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 20,

1868.

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1868.

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1867.

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JOHN CLOUD.

ANNUAL REPORT

OF THE

Chief Engineer of the Water Department,

FOR THE YEAR 1867.

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

GENTLEMEN:—In compliance with the usual custom, the following report upon the condition of the works, and the business operations of the Department of Water for the past year, is presented.

Upon assuming the duties of Chief Engineer in March last, that all important structure, the dam, was the first object to which attention was turned; but on account of the high stage of the water at the time, and the extraordinarily wet season, a complete examination of it could not be made until late in the summer; it was then found that considerable stone had escaped from several places, causing settlement in the timber work, and subjecting it to the possibility of damage should heavy freshets occur. These points have had the attention their importance demanded, and have been refilled with stone.

The original dam was built in the deep water, by sinking cribs as high as low tide, upon which the balance of the structure was placed; the stone doubtless worked out of them in consequence of the decay of the timber previously to the sinking of new cribs in 1866. The latter are sunk immediately in front of the dam in the deep water, and very materially add to the safety of the structure. They are decked with oak timber and appear to have withstood the effects of last winter (the first since they were sunk) remarkably well; they were not subjected to the action of very compact ice, or the destructive effects of falling timber, which frequently

comes over during heavy freshets, from which cause the deck upon the cribs is much exposed to damage at low tide.

The dam generally appears to be in fair condition; as far as can be seen, the only part showing symptoms of decay, is the front top log; this is considered safe for the present, but will require close attention next year. It will be difficult and very expensive to renew this log, as it will require the displacement and renewal of two thicknesses of ten-inch oak decking, with the pavement and earth backing now upon it.

The first dam was completely rotten above high tide, declared unsafe, and rebuilt at the end of the twenty-third year after its erection. The present structure has been in use, the western half for twenty-four, and the eastern half for twenty-five years last September; therefore, judging from that experience, it is but reasonable to assume that the present one has reached nearly the termination of its usefulness; the difference in its favor being, that the timber used in its construction was of much better quality than that of the old one, and the work was much better done.

If hereafter it shall be decided to build another dam of timber, it can be erected immediately in front of the present one, if the cribs sunk in front of it—already referred to—should prove, upon examination, to be sufficiently strong for the purpose. The manner in which they will stand another winter will go far to test their sufficiency or the reverse. The dam is so important to all the works situated on the Schuylkill, that it demands, and will have most vigilant attention.

All the pumps driven by the breast-wheels (with the exception of No. 1) were found to be more or less dilapidated, and the wheels, breastings, floors, flooms and head-gates all in very bad condition, requiring constant repairs to make them sufficient for the demands upon them. Permanent repairs have not been made for several years, doubtless for the reason that the substitution of turbine-wheels and new pumps was contemplated.

In 1851 I introduced the first turbine-wheel No. 9, with a view to the trial of that kind of motor for driving our heavy reciprocating machinery, and to the subsequent abandonment of the breast-wheels, if the test should be found satisfactory. The wheel has proved even better than was anticipated; it has run almost constantly since its erection,

with comparatively trifling repairs, and has pointed out the means of increasing the water-power at Fairmount far beyond what was originally thought of.

The introduction of Wheels Nos. 10, 11, 12 upon the same plan has since confirmed the wisdom of the selection, and the advantages, as well as the adaptability of the "Jonval Turbine" for our purpose and situation have been so conclusively shown, that it is obviously the proper course to substitute as rapidly as possible wheels of that character in place of the present breast-wheels.

Representation of the condition of the machinery and the advantages to be derived from the adoption of turbine-wheels, made to your honorable bodies in my report of June 20, 1867, met with immediate response, and the appropriation for the purpose of removing two of the breast-wheels and pumps and substituting a turbine for them, was granted. Unfortunately the work could not be commenced until October, when the excessive demand for water usually abates. It would not have been possible to have kept up the supply during hot weather without the aid of those two wheels; consequently the work will have to be prosecuted during the winter and early spring, to great disadvantage and increased expense.

The substitution should have been commenced several years ago, before the limit of the power was so nearly reached. This remark applies equally to all the steam-works; they have been allowed to "run down" so much that it is almost impossible to substitute new and improved apparatus for the defective and much worn machines in use; therefore, improvement can only be made by additions which may entail the erection of new engine and boiler-houses; whilst if the work had been undertaken sooner, a mere substitution of a new and larger, for an old and defective machine in the same building, could have been effected.

The valve-chest of every pump in the old mill-house (except No. 1) have been cracked and patched, and are liable to fail at any moment. A new casting, which can be made to fit any of the pumps, has been prepared to meet this emergency when it occurs.

It is only proposed to make such repairs as will enable the old wheels and pumps to work until turbines can be substituted; it is not possible at present to take out more than the

two, which are now being removed. It is confidently hoped that appropriations will be made during the year 1868 to enable the removal of two more of the breast-wheels during the ensuing autumn.

The turbine and pumps now building will be larger than any yet used; the wheel (ten feet three inches in diameter) will drive two pumps twenty-two inches diameter and six feet stroke, capable of raising at least 5,000,000 gallons per day more than the wheels and pumps Nos. 2 and 3, just removed.

The mill-house will require remodeling to adapt it to the new wheel and pumps; in general design it will not be materially altered, but the river front will be extended seven feet further west, and be built of cut stone; the present pitch roof will be removed in order to substitute a flat terrace.

The new wheel will be used for Fairmount reservoirs exclusively, and will pump its supply into them through a main of thirty-six inches diameter, which will be suspended nine feet above the level of the water in the dam, forming its own bridge across the forebay.

Head-gate to No. 9, constructed in 1843, is much decayed, and unsafe under heavy freshets; it is proposed to take this out during the summer and replace it by one of cast-iron, a sum being included in the yearly appropriation for the purpose. The wheel and pump are in good order, requiring but trifling repairs.

Wheels and pumps Nos. 10, 11, 12 are in excellent order, with the exception of the bevel mortice wheel of No. 11, which has been broken for eighteen months or more, but may, by careful attention, be useful for several months yet. A new wheel has been provided and cogged, ready to take the place of the defective one whenever it fails.

The bridges upon which the counter-shafts are placed have always been weak; they will be braced and strengthened by castings which are now being prepared for the purpose.

The old head-gates to the forebay are so much decayed that it is impossible to shut them sufficiently tight to drain the forebay, which is desirable in case of any accident to the pumping mains, which now cross upon the bottom of the race. Timber is prepared, and a new set will be put in as early as possible.

The reservoirs attached to these works are now in excellent order, with the exception of parts of the lining of No. 1,

which was the first built at Fairmount for the use of the steam-power works finished in 1812; it was subsequently (1818) raised by a wharf of timber, which, with its lining of plank, is now completely rotten, and should be renewed.

The stone walls having been originally built but nine feet high, are only sufficiently thick to make them safe at that height, it will therefore not be expedient to raise them now with stone. The reservoir is the centre one, and will be made quite safe by the renewal of the timber lining.

The walls, and flag-stone lining above them, of all the reservoirs, were thoroughly repaired in April last, and are in good order.

The division banks above the walls between the reservoirs, made necessary originally by the fact that they were built at considerable intervals of time, as the increased demands of the City required, are no longer of use for the purpose for which they were built. The propriety of removing them as low as the walls, and thereby gaining considerable water space (very desirable with our present limited storage capacity,) will be considered hereafter.

During the excessive rains of the past summer, several slides of the sodding and earth of the sloped banks of the reservoirs took place, caused, in a measure, by depression of the outside edge of the gravel roads on top of the bank, which threw the drainage in the wrong direction. This has been corrected, and the road raised so as to throw the water into the reservoirs, as it was originally constructed.

Corinthian avenue reservoir, supplied by turbines Nos. 10, 11 and 12, has required considerable attention. The forty-eight inch main from the pumps, when laid, was carried up the south-west corner of the bank, at a very great angle, to the top, and the water from it carried across the embankment in a brick sluice, was discharged by an overfall nine feet wide directly upon the brick lining of the reservoir, without any protection whatever. In consequence, the internal lining was undermined and slipped into the reservoir.

This occurred at a most unfortunate time, when the floods of last summer had stopped all the works and reduced the storage in the reservoirs to a minimum. Immediate repairs were commenced and continued, night and day, until completed. The surface lining has been protected by a heavy timber frame, filled in solid with brick on edge, laid in cement,

extending from the bottom of the reservoir to the overfall from the main. The original arrangement of this overfall was defective, and the accident which occurred had been anticipated by me, and closely watched from the first. Fortunately the slip occurred early in the day, and the water in the reservoir was very low. Had it happened at night, with a full reservoir, the work would have been in jeopardy.

Just before this accident, the bank over the main, on the outside, from its almost vertical position, caved and slipped into the street. It became necessary to construct a substantial retaining wall, which, with the protection on the inside of the reservoir, it is believed, will make this work perfectly safe.

The wharf at the foot of Coates street, at Fairmount, is much rotted, and must be rebuilt from low tide up. It now extends into the river on the north side of the entrance of the race to the wheels, only so far as to be on a line with the pier upon the end of the dam. In consequence, some drainage from the grounds above finds its way into the forebay. In rebuilding the wharf, it is proposed to carry it out some thirty or forty feet further west, whereby the drainage above named will be deflected over the dam and carried down the river.

The Park Commission propose to build a stone wall, in a semi-circular form, from the end of this wharf (when so extended,) to the front of the Park at the first club boat-house, and to dredge out the flats in front of it. Such an improvement will much benefit Fairmount, and should meet with the hearty co-operation of Councils.

The grounds at Fairmount are in satisfactory condition. The pavement upon the Callowhill street side of the works, from Biddle street to the garden gate has been much widened and re-paved, effecting a decided improvement of this entrance to the works.

To give more perfect control over Corinthian avenue reservoir, one of my first cares was to connect the thirty-inch main at Poplar and Twenty-second streets with the thirty-inch pumping main which terminated at the centre of the reservoir on Twenty-second street. This enables us to pump directly into the old Spring Garden (Schuylkill) reservoir from Fairmount, which could not be done before, except by first pumping into Corinthian avenue reservoir, a serious inconvenience,

as when the latter reservoir was shut off for repairs, Schuylkill reservoir could not be supplied from Fairmount. The connection proved of vital importance during the summer, as will be hereafter mentioned.

Another connection will be made from the same pumping main to the thirty-inch main now supplying the lower wards of the City, by which means we can pump directly through that main without passing through Corinthian avenue reservoir. These two connections will be of the greatest advantage, should repairs become necessary to the reservoir.

During the month of August, the unprecedented heavy rains caused the failure of the embankment of the Reading Railroad and Pennsylvania avenue, where they cross a ravine this side of the Schuylkill engine-house, the larger portion of the gravel from this breach was carried directly into the forebay of the works, in a few minutes almost filling the end of it nearest the engines, obstructing the inlet pipes to them, and effectually stopping all work there. A large force of men was immediately set to work, and the engines got into motion by cutting canals through the gravel; but, before it could be removed entirely, another rain, even heavier than the first, occurred, bringing with it from three to four thousand cubic yards of gravel, filling the forebay one hundred and ten feet of its length, fifty-four feet wide, and sixteen feet deep. As large a force as possible was immediately put to work, and by immense efforts, (continued under great difficulty night and day,) the works were again started.

The difficulties were much augmented by a freshet in the river, which rose seven feet four inches over the dam, flowing over the banks of the forebay, and making it impossible to shut off the water by the gates provided for the purpose. This freshet at the same time caused the suspension of the works at Fairmount (until then our main dependence); the turbines were, however, soon got to work, though the pumps were partly submerged when started, showing one of the advantages of this kind of motor. The breast-wheels could not be run for almost a day later. They had been at work scarcely half a day when the failure (already mentioned) took place in Corinthian avenue reservoir, and it had to be let down for repairs.

During these repairs, the thirty-inch connection at Poplar and Twenty-second streets, already described, came into use,

and by its aid the upper portion of the City was supplied, which, but for this connection, would inevitably have been left without water, as Schuylkill Works could not be worked, and Corinthian avenue reservoir could not receive the water from Fairmount, on account of the failure of its brick lining.

During the summer it is proposed to quarry out a bluff of rocks near the Schuylkill engine house, by which the flood of last summer was deflected into the forebay; the stone from it will be used to erect a wall, which will further protect the forebay and prevent recurrence of such accidents.

The very great difficulty with which the supply to the City was kept up during the floods named, proved incontestibly how miserably inadequate the power and storage of all the works are. Had the freshet at Fairmount, and the period of inaction at Schuylkill Works lasted six hours longer, the larger portion of the City would have been without a supply of water.

Need more be said to induce your honorable bodies to make early and large appropriations for the extension of all the works. This has already been delayed too long; large additions should have been made at least three years ago; they were doubtless deferred on account of the high price of labor and materials, but this must be disregarded now, the expense is unavoidable. Appropriations have already been granted for turbine and pumps at Fairmount, and partly for a new engine at Schuylkill Works; but this good work must be continued, and large storage reservoirs be provided, or the City of Philadelphia (the first in this country to supply its citizens with water) will fall into discredit, and lose the reputation it has enjoyed for nearly seventy years, of being one of the best watered cities in the world.

Subsequent reports will be made upon the subject, in which details of proposed additions will be given, with entire confidence that the amounts necessary will be freely granted and liberal appropriations made.

