379	7.02	4.09	13.80	8.04	0.50	Slightly vegetable	Slightly vegetable	81.°8
July	22	795	0.0025	0.00145	0.0130	0.0076	0.0001	0.00005	0.480	0.28	0.160	0.093	0.304	0.177	4.00	0.88	10.20	15.08	0.750	0.437	7.28	4.24	15.50	9.03	0.25	Slightly unpleasant	Woody	85.°0
July	29	796	0.0140	0.00820	0.0165	0.0096	0.0012	0.00070	0.432	0.252	0.200	0.116	0.184	0.107	3.85	1.91	10.14	15.90	0.750	0.437	7.48	4.36	15.30	8.92	0.25	Unpleasant	Vegetable	89.°7
August	5	806	0.0030	0.00175	0.0220	0.0128	None.	None.	0.480	0.280	0.360	0.210	0.288	0.168	3.26	1.66	9.68	14.60	0.400	0.233	4.44	2.59	13.30	7.75	*	Unpleasant	Slightly vegetable	76.°0
August	13	811	0.0060	0.00350	0.0165	0.0096	0.0016	0.00093	0.576	0.335	0.210	0.122	0.288	0.168	5.30	2.22	11.48	19.00	0.500	0.291	5.38	3.13	15.00	8.74	0.25	Pleasant	None	80.°0
August	19	812	0.0150	0.00870	0.0240	0.0140	0.0032	0.00190	0.576	0.335	0.290	0.169	....	....	3.64	1.25	12.65	17.54	0.450	0.262	3.42	1.99	11.60	6.76	3.50	Slightly earthy	Slightly vegetable	80.°0
August	27	813	0.0080	0.00466	0.0230	0.0134	0.0008	0.00046	0.528	0.307	0.250	0.145	....	....	4.70	2.35	12.02	19.07	0.475	0.277	4.21	2.45	11.10	6.47	0.75	Pleasant	None	80.°0
September	2	825	0.0110	0.00640	0.0130	0.0076	0.0016	0.00093	0.480	0.280	0.200	0.116	0.310	0.180	5.57	1.62	9.96	17.15	0.550	0.320	5.15	3.00	12.50	7.28	0.75	Slightly unpleasant	Slightly vegetable	74.°0
September	9	834	0.0090	0.00520	0.0125	0.0073	None.	None.	0.189	0.110	0.120	0.070	0.490	0.285	4.00	2.32	12.13	18.45	0.700	0.408	5.20	3.03	12.70	7.40	0.75	Slightly unpleasant	Slightly vegetable	72.°0
September	16	836	0.0030	0.00175	0.0150	0.0087	None.	None.	0.147	0.086	0.140	0.082	0.255	0.148	3.95	3.05	11.68	18.68	0.750	0.437	6.43	3.75	13.60	7.93	0.50	Slightly vegetable	Vegetable	74.°0
September	24	844	0.0030	0.00175	0.0310	0.0180	0.0006	0.00040	0.090	0.052	0.210	0.122	0.390	0.227	4.60	2.86	10.01	17.47	1.000	0.583	6.29	3.66	16.70	9.73	1.00	Vegetable	Vegetable	66.°0
September	30	849	0.0062	0.00360	0.0175	0.0100	0.0010	0.00050	0.220	0.128	0.160	0.093	0.330	0.192	4.44	1.73	11.83	18.00	0.725	0.422	6.86	4.00	14.30	8.33	0.00	Slight	None	70.°0
October	7	862	0.0057	0.00330	0.0310	0.0180	0.0020	0.00120	0.150	0.087	0.210	0.122	0.310	0.180	4.56	2.31	12.75	19.62	0.700	0.408	6.57	3.83	14.50	8.45	0.75	Pleasant	Oily	64.°0
October	14	865	0.0130	0.00760	0.0210	0.0122	0.0004	0.00023	0.160	0.093	0.190	0.111	0.320	0.186	4.08	1.38	14.95	20.41	0.725	0.422	8.86	5.16	16.35	9.53	0.50	Unpleasant	Vegetable	62.°0
October	21	875	0.0160	0.00930	0.0160	0.0093	0.0032	0.00190	0.210	0.122	0.310	0.180	0.310	0.180	5.30	1.42	12.54	19.26	0.600	0.350	8.30	4.84	16.70	9.73	2.00	Vegetable	Vegetable	62.°0
October	28	877	0.0050	0.00290	0.0160	0.0093	0.0002	0.00012	0.110	0.064	0.230	0.128	0.310	0.180	4.18	1.46	14.53	20.17	0.575	0.334	8.30	4.84	15.00	8.74	1.00	Pleasant	Vegetable	56.°0
November	4	894	0.0110	0.00640	0.0130	0.0076	None.	None.	0.400	0.233	0.280	0.163	0.357	0.208	4.08	1.06	12.54	17.68	0.550	0.320	4.70	2.74	10.05	6.12	2.00	Earthy	Vegetable	48.°0
November	11	897	0.0030	0.00175	0.0180	0.0105	None.	None.	0.420	0.245	0.250	0.145	0.298	0.173	2.76	4.09	13.76	20.61	0.625	0.364	4.60	2.68	10.65	6.21	1.00	Peaty	Peaty	54.°0
November	18	900	0.0050	0.00290	0.0150	0.0087	0.0001	0.00005	0.530	0.309	0.150	0.087	0.298	0.173	4.80	1.80	17.33	23.93	0.550	0.320	5.70	3.32	10.90	6.35	0.50	Earthy	Slightly vegetable	44.°0
November	25	901	0.0110	0.00640	0.0220	0.0128	Trace.	Trace.	0.360	0.210	0.340	0.198	0.298	0.173	4.82	1.14	18.87	24.83	0.525	0.305	4.70	2.74	9.40	5.48	2.00	Earthy	None	40.°0
December	3	916	0.0030	0.00175	0.0120	0.0070	0.0004	0.00023	0.450	0.262	0.210	0.122	0.238	0.138	4.72	1.49	20.08	26.21	0.550	0.320	4.60	2.68	11.10	6.47	1.75	Pleasant	None	43.°0
December	11	918	0.0070	0.00410	0.0185	0.0110	None.	None.	0.180	0.105	0.960	0.560	0.272	0.158	8.19	0.99	18.81	27.99	0.500	0.291	3.77	2.20	11.80	6.88	1.00	Unpleasant	None	34.°0
December	17	919	0.0055	0.00320	0.0150	0.0087	0.0004	0.00023	0.720	0.420	0.210	0.122	0.310	0.180	8.21	1.08	18.90	28.19	0.550	0.320	3.60	2.10	8.80	5.13	1.00	Slightly unpleasant	None	36.°0
December	23	922	0.0016	0.00090	0.0140	0.0080	Trace.	Trace.	0.360	0.210	0.170	0.099	0.200	0.116	7.28	1.27	15.85	24.40	0.550	0.320	6.07	3.54	9.70	5.65	0.50	Unpleasant	Unpleasant	36.°0
December	30	929	0.0090	0.00520	0.0125	0.0072	0.0001	0.00005	0.720	0.420	0.348	0.203	0.260	0.151	7.88	1.33	17.39	26.60	0.510	0.297	4.29	2.50	10.30	6.00	0.50	Very unpleasant	Vegetable	34.°0
January	6	941	0.0044	0.00260	0.0125	0.0073	Trace.	Trace.	0.270	0.157	0.312	0.181	....	....	7.92	1.86	16.50	26.28	0.400	0.233	4.43	2.58	10.30	6.00	4.25	Slight	Unpleasant	42.°0
January	13	946	0.0060	0.00350	0.0095	0.0055	None.	None.	0.560	0.326	0.192	0.112	....	....	7.65	1.10	17.20	25.95	0.425	0.247	4.43	2.58	10.20	5.94	0.75	Pleasant	None	32.°0
January	20	947	0.0055	0.00320	0.0120	0.0070	0.0002	0.00012	0.300	0.175	0.336	0.196	....	....	7.92	0.84	15.60	24.36	0.500	0.291	6.57	3.83	11.20	6.53	....	Pleasant	Slightly vegetable	32.°0
Averages	....	....	0.0081	0.00473	0.0161	0.0094	0.0006	0.00037	0.397	0.232	0.229	0.133	0.267	0.155	5.53	1.43	14.12	21.08	0.517	0.301	5.15	3.00	11.46	6.68	1.11			56°.4

