

REPORT
MADE BY AN
EXAMINING BOARD
OF
Hydraulic Engineers
TO THE
WATER COMMISSIONERS

UPON THE
Present State of the Brooklyn Water Works,

DECEMBER 9, 1858

BROOKLYN :

L. DARBEE & SON, PRINTERS, COR. SOUTH-FIRST & FOURTH ST.

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INTRODUCTORY REMARKS.

THE works now in progress of construction for the purpose of supplying the City of Brooklyn with water, which were commenced only two years ago, are now so far completed as to furnish a sufficient quantity for extinguishing fires and supplying all such houses and factories as have been connected with the distribution pipes, and it is expected that the large pumping engine will be ready some time in February to deliver water into the reservoir. This engine can supply all the water required by the city for some time to come.

The first of the series of ponds, whose surplus waters are to be brought to the city, has been filled and ready for use for a month past. The brick conduit, four and three-quarter miles in length, which is to lead the collected waters of the supply ponds to the pump-well, is completed and in use. The pump-well, large enough to receive and supply four pumping engines, is also completed. The engine-house is nearly ready to receive its roof, and its appendages are in a very forward state of progress. The engine itself is fast approaching completion, and promises to do the duty required of it.

The rising mains, through which the water is pumped into the reservoir, have been laid and are now in use, delivering a limited supply, by means of two small temporary engines, which are steadily at work.

Ridgewood reservoir is so far complete that a sufficient supply of water for present use may, with safety, be kept in the eastern division of it during the winter. The western division is nearly finished, and the influx and efflux chambers sufficiently so for use.

The mains, distributing pipes, stop-cocks, and 800 hydrants, laid and set, are all ready for use, and are being tested in sections. About 118 miles of pipe, out of the 120 required by the contract, have been laid.

The Prospect Hill reservoir and engine-house will soon be commenced, this portion of the work being designed to supply water at a level some fifty feet higher than it could be delivered from the Ridgewood reservoir.

The other ponds, east of Jamaica pond, are in active progress of completion.

The whole series will probably be able to furnish the supply required, and, if not, others must be prepared to make up the deficiency.

The only portion of the work not noticed is the open canal, 7 2-3 miles long, which is designed to lead the waters of the ponds to the head of the brick conduit. This portion of the work is in progress, though a brick conduit would be far preferable, for reasons ably set forth in the accompanying report.

It is not too late to take action on the subject of a change such as is there suggested, but the additional cost is considerable, and requires the sanction of the Common Council. This has been twice applied for.

At first, authority was asked to construct a full-sized brick conduit, capable of delivering forty millions of gallons, where it connects with the present one, which has that capacity.

The last application was for the permission to construct a circular conduit of reduced capacity, not in keeping, to be sure, with the rest of the work, but still far preferable to the open canal.

In both instances, the Common Council have thought proper to withhold their sanction to the increased cost, which is required by law, before the change can be made. The contractors, therefore, who had hesitated in expectation of such an alteration being made, are now actively engaged on the completion of the canal, according to the terms of the contract.

It would not be proper for the Commissioners to praise the work, which they have been entrusted to carry out; others must judge of it according to its merits. All they wish the public to understand, is the fact, that they fully appreciate the nature of the trust reposed in them, which is, to carry out the terms of the contract entered into by the City of Brooklyn with Messrs. Welles & Co., in May and June, 1856.

This trust they hope to fulfill to the entire satisfaction of the citizens generally, who, so far, have shown entire confidence in the Board of Water Commissioners. Full investigation is invited; and they desire nothing more ardently, than to see the people interest themselves in watching the progress of the work, and encouraging them in their labors.

The financial management of the work has been, according to their best judgment, carefully and conscientiously carried out for the best interests of the city.

It will be remembered that the contractors were bound to accept the first issue of bonds, amounting to \$1,300,000, at par, in payment for work.

This they complied with, even through the financial crisis of 1857, at a heavy loss to themselves.

When it became necessary to make cash payments, temporary loans were obtained at 7 per cent., secured by the pledge of bonds in the hands of the City Treasurer, in preference to disposing of the bonds at a heavy discount. These loans were not of large amount; and all that are due have been paid, and the bonds in pledge have been released.