The engines of the Schuylkill Works are in good condition, requiring only the ordinary repairs, with the exception of No. 1, which has not been run for several years. The engine itself is in fair order, but the pump is so much broken as to be useless. Engines Nos. 1 and 2 have been in constant use

for almost twenty-four years; besides being much worn, are defective in design and wasteful of fuel.

You have authorized the erection of a Cornish Engine in place of No. 1, but have yet to make appropriation for a suitable ascending main (in which particular these works are sadly deficient) and new boilers. The old ones having been erected at the same time with the Engines Nos. 1 and 2, are not strong enough to drive the new engine with economy; it was at first supposed that they might be made fit for the purpose, but more critical examination shows that they would be unsafe.

The new engine will be a full side-lever Cornish Engine, seventy-two inches diameter of cylinder, ten feet stroke, working a plunger pump thirty-six inches diameter and ten feet stroke, and capable of raising over 7,500,000 gallons per day; the pumping capacity of these works will then be about 18,963,221 gallons per day.

I have decided upon the side-lever form of engine, (never yet used in this country,) believing it to be the only one which can be erected to advantage in place of No. 1, without raising the roof of the engine-house and making expensive alterations thereto; also, because I consider it better, in several other respects, for our purpose than the overhead beams.

For this engine it will be proper to lay a thirty-six-inch ascending main; this will be connected with the present stand-pipe, so that its advantages can be secured for the engine.

The cylinders of the pumps of the present engines have a combined area of 1,358.92 square inches, whilst the mains through which they pump have an area of only 823 square inches; showing a deficiency in the size of the mains now in use (when all the engines are running) of 535.84 square inches, equal to another main of about twenty-six inches diameter. The effect of this is that the velocity in the main is over three feet per second, which is fully one-half more than it should be; consequently, the pumps are loaded with an unnecessary amount of friction, causing increased consumption of fuel. It will therefore be proper, at some future day, (should the present pumping station be retained), to lay another large main besides the one now proposed for the new

engine; this can be done when another engine becomes necessary in place of No. 2.

The roof of western end of the building over the boilers requires thorough repairs, both as regards the timber and the tin covering; an amount has been included in the annual appropriation for doing this work. A slate roof will be put on, being much better suited for a building subjected to internal moisture from escaping steam and the gases arising from the consumption of such large quantities of coal.

The wharf here is so much decayed that some of the top logs were carried away during the last freshet; a sum for its renewal above low water has also been included in the annual appropriation; the work will be done during the summer.

The reservoir attached to these works, the grounds around it and about the engine-house are in good order.

At the Delaware Works Engine No. 2 was found in excellent order, and is so now. One of the valve-chests of Pump No. 1, which was fractured, had been taken out and a stronger one ordered; this has since been put in place, making that engine and pump useful, and putting it in excellent order. A thorough examination of the heaters of the six-cylinder boilers disclosed the fact that they were much worn at the sides, and were pronounced by experienced boiler-makers unsafe to run at the pressure required to work the engines to advantage; new heaters were accordingly ordered and promptly put in. No provision having been made in the annual appropriation for doing this work, it become necessary to obtain authority to make transfers from other items to meet the expenditure.

The stand-pipe erected here in 1865 to relieve the pumping machinery, has proven too low to enable both engines to be run at one time, as was intended. An addition was made to it soon after its erection, but being still too low, the expedient of cutting out the ascending main and attaching the service pipes at several cross streets was resorted to; the works are since that time run in this manner. This method is of course objectionable, as most of the water used is pumped directly into the distributing pipes without reaching the reservoir at all, and in consequence no time is allowed for depositing the sediment contained in it.

The height of the stand-pipe could have readily been correctly ascertained before its erection, by means of pressure

gauges placed upon the ascending main, and observed during the running of the two engines at their maximum speed. It does not appear that any such experiments were made; it is not wonderful that a stand-pipe put up without such data should be found too short; the main being one of extraordinary length and of small size, none of the ordinary formula make sufficient allowance for the friction in it.

If these works be continued, the stand-pipe should be raised, or what will be much better, a new main should be laid to the reservoir, say thirty inches in diameter; the stand-pipe will then be sufficiently high, and the old ascending main can be used as a service pipe.

The area of the two pumps is now about 537.98 square inches, whilst that of the main is but 254.46 square inches, in addition to which it is about two and five-eighths miles long. A thirty-inch main would give a surplus area over that of the pumps of 168.81 square inches, equal to another main of over fourteen and one-half inches diameter.

Even with the service pipes attached to the ascending main as they now are, the engines cannot be run to their maximum speed without overflowing the stand-pipe.

As at all the other works, the power here is too limited. But for the fact of the reservoir being fed in part from Fairmount Works, the supply could not have been properly kept up last summer; and even with that assistance, it will be difficult to do so, should the next summer prove unusually warm and dry.

The thirty-inch main, laid in 1866, from Corinthian avenue reservoir to that of the Delaware Works, is therefore very useful; but that usefulness is much impaired by the fact of attachments having been taken off from it at several points between the two reservoirs. It should not have been tapped at all, but should have been kept exclusively for the object originally intended, viz: The supply of the Delaware reservoir from Fairmount Works. Already the loss of head from the cause named is considerable during warm days, and will increase rapidly, making it impossible, finally, to fill the Delaware reservoir to the proper height by this means during the heat of midsummer. For several months during the winter these works were supplied entirely from Fairmount.

The reservoir required the ordinary repair to the brick lining. During the heavy rains of the summer, a consider-

able portion of the grass banks slipped into the street, partly from the same cause as has been named in speaking of a similar accident at Fairmount reservoirs. This reservoir and grounds is now in excellent order.

The engines of the Twenty-fourth Ward Works have been sadly over-taxed; there being no reservoir here, they have to be kept running constantly, and much of the time at too high a speed. The leakage at the joints of the pumps is excessive; there is no opportunity to make any but very temporary repairs without stopping the engines, and for the time (probably a number of days,) depriving the whole Ward of water.

As you are aware, a reservoir is now building for the use of these works, but, until it shall be finished, the supply will be kept up under extraordinary difficulties, as it depends entirely upon the holding together of the much worn and overtasked engines and pumps.

A contract had been made for the erection of a "Cornish bull" engine at the present engine-house, and a well had been excavated for its reception. Careful consideration of the subject convinced me that it would not be judicious to erect a new and expensive engine at the present location, for reasons fully detailed in my report made to you upon this subject December 2, 1867, which, in a general way, will be briefly repeated here.

First. A bar of very considerable magnitude has formed, making a mud island directly in front of the works, through which the water is conducted to the forebay by means of a temporary wooden trunk over four hundred feet in length. To remove this bar or much improve it has been estimated to cost from $65,000 to $100,000, and even then it would be far from satisfactory.

Second. To place the engine here will require considerable and somewhat expensive additions to the engine-house and the building of a new boiler house, the position for which would have to be made by quarrying out the rock.

Third. An ascending main of over twelve thousand feet long will be required: objectionable as to first cost, and on account of increased danger and consumption of fuel.

It was therefore proposed in the report named—which proposition has received the approval of one branch of Councils—to change the location of the pumping works to a point higher up the river (where an ascending main of little more

than four thousand feet will be sufficient.) To transfer the Cornish engine (for which contract has already been made) to Schuylkill Works, and erect two new engines, of different construction, better adapted for use without a stand-pipe, at the new location.

The capacity of the old works, if the Cornish engine had been erected there, would have reached 8,225,800 gallons per day, whilst it is proposed to make that of the new works 10,000,000 gallons per day.

By this change a saving will be effected of the cost of laying over eight thousand feet of thirty-inch main, as well as the cost of laying an iron main, of large size, across the mud flats in place of the temporary wooden trunk named, and also the expense of re-arranging the old engine-house and building a new boiler-house.

It is estimated that a new works can be erected with an increased pumping capacity of 1,864,200 gallons per day, and an engine-house sufficiently large to contain engines capable of pumping 15,000,000 gallons per day, for a less sum than would be required if the pumping machinery be retained at the present location. If this change obtain your full sanction, the work can be commenced as early in the spring as the season will permit, and probably be finished at the same time as the reservoir.

Considerable work had been done upon the new reservoir for this Ward previous to my taking charge of the Department, and an embankment commenced on the Montgomery avenue side of the work.

Careful examinations of the levels of the ground showed that by adopting a higher level for the water-line than was proposed, and by moving further west, a larger reservoir could be constructed at less cost. To have continued the work upon the level and plan that it was commenced would have involved the moving of some 220,000 cubic yards of surplus earth to a distance of one or two thousand feet, whilst by taking the new position further west upon higher ground, the surplus remaining after the embankments are completed, should not exceed 12,000 cubic yards. These facts were presented to your notice in my report of June 17, 1867, and your authority obtained for the change mentioned.

Several unavoidable delays occurring, the work was not fairly commenced before the first of July, since which time

about 43,000 cubic yards of earth have been moved; and some 30,000 cubic yards of embankment raised, besides a large amount of grubbing and clearing of top-soil, and preparation for foundation and puddle trenches.

It is now proposed to make the level of the water two hundred and twelve feet above City datum, or two hundred and seven feet above Fairmount Dam. The contents of the reservoir is estimated at 35,400,000 gallons, divided into two sections, with inlet and outlet gate houses so arranged that either or both divisions can be used. The work will be pushed as rapidly as safety will permit. It is hoped that one section can be completed so as to be put into use during the year.

The Works at Germantown are in good order. The supply of water having been somewhat limited in 1866, a pipe was laid early this season to conduct the water from Harvey's Spring into the pool, should more water be required. But the season proving wet, and the supply of water in the pool ample, it was not put into use.

The lease of the pool engines and reservoir, which was made for a limited period, under the expectation that the Roxborough Works would be finished early, expired on the 15th of November last. Negotiations have been commenced for an extension of the lease and the purchase of the reservoir, which it is hoped will soon be brought to a satisfactory conclusion.

The new works intended for the supply of Roxborough, Manayunk and Germantown, are now in the following condition:

The reservor is finished, with the exception of sodding the outside slopes of the embankment, and making the attachments to the mains running to and from it, which can be done in a few weeks time. The engine-house is finished, the boilers are in their places, ready for immediate use. The foundation for the engine is nearly finished, and the work of setting up the engine is fairly commenced. The tunnel which brings the water from the river to the pump is finished, and the coffer-dam used in its construction will shortly be removed.

The engine is almost finished at the shop; the beams being the only large castings yet to make. The ascending main from the engine to the reservoir is laid, except two or three pipes necessary to connect it with the engine.

The distributing main has been laid upon Ridge avenue as far as the pipes found on hand reached—a sufficient number not having been ordered to reach to Green lane, as was intended—twelve hundred feet more will be required to carry the pipe to Green lane, where it will be reduced to sixteen inches, as far as Main street, where it will again be reduced to twelve inches. No pipes were ordered for this main nor the one required to carry the water to Germantown. To purchase and lay these will require the making of a new loan, that already made being entirely exhausted.

There are some unfortunate circumstances connected with these works, to which your attention was directed by my report on the subject, June 1, 1867.* For the information of those who may not have access to that report, they will be very briefly repeated here.

The reservoir at Roxborough has been located so that its water surface, when full, will be level, or nearly so, with the reservoir at Mount Airy, which it is intended to supply. Under such circumstances, it is obvious that no flow of water could possibly take place in the connecting main, until the demand would draw down the surface of the latter reservoir.

The connecting main was proposed to be twenty inches diameter, and cannot be less than seventeen thousand feet long, and must descend into the valley of the Wissahickon creek, at least two hundred and fifty feet below the level of the reservoirs, rising again to Mount Airy reservoir.

The maximum supply of Germantown was, in July, 1866, equal to 680,253 gallons per day, which would require a supply for that part of the day between the hours of 8 o'clock, A. M. and 3 o'clock, P. M., at the rate of 1,360,512 gallons per day.

To produce this flow would require Mount Airy reservoir to be drawn down nearly nine feet. It will therefore be seen that even to meet the present limited demands of Germantown, the new reservoir is about nine feet too low. The demand is rapidly increasing; in a very few years it will require a head upon a twenty-inch main of at least twenty-eight feet to produce a flow sufficiently great to supply Germantown. Looking to the future, the reservoir at Roxborough may therefore be considered as from twenty-eight to thirty feet too low. There will then be no alternative but to erect pump-

* See Appendix.

ing engines at the Roxborough reservoir, to raise the water into a stand-pipe high enough to supply Germantown.

Whilst the reservoir is not high enough to properly supply Germantown, it is too high to safely supply Manayunk. The engine must now raise the water three hundred and thirty-four feet above Flat Rock Dam, from which it will descend to a point on the main street (upon which the largest supply will be wanted,) nearly five feet lower than that from which it was originally pumped.

Two reservoirs should have been built here: one for the supply of Manayunk, for which a level of two hundred feet would have been ample, and from which the water could have been pumped to a reservoir some one hundred and sixty feet higher, for the supply of Germantown.

Such a plan was proposed several years since, by the former Chief Engineer of the Department. Why it was abandoned does not appear.

The cost of these works will much exceed the amount estimated for them. It will be very many years before the revenue derived from them can possibly pay an interest on the expenditure.

The engine erecting here is a full Cornish beam engine, from the designs of the late Chief Engineer; from the unusually high lift (334 feet,) and the fact of there not being any stand-pipe, it will be much exposed to danger, and must be costly in fuel.

If the mains necessary are ordered promptly, the works can be started for the supply of Manayunk about the middle of the present year.