* Yellowish red, between 5 and 6.

II.

The Great Variations in Quality of the Scuylkill River at the Spring Garden Pumping Station.

I have repeatedly called attention to this point, the variations in quality being so great, that many analyses of the Spring Garden water can be found in my various reports, which compare favorably with those of the best water supplies in the United States, while many others, on the contrary, show the fact of gross pollution in the most unmistakeable manner. Instead of appealing to impressions gathered from cursory examinations of elaborate and perplexing tables of figures, I can best establish this point by comparing the average composition of the Spring Garden water with its extreme variations, and with the number of times each constituent exceeds or falls below the average. This latter datum is of even more significance than the amounts by which the maxima and minima differ from the mean results.

Variations in Composition of the Spring Garden Water.

	Average of 59 samples.	Maximum.	Minimum.	Above average.	Below average.
Free ammonia	0.008	0.019	0.0005	21	37
Albuminoid ammonia	0.015	0.031	0.0085	23	31
Nitrous acid	0.0006	0.01	None.	13	36
Nitric acid	0.39	0.80	0.09	36	23
Oxygen required to oxidize organic substances	0.22	0 96	0.08	20	35
Chlorine	0.523	1.00	0 175	29	29
Total solids	11.95	19.00	6.00	25	33

From this table it will be seen that were the character of the Spring Garden water sought to be established by the favorable analyses, it would rank very high, whilst if the desire were to vilify it, abundant disparaging testimony could be gathered from the list of maximum figures. Furthermore, the maximum free ammonia exceeds the average 137 per cent., whilst the mimimum is 94 per cent. below it. The maximum albuminoid ammonia exceeds the average 107 per cent., the minimum falls below it 43 per cent. These various considerations establish in the most forcible manner, the fact of the great variability in composition of the Spring Garden samples.

But irrespective of the circumstance that either a very good or a very bad character might fairly be ascribed to it, in case isolated samples were made use of, yet the fact remains that its average composition, as deduced from not less than 59 samples, shows not only the certainty of sewage contamination, but also that the average amount of this sewage contamination is considerable.

III.

Yardleyville and Byram, (Point Pleasant.)

I present, in the accompanying table, comparative analyses of the samples taken during the last two weeks of October and the first week of November, these analyses having been made with a view to determining the relations in quality between the waters of the Delaware River at Yardleyville, and as they are at Byram, and these again with those of the Schuylkill River at Spring Garden Forebay. In order more readily to discuss the results, I have epitomized them in the following table of averages:

	Delaware River.		Schuylkill River.
Parts per 100,00	Byram.	Yardleyville.	Sp. Garden.
Free ammonia	0.004	0.005	0.011
Albuminoid ammonia	0.016	0.014	0.014
Nitrous acid	None.	None.	0.0011
Nitric acid	0.12	0.13	0 21
Oxygen required (permanganate)	0.48	0.45	0.27
Oxygen required (silver)	0.38	0.35	0.33
Chlorine	0.275	0.283	0.575
Hardness	3.3	3.37	7.10
Total solids	6.30	6.53	14.07

TABLE III.

COMPARISON OF THE DELAWARE RIVER AT BYRAM AND YARDLEYVILLE,

TOGETHER WITH ANALYSES OF THE SCHUYLKILL WATER ON THE SAME DATES.

