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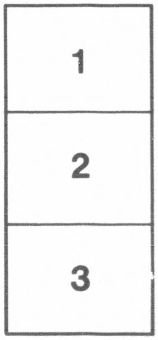


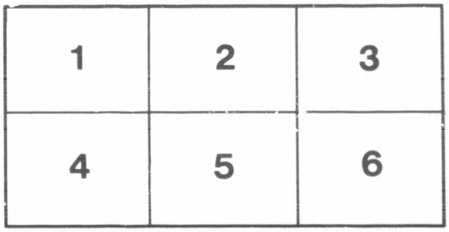

# REPORT

OF

# Chevalier C. BAILLAIRGE

*Engineer, of the City of Queb*

**On the Amelioration of its Aqueduct.**

—o—

RESOLUTION OF THE

## CITY-COUNCIL

Of the 10th June 1881.

NATURA·FORTIS·INDUSTRIA·CRESCIT



QUEBEC:
PRINTED BY ELZEAR VINCENT
224, St. John Street
1881.

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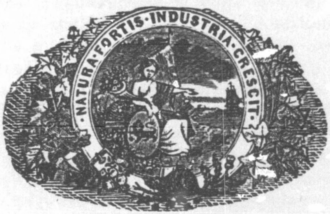


QUEBEC:

PRINTED BY ELZÉAR VINCENT

224, St. John Street

1881.

Quebec, 12th August, 1881.

*His Worship, The Mayor, The Aldermen, Councillors & Citizens of the City of Quebec.*

**Gentlemen,**

In 1848, a report was made to the then City Council, by an engineer said to be eminent, recommending an 18 inch main, computed after Prony's formulae, for a supply of water of 3,000,000 imperial gallons in the 24 hours: say 30 gallons for each man, woman and child of a population of 100,000 souls.

In his calculations for a continuous supply, the engineer made use of data applicable only to one of an intermittent nature. Thirty gallons is the approximate figure of the quantity of water supplied in London and elsewhere under the alternative system; while under the continuous, the allowance is more than double that quantity, as evidenced by the statistics of hundreds of American and European cities. Nor is it improbable that in computing the retardation of flow, sufficient importance was not given to the 78, or more, bends and deflections in the pipe, both in the vertical & horizontal planes.

If I allude to this error and others, it is the better to show the elements which must enter as factors into an exposition of the reasons to be given, for the inadequacy of the present aqueduct and the necessity of adding to it; and here let me observe, it is not since the present time only, when seven-eighths of the City are supplied with water, that the want of it is felt; but on the contrary, such has been the case since its first introduction into the higher wards in 1857.

Even at that time it was found necessary to have recourse to the adjustment of the gates or stop cocks, to cause the water to ascend to the required levels, and before incrustation of the pipes could be assigned as a cause for the want of pressure.

This incrustation of the interior of the pipes, this oxydation or tuberosity, had been long known previous to 1848, and should have determined an increase in their diameter proportional to its thickness, rendered more effective by the irregularity of its surface and the increased friction consequent thereon; nevertheless, no account was taken of such an important element, the effect of which, combined with that of eccentricity of joints, irregularities of alinement, stones and sediment in the pipes and other obstructions, Mr. Baldwin, in his report of 1865, estimates at more than 33 per cent of the total capacity of the pipe.

I may say, at once, that this estimate is some what exaggerated and that in reality the incrustation does not exceed a mean thickness of half an inch; sufficient, no doubt, to be taken into account in calculating the quantity of water the pipe would supply; but inadequate to explain, in its entirety, the almost total want of pressure in all the upper portions of the City and even in the upper stories of buildings on the lower levels.

It is the loss—the waste of water, its immoderate use in closets, urinals and sinks, and the criminal profusion with which it is let run to prevent the freezing of pipes which is the cause why it cannot be simultaneously supplied to all parts of the City.

The climate was known when first the aqueduct was projected; early statistics went to show that the consumption of water in a great many American cities was, not 30 gallons, but varied between 60 and 130 gallons to each individual of the respective populations of those cities. It was undoubted that Quebec, under a still lower temperature and a more prolonged cold spell, would have recourse to the same expedients to prevent the freezing of pipes; yet in the face of so many elements which should have determined a supply capable of meeting all eventualities, a size of pipe was fixed upon having less than half the required capacity.

The history of other cities was also at hand to enlighten public opinion in the premises. Many towns in the United States, in Canada and in Europe, having a population inferior to that of Quebec, had commenced by laying down a pipe of greater diameter and had found themselves, a few years after, driven to the necessity of adding to their respective aqueducts a second pipe larger than the first, a third more ample than the other two combined. Quebec had not the wisdom to profit by these lessons, and for not having done so has, since the existence of its water works, seen itself devastated at least three times by as many great fires—conflagrations of an extent to require millions in the reconstruction of the property destroyed, the quarter of which amount would have been ample at the time to cover the additional cost of a second line of pipe from Lorette.

Quebec is exceptional, perhaps among all known cities, in respect to a circumstance which up to the present, no body appears to have thought of;—I allude to the inadequate depth of its building lots. While, elsewhere, and especially in countries where, as is the case here, resinous woods make up so large a portion of our houses, out-houses and buildings of all sorts; wisdom was exercised in giving to building lots a depth of at least 100 feet, thus separating by a distance of from 50 to 60 feet houses from out-buildings likely to imperil them in case of fire; here, on the contrary, the almost criminal improvidence of seigniors, proprietors of the soil—their desire to make as much out of it as possible—caused them to reduce to 60 feet, and even to 50 ft. or less, a dept of lot which would have been little enough at more than double the figure.

And these very parties (to whom we really owe the extent of our conflagrations) are by a most unjust and iniquitous law exempt from the payment of municipal taxes, and refuse to pay an increased water rate, or any rate at all, proportional to the reduced insurance premiums due to the existence of the Water Works and fire brigade.

Quebec for this sole reason, and though there were none other, requires fire protection, more efficacious, more prompt, than any other city; but instead of this, and which at the time would not have enhanced the cost of the works by more than 20 per cent, instead of having its under surface traversed in all directions by a net work of pipes of the larger size (none less than six inches, and even these in short lenghts connected at each end with pipes of double, triple the capacity);—instead of this, I say, we find an almost uninterrupted series of 4 inch pipes communicating at only rare intervals with others of larger diameter, and, long since, reduced to an effective diameter of 3 inches, perhaps less,—that is, to nearly half their original capacity—by incrustation and other obstructions.

Now, had these small pipes been confined to short lengths of 100 to 200 feet and connected with others of additional capacity; but no, they are laid for distances of 1,000 to 2,000 feet, and would you know the consequence thereof—may I tell you to what extent, in such pipes, the dynamic or hydraulic pressure, or that of the water in motion or in the act of discharging itself, is reduced? The De Salaberry street service main 1,800 ft. long, 4 inches diameter, from St. John st. to the Grande-Allée could hardly do more than deliver its water into the basement of the New Gaol, until having by means of a piece of two inch pipe opened a communication between it and the 18 inch main immediately adjoining, the water at once attained the level of the cisterns under the roofing of this five story building.

Again see the effect of such conduits, in each case of a fire where, as the Chief of the fire department can tell you, the friction of a few hundred feet of these small arteries reduces the pressure to almost nothing, while the nearer you come to the principal arteries or those of enlarged size—and especially when the hydrants are attached directly to, or put into communication with them, by only a few feet of smaller pipe—the pressure increases in a proportion difficult to credit without being a witness to the fact.

Diminution of pressure due to smallness of pipes is further exemplified in the following experiments: after the fire of Montcalm ward in 1876, I had a hose attached to the 4 inch pipe in Scott st. near Artillery str., that is, at a level considerably below that of the Grande-Allée and fully 1000 ft. therefrom; the water hardly rose 10 ft. beyond the nozzle. The same hose was then attached to the main at a point nearer the supply pipe of the Grande-Allée or about half way between Artillery and St. Amable streets. Theoretically, and if the diameter of the pipe had nothing to do with it, the pressure should have been less under such increased elevation, while on the contrary it was much greater. A third trial opposite the end of St. Amable st.—the distance separating the hose from the Grande Allée being in this case but 500 ft.—the pressure was further increased and the jet from the hose attained the summits of the adjoining buildings. Finally, I had the hose removed on the same 4 inch main to a point situated in the immediate vicinity of the Grande Allée, at some 30 ft. only from the main 18 inch supply pipe, and there at a level so many feet above Artillery street, a jet of water issued capable of commanding the summits of the houses of this, the highest district in the City.

The same effect was observed, though in a less degree, when the hose was attached to the 4 inch main of St. Amable St. in the vicinity of the 6 inch one of Lachevrotière St.

Enough, I think, has been said to convince the public that, notwithstanding the immense static pressure of the water in our pipes, under a head of 480 feet (level of the reservoir at Lorette above the river St. Lawrence) this pressure being 200 lbs per square inch in the lower parts of the City, 110 lbs. or thereabouts at Mount-Pleasant and 70 lbs. on Perrault's Hill;—I say that notwithstanding this static pressure which would exist in the pipes at those points if the water in them were quiescent and unable to find an issue; the dynamic pressure which should equal the first, and would do so if it were not modified by friction, is reduced by the smallness of the pipes, rapidity of flow and waste, to such a degree as to be not only powerless in many parts of the city in case of fire, but at such points, and elsewhere, the water hardly rises sufficiently to attain the cisterns situated for the most part in the upper floors of houses and public buildings of the City—Assylums, hospitals, educational and other establishments; and, as is well known, it is only by concentrating, on one particular ward of the city, the whole force of the aqueduct and separately supplying each ward, to the exclusion of all the others, that it is possible to cause the water to rise to the ward in question.

I must refer to the report of T. C. Keefer Esq., of 1860 page 15 for a detailed statement of the pressure existing in different parts of the city, and there it will be seen, as proof of what I have just advanced, that it is often under an increased elevation that the pressure is the greater—due to the causes just alluded to.

Five years later, or in 1865, a second report was made on the state of the aqueduct and on remedial measures relating thereto, by G. R. Baldwin Esq, conformably to whose report of 1848, our aqueduct was laid down as it now exists.

These two reports of Keefer and Baldwin should be consulted and I therefore recall their existence to the present City Council, and to the Citizens, interested as they must be, one and all, in obtaining a full understanding of the defects of the present system so as to apply a remedy both reliable and of long duration.

A partial improvement in the water supply may be effected by cleansing out the pipes as was done some years ago in Halifax. This cleansing or scouring of the pipes consists in removing their interior incrustation, sediment and other obstructions. For this purpose, it was necessary to open the streets at distances of 150 ft. more or less, break out a pipe or cut it to disengage it from its position and scour out by means of a metallic broom to which was given a double motion of rotation and propulsion. This broom or scourer, with the help of a current of water, hauled towards it or pushed before it, the scourings, to the points of rupture, whence they were removed and the pipe then closed, or its continuity made good by the insertion of new pipes, or of the pieces removed, the jointings of which were rendered hermetical by the use of cast iron rings covering their ends or junctions.

True, this scouring at Halifax entailed an expenditure of only $7,500, I believe, and the same might be done here for a sum of, may be, $25,000; but such cleansing would only slightly remedy the evils complained of, and would have to be repeated again in a few years.

It suffices to repeat what I have already said, namely: that, as early as 1857, when the pipes had but recently been laid and were still quite new and without any incrustation whatever, the manipulation of the stop-cocks had, already, to be resorted to to to force the water to the upper levels of the City.

I am therefore of opinion that we should, as the only reliable remedy, for these inequalities of pressure, replace some of the smaller pipes by others of increased diameter, or else divide the long narrow pipes into short sections and connect them at their points of rupture or section with larger pipes if they be there or which should be laid down for the purpose.

Thus, for instance, in the suburbs and in St·Roch and Jacques-Cartier wards all pipes running North and South—through Scott, Lachevrotière, St. Augustin and other streers in Montcalm ward: through Sutherland, Deligny, St. Claire, etc. in St. John ward; through St. Ours, St. Anselm, Caron, Dorchester, etc. in St. Roch and Jacques-Cartier wards; should be of large size and the small pipes of all streets in the opposite direction, or which run East and West, divided into sections terminating in those of the first series and connected therewith. The hydrants should be placed as much as possible in the vicinity of the larger pipes, or at the intersection of two of the smaller ones which would considerably increase and strengthen the flow of water from them—the water thus reaching the hydrant from four different directions instead of only from one or two. See in this respect C. L. Stevenson's report of the 1st. september 1864 on a water supply for the City of Lynn, or the note, page 3, of Baldwin's report of 1865.

Many Cities, already have had recourse to this mode of increasing, or rendering constant, their water pressure, by replacing a certain number of the smaller pipes by others of increased bore. For instance, Chicago, some few years ago, removed two miles, or more than 10 000 ft. of 10 inch pipe and replaced it by a 24 inch one, the capacity of the latter being nearly six times that of the former.

Such are the pipes we should have in certain streets of the city: —St. Louis, St. John, St. Valier, St. Joseph, Prince Edward, St. Paul, St. Peter, Champlain and St. Denis. These large pipes act as so many reservoirs to maintain the pressure in their respective districts and their necessity is due to the fact that, under the present system, it is sufficient to draw water from one of the 4 inch pipes in certain parts of the City, to entirely destroy, during the interval, all pressure in such pipe and deprive the vicinity of water.

One would hardly credit how, under the effect of an arterial system so capillary in its dimensions, a purely local cause will affect the circulation. How many complaints do we not receive every day under this head at the City Hall where it is difficult to convince the public, that on this account, the least flow to fill a watering cart, a cistern, a well, to flood a skating rink, to supply small hand hose when several are playing at a time, a leak through a broken pipe, a waste or continuous flow in a sink or closet, affect the circulation in the vicinity. This would never happen if, as I recommend, we replaced a number of our microscopic pipes by others visible to the naked eye,—the 4 inch by 6 inch and 8 inch, the 8 inch by 12" or 14", the 12" and 14" by 18" and 24"—which, had it been done from the first, would not have added 50 per cent to the cost of distribution throughout the City.

I need hardly say that all this would not bring us an increased supply of water from Lorette. These are means, and practical ones, of equalizing the pressure, remedying the local drawbacks of which so many complain, and considerably augmenting the force of water for fire purposes.

The great evil—that which surpasses all others—is the loss, the waste,—the criminal waste, of a substance more precious than milk which we pay for at the rate of 15 to 20 cents a gallon; while, for the one gallon of milk we utilize, we uselessly employ from 500 to 1000 times the quantity of water.

If every one acted as I do myself, as do a thousand others who know how to appreciate the gift of an abundant supply of pure water; if each one saw to their interior distribution and so placed the pipes as to prevent freezing, thus saving the item of waste due to such a mode of prevention; if every one had a cistern with self-acting apparatus to cut off the supply when the cistern is full; if all closets were self acting, all taps in order, all pipes sound and in good repair; may I tell you how much water you would require? not more than 10 gallons per individual, 50 to 60 gallons or a barrel per family per day: and am I not right; have you already lost remembrance of the time when water was delivered here by the barrel and when you were content with from one to two barrels per week? Well, double this quantity, triple it if you like, and no one will have to complain.

After all, Baldwin was mistaken in 1848, merely because you will it so. He gave you 30 gallons of water per head to every man, woman and child of the population and you take 60 or more. You let it run night and day in your closets and urinals without necessity, you save yourself the cost of protecting your pipes against the cold of winter by allowing taps to run full bore through sinks, &c. Your taps are out of order, water runs from them by hundreds and thousands of gallons every 24 hours and you do not see to it. You use a hose with which to wash your vehicles and thus waste ten times—a hundred times more water than if you used a bucket for the purpose. You are not satisfied with sprinkling the street where the City watering carts do not pass, or during the intervals between their visits, your children and servants waste the water, use it at a dead loss to sprinkle where the city performs the service for you and during the very time the thing is being done; they waste it in attempted hieroglyphics (it is so pretty) in the dust, and finally reduce the whole to mud.