The Mayor of the City, in his Annual Message, recommended the appointment of a commission composed of Hydraulic Engineers for the examination of the "whole subject of water supply in all its aspects and bearings." This recommendation met the approval of the Committee on Water, and of Select Council, but failed to meet with favor in the Common branch.

The commission was, therefore, not created; this is much to be regretted, the subject being one of such vital importance, requires the closest and most thorough investigation by more than one mind.

The Act of the Legislature creating the Park Commission makes the protection of the purity of the Schuylkill water

one of its first duties. The Commission referred the subject to a Committee composed of the engineers of that body for the investigation of the subject, as far as the supply from the Schuylkill extends.

The report of this Committee, endorsed by the Committee on Water, has been some time before you. The conclusions arrived at are, that the Schuylkill river can be relied upon for many years, if proper means be taken early to guard it from pollution, and by the erection of works at its head waters calculated to compensate for the diminished supply of summer by collecting the surplus of winter.

The suggestions thrown out by the Committee are briefly as follows:

To construct a sewer from Manayunk to a point below the Fairmount dam, to intercept and carry off the pollution from the factories, &c. &c., along the banks of the river.

To build large retaining compensating reservoirs upon the streams at the head-waters of the Schuylkill.

To improve the water-power to its fullest extent by the erection of turbine-wheels.

To construct large distributing reservoir or reservoirs.

To erect additional engines at Schuylkill Works, capable of supplying the Delaware reservoirs as well as their own.

To erect large auxiliary engines, to be used when the water is insufficient to run all the wheels; so arranged as to be able to raise the water from below the dam, in case of any accident to that important structure.

It is hoped that these suggestions may meet your early approval, and that means be provided for the execution of all or a part of the works proposed.

A sum of five thousand dollars was asked for in the annual appropriation, for the purpose of making the proper surveys for the construction of the sewer above mentioned; this was reduced to one thousand—an amount, I regret to say, inadequate for the purpose.

The points in which the present works are deficient are, want of power at them all, storage for them all, and the limited size of the distributing mains. Upon these subjects it is proposed at an early day to make special reports, in which your attention can be more closely directed than in this mere annual record of the year's business.

Large appropriations and the creation of a new loan will

be necessary for the completion of the Roxborough, the Twenty-fourth Ward, and necessary additions to Schuylkill Works, which will doubtless be granted at the proper time.

During part of the past year, all of the City east of the Schuylkill, except Germantown, was supplied from Fairmount; thereby saving considerable fuel, and realizing the advantages which were expected to be derived from the connecting of all the reservoirs attached to the several works.

The usual statistical tables will be found appended. It will be seen that the distributing pipes have had an addition during 1867 of something more than fifteen miles.

The statement of the Register of the receipts of the Department will be found interesting and highly satisfactory; showing an increase of $95,264 50 over those of the previous year.

OPERATIONS OF FAIRMOUNT WORKS FOR THE YEAR 1867.

MONTHS.	Running time.	Number of Strokes during the month.	Total number of Gallons pumped during the month.	Average Gallons per day.	Cubic feet of Water pumped per month.	Average depth of Water passing over the Dam, in inches.	Rain-fall during each month, in inches.
	Days.						
January	31	3,042,104	556,597,314	17,954,752	74,406,288		1.70
February	28	3,095,230	583,406,164	20,835,934	77,990,060		2.89
March	31	3,328,420	657,017,600	21,194,116	87,830,477		5.46
April	30	3,721 662	666,334,224	22,211,140	88,844,448		1.31
May	30	3,576,776	676,311,158	22,543,705	90,409,651	$11\frac{5}{10}$	7.32
June	30	4,328 184	764,741,970	25,491 899	102.231,131	$8\frac{5}{10}$	11.02
July	31	4,168,549	742,213,719	23,942,700	99.219,542	7	2.38
August	31	3,617,455	637,414,128	20,561,778	85,209.874	$18\frac{8}{10}$	15.81
September	30	3,771,035	678,329,643	22,444,321	90,011,081	$8\frac{6}{10}$	1.72
October	31	4,140 083	753 811,187	24,316,490	100,769.898	$12\frac{1}{10}$	4.32
November	30	3,074,173	620,111,813	20,670,393	83,475,572	$10\frac{5}{10}$	2.94
December	31	3,434,562	659,127,674	21,262,183	88,112,554	$8\frac{7}{10}$	2.73
Total	364	43,293,183	7,990,416,594	21,951,694	1.068.510.526	av. $10\frac{75}{100}$	59.60

The greatest depth of water flowing over the dam was seven feet four inches, August 19, 1867.

COAL, TALLOW AND OIL ACCOUNT OF FAIRMOUNT WORKS FOR 1867.

MONTHS.	COAL.		TALLOW.		OIL FOR MACHINERY.	
	Amount of Coal received.	Amount of Coal Consumed.	Amount of Tallow received.	Amount of Tallow consumed.	Amount of Oil received.	Amount of Oil consumed.
	Tons.	Tons.	Pounds.	Pounds.	Quarts.	Quarts.
Amount on hand, January 1.....	15	.....	154½	.....	586	.....
January	20	.....	.....	55	.....	117
February.....	.....	.....	.....	26	.....	76
March	10	.....	.....	24½	.....	108
April.....	.....	.....	.....	67	.....	102
May.....	30	.....	.....	24	.....	107
June.....	.....	.....	.....	15	.....	143
July.....	.....	.....	303	30	164	153
August	.....	.....	.....	33	828	171
September	.....	.....	.....	55	.....	169
October	.....	.....	.....	28	.....	140
November	.....	.....	.....	21	.....	150
December.....	30	74	429	9	844	99
Total.....	105	74	886½	387½	2.422	1,530

RUNNING EXPENSES OF FAIRMOUNT WORKS.

Salaries of Engineers and labor, - - -	$4,898 38
Gas and oil for lighting, - - - -	1,452 22
90 tons of coal, for warming Works, at average price $5 94 per ton, - - - - -	535 00
459 gallons of oil, at average price of $63\frac{7}{10}$, -	292 20
732 pounds of tallow, " " $15\frac{3}{10}$, -	111 80
Packing and small stores, - - - -	801 38
Repairs, - - - - - - - -	9,481 84
	$17,572 82

Cost of raising water into reservoir, per million gallons, - - - - - - -	$2 26
Cost of raising water, per million gallons, one foot high, - - - - - - - -	02¼

OPERATIONS OF THE SCHUYLKILL WATER WORKS DURING THE YEAR 1867.

MONTHS.	Running time. Days.	Running time. Hours.	Number of strokes during the month.	Average strokes per minute.	Pounds of coal used during the month.	Total number of gallons pumped during the month.	Average gallons per day.	Number of gallons per pound of coal.	Number of pounds of water, one foot high, per pound of coal. Lift calculated at 115 feet.	Number of pounds of water, one foot high, per pound of coal. Lift calculated at 138 feet.	Cubic feet of water pumped per month.
January	.....	.....	Not running.								
February	13	17	235,546	11·93	192,304	73,000.164	5,325,240	379·61	364,738	437,691	9,758,702
March	0	06	3,797	10·54	3,584	1,366,920	911,280	381·39	366,454	439,745	182,730
April	30	00	598,835	12·74	384,160	146,179,152	4,872,638	380·51	365,611	438,733	19,541,310
May	31	00	569,502	12·00	357,280	140,460,336	4,530,978	393·13	374,519	453,258	18,776,815
June	30	00	730,452	11·76	534,688	184 395,418	6,146,514	344·86	331.357	397,628	24,650,081
July	31	00	985,566	12·52	634,480	244,314,900	7,881,126	385 06	379.355	443,976	32,660,151
August	31	00	676,665	12 56	515,984	168,450,718	5,433,894	326·46	313,677	376,404	22,518,585
September	30	00	678,185	12 00	497,392	182,700 066	6,090,002	367·12	352,928	423,499	24,423,446
October	31	00	698,934	11 40	511,504	184,629,450	5,955,788	360·95	347,040	416,139	24,681.367
November	30	00	526 307	11·62	353,248	158 370,610	5.279.020	448 03	430,765	516 919	21,171,071
December	31	00	295,502	10 52	250,432	106,380,720	3,431,636	424.79	408,149	488,182	14,221,034
Totals	288	23	5,999,291	14·42	4,235,056	1,590,248,454	5,502,590	375·50	360,788	432,946	212,585,292

The pounds of water raised one foot high, per pound of coal, is calculated at 115 feet and 138 feet, the former being the average height of water in the reservoir, above the pool, as ascertained by leveling—and the latter the height due to friction on the main ascertained by pressure gauges placed just beyond the discharge valve of the pump. In the month of November, the Cornish engine was run alone; during the previous months, she was run in connection with two crank engines.

COAL, TALLOW AND OIL ACCOUNT OF SCHUYLKILL WORKS, FOR 1867.

MONTHS.	COAL.						TALLOW.		OIL FOR MACHINERY.	
	Amount of Coal received.			Amount of Coal consumed.			Amount of Tallow received.	Amount of Tallow consumed.	Amount of Oil received.	Amount of Oil Consumed.
	Tons.	Cwt.	Qrs.	Tons.	Cwt.	Qrs.	Pounds.	Pounds.	Quarts.	Quarts.
Am't on hand, January 1	1,657	10	0	.....	.....	...	597	.....	504	.....
January...	.....	.....	...	.....	.....	...	... .	0	.....	0
February.	.....	.....	...	85	17	0	.....	50	.....	22
March.....	..... .	.....	...	1	12	0	.....	4	.....	4
April	.....	.....	...	171	10	0	803	125	.....	44
May.....	.....	.....	...	159	10	0	.....	115	.....	41
June.....	.....	.....	...	238	14	0	.....	140	.....	57
July.....	.....	.....	...	288	5	0	.....	150	.....	54
August....	.....	.....	...	230	7	0	201	151	.....	90
September	177	07	0	222	1	...	200	139	.....	71
October ...	1,352	03	0	228	07	0	283	138	876	72
November	.....	.....	...	157	14	0	.....	124	... .	51
December.	.....	.....	...	111	16	0	.....	75	.....	80
Total ...	3,187	00	0	1,890	18	0	1,584	1,211	1,380	536

RUNNING EXPENSES OF SCHUYLKILL WORKS.

Salaries of Engineers and firemen, &c., - -	$8,295 16
Gas for lighting the Works, - - - -	517 41
1,529 $\frac{10}{20}$ tons of coal, at average price $4 97 per ton, - - - - - - - - -	7,601 62
219 gallons of oil, at average price 65 cents, -	142 35
987 pounds of tallow, at average price 14 $\frac{4}{10}$ cents, - - - - - - - -	141 93
Packing and small stores, - - - -	700 00
Repairs, - - - - - - - - -	2,983 77
	$20,382 24

Cost of raising water into reservoir, per million gallons, - - - - - - - -	$12 82
Cost of raising water, per million gallons, one foot high, - - - - - - -	11 $\frac{1}{10}$

OPERATIONS OF THE DELAWARE WATER WORKS DURING THE YEAR 1867.

MONTHS.	Running time. Days.	Running time. Hours.	Number of strokes during the month.	Average strokes per minute.	Pounds of coal used during the month.	Total number of gallons pumped during the month.	Average gallons per day.	Number per pound of coal.	Number of pounds of water, one foot high, per pound of coal. Lift calculated at 112 feet.	Number of pounds of water, one foot high, per pound of coal. Lift calculated at 135 feet.	Cubic feet of water pumped per month.
January	.....	.....	.....	.....	*24,640						
February	.....	.....	.....	.....	*13,440						
March	.....	.....	Not running.								
April	.....	.....	" "								
May	.....	.....	" "								
June	.....	.....	" "								
July	14	00	238,599	12·87	168,671	40,019,940	2,858,567	237·27	222,026	267,619	5,349,888
August	23	00	711,231	10·90	607,840	177,016,720	7,696,379	291·22	272,515	328,479	23,663,693
September	26	00	644,092	10·74	545,704	106,946,980	4,113,345	195·97	183,391	221,051	14,296,731
October	21	00	301,940	12·09	183,025	49,412,700	2,352,986	269·97	252,636	304,516	6,605,517
November	13	00	221,231	11·80	181,955	35,396,960	2,722,843	194·53	182 040	213,928	4,731,885
December	12	00	119,636	10·86	131,122	19,141,760	1,595,147	145 99	136,607	164,660	2,558,881
Totals	109	00	2,236,729	14·25	1,856,897	427,935,060	3,926,010	230 52	216,814	260,009	57,206,595

* Used in pumping out cellar.
" " "

The pounds of water raised one foot high, per pound of coal, is calculated at 112 feet and 135 feet, the former being the average height of water in the reservoir above the river, ascertained by leveling, and the latter the height due to friction upon the main, ascertained by pressure gauges upon the ascending main.

COAL, TALLOW AND OIL ACCOUNT OF DELAWARE WORKS, FOR 1867.