Month.	Day.	Location.	Laboratory number.	Free Ammonia.		Albuminoid ammonia.		Nitrous acid.		Nitric acid.		Oxygen required to oxidize organic matter. [Permanganate.]		Oxygen required corresponding to silver reduced.		Gases in solution in 1,000 cubic centimeters.				Chlorine.		Hardness.		Total solids.		Color.	Taste.	Smell.	Temperature.
				Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Oxygen.	Carbon dioxide.	Nitrogen.	Total.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.				
October......	21	Schuylkill river, Spring Garden Forebay....................	875	0.016	0.0093	0.016	0.0093	0.0032	0.0019	0.21	0.122	0.31	0.18	0.31	0.18	5.30	1.42	12.54	19.26	0.60	0.35	8.30	4.84	16.70	9.73	2.0	Vegetable............	Vegetable........................	62.°0
	21	Delaware river, at Byram..	874	0.003	0.00175	0.0155	0.009	None.	None.	0.066	0.038	0.32	0.187	0.35	0.21	5.52	0.53	13.01	19.06	0.30	0.175	4.60	2.68	6.40	3.73	2.0	Slightly decayed...	Slightly vegetable.......	58.°9
	21	Delaware river, opposite Yardleyville........................	873	0.005	0.0029	0.014	0.0082	None.	None.	0.10	0.058	0.29	0.169	0.36	0.21	2.00	1.33	16.87	20.20	0.30	0.175	4.90	2.857	8.10	4.72	2.0	Pleasant..............	Slightly vegetable............	59.°1
	28	Schuylkill river, Spring Garden Forebay....................	877	0.005	0.0029	0.016	0.0093	0.0002	0.00012	0.11	0.064	0.23	0.128	0.31	0.18	4.18	1.46	14.53	20.17	0.575	0.334	8.30	4.84	15.0	8.74	1.0	Pleasant..............	Vegetable........................	56.°0
	28	Delaware river, at Byram..	878	0.004	0.0023	0.017	0.0099	None.	None.	0.11	0.064	0.54	0.315	0.37	0.216	3.68	1.46	16.54	21.68	0.275	0.159	3.0	1.75	5.80	3.38	2.0	Slightly vegetable..	None.............................	53.°1
	28	Delaware river, opposite Yardleyville........................	876	0.005	0.0029	0.013	0.0076	None.	None.	0.13	0.076	0.54	0.315	0.29	0.169	4.04	1.59	16.20	21.83	0.30	0.175	2.90	1.69	6.50	3.79	2.0	Slightly earthy......	Vegetable........................	52.°4
November...	4	Schuylkill river, Spring Garden Forebay....................	894	0.011	0.0064	0.013	0.0076	None.	None.	0.40	0.233	0.28	0.163	0.357	0.208	4.08	1.06	12.54	17.68	0.55	0.32	4.70	2.74	10.50	6.12	2.0	Earthy.................	Vegetable...........	48.°0
	4	Delaware river, at Byram..	896	0.005	0.0029	0.017	0.0099	None.	None.	0.17	0.099	0.57	0.332	0.408	0.237	3.96	2.48	16.61	23.05	0.25	0.145	2.30	0.134	6.0	3.5	2.0	Earthy.................	Decayed vegetable matter..	44.°6
	4	Delaware river, opposite Yardleyville........................	895	0.006	0.0035	0.015	0.0087	None.	None.	0.15	0.087	0.52	0.303	0.391	0.228	4.52	1.37	18.92	24.81	0.25	0.145	2.30	0.134	5.0	2.91	2.0	Earthy.................	Decayed vegetable matter..	46.°0

	Cubic centimeters per liter.		
Dissolved oxygen	4.39	3.52	4.52
Dissolved carbon dioxide	1.49	1.43	1.31
Dissolved nitrogen	15.39	17.33	13.20
Dissolved total gases	22.27	22.28	19.03
Temperature, Fahrenheit	52°.2	52°.8	55°.3

As between Byram (Point Pleasant) and Yardleyville, these results show that there is but little difference as to quality. The most striking difference between them is connected with a process of oxidation, taking place between the two points, the process resulting, as would properly be expected, is an increase in the amounts of free ammonia and nitric acid, and a diminution in the amounts of albuminoid ammonia, of required oxygen and of dissolved oxygen. The percentage of total solids, of chlorine, and of hardness, increases slightly in going from Byram to Yardleyville. These three factors, however, are very small, the total solids at the latter point amounting to only 6.53 parts per 100,000, or 3.8 grains per gallon, as compared with 14.07 parts per 100,000 (8.2 grains per gallon) at Spring Garden, and the relative hardness to 3.4, as compared with 7.1 at Spring Garden.

The Schuylkill water contains unoxidized sewage, as shown by the considerable amount of nitrous acid and a relatively larger quantity of oxidized nitrogenous matters, its free ammonia being 0.011 parts per 100,000 as compared with 0.004 and 0.005 parts in the Delaware samples, and its nitric acid 0.21 parts as compared with 0.12 and 0.13 parts respectively. The amount of chlorine in the Schuylkill samples is more than twice that contained in the Delaware samples.

At the season of the year during which these samples were taken, there appears to be a considerable amount of decaying vegetable matter in the Delaware River water, as is shown by the relatively large amount of oxygen required to effect the oxidation of the organic substances, and as evidenced by the smell, which is that of vegetable matter undergoing decay. In the effort of nature to oxidize these organic matters, the oxygen dissolved in the water is largely used up, its average amount at Yardleyville falling to 3.52 cubic centimeters per liter. As the season advanced, the amount of dissolved oxygen increased, for while it was only 2 cubic centimeters per liter on October 21st, it became 4.04 cubic centimeters on October 28th, and 4.52 cubic centimeters November 4th. With the disappearance of vegetable matters in streams at the close of autumn, and with the falling temperature of the water, the percentage of dissolved oxygen rises. But the facts above mentioned show the speed with which the water in the Delaware was disposing of the vegetable matters naturally leaching into it during the summer months. Such matters must always find their way into flowing streams, but they are not dangerous to health, and only temporarily affect the flavor of the water, which returns to its best condition as soon as they are oxidized and eliminated. Similar processes of oxidation were undoubtedly taking place in the waters of the Schuylkill. But that they had not sufficient time and opportunity to dispose of the sewage, and that a considerable amount of it remained in a non-oxidized condition, is shown, as I have above stated, by the considerable percentage of nitrous acid.

The average temperature of the Byram samples was the lowest, being 52.2; that of the Yardleyville samples a little higher, or 52.8, and that of the Schuylkill samples highest, being 55.3.

An impartial conclusion, therefore, in regard to the points discussed under this third caption, would appear to be as follows, viz:—that the difference in quality between the water at Yardleyville and at Byram is not great, the Byram water being the better of the two.

Delaware River at the Water Gap, Byram, and Frankford (Lardner's Point).

As the above results at Byram were obtained only for a short period, it will be well, before leaving this part of the subject, to give the average results obtained by a comparison of the Delaware river at various points at very many times and seasons. I append, therefore, below, such a tabular statement of the Delaware averages.

Delaware River. Average Results of Analyses. (Parts per 100,000).

	Water Gap.	Byram.	Frankford.
Number of samples	13.	44.	17.
Free ammonia	0.00249	0.0028	0.00385
Albuminoid ammonia	0.0105	0.00988	0.0149
Nitrous acid	0.000005	0.000022	0.00004
Nitric acid	0.2393	0.2543	0.328
Oxygen required to oxidize organic substances	0.2892	0.315	0.308
Chlorine	0.227	0.266	0.329
Total solids	4.910	6.880	8.300

It will be seen from the above, that the quality of the water at the Water Gap is superior to its quality at Byram, and both are very much better than at the Frankford Pumping Station.