Do you know what water you waste? probably not, for if you did you would not do it, in a nnmber of cases. An ordinary half inch tap under medium pressure, will run from 10,000 to 40,000 gallons of water in the 24 hours. The last report from Milwaukee whose population is about equal to ours, shows a loss of water of 750,000 gallons through a single tap in a tenement left vacant during the winter, equal to 7,500 gallons a day, for a cold spell of three months. The quantity was ascertained by the meter attached to the service pipe. A three dollar stop-cock, to prevent the water from rising to this untenanted floor, would have saved a waste which at 15 cents per thousand gallons amounts to $112.50. The use of the hydrometer detected, in a service pipe, a leak which had existed for 5 years; it equalled 5,000 gallons per day or 9,125,000 for the 5 years, a loss of $1,368 to the city. The water thus wasted would have sufficed to supply 166 families for a whole year or 33 families during the 5 years.

The only effective means of stopping the waste of water, is the use of the meter, in the same way as gas Companies guard against robbery by a similar process.

J. S. Brown, Water registrar for the town of Worcester, says in his report of Nov. 30th. 1878. "The water works department considers the use of meters as absolutely essential to its protection against the loss and waste of water; unknown leakages and wastes having thus been discovered which would otherwise have remained unknown and attained formidable proportions. In this respect alone" says Brown, "the meter has been a powerful auxiliary and of great value to the department."

I cite Worcester, Mass., because its population of 58,000 souls is comparable with our own and there the consumption of water per diem is only 2½ million gallons, of which each inhabitant receives a mean supply of 25 gallons. Now, it is the use of meters that brings about this result and it is admitted that without them, Worcester would do as is done every where else, use from 60 to 120 gallons per individual per day. The number of meters in use in Worcester was 3,791 in 1880 while the whole number of its water services was but 5,200. Providence R. I. has 4,401 meters on 9,276 services or 47½ per cent.

Experiments made at Worcester to establish the quantity of water actually required per individual, have fixed that quantity by meter measurement as varying from 12 to 18 gallons per diem or from one to two barrels per diem per family in the 24 hours, and where more is passed, it runs to waste through the different sources already indicated.

Every day I receive from the United States and elsewhere, the annual report on Water Works of some one or other of the towns and cities thereof, and in each of them is repeated the constantly recurring complaint of the waste of Water and of the consequent falling away of the water from the higher levels of these cities. In the appendices to this report will be found numerous extracts bearing on the subjects of waste, meters, consumption per individual per diem and much other pertinent and interesting information and statistic matter.

Boston, as yet, has but 1294 meters in use and received $163.74 per each metered service while the unmetered services being in a revenue of only $15.94 each.

If the whole of the water in Boston were measured it would derive a revenue of $1,780,438 while it actually receives only $812,922 showing a loss to the city of $967,516 due to unmetered water.

New York with a population of 1,200,000 souls consumes 125 gallons of water per capita per day. If, as at Worcester, nearly all its services were metered, the quantity of water poured into that City through the Croton aqueduct would suffice for a population of 6,000,000 souls; in the same way as, if the services were metered in Québec, there would be water everywhere and at all hours of the day. It would cost, say, $100,000 to meter each of the 5,000 city services. These meters would be subject to freezing in certain cases and give trouble, irrespective of their being a subject of complaint in other regards. In one word hydrometry would not be more popular with us than it is elsewhere, but it would be an effective remedy and by degrees we would become wedded to it as at Worcester where they commenced in 1874 by putting in 1100 of these registers and have steadily worked up in 1881 to the figure of 3791 meters on 5200 services.

I have not yet said what the waste is here in Quebec. Three successive measurements of the water during the fifteen years I have been in the employ of the City have shown (Keeper and Baldwin, both, corroborate it in their respective reports of 1860 and 1865) that the minimum quantity of water which enters the city during the small hours of the night is 87 per cent or $\frac{7}{8}$ of the maximum which flows into it at mid-day. If we allow one-eighth of this quantity as necessary to replenish cisterns drained out during the day—and less is required to fill all such vacuums—we have still to account for the other three-quarters of the total supply which flows at night when every one is asleep, or nearly all, and which cannot be explained otherwise than by admitting that it is uselessly lost and wasted by the voluntary or unknown leakages which I have already alluded to.

It is a fact that when during the stillness of night one perambulates the streets of the City (it has happened to me a thousand times) water is heard to run here and there, in a cellar, a closet, a sink, etc., in winter or spring through a pipe burst by frost, in quantities abundant enough to explain in a great measure the loss here alluded to, and who of us in visiting a neighbour, a friend, has not in at least five cases out of ten, heard the water running full bore through the tap over the kitchen sink, in a closet or elsewhere.

Now, had we even two water inspectors with nothing else to do than to visit all the taps of the city and who could do so every three months; what garantee have we that so soon as their backs were turned the same process would not continue. The advantage of these inspectors would at most be to cause leaky taps to be repaired and to discover a certain number of leakages inaccessible to or may be unknown to house-holders; but to discover them all and put an end to the waste, meters are the only known affective means.

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Taking the whole supply of water to the cape and sending it down again, is about the same thing as if a carter, to deliver you a barrel of water from the Palais to the Lower-Town, went around by the Upper-Town.

I am therefore of opinion that, with such differences of level as we have at the Grande Allée, on the Cape, at Mount-Pleasant and and in the Lower-Town, the city should be divided into three sections communicating the one with the other, but susceptible of complete separation by means of stop cocks or gates in all pipes running from one section into the other. The De Salaberry street pipe would thus be maintained for the supply of St. Louis and Montcalm wards through and over the Grande-Allée summit, with, possibly, a branch over the cove field to Champlain ward and the St. John street pipe be told off to do duty for St. John and Palace wards.

No injustice need be feared. The two pipes, to be sure, are in the ratio of three to two but their respective pressures are in the reverse ratio of two to three, so that each of them would give, or thereabouts, a quantity of water relatively proportional to the wards to be supplied or which by the use of stopcocks may be adjusted in a way to do equal justice to all concerned.

It remains to provide for the wants of St. Roch and the Lower Town—possibly Champlain ward, if not found preferable, on account of the long distance through Lower Town, to supply it directly over the cliff from the pipe in De Salaberry Str. or the Grande Allée as already hinted at. For this purpose the present pipe, without disconnecting it, and for valid reason, in any part of its course between Lorette and the Grande-Allée, would be broached at the foot of Sauvageau Hill (Baldwin's report of 1865) and the water directed by Arago and St. Valier Streets to the head of Crown Street hill, or at its passage across St. Valier Street in the village of St. Angèle, or by both together, thence causing the water to flow towards and attain the same point opposite Crown St. and through the present pipes spread itself over the lower wards of the City.

This pipe which now supplies at the rate of 1,800,000 gallons in the 24 hours over the summit level at Grande-Allée (in the open it would deliver 2,200,000 at the same point) and 2,700.000 gallons at Mount-Pleasant, will give 3,350,000 at the proposed level ; that is to say, the Lower Town, including Jacques Cartier, St. Roch and St. Peter wards (perhaps Champlain ward) would thus be provided with an increase of water capable of maintaining sufficient pressure to cause it to ascend to the summits of the highest buildings in these wards.

To provide for the two upper sections of the City, as already stated ,by the 18 inch pipe of De Salaberry Street and the 14 inch St. John St. main, it will be necessary to lay a second line of pipe from Lorette to Quebec. This conduit will be 30" bore and joined at Mount-Pleasant to the 18 and I4 inch pipes just mentioned. In this way the three sections of the city at as many different levels would each of them be supplied with water continuously and independently of the other sections.

I have said that the three sections would be united at pleasure by means of the stop gates and this would have to be done at any rate in cases of fire, where the pressure due to each lower section independently of that at a higher level, might not and would not always be sufficient to project the water through some hundred feet of hose to the summits of the higher edifices of the section under consideration and would have to be increased by the additional pressure of the neighbouring section to render it effective.

The 30 inch pipe, moreover, would also be connected by a stop-cock at the foot of Sauvageau Hill with the present pipe. In this way the whole supply of both pipes might be thrown entirely or in any required proportion on to either of the three sections to which I have alluded.

The present system of stop-cock manipulation by which the whole supply can be directed towards any quarter of the city evidently proves the possibility of so doing.

If I do not propose to discontinue that portion of the present main which lies between Arago and St. John streets after directing its waters towards St. Rochs, it is, as may be easily apprehended, that the city may not remain without water in case of a rupture of the new line, a thing which might occur as it has already, more than three times, to the present 18 inch main. If this portion of the present main were removed, each one will understand that in case of an accident to the second pipe, the two upper sections—St. John and Palace, Montcalm and St. Louis wards—would be completely deprived of water. Since it is only by shutting off the lower part of the city that the upper portion can be supplied, if the pipe to Mount-Pleasant be disconnected it is evident that the water concentrated on St. Roch and Jacques-Cartier would not go beyond the levels it attains to day, to wit; the lower portions of St. John and Palace wards, leaving, in such case, all higher parts of the city without water not only for fire purposes but even for domestic use. Therefore it is imperative to maintain the present pipe intact with the exception of the branches and gates already alluded to.

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A RESERVOIR on Perraults Hill subject as it would be by its want of volume and shallowness to daily fluctuationsof considerable extent in the level of its waters, which in winter wouldsoon reduce its contents to a mass of ice, must to prevent such an eventuality, be covered with earth supported by brick arches or vaultings bearing on pillars. Such a reservoir would cost $200,000. Its only utility would be, not that of adding to the supply of the City or rendering the supply continuous, since while it would be filling during night, the city mains, as at present, would empty themselves and would only be refilled somewhat the quicker through the meduim of said reservoir. Its only usefulness, I say, would be as a reserve of water in case of fire or of an accident to the feed pipe; and it would be useless, even with its ten million gallons of water, if such accident required more than a very few days to repair, and an accident to one or the other of the pipes under or over the St. Charles, might require one, two or even three months to make good. Baldwin who recommended this reservoir in 1848, afterwards admitted its uselessness (page 19 of his report of 1865.) appendix 9 to His report, No. 12.

Moveover there is in favor of a second line of pipe a reason which is more important than all others. Supposing that, by hydrometry—the metering or measuring of the water—it were possible to reduce its consumption to what is strictly necessary and by stopping the loss or waste, render its supply continuous in all parts of the City, which is doubtful--and it would cost $100,000 so to do—there would still be the imminent danger as there is to day, of seeing the pipe ruptured at a point where repairs would require more time than the interval during which the citizens would consent to be deprived of water ; and a still greater inconvenience, if possible, would present itself if during this stoppage of the aqueduct there occurred one of those monster fires which Quebec has so much reason to dread the recurrence of.

The proverb is incontrovertible :—always have two strings to your bow.

I propose, as mentionned in my annual report of 1868, that starting at a point on the Lorette side of the syphon, corresponding to the level of the summit delivery at Mount Pleasant, the diameter of the main be increased by 3 inches—or from 30 to 33 inches for a distance of 3300 ft., that is to a point corresponding in level with that of the pipe at Grande Allée summit, the difference of level between these two points being 84.78 feet. Thence to the point where the fall or inclination of the pipe, from 3.4 feet in 100, reduces to 1.0 and to 0.66 in 100, a second increase of diameter would obtain. This section, 3,500 feet in length would therefore have a diameter of 36 inches, and thence to the Chateau d'eau a distance of 3,150 feet, with very slight inclination, I would make the diameter of the pipe 40 inches.

It is unnecessary to say that the greater the bore, the less the friction, this friction being as the circumferences or diameters whereas the capacity of the pipes is as the squares of these factors. It is precisely the same as if the pipe were shorter or Lorette nearer the City.

The new aqueduct instead of bending into an additionnal or subsyphon under the rivers St. Charles and Des Mères, as the present pipe does, would cross each of these water courses on an iron tubular bridge supported by pillars or abutments of solid masonry. This tube would be lined inside allowing an intermediary space to be filled with sawdust or other material as a protection against frost, and would be of sufficient size to afford every facility for repairs if necessary at any time.

A more permanent structure, requiring less care and at longer intervals, would possibly be a stone arch between the abutments. This arch would carry an embankment of earth within which the pipe would laid as throughout the remainder of its course and which, in case of accident, would only have to be dug into, as is now done, to repair a leak or replace a length of pipe. In addition to considerations of durability of structure, the cost of the latter mode of bridging, compared with that of an iron tube will determine the choice to be made of one or the other scheme in the execution of the work.

The total length of the proposed pipe being 40,800 feet, if we deduct the 3 sections of increased diameter, 9,900, there will remain 30,900 ft. of 30 inch pipe, about two-thirds of which, on the lowest level and where the pressure is therefore greatest, must have a thickness of $1\frac{5}{8}$ inches, the remainder of the pipe, and the 9,900 feet of increased size varying upwards from $1\frac{1}{2}$ to $1\frac{1}{8}$ inches at the Lorette level where considerations, other than those of pressure at this high level, require a minimum thickness due to the eventualities of casting, hauling and laying, which it is imperative to provide for. The annexed estimate of cost of work shows, among other things the detailed lengths, thicknesses and weight of the proposed pipe.

The new aqueduct throughout its length would be laid parallel to the present pipe and at sufficient distance from it to permit of properly jointing it or even of cutting out and replacing a broken or defective pipe in case of accident, an eventuality to be provided against. The axes or axial lines of the two pipes would therefore necessarily be distant from each other by at least 42 inches, 48 might answer better.

Had we not to look at cost, this second pipe might perhaps require a second Chateau d'Eau or gate house, a second tunnel from the reservoir; but as this may cost a sum varying from 30 to $50,000 on account of the sandy and permeable nature of the soil and of the necessity of damming the site for the purpose, and because also the feed main or culvert to the well of the present building is large enough to feed both pipes without dangerously increasing the velocity of the water between the river and the well, I think I may propose (this is evidently what Baldwin does when allowing only $300 for the cost of the work) that this second feed be established alongside the first, that is, in the same well.

To effect this, the necessary excavations being made and materials, including the first length of the new pipe, prepared in advance; the gate shutting off the water from the reservoir should be hermetically closed, when workmen stationed within and without the well could labour day and night in the removal of its south east end. They would next remove the present feed pipe, to be previously loosened from the line, then replace this same pipe and the new one in their required positions, rebuild the whole in hydraulic cement, rerun and make good the loosened joint, close the entrance to the stop cock and again let the water on to the City.

It is probable this could be done in from 30 to 48 hours, may be less, and in this way the city would be without water for only an equal length of time. Moreover, the work may be done under cover during winter if there be reason to consider this the less dangerous season for large fires, on account of the snow which then covers and protects wooden roofs and thus eliminates the danger at least of a fire spreading as in summer through sparks and red-hot cinders from a fire more or less remote.

The lateral displacement of the old or present pipe to make room for the other, will necessitate the digging of it out for a distance of some 200 to 300 feet from the gate house and its removal sidewards to the left of flow throughout such length, the displacement being nothing at the point of departure and increasing gradually to 27 or 30 inches at the feed. This displacement of the old pipe can be done by known means, already employed elsewhere, and without endangering the joints except may be to the extent of a little re-staving to make good any looseness in the lead caused by the strain ?

As additional proof that the pipe may thus be displaced without loosening the joints, it will be remembered that when, in 1875, the bridge or arched superstructure and tube over the river St. Charles was forced from its position by the accumulation of ice against it, I was enabled by the use of a few jack screws and without turning off the water, to return it to its place in the original plane of structure and with it the similarly arched pipe, both of which had become crooked laterally to the extent of about 2 feet ; this was done without even the sign of leakage from any of the leaded joints.

When I say "move to the left," it is that the new pipe thus placed to the right ward of the old, will in no way interfere with the Arago street branch, or the St. Valier street one, or both, from the old pipe; and besides, the new pipe will be more solidly situated up aqueduct hill by being on the inside of the present pipe than on the other.

The stop and air cocks with which the new pipe must be provided may naturally be placed opposite those on the present line of aqueduct. The cost of constructing new vaults will be thereby saved together with that of the wells necessary to give access to them. It will, in each case, suffice to extend the present underground structure in the way of a pocket or cul-de-sac accessible through the present wells along the line and open an underground communication between the present vault and the proposed pocket.

Certain alterations must also be made in the initial portions of the 18 and 14 inch pipes at Mount-Pleasant which it is not necessary to detail, the cost thereof figuring in the estimates.