MONTHS.	COAL.								TALLOW.		OIL FOR MACHINERY.	
	Amount of Coal received.				Amount of Coal consumed.				Amount of Tallow received.	Amount of Tallow consumed.	Am't of Oil received.	Am't of Oil consumed.
	Tons.	Cwt	Qrs.	Lbs.	Tons.	Cwt	Qrs.	Lbs.	Lbs.	Lbs.	Qts.	Qts.
Amount on hand, Jan. 1.	300	...	...	...	.....	...	...	...	175	.....	36	
January.....	.....	...	...	...	11	..	...	...	.....	.....	.....	3
February. ...	.....	...	...	...	6	...	...	...	.....	.....	.....	11
March..	.....	...	...	...	.....	...	...	...	.....	4	.....	4
April.....	93											
May..... ..	.....	...										
June.....	92	16										
July..... ...	.....	...	...	...	75	05	3	27	290	21	.....	20
August	543	10	..	...	271	07	0	16	.....	26	.....	25
September...	271	17	...	...	243	12	1	12	.....	22	.....	21
October	.....	...	...	...	81	14	0	17	.....	14	.....	13
November ...	.....	...	...	...	81	4	2	11	.....	14	.....	8
December....	.....	...	...	...	58	10	2	26	.....	12	.....	6
Total.....	1,301	3	0	0	828	14	3	25	465	113	36	111

RUNNING EXPENSES OF DELAWARE WORKS.

Salaries of Engineers, Firemen, &c., - -	$4,441 68
Gas for lighting Works, - - - - - -	200 27
1,001 $\frac{3}{20}$ tons of coal, at average price $5 20 per ton, - - - - - - - - -	5,205 97
290 pounds of tallow, at an average price, -	59 51
Packing and small stores, - - - -	500 00
Repairs, - - - - - - - - -	6,460 28
	$16,867 72

Cost of raising water into reservoir, per million gallons, - - - - - - - -	$39 41
Cost of raising water, per million gallons, one foot high, - - - - - - -	29 $\frac{2}{10}$

OPERATIONS OF THE TWENTY-FOURTH WARD WATER WORKS DURING THE YEAR 1867.

MONTHS.	Running time. Days.	Hours.	Number of strokes during the month.	Average strokes per minute.	Pounds of coal used during the month.	Total number of gallons pumped during the month.	Average gallons per day.	Number of gallons per pound of coal.	Number of pounds of water, one foot high, per pound of coal. Lift calculated at 180 feet.	Number of pounds of water, one foot high, per pound of coal. Lift calculated at 280 feet.	Cubic feet of water pumped per month.
January	31	00	544,464	12·19	186,100	49,001,760	1,580,702	263·31	395,991	507,225	6,550,582
February	28	00	475,130	11·78	169,700	42,761,700	1,527,203	251·98	384,794	484,227	5,716,407
March	31	00	518,261	11·73	157,000	46,648,490	1,504,629	297·09	446,799	570,909	6,235,827
April	30	00	542,891	12·57	172,100	48,860,190	1,628,673	283·90	426,968	545,569	6,531,657
May	31	00	619,454	13 88	197,100	55,750,860	1,798,415	282·85	425,355	543,509	7,452,227
June	30	00	662,208	15·45	209,400	59,598,720	1,986,624	284·61	445,229	546,936	7,967,190
July	31	00	789,466	17·68	251,900	71,051,940	2,291,998	282 06	416,655	542,086	9,498,262
August	31	00	739,540	16·57	245,500	66,558,600	2,147,051	271 11	407,741	520,988	8,897,590
September	30	00	714,634	16·59	232,700	64,317,060	2,143,902	276·39	414,854	531,186	8,597,940
October	31	00	719 510	16·02	220,600	64,755,900	2,088,900	293·54	441,463	564,092	8,656,604
November	30	00	592,253	13·70	203,200	53,302,770	1,776,759	262·31	390,956	504,083	7,125,544
December	31	00	612,380	13·72	211,600	55,114,200	1,797,232	260·46	394,759	504,414	7,424,984
Totals	365	00	7,530,191	14·33	2,456,900	677,717,190	1,856,759	275 84	415,101	530,406	90,654,314

The pounds of water raised one foot high, per pound of coal, is calculated at 280 feet and 180 feet; the former being the height due to the plunger-weight, the latter is the head due to the resistance against the plunger ascertained by pressure-gauges upon the ascending main.

COAL, TALLOW AND OIL ACCOUNT OF THE TWENTY-FOURTH WARD WORKS, 1867.

MONTHS.	COAL.								TALLOW.		OIL FOR MACHINERY.	
	Amount of Coal received.				Amount of Coal consumed.				Amount of Tallow received.	Amount of Tallow consumed.	Am't of Oil received.	Am't of Oil consumed.
	Tons.	Cwt	Qrs.	Lbs.	Tons.	Cwt	Qrs.	Lbs.	Lbs.	Lbs.	Qts.	Qts.
Amount on hand, Jan. 1.	140	...	...	...	.....	...	...	...	200	.....	120	
January	.....	...	...	...	83	01	2	12	.....	25	.....	3
February	51	17	2	15	75	15	0	20	.....	20	.....	2
March	40	15	0	15	70	01	3	04	.....	24	.....	3
April.	77	06	1	00	76	16	2	12	.....	24	.....	3
May.....	101	10	3	01	87	19	3	08	.....	22	.....	4
June	103	15	0	00	93	09	2	16	288	16	.....	3
July.....	175	01	1	05	112	09	0	12	.....	30	.....	6
August	103	17	1	23	109	11	3	24	.....	24	.....	3
September...	111	01	0	08	103	17	2	20	.....	28	.....	4
October	150	17	1	13	98	09	2	16	.....	28	.....	4
November ...	140	00	0	00	90	14	1	04	.....	28	.....	4
December ...	.....	...	...	...	94	09	1	04	318	32	.....	3
Total.	1,196	01	3	24	1,096	16	2	12	806	301	120	42

RUNNING EXPENSES OF TWENTY-FOURTH WARD WORKS.

Salaries of Engineers and Firemen, - -	$4,400 00
Coal oil, for lighting, - - - - - -	107 70
1,056 $\frac{1}{20}$ tons of coal, at average price $5 42 per ton, - - - - - - - - - -	5,723 20
606 pounds of tallow, at average price 15 $\frac{3}{10}$, -	92 90
Packing and small stores, - - - - -	402 75
Repairs, - - - - - - - - -	2,239 84
	$12,966 39

Cost of raising water into stand-pipe, per million gallons, - - - - - -	$19 12
Cost of raising water, per million gallons, one foot high, - - - - - - -	08 $\frac{3}{10}$

OPERATIONS OF THE GERMANTOWN WATER WORKS DURING THE YEAR 1867.

MONTHS.	Running time. Days.	Running time. Hours.	Number of strokes during the month.	Average strokes per minute.	Pounds of coal used during the month.	Total number of gallons pumped during the month.	Average gallons per day.	Number of gallons per pound of coal.	Number of pounds of water, one foot high, per pound of coal. Lift taken at 230 feet.	Cubic feet of water pumped per month.
January	27	00	1,400,000	27·10	127,680	12,688,000	469,925	99·37	190,962	1,696,138
February	24	00	1,332,000	27·31	112,000	11,984,200	499,341	107·00	205,621	1,602,054
March	26	00	1,287,000	25·56	103,040	11,666,200	448,700	113·22	217,570	1,559,544
April	25	00	1,507,000	26·95	116,480	13,677,200	547,088	117·42	225,644	1,828,380
May	27	00	1,520,000	28·09	118,720	13,799,000	511,074	116·23	223,357	1,844,658
June	25	00	1,605,000	29·00	118,720	14,558,000	582,320	122·67	235,642	1,946,121
July	27	00	1,978,000	27·75	138,880	17,958,800	665,141	129·31	248,492	2,400,742
August	27	00	1,811,000	26·83	123,200	16,413,600	607,541	133·22	256,017	2,194,179
September	25	00	1,838,000	27.57	132,160	16,663,800	666,552	126·09	242,298	2,227,626
October	28	00	2,108,000	27·25	165,760	19,116,800	682,743	115·33	226,639	2,613,414
November	26	00	1,572,000	26·65	136,640	13,763,200	529,353	100·72	193,568	1,839,872
December	28	00	1,634,000	26·23	136,640	14,815,400	529,121	108·42	208,358	1,980,531
Totals	315	00	19,592,000	43·19	1,529,920	177,104,200	562,236	115·76	222,995	23,733,259

COAL, TALLOW AND OIL ACCOUNT OF THE GERMANTOWN WORKS, FOR 1867.

MONTHS.	COAL.								TALLOW.		OIL FOR MACHINERY.	
	Amount of coal received.				Amount of coal consumed.				Amount of Tallow received.	Amount of Tallow consumed.	Am't of Oil received.	Am't of Oil consumed.
	Tons.	Cwt.	Qrs	Lbs.	Tons.	Cwt.	Qrs.	Lbs.	Lbs.	Lbs.	Qts.	Qts.
January.....	23	.....	...	...	57	.....	...	...	.....	42	.....	10
February.....	50	.....	...	..	50	.....	...	...	.....	36	.....	9
March..	50	.....	...	...	46	.....	...	...	.....	36	.....	10
April.....	52	.....	...	...	52	.....	...	...	.....	34	158	9
May.....	62	.....	...	...	53	.....	...	...	.....	26	.....	9
June.....	96	.....	...	...	53	.....	...	...	.....	27	.....	9
July.....	25	.....	...	...	62	.....	...	...	.....	28	.....	10
August.....	45	.....	...	...	55	.....	...	...	319	24	.....	9
September ...	60	.....	...	...	59	.....	...	...	.....	24	.....	9
October.....	66	.....	...	...	74	.....	...	...	.....	23	.....	10
November....	71	.....	...	...	61	.....	...	...	.....	21	.....	9
December....	60	.....	...	...	61	.....	...	...	.....	20	.....	9
Total.....	660	.....	...	...	683	.....	...	...	.....	341	.....	112

RUNNING EXPENSES OF GERMANTOWN WORKS.

Salaries of Engineers, firemen, &c.,	$3,094 09
Coal oil for lighting works,	22 60
660 tons of coal, at average price $6 40 per ton,	4,114 00
39½ gallons of oil, at average price 50 cents,	19 75
319 pounds of tallow, at average price 15 5/10 cts,	49 35
Packing and small stores,	61 92
Repairs,	421 09
	$7,782 80

Cost of raising water into reservoir, per million gallons,	$43 96
Cost of raising water, per million gallons, one foot high,	19 1/10

AMOUNT OF WATER PUMPED BY ALL THE WORKS DURING THE YEAR 1867.

	Gallons of water pumped during the month.	Ave. number of gallons pumped per day.
January,	618,287,074	20,005,379
February,	711,152,228	28,187,718
March,	716,694,210	24,058,725
April,	875,050,766	29,259,539
May,	886,321,354	29,384,172
June,	1,023,294,108	34,706,857
July,	1,115,559,299	37,639,532
August,	1,065,853,766	36,446,543
September,	1,043,957,549	39,041,156
October,	1,071,726,037	35,396,907
November,	880,945,353	30,976,368
December,	854,579,754	28,615,319
Total,	10,863,421,498	29,771,018

STATEMENT OF THE OPERATIONS OF THE SHOP FROM JANUARY 1, TO DECEMBER 31, 1867.

Dr. To stock on hand, January 1, 1867,					$4,421 43
" 39,631 lbs. wrought iron at average,					1,434 13
" 215,506 " cast iron,			"		7,387 50
" 1,585 " steel,			"		364 50
" 11,832 " brass castings,			"		3,536 03
" 4,882 " lead,			"		488 20
" 22,496 feet of lumber,					957 81
" hardware,					360 80
" leather,					299 76
" paints and oils,					229 31
" coal,					352 50
" machine work,					2,654 12
" sundry bills,					64 80
" scrap iron and brass, from various districts and works,					100 00
" wages paid hands, Item 38,			$9,962 75		
Water Loan and repairs,			895 00		
					10,857 75
					$33,508 64
Cr. By 1,770 ferrules,		at 60 cts.,		$1,062 00	
" 462 "		" 60 "		277 20	
" 137 "		" 70 "		95 90	
" 117 "		" 80 "		93 60	
" 34 stop cocks,		$45 00		1,530 00	
" 108 "		65 00		7,020 00	
" 1 "		80 00		80 00	
" 4 "		125 00		500 00	
" 5 "		325 00		1,625 00	
" 5 "		425 00		2,125 00	
" 148 steam fire plugs,		40 00		5,290 00	
" 31 small "		25 00		775 00	
" 227 fire plug cases,		20 00		4,540 00	
" 433 stop cock boxes,		4 00		1,732 00	
" 1 geared stop cock, 20 in.,				481 00	
" 1 extra "		6 "		100 00	
" 164 frames and covers,		$7 00		1,148 00	
Amounts carried forward,			$28,484 70		$33,508 64

Amounts brought forward,	$28,484 70	$33,508 64
Cr. By scrap iron and brass sold, -	479 60	
" patterns made and repaired, -	300 00	
" repairs for First District -	806 77	
" " Second " - -	994 97	
" " Third " - -	605 95	
" " Fourth " - -	905 57	
" " West Philad'a Works,	69 94	
" work done for " reservoir,	632 52	
" " Fairmount Works, -	281 60	
" " Fairmount Dam, -	84 30	
" " " extension,	882 68	
" " Schuylkill Works, -	76 50	
" " Delaware " -	25 55	
" " Germantown " -	251 21	
" " Roxborough, " -	1,455 89	
" " Corinthian avenue, reservoirs, - -	64 68	
" " Building, grounds, and reservoirs, -	88 76	

Stock on Hand.