IV.

Certain Simultaneous Chemical and Biological Analyses of the Waters of the Schuylkill, Perkiomen and Delaware Rivers.

Unfortunately the methods of biological study three years ago, at the time when the present investigation was entered upon, were too imperfectly known in connection with water analysis, to make their application satisfactory, and after a brief trial, which is alluded to in the annual report for 1883, p. 369, I discontinued their use. Recently in connection with the new water supply of the City of Albany, I employed them again, and with so much better methods and results, that I forthwith took up their application to the problem of the Philadelphia Water Supply.

Such application is beset with very great difficulties. Micro-organisms exist in countless multitudes in air, water, food and even along the mucous surfaces and alimentary canal of the human body. The larger number are harmless or of benefit to mankind, whilst some are inimical to his health or safety, the latter being the so-called pathogenic organisms or disease germs. By the aid of the former, the complex operations of digestion are carried on, and decomposing organic matters are transformed into simple and innocuous compounds. In sewage polluted waters, these microbes grow and multiply rapidly, the sewage being the pabulum upon which they feed. As a requisite to the performance of their vital functions, oxygen is absorbed and carried by them to the decomposing organic matters, which are in this way oxidized and broken up. Thus it happens that largely by the aid of the vital processes of these countless benefactors, the nitrogen, hydrogen, and carbon which constitute the decomposing sewage, are oxidized and converted into such harmless products as ammonia, and nitrous, nitric, and carbonic acids. Hence it follows that where there is much sewage, there is ordinarily developed a corresponding multitude of microbes. In case they absorb the oxygen more rapidly than it is supplied, the percentage of oxygen in the water will diminish. And therefore, the determination of the greater or smaller number of micro-organisms may serve, like the measurement of the greater or smaller amount of dissolved oxygen, to aid us in ascertaining the relative amounts of sewage in a sewage-polluted stream. And in this way I have used the information obtained by culture experiments upon the waters collected in sterilized flasks, in the present instance, and in the study of the Albany waters. No pretence has been made of settling the relative purity of these waters by ascertaining that some contain disease germs and some do not. And inasmuch as the forms of the microbes give us no certainty as to which microbes are, or may develop into, dangerous organisms, and the methods of pure cultures and inoculation are as yet too

TABLE IV.

ANALYSES OF THE SCHUYLKILL, PERKIOMEN, AND DELAWARE RIVER WATERS,

TO ACCOMPANY THE BIOLOGICAL EXAMINATIONS OF DUPLICATE SAMPLES.

Month.	Day.	Location.	Laboratory number.	Free ammonia.		Albuminoid ammonia.		Nitrous acid.		Nitric acid.		Oxygen required to oxidize organic matter. [Permanganate.]		Oxygen required corresponding to silver reduced.		Gases in solution in 1,000 cubic centimeters.				Chlorine.		Hardness.		Total solids.		Color.	Taste.	Smell.
				Parts per 100,000.	Grains per gallon.	Parts per 100,000	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per galon.	Parts per 100,000	Grains per gallon.	Oxygen.	Carbon dioxide.	Nitrogen.	Total.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.			
November...	26	Schuylkill river, Phœnixville Pumping Station...........	903	0.003	0.00175	0.013	0.0076	0.0002	0.00012	0.33	0.192	0.16	0.093	0.23	0.134	3.92	1.64	19,76	25.32	0.425	0.247	5.0	2,91	10.0	5.83	1.0	Unpleasant...........	None.
	27	Schuylkill river, Roxborough Pumping Stat'n, surface.	904a	0.006	0.0035	0.024	0.014	Trace.	Trace.	0.56	0.326	0.25	0.145	0.29	0.169	3.81	0.88	18.24	22.93	0.45	0.262	4.9	2.86	11.3	6.58	2.0	Unpleasant...........	None.
	27	Schuylkill river, Roxborough Pumping Stat'n, bottom.	904b	0.004	0.0023	0.016	0.0093	Trace.	Trace.	0.56	0.326	0.21	0.122	0.255	0.147	4.30	0.76	20.38	25.44	0,45	0.262	4.9	2.86	10.70	6.23	2,0	Unpleasant...........	None.
	27	Falls of Schuylkill, surface..	905a	0.01	0.0058	0.019	0.0111	Trace.	Trace.	0.82	0.478	0.64	0.373	....	....	4.46	2.14	17.23	23.83	0.55	0.32	4.9	2.86	12.80	7.46	2,0	Very unpleasant...	Very unpleasant
	27	Falls of Schuylkill, bottom...	905b	0.003	0.00175	0.02	0.0116	Trace.	Trace.	0.79	0.46	0.35	0.204	0.357	0.208	4.62	1.26	17.68	23.56	0.55	0.32	4.9	2.86	11.30	6.58	2.0	Very unpleasant...	Very unpleasant
	28	Schuylkill river, opposite Spring Garden Stat'n, surface	906a	0.006	0.0035	0.015	0.0087	Trace.	Trace.	0.26	0.151	0.27	0.157	0.306	0.178	4.15	1.33	17.60	23.08	0.50	0.291	4.9	2.86	12.0	7.0	2.0	Unpleasant...........	Unpleasant.
	28	Schuylkill river, opposite Spring Garden Stat'n, bottom	906b	0.003	0.00175	0.012	0.007	Trace.	Trace.	0.51	0.297	0.26	0.151	0.255	0.147	4.73	1.76	18.24	24.73	0.50	0.291	4.6	2.68	10,8	6.29	2.0	Unpleasant...........	Unpleasant.
	30	Delaware river, Frankford Pumping Station, surface...	911	0.009	0.0052	0.016	0.0093	None.	None.	....	....	0.29	0.169	....	....	....	....	....	....	0.375	0.218	4.2	2.45	7,5	4.37	1.75	Slight..................	None.
	30	Delaware river, Frankford Pumping Station, bottom...	909	0.004	0.0023	0.015	0.0087	None.	None.	0.13	0.076	0.32	0.187	0.374	0.218	4.83	0.86	19.31	25.00	0.40	0.233	4.0	2,33	7.0	4.08	2.0	Slight..................	None.
December....	1	Perkiomen, at Green lane, surface.............................	910	0.006	0.0035	0.016	0.0093	None.	None.	0.475	0.277	0.19	0.111	0.306	0.178	5.11	1.50	21.00	27.61	0.55	0.32	4.2	2,45	8,4	4.89	1.5	Slightly unpleasant	Vegetable.

little worked out to permit of arriving at any definite conclusion in connection with water analysis by their use, the propriety of using biological methods only in the restricted manner above stated, would, I think, be considered by most bacteriologists as the prudent course.