We already have the necessary ground or right of way for the second line of pipe : a strip of land 30 feet in width from Lorette to Mount-Pleasant. Nothing therefore under this head need entail expenditure ; but important questions may arise relating to water power along the line. The City Council will have to consult its legal advisers, as to the extent to which we may be bound, if at all, towards the present mill-owners and others ; as also towards riparians who might suffer from a want of water during droughts, when the new pipe taking, if not all, the better part of the surplus now falling over the dam at Lorette, would not even leave sufficient water for the use of cattle or for domestic purposes.

It is even possible, pending a prolonged drought, and every now and then we hear of things happening in some part of the world or other to which the inhabitants of those parts had been unaccustomed or which had not recurred till after a lapse of many years, such as inundations, droughts, &c.—it might, I say, happen to be necessary to partially close one or other of the two pipes or both so as not to lower the water within the dam in a way injuriously to affect the head over the centre of pressure of the pipes. This however may be obviated by raising the dam a couple or more feet, thus to hoard or store the waters and prolong the supply.

This permanent raising of the water would no doubt cause claims for damages on part of those whose lands would be thus flooded and lost to culture.

Another, better and surer mode of facing the difficulty would consist in barring or damming the Lake at its outlet, This dam must of course be a water tight structure capable of elevating the level of the Lake by a quantity sufficient, taking into consideration the area of the lake, its adjoining waters, its water shed and rain-fall, that by means of a sluice or sluices, its surplus waters may be at pleasure emptied into the river below the lake and thus reestablish an equilibrium between receipts and expenditure.

This barring of rivers and lakes, also of ravines or other depressions of the soil, to turn them into reservoirs of water for public use, is a thing of every day occurrence in Europe and elsewhere, but then of course, as here, any lands thereby lost to culture must be paid for proportionally to their extent and value.

Another mode, it appears, of increasing the waters of the St. Charles would be that of rendering available those of lake Caché which now empties into "la rivière aux Hurons" but I know nothing positive on this head and I must advise the Corporation, in any case to cause to be made immediately the necessary surveys and levellings to establish – or the contrary – the advantage of the last named scheme as well as that of barring or damming the lake, or of raising the dam at Lorette, with all information required to arrive at the amount to be paid to riparians, if any, and in each or either of the foregoing cases.

The result of several months' labour should not be deferred till the last moment when such result is necessary at the present time and was so long since, as a basis for computing the cost of a new aqueduct, where land damages have to be looked to, as well as other items of expenditure, and the sufficiency and permanency of the supply established to a certainty aud in a way to leave no anxiety on that head in the public mind.

I an indebted to Mr. Taché, Deputy Minister of Crown Lands, for a plan by which it appears that the water shed of Lake St. Charles and its tributaries is 112 square miles; say 100 and let the annual rainfall be assumed as low as 30 inches. This should not rest on a mere assumption. If Quebec did, as is done in every other civilized country of the known world, data so precious would not be wanting, and I should now draw upon such data to a most important and utilitary end. Suppose, I say, 30 inches of water, 2½ feet cube to every square foot of area, 16 imperial gallons. Allowing one half of this for absorption and evaporation, there will remain 8 gallons for storage or supply. In 100 square miles there are 2,787,440,000 feet giving 22,000 millions of gallons in the 12 months, while the present pipe can take but 1000 million gallons in the same time. The annual mean would therefore appear to be 20 times the capacity of the present main or 7 times that of the proposed 30 inch main which is about three times the flow of the former.

There is therefore water enough to put in reserve and from which to draw at pleasure; but without such storage, the rainfall, were it ten times more than what it is, would be useless during a drought.

When after the fire of 1876, the subject of a second line of pipe was discussed I caused daily gaugings to be made of the overflow at Lorette by the guardian of the Chateau d'eau. This overflow which is sometimes as much as 20 inches, averages only from 3 to 4 inches, and more than once already during the last fifteen years have I seen the crest of the dam, during prolonged droughts, dry to a considerable extent of its total length of 200 feet, while an inch or two of water continued to flow over the remainder of the dam, due either to a defect in the level of the flash board or to the fact that where the current is greatest, increased velocity maintains a swelling of the surface at that point.

To appreciate with the necessary exactness the minimum flow—for that is the main point—which falls from the dam during droughts and, still more important, the duration of such drought and its effect on the level of the water in the reservoir and lake, it is necessary that careful and repeated measurements be made thereof, in winter as well as summer droughts. Cold and frost seize on and fix the water, retard its flow in the same way as the greater summer evaporation and absorption cause it to fail.

Nevertheless, the measurements to be made refer only to the possible necessity of providing against the eventuality of a greater and longer drought than that of the present summer, which many persons consider exceptional; Now, a measurement made on the 12th July last establishes the fact that there were then 25 million gallons flowing over the dam in the 24 hours, that is to say, as will be seen hereafter, three times the capacity of the proposed new main, and if ever we suffer from a greater or more prolonged water famine than that of the present year and that the mill owners and lessees of water power below the dam can have no claims for damages, the question, the cost of damming the Lake and of expropriating the low lands to to be flooded by such process, will not present itself.

In any case the river St. Charles in its actual state, being capable of the proposed main, we may proceed to lay it down and defer the question of making good the necessary quantity of water due to mill owers, &c until circumstances force us to do so under legal advice, and should we be obliged to make good the difference, the thing will be easy to do and a short time suffice to dam the lake at its outlet as may be required, thus storing its surplus waters with the view of letting them out again when necessary.

But if, on the other hand, as it appears, the mills below the dam now cease working for want of water, we cannot increase the damage by appropriating a portion of that, of which the whole is powerless to do the needful.

I have spoken of a 30 inch pipe and it remains to be seen on what this proposed diameter is based; for it must not be supposed that an aqueduct of a certain required capacity can be arrived at by a purely approximate calculation founded on empyrical or other like data.

We have first to see what quantity of water we require in the 24 hours and this is how I arrive at it. Appendix 2 shows that it is not prudent to fix upon less than 100 gallons per diem per capita of the population. Quebec to prosper must devote itself to manufacturing and industrial pursuits. All such industries will increase in a remarkable manner the consumption of water which is now 60 gallons and quite insufficient at that.

True, our population is now but 50,000 souls or say 60,000 inclusive of St. Sauveur. Should we again prosper as we did in former years during the era of ship-buildingand as we may hope to do again under the stimulus of our present means of communication with the rest of the world, our manufactories and industries, our grain elevators in perspective, our winter navigation which I consider practicable, our mineral resources, our docks and harbour works, the salubrity of our City, the picturesqueness of its site and for other reasons.--it is not too much for us to count upon a population of 100,000 souls in a not remote future. It is also possible that St. Sauveur may be one day annexed to the city or if not, it may have such acceptable proprosals to make in relation to a supply of water to its citizens—St. Angèle and Bedardville in like manner—as would help to liquidate the debt to be incurred or meet the interest thereof. I therefore consider myself justified in basing my calculations on a population of at least 100,000 souls.

Now 100,000 souls at 100 gallons each, gives 10,000,000 gallons of water. The water to be brought in by the new pipe must empty itself into the city at two different levels, namely: over the Grande-Allée for St. Louis and Montcalm wards and over Mount-Pleasant for St. John and Palace wards, while the contents of the present pipe will be directed towards the lower wards of the City and increased as may be required by a portion of the supply of the upper districts of which the lesser population and the fewer industries and manuactories will require less water than the manufacturing districts of Ss. Roch and Jacques-Cartier.

I have already shown that the present pipe supplies at the rate of 1,800,000 gallons in the 24 hours over the Grande Allée and 2,700,000 over Mount Pleasant. It is necessary to distinguish between the capacity of the pipe and what it is susceptible of giving under back pressure beyond the summit level. If the Grande Allée pipe were cut short at its summit on Perrault's Hill and there discharged into the open, its delivery would be 2,160,000 and this is the quantity of water which passes through it when the pipe beyond is empty as it is every day at the moment the water attains the summit and begins to flow beyond under the head 166.22 feet which separates this point from the level of the dam at the Chateau d'Eau; but when all the pipes beyond the summit have been filled and when in addition the water rises to the Cape, there is then at the summit level of the Grande-Allée a back pressure which reduces from 2,160,000 to 1,800,000 or in that ratio the consumption of water by St. Louis and Montcalm wards.

On the other hand the 2,700,000 gallons per 24 hours at Mount Pleasant under a head of 251 ft. or of 84.87 ft. greater than that of the Grande Allée is the entire capacity of the pipe at that level, since when the water is flowing into the city at that point the gauge shows no pressure and the hydrant there, while full open does not allow one drop of water to flow from it, so great is the velocity of flow: but when the 14 inch St. John St. main will have to do duty in St. John and Palace wards only, there will then be, as on the Grande Allée, a back pressure capable of reducing the flow in about the same ratio or from 2,700,000 to 2,250,000 in the 24 hours. The delivery of the new pipe must be divided in the ratio just established, that is of 2,250 to 1,800; it remains therefore to be seen what the present pipe would give under the aforesaid ratio if its contents were divided and flowed continuously both over Grande Allée and Mount-Pleasant, to obtain a term of comparison on which to base the quantity which will be supplied by the second pipe while flowing simultaneously over both the aforesaid levels.

Suppose then the present pipe to run for 12 hours out of the 24 at Mount Pleasant, it would give 1,125,000 gallons; then during 12 hours over the Grande Allée where it would give 900,000 gallons; together 2,025,000 in the 24 hours.

Now the two pipes which, were it not for friction—(proportional to diameter, while capacity is proportional to square of diameter)—would give in ratio of their sectional areas, give on the contrary in the approximate ratio of the square roots of the fifth powers of their diameters. These factors are as 2.756 to 9.859 and 2.756 is to 2,025,000 gals. as 9.859 is to 7,244,000 gals. or in round numbers 7¼ millions of gallons under the combined effect of the two different levels at which it will pour its water into the City.

I have already said that the present pipe directed towards St.

Roch and the other low wards of the City would supply at the level of the foot of "Aqueduct hill" under a head of 400 ft. 3,350,000 gallons; but a portion of this supply would be converted into pressure to cause the water to rise to the summits of the buildings in these wards and overcome the friction of the increased distance through Arago St. as compared with that to Mount-Pleasant.

These 3,350,000 gallons would thus be reduced to about 2,750,000, making, with the 7¼ million of the proposed pipe, the 10,000,000 gallons required.

If I err, it will be on the safe side, and I shall be pleased that, with the data which I here give, practical mathematicians may make me out awanting. Let it be proven that the new pipe will supply much more water than I say it will and I shall be most satisfied, as the whole Quebec public will also be, no doubt,since, of two things: either the aqueduct will give more water per capita to the supposed population of 100,000 souls; or if 100 gallons be sufficient, the result will allow of supplying a surplus population which it will be no idle precaution to provide for Again, any surplus of water need not be considered useless as it may be let out for water power, many will be found ready to avail themselves of the advantage of it.

Yes, it will be found in reality that a 30 inch pipe is capable of supplying more water than I here assign, but then the computation must apply to a theoretic pipe quite new, quite clean and smooth; while, not to do as the engineer of the present aqueduct—promise you three millions of gallons and give you only two—I have made allowance in advance for the incrustation of the proposed pipe and of all the eventualities of eccentric jointings, irregularities of alignment, increased and diminished bore, sediment and obstructions of all kinds and this, as is seen, not in calculating the pipe as if there existed not already one on which to base a comparison; but, precisely, in making use of the present pipe with all its factors eliminated in advance and allowed for under the actual flow from it, and so as to have no more to do than to compare together the only two elements to be taken into the computation, viz: the comparative areas or sections of the two pipes and the known ratio between their surfaces offriction.

In this way, all doubt also disappears regarding the flow due to the respective heads of the two levels.—Grande-Allée and Mount-Pleasant,—and which are supposed to be as the square roots of the heads; since the required term of the ratio sought for, eliminates this doubt by basing the calculation on the actual flows due to equal heads at the two points of discharge.

For any one who may desire to compute the flow of the proposed pipe without basing such flow on that of the present pipe I may add that its total horizontal length is 40,800 ft., say 41,000 feet, in allowing for its curves and sinuosities in a vertical plane. There are now, in the present pipe from Lorette to Mount-Pleasant and in the same way must there be in the new pipe, not less than 73 angles of deflection or deviations from a straight line of which the natural sines vary between 0.0003 and 0.0760, their sum is 1.8952 corresponding to a single angle of 62.28 between the two branches of the syphon or a total deviation from a straight line of 173°32' The deviations in the horrizontal direction are 8 in number; the sum of their sines, 2.22495, corresponding to an angle of 13° or to a total deviation of 193°, equivalent to a cusp of 13° under a radius of 100 feet or of which the branches cross each other at an angle of 13°, supposing all the deviations to be united consecutively on the same side and the curves joined end to end.

I have already said that the summit level Grande Allée is 166.22 feet below that of the dam at Lorette, and Mount-Pleasant delivery is 251 feet below the latter. The head over the centre of the pipe at Lorette is 3.5 ft. increased at certain seasons by the depth of flow over the dam or by a maximum of 1.8 ft. or a mean of .33 ft

Also allow for eccentricities, not likely in any case to exceed from $\frac{1}{8}$ to $\frac{1}{4}$ inch and the consequent narrowings of the water way, enlargements at stop-cocks of which there are 5 and air-cocks 10, and more important than all, take into consideration the effect of the three increases of diameter at as many different levels to wit: 30" to 33," 33" to 36," 36" to 40" and their conical junctions, the length of the first enlargement of bore from the city being 3300, of the second 3500 and of that reaching the Chateau d'eau 3100 feet, together 9900 ft. with 31000 ft. of 30 inch pipe to complete the line.

I shall always be ready at any time to supply any additional data in my possession bearing on the subject at issue, the capacity of the pipe, that is: to any one capable of making the calculations; for there are not wanting those, the most illiterate, ignorant of the very elements of hydraulic science, who are always ready to make known to the public, through the press, their schemes of improvement of our aqueduct: he for example, who, not long since in the columns of one of our local papers, proposed to tap the pipe at its lowest level and supply St. Roch, &c. through a 10 inch pipe—ignorant of the fact that, at that level a pipe of less size, would take the whole delivery of the present main; far from, as he supposed, leaving enough water to reach and supply each of the upper districts simultaneously and continuously with the first.

I should be pleased that any one having the leisure for such calculations, would compute the delivery of the proposed pipe: say by Prony's formulae, then by those of Du Buat, next by Eytelwein, again by Saint Vennant and successively by the formulae of Chezy, Hawksley, Leslie, D'Arcy, Blackwell, Neville, D'Aubuission, &c., and thus show how the results agree with those set forth in appendix VII, as calculated from said formulae for 5, 50, 500, 1,000 and 10,000 feet pipes of smooth straight bore. The result could not but prove highly interesting and instructive to scientists and of great value as data for the water supply of this and other cities.

I therefore now declare that, with the exception perhaps of a general system of metered allowance, as applied to the whole city, there is no mode by which the present line of pipe can be made to afford a continuous supply of water to every part of the City, an abundant or even adequate supply. The only means by which this can be done is by the laying down of a second line of pipe from Lorette.

The cost of cast iron in Scotland at the present time is as low and even more so than when we laid our first line of pipe in 1850 and I am now in a position to state that the total cost of the proposed pipe, with its air and stop-cocks, the addition to wells along the line, the required bridges over the St. Charles and Des Mères rivers, the alterations at Mount-Pleasant and at Lorette, the repairs to the dam 200 ft. in length, the required increase of a couple of feet to its height and the scouring out of the reservoir, pumping out its large deposit of sediment which invades the pipe and reaches to our cisterns; I may say, (see the estimates in the appendix) that the cost of doing all this work will not exceed half a million of dollars ($500,000).

