Department for Supplying the City with Water.

ANNUAL REPORT

OF THE

CHIEF ENGINEER OF THE WATER DEPARTMENT

OF THE

CITY OF PHILADELPHIA.

PRESENTED TO COUNCILS, FEBRUARY 5, 1863.

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24th Ward Works,	LEWIS W. SHARPLESS,	ROBERT J. DOWNING.

CONTENTS.

ANNUAL REPORT

OF THE

Chief Engineer of the Water Department,

FOR THE YEAR 1862.

TO THE SELECT AND COMMON COUNCILS OF THE CITY OF PHILADELPHIA:

Gentlemen:—In compliance with the requirements of the ordinances relating to the Department for Supplying the City with Water, the undersigned has the honor of submitting his Annual Report on the condition of the works, and the operations of the Department for the year 1862. In performing this duty, he begs the liberty of including, in their proper places, a few remarks on the general organization and capabilities of the Water Works, which, during the past year, have been fully tested by the occurrence of an unusually prolonged season of extraordinary drought, and by the disastrous freshet of September last.

The period of drought alluded to, extended from early summer until about the middle of November, during which time there was not sufficient water in the River Schuykill, except at limited intervals, to drive the machinery at the old

Fairmount Works. During this period, it has been only with the unremitting operation of the engines and pumps at their fullest capacity, that the Kensington, Spring Garden, and Twenty-fourth Ward Works have been enabled to supply their Districts; and even then not always successfully, nor adequate to the demands of the population.

In the district supplied by the Kensington Works, especially, from the cause here intimated, and other causes, there has not been either a sufficient supply, nor of a quality at all adapted to the health or comforts of the people; and I regret to say that great inconvenience and much suffering is, very probably, fairly to be attributed to this cause during the past year. Under the proper head, in this report, I beg leave most respectfully to call the attention of your honorable bodies to these works.

Generally, or in years during which there are no unusually disadvantageous circumstances, there is no difficulty in furnishing a full supply to the entire city during seven months of the year, with the works and facilities at present in operation. But this is the utmost extent of their entire reliability, and during the warmer months, it is not without difficulty that an adequate supply can be maintained in any year. This is the case particularly with the Kensington and Twenty-fourth Ward Works, and partially so with the Spring Garden Works, in all of which the supply depends entirely on the constant and successful working of the engines without intermission, and the utmost care and attention in their management. This state of the case, at present palpably existing, in connection with the well-established fact that the consumption of water increases disproportionately to the increase of population, renders the

question of the future supply of the city of Philadelphia worthy of the most serious consideration.

It must be conceded that the utmost capability of the Water Works is not equal to the present demands and necessities of our population, and especially so during a part of the year when a full supply is in all respects important and desirable; existing and prospective necessities require further and very extensive additions to our facilities for a supply of water.

The quantities of water consumed by the populations of cities in the United States are quite various. In this city it is a fraction over forty gallons per day to every inhabitant, and yet this quantity, large as it really is, and apparently almost unaccountable, is one of the smallest shown by the published reports and statistics. The amount varies from forty to ninety gallons per day, and in some cases reaches nearly one hundred gallons per day to every inhabitant. In the city of Boston it is ninety-four gallons, and in the city of New York it is about the same quantity.

The city of Philadelphia now requires over double the quantity that was required when its population was only one-third less than at present. These facts are, perhaps, not difficult to account for satisfactorily. The great increase of manufactures of all descriptions, very nearly all of which require water in unrestricted supply; the almost universal construction of baths in private dwellings, breweries, stables, and many other causes and devices requiring the use of water, contribute to this greater consumption. In some instances, as in the case of baths in dwellings, the use of water in large quantities, has become a necessity of ordinary occurrence within a few years past.

It is not improbable that other demands will arise in addition to those, incidental to the increase of population, for which the present facilities of the Department could not possibly provide. Much care should be taken to make the most ample provision practicable and expedient, with as great a degree of prospective consideration and anticipation as possible. This practice should be generally adopted, and is warranted by experience; and the difficulty has been, quite frequently, that estimates and calculations of supposed increase in demand, based on present population, have been found to be far behind the actual result, as shown by experience. But very rarely have Water Works been found to entirely answer the ends for which they were designed and constructed, and which were found capable of affording a supply the length of time proposed by their projectors.

In the design for supplying the city of Boston, it was estimated that, at the end of ten years, the demand would be 5,250,000 gallons per day; but at the end of only the second year after the completion of the works, the actual demand was 5,837,900 gallons per day—very considerably exceeding the supposed increase in ten years.

In consequence of the advance in the price of coal, the running expenses of the steam works have been somewhat increased in this item, but in other respects have not exceeded the expense of former years, and an increased demand on the works has been met without any disproportionate expense.

The Condition and Operations of the Works.

THE FAIRMOUNT WORKS.

The Fairmount Works are now in good general condition and repair. The eight original wooden wheels and their pumps, however, require constant examination and attention, and are, probably, more expensive in the item of repairs than any other machinery of the Department. Several of the pumps are, in fact, so entirely inefficient from long and excessive service, that entire renewal would be desirable. These pumps were originally designed and intended to raise the water to an elevation of about ninety-six feet, and such was the service performed by them satisfactorily for some years after their completion; but, since the construction of the Corinthian Avenue Reservoir, in 1852, which had an additional elevation of sixteen feet, and which has since received a further addition of eleven feet, making an additional altitude of twenty-seven feet above that of the reservoirs, as designed in the original plan of the works, these pumps have frequently been much overworked. They have never satisfactorily pumped water into the Corinthian Avenue Reservoir since the addition, nor for any considerable leghth of time without great risk and danger of incurring considerable expense in repairs, and possible deficiency of supply.

Frederick Graff, Esq., late Chief Engineer of the Water Works of this city, recommended the substitution of Turbine wheels in place of the eight wooden wheels above alluded to, and other Chief Engineers have since renewed the recommendation. The propriety and expediency of this proposed measure is apparent from the fact that the water

required to drive these eight wheels, if properly and economically applied to Turbines, would be capable of raising into our highest reservoirs nearly double the quantity of water. The eight breast-wheels can be kept in operation not longer than eighteen hours per day, and are capable of pumping into the reservoirs 12,727,708 gallons per day. Turbine wheels would be capable of running constantly, without intermission; and being generally constructed horizontally, can be increased in diameter as required, and made of very great power.

At Fairmount, Turbines could readily be applied which would be capable of raising 22,000,000 gallons per day, working twenty-four hours, making a total maximum capacity at Fairmount Works, of 40,000,000 gallons per day. It is a point also of much importance, that the running expenses of Turbines would be considerably less than has always been found necessary for the wheels at present in operation.

The following estimate of the expense of removing the old wheels, preparing foundations and erecting Turbines, pumps, and all necessary machinery and labor, is as correct as circumstances, and the present facilities for making an examination, will permit:

For the construction and erection of five Turbine Water Wheels and gearing, - -	$60,000 00
For the construction and erection of eight Pumps, - - - - - - - - -	24,000 00
For the removal of old wheels and pumps, and necessary alterations, - - - - -	10,000 00
Foundations, including masonry, blasting, etc.,	18,000 00
	$112,000 00

This estimate, I beg leave to say, is intended to include the entire expense of everything included in the work, from the commencement of the removal of the wheels to the entire completion and connection to the ascending mains of the new pumps. In the progress of the work, it is possible that contingencies might arise not now anticipated, making it necessary to change some items; but my impression is that this estimate would be found sufficient in the aggregate, under any circumstances. The comparative expense for repairs of Turbines and breast-wheels, is fully fifty per cent. in favor of the former, and as nearly, if not quite, all of the present pumps will have to be renewed at no distant day, I beg the liberty of most respectfully recommending as a matter worthy of your serious consideration, the subject of supplying the places of the present wheels and pumps at Fairmount with new and powerful machinery of more improved design and construction, which would utilize and economise the entire water power available, but diminished by great loss as at present applied.

The ascending mains from the works at present are not sufficient in size or strength, and the additional elevation which has been added to the Corinthian Avenue Reservoir has greatly increased the liability to serious accidents when these mains are employed in conveying water into that reservoir. In making the alterations and improvements, to which I have above taken the liberty of asking the attention of Councils, additional ascending mains would necessarily be required, in which the practice heretofore adopted of constructing ascending mains of a diameter not exceeding that of the pumps should be abandoned. In many cases the mains are of less area than the pumps, instead of which the

former should be at least one-tenth greater, or so much greater as to fully compensate for the obstruction and friction of the curves and angles of the main, and to insure the easy transmission of the water, and the safe working of the pumps and incidental machinery at their fullest capacity.

An examination of the ascending or pumping mains of the Water Works of our City, will demonstrate that they are generally inadequate and of insufficient area, and that accidents to the machinery and a large proportion of the wear and tear are directly to be attributed to this cause; and the velocity of the water in the mains is frequently greater, instead of being less, than in the pumps, requiring power in the machinery in proportion to the increased velocity, and charging it with work properly to be performed by the mains. The present condition and future security of the dam at Fairmount, I beg leave also to mention as a subject requiring early attention.

This matter received the careful attention of my immediate predecessor, and in his communications and recommendations, the facts and circumstances of the case were fully discussed, and ably and correctly presented to you. I most respectfully renew his recommendation, and coincide in his opinion that it would be very desirable to erect a substantial stone dam, instead of making the extensive repairs now or soon required by that at present existing. I respectfully recommend, in addition to this important proposition, that in the building of the proposed dam, whenever done, there should be constructed at least two substantial sluice-gates or ways, for the purpose of cleansing and thoroughly removing deposits of mud accumulating and

interfering with the flow or depth of water, and which would secure greater subsiding capacity and promote the process of purification. At no distant day, it will become necessary to remove, by the expensive process of dredging, deposits which, at this time, impede the flow of water into the fore-bay, and otherwise tend to impair and render imperfect the uses of the dam.

The sluice-ways here suggested would facilitate the removal of a greater portion of the present deposit at once, and entirely prevent any permanent accumulation which would interfere with the efficiency of the dam, except on the shore of Fairmount Park, from a point a short distance above the works, on a line with the fore-bay. In this portion of the dam the deposit would require to be removed by dredging, but subsequently could be kept comparatively free of deposit by a sluice near the eastern end of the dam.

On the security of the dam at Fairmount depends the entire ability of the Fairmount, Spring Garden, and Twenty-fourth Ward Works to supply their respective districts. It is therefore a matter of the gravest importance, and inviting most serious examination and attention. Accidents, resulting in injury or destruction of the dam, from any cause, would certainly result in failure of the supply, as temporary arrangements could not be made sufficiently expeditiously for prevention.

The buildings at these works need some repairs, especially the roofs of nearly all of them. The wooden floors of the wheel-houses have been partially replaced by flag stones, and it is quite desirable that this substitution should be continued until complete. Much of the wood work decays rapidly, and requires constant attention and outlay. When-

ever necessary and practicable its place should be supplied with a more durable material.

The new wheel-house and machinery are completed, and the new pumps have been in operation at intervals since the month of June last, and have been found to be of great service. The general performance of the new works is entirely satisfactory; but they cannot become fully available until the capacity of the ascending or pumping main is increased to a degree better corresponding to the area of the pumps. The six new pumps are each of eighteen inches diameter, and their combined area is 1526.76 square inches. The area of the pumping main to Corinthian Avenue Reservoir, into which it is necessary to pump from the new works, is 706.86 square inches, and it is already absorbed by four of the older pumps of sixteen inches diameter, which are generally working through it into the Corinthian Avenue Reservoir. With an additional main of forty-eight inches diameter, and with the reservoirs connected, as recommended in a communication, which I had the honor of transmitting to your honorable bodies, April 24th, 1862, the new works, during seven months of the year, could readily supply the districts dependent on both the Spring Garden and Kensington Works, in addition to the first four wards of the City, but until these proposed or similar additions and extensions are made, no permanent advantage can be secured from merely increased pumping facilities. At Fairmount there is a sufficiency of water in the Schuylkill to drive the whole number of wheels seven months of the year.

The following table shows the operations of these works for the past year, 1862:

OPERATIONS OF THE FAIRMOUNT WATER WORKS DURING THE YEAR.

1862.	Number of gallons pumped each month.	Average number of gallons raised per day.
January - - - - - -	200,169,932	6,457,094
February - - - - -	222,586,877	7,949,531
March - - - - - -	229,172,615	7,392,665
April - - - - - -	264,089,765	8,801,325
May - - - - - - -	313,138,895	10,101,254
June - - - - - -	293,172,371	9,772,412
July - - - - - - -	337,711,569	10,893,921
August - - - - - -	366,763,022	11,831,065
September - - - - -	421,621,861	14,054,062
October - - - - -	409,614,720	13,213,378
November - - - - -	248,904,002	8,296,800
December - - - - -	557,829,124	8,317,068
Total - - - - -	3,564,724,753	9,766,369

RUNNING EXPENSES OF FAIRMOUNT WORKS DURING THE YEAR.

Salaries of Engineers and Assistants, . .	$2,233 30
138½ gallons of oil, at 90, ...	124 65
403 pounds of tallow, at 12½, . . .	50 37
50 tons, 1 cwt., 77 lbs. of coal, for warming works, at $5 90 per ton, ...	295 50
Packing and small stores, ...	555 00
Gas for lighting, ...	387 77
Repairs, ...	3,983 34
Total,	$7,629 93

THE SPRING GARDEN WORKS.

The engines and pumps at these works, with one exception, are much worn, and their efficiency much impaired by constant and frequently excessive service, almost without interruption from the time of their construction. Indeed, at no time since consolidation, has there been sufficient reserve

power to enable the Department to make thorough or even necessary repairs. I beg to suggest that three of the engines now in use could be replaced by Cornish engines, with much advantage to the City, and that such substitution would be entirely warranted by the worn and unreliable condition of the former, and the superior adaptability and advantages for pumping purposes of the latter.

To clearly show the advantages of the use of Cornish engines at these works, I have only to state that the cost of raising water into the reservoir per million gallons, by means of the three older engines, is within a fraction of double that of the Cornish engine now in operation. The total quantity of water pumped at these works in 1862 was 3,038,527,420 gallons, of which quantity the old engines, Nos. 1, 2 and 3, pumped 1,897,391,360 gallons, and the Cornish engine, No. 4, pumped 1,141,136,060 gallons. In the performance of this work, the former three engines consumed 5,777,571 lbs. of coal, and the latter one engine consumed 2,547,161 lbs. It will be readily seen that the employment of the old engines is quite expensive in the item of fuel, and with Cornish engines, the same quantity of water may be raised at about half of the running expenses of the former. The saving would much exceed the interest on the cost of the substitution of Cornish engines, and, in fact, would pay the principal in no great length of time.

By a carefully conducted and accurate experiment, made during the past year, it was ascertained that with the consumption of one ton of coal, the Cornish engine, No. 4, raised 999,274 gallons into the reservoir, while with the same quantity of coal, engine No. 3, the least efficient of the three old engines, raised 517,969 gallons. Nos. 1, 2

and 3 are condensing engines, driving double-acting pumps; those of Nos. 1 and 2 delivering 160 gallons each, per revolution of the engine, and that of No. 3 delivering 150 gallons per revolution. The engine No. 3 can deliver into the reservoir 2,500,000 gallons per twenty-four hours. The Cornish engine, termed No. 4, is capable of delivering into the same reservoir 5,000,000 gallons, in the same period of twenty-four hours. It will be seen from this comparison that engine No. 3. with a capacity of 2,500,000 gallons per day, occupying more space than engine No. 4, of double the capacity, consumes nearly the same amount of fuel. The latter, which is the only Cornish engine at the Spring Garden Works, was built by I. P. Morris & Co., under a contract with the Districts of Spring Garden and Northern Liberties, at a cost of $30,000. The amount required for repairs and other incidental expenses, as well as the fact that a smaller number of hands are necessary in running this description of engine, give them a very decided advantage. In fact, a very limited investigation of this subject will show conclusively that it is in all respects the interest of the City to adopt exclusively the use of Cornish engines, similar in construction to engine No. 4.

The boilers attached to engines Nos. 1, 2 and 3, are in but imperfect condition, requiring frequent repairs, and are so much worn and unreliable, that frequently the working of all the engines has mainly depended on the new boilers recently added to those of the Cornish engine, and which have very nearly supplied the deficiency.

In the month of September, the Spring Garden Works were stopped, in consequence of an unusual and disastrous freshet, and all work was suspended for fourteen days, on

account of the filling up of the fore-bay by a deposit of earth and other material, and by some other circumstances and casualties of less moment from the same cause. During this emergency the district dependent on these works was supplied with much difficulty.

This occurrence, and the consideration of other possibly disastrous events, suggest as a remedy, the construction of an induction main from the pumps out into the River Schuylkill, at a depth sufficient to furnish them with water in any emergency, and quite independently of any probable accident.

Additional capacity of ascending mains at these works is much needed. There are four pumps, the combined area of which is 1,593 square inches; but the area of ascending mains is only 823 square inches, or an excess of capacity of pumps over the discharging or ascending mains of 769.99 square inches, or nearly double. The deficiency of mains equals 31.3 inches diameter. This great deficiency restricts the effective capacity of the works to the united capacity of three engines, and not more than this number can be kept in operation at the same time, without incurring serious risk of injury to the machinery, and also to the mains. This serious defect cannot be too early remedied—by putting down another ascending main of not less than 48 inches diameter, which would not only relieve the present machinery from liability to accident, and render available their effectiveness, but would be a most important addition to the means of supplying the district connected with these works.

In further improvements involving an increase in the size, number, capacity, or additional area of pumps, great

care should be observed that they be accompanied by mains of proportionate dimensions, and the impossibility of rendering pumps fully efficient, as well as the danger of accidents from the unusually limited area for the egress of water which exists at present, should be carefully avoided.

The practical advantages are too obvious, and the principles involved are too familiar to need further comment or illustration.