In the accompanying table IV, I give a series of samples, collected from the Schuylkill, Perkiomen and Delaware, a duplicate set of samples having been collected at the same time in sterilized flasks, and submitted to biological study.

It will be noted that at Roxborough, Falls of Schuylkill, Spring Garden, and the Frankford Pumping Station, water was taken from both the top and from the bottom of the stream. The quality of the surface samples was uniformly inferior to that of those taken from near the bottom, both in the Schuylkill River and in the Delaware. In no respect is the inferiority of the surface samples more strikingly shown, than in the quantity of dissolved oxygen, which is least at the surface where the water is in contact with the air. The result is quite unintelligible, until we come to the results of the biological examination. So likewise, instead of the greatest amounts of dissolved solid matters being found at the bottom they are at the top, the excess being due to a corresponding excess of dissolved decomposable organic substances. All of the Schuylkill samples, according to the testimony of the chemical analyses, contain incompletely oxidized sewage, and this fact is connected with their all containing less oxygen than they should contain, provided that the sewage had been destroyed, and, by processes of oxidation in a flowing stream, the percentage of oxygen had risen to its proper figures.

Turning now to the results of the biological examination, I should say, in the first place, that I had no sample from the bottom at Phoenixville, nor at Frankford, nor from the Perkiomen; but from the former locality I had two sterilized flasks filled with water at the middle of the stream and near the west shore.

Secondly, in estimating the character of the samples from a biological standpoint, I have placed those waters at the top of the list, which, in the course of culture experiments, developed the smallest number of micro-organisms.

This order is as follows:

I. Phœnixville and Frankford, (Lardner's Point, Delaware River).
II. Falls of Schuylkill, bottom.
III. Perkiomen.
IV. Roxborough, bottom.
V. Spring Garden, bottom.
VI. Roxborough, surface.
VII. Spring Garden, surface.
VIII. Falls of Scuylkill, surface.

This order does not correspond exactly with the order which I should assign from the chemical data. But it does tally with the statement previously made, that *pari passu* with the deterioration (as evidenced by the chemical factors) produced by the presence of sewage, there is a greater development of bacteria, and a more rapid absorption, with a correspondingly large deficiency in the percentage of dissolved Oxygen. The importance of not using the surface waters of a flowing stream, is very great, since they are, relative as compared with the under waters, far more impure than is usually supposed. Even where, as at Roxboro Pumping Station, the depth of the river is small, yet the benefit of extending the intake to a point well in the current of the river, and so that the water might be taken about two thirds the depth below the surface, would be very considerable.

Weighing the evidence presented by all the data, both chemical and biological, I should infer from the results above detailed, that the water taken at the bottom of the Delaware river at Frankford, and from the Schuylkill at Phœnixville, whilst they were not of a satisfactory degree of purity, were the least impure of the specimens examined in this series.

V.

EXPERIMENTS UPON THE IMPROVEMENT OF THE PRESENT WATER SUPPLY.

The most important of these experiments, are those which have been made upon a large scale by the satnration of the water with dissolved oxygen at the Belmont Pumping Station. At this station the water has been charged with 20 per cent. of its volume of air, the air having been forced by an air compressor into the main leading from the pumping engine to the reservoir, at a point in the main just beyond the pumps. I have understood that the people using this aërated water have accounted for its sparkle and liveliness on the supposition that the water was full of sewer gas. As a matter of fact, the water is super-saturated with oxygen, and a lesser percentage of injected air would have been adequate. The following analysis illustrates, in a striking manner, the change of composition in the Belmont water.

The non-aërated sample was collected by Assistant Engineer Lloyd Bankson, at 9.25 A. M. December 24, from the mouth of the forebay of the Belmont pumping station. The aërated sample was taken from the mouth of the main delivering the water into the Belmont Reservoir, at 11.20 A. M. on the same day. The former specimen was delivered to me December 25, the latter December 26, but with the cork and seal which secured it partially lifted out by the pressure of the excess of air over that which the water was able to hold in solution:

	Non-aërated.	Aërated.
Color	0.75	0.50
Taste	Normal.	Pleasant.
Smell	Vegetable.	None.
	Parts per 100,000.	
Free ammonia	0.017	0.004
Albuminoid ammonia	0.011	0.007
Oxygen required to oxidize organic substances	0.133	0.117
Nitrous acid	0.0008	None.
Nitric acid	0.45	0.54
Total solids	9.00	8.70

	Gases in solution, as cubic centimeters per liter.	
Oxygen	7.83	9.54
Carbon dioxide	0.65	0.90
Nitrogen	16.31	19.77
Total gases	24.79	30.21

It will be seen that the albuminoid ammonia has diminished nearly 40 per cent.; and, what is the most noteworthy feature of all, the nitrous acid has undergone complete oxidation, none being present in the aërated sample. At the same time, by oxidation of the nitrogenous portions of the organic matter, the nitric acid has been increased 20 per cent.; and by oxidation of the organic constituents in general, the total solids have been diminished from 9.00 parts per 100,000 to 8.7 parts, and the carbon dioxide has been raised from 0.65 cubic centimeters per liter to 0.90 cubic centimeters.

The same experiment has been in continuous operation in Hoboken for a year and a half, the entire water supply of four million gallons per diem being aërated, although it has been customary to inject air only to the extent of five per cent. of the volume of the water pumped. During the whole of that time the monthly analyses have shown the aërated water to be of excellent quality. It should be borne in mind also, that the testing of the aërated water, taken directly from the outlet of the delivery main into the reservoir, as was done at Belmont, is not a fair index of the total benefit which the water in the reservoir receives. Even under ordinary conditions, water improves on lifting into reservoirs where there is a constant inflow and outflow, a small amount of oxidation and improvement taking place, but the benefit is much greater when the water receives its full complement to start with. Where the capacity of the Receiving Reservoirs is quite large in comparison with the volume of water flowing through them, there is still further advantage in that, after oxidation of the impurities has occurred, they undergo precipitation and sedimentation along with the suspended earthy matters, so that the clear water racked off from the lees, may be made, and as a matter of fact generally is, superior to the same waters at the time of their pumping from the river.