This is the first, at that time approximate, figure and not based on the necessary information which I have since received from Europe, which I could give His Worship the mayor, and which suggested his answer to that effect to the question put to His Worship by the Chairman of the private bills committee of the house. If I deemed it advisable to recommend as I then did that power be given the city to issue debentures for an additionnal $100,000, it is not as was at the time asserted in any thing but polite language by the ill-bred editor of a certain journal thus insulting the Mayor and City Engineer; it was not, I say for want of an understanding between us as to the required figure, but that from the information which had just reached me from the United States as to the cost of the pipe proposed, I thought the figure I had given the Mayor was too low and that it was better not to run the risk of having to crave an amendment at the next session of the Legislature. Mr. .....'s should have known better, had he not been blinded by ignorance and bad faith, than to take occasion of such an incident to accuse the civic body as he did of collusion and corruption in the administration of its finances. Mr. .....'s too recent record of the past is anything but such as to justify him, of all others, in hurling accusations, and attacking the City Engineer and civic body as he has been doing for months, past in his journal and under inspiration, we know from what quarter, but so it is and always will be, those who are susceptible of corruption themselves think or feign to think that others are of like metal. A moment's reflection should have convinced him, that when there is question of an expenditure of which another continent holds the key, it was necessary to obtain the same, thus to pronounce in advance and at random on the cost of such an undertaking; and as proof of the necessity of such information, I may say that the same pipe which cost us 87s. 6d. sterling in 1850, was paid for at the rate of $48 or double the amount in 1873, and by far the greater portion of the expenditure to be incurred consists in the cost of the pipe itself irrespective of that of laying it down and of other items incident thereon.

I do not here constitute myself the apologist of the City Council of Quebec, all the evils and misfortunes of which are attributable to the city's poverty. I believe each of its 24 members and the Mayor to be imbued with a desire to do their duty honestly towards the public, and it is only the want of the pecuniary means of supplying so many requirements which is the cause of such oft repeated recriminations.

May be it is only the moral courage the City Council lacks of imposing additional taxes, and I am free to admit that others also would fail in the attempt under the discouraging influence of so many misfortunes coming one upon another in such quick succession; the loss of so many millions through the numerous and extensive fires which, since 1845, have destroyed three quarters of the city, may be more; loss through baron Grant and others of an additional half million, stagnation in business until recently that our Legislature has come to the rescue, aroused us from our long lethargy and put us in communication with the rest of the world by means of a railroad which should have been built 20 years ago; personal discouragement at seeing the taxes weigh so heavily on the two-thirds only of our citizens, whilst the other third is exempt therefrom; in a word a concurrence of circumstances capable of causing confusion and trouble in the best constituted community.

I here omit the cost of damming the Lake and of thus storing its rain-fall, on which to draw at pleasure, as the advisability, the necessity of so doing is not yet urgent; and, as already set forth, it will always be possible to do it at any time and under a brief delay. The item $10,000 for land damages on account of flooded low lands, does not enter either into the estimate of cost; neither will the alterations alluded to in the interior City distribution be of immediate necessity with a second line of pipe.

That this report may be full and complete of itself, it is well to say that, in case it be decided on hereafter to bar or dam the lake at its outlet, its area is 36½ million square feet. A dam which would elevate its waters by only one foot would thus give an increase of 230 million gallons of water, which if drawn from at the rate of 10 million gallons a day, would cover 23 days of a drought which with the present pipe might leave no overflow or surplus at the dam. Two feet of a rise would under similar circumstances supply our wants for 46 days and a maximum of 5 feet would take us over a water famine of 115 days if such a prolonged one should ever come upon us. We need ask no more.

Now if this second pipe is beyond our means, if we are ready to put up in the future with the alternative or intermittent system of supply, and that the only object be to master a fire, without in any way affording relief to the inhabitants of the City who justly complain that the water does not reach their cisterns and that the supply is of such short duration; I believe the most expeditious, the least expensive mode would be the establishment of a dozen or more wells similar to those already in existence at the corner of St. Augustin and St. Patrick Str. one at the Berthelot market, the other in the yard of the Asylum of the Good Shepherd. These three cisterns may be improved, their capacity increased by our incurring the cost of an interior lining to them in hydraulic masonry the effect of which will be to retain their water to a level from 5 to 7 feet above that at which the water now stands in them.

$50,000, or less, would give us this dozen or more wells situated at suitable points along the Glacis, Cove Field, tower fields, &c. The four Martello towers, as suggested I believe by Mr. H. Dinning, might also be utilized for the storage of water for fire purposes, Nos. 1 and 3 to Montcalm and St. John wards, Nos. 3 and 4 to St. John and J.-Cartier wards.

The following are the sites I would suggest for the proposed cisterns, their necessity and importance to be considered in the order in which they are hereinafter set forth, No. 1 being the most pressing and requisite of all, the others in a less degree.

No. 1 The Glacis, near St. Denis st. opposite Des Grisons street. or half way between Des Carrières and St. Ursule streets, to reach which level the water when in the lower town requires not less than 45 minutes.

No. 2. Seminary field near Grande-Allée, opposite De Salaberry Street or other ground in the vicinity. This is one of the highest points in the City and the water may be as many as 20 minutes or more in reaching it in full force, thus imperiling the St. Bridget Asylum, the Protestant Home, the Jail and the surrounding tenements and villas. Could No. 2 Martello tower be obtained for the purpose, it might, though at a considerable distance save us portion of the cost of the well.

No. 3. The ground opposite the New Parliament Buildings, Grande Allée, or may be better, to the Westward of these buildings near St. Augustin st. It is possible that in consideration of the protection, a well, so situated, would afford, the Government might build and donate it to the City, or erect one in the interior court of the edifice to which access might be had through the gateway facing North towards St. Julia street.

No. 4. The Glacis opposite the upper end of D'Auteuil street. A cistern here would cover Chalmer's Church, the Normal School, the City Hall and its vicinity.

No. 5. Centre of the Ursulines block between Ursule, Garden, Ann, Louis, Donacona and Parlor streets and may be, as with the Government, the Reverend Ladies would excavate and line it at own expense.

No. 6. The University and Seminary block—say in the vicinity of St. Famille street. These institutions, I have no doubt, would undertake to provide it and save the city the cost, seeing its importance to their own expensive property.

No. 7. Hotel Dieu lot, near the extremity of Charlevoix street, and accessible either towards Palace or Hamel streets.

No. 8. Corner of St. Stanislaus and Dauphine streets facing the Methodist Church and near to Morrin College, &c.

No. 9.—The Artillery barrack yard near McMahon St.

No. 10.—The Glacis near the street of that name and facing on Richelieu st., commanding the extensive and lofty premises of the Sisters of Charity.

No. 11.—Tower field No. 4, opposite Latourelle Street, unless we be allowed to use the tower itself for the purpose.

No. 12.—Tower field No. 3, near Plessis, Prevost and Burton streets unless No. 3 tower can be obtained in lieu thereof.

No. 13.—Tower field No. 3, opposite the lane leading therefrom to St. John St. at "Pointe d'Aiguillon."

Some of these as Nos. 6, 7 and 11 are due to the small size of the 4 inch pipes reduced now to 3 inches, which renders the wells if not of absolute necessity, advantageous at least as feeders to the steam fire engines while at the same time, the direct pressure from the pipe, may be made available.

With these wells we must also see to the necessity of erecting hydrants where they are wanting, as at the corner of St. John and d'Aiguillon streets; at the intersection of St. Eustache St. and Grande Allée; half way between those—1000 ft. distant from De Salaberry Str. and the western limits of the City; between those—1300 ft. distant from De Salaberry and Claire Fontaine Streets.

The Engineer of the Fire Department, Chief of the Fire Brigade, can point out many other places where hydrants should be laid down; their mean distance here being 500 feet or more, while in other cities their distances do not exceed from 200 to 300 feet, and I can tell you hereafter where others are required to perform double duty as fire hydrants and scouring wells at all the dead ends "in the city, some fifty in number, I believe; that is, where the pipes are not connected with the general circulation and where in consequence thereof, deposits of sediment form, which renders the water in the vicinity unfit for use.

Moreover, all the hydrants should be replaced by others on an improved plan, frost proof and such that they might be allowed to stand out above the sidewalk, thus rendering them visible and more readily accessible in case of fire. Really it is simply disgraceful in a City of this importance to see our sidewalks obstructed by the unsightly and cumbrous boxes with which under the present system it is necessary to cover the hydrant traps to protect them from snow and frost; whilst there are now and have been for years past, self acting hydrants with frost jackets certain to protect them against the severest cold and in which the barrel is always empty while the valve or cock is closed. Our system of hydrants thus buried under the snow and ice of winter may sometime give rise to serious inconvenience arising out of the delay consequent on getting at them and unicing the man hole.

The ditches around the Citadel; that for instance, of the South West angle, others, may be, in whole or in part, might, by roofing them over against snow and frost and lining them to hold, water afford us their aid of space and position.

With this it is also imperative that the turning on and off of the water as well in a case of fire as for ordinary purposes of supply, be confided to one and the same body of men; for, under the present system, things will always go wrong, there will always be errors committed as was the case during the late fire of the 8th. June last, and as constantly occur more or less at every fire.

It must not be believed that the first comer, can be taught, after only a few days apprenticeship, to efficiently perform a duty requiring long practice; and it is in this our Solons most often err, in replacing, or attempting to do so, men broken to the service by others who, to obtain a situation, are always ready to proclaim their ability to do any thing and every thing required of them, while at the same time absolutely incapable of so doing. No man should be thus thrust on the brigade without his nomination being approved of by the chief, neither should this be done as it often is by the police board without consulting the chief of police. There can be no discipline, a captain can have no command over men who know that their chief has nothing to say in their appointment or dismissal. There should be an end to this and a man's fitness for a situation considered before the influence of his wire pullers.

But before we cry out for water for the extinction of fires, it requires to be seen if this subject matter of complaint is well founded. It is not right to attribute to any certain cause that which may be due to quite another. It is not the want of water in American Cities which is complained of in cases of fire. How many great fires have devastated those cities? There are circumstances which, with us, render large fires inevitable and will always do so notwithstanding all possible precautions and all improvements in our means of combating them.

I have already said, I repeat and insist that on account of the narrowness of our streets, most of which are form 25 to 30 feet in width, whilst in other cities they are from 60 to 100 ft.; because of the agglomeration and closeness of our houses and out-buildings due the inadequate depth of the lots in the suburban wards; the immoderate use of resinous woods in structures of all kinds; the multiplication, juxtaposition, and superposition of galleries, porches, covered ways—all of wood; it suffices that, as was the case at the last fire, there be a delay of ten minutes in giving the alarm, to render all attempts to stay the fire, fruitless even with all possible water at command.

The last report received from New Haven, a town of less size, I believe, than Quebec, shows a fire brigade twice as numerous as ours and to which their city council votes an annual budget of some $58,000 while here we have to be content with just one quarter of the amount. Our brigade is not numerous enough, it is ill-paid—the whole municipal service is ill remunerated—the men are discouraged, hose in sufficient quantity is wanting, and then we wonder at the result. New-Haven has 15,000 feet of hose, we about one third of the quantity available.

No, the water was not wanting at the late fire. The alarm was not given in time and something was wrong with at least one of the three stopcocks which cut off the supply from St. Roch and the city, that is, it was not shut in time, while that at the head of St. Geneviève street, commanding the hydrants downwards towards the fire, was, by some mistake, shut instead of being opened, Our brigade are few enough as it is to attend to the hose and hydrants without having to tell off a number of them to manipulate the stop cocks as is done under the present system and sometimes wrongly done by men not sufficiently trained to the duty. Moreover, the well of the Berthelot market was there at less than 1200 ft. from the scene of the fire; it was as it always is, full of water to a depth of some 14 feet, but I suppose there were not hose enough to reach it, or more likely the idea never occurred of utilizing it until the fire had spread to the vicinity.

This well was, however, made to do good duty later on in the evening when, from near midnight till five of the following morning, that is, during over five consecutive hours, it held out under the double suction of the Clapp and Jones steam fire engine, one of the three belonging to the department, and certainly stayed the progress of the flames in that direction.

The stop-cock of the hydrant, corner of d'Aiguillon and St. Claire streets, was not opened as it should have been at a certain stage of the fire; hydrants said to be rusty to suit certain interests, were not so, and the fact of the water not flowing from them was merely due to the fact that, the supply being shut off, the water could not of course reach them. These facts are however of secondary importance when compared with that of the main cocks or gates not being shut at the proper time and on account of the delay in giving the alarm.

I must now direct attention to the several appendices which follow this report, the first of which is a somewhat detailed estimate of the cost of laying down a second line of pipe.

The second shows the quantity of water consumed per capita of the population by certain cities of the United States, of Europe and of Canada. In European cities the want of water for fires is less pressing than with us and American cities; the first having a larger proportion of structures composed of refractory or uninflammable materials as stone, brick, iron and non-resinous woods. This consumption for 23 American cities gives a mean of 64 gallons per capita per day, divided as follows (Fanning page 34):—

| | |
|---|---|
| Domestic use | 20 gallons. |
| Stables and vehicles | 3 " |
| Fountains—3 to 10, mean | 6 " |
| Commercial and manufacturing purposes from 5 to 15, mean | 10 " |
| Street watering and private hose | 10 " |
| Wastage to prevent freezing | 10 " |
| Loss by leakage and used for scouring purposes | 5 " |
| For fire purposes | $\frac{1}{10}$ " |

Appendix 3, to which I have added the line of means and that of similar data for Quebec, shows the revenue derived per million gallons supplied, and that Quebec receives one cent per hundred gallons while others charge as much as two cents and more per 100 gallons. The charge is less in some other cities.

See for instance page 21 of the last annual report of the aqueduct Committee of the City of Ottawa: the annual revenue for that city is set down at $91,412 for the year 1880, its population is only

22,000 souls; while here with a population more than double that of Ottawa we derive a revenue averaging hardly $90,000.

The minimum rate for water is every where else than in Quebec from $5 to $6 per family, namely: where there are neither baths nor closets, nor cows nor horses, nor any thing else affecting the consumption. In Quebec on the contrary, 2,832 families pay less than the minimum of $5.00, to wit: 23 in St. Louis ward, 30 in Palace ward, St. Peter's ward 163, Champlain 468, St. Roch 411, Jacques Cartier 534, St. John 624, Montcalm 579. A large number of families are charged but $1.60 to $2.40 and we persist in not correctly interpreting the law which evidently requires a tax of $5.00 per family instead of per house containing two or three families or more; so that the party for instance who does my washing and yours and that of others, pays but $2 for a consumption probably 100 times in excess of what others and I use, and for which we are made to pay from $20 to $40. In Quebec only are such things known.

Elsewhere than here, breweries are charged from $3,000 to $5,000 per annum for the water supplied them; here a brewer whose water, before the aqueduct, cost him $900 per annum, now pays but $160. Every where else all industries are rated for water; such is not the case in Quebec.

Appendix 8, is worthy of the serious attention of the public. It relates to the waste of water and to the metering thereof, and the City Council must properly weigh the different considerations regarding such metering before it be decided on. To this end, it is necessary to remind you of the difference between the several systems of supply. Thus, where the system is not that of gravitation, or where the water is elevated to reservoir level, or pumped directly into the pipes; while the consumption due to measuring the water is decreased and the revenue therefrom correspondingly diminished; on the other hand, the less consumption, the less pumping, and the cost of pumpage is thus reduced.

On the contrary, with gravitation the expenditure is incurred in advance and cannot be modified or lessened. With us therefore, the use of meters should be confined to establishments where the consumption is not susceptible of any decrease, as in manufactories, hotels, &c. But if generally introduced there would certainly be a decrease in the receipts, as many familes would then reduce their consumption to a quantity barely sufficient for domestic requirements and thus interfere with the salubrity of the City. In any case while using meters it would be necessary to give householders a minimum supply and impose at the same time a minimum water rate. In view of this matter, I give in appendices IV and V, to which I have added a column of means and the same data for Quebec, the cost of water for an ordinary family occupying a house of an average rental of $200. These tables show that the minimum, maximum and mean rates charged on items subject to water rate are as follows, to wit:

| Item rated. | Minimum. | Maximum. | Mean. |
|---|---|---|---|
| Bath | $1 00 | $6 00 | $3 36 |
| Water closet | 2 00 | 6 00 | 3 80 |
| Urinal | 1 00 | 10 00 | 3 20 |
| Fountain, ½ "nozzle | 3 00 | 60 00 | 15 55 |
| Sprinkling | 2 00 | 12 00 | 5 33 |
| Brick per 1000 | 0 05 | 0 12½ | 0 08½ |
| Stone per perch | 0 01½ | 0 12½ | 0 04½ |
| Plastering per 100 yds | 0 10 | 0 50 | 0 28 |
| Lime per barrel | 0 05 | 0 12½ | 0 07½ |
| Stables, per stall | 1 00 | 3 00 | 1 86 |
| Steam engines, per horse power | 2 00 | 10 00 | 4 32 |
| Metered water per 1000 gallons | 0 10 | 0 50 | 0 23½ |

This synopsis of the prices of 37 American cities gives a mean of 589 hydrants, while we have but 200 or thereabouts.