" 1,020 lbs. of forged work,	16 cts.	163 20	
" 18 sharp thread screws,	$2 50	45 00	
" 1 four inch sq. top screw,	4 00	4 00	
" 7 six-inch screws,	5 00	35 00	
" 7 three-inch "	4 00	28 00	
" 5 eight-inch "	6 00	30 00	
" 5 ten-inch "	7 00	35 00	
" 2 twelve-inch screws,	8 00	16 00	
" 6 sixteen-inch "	10 00	60 00	
" 8 twenty-inch "	12 00	96 00	
" 1 thirty-inch screw,	16 00	16 00	
" 5 six-inch spindles,	6 00	30 00	
" 38 four-inch "	5 00	190 00	
" 7 eight-inch "	6 00	42 00	
" 11 ten-inch "	8 00	88 00	
" 19 six-inch socket screws,	5 00	95 00	
" 25 four-inch "	4 00	100 00	
Amounts carried forward,	$37,554 39	$33,508 64

Amounts brought forward,			$37,554 39	$33,508 64	
Cr. By 2 sixteen-inch socket screws, - - -	8	00	16 00		
" 1,329 lbs. bolts and washers,		16	212 64		
" 40 gallons oil, - -		45	18 00		
" 129½ lbs. finished brass, -		60	775 20		
" 11,811 lbs. wrought iron,		05	590 55		
" 435 " steel, - -		23	100 05		
" 24,599 " cast iron, -		03¼	799 46		
" 3,040 feet of 5-4 white pine lumber, - -	37	50 m.	114 00		
" 1,274 feet of pattern lumber, - - -	80	00 m.	101 92		
" 73 wooden plugs, -		50	36 50		
Balance, profit of shop,				6,810 07	
			$40,318 71	$40,318 71	

DISTRIBUTION.

Service mains have been laid in the following streets, in 1867.

FIRST DISTRICT.

ACCOUNT OF IRON PIPES LAID IN THE FIRST SECOND, THIRD, FOURTH AND TWENTY-SIXTH WARDS.

Street.	Location.	Size. Inches.	Feet.
Fernon.	From Tenth to Eleventh,	4	422
Twenty-third.	From Washington Av. to Federal,	6	583
Washington Av.	N. side, from Third to Fourth,	4	420
Ellsworth.	West of Seventeenth,	6	96
Gray's Ferry Road.	From Twenty-ninth to Thirty-first,	6	983
Washington Av.	From Twenty-third to Twenty-fourth,	6	518
Mountain.	350 feet W. from W. side of Tenth,	4	365
Montrose.	From Fifteenth to Sixteenth,	4	452
Federal.	" Twentieth to Twenty-first,	6	607
Carpenter.	" Twenty-second to Twenty-third,	6	474
Kimball.	" " "	4	481
Emmet.	" terminus of pipe to Borden street,	4	96

Street.	Location.	Size. Inches.	Feet.
Fifteenth.	From Catharine to Christian,	6	300
Parade.	West of Twelfth, North from Wharton,	4	328
Lentz.	" " "	4	188
Tenth.	From Morris to Mifflin (re-laid),	6	550
Plug connection for the Navy Yard,		6	21
Eighth.	From Tasker to Morris,	6	450
Enue.	" Eighth to Passyunk Road,	4	382
S. Marshall.	" Broad to Thirteenth,	4	596
Tenth.	" Morris to Jackson,	6	1,315
Connecting Cantrall street with Tenth,		4	29
"	Mountain street with Eighth,	4	35
"	Fernon " "	4	35
Plug connections,		4	94
	Total number of feet of pipe laid,		9,820

Number of feet of pipe re-laid, 6-inch, 550 feet.

Number of feet of new pipe laid, 4-inch,	3,923
" " " " 6-inch,	5,347
Total number of feet,	9,270

Or 1 mile, 3,990 feet.

SECOND DISTRICT.

ACCOUNT OF IRON PIPE LAID IN THE FIFTH, SIXTH, SEVENTH, EIGHTH, NINTH, TENTH, TWENTY-FOURTH AND TWENTY-SEVENTH WARDS.

Street.	Location.	Size. Inches.	Feet.
Powelton Av.	From Thirty-second to Lancaster avenue,	6	2,243
Thirty-sixth.	" Bridge to Powelton avenue,	6	957
Thirty-seventh.	" " Garden, "	6	328
Thirty-sixth.	" Haverford to Penn'a R. R.,	6	1,654
Filbert.	" Twenty-second to Twenty-third,	6	256
Eadline.	Between Thirty-ninth and Union,	6	410
Thirty-ninth.	From Haverford Road to Eadline,	6	423

Street.	Location.	Size. Inches.	Feet.
Thirty-seventh.	Above Market, north 125 feet to terminus of pipe,	6	132
Thirty-ninth.	From Chestnut to Oak,	6	288
Fifteenth.	" Market to Chestnut,	6	526
Plug connections,		4	313
	Total number of feet of pipe laid,		7,530
	Number of feet of new pipe laid, 4-inch,	313	
	" " " 6-inch,	7,217	
	Total number of feet,	7,530	
	Or 1 mile, 2,250 feet.		

THIRD DISTRICT.

ACCOUNT OF IRON PIPES LAID IN THE ELEVENTH, TWELFTH, SIXTEENTH, SEVENTEENTH, EIGHTEENTH, NINETEENTH, TWENTY-THIRD AND TWENTY-FIFTH WARDS.

Street.	Location.	Size. Inches.	Feet
Unity.	From Frankford road to Waln,	6	942
Thouron.	" Diamond to Susquehanna avenue,	4	630
Sellers.	" Frankford road to Paul,	6	2,263
Connecting	R. R. works (Lehigh avenue),	4	54
Harrison.	From Frankford road to Willow,	6	937
Church.	" 114 feet west of Waln,	6	1,600
Huntingdon.	From Almond to Frankford road,	6	2,352
Connecting	Tulip to Huntingdon street,	6	72
Aramingo.	From Memphis to Gaul,	6	846
Gaul.	" Cumberland to Norris,	6	1,473
"	" " "	10	5
"	" " "	8	9
Clearfield.	" Richmond to Gaul,	6	1,812
Connection	for Beaver and Adamson (Richmond),	4	18
Somerset.	From Memphis to Amber,	6	1,549
Tulip.	" Huntingdon to Lehigh avenue,	6	783
Taylor.	" Emerald to Kensington "	4	852
Columbia Av.	" Hancock to Howard,	6	626

Street.	Location.	Size. Inches.	Feet.
Ireland.	From Hanover to Palmer,	6	573
Penn.	Allen to Orthodox,	6	420
Connecting Cedar and Lehigh avenue,		6	78
"	Collins and Huntingdon,	6	36
Jasper.	From Firth to Huntingdon,	6	564
York.	" Fifth to Sixth,	6	588
Connection Fifth to York,		6	27
Reese.	From Susquehanna avenue to Dauphin,	6	600
Sepviva.	" Cumberland to Huntingdon,	6	780
America.	" Master to Jefferson,	4	480
Palethorp.	" Jefferson to Oxford,	4	414
Dickerson.	" Collins to Cedar,	6	1,596
Delaware Water Works,		4	18
Connection, Cumberland street,		4	22
Plug connections,		4	511
	Total number of feet,		23,530

Number of feet of new pipe laid, 4-inch,	2,999
" " " " 6 "	20,517
" " " " 8 "	9
" " " " 10 "	5
Total number of feet,	23,530

Or 4 miles, 2,410 feet.

FOURTH DISTRICT.

ACCOUNT OF IRON PIPES LAID IN THE THIRTEENTH, FOURTEENTH, FIFTEENTH, TWENTIETH, TWENTY-FIRST AND TWENTY-EIGHTH WARDS.

Street.	Location.	Size. Inches.	Feet.
Franklin.	From Diamond to Susquehanna avenue,	6	600
Diamond.	" Seventh to Ninth,	6	675
Cadbury.	" Columbia avenue to Berks,	6	564
Eleventh.	" Berks to Norris,	6	536
Mervine.	" " "	6	576
Twelfth.	" " "	6	528
Thirteenth.	" " "	6	552

Street.	Location.	Size. Inches.	Feet.
Bolton.	From Ridge avenue to Twenty-third	6	912
Noble.	" Thirteenth to works of Stuart & Peterson,	6	615
Buttonwood.	From Fifteenth to Sixteenth,	6	440
Judson.	" Brown to Parrish,	6	444
Girard avenue.	" Twenty-fifth to Twenty-ninth,	10	1,164
Twenty-ninth.	" Girard Av. to Penn'a Av.,	6	1,476
Township Line road.	From Tioga to junction of water pipe heretofore laid by the Germantown Water Company,	6	360
Twenty-third.	From Green to Mount Vernon,	6	270
Broad.	" Berks to the Germantown and Norristown R. R.,	6	8,280
Twenty-second.	Connecting 30-inch main at Corinthian avenue reservoir with 30-inch main on Poplar,	30	376
Ogden.	From Twentieth to Corinthian avenue,	6	360
Sixteenth.	" Master to Columbia "	6	1,536
Eighth.	" Dauphin to Germantown road,	6	480
Attachment for	Bergdoll & Psotta's Brewery,	6	204
"	Bushnell's Skating Park,	4	45
Susquehanna Av.	From Franklin to Seventh,	6	195
Camac.	" Diamond to Norris,	6	132
Plug connections,		4	153
North College Av.	From Ridge to Twenty-first, re-laid,	16	1,170
Pumping main at	Roxborough,	20	3,824
Distributing main at	"	20	7,463
	Total number of feet of pipe laid,		33,930

Number of feet of pipe re-laid, 16-inch,	1,170
Number of feet of new pipe laid, 4-inch,	198
" " " 6 "	19,735
" " " 10 "	1,164
" " " 20 "	11,287
" " " 30 "	376
Total number of feet of new pipe laid,	32,760

Or 6 miles, 1,080 feet.

GERMANTOWN.

ACCOUNT OF IRON PIPES LAID IN GERMANTOWN, TWENTY-SECOND WARD.

Street.	Location.	Size. Inches.	Feet.
Bringhurst.	From Germantown avenue to Philadelphia and Germantown Railroad,	6	2,154
Queen.	" Green to Wayne,	4	988
Walnut Lane,	" present termination to Adams,	6	791
Adams.	North from Walnut Lane,	6	371
Chelten avenue.	West from Hancock,	6	333
School.	Extending westward from present termination,	4	1,796
High.	From Morton, east to end of Main, re-laid,	3	1,159
Haines.	" " to Main,	6	1,966
Morton and Haines, re-laid,		3	60
East Walnut Lane.	From 400 feet east of Morton, 400 feet eastward,	4	525
Wakefield.	From Wistar to Bringhurst,	4	970
Harvey's Spring Dam to dam at Works,		6	754
Armat.	From Wilson east, re-laid,	4	400
Centre.	Germantown avenue east, "	4	196
Chew.	Mill street south-west, "	3	337
Thorp's Lane.	Over race at Harper's Dam, re-laid	3	80
School Lane.	West or Main street, re-laid	4	109
Plug connections,		4	433
Total number of feet,			13,422

Number of feet of pipe laid, 3-inch,	1,636
" " " " 4-inch,	705
Total,	2,341
Number of feet of new pipe re-laid, 4-inch,	4,712
" " " " 6-inch,	6,369
Total,	11,081

Or 2 miles 521 feet.

RECAPITULATION OF PIPE LAID IN THE SEVERAL DISTRICTS DURING THE YEAR 1867.

Wards.	4 inches diam.	6 inches diam.	8 inches diam.	10 inches diam.	20 inches diam.	30 inches diam.	Total.
1st Dist., 1, 2, 3, 4, 26,.....	3,923	5,347	.....	.....	.....	.....	9,270
2d Dist., 5, 6, 7, 8, 9, 10, 24, 27,....	313	7,217	.....	.....	.....	.....	7,530
3d Dist., 11, 12, 16, 17, 18, 19, 23, 25,	2,999	20,517	9	5	.....	.....	23,530
4th Dist , 13, 14, 15, 20, 21, 28,.....	198	19,735	.....	1,164	11,287	376	32,760
Germantown, 22d,.....	4,712	6,369	.....	.....	.....	.....	11,081
Total,.....	12,145	59,185	9	1,169	11,287	376	84,171

Being a total of 15 miles, 4,971 feet.

Total number of feet of pipe as per last report, - - - -		2,158,351
" " " laid during the year, - - -		84,171
Feet, - -		2,242,522

Or 424 miles, 3,802 feet.

SERVICE MAINS ORDERED.

Councils have ordered pipe laid in the following streets:

FIRST DISTRICT.

Pipe ordered to be laid in the First District.

Street.	Location.
Taylor.	From Eighth to Ninth.
Twenty-sixth.	" Park to Gray's Ferry Road.
Twelfth.	" Wharton to Passyunk Road.
Pierce.	" Seventh to Eighth.
Reed.	" Eleventh to Thirteenth.
Moore.	" Ninth to Broad.
Reed.	" Fifteenth to Sixteenth.
Montrose.	" Jessamine to West, 170 feet.
Pierce.	" Passyunk Road to Thirteenth.
Twenty-third.	" Shippen to Pemberton.
Ingerson.	" Christian to Gray's Ferry Road.
Carpenter.	" Burnett " "
Ingerson.	" " " "
Seventeenth.	" Federal to Reed.
Wharton.	" Sixteenth to Eighteenth.
Mount Holly.	" 300 feet south from Wharton.
Peter.	261 feet east of Twelfth.
Dean.	" West of Twelfth, north from Wharton.
Morris.	" Front to Otsego.
Dutton.	" Morris to Mifflin.
	North side of Washington, from Twenty-third to Twenty-fourth.
South Marshall.	" Broad to Fifteenth.
League.	" Twenty-second to Twenty-third.
Fernon.	" Eighth to Ninth.
Twenty-first.	" Catharine to Christian.
Twenty-second.	" " "
Catharine.	" Twenty-first to Twenty-second.
Webster.	" " "

SECOND DISTRICT.