Since the rise in moneyed securities, the bonds have been disposed of, so as to realize very nearly their par value. In this, the officers in charge of the financial concerns of the city have been of great assistance, and deserve the thanks of the tax-payers generally.

The work actually done has been paid for in monthly instalments, upon careful and detailed estimates made by the Chief Engineer, from ample data obtained from the reports of the assistant engineers and the inspectors on the work in progress, on the ground or in workshops.

Twenty per cent. was reserved upon all the first estimates for work, until a fund of \$500,000 was laid aside; which is now held, as a pledge, for the proper completion of the contract.

There is an ample fund remaining of cash and bonds, *not sold*, sufficient to complete the work and allow for contingencies. The only important addition to the total cost of the works will be the interest on bonds issued and sold, which, by law, was directed to be paid for until 1860, by the issue of additional bonds.

Regular books are kept by the Commissioners; and the cost of each part of the work, engineering expenses and superintendence, can be accounted for.

The cash transactions of the Board are limited to the payment of certain small expenses, not embraced in the contract, and to such portions of the salaries, &c., of employees as exceeds the sum allowed in the contract for that purpose. The payments to the contractors are made by drafts on the Comptroller; the proceeds of all bonds sold being held by the City Treasurer.

To the efforts and plans of the chief engineer, Mr. JAMES P. KIRKWOOD, based on the well-considered labors and designs of his predecessors, and the specifications which control our works, we owe the satisfactory results thus far obtained.

The ability and industry shown by him and by his assistants, who have all labored faithfully in the performance of the duties assigned them, will, however, be best proved by the completion of their work.

In conclusion, the Commissioners feel it incumbent on them to express their satisfaction at the spirit and energy shown by the contractors, Messrs. WELLES & Co., in endeavoring to fulfil the terms of the arduous contract they have undertaken; they have labored under

difficulties of no ordinary kind, but without complaint, and with undiminished zeal in their work. The Board have always expected and exacted from them the full performance of the contract in spirit and in letter, except where changes have been made for the advantage of the work as a whole; in which cases, satisfactory arrangements have been entered into for the alterations made.

Most of our public officers have been anxious, so far as in their power lay, to promote the progress of the work by their action and efforts. The change of city officers, which the laws annually require, shows the wisdom of entrusting the completion of the contract to a permanent Board, independent of local or political influences. These would, perhaps, in a certain degree, have impeded the steady and active progress of the great enterprise, which promises to place us on a par with our sister city.

An abundant supply of pure water, coursing through the streets of a populous town, and a well organized plan of sewerage to drain it, are of the same value to its inhabitants as a supply of pure blood is to the human body, which, after vivifying its most remote organs by means of the arteries, carries off the impurities of the system through the veins, to be again prepared for use by contact with the air.

With these brief remarks, we present the interesting report made by the Board of Examining Engineers on the present state of the works; the changes already made, and alterations which they have thought proper to suggest.

The gentlemen comprising this Board met on Tuesday the 30th ult., and have been actively engaged since

that time in inspecting the works completed or in progress, and have been left free from all influence or control in the preparation of their report.

It is to be regretted that illness has prevented Mr. WM. J. MCALPINE from acting with these gentlemen. His able report made to the Water Committee of the Common Council of 1853, of which Mr. CHAS. R. MARVIN was Chairman, is well known, and to him belongs the merit of first suggesting the system of supply which is now being carried out.

General WARD B. BURNETT afterward examined the same ground and matured the plan upon which the present contract is based. The works now being constructed are carried out, in general, in accordance with the specifications submitted with his reports.

BROOKLYN BOARD OF WATER COMMISSIONERS.

Read and approved, December 16th, 1858.

J. CARSON BREVOORT,

Secretary.

REPORT,

Made by an Engineering Board of Hydraulic Engineers to the Water Commissioners, upon the present state of the Brooklyn Water Works.

BROOKLYN, 9th Dec., 1858.

*To the Board of Water Commissioners
of the City of Brooklyn:*

GENTLEMEN—

The undersigned received from your President and Secretary the following minute from the proceedings of your Board:

"IN BOARD OF WATER COMMISSIONERS,
Brooklyn, Nov. 19th, 1858.