In 23 of these cities, the water is raised by steam power, in 2 of them by water applied to wheels and turbines, in 1 by the combined force of water and Steam, in 9 others by gravitation, the same as in Quebec, in the last by gravitation and steam power combined.

Appendix 6 shows the economic influence of aqueducts on insurance premiums. It is worthy of close attention.

Next, for the information of those who think it the easiest thing imaginable to compute correctly the delivery of an aqueduct like ours with its length of line, its 81 deviations from a straight line, its irregularities, obstructions and all the other unknown elements which affect its flow; here are the varied rules and results laid down by the most celebrated practical mathematicians. The delivery as computed under the several formulae for a head of 100 feet and diameter of 1 ft. varies from 62 to nearly 300 in a pipe 5 ft. long; from 47 to 102 for a pipe 50 ft. long; between 39 and 81 when the length of pipe is 100 ft. With a length of 1000 ft. the results are as 14 to 19, and for 10,000 ft. the computed deliveries are as 40 to 55.

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To sum up:—

**The metering of the water, its measurement by meters, would**

save it, render it more abundant for useful purposes; that which is now wasted would go to increase the pressure in the pipes in a larger portion of the city; the water would rise to a higher level and the four upper wards of the city might thus be made to enjoy a supply of longer duration—say, 4 hours each in lieu of two.

If this metering could be applied to all the services of the city, it is possible the consumption might be restricted to a degree that would cause the pipes to remain full and under pressure during the 24 hours, but in such case the revenue would suffer and it is hardly to be expected that any plan will be adopted which would decrease a revenue that, on the contrary, we require to enhance, to meet the interest on the cost of the aqueduct and cover the expense of yearly administration.

On the one hand the amount received for water would be increased where no restriction could be put upon the quantity consumed; while on the other the greater number would reduce their consumption of water to a figure, which, even at the highest price per 100 or 1000 gallons, would be far from affording the revenue now obtained under the rate of 10 cents in the dollar on the rental and, as already said, the sanatory condition of the city might be, to some extent jeopardized by those who, to reduce their expenditure, would consume and use so little water as to interfere with their family hygiene.

A general metering of the water in this city would only be possible under a completely different mode of assessment, say for instance by establishing a minimum $10 family rate for a maximum supply of so many gallons, the surplus being payable at so much per 100 or 1,000 gallons subject to the indications of the meter.

If water were metered at my place, it would cost me but $4 a year instead of $42 which I now pay, and the increase obtainable elsewhere by taxing industries which in all other cities are subject to be rated for water, but pay nothing here, would hardly make up the loss on rental rates. This metering of the water, I have already said, would cost the city.......................................$100,000

A *Reservoir* on the heights capable of containing 12 million gallons (460 x 200 x 20 ft. deep) would cost according to Baldwin's report, page 19, $180,000, and Baldwin himself considers such a reservoir as absolutely inadequate to confer any of the advantages of a second line of pipe, that is, to aid or increase, in any way, the supply to the City, the delivery of the present main.

Let us for an instant suppose the reservoir built and that we fill it at night; say between the hours of 10 P. M. and 4 A. M.—we could hardly do more without inconvenience to our citizens—that is during 6 hours out of the 24. During this interval the main would deliver into the reservoir half a million gallons at most, and it would require 24 days to fill it. All that this reservoir could throw into circulation during the day, without lowering the level of the water in it and gradually emptying it, evidently consists in the half million gallons poured into it at night, and this half million gallons taken from the night waste to be utilized during the day, this increase of only 20 per cent in the daily supply would have but an insignificant effect on the pressure in the pipes and on the additional height to which the water can attain under increased pressure.

Moreover, during the 6 hours the present pipe would thus pour its contents into the reservoir, it must be evident to every one that the pipes throughout the whole City would be empty, and that in case of a fire between 10 P. M. and 4 A. M. there would be the same delay in refilling the pipes as exists under the present system, though to a less degree, as in such case, both the pipe and the reservoir would cooperate in the filling.

In one word, the only advantage to us of this reservoir would be to cause less delay than at present in getting up a fire pressure, after which the flow into the reservoir must be cut off; and if the fire were on the cape or near the summit level, the flow from the reservoir also must be cut off, as if not so, the back pressure from these points where the water must, to command the tops of houses, &c., be elevated above reservoir level, would only cause the water to flow back again towards the reservoir where it must fill and overflow it, or if not full at the time run uselessly into it. Hence it is evident that during a fire in the upper wards, the reservoir could not be utilized except as just said for filling the pipes, after which all communication with it must be shut off to enable the high levels to obtain the direct pressure due to the fountain head at Lorette 150 feet above that of the Grande Allée reservoir.

We would thus be going to an expense of some $200,000 for an advantage which we could equally obtain from a dozen or more *cisterns* or wells which would not cost the city one quarter of the amount.

Another advantage of the reservoir would be that of covering a delay of a few days in case of an accident which it might require that time to repair. I can see none other.

Once more, Gentlemen, if it be only to the question of the extinction of fires that you wish to direct your attention, the reservoir will help you to do so, but will cost you many times the price of remedies as efficacious and less expensive.

There is but one known means of attaining, at once, all the advantages which you expect from the improvement of your aqueduct. These advantages are: abundance of water for all requirements including that of allowing some of it to run continuously during winter to prevent the freezing of pipes; continuous supply during the 24 hours; constant pressure in the pipes in all, even the highest parts of the city; the certainty of immediate water at the beginning of a fire in whatever part of the city it may occur and this at all hours, at any and every moment of the night as well as of the day.

The watering of our streets is indispensable and we cannot afford to forego this luxury if it be one. Our streets no doubt are more dusty than elsewhere, from our pecuniary inability to sweep them, and even if paved or their surface otherwise improved, they would still be subject to the dust of wear and tear, as also to that of dung and detritus of all sorts like in every other city. We must come to the rescue of dry goods and other merchants whose wares suffer from this daily deposit of a substance which deteriorates the articles and renders them unsalable. We want this watering of the roadway to be done, not as it is now, in only a few streets or portions of streets, but in every street, and not once, but several times a day during the hot spell. We must not even be restrictive with those who avail themselves of their water supply to sprinkle sidewalks; for, let us admit one and all, it is delicious on a hot summer day or night to breathe the air thus rendered cool and refreshing by this simple process of sprinkling which costs so little when compared with its undeniable advantages. Lullin, in his premiated essay on the Geneva water works has the following: "Ce n'est plus seulement de l'eau qu'on demande de nos jours, il faut le reconnaître, c'est de l'eau en abondance: ce n'est plus seulement à *l'usage de l'eau* qu'il s'agit de faire face, c'est *au luxe de l'eau,* et ce luxe si sain, si utile, si agréable, si gracieux, Genève (Québec) ne voudrait pas en rester privée." It is therefore 100 gallons per diem we require, for we now have 60 and hardly half enough at that, since the upper wards of the city have but a two hours daily supply. There is but one mode of giving us this indispensable supply of water:—it is a second line of pipe the cost of which will not exceed $500,000. Then, instead of 2½ million gallons in the 24 hours, we will have 10 millions, or 100 gallons to every man, woman and child and for years to come.

The interest on the cost of this pipe, including may be a sinking fund of 1 per cent to wipe out the debt in 40 years, will be $30,000. Let our City Council approach that of St. Sauveur which I have no doubt will tax itself to the extent of one-third of this amount in exchange for a proportional supply of water, say 1,000,000 gallons daily to be given them by a branch pipe from the main for that purpose. St. Sauveur would at its own expense distribute this water to its Citizens, collect from them a proportional assessment and hand us over the amount annually, semi-annually or quarterly as might be agreed on.

The Water Works Committee submitted to the Council a proposed water assessment on churches and other property which pay nothing or next to nothing into the City Treasury—here is another sum of $10,000 or more towards the interest of the capital to be expended.

The 2830 families who now pay only from $1.60 to $4.00 for water, by taxing them at $5.00, as a minimum, would give us an increase of $4000, which will leave but $6,000 to make up the required sum of $30,000. The $6,000 we can obtain, and even double and triple the amount by assessing, as in all other cities or in rating for water, all industries, manufactures, &c., which do not now give the City one single cent in addition to the 10 cent rate in the dollar on the rentals of their respective locations, a rate which only covers the use of water for domestic purposes.

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## REVENUE OF THE AQUEDUCT.

The mode of assessment for water requires to be completely altered. Under the present system many pay too high a rate, a great number pay too little, others pay nothing at all.

The minimum tax for a family should be from $6 to $9; that of Geneva is 48 francs, say $9.60 for 360 gallons per diem per family or 60 gallons per head to a family of 6; the mean of other cities being $9.65, and this tax should be payable by the tenant, not by the proprietor. Let it be remarked, I do not here speak of other assessments or rates for which it is perhaps right that property should be burthened and made responsible. Property is already taxed beyond its capacity and to burden it in addition with the responsibility of paying for the tenant's water, is to diminish and destroy its value to an alarming extent. The water tax is different from all other taxes. Water is a commodity, a substance, an article of consumption for which it is not more just to have the proprietor pay than for the milk or bread which goes towards the subsistence of the family. This responsibility of the proprietor is simply outrageous where an article of consumption is concerned

All those who exercise an industry which requires a supply of water in addition to that for domestic purposes must be made to pay for it in proportion to the requirements of the business carried on. Every other city, without exception, includes under this head—tanners; curriers; bakers; breweries; distilleries; dyeing establishments; barbers; bathing establishments; laundries; soap and potash factories; pork-curing establishments; marble yards; slaughter houses; manufactories of ginger, root and other beers and of nectar, soda, &c; water fountains; soda, nectar and other fountains, steam engines; hand hose for sprinkling and for the washing of windows, vehicles, &c.; refineries; photographic galleries; restaurants; hotels; inns, and the like.

In my report to the Council, of 1872, I have shown that a revenue of at least $15,000 could be raised on a few only of the above named industries including laundries, steam-engines, beer bottling establishments, &c., and if the whole were assessed, I doubt not, but what the revenue would be thereby increased to the extent of at least 20 to $25,000

Steam engines alone, of which, in 1872 there were 50 averaging 10 horse power, would, by taxing them at the lowest rate of other cities, say $5.00, bring in a revenue of $2,500, and as their number has greatly increased since the date of my report, the figure would probably now reach $3,500, even $5,000.

Water closets which are here charged but $2, afford a revenue every where else of from $3 to $6 or a mean of $4.22. Why then not adopt this mean, say of $4 and thus add some $1500 to $2000 to our receipts. We charge $2 for baths; the mean in this case is $4.20. Would it be extravagant for us to impose this mean of $4 since it is only the well-to-do class which can afford the luxury. Fixed wash stands in houses &c. are elsewhere rated at an average of of $2.19; let us say $1.00, even this would be an addition of some hundreds of dollars to our receipts.

The use of water for horse and vehicle is certainly worth $5.00 in place of the $1 which we charge; other cities charge from $2 to $10, a mean of $4.58. Suppose we said $4 or even $5, how could it be contested. Many carters whom I have questioned on this head admit that the charge would be far from exorbitant. I have just received from Cambridge, U. S. their budget of charges for 1880 and there find quoted: "private stables, for the first horse $5, for each additional horse $3; each cow $2; livery stables, for the first 5 horses, the same rates as for private stables, for each additional horse above five $2.50."

In one word, the thing to be done is to cause those parties to pay for the water who use and consume it, and extend a helping hand to those who, like myself, pay exorbitant rates and do not consume one-tenth of the water which others do who pay ten times less.

Now it is not enough, merely to impose taxes and water rates, they must be collected. The ignorant and foolish cry of those who would have every thing done by a minimum number of employees, has already had the effect of thousands of dollars being lost to the city. To save the cost of a collector, the percentage to be paid him, we but too often lose the amount in toto. Under the plea of poverty, of inability to pay, we would continually reduce the staff; the employees, many of them, are worked beyond the limits of endurance; they are charged with the performance of duties too numerous, too varied, without regard to the well known principle of the division of labour; that is why there is always something neglected, something not properly done; and again I say, and defy contradiction, the city receipts have in the past suffered considerably and continue to do so under the mad policy of having one man to do the work of two or three.

Have we not half a million dollars due for arrears of assessments and how many thousands more are due and will never be paid, for want of collectors at the time, for deals supplied for sidewalks, rentals of corporation property, service drains laid down at the cost of the city and for which, by law, proprietors are responsible. Does any one know this better than I do, who have been here for the last 15 years?

Let us adopt the necessary means to collect the municipal revenue—as the gas Company does which has never lost one cent of its dues,—and the annual arrears, the amounts due and which under the present system will never be paid, will immediately be found to diminish in a most encouraging degree.

Why has it been found advantageous every where else to confide the management of water works to a board of Commissioners?

This is what Mr. Keefer has to say on the subject, page 16, of his report of 1860: "In the principal cities of the United States where aqueducts are city property, it has been found in the greatest number of cases that it was impossible to cause them to be administered by the City Council. If the management of an important hydraulic work is placed in the hands of a numerous body, charged in addition with the superintendence of all the other affairs of the City, it is conceivable there can be no individual responsibility, especially if the "personnel" of the body is every year changed in part or in toto.

To remedy such inconvenience it has been found useful to form a small body of men under the denomination of " Water Commissioners " chosen either directly by the municipal electors as at Hamilton or by the Council itself on proposition of the Mayor as at New York." Mr. Keefer is right in what he says, and for other reason which he does not give but which are evidently implied; they are these:—By confiding the Water Works to a Board of Commissioners, City Councillors would escape the importunities of their constituents and not be forced, as they are under the present system to use their influence to reduce to a minimum the amount to be charged and collected for each special water service; and were it not so, the time has long passed when under a board of commissioners the receipts would have equalled and even exceeded the annual cost of our Water Works for interest and management; for, since their very inception a board of the kind after the example of other cities and guided by the principle of simple justice and common sense would have imposed a water tax or rate on all those who now make use of the water without paying for it—all the industries I have enumerated—and we would not now see, as we have done for so many years, immense establishments, educational and others, churches, asylums and what not, elude the payment of water rates or pay sums absolutely out of all proportion with their consumption and more particularly with the advantages they derive from the existence of the aqueduct and fire brigade under the form of reduced insurance premiums.

We would not have seen a brewer of this city, whose water, according to a calculation made at the time by Mr. O'Donnell, then water works Manager, cost him $900 before the establishment of the Aqueduct, play his cards with the then Mayor and Councillors in a way to obtain from them a perpetual contract by which the city supplies him with 6000 gallons of water per day for the sum of

$160, while it is seen by the reports from other cities that brewers there pay sums varying from $3,000 to $5,000, and while, too, a meter used for the purpose showed that instead of 6000 gallons he was consuming 60,000, and the city was not even successful in obtaining payment for this extra supply because it pleased the then Recorder's Court to declare in the plenitude of its wisdom that the meter might be mistaken, and it, a " Worthington " among the most reliable of all.

Mr. Mayor and Gentlemen, the time has come when Quebec must be aroused from its slumbers ; it is time that injustice should cease ; that immunities and privileges for the existence of which there is no valid reason be done away with, and the water tax like all other taxes, be made to bear on the whole City, instead of weighing as it now does on only two-thirds of the inhabitants. Churches must be made pay like other properties an amount not in proportion merely to the quantity of water consumed, which is only trifling in the case of a church, but to what is saved on insurances.

The Legislature in giving us the right to lay down a second line of pipe, cannot refuse us the means of making good the cost thereof without imposing additional burdens on our already aggrieved citizens.

The report is there which recommends it, but how not to do the thing is the question. It is " the thunders " we fear. Yes, gentlemen, you do not dare to do it, influences are there to paralyze your efforts in the good work of municipal regeneration. You fear the unpopularity of the thing. You are afraid of imperilling your chances at the next municipal elections. Others have feared it before your time. Those who will come after you will fear it also, and the thing will never be done under the present system—under the council. I tell you so, you know it, not one will dare say that I am wrong.