Pipe ordered to be laid in the Second District.

Street.	Location.
Story.	From Thirty-seventh to Thirty-eighth.
Thirty-seventh.	" Garden to Aspen.
Thirty-fourth.	" Race to Lancaster Avenue.
On a certain street running from Twenty-first to Twenty-second, south of Arch.	
Story.	From Thirty-eighth to Thirty-ninth.
Thirty-fourth.	" Haverford Road to Elm.
Powelton Ave.	" Fortieth to Forty-first.
Ludlow.	East of Thirty-sixth.
Thirty-seventh.	" Filbert to Warren.
Thirty-ninth.	" Ludlow to Market.
Somerset.	" Haverford Road to Mary.
Ludlow.	" Thirty-ninth to Fortieth.

THIRD DISTRICT.

Pipe ordered to be laid in the Third District.

Street.	Location.
Toronto.	From Melvale, south 806 feet.
Wager.	" Fourth to Fifth.
Day.	" Girard Avenue to Thompson.
Tilton.	" Emery to Huntingdon.
Sergeant.	" Cedar to Memphis.
Emlen.	" Trenton Avenue to Cedar.
Waterloo,	" Cumberland to Davis.
Lloyd.	" Sergeant to Hamilton.
Anthracite.	" Salmon to Almond.
Berks.	" Front to Germantown Road.
Newkirk.	" Cumberland to the line of the property owned by the Church of the Messiah.
Ann.	" Emerald to Kensington.
Hackley.	" Fourth to Fifth.
Eagle.	
York.	" America to Germantown Road.
Huntingdon.	" Fillmore Ave. to Kensington Ave.

Street.	Location.
Wellington.	From Richmond to Cedar.
Almond.	" Dauphin to Cumberland.
Capewell.	" Belgrade to Gaul.
Leib.	" Columbia Avenue to the south line of the estate of Lydia Harrison, dec'd.
Martha.	" Huntingdon to Lehigh Avenue.
Monmouth.	" Salmon to Edgemont.
Brinton.	" Jefferson to Oxford.
Ash.	" William to Richmond.
Clearfield.	" Gunner's Run to Frankford Road.
Paul.	" Mill to Frankford Road.
Oakney.	" Norris to Diamond.

FOURTH DISTRICT.

Pipe ordered to be laid in the Fourth District.

Street.	Location.
Thompson.	From William to Schuylkill Water Works.
Master.	" Twenty-seventh to Twenty-eighth.
Geary.	" Poplar to Wiley.
Callowhill.	" Twenty-sixth to Wire Bridge.
Bolton.	" Twenty-third to Twenty-fourth.
Thirty-third.	" Running N. W. from Pennsylvania Ave.
Cadbury.	" Montgomery Avenue to Berks.
Thirty-third.	" Pennsylvania Avenue to Master.
Twenty-third.	" Mount Vernon to Wallace.
Jefferson.	" Sixteenth to Suydenham.
Opal.	" Jefferson to Oxford.
Lehigh Avenue.	" Germantown Avenue to Eleventh.
"	" Suydenham to Eighteenth.
Franklin.	" Columbia to Montgomery Avenue.
Girard Avenue.	" Twenty-ninth to the Bridge.

ACCOUNT OF THE NUMBER OF HOLES DRILLED FOR MAKING NEW ATTACHMENTS TO PUBLIC MAINS DURING THE YEAR 1867.

MONTHS.	½ inch diameter.	⅝ inch diameter.	¾ inch diameter.	1 inch diameter.	Total holes drilled and attachments made.	Shut off for repairs to private pipes.	Shut off for repairs to public pipes.
January	7	17	8	7	89	22	12
February	22	26	11	11	70	72	22
March	77	29	16	10	182	82	32
April	287	28	8	13	281	41	12
May	185	16	17	10	228	28	12
June	153	26	11	4	194	43	10
July	160	14	13	8	195	35	10
August	150	31	12	6	199	23	11
September	171	62	10	6	249	29	12
October	221	33	12	5	271	28	16
November	232	100	8	5	345	31	20
December	129	82	8	7	171	39	21
Total	1,744	409	129	92	2,374	418	190

THE ABOVE ATTACHMENTS WERE MADE IN THE WARDS AS FOLLOWS:

WARDS.	½ inch diameter.	⅝ inch diameter.	¾ inch diameter.	1 inch diameter.	Total holes drilled for attachments.	Shut off private pipes for repairs.	Shut off public pipes for repairs.
1st Dist., 1, 2, 3, 4, 26,	308	62	9	22	401	43	9
2d " 5, 6, 7, 8, 9, 10, 24, 27,	311	54	44	21	430	118	14
3d " 11, 12, 16, 17, 18, 19, 23, 25,	501	82	18	25	626	115	108
4th " 13, 14, 15, 20, 21, 28,	564	198	53	24	839	134	34
Germantown, 22d,	60	13	5	0	78	8	25
Total,	1,744	409	129	92	2,374	418	190

THE FOLLOWING TABLE EXHIBITS THE NUMBER OF REPAIRS TO MAINS, STOPS, PLUGS, BY DIFFERENT DISTRICTS, DURING THE YEAR 1867.

DISTRICTS.	Repairs to MAINS.	Repairs to STOPS.	Repairs to PLUGS.
First District	51	184	524
Second "	16	421	463
Third "	108	507	339
Fourth "	34	232	319
Germantown	25	3	42
Total	234	1,847	1,687

ACCOUNT OF NEW STOPS AND FIRE PLUGS.

DITRICTS.	No. of Stops.	No. of Fire Plugs
First District	14	7
Second "	32	19
Third "	69	60
Fourth "	23	65
Germantown	11	28
Total	149	179

PERMITS FOR THE YEAR 1867.

WARDS.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	28 21	22	23	27 24	25	26	TOTAL.
Dwellings	91	51	5	5	3	9	49	16	11	22	4	3	10	12	140	11	23	101	366	383	78	58	37	183	31	377	2079
" ½ and ¾	1	1	.....	.....	.....	.....	2	.....	2	4	3	.....	.....	.....	7	.....	1	4	17	.....	.....	.....	.....	5	5	.....	52
Baths	42	35	5	5	4	7	43	26	3	26	6	4	14	7	113	17	9	15	76	305	66	39	18	84	10	105	1088
Wash Paves	29	31	1	9	10	13	40	24	18	26	5	13	15	33	41	16	12	14	59	250	48	12	17	33	6	45	820
Water Closets and Urinals	5	2	2	1	23	19	53	38	26	30	.....	8	21	13	20	1	2	.....	10	145	15	34	3	32	2	3	508
Basins, Sinks and Tubs	.....	2	.....	.....	36	20	72	50	23	52	4	2	14	11	56	.....	3	6	4	222	15	28	10	38	.....	1	669
Steam Engines	7	.....	.....	.....	5	1	1	1	3	3	2	2	2	.....	.....	1	3	1	5	4	.....	.....	.....	.....	1	2	46
Horse Power	41	.....	.....	.....	48	8	15	3	30	14	9	9	16	.....	.....	15	19	5	70	59	.....	.....	.....	35	2	21	419
Distilleries	9	7	3	11	3	2	8	1	.....	4	2	.....	.....	3	1	5	12	1	9	1	1	1	.....	1	.....	8	93
Breweries	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	2	2	.....	2	3	4	2	.....	.....	.....	1	20
Stables	3	4	.....	.....	1	.....	5	1	7	4	1	1	2	4	12	3	2	2	8	16	12	4	2	3	3	9	109
Church and School Houes	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	1	1	4
Rectifying establishments	2	1	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	6
Fountains	.....	.....	.....	.....	1	2	.....	.....	1	3	1	.....	.....	1	.....	.....	.....	1	.....	2	.....	.....	.....	2	.....	1	15
Building purposes,	5	2	2	.....	2	.....	8	7	2	4	.....	.....	.....	2	5	1	2	8	27	35	5	21	.....	23	1	17	179
Stores and Shops	.....	.....	.....	.....	5	2	1	4	5	2	2	.....	.....	1	.....	1	1	3	2	3	1	1	.....	2	.....	.....	36
Barber "	1	.....	.....	1	2	.....	.....	.....	2	.....	2	.....	1	.....	.....	.....	.....	2	.....	3	.....	.....	.....	1	2	.....	17
Foundries	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1	.....	1	1	2	.....	.....	.....	2	1	.....	9
Slaughter Houses	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	1	.....	1	1	2	.....	.....	.....	.....	.....	8
Hotels and Bars	1	2	2	2	3	3	.....	3	2	1	1	.....	1	3	3	1	1	1	8	3	3	.....	1	1	3	5	54
Skating Parks	2	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	3	.....	.....	.....	1	3	.....	.....	.....	.....	.....	.....	9
Bakeries	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	.....	.....	.....	1	.....	.....	1	7
Mineral Water establishments	4	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
Dye Houses	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	3
Photographic establishments	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1
Brick Yards	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	2	3	.....	.....	.....	.....	.....	9
Soap Works	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1	.....	1	.....	.....	.....	.....	.....	.....	3
Market Houses	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Watering Streets	.....	.....	.....	.....	3	3	1	1	1	1	1	.....	.....	1	.....	.....	.....	.....	.....	1	.....	.....	1	.....	.....	.....	14
" Ships	.....	.....	.....	.....	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
" R. R. Horses	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Laundries	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Green Houses	.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	1	3	.....	.....	.....	.....	7
Cotton Mills	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	2
Total	244	139	21	35	152	92	299	176	136	197	43	42	97	93	409	75	94	170	676	1444	254	203	90	449	69	598	6297

RECEIPTS AND EXPENDITURES.

RECEIPTS.

The gross receipts for the year have been $767,450 89. The sources from which this amount has been received will be exhibited by the statement of the Register, George F. Keyser, Esq. Of the above sum, $5,891 44 has been received at the Engineer's Office.

The following amounts have been received at the Chief Engineer's Office, and paid to the City Treasurer :

For rents,			$1,135 00
" Old iron and brass,			540 45
" Unloading pipe, (Roxborough,)			38 50
" Sharpening tools,	do		81 76
" Stone and sand,			105 00
" Hay from Fairmount,			246 45
U. S. Government,	for stand-pipe for fire-plug,		25 00
A. Born,	for four-inch attachment,		102 59
S. Kalmwiler,	do	do	163 00
West Phila. Pass. R. W. Co.,	do	do	137 83
Bentz & Riley,	do	do	289 00
U. S. Government,	do	do	304 68
Phila. & Reading R. R. Co., (3)		do	600 03
Chestnut Street Theatre,	do	do	144 54
J. P. Bruner & Sons,	do	do	452 15
American Variety Theatre,	do	do	140 09
Connecting Railroad Co.,	do	do	104 59
Rothacker & Tallman,	do	do	287 41
M. Baker & Son,	do	do	166 15
Merrick & Sons,	do	do	132 44
Walnut Street Theatre,	do	do	143 26
Baeder & Adamson,	do	do	150 13
Harrison Sugar Refinery,	do	do	120 79
F. Orth,	do	do	230 31
C. D. Frick, for removing fire-plug,			50 29
Total,			$5,891 44

DEPARTMENT FOR SUPPLYING THE CITY WITH WATER,

Register's Office, No. 104 South Fifth Street.

PHILADELPHIA, *January*, 1868.

FREDERIC GRAFF, ESQ.,

Chief Engineer of the Water Department:

DEAR SIR:—The tabular statement annexed will present to you in detail a full report of the financial operations of the office for the year 1867.

From January 1st to March 16th, 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.

By comparing the receipts of 1867 with 1866, will be noticed an increase in the amounts of Water Rent and penalties collected, of $40,553 01. The amount collected for Water Pipe—$76,938 39—is also largely in excess of that received in 1866, owing to the large amount of feet of Pipe laid in the various sections of the City. The amount yet uncollected for Pipe is $56,044 24, which includes that sent to the City Solicitor for lien, amounting to $22,830 11, and of which over $10,000 has been collected during the first two weeks of January, 1868.

OFFICE OF DEPARTMENT FOR SUPPLYING THE CITY WITH WATER.

List of Consumers of Water in the several Wards, as charged in Registers of 1867.

WARDS.	Dwellings.	¾ dwellings.	½ dwellings.	Stables.	Manufactories.	Total.	Statement as per Board of Revision.
1	3,038	88	586	89	85	3,836	
2	3,662	237	1,252	102	38	5,291	
3	1,827	94	1,232	36	17	3,206	
4	1,854	91	1,423	48	10	3,426	
5	2,534	46	598	56	70	3,304	
6	2,882	39	505	30	55	3,511	
7	3,231	147	1,536	101	24	5,039	
8	2,653	59	606	199	24	3,541	
9	2,632	38	558	112	33	3,373	
10	2,718	93	979	102	38	3,930	
11	1,839	35	1,026	35	42	2,977	
12	1,902	45	827	42	26	2,842	
13	2,847	71	678	35	19	3,650	
14	3,292	174	786	56	34	4,342	
15	4,999	387	1,027	102	78	6,593	
16	1,902	143	1,259	81	99	3,484	
17	2,138	179	1,005	46	47	3,415	
18	2,898	334	771	66	50	4,119	
19	4,680	300	436	154	74	5,644	
20	6,663	268	520	156	46	7,653	
21	336	2	14	10	1	363	
22	757	.....	17	120	19	913	
23	123	.....	4	2	7	136	
24	2,003	41	90	54	26	2,214	
25	566	65	239	19	10	899	
26	4,577	63	522	96	34	5,292	
	68,553	3,039	18,496	1,949	956	92,993	

Total number of Steam Engines, as per registers, January 1, 1868, is 592, and the aggregate horse-power 10,226.