One other feature in the arrangement of the mains at these works is not without disadvantages. It is the connection of all four pumping mains at a distance of about 100 feet from the works, with a box, into which all the water is at first thrown, and from which it is forced to the reservoir through three mains only; one of which is twenty inches diameter, and two of eighteen inches each. Mr. Graff, late Chief Engineer, very properly had one of these mains connected with its engine outside of the box alluded to, and recommended a similar connection for the whole of them; which, in case of accident, would leave the entire capacity still available. In this valuable suggestion, I beg to say that I fully concur; and to it I respectfully ask your attention. It is of much importance that such connection should be made as will remove the necessity for the successful operation of all the engines being made to depend on the strength of a single point; on the contrary, they should be, as far as practicable, independent of each other, and capable of isolated and independent action. The propriety of relying on this box as a permanent or safe arrangement, is exceedingly questionable.

The buildings at the Spring Garden Works are generally in good condition, the roof of the main building being the

exception, which is in bad repair, on both the inside and outside. It is of tinned sheet iron, and appears to be injuriously affected by the gases arising from the furnaces of the boilers, which, in addition to the water, appear to produce rapid oxidization, and in many places has become so thin that it is almost impossible to prevent leaks from constantly occurring. A roof of slate would be much preferable, and that is the only material in common use that would effectually resist the destructive influences mentioned.

In July last, gas was introduced into these works, and is found to be a great improvement over the oil lights previously used, both in safety and economy. The coal-shutes have been newly floored, and put in thorough repair, and the tracks from the Reading Railroad into these shutes have been relaid and are now in a substantial condition. The tracks from the shutes to the boiler rooms, which were torn up by the freshet above mentioned, have also been relaid and carefully repaired.

All the damages done by the freshet have also been fully repaired, with few unimportant exceptions.

The engine house and engines also need painting. These works have been, on several occasions, greatly overtaxed on account of the demand upon them for the supply of the district usually supplied by the Kensington Works, but though some expenditure for repairs was necessary, there has been no permanent injury.

The following is a statement of the quantity of water pumped, with the quantity of coal consumed, and other particulars:

OPERATIONS OF THE SPRING GARDEN WORKS DURING THE YEAR.

Months.	*No. of Gallons of Water Pumped.*	*Average No. of Gallons per Day.*	*Pounds of Coal Consumed*	*Average No. Lbs. Per Day.*	*Gallons raised into Reservoir, per Pound of Coal.*	*Gallons raised one foot high, per pound of Coal.*
January.....	189,839,520	6,123,855	576,016	18,581	329.5	37,892
February.....	156,565,500	5,591,625	470,166	16,792	333.0	38,295
March.....	245,035,880	7,904,383	676,480	21,822	362 2	41,653
April.....	269,535,040	8,984,501	815,144	27,171	330.6	38.019
May.....	278,095,720	8,970,836	815,770	26,315	340.9	39,204
June.....	313,473,680	10,449,123	917,126	30,571	341.8	39,307
July	343,352,280	11,075,880	940,176	30,328	365.2	41,998
August.....	354,677,080	11,441,196	1,057,160	34,102	335.5	38,582
September ...	182,352,040	6,078.401	488,210	16.271	373.5	42,953
October.....	292,576,080	9,437,938	1,025,188	33,071	285 4	32,821
November....	242,886,560	8,096,219	661,095	22,036	367.4	42,251
December	170,138,040	5,488,324	452,928	14,611	375.6	42,198
Total.....	3,038,527,420	8,324,732	8,895,459	24,371	345.05	39,598

Average duty for the year, 32,998,333 pounds raised one foot high with 100 lbs. coal.

Average amount of coal consumed per day, 24,371 lbs., or 10 tons, 17 cwt., 2 qrs., 11 lbs.

Total amount of coal consumed by engines, 8,895,459 lbs., or 3,971 tons, 1 cwt., 3 qrs., 23 lbs.

The freshet of September suspended the operation of the Works fourteen days. During a portion of the month of October the Cornish Engine was undergoing repairs.

RUNNING EXPENSES OF SPRING GARDEN WORKS DURING THE YEAR.

For Salaries of Engineers and Firemen, . .	$7,106 53
" 138½ gallons of Oil, at 90c. . . .	124 65
" 2,151 lbs. of Tallow, at 12½c. . . .	268 87
" 3,971 tons, 1 cwt., 3 qrs., 23 lbs. of Coal, at an average price of $4 $\frac{23}{100}$ per ton, .	16,797 90
" Packing and Small Stores, . . .	450 00
" Repairs, ...	2,987 49
" Coal Oil, Fluid, and Gas, for Lighting Works, ...	207 51
Total, ...	$27,942 95

These works are now in good repair. Such, however, is the demand upon them, that if it is decided that they shall be continued, it will be soon necessary to have an additional ascending main, of such capacity as to anticipate, at least in some measure, the greater demand that must arise.

There are at present at these works, two engines, one of which is a condensing engine, driving a pump of nineteen inches diameter; the other is a non-condensing engine, driving a pump of eighteen inches diameter. The single ascending main is 13,300 feet long, and eighteen inches in diameter, being capable of carrying the water from one pump only.

During the warm season, more water is required in the district than this one main can safely supply. The average maximum capacity of the pumps is rated at 3,000,000 gallons each per twenty-four hours. The daily demand has reached as high as 3,780,290 gallons, and the least demand in any day of the past year, was 2,954,770 gallons, or an excess of capacity over the least demand of 45,230 gallons only.

The average quantity daily supplied during the period of greatest demand, it will be seen, is beyond the rated maximum capacity of each pump, and it has only been by severely overtaxing that they have been made to perform this amount of labor. To work another pump, would not only endanger the main, but would greatly increase the labor and cost of pumping, in consequence of the great increase of power necessary for the transmission of water through a main of entirely insufficient area. The combined area of the two

pumps is 537.98 square inches, and this area would require an ascending main of not less than 27½ inches diameter, for the easy transmission of water from the works to the reservoir, or an additional ascending main of 20¾ inches diameter. This would cost about $80,000. If constructed of the diameter mentioned, it would leave no excess of main over the requirements of the present pumping capacity, and would be a most important addition to the facilities for supplying the district; but it would be by no means judicious to limit its size only to such present requirements. Provision should be made for the addition of at least one-half more area of pumps, the necessity of which will arise at no distant day, if these works are continued as a source of supply. In all works of this description, where there is a continued and steady increase of demand, it is not advisable to confine the size of mains to near the immediate requirements, as the cost of laying does not increase proportionately to size, the larger being relatively less expensive than the smaller.

The continuance of the Kensington Works, as a means of supply, is assuredly of doubtful economy, even if the quality of water was not objectionable.

During the past year there have been supplied 909,126,440 gallons of water to this district, at an outlay of $13,709 44—exclusive of interest on the original cost, which is nearly double the expense similarly incurred at any other works. On account of their expensive character, the impurity of the water supplied by them, and other reasons, at least two of my predecessors have recommended the abandonment of these works, in which I fully concur.

Several theories or propositions have been advanced, by which it has been supposed that water of greater purity can be obtained at this point, all of which seem to be of doubtful

practicability, as well as of too expensive character for experiments. One of these is the plan of extending an induction main or pipe from the pumps into the channel of the river Delaware. The present area of pumps would require that this pipe should be not less than 30 inches diameter. The difficulties, and consequent cost of laying it at a sufficient depth to cause no obstruction to navigation, or on the bed of the river, and to a point at which it may be assumed that pure water can be obtained, if at all, cannot be estimated with any degree of accuracy. The proposed pipe could not be less than three hundred and fifty feet long, and might, and very probably would, much exceed this length. The possibility of obtaining water that is sufficiently free from the deteriorating influences of the sewerage of the city has, by no means, been proved or rendered probable, and it has been shown that the water from the eastern side of the river, intended to supply the city of Camden, contains so much impurity as to be highly objectionable for domestic purposes. In thus briefly alluding to this measure, I beg leave respectfully to ask your attention to the fact, that in laying a pipe in the Delaware of this description, the necessity is involved of no longer considering it an experimental measure, but of constructing it of such ample dimensions and substantial character as will guarantee its prospective, as well as present utility. It must, necessarily, be adapted to the future extension and enlargement of the Kensington Works, and facilities for supply, and will involve a heavy outlay. In the consideration of this question, there is, however, one most important feature, which is, that with any arrangement, whether of this or any other known description, or under any circumstances, water cannot be obtained from the river Delaware at these works at

a less average cost than double that of supplying the same quantity from the river Schuylkill.

It is also, I beg to suggest, worthy of the gravest consideration, whether any expenditure would be judiciously incurred, when in any event the water furnished from the Delaware must be admitted to be inferior to that from the Schuylkill, and the yearly saving would nearly, if not quite suffice to cover the interest on the expense of a supply from the latter source, reliable in quantity, and unobjectionable in quality.

It may be true that pure water can be made accessible to the pumps by means of the induction main or pipe here mentioned, but assuming or admitting this to be the case, there is not in the consideration of the subject from any point of view one possible argument in favor of this plan, other than the proposal to improve the quality of the water supplied by these works. It cannot lessen the present cost, nor can it alter the fact, that for every gallon supplied, double the expense is incurred by the city, which would supply the same quantity from the Schuylkill Works.

No other plan has been proposed, to my knowledge, which is not liable to the same very serious objections.

The demand upon the Kensington Works is already greater than can be supplied with safety, and is constantly increasing. To the consideration of the means of meeting it, I beg leave most respectfully, but earnestly, to ask your early attention, and to say that I have seen no reason to recede from or to change the views and suggestions which I had the honor of presenting to your honorable Councils, under date of April 24, 1862, in response to a resolution adopted by you, which resolution and response are herewith appended.

The additional mains and other work contemplated in the plan contained in my communication just mentioned, cannot conflict with any plan which may hereafter be devised for supplying the city, and the reservoir will always be available for the purpose of distribution in the district now connected with it, and also for supplying large additions to that district, into which water pipes have not yet been introduced—the proposed additional elevation giving an increased *head*, will prevent the necessity of laying additional supply mains, as the district is at present constituted.

Accompanying is an analysis of the water of the Delaware river, at the point from which the supply is now taken by these works, from which it may be readily seen that it is quite unfit for domestic purposes, and strongly contrasting with water from the Schuylkill river. The analysis of the Delaware water, from a point opposite Cedar Hill, which is about six miles above the built-up portion of the city, was made for the purpose of ascertaining whether it is of unobjectionable quality, and incidentally, whether such point would prove, in this respect, a suitable location for the erection of Water Works, as has been suggested. From this latter analysis, it may be seen, that at the point mentioned, the deleterious effects of the drainage of the city are still quite perceptible.

Another important consideration, in regard to this proposed site, is the fact that a reservoir can be constructed only at a considerable distance from the river and the built-up portion of the city, with the circumstance that the intermediate distance is but sparsely populated, seem to be unfavorable to the expediency of its adoption. Considering, too, the elevation of the district now, and for many years requiring the supply, and from which the income sustaining

it must be principally derived, the great cost of construction and running expenses, it may be safely assumed that the expenditure would not be warranted, and should it become necessary to locate a reservoir at this point, the district to be supplied by it should be as restricted as possible. As a general consideration, the propriety of constructing reservoirs, at this time, for the supply of the very large present and future population, for which purpose little over half the elevation at Cedar Hill is necessary, is very doubtful, if not entirely unworthy of consideration. This subject will be again alluded to, in the report which I now have the honor of making.

The following is a statement of the operations at the Kensington Works, for the year 1862:

OPERATIONS OF THE KENSINGTON WATER WORKS DURING THE YEAR.

Months. 1862.	*Gallons of Water pumped each month.*	*Average Number of Gallons pumped per day.*	*Pounds of Coal consumed during the Month.*	*Average No. lbs. of Coal used per Day.*	*Gallons raised into Reservoir per Pound of Coal.*	*Duty in Gallons raised one ft. high per lb. Coal.*
January.....	64,786,400	2,089,884	291,830	9,413	222.	24,864
February....	57,745,520	2,062,340	254,947	9,105	226.50	25,368
March.....	37,458,080	1,208,325	157,188	5,070	238.30	26,689
April.....	42,995,350	1,433,178	181,262	6,042	237.20	26,566
May.....	104,658,420	3,376,949	407,971	13,160	256.60	28,739
June.....	53,510,390	1,783,679	220,479	7,349	242.70	27,182
July	62,130,920	2,004,223	252,462	8,143	246.10	27,563
August.....	106,990,340	3,451,301	436,339	14,075	245.20	27,462
September..	105,237,360	3,507,912	417,774	13,992	250.70	28,078
October	99,928,940	3,223,514	415,332	13,397	240.60	26,947
November...	87,246,040	2,908,201	340,405	11,346	256.30	28,705
December ...	86,411,680	2,786,473	345,370	11,140	250.20	28,022
Total, ...	909,128,440	2,490,757	3,723,359	10,200	244.16	27,345

Average duty for the year, 22,778,385 pounds raised one foot high by the consumption of 100 lbs. of anthracite coal.

Total amount of coal consumed by engines, 1662 tons, 4 cwt., 1 qr.

Average amount of coal consumed per day, 4 tons, 11 cwt., 8 lbs.

RUNNING EXPENSES OF KENSINGTON WORKS DURING THE YEAR.

Salaries of Engineers and Firemen, .	$4,383 10
74 gallons of oil, at 90, ...	66 60
629 pounds of tallow, at 12½, . .	78 62
1660 tons, 4 cwt., 1 qr., 23 lbs., of coal at an average price of $4.76 per ton, .	7,802 66
Coal oil and fluid for lighting, . .	87,40
Packing and small stores, ...	130,50
Repairs, ...	1,160 56
Total,	$15,709 44

The average daily demand for the year is much decreased by the fact, that the district was supplied from the Spring Garden Works for seventy days.

THE TWENTY-FOURTH WARD WORKS.

The works for the supply of the Twenty-fourth Ward are now in good repair and condition, but such is the rapid increase in the demand in the district supplied by them, that it is difficult to provide for it satisfactorily. On account of there being no reservoir, nor any other facilities for storage, and the fact that there is only one main from the works to the stand-pipe, the demand is supplied directly from the pumps, and requires the constant and unremitting operation of one engine, the other being kept in constant readiness in case of accidents. It is only at the risk of absolute failure in the supply, that frequently necessary and usual repairs can be made, and such is the demand and large amount of work performed by these two engines, that it is almost impossible to keep them in as good condition as would be desirable.

The demand in the district supplied by these works is

now fully up to, and in fact somewhat beyond the ordinary duty of one engine, and during the ensuing summer the assistance of the second engine will undoubtedly be required. For the purpose of running both engines simultaneously, and providing for a sufficient supply, an additional ascending main will be indispensable, and which will be required before, as well as after, the erection of a reservoir. The capacity of the stand-pipe is so inconsiderable, that it cannot be regarded in the question of storage. It is merely a fixed point of elevation, which has been found necessary to afford a supply, and from which the water is immediately withdrawn by the demand.

During the past year, the quantity of water pumped at these works averaged 1,152,076 gallons daily. Assuming that each pump is capable of supplying this quantity, which would very probably be the case, if there were sufficient ascending mains to allow the working of both engines at once, there would be an excess of 1,152,076 gallons daily over the present demand at all times, when the engines are in their present good condition. This excess, however, cannot be made entirely available without a reservoir, but with such provision for storage, ample time would be afforded for keeping the works in good order, and it would also guarantee a reliable supply, as well as to tend to greater purity, by affording facilities for subsidence, and other purifying processes not now possible, and would give the works a character of reliability which they cannot otherwise attain. The revenue will, undoubtedly, constantly increase, and the comforts and interest of the already large and greatly increasing population, would be advanced in a most important degree by the early consideration and consummation of additional means of supply by your honorable bodies.

The operations of the works for the year 1862, are given below:—

OPERATIONS OF THE TWENTY-FOURTH WARD WATER WORKS DURING THE YEAR.

1862.	No. of Gallons pumped each Month.	Average No. of Gallons raised per Day.	No. lbs. of Coal consumed each Month.	Average No. of Pounds consumed per Day.	No. of Gallons raised into stand-pipe per lb of Coal.	No. of Gallons raised one foot high per lb. of coal.
January.....	28,634,940	923,707	160,720	5,184	178.16	40,976
February...	26,612,370	950,441	145,230	5,186	183.24	42,145
March.....	33,741,720	1,088,442	170,450	5,498	197.95	45,528
April.....	33,343,740	1,111,458	162,350	5,411	205.38	47,237
May.....	34,306,200	1,106,651	165,350	5,333	207.47	47,718
June.....	33,270,840	1,109,028	150,755	5,025	220.69	50,758
July.....	38,268,540	1,234,469	173,200	5,587	220.95	50,818
August.....	43,851,330	1,414,559	202,500	6,532	216.54	49,804
September...	39,051,360	1,301,712	202,800	6,760	192.56	44,288
October.....	38,531,070	1,242,937	193,200	6,232	199.43	45,868
November...	34,934,490	1,164,483	177,400	5,931	196.92	45,291
December...	35,961,210	1,160,039	188,000	6,064	191.28	43,994
Total.....	420,507,810	1,152,076	2,091,955	5,731	201.1	46,232

Average duty for the year, 38,525,000 pounds raised one foot high by the consumption of 100 pounds of anthracite coal.

Total amount of coal consumed by engines was 933 tons, 18 cwt., 19 lbs.

Average per day, 2 tons, 11 cwt., 19 lbs.

RUNNING EXPENSES OF TWENTY-FOURTH WARD WORKS DURING THE YEAR.

Salaries of Engineers and Firemen, . .	$2,500 00
933 tons, 18 cwt., 19 lbs., of coal, at an average price of $4.84 per ton, . .	4,520 12
10½ gallons of oil, at 90, ...	9 45
213 pounds of tallow, at 12½, ...	26 62
Coal oil and fluid for lighting, . . .	94 50
Packing and small stores, ...	65 50
Repairs, ...	1,999 68
Total, ...	$9,215 87

TABLE SHOWING THE MAXIMUM CAPACITY OF THE WORKS AND THE CONSUMPTION PER DAY, DURING THE MONTH OF AUGUST, 1862.