Resolved. That this Board invite four Hydraulic Engineers of acknowledged merit, who shall constitute a Board, to thoroughly examine the works already constructed, and to be constructed, for supplying the City of Brooklyn with water, as to their efficiency and competency to the duties required of them; the conditions of the contract with H. S. Welles & Co., and the propriety or advantage of such changes from the original specifications as have been made or suggested, and to report their opinion thereon in full to this Board.

Resolved. That the following gentlemen be invited to form said Board, viz: JOHN B. JERVIS, FREDERICK GRAFF, WM. J. MCALPINE and JOHN T. CLARK.

Resolved. That the President and Secretary be requested to communicate with the above named gentlemen, and arrange with them for a meeting at as early a day as practicable.

"A copy from the minutes.

"J. CARSON BREVOORT, Secretary."

The letter received from your President and Secretary requested us to meet at your office in the City of Brooklyn on the 30th day of November ultimo. In accordance with that request, Messrs. Jervis, Graff and Clark met on that day, and proceeded to examine the works and consider the matters referred to them.

It has appeared proper to consider—

First. The alterations from the plan contemplated in the contract.

Second. The efficiency of the works to secure the supply of water contemplated, and

Third. Any improvements beyond the provisions of the contract, that would render the works more complete and satisfactory.

And, *first*, the alterations from the plan contemplated in the contract:

The most important of these are, the omissions of work, and changes in the Ridgewood reservoir, and the additional works and extension of the west end of the conduit. As we understand the contract and the powers of your Board, it appears necessary to consider these changes as involved in each other; that is, if the change

in the west end of the conduit was proper, it became necessary to provide for the extra expense by dispensing with a corresponding amount of work on some other part. That, in other words, the Commissioners had not the power to increase the cost of the works above the terms the contract.

The duty of the Chief Engineer in preparing estimates for such changes would, in many respects, be a difficult one. It was not possible for him in all cases to reduce his estimates by exact calculation, and he must depend on his general judgment, without the aid of computation or direct experience.

In the contingency of such items, it would be very natural for the contractors to make a higher estimate than the Engineer.

On the reservoir part, most of the work could be estimated with satisfactory approximation. But the change in the west end of the conduit involved much uncertainty, and of a character that is rarely over-estimated.

We have examined the estimates of the Chief Engineer and considered the circumstances of the proposed work, and have arrived at the conclusion that they were made with as much accuracy as could have been reasonably anticipated. It appears the contractors were not satisfied with his estimate for the change in the west end of conduit, and the Commissioners acceded to their proposition for an advance of \$20,000 over the estimate of the Chief Engineer. There does not appear to us anything unreasonable or improper in this. The Commissioners no doubt regarded the change as required for the interest of the

work, and they could not require the contractors to make it, except on terms satisfactory to them.

The change in the reservoir from three divisions to two divisions we regard as a proper one; it allows greater directness and simplicity in the arrangements for receiving and distributing the water, than that proposed by the three divisions.

Having two divisions, there is all the facility necessary for supplying the city by one division, when the other may be emptied for repairs or cleaning, and we do not see sufficient reason in this case for complicating the work with three divisions.

It is presumed the plan of three divisions originated in the idea of obtaining greater facility for depuration. From the character of the supply, we do not regard this as at all important. It is a peculiarity of this source that the water mainly comes to the aqueduct by percolation through vast beds of sand, and may be said to be thoroughly filtered before it enters, and unless it becomes turbid on its way, it will be received into the reservoir in a very pure state.

The only other change of moment in this reservoir is the abandonment of the brick and concrete lining, provided in the contract, for the bottom and sides. This was a large item in the cost of the work. Had there been no object to change this, so as to convert the saving to more important work, very possibly it would not have been made.

No doubt this lining would have made the bottom of the reservoir more impervious to water, and saved some

loss, from the filtration that will occur through the earth; and it becomes necessary to consider the importance of this exposure. The reservoir is very favorably situated; except to a small extent, it is in excavation. The outside embankments, for the most part, have their base from five to twenty feet above the bottom water line of the reservoir.

The earth is a mixture of gravel and loam, that has been carried on, in thin layers, by teams. The bottom has been lined with two feet of puddled earth, carried up on the face of the excavation. In the centre of the banks a puddled wall has been carried up.

We examined the puddle in the bottom, and found it to appear satisfactory.