CONCLUSIONS.

In conclusion, I shall very briefly reiterate the statements which will be found at greater length in this and preceding reports.

First.—The present water supply of Philadelphia is not satisfactory in regard to purity.

Second.—The water taken from the Frankford Pumping Station is superior in its average quality to that taken from any of the Schuylkill Pumping Stations.

Third.—The quality of the water in the Schuylkill is very variable, sometimes approximating to a high standard of purity, at other times exhibiting gross pollution, and ordinarily revealing the presence of more or less incompletely oxidized sewage, at all points after the stream has received the sewage from the Borough of Phœnixville down to the Fairmount Pumping Station.

Fourth.—For the above reasons, the supply from the Schuylkill river should either be abandoned, or it should be subjected to purification, this purification requiring for its successful accomplishment, the following measures, viz.:

(*a.*) The exclusion to the greatest practicable extent of the sewage at present entering the river.

(*b.*) The construction of the intakes in such a manner that surface water should not find its way into the pump-wells at the Pumping Stations. This precaution indeed should be observed on the Delaware river as well.

(*c.*) The thorough aëration of the water followed by storage and sedimentation in reservoirs of large capacity, properly cleansed at reasonable intervals.

(*d.*) The removal of earthy and other suspended impurities, by the application of suitable methods of filtration, so that the water may be rendered at all times clear and limpid.

Fifth.—In the selection of a new water supply for the City of Philadelphia, the Blue Mountain tributaries of the Delaware and Lehigh rivers are to be preferred before all others. And whilst of the Delaware river waters that at the Water Gap is entitled to the first place, that gathered at Byram, (Point Pleasant), is uniformly wholesome and of satisfactory purity and quality.