You are not singular in this respect, other cities have acted in the same way and for the same motives until a board of commissioners came to their rescue; it is inherent in the system not in the individual. You admit this, you say that I am right, but you will not do it. Why not then adopt the proper means of bringing it about or of causing it to be done by others. Follow the example which has, for such a length of time, been traced out for you by nearly every other city in the world where, as here, the elected are made to bow to the will of the electors. Profit by the occasion of a new aqueduct; the Legislature will be but too ready thus to give you the means of doing honor to the affairs of the city; ask for a board of commissioners, you will obtain it, you will have to pay it; but it will increase the revenue from Water-Works by more than ten times the amount necessary for the purpose. This board will do more, it will know how to make up, the proper parties to tax, to meet the annual deficit which exists to day between our Water Works revenue and expenditure and so much more as may be needed to cover the accumulated deficits of former years, and all this without pressing more heavily on those who are now groaning under the burden of past and present grievances.

———

Under the resolution of the City Council ordering this report on the improvement of our aqueduct, there is still to be considered the project of drawing an additional supply of water from the St. Charles or the St. Lawrence. If I do not go into details regarding the mode of doing this, it is because the cost of the necessary pumps and erection of suitable buildings in which to set them up, that of the feed pipe from one or the other of these rivers, and the alterations to be made in the distribution cannot be less than $100,000. The annual cost of pumping to the desired level the seven million additional gallons which a second pipe would supply can hardly be less than $24,000, may be more. This sum added to the interest $6,000, of the cost of equipment, brings us again to the figure of $30,000, interest on cost of second pipe, and we cannot for a moment think of prefering the less certain system of pumping to that of gravitation. However I would be pleased to see the corporation invite tenders for such a service so that the cost may be established and the city placed a position to choose from among the several methods proposed for its relief.

When I say " pumping to the desired levels " I mean to a height of 100 feet or so, for the service of the lower wards of the city, reserving the present pipe for the higher wards. Now the cost of pumpinga million gallons of water to a height of 100 feet varies(see appendix VIII) in 18 of the principal cities of the United States, including Montreal, from $5.18 to $30.38, or omitting Indianapolis, Ind. and the upper service of St. Louis—Indianapolis especially where the cost is evidently excessive—from $7.17 to $16.47 the figure of Montreal. The mean of 24 pumping systems is $10.95½ per million gallons raised to a height of 100 feet. At the figure even of $10, it would cost $70.00 per day or $25,550 a year to give to the City the 7 millions of gallons required.

Now, this quantity of water raised to such an inadequate height, while being abundant and furnishing a continuous supply to all the lower sections of the City, would still be powerless in case of a conflagration to command the summits of high buildings in St. Roch, Jacques-Cartier, St. Peter and Champlain wards; and the other wards, St. John and Palace, St. Louis and Montcalm, by distributing among them all the water of the present pipe, would only have the water continuously during eight hours at most, that is, eight hours to St. John and Palace wards combined which the pressure of the aqueduct allows of supplying simultaneously, eight hours to St Louis ward and eight hours to Montcalm ward, which notwithstanding the pressure of the aqueduct would have to be served separately.

Therefore with the pumping system, an annual expenditure of perhaps more than $30.000 for interest on the cost of the necessary apparatus and buildings and for working expenses would be far from obtaining for us the advantages to be derived from a smaller sum applied to a second pipe, and if the cost of pumping the water should reach, as in Montreal, the sum of $16.47 or even $15.00, the annual cost of adding to our water supply would then amount to $44,325.

It may be asked : if the four higher wards of the City have to be content with what the present pipe gives, and each have the water only during eight hours out of the 24, why allow 7 millions for the other four wards which together are scarcely more populous than the former; it is because we have first to deduct a million gallons for St. Sauveur and secondly to allow for the more considerable wants of the tanneries, breweries and factories of all sorts erected, or which will be, at these lower levels; but let us suppose for a moment that 5 millions of gallons additional will suffice and that, taking them from the St. Charles or the St. Lawrence, they could be raised 100 feet at the rate of $10.00 each million gallons, that would cost $50.00 a day or $18,000 a year. These $18,000 added to the $6,000 interest on the cost of equipment make still $24,000 which has to be paid every year for a merely partial amelioration of the aqueduct—for a work half done and very soon to be repeated, whilst for only $6,000 more the amelioration is made complete and for all time to come, not to mention that with the 7 millions of gallons one is given to St. Sauveur for which $10,000 is received and with the 5 millions, the city gives none to St. Sauveur, receives nothing from that municipality and will have to raise $4,000 more taxes on the city.

Therefore, in my opinion, everything considered, every estimate and amount considered, we are forced to prefer a second line of pipe to all other projects.*

There is still another point which it may be well to touch upon, to wit: in how far the delivery of the present aqueduct would or could be benefited by laying down an additional pipe for only a portion of the distance from the gate house or Château d'Eau, and connecting it at its extremity with the present main; or, which is the same thing, taking up so much of the present main and replacing it by a pipe of twice the size or capacity.

The following Statement shows the increase independently computed by Mr. J. M. Gale engineer of Glasgow and by Mr. René Steckel engineer now in the employ of the Fed. Govt. at Ottawa. The near agreement of the figures arrived at gives them a character of absolute reliability.

| GALE. | | STECKEL. | |
|---|---|---|---|
| Distance in miles. | Percentage of increased delivery. | Distance in miles. | Percentage of increased delivery |
| 1 | 4.8 | 1 | 4.8 |
| 2 | 10.2 | 2 | 10.3 |
| 3 | 16.3 | 3 | 16.7 |
| 4 | 24.1 | 4 | 24.6 |
| 5 | 34.2 | 5 | 34.2 |
| 6 | 46.9 | 6 | 46.5 |

The figures speak for themselves and render it evident that no benefit, at all proportional with the cost of this mode of increasing the supply, can be looked for in this direction.

It suffices however to remark that while the total or combined sectional area of the 5000 services is 966 square inches, that of the main is but 254, or that in other terms the capacity of the main is but one quarter of that of the services, to show that it is not by 5, 10, or even 50 per cent that the supply must be increased but by 300 per cent, as the conclusion arrived at in the report.

*We must find the where-with to do it and the thing to my mind is easy. We see all around us nations, cities, towns, municipalities, institutions and individuals consolidating, or bent upon doing so, their respective indebtedness at reduced rates of interest. The sixes and sevens of the immense debt contracted by the United-States during the Southern war, have given place to threes and fours. English consols never go beyond three and a fraction. Money can be had any where and every where at 3 and 3½. The banks only allow 3, the Saving banks 4. The pacific railway syndicate has but lately effected a sale of their bonds, $10,000,000 at 5 per cent, and in the face of all this we persist in paying 6 and 7.

Let us effect a loan—our treasurer Lafrance can do it—at 4 or even 4½. Let us get Government to cancel our permanent Stock of sevens and replace them by terminable values at 30 or more years, even with the present interest if we cannot do better. Let us effect a loan which may put us in a position to retire our other debentures as they mature and we shall see all of the present holders using their utmost endeavours to get them back again or others at the reduced rates of 4 and 5, may be less.

This is what we can most certainly do, and our City Treasurer who is now and has been for some time past in correspondence with French bankers on the subject, will soon be in a position to inform us in the premises, and to submit I believe, I hope, some scheme capable of relieving us from our pecuniary embarrasments.

We must accustom ourselves to look such shemes in the face. Let us occupy our attention with such questions, most important to us, as the settlement of our subscription of a million to the North Shore railroad, and let us hope if it be true as reported that the Hble. Mr. Chapleau has been succesful in disposing of the road at the alleged figure of ($14,000,000) fourteen millions of dollars, Government may be persuaded to forgive us the second half million, and refund us the first, which we may then devote to the laying down of a second pipe so necessary, so indispensable to the proper water supply of the city.

Gentlemen of the City Council, I pray you, do take the means of relieving us from our embarrassments; you can do it if you will, you have only to will it Let me persuade you that it is not by reducing the wages of the police, fire brigade, road and water works laborers, nor by the reduction of your employees salaries to starvation rates, nor even by reducing the staff that you will restore the municipal budget. Such means are unworthy of you and those who suggest them should be held up to public scorn.

Occupy the attention of the City Council with the advisability, or the contrary, of retaining 15 days of a man's salary, a miserable $25 from an employee of 36 years standing who had grown grey in the City service, half a month's salary for having had to lay up after getting badly beaten by a lot of rowdies, while on the contrary it is he who has an undoubted right of action for damages against the city whose police on that occasion and every other is, from want of numerical force, powerless to do the needful.

Discuss the advisability of a coal oil lantern in an unfrequented and dangerous locality; that of an expenditure of $7 in relation to the band of the french frigate, and God only knows what else of a like nature.

Oh! it is not singular, Gentlemen, that the public should be indignant as they justly are, and threaten the very existence of an institution capable of occupying its deliberations with measures of like importance.

The public does not want this, the cutting down of the charwomen's wages by 10 cents, those of the fire wood purveyor by 20 cents. Refuse to pay a party his just due and then pay capital and costs together. Capital and costs in a hundred pending suits against the City for injury to life and limb of man and beast, injury to vehicles, because you will persist in believing or affecting to believe and trying to impress the public with the fact that a corporation employee can do the work of ten men in other cities...... I must stop, for God only knows what I might not add under the legitimate indignation I feel while contemplating a mal-administration which if it did exist prevously to 1880, has but increased and since become more marked, more accentuated and has at last attained its apogee under the pretended reformers of the municipal concern, elected by an intelligent ward of the city which has been led astray by the false representations of one man in particular, he of whom one of the judges of the .......Court, as good a physiognomist as he is a judge of every thing else says (and if he did not say it I should do so myself) that the moral element is entirely wanting notwithstanding a certain talent he may be possessed of as a public writer and stump orator.

Most assuredly it is not in this way you will do honor to the municipality. Have done with all such trifles, worthy at most of occupying the attention of a village council. Apply yourselves to something worthy of deliberating on. Elevate yourselves to the position of representatives of one of the oldest and most important cities of Canada. Restore your laborers wages, put those of your officers back to their former figure of 1878, unless you further increase them which you should do in the true interests of the city. Take on the necessary hands to

**do the work, and that nothing may be neglected as things are at present, and for the purpose of collecting the revenue, together with all arrears which without such aid will remain a dead letter.**

**Effect a loan, lay down a second line of pipe, consolidate the city debt. You will thereby in course of time save $100,000 yearly in interest and sinking fund. Settle immediately with the goverment the subscription in favor of the Q. M. O. & O. R. R., that in favor of the lake St. John railway, the cession of the Palais harbor.**

**Be not formalized at my telling you so. If I am your employee, remember that I am also like yourselves a citizen and that as you are now, I was in 1861 deputed to the municipal assembly for a term of 3 years and unanimously re-elected for a second term of like duration. Listen not to that portion of our City press which in its ignorance, error and bad faith, advises you not to allow your selves to be lectured by me, and does so only with the view of fomenting hatred and discord in the municipal camp.**

**On the contrary, gentlemen, it pertains to me who have been here for 20 years as deputy and engineer and who know as much and more of municipal affairs than any other man in the City to impart such knowledge to my neighbors. Do not forget that, like you, I am an interested proprietor, and that as such, I cannot give you bad advice or counsel things improper without being with you a victim to my own erroneous teachings.**

# APPENDIX I.

Estimated cost of a second line of aqueduct from Lorette to Quebec.

1st. Section from Chateau d'Eau under a head of from 6 to 28.66 feet.
3,100 ft. lin. 40 inch main $1\frac{1}{8}$ thick.................1,526,200 lbs.
2nd. Section. Head 28.66 to 166.22 ft.
3500 ft. lin. 36 inch pipe $1\frac{1}{8}$" thick.................1,563,795 "
3rd. Section. Head 166.22 to 251 ft.
3300 ft lin, 33 inch pipe, $1\frac{1}{4}$ inch thick............1,513,432 "
4th. Section from Lorette, Head 251 to 300 ft.
4400 ft. lin, 30" pipe, $1\frac{3}{8}$" thick.....................2,024,640 "
5th. Section. Head 300 to 400 ft.
4700 ft. of 30" main $1\frac{1}{2}$" thick.......................2,364,470 "
6th. Section. Head 400 to 410 ft.—2,500 ft. lin.
7th. section. Head 410 to 462 ft.—17,800 "
Together 20,300 ft. lin. of 30" pipe $1\frac{5}{8}$" thick.....11,075,500 "
8th. Section up Aqueduct Hill. Head 400 to 300 ft.
1000 ft. lin. of 30" pipe $1\frac{1}{2}$" thick.................. 514,796 "
9th. Section and last to Mount-Pleasant. Head 300 to 251 ft.
500 ft. lin. 30" main $1\frac{3}{8}$" thick...................... 235,296 "

20,818,129 "

being 185,876 cwts. or 9293 tons 16 cwts. which at 87.6 stg. per ton in Glasgow, with 25 per cent added for duty and £1 stg. freight, figures up to............ $302,048.77

Lead for joints at from 80 lbs. for 30" to 110 lbs. for 40 for 3427 joints—300,000 lbs. or 2680 cwts. at $5.00.. 13,400.00

Haulage of 3427 pipes of 30" to 40" diam. and varying in weight from 6515 to 5300 lbs. an average distance of over 6 miles at $3.00 per pipe.................. 10,281.00

Forward $325,729.77

| | |
|---|---|
| Brought over | $325,729.77 |
| Laying, leading and staving 3427 pipes $3.00 each.... | 10,281.00 |
| 41,000 ft. lin. excavation, averaging say 10 ft deep by 5½ wide. or 2 cube yds. per lin. ft a $1.00............. | 41,000.00 |
| 41.000 ft. lin. refilling a 20 cts.......................... | 8,200.00 |
| Alterations at chateau d'Eau............................ | 500.00 |
| Moving say 200 ft. lin of present pipe at Lorette end to suit position of new main............................ | 200.00 |
| 5 Stopcocks 30 to 40 inches diameter.................. | 3,000.00 |
| 10 Air cocks a $100..................................... | 1,000.00 |
| 11 Well pockets or additions to wells a $300.......... | 3,300.00 |
| Bridge at Rivière des Mères............................. | 10,000.00 |
| Bridge over River St. Charles.......................... | 40,000.00 |
| Alterations at Mount Pleasant......................... | 2,000.00 |
| Scouring out reservoir at Lorette....................... | 2,000.00 |
| Repairing and raising dam at Lorette.................. | 10,000.00 |
| Scouring gates at Rivers St. Charles and des Mères... | 2,000.00 |
| Arago St. Connection, 3450 ft. lin. laid complete, inclusive of branches, gates, lead, excavation and refilling complete.................................... | 15,500.00 |
| | 474,710.77 |
| Engineering and contingencies | 25,289.33 |
| Total | $500,000.00 |

# APPENDIX II.

A Statement of the number of gallons of water used per day (per capita) in the principal cities of the United-States, foreign countries and Canada, compiled from reports of the different cities of the latest date, and from letters in answer to inquiries relating thereto.

| UNITED-STATES. | gallons. | UNITED-STATES. | gallons. |
|---|---|---|---|
| Pitsburg | 100 | Milwaukee | 125 |
| New York | 90 | Cambridge | 43 |
| Detroit | 108 | Charlestown | 43 |
| Chicago | 123 | Jersey City | 83 |
| Hartford | 80 | Louisville | 28 |
| Reading | 75 | Newark | 60 |
| New Haven | 75 | New-Orleans | 30 |
| Albany | 70 | Salem | 41 |
| Springfield | 66 | Washington | 127 |
| Buffalo | 80 | Worcester | 48 |
| Boston | 98 | Lancaster | 112 |
| Brooklyn | 60 | Taunton | 20 |
| Philadelphia | 67 | Newton | 21 |
| Toledo | 54 | Fall River | 27 |
| Cincinnati | 55 | Pawtucket | 32 |
| Baltimore | 50 | Lynn | 35 |
| Lowell | 44 | Lawrence | 38 |
| St. Louis | 44 | New Bedford | 76 |
| Cleveland | 60 | Wilmington | 80 |
| Providence | 30 | | |

FOREIGN.

| | | | |
|---|---|---|---|
| Dublin | 60 | Leeds | 23 |
| Glasgow | 60 | Manchester | 60 |
| Paris | 38 | Birmingham | 20 |
| Edinburgh | 35 | Sheffield | 20 |
| London | 33 | Sunderland | 19 |
| Newcastle | 28 | Nottingham | 18 |
| Exeter | 25 | Bristol | 11 |
| Preston | 24 | Bath | 16 |
| Derby | 20 | Marseilles | 46 |
| Norwick | 14 | Geneva | 18 |
| Cambridge | 13 | Madrid | 10 |
| Huddersfield | 10 | Berlin | 10 |
| Gosfort | 10 | Hamburg | 30 |
| Liverpool | 27 | Genoa | 30 |

CANADA.

| | | | |
|---|---|---|---|
| Montreal | 70 | Toronto | 69 |
| Quebec | 60 | Hamilton | 44 |
| Three Rivers | 20 | Kingston | 133 |
| Ottowa | 124 | London | 166 |
| St. John N. B | 70 | Halifax | 207 |

# APPENDIX III.

"CONTINENTAL WATER METER COMPANY." U. S.