In other respects, it was covered by wall and embankment, and we had not opportunity to judge of its quality; we presume, however, it has all been fairly done. Considering the general character of the material of which the reservoir is made, and the method of building, with the additional protection of the puddling, we are of opinion that no material loss of water will result from filtration, and, to guard against this, we consider the only object of the brick and concrete lining. In other respects, as to the protection of the face of the banks from abrasion by the action of the wind on the water, the stone walling that has been substituted, provided it be secured (as we are informed it is,) by a base of small stone or stone-chips, is a better protection.

If it should appear, on trial, that so much water is lost by filtration that it would be sound policy to still adopt the brick lining, it can at any time be laid down by

taking one division of the reservoir at a time—a measure, however, we do not believe will be necessary.

The change of route in the west end of the conduit, as before observed, involved a large additional expenditure.

The advantage of this consisted in substituting about half a mile of brick conduit, or aqueduct, for a like amount of iron pipe, and mainly, to bring the pumping-station nearer to the reservoir, by the same distance.

The value of the objects secured by this, as relates to the question of shortening the pumping-mains, cannot, so far as we know, be reduced by any exact method of computation.

It is generally acknowledged by engineers, that it is important to have the pumping-mains as short as circumstances of location and expense will reasonably permit. Some engineers regard this as so important, that they erect what is termed a stand-pipe, by which the water is raised vertically to the required height, and then carried to its destination by gravitation. The extra expense of this method, for great elevations, has in most cases prevented its adoption, and the sloping-main has been relied on. We regard it, however, in a case like the one under consideration, where a large body of water is to be raised to a great height, as very desirable to bring the pumping machinery as near the point of delivering the water as is practicable, at reasonable expense.

The aqueduct, of masonry, is here substituted for about half a mile of iron mains. When the two additional pumping-mains shall be required, they will be this distance shorter, and about \$65,000 less expense will be necessary than

would have been required on the east, or contract line. Iron mains are not indestructible, and, when subject to the action of pumping, are liable to sudden rupture, which is a further reason for reducing their length. It may be added, the substitution of the masonry conduit will furnish a work scarcely liable to any deterioration, and its repairs will be nominal, as compared with the iron pumping mains. This change, as before observed, has secured the reduction of about half a mile of pumping mains. It has, by means of the aqueduct of masonry, established a kind of work as a substitute that may be regarded as indestructible, requiring, comparatively, a trifling expense for repairs and maintenance, and, when the wants of the city require the two additional mains, a saving of about \$65,000 will be effected in their expense.

The extra expense drawn from reductions in other items is \$114,000. We are not inclined to question an absolute expenditure of this amount, for the objects secured in this alteration, but regarding it as a substitution for the work that has been dispensed with on the reservoir, there can be no doubt, as we think, of the wisdom and propriety of the changes.

The change of line at Baiseley's pond, and the introduction of the water of that pond by a brick conduit, appears to be clearly proper and an improvement of the work. This change will allow the pond to be shut off from the aqueduct, and cleaned out or repaired when necessary, which, under the original plan, could not be done without shutting off the water from the aqueduct, and as it has been done at the small cost of \$500, saved from work that could well be dispensed with, there appears no ground to doubt its propriety. This change, together

with the adoption of branch conduits from the other ponds, will allow any pond to be shut off and cleaned out, without obstructing the flow of water in the aqueduct from all the remaining sources—a very important provision.

Second—The efficiency of the works to secure the supply of water contemplated.

The plan of work provided in the contract contemplates an ultimate daily supply of forty millions of gallons, and all the works are to be sufficient for this quantity, except the machinery for pumping, which is to be put up for twenty millions only; the buildings to be sufficient for double the machinery, and every thing ready to receive the additional engines and pumps, when the wants of the city require it.

The contractors, as before observed, are to provide water sufficient for twenty millions of gallons daily. The reservoir and channel of aqueduct, and all buildings for the machinery, are to be adapted to a daily supply of forty millions.

When the contractors shall have completed their work, the city will have a daily supply of twenty millions of gallons, and as the demand increases beyond this quantity, the city must so extend the works as to find the water wanted, and prepare the additional machinery to raise it.

The work for distribution is fixed in the contract at a specified quantity of pipe of certain sizes, with their appurtenant fixtures. In conformity with the general plan, the city will have, on the completion of the contract, a daily supply of twenty millions; and as the works are

well advanced, it might be considered unnecessary, at this time, to discuss this question; but in so large an outlay, the greater part of which must be made by the city, before it will be possible for the Commissioners to know whether the contractors can furnish the required supply, it becomes proper to enquire into the prospect of success.