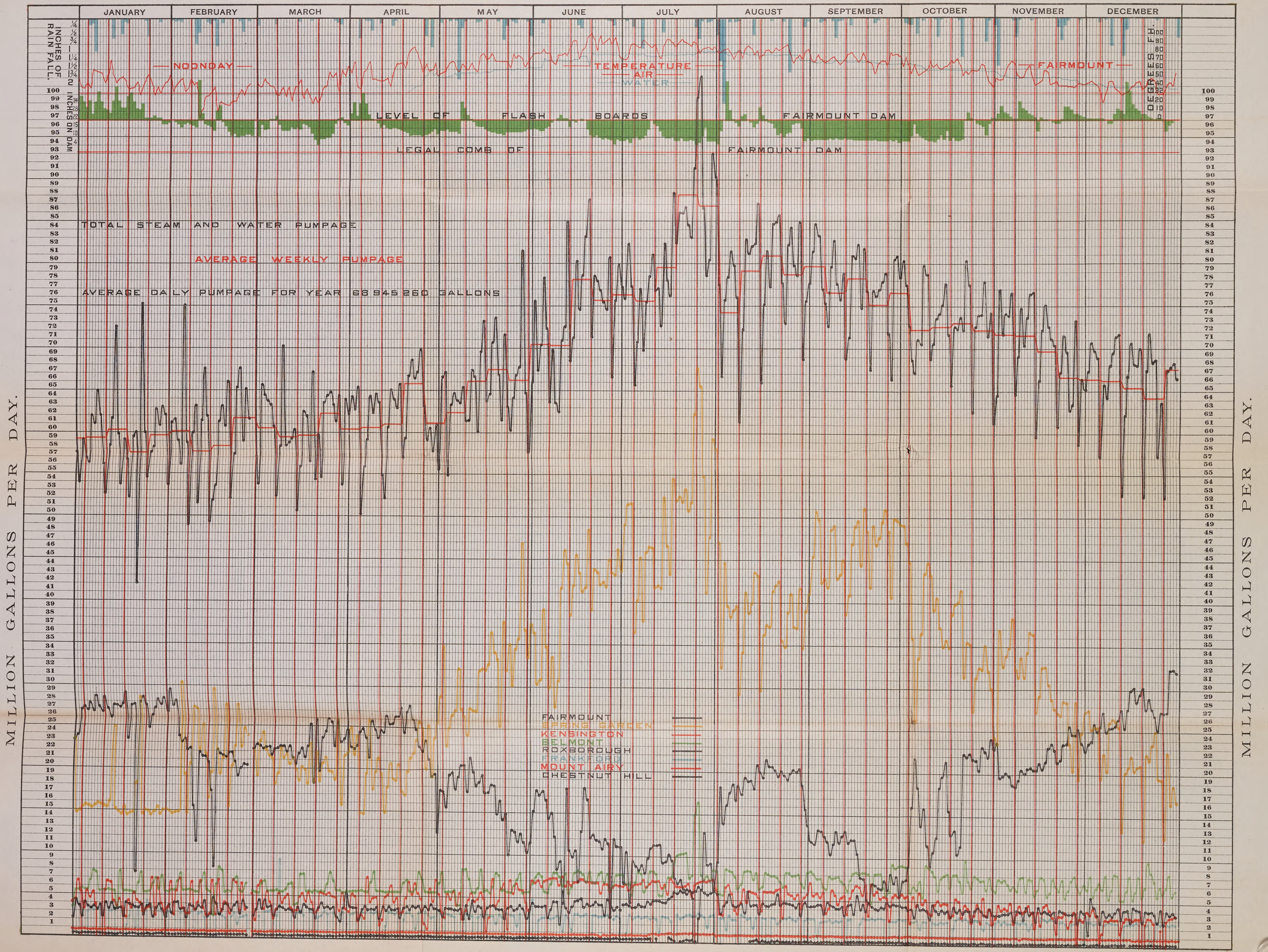
Very respectfully,

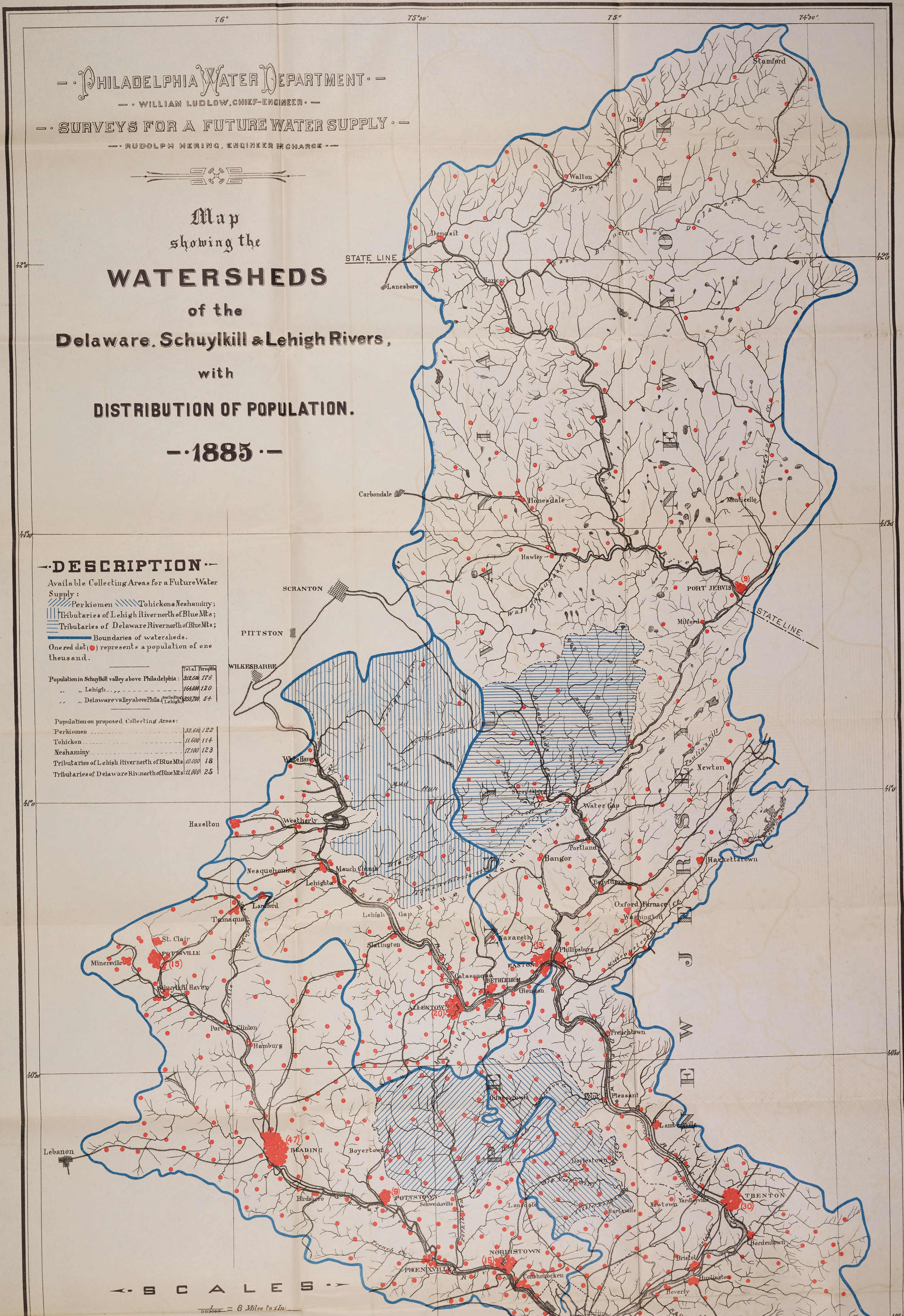
ALBERT R. LEEDS, Ph. D.,

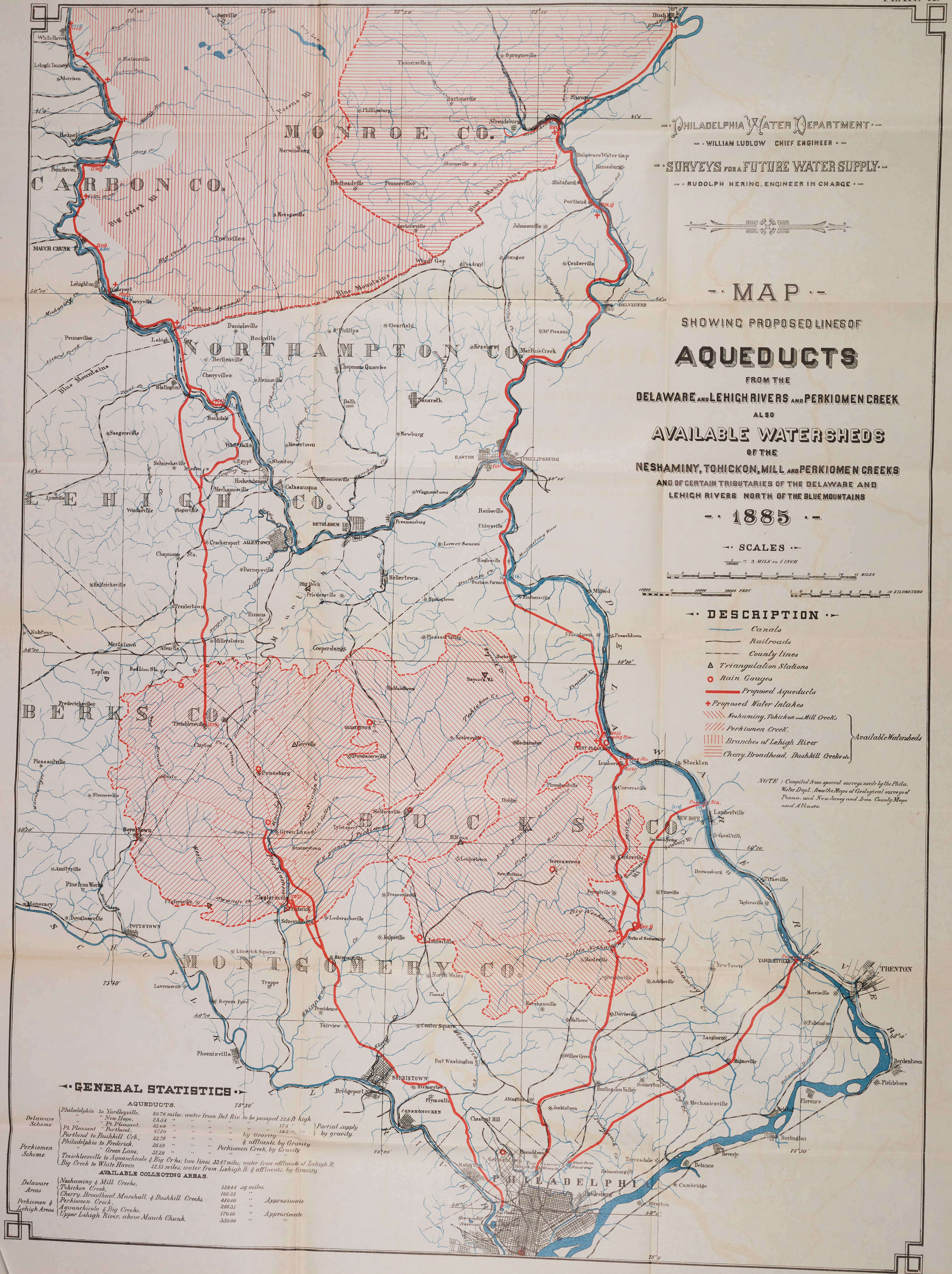
Consulting Chemist.