Ward.	Am't of Duplicates for 1867.	Am't of Duplicates for 1868.
First,	$24,227 25	$25,818 00
Second,	28,517 25	29,680 25
Third,	17,083 25	17,067 25
Fourth,	17,859 50	18,012 75
Fifth,	27,822 20	28,437 50
Sixth,	35,021 05	36,403 25
Seventh,	29,982 25	34,389 25
Eighth,	34,027 25	35,059 25
Ninth,	28,985 75	29,835 25
Tenth,	29,461 50	29,680 25
Eleventh,	18,380 50	18,816 50
Twelfth,	19,257 00	19,454 50
Thirteenth,	27,153 50	27,422 50
Fourteenth,	30,467 25	30,901 00
Fifteenth,	52,625 75	61,702 50
Sixteenth,	22,730 25	21,956 75
Seventeenth,	19,442 75	19,986 00
Eighteenth,	25,347 25	26,228 00
Nineteenth,	31,568 75	39,869 75
Twentieth,	56,762 00	64,880 75
Twenty-first,	3,267 50	4,172 50
Twenty-second,	8,922 50	9,932 00
Twenty-third,	802 00	1,233 00
Twenty-fourth,	19,142 25	20,133 25
Twenty-fifth,	5,035 75	5,360 25
Twenty-sixth,	26,281 00	28,924 75
Total,	$640,173 55	$685,357 00

STATEMENT OF RECEIPTS AT THE REGISTER'S OFFICE, FROM JANUARY 1, TO DECEMBER 31, 1867.

MONTHS.	Rents, 1865.	Penalties, 1865.	Rents, 1866.	Penalties, 1866.	Rents, 1867.	Penalties, 1867.	Fractional Rents.	Water Pipe.	TOTAL.
January.....	$453 25	$55 42	$2,553 00	$348 31	$21,423 00	.....	$1,475 25	$8,796 17	$35,094 40
February.....	244 50	22 51	2,465 25	310 05	77,912 50	.....	2,183 75	3,846 00	86,984 56
March.....	321 25	44 30	2,470 62	355 19	86,246 00	.....	2,374 53	4,933 11	96,745 00
April.....	452 00	47 54	2,470 75	357 21	304,803 50	.....	4,100 25	2,785 17	315,016 42
May.....	192 00	18 32	1,126 25	137 98	28,000 80	1,212 07	3,362 75	7,811 97	41,862 14
June.....	63 50	4 65	483 50	40 71	30,899 00	1,148 12	2,848 75	5,006 63	40,794 86
July.....	286 00	7 60	203 50	14 93	5,342 75	722 07	2,543 50	4,895 44	14,015 79
August.....	109 75	7 20	331 25	43 08	14,059 00	1,926 84	1,920 25	6,008 94	24,406 31
September.....	110 50	5 17	804 75	103 02	21,854 75	2,644 41	2,067 50	8,477 13	36,067 23
October.....	159 50	13 80	593 75	71 29	12,894 50	*1,611 88	2,457 00	8,502 29	26,304 01
November.....	363 75	37 24	960 75	120 82	13,053 50	1,317 71	2,372 50	7,906 08	26,132 35
December.....	360 50	42 96	658 75	70 25	5,251 25	649 21	3,134 00	7,969 46	18,136 38
Total.....	$3,106 50	$306 71	$15,122 12	$1,972 84	$621,740 55	$11,532 31	$30,840 03	$76,938 39	$761,559 45

Annexed you will find the Amounts of the Duplicates for the years 1867 and 1868, showing the aggregate amount of Water Rents charged upon the same, and the increase thereof, which, with the income from Fractional Water Rents, Delinquents and Water Pipe, will probably give a grand total of $800,000 for the year 1868.

Respectfully yours,

GEORGE F. KEYSER,

Register.

EXPENDITURES OF THE DEPARTMENT FOR THE YEAR 1867.

Salaries of Chief Engineer, Register, Clerks, &c.,		$27,541 43
Office expenses,		3,483 37
Salaries of engineers, firemen, &c., at works,		25,129 31
Supplies to Works, viz:		
Coal,	$23,179 80	
Tallow, oil and gas,	3,194 39	
Wood,	94 07	
Small stores,	2,404 13	
		28,872 39
Repairs to Works, viz:		
Fairmount Works,	9,481 84	
Delaware "	6,460 28	
Schuylkill "	2,983 77	
Twenty-fourth Ward Works,	2,239 84	
Germantown "	421 09	
		21,586 82
Buildings, Grounds and Reservoirs,		
Lumber,	2,268 78	
Bricks,	318 50	
Lime and cement,	273 90	
Stone,	684 82	
Roofing,	45 00	
Paints,	150 32	
Plumbing,	162 90	
Hardware,	249 30	
Smithwork,	187 38	
Drain pipe,	15 30	
Powder,	18 50	
Ropes, &c.,	160 66	
Fire hose,	323 00	
Glass and glazing,	147 68	
Puddling clay,	72 00	
Batteau,	35 75	
Granite steps,	526 90	
Rent of poratable engine,	248 70	
Mason-work,	3,025 43	
Amounts carried forward,	$8,914 82	$106,613 32

Amounts brought forward, -	$8,914 82	$106,613 32	
Bricklaying, - - -	1,099 78		
Carpenter-work, - -	127 38		
Tin-work, - - -	84 79		
Sundry bills, - - -	419 20		
Wages, - - - -	17,973 37		
Pumping at forebay, -	300 00		
		28,919 29	
Keeping grounds in order,			
Flowers, - - - -	47 77		
Lumber, - - - -	458 11		
Hoes, - - - -	26 50		
Lime, - - - -	25 50		
Trees, - - - -	12 00		
Gutter-box, - - -	45 00		
Sundry bills, - - -	23 50		
Wages, - - - -	2,329 00		
		2,967 38	
Iron pipes, fire plugs, and other fixtures and materials for laying pipe, &c.,			
Iron pipe, - - -	98,168 29		
Iron castings, - - -	6,458 04		
Brass " - - -	3,431 11		
Lead, - - - -	5,931 60		
Wrought iron and steel, -	1,402 42		
Wood, - - - -	90 20		
Hardware, - - -	1,011 33		
Coal, - - - -	352 50		
Bolts and nuts, - -	662 06		
Leather, - - -	260 51		
Lumber, - - -	1,388 54		
Oil, - - - -	20 50		
Gasket, - - - -	37 75		
Paints, - - - -	184 84		
Machine work, - -	681 89		
Covering spindles, - -	363 00		
Hauling pipes, - -	113 50		
Amounts carried forward,	$120,558 08	$138,499 99	

Amounts brought forward,	$120,558 08	$138,499 99	
Wharfage, - - -	36 00		
Purveyor's office, - -	458 25		
Rent of yards, - -	115 00		
Wheels for tool-house, -	81 50		
Repairs, - - -	55 79		
Belting, - - -	16 80		
Inspecting pipe, - -	485 65		
Sundry bills, - - -	90 26		
		$121,897 33	
Labor. Laying pipe, setting plugs, &c., and for fitting up stop cocks, fire, &c., &c., viz:			
Pipe, First District, -	2,392 32		
" Second " -	2,832 24		
" Third " -	4,096 74		
" Fourth " -	6,279 93		
" Germantown, -	4,379 07		
		19,990 30	
Shop, viz:			
Wages, - - - -	9,962 75		
Surveyors for measuring pipe,	2,150 90		
Hauling pipe, &c., -	5,598 55		
Pipe plans, - - -	936 00		
Sundry bills,, - -	294 07		
		13,942 27	
Keeping pipes, plugs, stops and fixtures in good order, viz:			
Wages, First District, -	3,594 65		
" Second " -	3,433 55		
" Third " -	6,633 62		
" Fourth " -	5,168 50		
" Germantown, -	933 13		
Paving around Plugs, -	700 40		
Plumbing, - - -	101 57		
Sundry bills, - -	221 86		
Surveys for a better supply of water, - - -	9 00		
		20,787 28	
Amount carried forward, - -		$315,126 17	

Amount brought forward, - -		$315,126 17
Drilling and making new attachments, viz:		
Wages, First District, -	1,408 50	
" Second " -	1,477 25	
" Third " -	1,421 75	
" Fourth " -	2,293 50	
" Germantown, -	122 00	
		6,723 00
Railing at Fairmount, - - - - -		931 63
Carriage hire, - - - - - - -		154 50
		$322,935 30
Matthew Newkirk, for damages, - - -		209 02
Sewer on Twenty-fifth street, N. from Green, -		86 02
Repairs, Fairmount Dam (Wages), - - -		449 63
C. Kennedy, for sewer, Twenty-fifth street, -		614 48
Bills for over-paid and twice paid water rents, &c., of 1864, 1865, 1866 and 1867, - - -		180 53
D. Cramer & Son, for balance on contract for building engine-house, foundation and stack at Roxborough Water Works, - - - -		4,784 62
Substituting turbine wheel at Fairmount, in place of old breast-wheels Nos. 2 and 3, viz:		
Turbine wheel, - -	13,091 02	
Stone, - - - -	2,987 66	
Granite, - - -	800 00	
Lumber, - - -	1,525 59	
Iron beams, - - -	3,058 09	
Hauling beams, - -	42 00	
Iron castings, - -	101 43	
Wrought iron and steel,	217 89	
Hardware, - - -	154 78	
Dressing tools, - -	108 41	
Marine pump and pipe, -	311 63	
Belting, - - -	66 40	
Brass castings, - -	53 85	
Machine work, - -	15 81	
Sundry bills, - -	139 75	
Wages, - - - -	8,585 63	
		31,259 94
		$360,519 54

EXTENSIONS OF WORKS.

AMOUNTS PAID FROM WATER LOAN FOR WORKS AT FLAT ROCK.

Item 1.

For Cornish engine, boilers and connections:		
Engine, - - - -	$53,394 36	
Iron castings, - - -	24 24	
Brass " - - -	13 40	
Drilling holes, - - -	477 50	
Ratchet drill, - - -	35 00	
Ropes, - - - -	562 24	
Rent of scow, - - -	102 00	
Sundry bills, - - -	137 25	
Wages, - - - -	3,986 13	
		58,732 12

Item 2.

For engine-house foundation and stack:		
Contract, - - -	2,550 00	
Granite, - - - -	950 00	
Stone, - - - -	669 70	
Lumber, - - - -	848 89	
Fire morter, - - -	24 50	
Cement, - - - -	92 00	
Hauling granite, &c., -	94 00	
Hardware, - - -	50 97	
Coal, - - - -	67 60	
Sundry bills, - - -	201 51	
Wages, - - - -	4,807 60	
		10,356 77

Item 3.

For pumping main:		
Mains, - - - -	12,914 52	
Machine work, - -	753 83	
Lead, - - - -	908 80	
Cov. spindle, - - -	12 50	
Hardware, - - -	132 08	
Sundry bills, - - -	122 42	
Wages, - - - -	6,889 16	
		21,733 31
Amount carried forward, - - -		$90,822 20

Item 4.

Amount brought forward, - - -		$90,822 20
For reservoir:		
Mill-racks, &c., for tempering machines, - - -	82 37	
Lumber, - - -	310 72	
Clay, - - - -	500 00	
Coal, - - - -	45 15	
Lime, - - - -	187 52	
Bricks, - - - -	205 90	
Soap-stone, - - -	1,026 69	
Stone, - - - -	517 39	
Sundry bills, - - -	9 06	
Wages, - - - -	16,760 41	
		19,645 21

Item 5.

For twenty-inch, sixteen-inch and twelve-inch mains:		
Mains, - - - -	37,158 92	
Machine work, - -	320 89	
Stop cock, - - -	391 75	
Lead, - - - -	2,531 35	
Iron castings, - -	439 64	
Brass " - - -	101 74	
Gasket, - - -	523 26	
Iron and steel, - -	132 18	
Hardware, - - -	21 15	
Inspecting mains, - -	194 50	
Powder, - - -	68 50	
Sundry bills, - - -	76 86	
Wages, - - - -	3,656 24	
		45,616 98

Item 7.

For incidentals:		
Photographs, - -	66 00	
Sundry bills, - - -	151 49	
		217 49
Amount carried forward, - - -		$156,301 88

FOR TWENTY-FOURTH WARD WORKS.

Item 8.

Amount brought forward, - - -		$156,301 88
For Cornish pumping engine, boilers and connections:		
Contract, - - -	$6,750 00	
Wages, - - - -	767 00	
		7,517 00
		$163,818 88

Item 10.

For Reservoir:		
Lumber, - - -	198 89	
Hardware, - - -	100 12	
Steam pump, - -	190 00	
Boiler, - - - -	125 00	
Sprinkling cart, - -	100 00	
Tubing, - - -	113 51	
Iron castings, - -	43 60	
Coal, - - - -	21 25	
Blacksmithing, - -	634 55	
Machine work, - -	112 76	
Sundry bills, - -	126 07	
Wages, - - - -	35,904 63	
		37,670 38

Item 11.

For Real Estate:	
Preparing titles to real estate, - - - -	192 50

Item 13.

For Incidentals:	
Sundry bills, - - - - - - -	6 22

Item 14.