	Gallons.	Gallons.	Gallons.
The Maximum Daily Capacity of Fairmount Works is - - -	30,000,000		
The Average Daily Consumption in August, 1862, was - -	11,831,065		
Leaving a Daily Excess of Capacity of - - - - - -		18,168,935	
The Decrease of Daily Consumption in August, 1862, under August, 1861, was - - - -			721,695
The Maximum Daily Capacity of Spring Garden Works is - -	12,756,800		
The Average Daily Consumption in August, 1862, was - -	10,273,509		
Leaving a Daily Excess of Capacity of - - - - - -		2,488,291	
The Increase of Daily Consumption in August, 1862, over August, 1861, was - - - - - -			2,131,977
The Maximum Daily Capacity of Kensington Works is rated at -	8,000,000		
The Average Daily Consumption in August, 1862, was - - -	8,451,301		
Leaving a Daily Excess of Demand of - - - - - - -		451,301	
The Increase of Daily Consumption in August, 1862, over August, 1861, was - - - - - -			120,856
The Maximum Daily Capacity of 24th Ward Works, is rated at -	1,152,076		
The Average Daily Consumption in August, 1862, was - - -	1,414,519		
Leaving a Daily Excess of Demand of - - - - - - -		362,423	
The Increase of Daily Consumption in August, 1862, over August, 1861, was - - - - - -			186,580
Total Daily Excess of Capacity over Consumption in Aug., 1861, was		19,838,502	
Total Increase of Daily Consumption in August, 1862, over August, 1861, was - - -			1,717,218

The Fairmount Works are rated exclusive of capacity of mains. The other Works are rated in proportion to the capacity of pumping mains.

NUMBER OF GALLONS PUMPED BY ALL THE WORKS DURING THE YEAR.

Months.	Number of gallons pumped each month.	Average number of gallons pumped each day.
January, - - - - -	483,430,792	15,594,541
February, - - - - -	463,510,267	16,553,938
March, - - - - - -	545,408,295	17,593,816
April, - - - - - -	609,913,895	20,330,463
May, - - - - - - -	730,226,235	23,555,685
June, - - - - - -	693,427,281	23,114,242
July, - - - - - -	781,463,309	25,208,493
August, - - - - -	872,281,772	28,138,121
September, - - - -	748,262,621	24,942,087
October, - - - - -	840,650,810	27,117,768
November, - - - -	613,971,092	20,465,703
December, - - - -	550,340,054	17,752,905
Total, - - - -	7,932,886,423	21,733,935

RESERVOIRS.

The reservoirs at Fairmount, though not all in good condition, have continued in constant use during the year. From these reservoirs are supplied the Fifth, Sixth, Seventh, Eighth, Ninth, and Tenth Wards of the city, the population of which, according to the census of 1860, was 137,756. The number of water tenants in 1862 was 20,896, and the water rents amounted to $169,919 00. The average daily supply was 5,874,013 gallons.

One of the compartments of these reservoirs needs extensive repairs, requiring new lining, and others partially so, or that the old lining (in the latter) should be thoroughly repaired. The cartways and walks around the reservoir need re-grading, so as to throw the accumulation of rain water outward on the surface of the embankments. In the cartways especially, the rain water drains into and through the embankments to such an extent, that during the heavy

rains of the freshet of September last several slides occured from this cause. The surfaces of the cartways and walks would be much better in this and other respects if they had a covering of clay, and upon that a sufficient amount of gravel to protect it.

During the year, the arbor on the hill and in front of the works has been partially renewed by new columns and other repairs. The walks have been further improved and completed by the erection of iron railing on exposed situations and borders, and further additions of this description, to the extent of some hundreds of feet of railing, are desirable. A considerable portion of the wood work around and about these reservoirs has required renewal for some years past, and further renewals or repairs are now indispensable, on account of the decayed condition of the wood. As iron is much the most economical ultimately, it would undoubtedly be most expedient to substitute it as a material whenever the wooden fences require renewal or removal. On the western side of the reservoir a new house has been erected over the stop-cocks, which are now well protected from freezing, and readily accessible. A small amount of re-painting ought to be done during the coming Spring. As the Fairmount Works and reservoirs have always since their construction, been points of much attraction and gratification both to our citizens and strangers, it has always been the uniform action and policy of the honorable Councils of the City to provide, not only for their utility, but for their embellishment, as far as possible. The attractiveness of these works and the grounds, as a favorite resort, have constantly increased under this liberal policy, and they have been visited, in connection with Fairmount Park, during the past year,

by very large numbers, very probably greatly beyond the number of visitors in any preceding year. The Corinthian Avenue Reservoir is now completed, and in good condition, with the exception of a small leak on Poplar street, which has been in existence nearly ever since the construction of this reservoir. This reservoir supplies the First, Second, Third, and Fourth Wards, the population of which, according to the census of 1860, was 103,399. The number of water tenants, in 1862, was 16,360, and the amount of water rents, $93,134 00. The demand for the year has averaged 3,892,356 gallons daily. A substantial picket railing has been placed on this reservoir, the embankments widened, re-sodded, and strengthened, at several points. In proportion to its capacity, which is 37,500,000 gallons, there is a much less demand on this than on any other reservoir of the City, and it is capable of affording storage and supply to a district, now comparatively deficient. The elevation of this reservoir is 124 feet above high water. It has one 30-inch pumping main connected with the Fairmount Works, and one 30-inch supply main, which supplies the wards above mentioned.

The usefulness of this reservoir would be very greatly increased, and its capabilities rendered available, by its being connected with the new works at Fairmount, and with the Spring Garden Reservoir, an improvement which, for this and other urgent reasons, it is assuredly very important and desirable to consummate at the earliest practicable period.

The Spring Garden Reservoir has been thoroughly repaired, and is now in excellent condition. From this reservoir is supplied the Eleventh, Twelfth, Thirteenth,

Fourteenth, Fifteenth, Twentieth, and parts of the Sixteenth and Twenty-first Wards, the population of which district in 1860 was 113,256. The number of water tenants in 1862 was 23,275, and the revenue from water rents, $164,122. The average supply was 8,324,732 gallons daily. The elevation of this reservoir is 124 feet above high water. There are three pumping mains connected with the Spring Garden Works, two of 18 inches diameter, and one of 20 inches diameter. There are four supply mains, one of 30 inches diameter, and three of 16 inches diameter. This reservoir, now inadequate to the demands of the district dependent on it, must shortly prove entirely incapable as a means of affording a proper supply, by the extension of the City, and increase of population. Its capacity is 9,800,000 gallons, or less than one and a half days' supply of the present demand. In September a slide of some extent occurred in the northern embankment, caused by unusually heavy rains. The grass has been removed from the interior of the reservoir, and the top of the embankments regraded and graveled.

The Kensington Reservoir has continued in good condition since April last, when it was thoroughly cleansed and repaired. This reservoir supplies the Seventeenth, Eighteenth, Nineteenth, a large portion of the Sixteenth, and parts of the Twenty-third and Twenty-fifth Wards, the population of which district in 1860 was 108,600. The number of water tenants in 1862 was 14,710, and the revenue from water rents was $88,489 50. The elevation of this reservoir is 117 feet above high water. Its capacity is 9,400,000 gallons, and the average supply in 1862 was 2,547,220 gallons daily. There is a rapid deposit of mud

in this reservoir, requiring to be removed at frequent intervals. This deposit seems to be incident to the use of the water from the Delaware river, and very probably cannot be prevented.

The Twenty-fourth Ward Water Works are entirely deficient in storage, having no reservoir. The stand-pipe connected with the works is 130 feet high, and 5 feet in diameter, and can contain only 19,094 gallons when filled to its utmost capacity. Only about 40 feet of its heighth, however, are available for the supply of the district. The necessity for the erection of a reservoir for the supply of this district has been frequently correctly stated and recommended to the Honorable Councils by my predecessors, and I do not deem it necessary here to recapitulate the great importance and advantages of this proposed improvement. These works supply the Twenty-fourth Ward, the population of which in 1860 was 23,738. The number of water tenants in 1862 was 1,058, and the water rents amounted to $10,498 75. The average daily demand for 1862 was 1,152,076 gallons. The stand-pipe has an elevation of 230 feet above high water.

GROUNDS.

So far as it has been contemplated and provided in the appropriations to this department, the grounds at Fairmount have been completed. Many other improvements may readily be made, however, which will add much to the beauty and attractiveness of this favorite resort, especially in the grounds on Coates street, north of the reservoir. That portion of the latter on the river front will require to be raised, sodded, and the gravel walks extended through

them, to correspond with those already completed. The whole should be enclosed with an iron railing. That portion adjoining the grounds recently added to Fairmount Park will require to be graded and finished to correspond with the contemplated improvement of the Park. A water pipe should be laid through these grounds as early as practicable, for the purpose of supplying additional drinking hydrants, fountains, or plugs, for watering the grass and shrubbery. Of all these, additions may be made which will be required by future improvements, and will add much to the comfort and gratification of visitors to Fairmount. The grounds south of the reservoir, and lying on Callowhill street, are in good order, but the growth of the grass for some years has been much checked by the thick foliage of the trees obstructing the warmth and light of the sun, but it is probable that some species of the forest grasses, or of orchard grasses, could be successfully cultivated, and by some attention made even more appropriate than the ordinary field grasses.

The grounds at the Spring Garden Works require no repairs, and are in all respects in excellent condition. These grounds and the works are visited by large numbers of our citizens, and the means of more completely connecting them with Fairmount Park, I beg the liberty of suggesting, as worthy of the consideration of your honorable bodies.

At the Twenty-fourth Ward Works the fences need some repairs. The proposed improvements in the lot surrounding the stand-pipe have not been completed. The embankment at the stand-pipe requires to be further raised and sodded, and the fronts on the streets to be graded and sodded also.

There are several vacant lots in charge of this department, which are not used for its purposes, and which produce little or no revenue to the City. It is not probable that some of these will ever be required or occupied by the Water Department, and these, I beg to suggest, might be disposed of with advantage.

DISTRIBUTION.

The facilities for the distribution of water in this City are in many respects quite imperfect, and in some localities but partially fulfill that purpose. Cases exist in which mains of small size are feeders to those of larger size, which circumstance originated in the fact, that before consolidation several of the then independent corporations had arrangements for the supply of their districts, and, of course, the separate and exclusive control of the distribution and supply from their own works, and no co-operative system had existed, nor apparently had the probable or prospective importance of such ever been considered. In some localities, where pipes have been laid for many years, and the stops not frequently used, it has been found on examination that the latter are often in bad condition, and in some instances unfit for use. Defects of this and of other descriptions have, however, to a great extent, been remedied.

In the higher localities of the district supplied by the Spring Garden and Kensington Works, a pressing necessity exists for a considerable enlargement of the capacity of supply mains, and I beg leave to again suggest this subject as worthy of the early attention of your honorable bodies. In the Spring Garden district, this deficiency may be remedied by laying a main on Columbia avenue, from the Spring

Garden reservoir to Tenth street, which is the highest practicable point in this district, on which a supply main can be laid. This main should be of such area as would admit of the connection of all mains now running at right angles with its course, and also that those mains which do not now extend so far north should be extended and connected with this proposed main. It would probably be necessary to enlarge some of them now running south, of which, for instance, that on Nineteenth street is one, and also to run a main of considerably enlarged dimensions on Fifteenth street, from Columbia avenue south to Spring Garden street, and then to make a separate distribution district in the higher portion of the Spring Garden district, west of Twelfth street, by which a constant supply could be guarantied. As a general consideration, the only practicable and reliable plan for giving a supply to the higher localities is to make them separate and distinct in their distributing facilities, and entirely independent of the lower portions. In some of the higher localities, however, very probably no full supply is practicable without a reservoir of greater elevation than at present.

The increased elevation of the Kensington reservoir, which has been heretofore suggested to the honorable Councils, and the proposed substitution or adaptation of the present pumping main to the purposes of distribution, would give a generally satisfactory supply to the whole of the Kensington district. In districts where there is any considerable diversity of elevation, the true method of insuring a full supply of water to every part of them, is to divide them into sub-districts, and make the area of supply mains correspond to the elevation and extent of each sub-district, or, in other

words, make them exactly proportionate to the *head* or elevation of the reservoir above such sub-district, and additional area to compensate for the length, angles and curves in such supply mains, and each sub-district in this respect to be independent of any other.

It would be much to the interest of the City, and of a very large majority of the water tenants, in a strictly pecuniary sense, if a more equitable method could be devised for the distribution of water, in such manner that consumers or water tenants might be required to pay only according to the quantity furnished to, and consumed by them, or that the facilities of the City are capable of affording.

The most obvious and most effectual plan would be the adoption of water meters, analogous in object to those now used in supplying gas, which would not only ensure that consumers should pay proportionately to quantity used, but would, very probably, in a great measure, prevent the immense waste which undoubtedly takes place under the present system. This plan is, however, quite impracticable, on account of the cost, and perhaps inexpedient at any time. It is by no means certain that the adoption of meters would accomplish all desirable results, except in cases where large quantities are used; and a very important consideration is, whether such method would not act as too stringent and restrictive on the use of water to such extent as to insure its benefits to the comfort and convenience of all, as well as to the health and general sanitary condition of the City. There are at present 76,299 water tenants, the supply of whom with a meter would not cost less than twenty dollars each, and would amount to the enormous sum of $1,525,980, the interest on which, with an annual expense for repairs to

meters, and other incidental expenses, would result in an additional expenditure of at least $100,000 dollars per annum. The saving to the Water Department could not possibly be adequate to this increased expenditure, nor such as to offer the slightest inducement to favor the general introduction of water meters at this time.

The most desirable point to be arrived at, (and not accomplished by the meter,) is to give to each tenant the same quantity, or a quantity proportionate to the amount of water rent paid, as nearly as practicable, without restricting its free and copious use. This may be effected by proportioning the sizes of ferrules to the pressures on the service mains, or by adopting as a uniform size of ferrule the largest size now used, and restricting the area by a private cock, in proportion to the pressure on the service main. The pressures on the service mains vary according to circumstances, being greater during the colder months, and also greater in wet seasons than dry, in consequence of a less demand, and a less area of openings being required, or service connections in operation; but a limited experience in adjusting the flow would soon render those having charge of this matter practically perfect in its adjustment. It may be asked what it is proposed to do with the tenants already supplied? but these may be similarly arranged by adopting a discharge deduced from the above plan, and restricting, by means of the curb stop-cock, all above the fixed amount of discharge, and those that are below that will rectify themselves, by increasing the sizes of their ferrules. The expense of doing which will be within the province of Councils to decide.

In the district supplied from the Spring Garden Works,

there exists a great inequality in the quantities supplied from hydrants in different localities. From experiments made during the past year, it has been ascertained that under the greatest average pressure there is an actual discharge of $16\frac{55}{100}$ gallons per minute, through an opening of $\frac{5}{8}$ inch diameter. The greatest presure on the mains in this district is 41 pounds per square inch, and is at the intersection of Callowhill street and Delaware avenue. The medium average discharge through a $\frac{5}{8}$-inch opening is $14\frac{1}{2}$ gallons per minute. The average pressure in this central district is $34\frac{1}{2}$ pounds per square inch. The lowest average pressure in the third or highest district is $8\frac{1}{2}$ pounds per square inch, and gives an actual discharge, through an opening $\frac{5}{8}$-inch diameter, of $7\frac{52}{100}$ gallons per minute. The lowest pressure on the mains in the whole Spring Garden District is 4 pounds per square inch, and gives an actual discharge, through a $\frac{5}{8}$-inch opening, of $5\frac{16}{100}$ gallons per minute. With 15 pounds pressure on the mains, a hydrant with a discharge pipe of $\frac{1}{2}$ inch diameter discharged $6\frac{4}{10}$ gallons per minute. To equalize the supply, or to discharge the same quantity of water in the same time, under 4 pounds pressure, as is discharged through a $\frac{5}{8}$-inch ferrule, or opening under a pressure of 41 pounds, there would be required a ferrule or opening of slightly less than $1\frac{1}{8}$ inches diameter. If it is desirable to have the same quantities discharged in a given time at all points, then the principle of proportioning the sizes of supply mains to the respective general elevations or pressures, should be extended in detail by proportioning the size of ferrule to the pressure at the point of insertion in the main. This is entirely practicable, and the only objection to it is, that it would require greater time to make the

connection than it does at present. In all that portion of the City south of Vine street, the supply of water has been full and reliable at all times throughout the past year. In the Twenty-fourth Ward, at some points, there is occasionally a limited supply, owing to the fact that the capacity of the service mains is nearly exhausted by connections before reaching their points of termination, and it is approaching and near those points that the deficiency generally occurs. In this ward a considerable amount of pipe will soon require to be relaid, on account of the changes in the grades of streets.

The ordinance in reference to the use of wash-paves, and restricting their use within certain hours of the day, should be continued and enforced as a permanent policy and enactment. The greatest waste of water very probably arises from the negligent use of these fixtures. All facilities in the department for the distribution of water, except those above alluded to, are in good condition.

The following table gives the number of water tenants, and the amounts of water rents, in the respective wards of the city:—

TABLE SHOWING THE NUMBER OF WATER TENANTS AND THE AMOUNTS OF WATER RENTS.