## CIRCULAR OF 1881.

PAGE 50.

*TABLE showing the Consumption of Water in*

| CITIES. | Year. | Population | System of Supply. |
|---|---|---|---|
| Taunton | 1879 | 20,000 | Steam power. |
| Newton | " | 17,300 | " |
| Fall River | " | 47,000 | " |
| Providence | " | 100,000 | " |
| Pawtucket | " | 25,000 | " |
| Lynn | " | 36,000 | " |
| Lowell | " | 50,000 | " |
| Lawrence | " | 38,000 | " |
| Cambridge | " | 50,000 | " |
| Worcester | " | 50,000 | Gravity. |
| St. Louis | 1877 | 400,000 | Steam power. |
| Salem | 1879 | 34,400 | " |
| Cincinnati | 1878 | 280,000 | " |
| Philadelphia | " | 850,000 | Water & steam. |
| Brooklyn | 1877 | 485.000 | Steam power. |
| Boston (Cochituate) | 1879 | 340,000 | Gravity. |
| " (Mystic) | " | 110.000 | Steam power. |
| " (Cochituate and Mystic | " | 450,000 | Gravity & steam. |
| New York | 1878 | 1,050000 | Gravity. |
| Chicago | 1877 | 446,000 | Steam power. |
| New Bedford | 1879 | 27,200 | " |
| Columbus | 1880 | 51,665 | " |
| Pittsburg | 1879 | 156,381 | " |
| Washington | 1880 | 147,307 | Gravity. |
| Minneapolis | " | 46,887 | Water power. |
| Louisville | 1879 | 123,645 | Steam power. |
| Cleveland | 1877 | 136,000 | " |
| Detroit | " | 110,000 | " |
| Buffalo | " | 135,000 | " |
| Milwaukee | 1879 | 116,000 | " |
| Average | " | 197.426 | " |
| Quebec | 1881 | 50,000 | Gravity. |

# APPENDIX III.

## " CONTINENTAL WATER METER COMPANY. U. S.

### CIRCULAR OF 1881.

PAGE 51.

*Different Cities, and the Receipts for the Same,*

| Average daily consumption. Gallons. | Daily consumption per capita. | Miles of pipe. | Number of meters in use. | Number of serv.-pipes in use. | per cent. of serv.-pipes with meter | Total receipts for water. | Receipts per million gallons. |
|---|---|---|---|---|---|---|---|
| 394,061 | 20 | 27.63 | 188 | 1;370 | 14 | $23,306 85 | $162 04 |
| 355,925 | 21 | 51.25 | 358 | 1,917 | 18 | 27,155 52 | 209 02 |
| 1,263,923 | 27 | 52.05 | 1,378 | 2,497 | 5[illegible] | 69.691 46 | 151 04 |
| 3,110,279 | 31 | 152.04 | 4,036 | 8,656 | 47 | 229,557 78 | 202 23 |
| 802,467 | 32 | 43. | 588 | 1,400 | 42 | 18,320 17 | 62 55 |
| 1,267,827 | 35 | 52.53 | 118 | 4,127 | 3 | 73.791 47 | 159 81 |
| 1,890,181 | 38 | 57.54 | 377 | 4,714 | 8 | 99,569 84 | 144 32 |
| 1,456,030 | 38 | 40.68 | 209 | 2,978 | 7 | 58,287 40 | 109 68 |
| 2,432.386 | 49 | 79. | 134 | 7,145 | 2 | 168,000 00 | 189 23 |
| 2,500,000 | 50 | 77.50 | 3,481 | 4,984 | 70 | 73.149 40 | 80 16 |
| 22,349,443 | 56 | 185. | 350 | 16,800 | 2 | 494,629 74 | 60 60 |
| 1,939,048 | 56 | 43.28 | 120 | 4,428 | 3 | 48,937 22 | 69 14 |
| 17,120,338 | 61 | 178.90 | 406 | 20,600 | 2 | 451,953 94 | 72 03 |
| 52,333,326 | 62 | 722.34 | 16 | ...... | .. | 1,376,532 05 | 72 06 |
| 30,342,909 | 63 | 388.30 | 930 | 54,879 | 2 | 1,905,842 14 | 90 90 |
| 25,695,900 | 75 | 313. | 1,100 | 41,000 | 3 | .............. | ........ |
| 8,884,460 | 81 | 172. | 156 | ...... | .. | .............. | ........ |
| 34,580,360 | 77 | 485. | 1,256 | ...... | .. | 1,237,256 23 | 98 0[illegible] |
| 93,400,000 | 89 | 463.70 | 5,000 | 77,400 | .. | 1,606,509 29 | 47 12 |
| 52,183,900 | 119 | 425. | 1,623 | 64,898 | 3 | 908,509 64 | 47 70 |
| 2,056,311 | 76 | 40 35 | 23 | 3,370 | 1 | 38,031 21 | 50 67 |
| 2,159,327 | 42 | 50.5 | 534 | ...... | .. | 48,228 41 | 61 19 |
| 16,021,624 | 100 | 105.5 | ...... | ...... | .. | 312,084 66 | 73 13 |
| ......... | ...... | 175.1 | ...... | ...... | .. | 110,065 15 | ........ |
| 2,628,569 | 56 | 18.6 | ...... | ...... | .. | 16,008 72 | 16 69 |
| 6,578,670 | 53 | ...... | ...... | ...... | .. | 176,097 45 | 93 27 |
| 7,726,920 | 56 | ...... | 248 | 7,760 | .. | 152,794 00 | 54 00 |
| 11,543,120 | 105 | ...... | 9 | 18,754 | .. | 210,288 00 | 50 00 |
| 11,691,200 | 87 | ...... | ...... | 6 380 | .. | 189,296 00 | 44 00 |
| 10,603,867 | 124 | ...... | 101 | 6,835 | .. | 121 555 00 | 31 00 |
| 14,177,079 | 59.3 | 176. | 909 | 16,495 | .. | 333,763 88 | 92 60 |
| 2,500,000 | 50 | ...... | 2 | 5,000 | .. | 91,000 00 | 100 05 |

# APPENDIX IV.

" CONTINENTAL WATER METER COMPANY. U. S.

## CIRCULAR OF 1881.

## PAGE 52.

*TABLE showing Amounts Paid for Water by a*

| CITIES. | Familly. rate. | Pan closet. | Bath tub. |
|---|---|---|---|
| Columbus, Ohio | $9 00 | $3 00 | $3 00 |
| Lawrence, Mass. | 5 00 | 4 00 | 3 00 |
| Lynn, Mass., | 6 00 | 5 00 | 5 00 |
| Fitchburg, Mass., | 6 00 | 5 00 | 5 00 |
| Newton, Mass., | 6 00 | 5 00 | 5 00 |
| Cambridge, Mass., | 7 00 | 6 00 | 6 00 |
| Providence, R. I. | 6 00 | 5 00 | 5 00 |
| Taunton, Mass., | 5 00 | 5 00 | 3 00 |
| Lowell, Mass., | 6 00 | 4 00 | 3 00 |
| Fall River, Mass., | 5 00 | 5 00 | 5 00 |
| Brooklyn, N. Y., | 16 00 | 2 00 | ........ |
| Albany, N. Y., | 18 00 | 2 00 | ........ |
| Buffalo, N. Y., | 20 00 | 8 00 | 5 00 |
| Niagara Falls, N. Y., | 9 00 | 3 00 | 3 00 |
| Detroit, Mich., | 7 00 | 3 00 | 2 00 |
| Cincinnati, Ohio, | 14 00 | 3 00 | 6 00 |
| Cleveland, Ohio, | 10 00 | 5 00 | 2 50 |
| Toledo, Ohio, | 10 25 | 2 50 | 3 50 |
| Chicago, Ill., | 19 00 | 5 00 | 3 00 |
| Alton, Ill., | 7 00 | 5 00 | 8 00 |
| Philadelphia, Penn., | 8 75 | 2 00 | 3 00 |
| Pittsburg, Penn., | 27 77 | 7 55 | 10 85 |
| Milwavkee, Wis., | 11 50 | 5 00 | 3 00 |
| Salem, Mass., | 3 50 | 5 00 | 5 00 |
| Concord, N. H., | 6 00 | 3 00 | 3 00 |
| Hartford, Conn., | 5 00 | 3 00 | 1 00 |
| Louisville, Ky., | 10 o0 | 3 00 | 4 00 |
| Grand Rapids, Mich. | 8 00 | 4 50 | 3 75 |
| Springfield, Mass., | 8 00 | 4 00 | 4 00 |
| Average | 9 65 | 4 22 | 4 20 |
| Quebec | 20 00 | 2 00 | 2 00 |

# APPENDIX IV.

## " CONTINENTAL WATER METER COMPANY." U. S.

## CIRCULAR OF 1881.

### PAGE 53.

*Family Occupying a Large House in Different Cities.*

| Wash stand or 2nd faucet | Wash-tub | Horse and Carriages with use of hose. | Cow. | Hose, single rate. | Total. |
|---|---|---|---|---|---|
| ........ | ........ | $3 50 | ........ | $5 00 | $23 50 |
| ........ | $1 00 | 3 00 | $1 50 | 2 50 | 20 00 |
| $2 00 | 2 00 | 5 00 | 1 50 | 3 00 | 29 50 |
| 2 00 | 2 00 | 8 00 | 2 00 | 5 00 | 35 00 |
| 2 00 | 1 00 | 10 00 | 1 50 | 5 00 | 35 50 |
| 2 50 | 2 50 | 5 00 | 2 00 | 10 00 | 41 00 |
| 2 00 | 3 00 | 4 00 | 1 00 | 5 00 | 31 00 |
| 2 00 | 2 00 | 4 00 | 1 50 | 5 00 | 27 50 |
| ........ | 1 00 | 4 00 | 2 00 | 3 00 | 23 00 |
| 2 50 | 2 50 | 4 00 | 1 00 | 6 00 | 31 00 |
| ........ | ........ | 5 00 | 75 | 5 50 | 29 25 |
| ........ | ........ | 3 00 | ........ | 8 00 | 31 00 |
| ........ | ........ | 4 00 | 1 50 | 5 00 | 43 50 |
| ........ | ........ | 3 00 | 1 50 | 6 00 | 25 50 |
| 1 25 | 2 00 | 4 00 | 1 00 | 3 00 | 23 25 |
| 1 00 | ........ | 5 00 | ........ | 4 80 | 33 80 |
| ........ | ........ | 2 50 | ........ | 1 50 | 21 50 |
| 2 00 | ........ | 5 00 | ........ | 5 00 | 28 25 |
| ........ | ........ | 4 00 | ........ | 3 00 | 34 00 |
| ........ | ........ | 8 00 | 2 00 | 9 00 | 39 00 |
| 1 00 | 1 00 | 3 00 | ........ | 9 00 | 27 75 |
| 8 25 | ........ | 8 25 | 2 05 | 6 87 | 71 50 |
| 2 00 | ........ | 4 00 | 1 00 | 8 00 | 34 50 |
| 1 50 | ........ | 6 00 | 1 00 | 3 00 | 24 00 |
| 1 00 | ........ | 2 00 | 1 00 | 3 00 | 19 00 |
| ........ | ........ | 4 00 | 1 00 | 5 00 | 19 00 |
| ........ | 1 00 | 5 00 | 1 00 | 7 50 | 31 50 |
| 2 00 | 3 00 | 2 50 | 1 00 | 2 00 | 26 75 |
| ........ | ........ | 4 00 | 2 00 | 5 00 | 27 00 |
| 2 19 | 1 84 | 4 58 | 1 40 | 516 | 33 24 |
| ........ | ........ | 1 00 | 1 00 | ........ | 26 00 |

# APPENDIX V.

## *Circular of A. D. WOOD & Co.,*

### RATES CHARGED FOR WATER

| CITIES. | House. + | Bath. | Water Closet. | Urinal. | Fountains. $\frac{1}{8}$* diam. | Sprinkling. | Brick, per 1000. | Stone, per perch. | Plaster. p. 100 yds. |
|---|---|---|---|---|---|---|---|---|---|
| Auburn, N. Y... | $10 50 | ..... | $3 00 | .... | $30 00 | $1 00 | 10c. | 3c. | 30 |
| Augusta, Me.... | 12 00 | $5 00 | 6 00 | .... | ..... | 3 00 | Cask | of lime | 10c. |
| Boston, Mass... | 7 00 | 5 00 | 5 00 | .... | 3 00 | 5 09 | " | " | 7 |
| Buffalo, N. Y... | 15 00 | 5 00 | 5 00 | $6 00 | ..... | 6 cts. per p. | $12\frac{1}{2}$ | 4 | 40 |
| Chicago, Ill.... | 14 00 | 3 00 | 3 00 | 3 00 | 60 00 | 3 00 | 6 | 6 | 15 |
| Cincinnati, Ohio | 6 00 | 6 00 | 3 00 | 5 00 | ..... | 3 00 | 10 | 3 | |
| Cleveland, Ohio | 7 50 | 2 50 | 2 50 | 1 25 | 25 00 | ............ | $6\frac{1}{2}$ | $2\frac{1}{8}$ | $18\frac{3}{4}$ |
| Concord......... | 6 00 | 3 00 | 3 00 | 3 0 | 8 00 | 4 00 | Lime | p. bbl. | 6c. |
| Davenport...... | 12 00 | 6 00 | 6 00 | 6 00 | 37 00 | 6 00 | $12\frac{1}{2}$ | 5 | 40 |
| Dayton.......... | 4 00 | 2 00 | 2 50 | 1 00 | 6 00 | 3 00 | 5 | 4 | 30 |
| Detroit.......... | 8 00 | 2 00 | 4 00 | 2 00 | ..... | 5 00 | Lime | bbl. | 5c. |
| Fitchburg ...... | 6 00 | 5 00 | 5 00 | .... | ..... | 5 00 | " | " | 6 |
| Lawrence ...... | 5 50 | 3 00 | 4 00 | 3 00 | 9 00 | 10 00 | " | " | 5 |
| Lowell.......... | 7 00 | 3 00 | 3 00 | .... | ..... | 3 00 | " | " | 6 |
| Manchester..... | 5 75 | 2 50 | 2 50 | 1 00 | ..... | 3 00 | " | " | 10 |
| Memphis ....... | 6 00 | 5 00 | 5 00 | 5 00 | 15 00 | 5 00 | 10 | | 50 |
| Milwaukee ..... | 6 00 | 3 00 | 3 00 | 5 00 | ..... | 3 00 | 6 | | 30 |
| Montgomery.... | 12 00 | 6 00 | 5 00 | 5 00 | 15 00 | 12 00 | ..... | ..... | ..... |
| Minneapolis..... | 5 25 | 1 00 | 3 00 | 2 00 | 6 00 | 2 00 | 5 | $1\frac{1}{2}$ | 20 |
| Muskegon ...... | 3 50 | 2 00 | 2 00 | 2 00 | 7 50 | 5 00 | 5 | $12\frac{1}{2}$ | 30 |
| New London... | 6 00 | 3 00 | 3 00 | .... | 10 00 | 5 00 | Lime | bbl. | $12\frac{1}{2}$ |
| Newport........ | 9 00 | 6 00 | 6 00 | .... | ..... | 10 00 | ..... | ..... | ..... |
| New Orleans... | 12 00 | 3 00 | ..... | .... | ..... | 10 00 | ..... | ..... | ..... |
| Northampton... | 6 00 | 2 00 | 2 00 | .... | ..... | ............ | 8 | 5 | 20 |
| Norfolk.......... | 7 00 | 2 00 | 3 00 | 1 50 | 5 00 | 5 00 | 10 | 6 | 10 |
| Portland ........ | 12 00 | 5 00 | 6 00 | .... | ..... | ............ | Lime | bbl. | 7c. |
| Poughkeepsie... | 4 00 | 1 50 | 2 00 | 2 00 | 8 00 | 4 00 | ..... | ..... | ..... |
| Pittsfield....... | 7 50 | 2 50 | 3 75 | .... | ..... | ............ | $7\frac{1}{2}$ | $2\frac{1}{2}$ | 25 |
| Providence..... | 6 00 | 5 00 | 5 00 | 3 00 | 10 00 | 5 00 | Lime | Cask | 8c. |
| Pawtucket...... | 5 00 | ..... | ..... | .... | ..... | 8 00 | ..... | ..... | ..... |
| Rochester ...... | 2 50 | 2 00 | 2 00 | 1 00 | 12 00 | 3 00 | 5 | 2 | 20 |
| Rockford....... | 5 00 | 3 00 | 2 50 | 2 00 | 15 00 | 6 cts. per p. | 10 | 10 | 20 |
| Springfield ..... | 8 00 | 4 00 | 4 00 | 2 00 | ..... | 5 00 | 10 | 5 | 20 |
| St. Louis....... | 6 00 | 3 00 | 5 00 | 10 00 | ..... | 10 cts. per p. | 10 | 5 | 50 |
| Syracuse ....... | 15 00 | 5 00 | 5 00 | 3 00 | 25 00 | 3 00 | $12\frac{1}{2}$ | 4 | 40 |
| Taunton......... | 5 00 | 3 00 | 6 00 | 2 00 | 5 00 | 5 00 | Lime | Cask, | 6c, |
| Worcester...... | 7 00 | 5 00 | 4 00 | .... | ..... | 4 00 | ..... | ..... | ..... |
| 37 Average...... | 7 62 | 3 57 | 3 82 | 3 20 | 15 58 | 5 03 | $8\frac{1}{2}$ | $4\frac{3}{4}$ | $26\frac{3}{4}$ |