The first question is obviously as to the practicability of obtaining the supply of water. The mode of obtaining it has a striking peculiarity. An extensive plain forms the southerly shore of Long Island, rising very gradually as it recedes from the coast and extending a considerable distance to the dividing ridge, which in this locality lays nearest the northern shore of Long Island and is of a much more impervious character. This plain is composed mostly of clean, compact sand, into which the water from rains slowly percolates and gradually discharges into the ocean, near the level of tide-water in Jamaica bay. The water held in this great sand reservoir passes slowly into small streams, several of which are sufficiently large to be valuable as water power, and have for many years been used for milling purposes. These streams have the reputation of unusual regularity in the flow of water, and so far as we can ascertain, furnish a very reliable basis for a regular supply. The sources relied upon are to be drawn mostly from ponds that lay in the valleys of the small streams, their surfaces on or below the general level of water as it lays in a natural state in the sand plain. The water cannot be raised above this level without loss, and of course the reliance must be upon the natural flow.

Jamaica (or Baiseley's) pond is the most westerly and nearest source. This pond is about five miles from the pump well. Hempstead pond (sometimes called L. Cor-

nell's pond, or Parsonage creek,) is the most easterly, and is about seven and three-quarters miles from Jamaica pond. These two, and several intermediate sources, are relied upon by the contractors to furnish the twenty million gallons they have to supply. At different times, prior to the making of the present contract, these sources were gauged, and reported to yield from twenty-three millions to twenty-five millions of gallons daily. Since the work has been in progress, gauging has been made under the direction of your chief engineer, and the result has shown a daily flow of a trifle over twenty millions. We have no means of deciding which set of gaugings are most reliable; all purport to be taken at a minimum stage of water. We have visited all the principal sources, and are favorably impressed with the supply, as indicated by the gaugings. It is obvious, however, that the margin beyond twenty millions is very small, and it is possible the contractors may, to some extent, be called upon to extend their range, in order to obtain the supply contracted for. On this point, much will depend on the impervious character of the work. As the contractors are required to deliver twenty millions gallons daily into the Ridgewood reservoir, it is material to them that the channel for conveying it be very impervious. In regard to the sources from whence the additional twenty millions is ultimately to be drawn, we have not any means of judging, beyond the gaugings formerly reported. These show an aggregate of about forty-one millions. So far as they had been modified by the gaugings of your chief engineer, they are reduced to about thirty-seven millions. It may be there are other sources, not gauged, that will make up any deficiency. We understand there are.

For the supply at present contemplated, one half is from Hempstead and Pine ponds, situated at the east extremity of the present works. It is obvious, from the facts before stated, that the works should be constructed so as to guard against material loss by leakage. The whole length of the channel is twelve and three-quarters miles, of which seven and three-quarters miles is an open canal, made in the sand-plain. In this sand-plain there appears to be a water-line varying, but not greatly, below the natural surface of the ground. This line seems to incline very much with the surface of the plain, running down towards the shore of Jamaica bay. The top water-line of this canal is, in some places, below this natural water-line, but, for the most part, it is above. At all the small depressions, where streams flow through to the bay, and at other depressions in the plain, this natural water-line falls below the top water-line of the aqueduct, even with three and a half feet depth of water; and when the water is raised, as contemplated, to five feet, to give the canal capacity to carry the additional twenty millions, it will so far increase this difference, that a very small part will be below the natural water-line of the plain. It has been suggested to us, that where the top water-line of canal was below the natural water-line in the plain, the canal would need no protection against leakage; but, as we are informed, there is so small a portion that is in this condition, in view of the ultimate top water-line of canal, and which is of course to be provided for, and in view of the uncertainty of always meeting this natural water-line, there is danger of trusting to any arrangement of this kind.

We do not understand that any such course has been sanctioned, and it is only alluded to as a means of col-

lecting into the canal an additional supply of water from that which is constantly flowing below the surface through the plain, but this can only be done by sinking the canal to a lower level, so as to bring its top water-line in all places below the natural water-line in the plain. This would render puddling the canal unnecessary; it would, however, render the work difficult to construct and more difficult to maintain.