WARDS.	Number of Water Tenants.	TOTAL.	Amount of Water Rents.	TOTAL.	WORKS AND RESERVOIRS. Supplied from	
					WORKS.	RESERVOIRS.
First, ...	5,509		$34,530 75		Fairmount.	Corinthian avenue.
Second, ...	4,411		24,788 50		"	"
Third, ...	3,076		16,570 50		"	"
Fourth, ...	3,364		17,294 25		"	"
		16,360		$93,184 00		
Fifth, ...	3,870		$27,363 00		Fairmount.	Fairmount.
Sixth, ...	3,049		29,060 25		"	"
Seventh, ...	4,798		31,613 25		"	"
Eighth, ...	3,385		28,403 25		"	"
Ninth, ...	2,877		26,371 25		"	"
Tenth, ...	3,467		27,108 00		"	"
		20,896		$169,919 00		
Eleventh, . . .	2,691		$17,250 25		Spring Garden.	Spring Garden.
Twelfth, ...	2,684		16,630 50		"	"
Thirteenth, . . .	3,459		26,049 00		"	"
Fourteenth, . . .	4,165		28,697 25		"	"
Fifteenth, . . .	5,270		40,067 00		"	"
Twentieth, . . .	4,979		35,290 45		"	"
Twenty-first, . .	27		137 50		"	"
		23,275		$164,121 95		
Sixteenth, . . .	3,487		$20,309 75		Kensington.	Kensington.
Seventeenth, . .	3,360		18,695 25		"	"
Eighteenth, . . .	2,861		19,246 00		"	"
Nineteenth, . . .	4,183		24,587 00		"	"
Twenty-third, . .	43		651 50		"	"
Twenty-fifth, . .	776		5,000 00		"	"
		14,710		$88,489 50		
Twenty-fourth, . .	1,058	1,058	10,498 75	10,498 75	24th Ward.	Stand-Pipe.
Totals, ...		76,299		$526,268 20		

STATEMENT OF PIPES LAID IN FIRST DISTRICT,

(First, Second, Third and Fourth Wards,)

DURING 1862.

In what Streets.	Between what Streets.	Diameter of Pipe.	Feet of Pipe.
Christian,	Sixteenth and Seventeenth, (First Ward,)	12	445
"	Fourteenth and Fifteenth,	12	542
	Total 12-inch in First Ward,		987
Christian,	Twenty-first and Gray's Ferry Road,	6	576
Gray's Ferry Road,	Christian and Federal,	6	1,167
Ellsworth,	Fifteenth and Sixteenth,	6	445
Sixteenth,	Ellsworth and Federal,	6	370
"	Carpenter and Ellsworth,	6	873
Fifteenth	Federal and Reed,	6	1,067
"	Prime and Ellsworth,	6	350
Church,	Canal and Mifflin,	6	243
Twenty-second,	Christian and Montrose,	6	179
Federal,	Fifteenth and Sixteenth,	6	464
Mifflin,	Second and Fifth,	6	1,329
Reed,	Broad and Thirteenth,	6	679
Second,	Moore and Wolf,	6	2,071
Moore,	Broad and Eleventh,	6	885
	Total 6-inch in First Ward,		10,698
Lukens,	Fifteenth and Sixteenth, (First ward),	4	450
Afton,	Sixteenth and Seventeenth,	4	425
Lingo,	Carpenter and Washington,	4	431
Watkins,	East of Twelfth,	4	342
Enterprise,	Fifth and Sixth,	4	459
Celeste,	Moyamensing Avenue and Second,	4	538
McClellan,	Front and Second,	4	621
	Plug attachments,	4	393
	Total 4-inch in First Ward,		3,659
Sidney,	Ellsworth and Federal, (First Ward,)	3	333
	Total 3-inch in First Ward,		333
Swanson,	Christian and Washington, (Second Ward,)	6	671
	Total 6-inch in Second Ward,		671
Christian,	United States Hospital, (Second Ward,)	4	179
	Total 4-inch in Second Ward,		179
	Connections,	12	18
	"	10	16
	"	6	293
	"	4	363
	"	3	34

STATEMENT OF PIPES LAID IN SECOND DISTRICT,

(Fifth, Sixth, Seventh, Eighth, Ninth, Tenth and Twenty-fourth Wards,)

DURING 1862.

In what Streets.	Between what Streets.	Diameter of Pipe.	Feet of Pipe.
Delaware Avenue,.....	Spruce and South, (Fifth Ward,).....	6	1,412
	Total 6-inch in Fifth Ward,.....	.....	1,412
	Plug attachments,.....	4	45
South,.....	Sutherland Avenue and Bank, (Seventh Ward,)	6	372
	Total 6-inch in Seventh Ward,.....	.....	372
Factory,.....	Willow and Carbon,.....	3	338
	Plug attachments,.....	.....	34
	Total 3-inch in Seventh Ward,.....	.....	372
Albion,.....	Race and Cherry, (Tenth Ward,).....	4	334
	Total 4-inch in Tenth Ward,.....	.....	334
Haverford Road,.....	West of Forty-first, (in Twenty-fourth Ward,)..	6	136
Forty-first,.....	Haverford Road and Market,.....	6	1,867
Thirty-seventh,.....	Baring and Powelton Avenue, ...	6	459
Hamilton,.....	Thirty-second and Thirty-third, ...	6	420
Garden,.....	Thirty-fifth and Thirty-sixth,.....	6	415
Locust,.....	West of Till,.....	6	237
	Total 6-inch in Twenty-fourth Ward,.....	.....	3,534
	Plug attachments,.....	4	180
	Connections, ...	12	15
	"	6	281
	"	4	120
	"	3	37

STATEMENT OF PIPES LAID IN THIRD DISTRICT,

(Eleventh, Twelfth, Sixteenth, Seventeenth, Eighteenth, Nineteenth, Twenty-third, and Twenty-fifth Wards,)

DURING 1862.

In what Streets.	Between what Streets.	Diameter of Pipe.	Feet of Pipe.
Vienna,	West and Gaul, (in Eighteenth Ward,)	4	306
Gaul,	Otis and Hewsen,	4	165
	Hewsen and Vienna,	4	156
	Plug attachments,	4	24
	Total 4-inch in Eighteenth Ward,		651
Cumberland,	Front and Second, (in Nineteenth Ward,)	6	1,130
Collins,	Cumberland and Huntingdon	6	696
Jasper,	Front and York,	6	400
Edgemont,	Lehigh Avenue and Anthracite,	6	34
	Total 6-inch in Nineteenth Ward,		2,260
Ball,	Richmond and Beach, (in Nineteenth Ward,)	4	487
Tilton,	Cumberland and Emery,	4	364
Taylor,	Amber and Emerald,	4	833
Hope,	York and Huntingdon,	4	1,104
Tucker,	Memphis and Cedar,	4	424
	Plug attachments,	4	110
	Total 4-inch in Nineteenth Ward,		3,322
Pine,	Main and Edward, (in Twenty-third Ward,)	6	600
	Total 6-inch in Twenty-third Ward,		600
	Plug attachments,	4	15
	Connections,	6	106
	"	4	245
	"	3	10

STATEMENT OF PIPES LAID IN FOURTH DISTRICT,

(Thirteenth, Fourteenth, Fifteenth, Twentieth, and Twenty-first Wards,)

DURING 1862.

In what Streets.	Between what Streets.	Diameter of Pipe	Feet of Pipe.
	In new Mill House at Fairmount, (15th Ward,).	30	108
	Total 30-inch in Fifteenth Ward		108
	In new Mill House at Fairmount.	20	170
	Total 20-inch in Fifteenth Ward		170
	Relaid at Fairmount, (Fifteenth Ward,)	16	65
	Total 16-inch in Fifteenth Ward		65
	Relaid at Fairmount, (Fifteenth Ward,)	10	90
Spring Garden	Sixteenth and Eighteenth, (Fifteenth Ward,)	10	890
	Total 10-inch in Fifteenth Ward		980
Corinthian Avenue	Coates and Poplar, (in Fifteenth Ward,)	6	1,568
	Fairmount Park, (Fifteenth Ward,)	6	1,557
	At Fairmount, (Fifteenth Ward,)	6	98
	Total 6-inch in Fifteenth Ward		3,223
Springett,	Nineteenth and Twentieth	4	526
Howard	Brown and Hare	4	468
Hare	Twenty-fourth and Twenty-fifth	4	468
	Plug attachments	4	130
	Total 4-inch in Fifteenth Ward		1,592
Thirty-first	and Thompson (relaid,) in Twentieth Ward	20	81
	Total 20-inch in Twentieth Ward		81
Ridge Avenue	Twenty-third and Twenty-fourth	6	576
Broad	Columbia Avenue and Montgomery	6	1,130
Corinthian Avenue	Poplar and Girard Avenue	6	485
Tenth	Columbia Avenue and Susquehanna	6	2,820
Ginnodo	Ridge Avenue and Nineteenth	6	470
Cambridge	Seventeenth and Ridge Avenue	6	433
Diamond	Tenth and Gas Works, (Twentieth Ward,)	6	326
Columbia Avenue	Sixth and Seventh	6	440
Tenth	and Berks, (relaid,)	6	98
	Total 6-inch in Twentieth Ward		6,778
Geary	Ginnodo and Wiley, (in Twentieth Ward,)	4	215
Thompson	Thirty-first and Thirty second, (in 20th Ward,)	4	92
	Plug attachments		295
	Total 4-inch in Twentieth Ward		602
Thirty-first	and Thompson, (in Twentieth Ward)	3	45
	Total 3-inch in Twentieth Ward		45
Broad	Montgomery and Berks, (in 21st Ward,)	6	1,100
Tenth	Susquehanna Avenue and Germantown Road,	6	1,932
	Total 6-inch in Twenty-first Ward		3,032
	Plug attachments	4	95
	Connections	16	15
	"	6	272
	"	4	299

RECAPITULATION.

DISTRICTS.	1862.	DIAMETER IN INCHES.							
		30	20	16	12	10	6	4	3
1st District..	Total number of feet laid.....	.....	.....	.....	1,005	16	11,662	4,201	367
"	Stop cocks in the same.....	.....	.....	.....	1	2	26	6	1
2d District...	Total number of feet laid.....	.....	.....	.....	.....	.....	5,599	679	409
"	Stop cocks in the same.....	.....	.....	.....	.....	.....	13	2	2
3d District...	Total number of feet laid.....	.....	.....	.....	.....	.....	2,966	4,233	10
,,	Stop cocks in the same.....	.....	.....	.....	.....	.....	7	12	.....
4th District..	Total number of feet laid.....	108	251	80	.....	980	13,305	2,588	45
"	Stop cocks in the same.....	.....	.....	.....	.....	2	21	6	.....
	Total of pipe.....	108	251	80	1,005	966	33,532	11,701	831
	Total of stop cocks.....	.....	.....	.....	1	4	67	26	3

Total number of feet of Pipe laid in the year 1862,.....48,474 feet,
Or 74 feet more than 9 miles and ⅛ of a mile.
Total number of Fire Plugs in the Four Districts,.....3,055

ACCOUNT OF THE NUMBER OF HOLES DRILLED FOR MAKING NEW ATTACHMENTS DURING THE YEAR 1862.

MONTHS.	Half-inch Diameter.	Five-eighths Inch Diameter.	Three-fourths Inch Diameter.	One Inch Diameter.	TOTAL.	Shut off for Repairs to Private Pipe.	Shut off for Repairs to Public Pipe.
January, . .	25	5	3	0	33	46	11
February, . .	34	6	2	0	42	25	2
March, . . .	48	24	1	0	73	40	4
April, . . .	78	45	0	2	125	31	5
May, . . .	82	10	2	6	100	17	4
June, . . .	79	11	4	1	95	12	0
July, . . .	122	8	9	6	145	16	4
August, . .	92	12	4	4	112	11	9
September, .	80	21	3	1	105	9	1
October, . .	105	32	5	4	146	24	5
November, .	59	27	2	2	90	21	5
December, . .	64	21	3	0	88	38	4
Total, . . .	868	222	38	26	1,154	290	54

The following attachments were made in the Districts during 1862, as follows:—

DISTRICTS.	Half-inch Diameter.	Five-Eighths Inch Diameter.	Three-fourths Inch Diameter.	One Inch Diameter.	TOTAL.	Shut off for Repairs to Private Pipe.	Shut off for Repairs to Public Pipe.
First, . . .	184	22	4	11	221	13	18
Second, . .	172	53	13	7	245	51	7
Third, . . .	236	19	10	4	269	138	9
Fourth, . . .	276	128	11	4	419	88	20
Total, . .	868	222	38	26	1,154	290	54

STATEMENT OF PIPES, BRANCHES, CASTINGS, AND OTHER STOCK, ON HAND JANUARY 1, 1863.

FIRST DISTRICT.....DEPOT, 516 CARPENTER STREET.

PIPES, BRANCHES, &c.	DIAMETER IN INCHES.						
	20	18	12	10	6	4	3
Pipes 9 feet long	.....	.....	3	12	207	471	59
Fire Plugs, Single	.....	.....	.....	.....	.....	3	.....
4-Way Branches	.....	.....	1	.....	33	13	2
3-Way Branches	.....	1	.....	.....	.....	.....	.....
Caps	1	.....	1	.....	12	14	1
Sleeves	.....	.....	.....	.....	10	3	1
Reducers	.....	.....	.....	.....	12	8	.....
Bevel Hubs	.....	.....	.....	.....	11	15	.....
Curved Pipe	.....	.....	.....	.....	2	1	.....
Quarter Turns	.....	.....	.....	.....	2	2	.....
Offset Pipes	.....	.....	.....	.....	2	3	.....
Stop Cocks	.....	.....	.....	.....	4	.....	.....
Goose Necks	.....	.....	.....	.....	.....	3	.....
Pieces of Pipe	.....	.....	.....	.....	9	1	2

STATEMENT OF PIPES, BRANCHES, CASTINGS, AND OTHER STOCK, ON HAND, JANUARY 1, 1863.

SECOND DISTRICT..... DEPOT, 918 CHERRY STREET.

PIPES, BRANCHES, &c	DIAMETER IN INCHES.								
	30	20	16	12	10	8	6	4	3
Pipes 9 feet long	.....	.....	.....	29	11	1	455	64	43
Fire Plugs, Plain	.....	.....	.....	.....	.....	.....	.....	42	.....
Fire Plugs, 3-Way	.....	.....	.....	.....	.....	.....	22	.....	.....
3-Way Branches	.....	.....	.....	4	2	3	7	3	5
4-Way Branches	.....	1	.....	1	.....	1	5	34	.....
Flange Pipes	.....	.....	.....	.....	.....	1	.....	.....	.....
Caps	1	.....	.....	.....	1	2	10	18	33
Sleeves	1	.....	6	12	1	16	14	33	17
Reducers	2	.....	.....	2	2	1	14	.....	4
Bevel Hubs	.....	.....	.....	.....	.....	1	.....	3	.....
Curved Pipe	.....	.....	.....	.....	.....	.....	.....	11	.....
Quarter Turns	.....	.....	2	4	.....	.....	10	6	12
Double Hubs	.....	.....	.....	.....	1	3	.....	1	3
Offset Pipes	.....	.....	.....	.....	.....	.....	27	4	.....
Pieces of Pipes	.....	.....	.....	.....	.....	.....	14	5	2
Stop Cocks	.....	.....	.....	3	1	6	8	12	1

STATEMENT OF PIPES, BRANCHES, CASTINGS, AND OTHER STOCK, ON HAND JANUARY 1, 1863.

THIRD DISTRICT.....DEPOT, 1420 FRANKFORD ROAD.

PIPES, BRANCHES, &c.	DIAMETER IN INCHES.					
	20	18	16	10	6	
Pipes 9 feet long	.....	.....	.....	2	79	126
Fire Plugs, Single	.....	.....	.....	.....	.....	5
3-Way Branches	.....	.....	.....	7	.....	3
4-Way Branches	.....	1	.....	4	17	2
Caps	.....	.....	.....	12	11	8
Sleeves	.....	4	.....	10	18	13
Reducers	.....	.....	.....	4	9	.....
Bevel Hubs	.....	.....	.....	.....	.....	7
Curved Pipe	.....	.....	.....	2	6	3
Quarter Turns	.....	.....	.....	.....	15	.....
Pieces of Pipe	.....	.....	1	3	5	20
Stop Cocks	.....	.....	.....	1	8	1
Stop Covers	5	.....	.....	.....	.....	.....
Stop Boxes	.....	.....	.....	.....	2	.....
Plug Cases	1	.....	.....	.....	.....	.....

STATEMENT OF PIPES, BRANCHES, CASTINGS, AND OTHER STOCK, ON HAND JANUARY 1, 1863.

FOURTH DISTRICT.....DEPOT, 1324 BUTTONWOOD STREET.

PIPES, BRANCHES, &c.	DIAMETER IN INCHES.									
	30	24	20	18	16	12	10	8	6	4
Pipes 9 feet long	19	.....	19	.....	11	1	124	.....	293	396
Fire Plugs, Single	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Y Branches	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
3-Way Branches	3	.....	1	1	1	2	9	.....	23	18
4-Way Branches	1	.....	8	1	2	.....	18	.....	43	11
Caps	.....	.....	.....	.....	.....	2	10	1	10	18
Sleeves	2	.....	7	6	.....	15	.....	.....	6	4
Reducers	.....	.....	.....	.....	.....	.....	2	.....	.....	12
Bevel Hubs	.....	.....	.....	.....	.....	.....	1	.....	2	10
Curved Pipe	.....	.....	.....	.....	.....	.....	.....	.....	3	.....
Stop Cocks	.....	.....	.....	.....	.....	.....	.....	.....	3	.....
Stop Boxes	.....	2	.....	.....	.....	.....	.....	.....	.....	.....
Stop Covers	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Iron Frames	.....	7	.....	.....	.....	.....	.....	.....	.....	.....
Goose Necks	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
Bends	.....	.....	6	.....	14	.....	.....	.....	.....	.....

LOCATION OF PUBLIC HYDRANTS SET DURING THE YEAR 1862.

DISTRICTS.	LOCATION.
First District,	N. W. corner Eleventh and Christian.
" "	Washington, above Swanson.
" "	Broad, above Washington.
" "	Eleventh and Fitzwater.
" "	Ostego, below Washington.
Fourth District,	Ridge Avenue, below William.

LOCATION OF THREE-WAY FIRE PLUGS SET DURING THE YEAR 1862.