For a thirty-inch main to connect Corinthian avenue reservoir with Kensington Water Works:		
Mains, - - - -	$5,535 13	
Iron castings, - -	268 25	
Lead, - - - -	682 65	
Hauling main, - -	93 00	
Digging ditch, - -	2,000 00	
Machine work, - -	263 13	
Wages, - - - -	1,548 99	
		10,391 15
Amount carried forward, - - - -		$212,079 13

Amount brought forward, - - - -		$212,079 13
Making and sinking a crib in front of Fairmount Dam, through the deep water, and placing an oak apron upon it:		
Lumber, - - -	$787 98	
Scow, - - - -	925 00	
Wrought iron and steel, -	199 43	
Barrows, - - -	40 50	
Hardware, - - -	87 00	
Stone, - - - -	255 50	
Towing, - - -	12 00	
Sundry bills, - - -	49 46	
Wages, - - - -	938 95	
		3,245 82
		$215,324 95

LENGTH OF PIPE LAID SINCE CONSOLIDATION.

YEARS.	Miles.	Feet.
1855	6	44
1856	10	2,079
1857	12	324
1858	13	3,484
1859	22	784
1860	19	224
1861	11	2,368
1862	9	954
1863	10	4,161
1864	6	4,287
1865	8	4,754
1866	12	2,964
1867	15	4,971
Total,	158	4,498

RECEIPTS AND EXPENDITURES SINCE CONSOLIDATION.

YEARS.	Received by Register for Water Rents and percentage.	Received by Chief Engineer for rents, old iron, scraps, and private fire-plug attachments.	Total Receipts from all sources.	Yearly Increase.	Total Expenditures.
1855.....	$381,410 17	$626 55	$382,036 72	.....	$250,895 87
1856.....	351,936 49	960 11	352,896 60	Decrease.	160,368 02
1857.....	425,661 94	302 20	425,964 14	73,067 54	200,605 82
1858.....	457,518 48	129 75	457,648 23	31,684 09	187,978 09
1859.....	548,128 19	3,051 89	551,180 08	93,531 85	411,737 09
1860.....	557,121 76	1,409 77	558,531 53	7,351 45	252,506 23
1861.....	533,094 76	885 30	533,980 06	Decrease.	238,989 54
1862.....	544,767 25	1,025 82	545,793 07	11,813 01	177,271 69
1863.....	568,740 60	937 69	569,678 29	23,885 22	213,750 20
1864.....	609,257 28	855 29	610,112 57	40,434 28	253,968 75
1865.....	629,887 47	6,500 95	636,388 42	26,275 85	422,337 58
1866.....	666,294 95	3,927 18	670,222 13	33,833 71	616,712 92
1867.....	761,559 45	5,891 44	767,450 89	96,228 76	575,844 49

APPENDIX.

To the President and Members of the
Select and Common Councils of Philadelphia.

GENTLEMEN:—A comparison of the level of the reservoir now building at Roxborough, with that at Mount Airy, (from which Germantown is now supplied,) shows that the first named has, unfortunately, not been located sufficiently high to properly supply the latter.

The two reservoirs are shown upon all the plans and sections of surveys made last year (found in the office) as precisely level when full; under such circumstances it is very obvious that no flow of water could possibly take place in the connecting main, until the demand would draw down the surface level of Mount Airy reservoir.

In order that there should be no doubt about so important a matter, I caused levels to be run to each reservoir by the respective District Surveyors, by which we find that the water in Mount Airy reservoir will be $1\frac{74}{100}$ feet lower than that at Roxborough, when both are filled to within three feet of the top of their embankments; this then will be the available head to produce a flow through the main, when both are filled.

A new main of twenty inches diameter (the size proposed to be used) and 17,000 feet long, which will be the length by the best route, is calculated to deliver, when in its best condition, 786,899 gallons per twenty-four hours, but as the pipe, if uncoated, would soon collect accretions and silt, this amount would be materially reduced daily, and must be considered as a maximum.

Careful experiments upon a main twenty inches in diameter and 29,715 feet long, which connects the receiving and distributing reservoirs of the Jersey City Water Works, after it had been in use four years, show the formula used above in calculating the flow to be much in excess of the actual results obtained from the experiments named; from formula given

by the Engineer, in his report upon the subject, and modified from a well known formula of Proney to accord with the actual flow obtained, we find that a flow of 327,131 gallons per day is all we can confidently calculate upon with so limited a head as $1\frac{74}{100}$ feet, and a corroded pipe.

The experiments referred to were made by direction of Mr. Kirkwood, previous to the erection of the reservoir at Prospect Hill, Brooklyn, with great care and under very favorable circumstances, in order to determine a similar problem to the one we have now under consideration.

They are the most reliable experiments, upon a large scale, with which I am acquainted; a similar set of experiments made with the same object upon the 36 in. mains, between the receiving and distributing reservoirs of the Croton Aqueduct, fully confirmed the deductions drawn from the first named; I have, therefore, made use of the formula which these experiments indicated, believing it to be reliable, where uncoated pipes, a few years old, are employed to convey soft water.

The experiments show: that the actual head required to deliver 202,494 gallons per day through 25,715 feet of 20 inch main was $28\frac{128}{1000}$ feet.

The maximum supply pumped at Germantown in July, 1866, was 680,253 gallons; carefully conducted observations made in Boston and other cities, show that the demand during some hours of the day is more than double the hourly average of the whole day. Supposing that in Germantown it is double, the supply for the hours say between 8 and 3 o'clock in the day, would be at the rate of 1,360,512 gallons; we have already shown that a flow of 327,131 gallons is all that we can confidently rely upon when both reservoirs are full.

The reservoir at Mount Airy is now very imperfect, and I am informed cannot be filled to a greater depth than ten feet without leaking. We may, therefore, consider that as its normal depth at present, this would give us a head of $8\frac{74}{100}$ feet, when Roxborough is entirely full, with which head a twenty inch main will probably deliver 1,351,002 per day, an amount insufficient to supply the maximum demand of the hottest portions of a summer day.

It is to be remembered that Manayunk is to be supplied by these Works as well as Germantown, and that but one pumping engine, of but limited capacity, is provided, it is evident,

therefore, that Roxborough reservoir cannot always be kept full, and probable fluctuations in the level of the water of at least five feet must be allowed. Supposing, then, that this depression of five feet has taken place, and as we have shown a head of $8\frac{74}{100}$ feet is required to deliver 1,351,002 gallons, we will necessarily be left with but five feet water in Mount Airy reservoir, equal to about 980,327 gallons, so that at such times this reservoir may be considered as practically almost useless.

The plan of the late Chief Engineer was, as I learn, not to use the reservoir at Mount Airy at all, (and by his advice it was not purchased by the City), but to run directly to the stand pipe now used by the works, situate on Tulpahocken street; this course would materially increase the difficulty; the main to that point will be 27,500 feet, or five and two-tenth miles long; to produce a flow of 1,351,002 gallons at the stand pipe will require a head of $14\frac{2}{10}$ feet, or $5\frac{46}{100}$ feet greater than to effect the same flow at the Mount Airy reservoir.

The loss of head will, of course, be increased with greater demand, and when a supply at the rate of 2,832,773 gallons for any part of the day is required, the stand pipe will be drawn down $44\frac{19}{100}$, or $24\frac{5}{10}$ feet below the highest curb in Germantown, and $13\frac{41}{100}$ feet below the highest curb on the Chew property, now being rapidly improved.

The advantage of having a reservoir at the terminus of so long a main, is that there is an opportunity to fill it at night, and at times, when the demand is at the minimum, giving out the water so accumulated when the demand increases, during the heat of the day, thus preventing the violent fluctuations in head which must necessarily take place if no reservoir be used; beside, should any accident happen to the line of main from Roxborough, Germantown must be without water if the stand pipe be depended upon, whilst, if the reservoir be used, it might (small as it is) possibly contain sufficient water to admit of the repair being made without depriving the district of water.

Whilst the reservoir at Roxborough is not high enough to properly supply Germantown, it is too high to safely and economically supply Manayunk; the engine must now raise the water $344\frac{6760}{1000}$ feet above Flat Rock dam, from which

height it will return to a point on the main street, $4\frac{912}{1000}$ feet lower than that from which it was originally pumped.

It is probable that before these works can be started, Germantown will require a supply at the rate of at least 2,000,000 gallons per day for some part of the day. The engine at Flat Rock will raise, when working at eight strokes per minute, (which, considering the heavy lift, will probably be her fair speed,) about 1,638,240 gallons per day, and with a speed of twelve strokes, which must be considered as a maximum, she should throw 2,457,360 gallons per day into the reservoir.

This supply, as previously mentioned, is intended for both Germantown and Manayunk; the latter from the number of its factories and very great head of water upon the mains, will probably require as much water as the former; it will therefore be seen that the engine power will, in a very few years, be quite inadequate.

There are two means of relief left us, one being the laying of a thirty inch main to Mount Airy, instead of a twenty inch, whereby a flow of 1,073,433 gallons per day with the minimum head could certainly be secured, and with pipe coated with pitch varnish, this, and even a considerably greater supply, possibly as much as 2,168,280 gallons per day, could be relied upon for at least five years.

The other plan is the laying of a coated pipe of twenty inches diameter, and the erection of a pumping engine and stand pipe at the Roxborough reservoir.

Even with a thirty inch main a pumping engine will finally be required, but the time for the erection of such can, of course, be deferred somewhat longer than if a twenty inch is used.

By the best authorities, a velocity of two feet per second in the pipe is considered to be the greatest that should be permitted; to produce this velocity through an uncoated pipe of twenty inches diameter, will require the water to be pumped not less than 28 feet above the Roxborough reservoir, and would furnish a supply of 2,832,773 gallons per day.

As the terms coated and uncoated pipes are used above, it may be well to mention that it has been found that in less than a year's time, a main, unprotected by any artificial means, has collected tubercular corrosions sufficient to reduce the internal area of the pipe fully one-tenth, the friction of

the water being of course correspondingly increased, and the flow reduced.

We fortunately have now a means of coating the pipes with coal pitch varnish, which has proven satisfactory for a period of fourteen years in Scotland, and for eight years in this country; pipes with this coating have been found to deliver nearly one-third more water than uncoated pipes of the same diameter, after both were in use four years.

The Committee have wisely authorized the coating of all pipes hereafter laid by the department, and of course the main required for Germantown will be so coated, yet I have considered it prudent to give the calculations of flow as though the pipe was unprotected from corrosion.

I am obliged to report that the sums estimated for, and appropriated to this work, are insufficient to finish it; below will be found a statement of the amounts already expended, and an estimate of the sums which will probably be required to finish the whole upon the plan originally proposed by the late Chief Engineer. And also, with the addition of a pumping engine as above proposed.

Total amount expended to May 1, 1867, .		$200,612 81
Estimated sum required to finish the whole.		
Twenty inch main to Mount Airy reservoir, ...	$175,392	
Sixteen inch main to Manayunk, .	11,374	
Twelve " " " .	22,121	
Laying twenty inch main to Manayunk,	25,000	
Total cost of mains, .	$233,887	
Purchase and repair Mount Airy reservoir, ...	40,000	
To finish engine and foundation, .	35,325	
To finish engine house, boiler house, pavements, tunnel, grading, railroad coal schute, scales, &c., &c.,	17,063	
To finish reservoir, . . .	30,500	
		356,775 00
Probable total cost of the work, .		$557,387 81
Amount originally estimated, not including the main to Germantown, but including the 20, 16 and 12-inch mains for Manayunk, . .		250,000 00

No estimate has been made for service mains in Manaynnk, as they were intended to be supplied from the annual appropriation for service pipes throughout the City.

To lay a main of thirty inches to Mount Airy reservoir, instead of one of twenty inches, will increase the sum reported required to finish the work to	442,075 00
To lay a twenty inch main and erect a pumping engine and stand pipe at Roxborough, will require an expenditure, in addition to that already made, of	446,775 00
Making the total cost of the work, then, . .	$647,387 81

I learn that it was proposed to supply part of the Twentieth Ward from these works; from the foregoing statement it will be seen, that to do this will involve large increase of engine power, larger mains from Mount Airy reservoir, and, of course, very considerable additional expense.

An arrangement with the Germantown Water Company, for the use of their pumping machinery and Mount Airy reservoir, was effected for eighteen months, which time expires on the 15th day of November next; as no pipes are yet ordered to lay a main from Germantown to Roxborough, it will be seen that the works cannot possibly be put in operation at the time named. Provision should be made as early as possible for the purchase of the necessary mains, that the use of the works of the Germantown Company may be discontinued, and the new works made available.

All of which is respectfully submitted by

Your obedient servant,

FRED. GRAFF,

Chief Engineer Water Department.

June 1, 1867.

The following formula was used for calculating the flow of the coated pipe:

$$V = \sqrt{\frac{(15\ D)^5\ H}{L}}$$

G=Number of gallons per hour,
L=Length of main yards,
H=Head of water pipe,
D=Diameter pipe inches,
} Hawksley's formula per Molesworth.

And the following for uncoated pipes:

$$V = 46^{2502} \sqrt{\frac{H\ D}{L}}\ 0.397.$$

V=Velocity in feet,
H=Head in feet,
D=Diameter in feet,
L=Length in feet,
} Formula deduced from experiments made at Jersey City and N. York.

And the loss of head in corroded pipes by the following:

$$H = 0.\ 00046749 \frac{L}{D} (V + 0{,}397)^2$$

Terms all in feet.