The contract provides that this canal shall be puddled with water-tight materials, and we see no other way to make the canal reasonably impervious. It is required to put on the bottom and sides one foot in thickness of puddled earth. But a small part of the puddling has yet been done. We are of the opinion the puddling should be made of greater thickness than provided for in the contract, especially on the sides. The bottom may answer if the puddle is thoroughly done; the puddle on the slope will be likely to be more imperfect and should be a greater thickness to secure equal imperviousness and security against frost.

We recommend the bottom course of puddle to be carried beyond the bottom angle of the canal, and the sides carried up on a steeper slope, so as to permit a facing of sand in front of it, of four feet in thickness at the bottom and two feet at the top. This facing to be well turfed from the top water-line. It may require some further protection by stone pavement below the water-line, though the turf may prove sufficient. We further recommend that the puddling be made fifteen inches instead of twelve, as provided for in the contract. The sand along the canal in the face and spoil banks is very much drifted by the winds, and of course much of it blows into the bottom.

To protect it, these banks should be well turfed; if this is not done, the bottom of the canal will be so filled with sand as to require large expense to clear it out, and hazard serious interruption to the supply of water, especially when the large ultimate supply is required.

The canal, if well completed, will no doubt make a fair channel to conduct the water; but an open canal of this length, with its ultimate extension, is in general an objectionable mode of conducting water for the supply of a large city. In addition to the ordinary and obvious objections, it has, in this case, the objection that it passes through an open, porous soil, depending entirely on artificial means to retain the water, and we regard it proper to urge the adoption of the most effective means to secure it against leakage and protect the prism from being filled with drifting sand.

From the feeder that enters from Jamaica pond, the channel is a conduit of hydraulic masonry, extending five miles, to the pump-well. We passed through this in a boat, and have no hesitation in saying it is sufficient in dimensions to pass forty millions of gallons of water daily and is substantially constructed. We discovered no defect, and see no reason to doubt it will stand for centuries, with very little care and expense for maintainance.

The pump-well, located at the western termination of the conduit of masonry, is in progress of erection, and well advanced. The boilers for one engine are in place, and the work of setting up the engine and pumps is going on.

These engines are of large size, and intended to be capable of raising, each, ten millions of gallons per day, one hundred and seventy feet, to the Ridgewood reservoir.

They are larger than any we have known in this country, for pumping water. The foundations prepared for them appear substantial, and great care seems to be taken in putting up the work, so as to make them competent to the duty intended.

The Ridgewood reservoir we have incidentally discussed, and little further need be said. The works appear substantial, and well adapted to the object to be secured. The character, general arrangement, and probable efficiency of the feeding-mains, distributing-pipes, and their attendant fixtures, has occupied some attention. We find it quite satisfactory in its general plan, in the position of the feeding-mains, with reference to the connections of the lateral pipes with them, and the adaptation of these mains to the adequate supply of such lateral distributing pipes, and also in the weight and consequent thickness, which has been adopted for them. We are glad to find that the disposition which has prevailed to a considerable extent of late years in some of the water-works of the country to put in pipes of light weight, has not obtained with you, and that a thickness of pipe has been concluded upon, which will not only insure their perfect safety, but their duration and positive efficiency for very many years.

On a number of the works of recent construction, this latter item does not appear to have received the least consideration, the only effort being to obtain a pipe as nearly proportioned as possible to the work it is called upon to do when it is first laid, without regard to the deterioration which must necessarily take place from corrosion internally from the water and air passing through it, and externally from the destructive fluids which reach

it by saturation of different soils with the water of surface drainage, more or less destructive to the pipe.

An examination of samples of the stop-cocks, fire-hydrants, and other fixtures, satisfies us that they have been judiciously selected, and that these will prove effective for their respective objects.

The fire-hydrants may be considered as the most important of the fixtures connected with the distribution. To these it is evident much attention has been directed, in order that you should obtain such as will secure and maintain their efficiency. To this end, they have been lengthened, so as to place the valve a greater distance from the surface of the ground, and consequently further from the ordinary depth of frost; and wooden instead of iron cases have been adopted, the former being undoubtedly a surer safeguard from the effects of frost than the latter, wood (and particularly the thickness of it which you use,) being a much slower conductor of heat and cold than iron; besides, from its increased size over the ordinary iron case, it admits of straw or other non-conducting substances being packed in around the hydrant, by which means additional protection is afforded, and in case of its being accidentally frozen, a ready method of thawing it promptly is always at hand, namely setting fire to the contained straw packing and if necessary the wooden case itself; this method has frequently been resorted to successfully in other cities where wooden cases have been used.