DISTRICTS.	LOCATION.
First District,	S. E. corner Fifteenth and Christian.
" "	Christian, above Tenth.
" "	Eighth, above Fitzwater.
Second District,	Cor. Ninth and Swanson (Lowery Plug.)
" "	Seventh, below Arch.
" "	Swanson, below Ninth.
Fourth District,	Thirty-first and Thompson.
" "	Thirty-second and Thompson.

It will be found that the pipe laid in 1862 has been done quite as cheaply as in former years, notwithstanding that increased prices of twenty-five per cent. were paid for labor. The frontage tax charged by the City to property owners, for laying water-pipe, and which is one dollar and fifty cents per foot, is frequently complained of and represented as exorbitant. When it is borne in mind that, in addition to laying this pipe, the City assumes the responsibility also of keeping it in good repair forever, renewing or relaying it whenever it shall become necessary, and that the City lays all supply mains, and supports the entire distributing facilities, including those for the protection of property from fire, and keeps all in good order and condition in perpetuity, I do not see, I beg leave to say, that this charge is unreasonable.

SHOP.

A considerable increase in the shop connected with this Department, and used for the purposes of fitting up fire-plugs, stop-cocks, and for other incidental and necessary work in the supply of water, is much needed. Much of this description of work, for which the present facilities are not sufficient, has to be sent to private establishments.

EXPENDITURES OF THE DEPARTMENT FOR THE YEAR 1862.

Salaries of Engineer, Register, Clerks, &c.,	$18,649 43
Office expenses,	2,617 83
Salaries of Engineers, Firemen, &c.,	16,222 93
Coal for different Works,	25,288 31
Tallow and Oil,	1,846 17
Wood,	147 50
Small stores,	1,494 45
	$66,266 62

Amount brought forward,	$66,266 62
Repairs to Fairmount Works,	3,983 34
" " Kensington "	1,160 56
" " Spring Garden Works,	2,987 49
" " Twenty-fourth Ward Works,	1,999 68
Buildings and Grounds,	8,997 55
Iron pipes, lead, brass castings, and other materials,	33,366 06
Labor laying pipes, setting plugs, making pipe, plans, &c.,	22,991 11
Keeping pipes, plugs, &c., in good order,	7,998 85
Drilling and making new attachments,	4,999 67
Iron railing at Fairmount,	997 50
Germantown Water Company,	275 00
Balance of Appropriation unexpended,	301 57
Total,	$156,325 00

APPROPRIATIONS AND EXPENDITURES.

Date of Appropriation.	Amount of Appropriation.	Amount Expended.	Balance of Appropriation.
General Appropriation, March 1, 1862,	$156,825 00	$156,023 43	$301 57
Special Appropriation to Pay Bills of 1861, March 1, 1862,	384 65	384 65	
Special Appropriation to Refund for Dead Ends, March 22, 1862,	500 00	112 50	387 50
Special Appropriation to Pay J. S. Mintzer, June 2, 1862,	5 00	5 00	
Special Appropriation to Repair Damages caused by late Freshet, September 22, 1862,	20,000 00	19,994 74	5 26
Special Appropriation to pay Bills of 1861-2, November 8, 1862,	572 74	572 74	
Special Appropriation to Pay Jas. Miller, April 16, 1859,	80 18	80 18	
	WATER	LOAN.	
Balance of Appropriation, January 1, 1862,	10,797 98	10,797 98	
Supplementary Appropriation, May 19, 1862,	30,000 00	29,896 51	103 49
For Public Drinking Hydrants, July 9, 1859,	368 97	148 45	220 52

TOTAL AMOUNT EXPENDED UPON EXTENSION OF WATER WORKS.

Item 1	For laying 30 inch main from Corinthian Avenue Reservoir to 1st District, with connections, prior to January 1, 1862, - - -		$126,175 10
" 2	For increasing the capacity of Corinthian Avenue Reservoir, prior to January 1, 1862, - - -	$61,636 80	
	During the year 1862, - -	2,452 84	
			64,089 64
" 3	For Turbine wheels and new pumps for new mill house, prior to Jan. 1, 1862, - - - - - -	$46,165 75	
	During the year 1862, - -	21,810 23	
			67,975 98
" 4	For erecting a mill house on the mound dam, prior to Jan. 1, 1862,	$64,737 08	
	During year 1862, - -	8,312 97	
			73,050 05
" 5	For mains to connect new and old works, prior to January 1, 1862, -	$13,627 53	
	During year 1862, - -	2,197 49	
			15,825 02
" 6	For finishing bridge over forebay, during year 1862, - - -		3,250 00
" 7	For macadamizing and filling walks, during year 1862, - - -		2,698 13
	Total, - - - - -		$353,063 92

THE APPROPRIATION TO REPAIR DAMAGES DONE BY THE LATE FRESHET TO THE WORKS, RESERVOIRS, AND MAINS, HAS BEEN EXPENDED AS FOLLOWS:—

APPROPRIATION APPROVED SEPTEMBER 22, 1862, .	$20,000,000	
Wages of Bricklayers, Masons, Carpenters, Laborers, &c., ...	$15,847	03
Hauling Portable Engine, ...	10	00
Stone, ...	1,235	25
Bricks, ...	313	00
Lumber, ...	1,299	21
Cement, ...	407	50
Wood, ...	112	50
Iron, ...	140	67
Damage done to Hope Fire Company, while pumping out Forebay, ...	203	25
Repairing Scales, ...	25	00
Tin Work, ...	39	50
Machine Work, ...	327	46
Repairs to Fountain, ...	34	37
Balance of Appropriation, ...	5	26
	$20,000	00

THE FOLLOWING AMOUNTS HAVE BEEN RECEIVED AT CHERRY STREET OFFICE, AND PAID TO CITY TREASURER.

Wharfage, ...	$15	00
Rents, ...	290	00
Attachments, ...	406	39
Old Iron, ...	283	38
Old Brass, ...	19	00
Cement Barrels, ...	7	05
Old Register, ...	5	00
Total, ...	$1,025	82

TABLE SHOWING THE AMOUNT OF RAIN AND SNOW (MELTED) THAT FELL AT PHILADELPHIA, PA., SINCE JULY, 1851, AS MEASURED BY PROF. JAMES A. KIRKPATRICK.

YEAR.	JANUARY.	FEBRUARY	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUGUST.	SEPTEM'R	OCTOBER.	NOVEM'R.	DECEM'R.	ANNUAL TOTAL.
	Inches.	Inches.	Inches	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1851.....	.....	.....	.....	.....	.....	.....	4,360	3,420	3,600	3.038	3,410	1,880	.....
1852.....	2,010	2,710	4,270	6,440	3,040	4,500	4,060	4,400	1,290	2,250	6,050	5,180	46,200
1853.....	1,840	4,440	2,460	3,880	5,170	1,050	8,630	3,080	4,460	3,470	2,320	2,165	42.965
1854.....	2,320	4,200	1.625	8,145	7,299	3 441	3,837	0,918	4,883	1,918	3,460	3,185	45,231
1855.....	2,601	2,480	1,979	2,148	3.033	8,008	6,594	3,237	4,129	3,416	2,022	5,006	44,653
1856.....	3,368	1,128	2,939	3,149	2,334	1,677	1,127	5,186	5,702	1,303	2,886	3,619	33,518
1857.....	2,989	0,921	1,773	6,932	6,043	7,426	3,373	8,039	1,132	2,742	1,575	5,503	48,448
1858.....	2,686	2,393	1,124	4,681	5,308	4.205	1,454	5,157	1,589	1,778	5,225	5.459	41.059
1859.....	5,230	3,569	6,503	5,668	1.946	5,229	3,915	4,447	7,779	3,210	3,796	3 460	54.752
1860.....	3,351	2,724	1,323	3,646	3,589	3,706	0,851	9,260	2,907	4,685	6,057	3,301	45,400
1861.....	4,620	2,124	3,903	4,150	6,240	4,485	2,826	2,864	4,976	3,597	4,613	2 016	46 414
1862.....	4,500	4,277	3,509	3,947	2,083	6,592	2,841	1,455	6,282	4,160	4,455	1,555	45.656
Monthly Av'ge	3,229	2,815	2,773	4,799	4,226	4,574	3,656	4,289	4,061	2,964	3,822	3,527	44 938

FUTURE MEANS OF SUPPLY.

The most prominent and important deficiency in the Department for Supplying the City with Water, is the entirely insufficient provision for storage; and there is no question involved in the consideration of its objects or improvement, meriting more serious attention, than that of providing fully for the present demand, and, as far as practicable, for the future, especially with reference to increased and more reliable storage, capacity and facilities.

Nothing is more strongly apparent, nor more easily demonstrated, than the inadequacy of the Water Works of this City to protect our population from entire failure in the supply, in case of contingencies quite within the range of possibility, or to meet even the ordinary demand in the early future. In the arrangement and construction of the works now supplying the City, such an immensely and unexpectedly increased demand as has been incidental to a very greatly increased population, was not anticipated, and this increased demand, if continued in the same or nearly the same ratio, must very soon render the question of providing additional facilities for supply of the highest possible importance.

At present, should the dam at Fairmount give way from natural decay, or be carried away by a flood, or removed, partially or totally, by any cause, such accident would at once suspend entirely the operations of the Fairmount, Spring Garden, and the Twenty-fourth Ward Works, and an entire failure in the supply of water would ensue within four and a half days. The combined storage capacity of all the reservoirs would, during the summer months, be

exhausted in about four days. In case of any accident interfering with or suspending the operations of the pumps for a considerable length of time, the deficiency of supply must at present be proportionate to its extent and the time required to complete repairs, no temporary arrangement nor substitution being possible to prevent an entire failure.

At present it is quite impossible to provide in anticipation of any serious emergency, or for even probable accidents. At the Fairmount Works there is an excess of pumping capacity, over the average daily demand, of 18,000,000 of gallons per day, and during seven months, or say two hundred days of the year, there is amply sufficient water in the Schuylkill river to drive all the machinery of the Works.

The excess of pumping facilities over demand or storage facilities, and capacity of mains, at these Works, is about 3,600,000,000 of gallons per annum, and they could readily supply not only their district, but that also of the Spring Garden Works, and have still an excess of at least 500,000,000 of gallons per year. This excess of pumping capacity is almost entirely lost for want of storage facilities, and deficiencies of the area of the pumping mains. To render fully available the full ability of the pumps at Fairmount, would involve the necessity of an additional ascending main, as I have had the honor of previously suggesting. With the present deficiency of mains and storage facilities, the greater pumping power is almost entirely useless, and no advantage can be taken of occasional great increase of water power in the Schuylkill, which frequently occurs from rains for limited periods during the months of greatest demand. The very considerable increase of storage capacity at these

Works, I beg the liberty of suggesting, is a subject worthy of the most serious consideration of your honorable bodies—a remark, however, which applies almost equally well to all the Water Works of the City.

The general requirements of the City of Philadelphia, in its supply of water, I beg leave to say, may, in my opinion, be stated in a few words. *First.* Works capable of furnishing a full supply with not more than two-thirds of their machinery in operation. *Second.* Storage capacity, which will secure the supply of all known demand, and anticipate and provide, as far as practicable, for all emergencies. *Third.* An equal distribution and supply, as nearly as possible, to all water tenants, in whatever locality, with restraints only intended to prevent wilful, useless or accidental waste.

In the location of storage reservoirs, it has been a favorite theory that sites should be selected of much greater elevation than that of the present reservoirs, and the elevations of proposed sites have generally exceeded two hundred feet. In this apparently generally received theory, I beg leave to say that I do not concur, and it is very probably demonstrably incorrect. The Spring Garden and the greater part of the Fairmount Works are capable of raising water 115 feet, and with a very moderate expense, and with pumping mains of proper size, would be enabled to increase this elevation to 140 feet, which would be fully adequate to insure a supply throughout an area of territory now including nearly the entire City, and a vast majority of the population, and which must continue to include such. This area is between the rivers Delaware and Schuylkill, and embraces about 25,000 acres, the whole of which could readily be

amply supplied by an increased elevation of reservoirs to 140 feet, to which the present works are adapted. The population not included in this district should be embraced in districts or sub-districts, according to their local elevations, and specially provided for, as I have taken the liberty of previously suggesting. The greatest elevation required to supply water at a point where any demand exists at present, or is likely to occur, would greatly exceed that required to amply supply the lower and vastly more extensive district. The highest point in the district, including Chesnut Hill, is 440 feet above high water, but the locating and constructing of reservoirs having an elevation capable of reaching and supplying so high a locality, for the general purpose of supplying the City, would be palpably unnecessary and inexpedient in the highest degree.

It is well known that in the construction of Water Works, the true points of economy and utility are attained by raising the water to no greater elevation than is actually required to furnish a full supply. If a sufficient elevation can be attained at an expense, for pumping, of two dollars per million gallons, it is clearly unwarrantable to adopt an elevation that would cost double that amount for raising the same quantity. This simple principle, which is quite familiar to all engineers, seems to have been overlooked in some measure, in propositions and discussions on this important subject of future supply, which have occasionally occurred within some years past.

The high grounds near the Flat Rock Dam, on the river Schuylkill, have been referred to as a proper point for the location of large storage reservoirs. This dam is nine miles above the Fairmount Works, and the highest point of eleva-

tion to be attained there is 293 feet above the surface of water in this dam, and 323 feet above high water, or 174 feet higher than is necessary for supplying all points east of the Schuylkill, at which the greatest increase in demand most probably can ever arise, but will not supply the high point at Chesnut Hill above mentioned. The point at Flat Rock for the location of reservoirs, then, is only worthy of consideration in connection with localities requiring this elevation. An engine which will raise ten millions of gallons 140 feet, will be capable of raising about four and three-quarter millions of gallons to an elevation of 293 feet, or about three millions of gallons to an elevation capable of supplying the highest points in the City; and it is most assuredly, I beg leave to say, the true policy, both practically and economically, and in all respects to the best interests of the City, to decide first upon an elevation which will meet the greatest and most general demand, and confine the pumping operations to points of greatly increased elevations, within the most limited area practicable.

An increased elevation of 25 feet over the present reservoirs, giving an additional degree of *head* or momentum in the mains, would not only serve to provide a supply at points now impracticable, but would increase the pressure sufficiently to avoid the necessity, in some cases, of additional supply mains. The proposed additional elevation is not such as would render the present supply and service mains liable to accidents from breaks and otherwise, which, under any very considerably increased pressure, would be certainly attended with very inconvenient and expensive consequences.

This proposed increased capacity and elevation of reser-

voirs, with an incidental increase of mains, is, I beg leave to say, the most important, as well as urgent, question of a practical character now relating to the Water Works, having for their object the supply of the City in the future immediately ensuing, and requiring the earliest practical provision. The consideration of the foregoing, and other facts involved in the very important question of future supply, and especially of the even now pressing, and almost indispensable, necessity for additional facilities for storage or reservoirs, within easy and economical access of the Fairmount and Spring Garden Works, has induced me to believe that a most suitable locality would be the grounds immediately north of Thompson street, between Ridge Avenue and Twenty-seventh street. This locality presents many advantages. It is within easy access of both the Fairmount and Spring Garden Works, and may be reached by ascending mains almost perfectly straight. Intersections may be made with all the present supply mains by the shortest possible route, by way of the Ridge Avenue. The streets running north and south in this locality are, to a great extent, practically vacated by the Girard College grounds and the Spring Garden Reservoir. It is near the point of demand, and it may be reached by the shortest and most advantageous routes for the supply of all parts of the City, and it is an advantageous location in respect to facilities and materials for construction. In this locality a reservoir could be constructed with an elevation of one hundred and forty-nine feet above high water, or twenty-five feet higher than the Spring Garden Reservoir, which would be amply sufficient to fully supply all that portion of the City which must, for an incalculable period, contain nearly the

entire population, and on which depends the pecuniary provision and reimbursement for all municipal improvements and expenditures. There is ample space for the erection of a reservoir holding fifteen hundred millions of gallons, or a storage capacity of a supply for seventy-five days, at the present average demand. At this locality a reservoir to contain a supply for at least sixty days, would very probably be most desirable; and after mature reflection, I beg leave respectfully to recommend this locality, and a construction of a reservoir of the latter description, to the attention of your honorable bodies.

In addition to the preceding remarks, I may be allowed to mention that the location of storage reservoirs at a point on the Schuylkill near Belmont, or near the head of the Inclined Plane, formerly in use on the Columbia Railroad, has been advocated by highly intelligent and respectable parties. The proposition is to supply such reservoirs from the Fairmount Works. The elevation of this proposed locality is 225 feet, and the distance from Fairmount is so great, that for the purpose of raising water into such reservoirs, with the present wheels, it would require the area of the pumps to be reduced to such extent, that the entire pumping capacity of the Fairmount Works would be so much reduced as to render this proposition impracticable. The Twenty-fourth Ward Works are the only works adapted to raising water to this elevation. In the proposing of localities for additional reservoirs, much beyond any possible requirements of that greatly larger part of the city from which is derived nearly the entire demand, and which must long continue such, and at elevations only necessary for quite restricted localities, now or prospectively, far too much

consideration is given to merely prospective populations in high localities, which must always be comparatively restricted. It does occasionally occur, too, that it is in some measure overlooked that the points and elevations requiring almost the entire demand at present, must continue to be the same for a very long period in the future, and the population of which has, and must continue to have, a quite substantial existence. It would not be advisable at present to attempt to furnish any supply to the district west of the Schuylkill river from the works at Fairmount. The entire ability of these works will be required certainly, at no distant day, to supply the district now dependent on them. The annual increase in the demand in this and other districts east of the Schuylkill River is shown in the following table:—

AMOUNT OF WATER PUMPED BY WORKS EAST OF THE SCHUYLKILL, (FAIRMOUNT, SPRING GARDEN AND KENSINGTON WORKS,) FROM JANUARY, 1854, TO DECEMBER, 1862, INCLUSIVE.