INDEX.

PUMPAGE DIAGRAM FOR THE YEAR 1885.




PHILADELPHIA WATER DEPARTMENT
WILLIAM LUDLOW, CHIEF-ENGINEER
SURVEYS FOR A FUTURE WATER SUPPLY
RUDOLPH HERING, ENGINEER IN CHARGE
Map showing the
WATERSHEDS
of the
Delaware, Schuylkill & Lehigh Rivers,
with
DISTRIBUTION OF POPULATION.
1885
DESCRIPTION
Available Collecting Areas for a Future Water Supply:
Perkiomen
Tohickon & Neshaminy;
Tributaries of Lehigh River north of Blue Mts;
Tributaries of Delaware River north of Blue Mts;
Boundaries of watersheds.
One red dot represents a population of one thousand.
Total Per sq Mile
Population in Schuylkill valley above Philadelphia: 312.600 176
Lehigh 164.000 120
Delaware valley above Phila. (excluding Lehigh) 393.700 54
Population on proposed Collecting Areas:
Perkiomen 32.600 122
Tohickon 11.600 114
Neshaminy 17.100 123
Tributaries of Lehigh River north of Blue Mts 10.000 18
Tributaries of Delaware Riv. north of Blue Mts 11.000 25
SCALES
1/380160 = 6 Miles to 1 In.
Statute Miles
Kilometers
STATE LINE
PHILADELPHIA
TRENTON
READING
POTTSVILLE
ALLENTOWN
BETHLEHEM
EASTON
NORRISTOWN
PHŒNIXVILLE
POTTSTOWN
PORT JERVIS
SCRANTON
PITTSTON
WILKESBARRE
Hazelton
Lebanon
Carbondale
Honesdale
Hawley
Milford
Stamford
Delhi
Walton
Deposit
Lanesboro
Monticello
Newton
Water Gap
Stroudsburg
Portland
Bangor
Belvidere
Hackettstown
Oxford Furnace
Washington
Phillipsburg
Nazareth
Catasauqua
Glendon
Slatington
Lehigh Gap
Mauch Chunk
Lehighton
Nesquehoning
Weatherly
White Haven
Lansford
Tamaqua
St. Clair
Minersville
Schuylkill Haven
Port Clinton
Hamburg
Boyertown
Birdsboro
Schwenksville
Quakertown
Doylestown
Lambertville
Pleasant
Frenchtown
Newtown
Yardleyville
Bordentown
Bristol
Burlington
Beverly
Mt. Holly
Conshohocken
Lansdale
Hartsville
NEW YORK
PENNSYLVANIA
NEW JERSEY


PHILADELPHIA WATER DEPARTMENT
WILLIAM LUDLOW CHIEF ENGINEER
SURVEYS FOR A FUTURE WATER SUPPLY
RUDOLPH HERING, ENGINEER IN CHARGE
MAP
SHOWING PROPOSED LINES OF
AQUEDUCTS
FROM THE
DELAWARE AND LEHIGH RIVERS AND PERKIOMEN CREEK
ALSO
AVAILABLE WATERSHEDS
OF THE
NESHAMINY, TOHICKON, MILL AND PERKIOMEN CREEKS
AND OF CERTAIN TRIBUTARIES OF THE DELAWARE AND
LEHIGH RIVERS NORTH OF THE BLUE MOUNTAINS
1885
SCALES
1/190080 = 3 MILE TO 1 INCH
MILES
FEET
KILOMETERS
DESCRIPTION
Canals
Railroads
County lines
Triangulation Stations
Rain Gauges
Proposed Aqueducts
Proposed Water Intakes
Neshaminy, Tohickon and Mill Creeks
Perkiomen Creek.
Branches of Lehigh River
Cherry, Broadhead, Bushkill Creeks etc.
Available Watersheds
NOTE: Compiled from special surveys made by the Phila. Water Dept., from the Maps of Geological surveys of Penna. and New Jersey and from County Maps and Atlases.
MONROE CO.
CARBON CO.
NORTHAMPTON CO.
LEHIGH CO.
BERKS CO.
BUCKS CO.
MONTGOMERY CO.
PHILADELPHIA
TRENTON
MAUCH CHUNK
ALLENTOWN
BETHLEHEM
EASTON
PHILLIPSBURG
NORRISTOWN
POTTSTOWN
DOYLESTOWN
BELVIDERE
NEW HOPE
YARDLEYVILLE
GENERAL STATISTICS
AQUEDUCTS.
Delaware Scheme.
Philadelphia to Yardleyville, 20.76 miles; water from Del. Riv. to be pumped 228 ft high
" " New Hope, 28.54 " " " " " " "
" " Pt. Pleasant, 33.09 " " " " " " 178 " "
Pt. Pleasant " Portland, 47.20 " " " " " " 145 " "
Portland to Bushkill Crk., 22.79 " " " " by Gravity
Partial supply by gravity.
Perkiomen Scheme.
Philadelphia to Frederick, 26.69 " " " & affluents, by Gravity
" " Green Lane, 32.29 " " " Perkiomen Creek, by Gravity
Treichlersville to Aquanchicola & Big Cr'ks; two lines 33.47 miles; water from affluents of Lehigh R.
Big Creek to White Haven 22.15 miles; water from Lehigh R. & affluents, by Gravity.
AVAILABLE COLLECTING AREAS.
Delaware Areas
Neshaminy & Mill Creeks, 139.44 sq. miles.
Tohickon Creek, 102.33 "
Cherry, Broadhead, Marshall, & Bushkill Creeks, 480.00 " Approximate
Perkiomen & Lehigh Areas.
Perkiomen Creek, 266.31 "
Aquanchicola & Big Creeks, 170.00 " Approximate
Upper Lehigh River, above Mauch Chunk, 350.00 " "