We consider the form of hydrant itself to be the best with which we are acquainted; it is no experiment, but has withstood the test of practice for very many years.

For fixtures, which have to be frequently resorted to by citizens and the uninitiated in the proper treatment of such apparatus, during fires, in great haste and under much excitement, it is positively necessary to have them perfectly simple, and of such structure as will admit of their ready repairs. We think the hydrant selected has all these requisites.

Although the supply-mains are now complete in themselves, we would suggest that for greater security, it is desirable that a line of twenty inch main should be laid upon Bedford avenue, in order to connect the thirty-six inch main on De Kalb avenue, with the thirty inch upon Division avenue, leading to Williamsburgh, as, we believe, your Board has already contemplated. Such connection, should any accident occur to either the thirty-six inch main on De Kalb avenue, or the thirty inch main upon Division avenue, below the point of their present connection, the city could still be supplied by the perfect main; whereas now, the bursting of the thirty-six inch main, below the point mentioned, would deprive the city of water, and the failure of the thirty inch main would effectually cut off the supply from Williamsburgh. After the water is fairly introduced and the citizens become entirely dependent upon it, any detention of the supply would prove exceedingly inconvenient, and might turn out very disastrous, should conflagration occur at the time.

The manner in which the pipe has been laid, we have, of course, no opportunity of seeing, but believe the detailed specifications for that work to be adequate to insure a perfect job.

Having remarked on the general characteristics of the work, we have no hesitation in saying, the plan provided for in the contract, with one exception, (the open canal,) is well adapted to secure the object contemplated. This exception we do not consider of a nature to prevent your obtaining a good supply of water, but as inferior in character to all the other parts of the work. It is gratifying to us, to notice that the work, so far as we could discover, has been executed on the part of the contractors with fidelity to the terms of their contract.

The works, so far as they have been constructed, appear to be substantially and well built. Indeed, the terms of the contract, requiring the delivery of twenty millions of gallons daily for six consecutive months, is a stringent provision, and holds the contractors under a severe responsibility to construct their work in a substantial and efficient manner, and they appear well impressed with their obligations in this respect.

We have no right, however, to intimate that they need, or are actuated by any other motive than an honorable sense of their duty under the contract. It is however important to the interest of the enterprise, that the contractors are capable of appreciating their responsibilities and disposed to carry them out with fairness, whatever may be the inducement.

Mr. KIRKWOOD, your Chief Engineer, has accompanied us in most of our examinations of the works. In this he has fully explained all matters of enquiry. He is obviously, as he ought to be, deeply impressed with the responsibility of the duty that devolves upon him, and which cannot be relieved until he can witness the full and suc-

cessful accomplishment of what he has undertaken. Before this can be realized, there will doubtless be more or less cause of anxiety, as it can hardly be expected that works of this character will go at once into full and successful operation in all its details.

Some time may be required to correct incidental and unimportant defects, to which works of this magnitude are more or less subject, and bring all the parts into complete and harmonious action. Some patience is due towards men who engage in large undertakings, and though we do not see any special cause for apprehending any untoward occurrence, we would caution the Commissioners not to be disturbed, or alarmed, should any imperfection or oversight in any part of the work cause temporary delay or disappointment; for we are confident that nothing of the kind will occur, that will not admit of easy correction, and we further advise that no attempt be made to start works, until they are in complete order.

We are led to this remark from noticing great anxiety for the introduction of the water into the city, which is natural enough, for the city is greatly in need of it; but the public are not responsible, and do not know that improper haste may greatly retard rather than hasten the day when a regular supply of water may be introduced. Let the works be completed with all practicable dispatch, and, when ready, give a fair and quiet trial.