Months.	1854. Daily Average of Gallons.	1855. Daily Average of Gallons.	1856. Daily Average of Gallons.	1857. Daily Average of Gallons.	1858. Daily Average of Gallons.	1859. Daily Average of Gallons.	1860. Daily Average of Gallons.	1861. Daily Average of Gallons	1862. Daily Average of Gallons.
January.....	8,910,827	10,304,355	10,672,187	11,307,342	14,799,368	13,230,316	15,878,414	14,662,966	14,600,383
February.....	7,645,207	10,739,709	10,517,864	13,659,953	13,221,053	13,241,788	14,609,688	16,467,369	15,587,155
March.....	10,026,808	11,408,327	10,598,167	13,739,000	14,816 907	13,450,670	16,990,722	16,923,090	15,485.912
April.....	10,060,254	12,452,746	13,259,815	15,712.565	18,800 360	14,540,278	19,809,436	18,165,190	18,672,859
May.....	11,543,582	14,368,663	14,911,861	18,468,916	17,367,794	17,939,485	18,510,093	20,911,644	21,632,719
June.....	13,887,357	14,792,087	18,444,348	19,852,918	22,151,572	18,337,702	21,906,881	21,366,530	21,248,612
July.....	15,752,257	16.895,042	21,566,209	21,718,569	23,655,867	23,817,440	26,274,740	23,962,495	23,219.619
August.....	14,444,955	16,742,442	19,071,777	21,142.471	21,502,867	24,723,534	24,701,217	24,025,237	25,555,875
September.....	14,543,610	14,956,881	19,168 244	19,988.332	21,717,051	21,820,404	23,275,995	23,516,379	22,966,742
October.....	13,325,580	13,846,053	18,194,009	17,060,484	19,096,688	24,346,592	20,849,924	21,810,954	25,632,549
November.....	11,182,072	13,138,838	16,105,115	16,106.474	16,457,501	22,146,675	17,853 350	20,152,969	18,905,237
December.....	8,787,095	10 486,732	11 535,746	14,810,475	14,285,159	18,829,172	14,634,994	15,950,299	16,467,831
	11,700,791	13,360,352	15,348,066	16,701,348	18,206,159	18,911,165	19.623,216	19,870,641	20,029,249

The following table will show the annual increase in demand in the district west of the Schuylkill River:

AMOUNT OF WATER PUMPED BY WORKS WEST OF THE SCHUYLKILL, (TWENTY-FOURTH WARD WORKS,) FROM OCTOBER, 1855, TO DECEMBER 31, 1862, INCLUSIVE.

Months.	1855. Daily Average of Gallons.	1856. Daily Average of Gallons.	1857. Daily Average of Gallons.	1858. Daily Average of Gallons.	1859. Daily Average of Gallons.	1860. Daily Average of Gallons.	1861. Daily Average of Gallons.	1862. Daily Average of Gallons.
January.....		115,949	210,504	323,654	632,642	656,831	746,042	923,707
February.....		132,914	189,524	335,378	630,472	611,165	799,232	950,441
March.....		114,529	226,112	355,135	713,502	617,196	756,499	1,088,442
April.....		113,814	297,270	349,131	629,886	663,768	841,194	1,111,458
May.....		131,324	357,671	382,094	712,684	697,195	897,689	1,106,651
June.....		147,270	405 303	572,112	695.920	818,415	1,061,301	1,109,028
July.....		178,124	463,967	604.829	824,394	890,910	1,185,102	1,234,469
August.....		140,054	453,733	469,352	929,861	1,070,436	1,227,939	1,414,[illegible]
September.....		128,355	376 479	1,000.843	856,125	869,754	1,154,325	1,301,712
October.....	94,041	179,642	376,856	970,595	747,920	872,579	1,146,756	1,242.937
November.....	97,275	161,730	316,473	668,703	692,250	749,370	820,725	1,164,483
December.....	119,504	178,699	315,171	670,574	651,173	771,723	962,843	1,160,039
Total average,	103,675	143,654	334,106	559,390	727,277	774,989	967,983	1,152 076

It not being expedient to furnish a supply from the Fairmount Works to the higher portions of the district west of the Schuylkill, now embraced in the Twenty-fourth Ward, nor from any other of the present works on the eastern side of that river, the higher portions of this ward should probably continue, I beg leave to say, a separate district, with all its facilities distinct from, and independent of any other. Under any circumstances, it could only be allowable to locate a reservoir at Belmont for the supply of this ward, the population of which, according to the census of 1860, was 23,738, and the average daily demand is 1,152,076 gallons. For the purpose of supply at every point in the Twenty-fourth Ward, an elevation of not less than 225 feet is necessary, and could be obtained at the locality mentioned, all other circumstances permitting. But it will readily be seen that it is entirely unnecessary to raise, or incur the expense of raising, the water to this height for the purpose of supplying the great population of the City east of the Schuylkill, or any portion of it, because it is requisite to do so to supply the population of the Twenty-fourth Ward. A population of about 525,000 require for their water supply an elevation of reservoir not exceeding 140 feet, while a population of 24,000 only require for the same purpose an elevation of 225 feet, and it is very probable that this relative population will not vary in any very considerable degree for many years, or if it does, it will most probably be in favor of the larger population, and lower elevation.

The most densely populated wards of the City are the Fifth, Eighth, Eleventh, Twelfth, Fourteenth, and Seventeenth, the aggregate area of which is 1,049 acres, and the

population is 133,446. The territory which will undoubtedly contain forever the great bulk of the population of the City of Philadelphia, is that included within the limits of the area of 25,000 acres, to which I took the liberty of alluding in a preceding page. This territory embraces the entire district between the Delaware and Schuylkill rivers, from their junction to a point on the Delaware about one mile above Frankford, and thence through the lower portions of the late boroughs of Germantown and Manayunk, to the Schuylkill.

The lower portions of these boroughs are included in it, and it may not be amiss to add that the southern and southwestern parts of the Twenty-fourth Ward are of similar elevation to this great district, and so is also the immediate vicinity of both rivers for a considerable distance beyond the above named limits. As the extension of the City, and of its population, must mainly be, very probably, always within the limits just given, and as it must certainly continue to contain the most dense population, and in fact the greatest mass of population, it is for the supply of this district at present, and for the future, that the consideration of the means of supply is most strictly to be applied. The greatest wants, prospectively, will undoubtedly be within this district, the whole of which only requires for its full supply an elevation of 140 feet above the level of Fairmount Dam. The territory here designated would contain a population of about three millions if populated as densely as the wards before referred to, and would require, according to the present rate per every inhabitant, about one hundred and twenty-five millions of gallons of water per day, or more, according to the disproportionate ratio which is

found to prevail in the increase of population, and would require tenfold greater pumping facilities and capabilities than at present possessed by the entire Department.

While I am fully aware that this is a prospect certainly remote, and while I do by no means say that it is in anywise necessary or expedient at present to provide for so great a demand, I do most respectfully suggest and submit that, in the consideration of this subject, all proper and practicable degree of anticipation should be kept prominently in view. It is impossible, I beg leave to add, to reach a point in the extension of the Water Works of this City when it would be justifiable to say that they were completed, and the provisions and additions of the present should certainly be made as far as possible with reference to the future as well as the present, and as a further step in the progress and further development of a defined and organized system. The question of supplying the City with water by gravitation, by means of an aqueduct, has met with considerable attention and inquiry. I will take the liberty of giving here some facts having a practical bearing on this matter, as briefly as possible. The river Delaware presents no point of sufficient elevation for the purposes of an aqueduct within a distance which would render this plan practicable. The elevation required, with an additional fall of one foot to the mile, cannot be obtained, and would have to be over three hundred feet. At a distance of sixty miles from this City the elevation of the Delaware is only 140 feet.

The following table of distances and elevations on the Schuylkill river will afford an idea of the length and cost

of constructing an aqueduct for the supply of the City from this source:—

TABLE SHOWING THE ELEVATIONS ON THE SCHUYLKILL RIVER ABOVE HIGH TIDE AT PHILADELPHIA, AND THE DISTANCES FROM FAIRMOUNT WATER WORKS.

Location.	Distances from Fairmount Works.	Elevation.
Fairmount Dam,	Miles.	7 Feet.
Flat Rock,	9 "	33 "
Norristown,	16 "	54 "
Valley Forge,	27 "	80 "
Pottstown,	43 "	154 "
Reading,	64 "	197 "
Felix' Dam,	70 "	233 "
Kernsville,	87 "	361 "
Auburn,	95 "	448 "
Schuylkill Haven,	102 "	506 "
Pottsville,	106 "	610 "
Port Carbon,	108 "	615 "

It may be seen, by referring to the analyses of water from the Schuylkill, in a future page, obtained at points where the necessary elevations may be found, that it is there not adapted, if not entirely unfit, for the proposed purpose, and that to obtain it of a suitable character and quality, it is necessary to descend the river to a point where the necessary elevation does not exist. To introduce water into the City of Philadelphia by means of an aqueduct of sufficient dimensions, over a country perhaps not unusually well adapted to such purpose, would probably cost not less than works of similar character which have been constructed by other cities in this country. The length of the Croton Aqueduct, for the supply of the City of New York, from the Croton Dam to the originally constructed receiving reservoir, is $38\frac{3}{10}$ miles. Thence the water is conveyed in iron pipes a distance of 11,489 feet, to the Distributing Reser-

voir, making a total length of $40\frac{48}{100}$ miles. The cost of the whole, including the dam in the Croton river, and the two original reservoirs, make an average of $225,000 per mile. The area of the conduit of masonry is $53\frac{336}{1000}$ square feet. The Cochituate Aqueduct, for the supply of the City of Boston, is about 25 miles long, and its cost was about $200,000 per mile.

It may safely be assumed as the approximate or probable cost of works of this character capable of supplying the City of Philadelphia, and in which capacity might be included ample prospective provision, would not be less per mile than that of the City of New York. In the absence of surveys or other positive and reliable information, especially determining the exact length and other indispensable facts necessary to an accurate estimate, it may be assumed that an aqueduct supplying this City from any stream capable of affording a reliable supply, could not be less than eighty miles in length, and would probably cost not less than $18,000,000. The interest on this cost, added to the expenses of the Department, would be an annual expenditure not warranted now, nor probably for an indefinitely great length of time, and the supplying of this City with water by this means must be regarded at present as impracticable. For the purpose of more fully providing for the supply of this City by the methods now in use, the continuance and progressive improvement of which are desirable and expedient, the entire territory now included in the City limits might be properly divided into four districts, according to their elevations.

The first and much the most extensive would embrace the whole of the wards of the City from the First to the

Twentieth, and also the Twenty-fifth and portions of the Twenty-first, Twenty-second, Twenty-third and Twenty-fourth Wards. To supply this district would require an elevation of 149 feet above high water. The Second District would embrace all the higher portion of the Twenty-fourth Ward, requiring an elevation exceeding 200 feet. The lower portion of this Ward, near the Delaware river, and west of the lower wards of the first proposed district, could be supplied with that district and from the same elevation much more economically than from the high elevation required for its western and north-western portions. The Third District would embrace the higher parts of the Twenty-first, Twenty-second and Twenty-third Wards, requiring an elevation of not less than three hundred feet. It is possible that the higher parts of the Twenty-fourth Ward could be attached to this proposed Third District, and the lower parts being attached to the First District, any especial pumping provisions in this ward might be entirely dispensed with. The consideration of some questions here involved will, at an early period, be highly important, as special provision will soon become necessary, and possibly works will have to be erected for supplying portions of this proposed Third District, especially of parts of the Twenty-first Ward, and in perhaps not a greater length of time much more extended facilities will have to be provided for the supply of the Twenty-fourth Ward. The Fourth District would be quite limited, being confined to Chesnut Hill and immediate vicinity, now supplied with water by a private company. The elevation is 440 feet above high water. The supply could be derived from one of the streams in the vicinity, and the water could

undoubtedly be raised to a sufficient height from one of those streams much more economically and satisfactory than it could be supplied from works on the Schuylkill river. The elevations herein alluded to, I beg leave to be distinctly understood, are not in all instances derived from data which can be relied on as absolutely or mathematically correct, but the true elevations of localities referred to, where extensions or additions are either actually needed at present, or very probably will be in the early future, will be found to vary but inconsiderably from the statements herein given. Much of what I have herein stated with reference to the proposed Second and Third Districts is based on the best sources of information within my reach, and a full and complete investigation will not probably materially change the statements, but I have taken the liberty of presenting these views more for the purpose of inviting inquiry and investigation, than to assert that they are, positively and without qualification, correct in all particulars.

My object is to present what I conceive to be strictly a practical and common sense view of the whole subject of present and prospective requirements, and of all the means and facilities for the very important purpose of furnishing a supply of water to the City of Philadelphia.

ANALYSES OF WATER OF THE SCHUYLKILL AND DELAWARE RIVERS.

The annexed Analyses of water from various points on the Delaware and Schuylkill rivers, were made by the eminent Chemists, Professors BOOTH and GARRETT, and are probably the most complete and comprehensive ever made. They are quite important, as affording valuable information in reference to the water to be obtained at the points mentioned, and in connection with the general subject of the supply of water to this City:—

To ISAAC S. CASSIN,
Chief Engineer of the Philadelphia Water Works:

SIR:—We herewith present the results of our analyses of the Delaware and Schuylkill waters, undertaken with the view of determining their relative fitness for the use of Philadelphia, and the relative purity of each at different distances from the City. All the waters were drawn after the dry season, in October, 1862, and would therefore be most likely to exhibit, in the most concentrated form, any organic or other impurities, introduced into the waters by human agency. The several localities whence the waters were drawn, are Fairmount, Flat Rock, Valley Forge, Reading and Schuylkill Haven on the Schuylkill, and Kensington and Tacony on the Delaware river.

Before presenting the results, it is proper to observe, that if more time could have have been allowed for the investigation, we might have determined some other ingredients in the waters, if present, and that we might have determined those we found with a somewhat more rigid accuracy. We have, however, determined a sufficient number, and all of these with sufficient nicety, for the purely practical objects in view; and we believe that a fuller and minuter investigation would have added, perhaps unnecessarily, to the time and expense of performing it.

The following table (No. 1) gives the direct results of analysis. The first column contains the names of the substances found in

the waters, and the figures opposite to each express the number of grains, or fractions of a grain, of that substance, found in the U. S. wine gallon. The vertical columns, 2 to 11, give the quantities of each substance in the gallon of water, drawn from the locality indicated at the head of the column, with the date of the analysis.

By way of comparison with our results, and for future reference in this report, we give, in columns 2 and 3, the results of two analyses of Fairmount water, one made in 1842 by Professor M. H. Boyé, and the other by ourselves, for the City Councils, in 1854. For the same reasons we append, in column 11, an analysis of the Delaware water at Trenton, made by Mr. Henry Wurtz, in 1855. This last we calculated from his published results, which are given in our Table II., the 11th column. We here note, once for all, that all the substances are presented, in all the tables, in the dry or anhydrous condition.

TABLE I.—DIRECT ANALYSIS.

	SCHUYLKILL WATER							DELAWARE WATER		
Names of Substances Found.	Boye. Fairmount 1842.	B & G. Fairmount 1854.	B. & G. Fairmount 1862	B & G Flat Rock. 1862	B & G Val Forge 1862	B & G Reading. 1862	B & G Sch Haven 1862	B & G. Kensington. 1862.	B & G Tacony. 1862	Wurtz Trenton. 1855
Lime	1.226	1.404	1.457	1.987	1 161	1.276	1.322	0.548	0.784	0.881
Magnesia	0.230	0.696	0 835	0.801	0 754	1.608	0.822	0.404	0.301	0.423
Soda and Potassa	0.455	0.348	0 131	0.266	0.188	0.183	0.266	0.179	0.127	0.168
Sulphuric Acid.	0.302	1.417	1.5 8	1.540	1.532	2.562	9.888	0 384	0.296	0.109
Chlorine	0.086	0.168	0.139	0.129	0.129	0.129	0.059	0.099	0.069	0.071
Alumina and Oxyde of Iron	0.077	0.068	0.075				0.96			0.027
Silex and Insoluble Mat	0.395	1.080	0.339	0.226	0.320	0.480	0.440	0.08	0.160	0.498
Organic Matter	0.036							1.267	1.027	0.635
Total Amount per gall., directly determined	4.421	6.109	7.040	7.200	6 960	7.640	18.000	3.640	3 120	3.535

The total amount in the gallon was ascertained by evaporating the water and weighing the residue. It therefore embraces carbonic acid, &c., and more or less water, which are not included in our determinations, and hence the sum of each column falls short of the amount directly determined.

As it is customary to theorise on the direct results of the analysis of waters, by combining the acids and bases into well known compounds or salts, we subjoin such a calculation in another table.

We have preferred combining all the chlorine with sodium to form common salt, as it is probable that those elements enter into the water in such a state of combination. We have calculated all the sulphuric acid as combined with lime, magnesia, soda and alumina successively, except with the minute quantity of oxide of iron and alumina in the Fairmount water, as the latter appears to be sedimentary, and not in solution. The balance of lime, magnesia and soda, we have combined with carbonic acid, which we proved all the waters to contain, except that from Schuylkill Haven, and, perhaps that from Reading. No doubt some portions of the bases are united with silex, or silicic acid, but we preferred regarding the latter as insoluble matter, that is, insoluble in acid after evaporation. Although a small quantity of potassa was found by Boyé, Wurtz, and by ourselves in 1854, yet we found it almost wholly absent in our present analyses, and as it is immaterial whether the alkali be soda or potassa in our present inquiry, we have called it all soda in Table I., and, therefore, chloride of sodium in Table II. We have further omitted the minute quantity of phosphate of lime found by Wurtz at Trenton.

TABLE II—RATIONAL ANALYSIS.

	SCHUYLKILL WATER.								DELAWARE WATER.		
Names of the Calculated Compounds.	Boye Fairmount. 1812	B & G. Fairmount. 1854	B & G. Fairmount 1862	B & G. Flat Rock. 1862	B. & G Val Forge 1862	B & G. Reading 1862	B & G Sch. Hav'n 1862		B & G Kensingt'n 1862	B & G Tacony. 1862	Wurtz Trenton. 1855
Sulphate of Lime..... ..		2.409	2.564	2.618	2.604	3.099	3.211		0.653	0.503	0.186
do. Magnesia...						1 108	2.466				
do. Soda.....	0.560						0.490				
do. Alumina & Iron.....								3.201			
Sulphuric Acid								3.838			
Chloride of Sodium.....	0.153	0 307	0.229	0.213	0.213	0.213		0.097	0.163	0.114	0.119
Carbonate of Lime.....	2.190	0.736	0.716	0.016	0.159				0.498	1.030	1.300
do. Magnesia...	0.484	1.412	1.753	1.682	1.583	2.602			0 848	0.632	0.889
do. Soda.....	0.185	0.292	0 017	0.261	0 128	0.120			0.159	0.113	0.172
Ox. of Iron & Alumina	0.077	0.068	0.075								0.027
Silex & Insoluble Mat.	0.395	1.080	0.339	0.226	0.320	0.480	0.440		0.080	0.160	0.498
Organic Matter.....	0.036								1.267	1.027	0.635

REMARKS ON THE COMPOSITION OF THE SCHUYLKILL WATERS.

Since the substances given in Table I. are common to all river waters, we will select a few of the most important, either in their quantity or nature, which influence the question of the relative

fitness of the waters for city use, leaving the unimportant ingredients out of view, in order not to embarrass the question.

The following table embraces these selected ingredients of the Schuylkill waters, and are merely copied from columns 4 to 8 of Table I.

TABLE III.—SUBSTANCES AFFECTING THE SCHUYLKILL.

Names of Substances.	Fairmount.	Flat Rock.	Valley Forge.	Reading	Schuylkill Haven.
Lime, ...	1.457	1.087	1.161	1.276	1.322
Magnesia, ...	0.835	0.801	0.754	1.608	0.822
Sulphuric Acid, . .	1.508	1.540	1.532	2.562	9.888
Organic Matter, . .					

The quantity of organic matter in the gallon being so minute that we could not weigh it, we have indicated it as absent.

Upon examining Table III. we observe that organic matter is equally absent, and that the quantity of lime per gallon is sensibly the same, in all the Schuylkill waters examined. Magnesia is about the same in all of them, except that it is twice as great at Reading, giving rise to the formation of some sulphate of magnesia, (Epsom Salt,) and a quantity of carbonate of magnesia or other magnesian salt, as shown in Table II. This larger quantity is readily accounted for, when we bear in mind that Reading lies at the foot of a broad and highly magnesian limestone valley.

The most important variation in the Schuylkill waters lies in their content of sulphuric acid. From Fairmount up to Valley Forge the amount of it is the same, 1½ grains per gallon; at Reading it is increased to 2½ grains, and rises at Schuylkill Haven to nearly 10 grains per gallon. Table II. shows the influence of this large amount of acid at the last locality, in forming nearly 9⅜ grains per gallon of the sulphate of lime, magnesia, soda and alumina, and leaving, over and above these, nearly four grains of dry sulphuric acid, which is equivalent to more than 4½ grains of oil of vitriol per gallon. In fact, while the waters, from Reading downward, test alkaline, that at Schuylkill Haven is decidedly

and strongly acid. We learn that nearly all aqueous life is destroyed by the acid and acid salts in the waters, at a considerable distance below the coal mines.

We have elsewhere explained the origin of the sulphuric acid in the upper Schuylkill, as well as its diminution, and change of combination in its descent towards Philadelphia, in our Report on Fairmount Water, presented to the City Councils in 1854. We refer to that paper for our views on this point, which we now reaffirm.

We may mention in this connection, that the quantity of free acid is greater still further up the Schuylkill and its coal-bearing branches; and that this explains why iron boilers are liable to be cut out in the coal region. Of course such a water as that which analysis unveils to us at Schuylkill Haven is unfit for domestic use, and even for most manufacturing purposes.

We cannot forbear drawing your attention to one general result, which, we infer, must follow the presence of much free sulphuric acid in the waters issuing from coal-workings. Because such water tends to injure boilers and other iron work, general manufacturing can never be extensively carried on in the coal region, nor for some distance below it, until the free acid becomes neutralized in the river's descent, or until the coal beds are exhausted. Neutralization now takes place before reaching Reading, where the water is feebly alkaline. We therefore think ourselves warranted in the conclusion that general manufacturing on the Schuylkill will be limited, as long as anthracite is mined on its tributaries, to the space between Philadelphia and a short distance above Reading.

The larger proportion of sulphates of lime and magnesia at Reading, (see Table II.,) as compared with the waters below it, accounts for the more ready formation of boiler-scale deposit, or pan-stone, at that city than lower down. As yet, this offers no serious impediment to the use of the water in manufacturing; but should the proportion of these sulphates increase considerably in subsequent years, it is possible that general manufacturing might be driven lower down the river. We believe, however, that fair inferences from facts warrant the conclusion that no great increase will ever take place. These two causes, excess of acid, or sul-

phate of lime, resulting from the exploration of coal, tend to counterbalance the economical advantage of approximating manufactures to fuel.

Since there is only about a half grain more of solid matter per gallon in the water at Reading than in that lower down the river, and the whole is but 7½ grains per gallon, and since the composition of this slight increase may be called sulphate of magnesia, we cannot but conclude that the water at Reading is well enough adapted for domestic use, as well as for manufacturing industry, at the present time, and that it is likely to continue so.

A glance at Table III., or at the fuller analysis of Tables I. and II., exhibit the three waters at Valley Forge, Flat Rock and Fairmount, as not sensibly varying in the quantities of solid matter per gallon, nor in its composition. All three may be called equally good waters. The total quantity of solid matter per gallon, amounting only to seven (7) grains, makes the Schuylkill compare favorably with other waters of the world, applied to the use of large cities. In the nature of its ingredients we think it superior to most others. The quantities of lime, magnesia and sulphuric acid in solution, are only such as to produce a very slight curdling of soap—scarcely tending to produce pan-stone—producing no injurious medicinal effect that we have heard of; but their presence results in the positive benefit of forming a hard, white and insoluble coating on lead, so that lead-pipe may be employed to any extent in conveying the water, without the least apprehension of the latter becoming deleterious by taking up lead into solution. Add to this enumeration the important fact that it is almost wholly free from organic matter, one of the most objectionable constituents of water for domestic use, and we think our conclusion tenable, that the Schuylkill water, from Valley Forge to Fairmount, will prove superior to most waters of the world employed in large cities. To meet objections sometimes urged against the Schuylkill water, we point to the analyses, and conclude, that whatever real or alleged, manufacturing or other impurities, may be thrown into the river above Fairmount—dye-stuffs, animal remains, &c.—their presence is not indicated at Fairmount in appreciable quantities. All objections, therefore, to the Schuylkill water on this score, may be summarily dismissed as illusory and unsubstantiated.

REMARKS ON THE DELAWARE WATERS.

The following table contains the similarly selected ingredients of the Delaware waters, drawn from columns 8 to 10, of Table I.

TABLE IV.—SUBSTANCES AFFECTING THE DELAWARE.

Names of Substances.	Kensington.	Tacony.	Trenton.
Lime,.	0.548	0.784	0.881
Magnesia, ...	0.404	0.301	0.423
Sulphuric Acid, ...	0.384	0.296	0.109
Organic Matter, ...	1.267	1.027	0.635

A comparison of the Delaware waters from the three points indicated, reveals no important differences between them except in the organic matter. For, although there is half as much more lime at Trenton, and three times as much sulphuric acid at Kensington and Tacony, as at the other points respectively, yet the total amount of mineral matter is only three grains per gallon at Trenton, and 2 *a* 2½ grains at Tacony and Kensington. Moreover, the nature of the mineral matter exhibits nothing objectionable, as the waters are alkaline. In fact, in its mineral contents, the water of the Delaware river is not easily surpassed by any other river-water.

The most objectionable feature is the presence of organic matter, and that in no inconsiderable quantity. The half grain per gallon at Trenton becomes one grain at Tacony, and is 20 per cent. more at Kensington than at Tacony. One objection to water for city use, and containing organic matter, is its liability to putrefaction. We are informed that the Delaware water will putrify on a sea voyage, after which it becomes sweeter, by the organic matter being partly destroyed and partly settling, and it is further affirmed that on the longer voyages of Government vessels it will putrify twice or thrice, and will then remain sweet for an indefinite period of time. Probably all the organic matter has disappeared from solution by several putrefactions. But however the Delaware water may be valued for voyages, because it purifies itself by putrefaction, it is clearly not a reason why it should be preferred for

immediate domestic use. Citizens would not be disposed to manufacture sweet drinking water by a process of putrefaction.

Delaware water is admirably adapted to manufacturing purposes, being very soft, alkaline, and containing very little mineral matter; but for domestic use a water is preferable more free from organic matter than even that at Trenton. Much more objectionable, in this respect, is the water at Tacony, and still more so that at Kensington.

When we consider the probability, we may say the certainty, that the streams entering the Delaware below Trenton could not give rise to so large an increase of organic matter, we are forced to the conclusion that the excess is almost wholly due to the waste waters of Philadelphia. In asserting this, we do not forget that some organic matter is due to the streams flowing from the upper swampy levels of New Jersey. We think we are warranted in concluding that the Delaware would have to be tapped many miles above Philadelphia, even above Tacony, above the influence of the Tidal current, before we could procure a water for domestic use equal to that at Trenton.

COMPARISON OF THE DELAWARE AND SCHUYLKILL WATERS.

After what has been said, it might seem superfluous to compare the Delaware and Schuylkill waters; nevertheless, it may prove interesting to view them side by side. To do this, we will take the purer water near the city, that at Tacony, and the average of the three Schuylkill waters, (Fairmount, Flat Rock and Valley Forge,) and contrast the total mineral and organic matters in each, as these two classes of substances exert different influences on water for domestic or manufacturing employment.

TABLE V.—COMPARISON OF DELAWARE AND SCHUYLKILL WATERS.

Substances in Solution.	Delaware.	Schuylkill.
Mineral Matter, (grs. per gallon,)	2⅛	7
Organic " " " "	1	none
Total, ...	3⅛	7

Because the Schuylkill has more than three times as much mineral matter, and more than twice as much solid matter per gallon as the Delaware, the latter is better adapted to manufactures generally. Because the Delaware has one grain of organic matter per gallon, and the former none, the Schuylkill is preferable for domestic use. Since, however, the absolute quantity of solid matter in the Schuylkill is moderate, compared to that in waters supplied to cities generally, and its composition is such as to exert no appreciable detriment to manufacturing, and since the Delaware is positively more objectionable for domestic use, we unhesitatingly give the preference to Schuylkill water for the varied uses of Philadelphia.

FUTURE PROSPECTS OF WATER SUPPLY.

While the considerations drawn from our analyses lead to a preference of the Schuylkill at the present time, we should be wanting in prudence if we should not endeavor to lift the veil from the future, and pry into the possible condition of the two rivers at some remoter period of time. The following table of selected ingredients, drawn from columns 1, 2 and 3, of Table I. shows us the past history of the Schuylkill at Fairmount:

TABLE VI.—CHEMICAL HISTORY OF THE SCHUYLKILL.

Names of Substances.	Fairmount Water.		
	In 1842.	In 1854.	In 1862.
Lime, ...	1.226	1.404	1.457
Magnesia, ...	0.230	0.696	0.835
Sulphuric Acid, ...	0.302	1.417	1.508

Since the increase of lime and magnesia during the two periods indicated is mainly due to the increased quantity of sulphuric acid, we must devote a few moments consideration to this acid. Between 1842 and 1854, (12 years,) sulphuric acid became nearly five times as great, or, more precisely, it increased at the rate of 30¾ per cent. per annum, while in the eight following years, (1854

to 1862,) it only increased by a $\frac{1}{14}$, or at the rate of $\frac{1}{4}$ of one per cent. per annum. The increase on the first twelve years was singularly and alarmingly in direct proportion to the coal trade, but in the last eight years it fell greatly short of this ratio. Nevertheless, as the increase of sulphuric acid is due to the extension of coal-mining in the Schuylkill region, we will inquire into the prospects of a further extension of the same.

Coal-mining expanded rapidly up to the year 1856, by a large annual increase, chiefly on the tributaries of the Schuylkill; but as the coal beds above water-level became exhausted, and lower mining levels were successively reached, the increased expense of mining began to counterbalance the cost of transportation from the more distant second coal-field, the Mahanoy region, where large beds of anthracite lie nearer the surface. Hence the increase in the coal trade down the Schuylkill river became largely indebted to coal mined on the tributaries of the Susquehanna. The following estimates, closely approximating to truth, exhibit the ratio of coal mined on the Schuylkill to the coal trade of the river in the years 1855 and 1862, expressed in tons:

	In 1855.	In 1862.
Mined on the Schuylkill,	3,196,000	2,000,000
Mined in the second coal-field,	122,000	700,000
Mined elsewhere, but not on the Schuylkill, - - - - -		200,000
Schuylkill coal trade,	3,318,000	2,900,000

While the trade is about the same in 1855 and 1862, nearly one-third of the amount in 1862 was not mined on Schuylkill waters. The amount mined in 1854 was about 2,900,000, in which year we have an analysis of the water. These facts singularly confirm the analysis of Table VI., and sufficiently account for the rapid increase of sulphuric acid in the first period, (1842 to 1854,) and for its almost stationary quantity in the second period, (1854 to 1862.)

Since the expense of mining must increase with the increasing depth of the workings, it may be reasonably inferred that the quantity of coal raised in the vallies of the Schuylkill will not be materially increased for a considerable period of time, nor, in-

deed, ever, by the present methods of working, through inability to compete with the less expensive mining near the surface in the second coal-field. So long, therefore, we need not fear an increase, but may expect a decrease of sulphuric acid in the Schuylkill.

By the introduction of a mining system with heavy capital and machinery, the present stationary, or rather decreasing, amount of mining on the Schuylkill, will undoubtedly increase, because the expense of extraction per ton will be diminished; but when this method of operating will commence, and how great its expansion may be, we have no data for determining. When, however, it does take place, we have every reason to look for an increase of sulphuric acid in Schuylkill water, and somewhat in proportion to the expansion of the mining operations. We might venture a step further, and inquire how long such augmented mining is likely to continue after it has commenced? From the calculated amount of coal remaining in the Schuylkill basin, we may estimate that a much larger annual amount than the present can be mined for a period of one hundred years, more or less. During such a period, therefore, the quantity of sulphuric acid in the Schuylkill will be proportionately greater, unless means are contrived and adopted to diminish the formation of the acid.

To silence objections to the erection of costly Water Works on the Schuylkill, lest the water should subsequently deteriorate or become too hard for general use, we propose to show that it is in our power, under any circumstances of increased mining, to prevent much augmentation, perhaps even to diminish the present unobjectionable quantity of sulphuric acid in the Schuylkill.

We have shown, in our Report to Councils in 1854, that the source of augmenting sulphuric acid in the Schuylkill, is Iron Pyrites, a mineral consisting of sulphur and iron, and which, by continued exposure to the air, is more or less oxidized into sulphuric acid and oxide of iron. These substances, dissolved in rain or mining water, find their way to the river, and in their descent down the Schuylkill valley part company, the oxide of iron being precipitated, and lime and magnesia being taken up in its place. This fact is shown upon an examination of Table II., where the large amount of acid in the water at Schuylkill Haven, both as sulphate of iron

and alumina and as free sulphuric acid, are converted into the sulphates of lime and magnesia in the waters below that point, so that the quantity of sulphate of lime per gallon remains nearly the same through the whole length of the river, in spite of dilution by numerous affluents. In every known carboniferous formation pyrites exists in the coal and its accompanying slates, varying in size from visible masses, often of many pounds weight, to minute particles disseminated throughout. To the latter is due the peculiar sulphurous odor of burning anthracite. The larger masses are more or less removed by hand in the mining region, and thrown on the heaps of rubbish.

By offering an inducing price, say twice the value of coal per ton, is it not likely that the multitude of children in the coal region would gather a thousand tons of pyrites in the year?* As the cost of transportation would scarcely be greater than that of coal, the annual expense of delivering a thousand tons of pyrites at tide-water could be readily determined, even if it admitted of no useful application. But, because the one-half of iron pyrites is sulphur, it might be made available in the manufacture of oil of vitriol, for which it has been employed, and is now used to a moderate extent in England and on the Continent of Europe. It has also been used, at times, as a source of sulphur itself, for the manufacture of gunpowder, and we have heard that it is now employed for this purpose in our Southern States. We are aware that it is not as desirable as volcanic sulphur in the manufacture of oil of vitriol; nevertheless, if offered for sale at a low rate, perhaps some manufacturers might be induced to employ it. At all events, the price paid for it, for whatever application, would proportionately lessen the cost of its collection and removal to tide-water. In fine, whether employed on tide-water to fill up cavities, or burned to destroy its sulphur as a waste product, or burned to make oil of vitriol, or sublimed to extract sulphur, a very large amount of pyrites could be removed from the coal region at a moderate annual expense, and much sulphuric acid prevented from entering the waters of the Schuylkill.

We have thus shown that mining on the Schuylkill and its

*We have no positive data for this amount, but have based the number of tons probable on per centage estimates derived from coal operators.

tributaries will probably be stationary or diminish for some time to come, attended by a proportionate diminution or uniformity in the content of sulphuric acid in the water—that it will subsequently increase beyond the present mining yield, with a corresponding augmentation of the acid in the water—and that such increase may continue for a century—but we have also shown that we can moderate or lessen the augmentation during that period. After the coal shall have been measurably exhausted on the Schuylkill waters, their content of sulphuric acid will gradually return towards the small amount which it must have originally been prior to the development of anthracite.