You have *now* daily at command three millions of gallons, available as soon as your machinery is ready, which will enable you to test the work fully as to the pumping capacity, and give good confidence as to its sufficiency, when the quantity of water for a full day's work shall be reached. So far as we can judge, we think the works

will not be ready for introducing the water as soon as is expected; there is considerable work to do before the machinery for pumping can be completed; the season is unfavorable, and the contractors will most likely be disappointed in the time it will take to get it ready. We do not from this intend to be understood as expecting any great delay. We have heard it stated, that the machinery would be ready in January, possibly it may be, but if it would be a month or two later, it would not surprize us.

We now come to consider the *third*, or any improvements beyond the provisions of the contract, that would render the work more complete and satisfactory. It will have been noticed, that we regard the open canal as an inferior and unsatisfactory feature in the improvement.

Under favorable circumstances for obtaining an impervious water course, an open canal for any considerable length, for reasons that have often been given, has been regarded highly objectionable as a channel to convey water for the supply of a large city.

In this case, these are the special objections—that the canal must be made through a porous sand, depending wholly on artificial means to retain the water, and so subject to drift as to require all its regular, and the near spoil banks, protected by turving in order to prevent the sand from being driven by winds into the prism of the canal. It will be remembered that about four-fifths of the first twenty millions of gallons of water is taken in this canal, and more than half of it at the extreme head; if there was abundance of water, the objection to the canal would be impaired; but the quantity that is at command leaves very little margin, and there can be no doubt, that an

aqueduct of hydraulic masonry is superior to any earth-work to retain water. We have no doubt the puddling, as proposed, will afford a good degree of imperviousness, and retain the greater part of the water, but such work is liable to imperfections.

For greater security, we have before suggested, that the bottom puddling be carried so far into the bank, as to allow a covering to protect it from the frost; but this was not required by the contract, and as the work has not been done in reference to it, it cannot be now done without considerable extra expense. The question may well be asked, why make this portion so inferior to all the rest? Deducting the expense which must be incurred for puddling and other purposes to complete the canal, (which in relation to puddling is found to be more expensive than originally contemplated) we believe it will not cost an additional sum of over \$500,000, to make a conduit of masonry that will transmit the water without loss over the seven and three-quarter miles.

After spending \$4,200,000 for the works, is it reasonable to have such an imperfection on three-fifths of the channel that is to convey nearly the whole quantity of water to the city, for the saving of comparatively so small a sum? The idea that the works in this important respect are less perfect than they should be, will be more unfavorable than this saving is worth.

It may turn out that, after all the care you can take with the canal, you will lose one or two millions of gallons daily, and this would not be a great loss for so long a canal, even if it be made with great care. You are to consider your pumps and reservoir and conduit will all be impaired in value by any loss of water in the

canal, and what is more serious, the city must have so much less water. Nor will the matter be much better for the city if the contractors extend their line so as to make good this loss; for, it is obvious, they would take water that will ultimately be wanted to provide the additional twenty millions that is contemplated, and which does not appear so abundant as to warrant any such reduction. You are engaged on an important enterprise, that is designed to supply a large city with the invaluable article of water. No public works so imperiously demand thorough and durable structures. It is eminently important that they be so constructed as to provide against any suspension of their functions, so far as it may be practicable. We regard it a very important matter, that this manifest imperfection of your general plan be corrected. By deciding on the question soon, the work may be contracted for, or probably you may make satisfactory arrangements with the present contractors, to be prepared to commence it as soon as the spring opens, and it may be carried through next season. In the mean time you can commence the introduction of water into the city as soon as your machinery is ready, as you have the Jamaica pond to draw from, which will probably supply all the tenants you will have, until you reach other sources as the aqueduct is extended from Jamaica pond eastward.

We have been urgent on this point, because we regard it a serious defect, in a plan otherwise well calculated to supply your city with an abundance of good water, and while you have gone forward with a liberal hand in all other respects, you should, as we regard it, make this change in order not only that the whole may be symmetrical, but that the city may depend with all the certainty that can be secured on an abundant and regular supply of

water. We believe you have a good resource, though not such, that you can afford to risk much loss.

If properly husbanded, you may furnish a good supply for a population of nearly, if not quite, a million of inhabitants.

We are, therefore, of the opinion that in any event, a conduit of masonry should be substituted for an open canal, and believing, as we do, that such substitution can be accomplished at an additional expense not exceeding five hundred thousand dollars, we have no hesitation in urging the importance of such change.

Respectfully submitted,

JOHN B. JERVIS,
FREDERICK GRAFF,
JOHN T. CLARK.