We have dwelt at length on sulphuric acid in Schuylkill water, because it appears to us the most important question in relation to future supply. To avoid misunderstanding, let us again note, that it does not reach Philadelphia in the form of sulphuric acid; that it is already neutralized at Reading, and may be called the sulphates of lime and magnesia, and that the neutral water of Reading becomes decidedly alkaline before it reaches Valley Forge, and maintains a uniform composition from that point to Fairmount. The same causes of neutralization and alkalinity will undoubtedly continue to operate, whatever may be the extension of coal mining in the Schuylkill valleys. An increase in the content of sulphuric acid on the Upper Schuylkill will only result in an increase of sulphate of lime at Philadelphia.

A similar glance at the Delaware would be interesting, but unfortunately we know of no historical record of the composition of this river near Philadelphia. However, since we may affirm that it is rendered certain that the objectionable organic matter in the Delaware is largely due to the waste waters of the City, and since we have the chemical history of other river waters near large cities for comparison, it is a well warranted conclusion, that the Delaware water will deteriorate still further with increasing population, and precisely in the direction of the most obnoxious ingredient for domestic use, organic matter.

Our general conclusion, from a review of the whole subject, is, that the Schuylkill is preferable to the Delaware water, at the present time, for the varied uses of Philadelphia, the united objects of domestic use and manufactures; that it is preferable to

the latter from the city to a distance of many miles above it on each river, and that it will continue to maintain its superiority for a lengthened period of time. We further conclude, that to obtain a water sufficiently good for domestic use, the Delaware would have to be tapped many miles above Tacony, beyond the influence of the tidal current, while the water of the Schuylkill is equally fit for all city uses, from Fairmount up to Valley Forge.

Lastly, we conclude that no practical system of sewerage could be adopted on the Delaware side of the City, to convey its refuse waters further down than the mouth of the Schuylkill, whence the upward tidal current would carry it for many miles above the city, and thus far contaminate the river, rendering the water unfit for domestic use, while a very simple and inexpensive system of sewerage on the Schuylkill can convey all the refuse waters of the Schuylkill slopes into the river below the dam at Fairmount. Such a system of sewerage on the Schuylkill would forever silence the most fastidious objector, if it could be extended for some distance up the river.

Very respectfully,

Your ob't serv'ts,

BOOTH & GARRETT.

Philadelphia, January 19, 1863.

REVENUE OF THE DEPARTMENT.

Accompanying will be found the Report of Mr. CHARLES L. WOLFF, Register, in which is laid before your honorable bodies a full and comprehensive statement of all the operations in that branch of this Department.

Very respectfully,

ISAAC S. CASSIN,

Chief Engineer of Water Department.

REGISTER'S STATEMENT.

DEPARTMENT FOR SUPPLYING THE CITY WITH WATER,
REGISTER'S OFFICE, JANUARY 23, 1863.

ISAAC S. CASSIN, ESQ.,
Chief Engineer of Water Department.

DEAR SIR:—The Tabular Statement enclosed will present to you in detail a full report of the financial operations of the office for the year 1862.

From January 1st to March 24th, inclusive, embraces the term of office of my predecessor, W. J. P. WHITE, Esq., and is made up from the weekly statements filed in the office of the City Controller.

The exhibit is entirely satisfactory, notwithstanding the very many reductions I was compelled to make on account of the almost entire stoppage of a large number of manufacturing establishments. The receipts for water rents show an increase of $16,284, the whole receipts for water rents in 1861 being $485,625 70,and in 1862, $501,909 70.

The amount due for iron pipe, still outstanding, is $12,968 81, exclusive of the amount of $24,200 28 sent to City Solicitor for lien during the year.

I desire to call your earnest attention to the condition of this office. On account of the hope of a removal held out

to every Register since consolidation, the place has been allowed to become very much dilapidated. A visit to it in the busy season (extending over some seven months of the year) will convince any one of its utter incapacity for the business transacted in it. It is to be hoped that, with the vacation of that portion of the building of the Philosophical Society occupied by the United States Courts, that that or some other suitable place will be procured without delay.

Yours, very respectfully,

CHAS. L. WOLFF,
Register.

STATEMENT OF RECEIPTS AT THE REGISTER'S OFFICE, FROM JANUARY 1st TO DECEMBER 31st, 1862.

Months. 1862.	Rents of 1858.	Penalties of 1858.	Rents of 1859.	Penalties of 1859.	Rents of 1860.	Penalties of 1860.	Rents of 1861.	Penalties of 1861.	Rents of 1862.	Penalties of 1862.	Fractional Rents.	Iron Pipes.	Total.
January,.....	.....	.....	.....	.....	$78 50	$5 70	$2,855 75	$337 75	$18,578 00	.....	$495 15	$6,305 94	$28,656 79
February,....	.....	.....	29 00	3 60	168 25	17 10	1,214 00	115 97	50.401 75	.....	486 06	1,978 37	54,414 10
March,.....	.....	.....	8 00	1 20	218 00	32 70	1.299 25	25 80	169,932 49	.....	1,036 21	664 01	173,217 66
April,.....	.....	.....	.....	.....	.....	.....	1,083 25	121 59	170,316 50	.....	1,673 15	1,626 15	174,820 64
May, ...	.....	.....	.....	.....	26 50	75	624 00	76 69	12,127 75	531 58	1,744 35	1,104 12	16,236 01
June,.....	.....	.....	.....	.....	.....	.....	538 25	74 14	24,232 60	1,130 48	1.182 17	980 06	28,137 70
July, ...	.....	.....	.....	.....	.....	.....	410 84	52 26	2,533 50	332 65	1,312 09	2,496 42	7.137 70
August,.....	.....	.....	.....	.....	5 00	75	266 00	35 41	8,140 50	1,104 23	948 94	2,441 11	12,941 94
September,...	.....	.....	21 25	.....	58 50	6 15	526 54	61 43	12,040 00	1,639 81	771 56	1,595 36	16.720 60
October,.....	.....	.....	3 75	56	15 25	56	506 75	61 73	7,764 75	1,012 82	1,105 75	2.816 37	13.288 29
November, ...	12 00	1 80	16 25	.....	44 25	2 55	367 75	32 06	3.847 50	504 69	856 84	2.910 02	8,595 71
December, ...	.....	.....	11 75	56	21 75	2 06	321 25	40 05	3,567 05	308 23	3 080 97	3,246 38	10,600 05
	$12 00	$1 80	$90 00	$5 92	$636 00	$68 32	$10,013 62	$1,034 88	$483 482 39	$6,564 76	$14,693 24	$28.164 31	$544,767 25

APPENDIX.

RESOLUTION

RELATIVE TO THE KENSINGTON WATER WORKS.

Resolved, By the Select and Common Councils of the City of Philadelphia, That the Chief Engineer of the Water Works be, and he is hereby authorized to stop the pumping of water at the Delaware Works, and to supply the district now furnished with water by those works, with water from the Schuylkill or Spring Garden Works, until a thorough examination of the character of the Delaware water can be made, and a permanent remedy for the existing evil adopted.

DEPARTMENT FOR SUPPLYING THE CITY WITH WATER,
PHILADELPHIA, APRIL 24, 1862.

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

GENTLEMEN:—In compliance with a resolution adopted by your honorable bodies, and approved March 15th, 1862, I beg leave to state, that the district usually supplied with water by the Kensington Water Works, has been supplied temporarily from the Spring Garden Works, and that the reservoirs of the former have been emptied and cleaned in the meantime. In the performance of this duty, I have found an accumulation of soft mud in the bottom of the reservoirs, undoubtedly derived from the river Delaware, and which appears to have been deposited at the rate of nearly one inch per month.

The Kensington reservoirs have been thoroughly cleansed, and the induction passage from the river to the pumps, which consists of a wooden trunk or box, has been repaired so as to make it certain that water will be taken hereafter from the end of the wharf. This trunk has for some time past been in such bad repair, that the water has been taken mainly from the sluiceways of the docks, and has contained, consequently, more or less impurity.

I beg leave to say in this connection, that although this altera-

tion, and some care in future, may prove a partial remedy, I regard it as certain that the supplying of pure, or in any considerable degree suitable water for domestic purposes from the river Delaware, at the location of the Kensington Water Works, is impossible.

The sewers opening into the river Delaware discharge their contents at the rate of an average of about thirteen millions of gallons daily, which large quantity is greater during summer, and necessarily includes every description of impure and refuse matter from the city, and this impurity is undoubtedly increased of late years by the prevalent and growing plans of constructing and connecting with the sewers, water closets in the large hotels and in private dwellings. It is by no means safe to assume that the water in the channel of the Delaware is beyond the reach of the deterioration which results from the cause here alluded to, and the action of the tides very probably carries a large portion of the impurities from the sewers much beyond the present location of the Kensington Works, and before there can be any complete subsidence or deposit in the bottom of the river. Other less important causes—the movements of steamboats and the general traffic on the river, for instance—also co-operate with the tides to keep in suspension, for a time, the contents of the sewers thus thrown into the river.

At the Kensington Works the water is further deteriorated by the emptying of Gunner's Run into the Delaware, which takes place at less than fifty yards above their location, and by the fact that the docks in their immediate vicinity have been for some years much used for the preparation of catfish and other fishes for the markets of the city.

I beg leave to state that there are demonstrable, in my opinion, ample causes for the unsuitable quality of the water supplied by these works, and which also, in my opinion, render impracticable and inexpedient any plan for obtaining water from the river Delaware. One plan, which is the extension of the main induction passage into the channel of the river, I regard as too doubtful to be worthy of the expense of the experiment, and another, which is to remove the works to a point above the city, is not only very

doubtful in point of success, but would be much more expensive than an obvious remedy, which I beg leave to suggest.

The district now supplied from the Delaware can readily be supplied from the Schuylkill (and the supply of water from the Schuylkill throughout the city can be readily equalized when the new additions to the Fairmount Works are completed, and with an additional engine at Spring Garden Works). For this purpose it would be necessary to elevate the reservoir at the Kensington Works to the same height as the reservoir at Corinthian avenue and Spring Garden Works, and to connect the former with the two latter by a main of forty inches diameter to Tenth street, thence by a thirty inch main to Kensington reservoir. This would give an additional capacity to the Kensington reservoir of eight millions of gallons, and the greater height would much increase its capacity of distribution over an area now but partially supplied in its higher localities and in its more distant parts, for instance, in the late borough of Frankford, in which the supply is deficient.

The proposed elevation of the Kensington reservoir, and the connection suggested, would also insure a supply of water to an extensive district which it is now impossible to supply from any of the works, and would thus tend materially to the general improvement of that portion of the city.

It is proposed to connect the Spring Garden reservoir and that at Corinthian avenue by a forty-eight inch main, with the necessary branches, to which may connect a forty-eight inch main from Spring Garden Works, and also a main of forty-eight inches from Fairmount Works; then connect the Spring Garden and Kensington reservoirs by a main as before suggested.

This main would be of sufficient capacity to fully supply the Kensington reservoir, with the additional elevation above suggested, and to allow all the distributing mains on the high parts of the district included between the Spring Garden reservoir and Tenth street to be attached, thus giving a reliable supply to the higher portions of the Fifteenth and Twentieth Wards, which are now deficient, and frequently almost without any supply of water whatever.

The proposed connections would effectually remedy the evil of a short supply by bringing an ample storage into the immediate

vicinity of the demand. By opening the connections between the Kensington district and the lower portion of the district now supplied from Spring Garden reservoir, the great draught from the higher parts of the latter district would be prevented; and the Kensington district, from its increased head, and an additional distributing main, would still have a better supply than at present.

The water supplied from the Kensington reservoir would, under the arrangement and connection, be the purest of any in the city, on account of its increased depth, and the Spring Garden and Corinthian avenue reservoirs acting as subsiding reservoirs. At present, the Kensington Works supply the Seventeenth, Eighteenth, Nineteenth, and parts of the Sixteenth, Twenty-third and Twenty-fifth Wards.

The greatest demand on the works is during the months of July and August, at a season when there is a possibility of low water in the Schuylkill, and the consequent inability of the Fairmount and Spring Garden Works to make up the additional demand which would arise from the connection of the Kensington district; should any serious accident occur in the machinery at the Spring Garden Works, further inability would necessarily arise.

I would therefore recommend the erection of an additional Cornish engine at these works, capable of pumping ten millions of gallons per day, with a forty-eight inch ascending main to the reservoir, and which would be sufficient to meet all emergencies.

For the purpose of supplying water to all parts of the city from Fairmount and Spring Garden Works, I would recommend also the laying of a main forty-eight inches in diameter from Fairmount Works to Corinthian avenue reservoir, which would enable these works to pump directly into the three reservoirs to which I have above referred. This arrangement would render the new works now in progress and nearly completed at Fairmount, completely available, and during nearly the whole year these new works could be exclusively devoted to contributing to the supply now derived from the Spring Garden, Corinthian avenue and Kensington reservoirs, and only in cases of extreme draught or

accident at the Fairmount Works, would the proposed additional power at the Spring Garden Works be called into requisition.

The proposed main between the Spring Garden and Kensington reservoirs would contain 811,091 gallons, and would be a valuable addition to the storage capacity of the higher localities with which it would be connected.

The capacities of the several reservoirs here alluded to are as follows:

The Corinthian avenue reservoir,	37,500,000	gallons.
The Spring Garden "	9,800,000	"
The Kensington "	9,400,000	"
Total, ...	56,700,000	gallons.

The demand on the Corinthian avenue reservoir is about three and a half millions of gallons per day, and it has therefore a capacity of ten and three-quarter days' supply.

The demand on the Spring Garden reservoir is about seven millions of gallons daily, and its capacity is therefore not quite one and a half day's supply.

The demand on the Kensington reservoir is about two and a half millions of gallons daily, and its capacity less than four days' supply.

The suggested elevation of the Kensington reservoir added to the preceding, would make a total storage capacity of the three reservoirs of 65,000,000 gallons, and the total daily demand on them is 13,000,000 gallons, or their united capacity would be five days' supply, by connecting them as I have herein suggested.

This connection would insure five days' supply to the whole of the Eleventh, Twelfth, Thirteenth, Fourteenth, Fifteenth, Sixteenth, Seventeenth, Eighteenth, Nineteenth and Twentieth Wards, and to parts of the Twenty-first, Twenty-second, Twenty-third and Twenty-fifth Wards, in portions of which at present there is not more than a supply for half this time, and in some localities, a supply for only a few hours.

The connection of the three reservoirs here alluded to would not only give a better supply, but would so equalize the storage capacity, that localities now having only a few hours' supply

would be increased to five days, and some portions of the district supplied from the Fairmount Works could be added so as to entirely equalize the supply to the whole city. Such an arrangement would somewhat increase the supply in the district watered by the Fairmount Works, and the increase and consequent advantage to the districts supplied by the Kensington and Spring Garden Works are sufficiently obvious.

The arrangement suggested would be a permanent remedy, and would certainly, as above stated, so greatly increase the capacity of the Kensington reservoir, as to include a large area now impossible to supply, and would undoubtedly create an additional demand for water from property owners, and incidentally increase its value, and greatly encourage improvement and enterprize.

In the first year after the laying of the thirty inch main which supplies the first four wards of the city, and the consequent greater capability of supply, the increased receipts were about twenty per cent. of its cost, and there has been a constant annual increase.

The total quantity of water supplied by the Kensington Works in 1861, was . .	983,805,740 gallons.
Or a daily average of	2,695,358 "
The total cost of supplying the above . .	$22,470 12
To supply the same quantity from Spring Garden Works would cost	11,884 37
And the same quantity supplied from the Fairmount Works would cost	11,126 84

These sums include the interest on the cost of the works, and exclusive of such interest, the cost of supply would be as follows:

From Kensington, ...	$13,468 30
Spring Garden, ...	8,382 00
Fairmount, ...	1,632 00

The value of the property owned by the City, now occupied by and including the Kensington Works, is about $60,000, and in

the event of adopting the proposed recommendation, their use as a water works would be abandoned.

The present pumping main, which would cost about $50,000 to lay, could be advantageously used as an additional distributing main, already much needed, and even now almost indispensable in supplying fully the higher parts of the district, and would leave the present distributing main to connect directly with the lower portions of the Kensington and Spring Garden districts.

The district supplied by the Kensington Works contains a population of about 110,000, and pay water rents amounting to $88,000.

The first four wards of the city, which are supplied from the Corinthian avenue reservoir, contain a population of about 100,000, and pay water rents amounting to $93,000.

In these two cases the smaller population pays the larger amount of water rents.

The increased demand in the Kensington district in 1861 over that of 1856 is little more than 590,000 gallons per day, while in the district supplied from Fairmount Works, during the same period of five years, the increase is about 2,500,000 gallons daily.

In the Spring Garden district, the increased demand in the same period is about 1,500,000 gallons per day; and in the Twenty-fourth Ward, where the facilities for obtaining a supply are not reliable, and are inferior to those of the Kensington Works, the daily increase in a period of five years is over 800,000 gallons. These facts are given for the purpose of showing that causes exist rendering the demand for water supplied by the Kensington Works comparatively more restricted than the demand from any other of the water works of the city.

The proposed arrangement would very probably much increase the value of property in the entire district now supplied from the Kensington Works, and also in the more limited districts above referred to in the Fifteenth and Twentieth Wards, and would tend directly to the development of general improvement in those parts of the city.

The greatly increased ability to supply, by means of the proposed connections, and the additional area which would result from raising the Kensington reservoir, would undoubtedly create

a very largely increased demand for consumption, and this ability to supply may very properly be kept in advance of private enterprize.

In compliance with your resolution, the Kensington district was supplied with water from the Spring Garden Works for thirty-four days, during which time no complaint of the quality of the water, nor relating to the health of the district, reached this Department, nor has there been, to my knowledge, any further action of the Board of Health, nor of the citizens of the district.

Very respectfully,

ISAAC S. CASSIN,

Chief Engineer of Water Department.