+ The charge to a house is often regulated by the character and size of the house.

The table is based on a house of six rooms, or costing $1500, or being 25 feet front by 3 stories high, or containing six people.

* The prices given for fountains, a $\frac{1}{8}$ jet, playing a limited number of hours daily.

# APPENDIX V.

## *Philadelphia U. S.* 1881, *page* 69.

IN VARIOUS CITIES.

| Stables per stall.‡ | Engines.§ per horse power. | meter.‖ per 1000. | Kind of service-pipe. | No. of fire hydrants. | miles of Main. | Mode of supply. |
|---|---|---|---|---|---|---|
| ...... | $2-4 | ...... | .................. | 224 | 22 | Steam and water pow. |
| $3 00 | 6 | ...... | .................. | 8 | 3 | Gravity. |
| 2 00 | 10-6 | 20 cts. | Lead. | 3854 | 355 | Gravity. |
| 2 50 | 6 | 30 | Cast-iron. | 1052 | 94 | Steam. |
| 2 00 | 5 | 30 | Lead. | 3002 | 400 | Steam. |
| 2 00 | ...... | 15 | Lead. | 470 | 180 | Steam. |
| 2 50 | 2-50 | 10 | Lead. | 873 | 113 | Steam. |
| 2 00 | 3 | 13½ | Iron and cement. | 94 | 25⅔ | Gravity. |
| 3 00 | 4-5 | 30 | Galv. | 240 | 22 | Steam. |
| 1 00 | ...... | 20 | Lead. | 276 | 32 | Steam. |
| 2 00 | ...... | 10 | Lead. | 681 | 200 | Steam. |
| 2 00 | ...... | 25 | Iron and cement. | 200 | 25½ | Gravity. |
| 2 00 | 4 | 25 | .................. | 455 | 39 | Steam. |
| 2 00 | 4 | ...... | Rubber, coated. | 653 | 57½ | Steam. |
| 1 00 | 4-6 | 20 | .................. | 303 | 32 | Water-power. |
| 2 00 | 5 | 50 | Lead and iron. | 173 | 17 | Steam. |
| 1 00 | 4 | 20 | Lead. | 644 | 79 | Steam. |
| 2 00 | 8 | 25 | Wrought-iron. | 100 | 10 | Steam. |
| 1 00 | 2-4 | 10 | Wrought-iron. | 198 | 16 | Water-power. |
| 1 50 | ...... | 12½ | Galv. | 156 | 16⅝ | Steam. |
| 2 00 | 3 | 15 | Iron and Cement. | 105 | 21 | Gravity. |
| 3 00 | 7 | 40 | Iron. | ...... | 21 | Steam. |
| 3 00 | ...... | ...... | Lead. | ...... | 60 | Steam. |
| 1 00 | 3 | 20 | .................. | ...... | ........ | Gravity. |
| 1 00 | ...... | 30 | Cast-iron. | 91 | 29⅓ | Steam. |
| 3 00 | ...... | 40 | Galv. | 2[illegible]6 | 55 | Gravity. |
| 1 00 | 2.50 | 15 | Lead. | 282 | 17½ | Steam. |
| 1 25 | 3⅛ | ...... | Various. | 70 | 25 | Gravity. |
| 2 00 | ...... | 30 | Lead. | 1103 | 149 | Steam. |
| 1 50 | 5 | 20 | Tarred iron. | 283 | 30½ | Steam. |
| 1 50 | 3 | 15 | Lead. | 812 | 95⅛ | Gravity and W.-power |
| 1 25 | 2 | 25 | Iron. | 173 | 23 | Steam. |
| 2 00 | 5 | 30 | Enam. | 302 | 62¾ | Gravity. |
| 2 00 | ...... | 20 | Lead. | 1600 | 195 | Steam. |
| 2 00 | 5 | 35 | Lead. | 287 | ........ | Gravity and steam. |
| 1 50 | ...... | 25 | Iron and cement. | 238 | 27 | Steam. |
| 1 50 | ...... | 25 | Iron and cement. | 601 | 76⅓ | Steam. |
| 1 86 | 4 30 | 23½ | | 583 | 75 | |

‡ The prices given for stables are for the additional stalls over a certain charge for the first stall.

§ The prices given for horse power are for additional power over 15 horse-power.

‖ The prices given for metered water are for 3000 gallons per day.

## APPENDIX VI

From circular of R. D. Wood & Co. Philadelphia 1881.

Economic Influence of Wa ter-Works on Insurance premiums.

A schedule of standard rates of Insurance and deficiency charges, adopted by the National Board of Underwriters is a follows:

For standard cities, having gravity Water-Works, paid steam fire department, fire patrol, fire alarm telegraph, building law, paved streets, gas for light, coal for fuel, and no inherent exposures, the minimum basis rate for a standard city, on a standard building, is 25 cents.

| For deficiency charges add as follows: | cents. |
|---|---|
| If no water supply | 15 |
| If only cisterns or equivalent | 10 |
| If system is other than gravity | 5 |
| If no fire department | 25 |
| If no volunteer department | 10 |
| If uo steam fire-engines | 5 |
| If no hook and ladder trucks | 5 |
| If no fire patrol | 5 |
| If no fire-alarm telegraph | 5 |
| If no police department | 5 |
| If no paved streets | 5 |
| If no building law in force | 5 |
| | $1.00 |

Or a total of $1.25 per $100.00 where deficient in all the foregoing appliances.

# APPENDICE VII.

Results given by various Formulas for Flow of water in smooth Pipes, under Pressure, compared.

DATA :—Head=100 ft., Diameter one foot, and Lengths, respectively as follows :—

| Authority. | LENGTHS IN FEET. | | | | |
|---|---|---|---|---|---|
| | 5 | 50 | 100 | 1,000 | 10,000 |
| | Velocity | Veloc. | Veloc. | Veloc. | Veloc. |
| Equation (II)........ | 63.463 | 51.111 | 43.111 | 17,386 | 5 392 |
| Chezy................ | 223,607 | 70.710 | 50.000 | 15,810 | 5.0000 |
| De Buat.............. | ......... | 102.918 | 81.510 | 13.662 | 3.9781 |
| Prony (a)............ | 216.94 | 68.54 | 48.446 | 15.258 | 4.770 |
| " (b)............ | 223.214 | 70.480 | 49.792 | 15.641 | 4.842 |
| Eytelwein (a)........ | 241.778 | 76.367 | 53.960 | 16.975 | 5.280 |
| " (b)........ | 67.40 | 50.000 | 40.820 | 15.427 | 4.985 |
| St. Vennant.......... | 246.171 | 73.682 | 51.247 | 15.232 | 4.592 |
| D'Aubuisson (a)...... | 218.758 | 69.114 | 48.845 | 15.384 | 4.800 |
| " (b)...... | 213.761 | 67.589 | 47.804 | 15.114 | 4.780 |
| Neville (a).......... | 62.540 | 47.080 | 38 750 | 14.780 | 4.780 |
| " (b).......... | 294.650 | 90.263 | 63.070 | 18.917 | 5.507 |
| Blackwell............ | 214.267 | 67.715 | 47.913 | 15.140 | 4.791 |
| D'Arcy............... | 244.120 | 77.133 | 54 640 | 17.279 | 5.464 |
| Leslie............... | 223.607 | 70.710 | 50.000 | 15.810 | 5.000 |
| Jackson.............. | 223.607 | 70.710 | 50.000 | 15.810 | 5.050 |
| Hawksley............. | 62.555 | 47.084 | 38.724 | 14,797 | 4.804 |

For Formulas-see Fanning—" Water Supply "—page 254.

# APPENDIX VIII.

**Cost of Pumping per Million Gallons, in Various Cities, in 1875. See Fanning, page 575.**

| City. | Steam Power. Name of Pumping Works. | Lift in feet. | Millions of gall. pumped during year. | Pounds of coal per mill. galls. | Cost of coal per million gallons. | Wag's of engine-men, firemen, and lab. per mill. galls. | Cost of ordinary repairs to eng's & pumps per mill. galls | Cost of engine men's stores and supplies, per mill. gall. | Total cost of pumping one mill. U.S. gall. into reservoir. | Cost of raising one million U. S. galls. 100 feet. | Pounds of coal used to raise one mill. U. S. galls. 100 feet. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Brooklyn, N. Y. | Ridgewood Station | 176.3 | 9998.00 | 2703 | $8.44 | $3.64 | $1.45 | $1.97 | $15 50 | $3.79 | 1533 |
| Jersey City, N. J. | Belleville " | 160 | 4439.36 | .... | 18.33 | .... | .... | .... | 18.03 | 11.27 | .... |
| Philadelphia, Pa. | Schuylkill " | 115 | 1356.30 | 2532 | 5.61 | 10.17 | 2.66 | 1.23 | 19.62 | 17.06 | 2201 |
| | Delaware " | 118 | 1839.20 | 3282 | 7.26 | 6.39 | 1.17 | .50 | 45.32 | 12.08 | 2781 |
| | Belmont " | 208 | 3055.50 | 4331 | 9.86 | 3.62 | 2.18 | .67 | 16.33 | 7.85 | 2082 |
| | Roxborough " | 334 | 818.34 | 9209 | 22.20 | 9.00 | 1.55 | .77 | 34.42 | 10.31 | 2757 |
| Cincinnati, O. | Old Service | 159.3 | 4441.73 | 5327 | 7.65 | 5.97 | .98 | .73 | 15.33 | 9.61 | 3351 |
| | New Service | 218 | 1250.18 | 6650 | 8.96 | 6.84 | .54 | 1.01 | 17.34 | 7.95 | 3050 |
| | Mount Auburn | 320 | 456.60 | 9980 | 18.00 | 17.43 | .61 | 1.10 | 37.14 | 11 61 | 3119 |
| Louisville | Pumping Station | 160 | 1318.00 | 3147 | 4.61 | 6.76 | .37 | .47 | 13.51 | 8.45 | 1967 |
| Chicago | " " | 120 | 10957.25 | 3095 | 8.91 | 1.59 | .14 | .21 | 10 81 | 9.00 | 2571 |
| St. Louis, Mo. | High Service | 225 | 3130 00 | 6537 | 6.13 | 4.87 | .30 | .37 | 11 66 | 5.18 | 2905 |
| | Low Service | 50 | 3199.46 | 3209 | 3.01 | 2.64 | .15 | .18 | 5.97 | 11.94 | 6418 |
| Detroit, Mich. | | 89 | 4207.45 | .... | 5.16 | 2.02 | 1.47 | .15 | 7.31 | 8.21 | .... |
| Columbus, O. | | 171.24 | 486.89 | 6372 | 5.29 | 15.23 | 1.55 | .13 | 22.20 | 12.96 | 3772 |
| Cleveland, O. | | 158.4 | 2770.37 | 4133 | 6.71 | 5.36 | .53 | .76 | 13.36 | 8.41 | 2609 |
| Charleston, Mass. | | 160.7 | 2750.28 | 2584 | 8 12 | 2.58 | .83 | .... | 11.53 | 7.17 | 1608 |
| Lynn, Mass. | | 164.5 | 458 24 | 1308 | 5.04 | 4.13 | 3.15 | 1.22 | 13.54 | 8.23 | 705 |
| Milwaukee, Wis. | | 143 | 953 72 | 2428 | 10.92 | 6.29 | .... | .67 | 17.88 | 12.50 | 1698 |
| Poughkeepsie, N. Y. | | 282 4 | 476.89 | 6183 | 16.76 | 5.92 | .22 | .44 | 23.34 | 8.27 | 2189 |
| Toledo, O. | | 168 | 663.78 | 3579 | 7.56 | 6.84 | .... | 1.23 | 15.63 | 9.50 | 2130 |
| Lowell, Mass. | | 163 | 445.17 | 1864 | 7 76 | 5.84 | .13 | .60 | 14.33 | 8.79 | 1144 |
| Indianapolis, Ind. | | 117 | 353.25 | 1697 | 14.11 | 16.01 | 2.31 | 3.12 | 35.55 | 30.38 | 1450 |
| Montreal | | 165 | 1326.47 | 6204 | 16.06 | 7.86 | .94 | 2.30 | 27 18 | 16 47 | 37[illegible]0 |
| | Water Power. | | | | | | | Average. | 432.83 | 262.92 | |
| | | | | | | | | | 18.04 | 10.95½ | |
| Philadelphia | Fairmount | 90 à 115 | 7670.1 | | | 1.57 | .13 | .39 | 2.09 | 2.15 | |
| New Haven | Lake Whitney | 115 | 1769 | | | 1.00 | .... | .33 | 1.33 | 1.16 | |
| Manchester | Lake Massabesic | 113 | 424 | | | 2.60 | .16 | 1.30 | 4 06 | 3.59 | |
| Montreal | | 163 | 1879.56 | | | .76 | 1.33 | 1.33 | 3 42 | 2.07 | |

# APPENDIX IX.

**Waste of water and remedial measures, Meters.**

**Compiled from the "Continental Water Meter Co's circular of 1881. and from other sources.**

---

The commissionner of public works for the City of New York, in his report for the quarter ending March 31st. 1880, says that:

The most important step which has been taken towards the suppression of waste, is the introduction of the meter system under which water meters are being placed in all buildings and establishments where water in used in large quantities and for business purposes other than private houses, which are exempt by law from the application of meters.

As the larger establishments have been first metered, the good effects of the system are even now quite evident and as the work is to be continued without intermission until all business places are metered, very great improvements are anticipated within the next two years.

The meters now in use are distributed among various establishments, as follows:

| | | | |
|---|---|---|---|
| Railroads | 121 meters | Gas Companies | 33 meters |
| Hotels | 298 " | Bottling establishmts. | 62 " |
| Slaughter & packing houses | 111 " | Docks | 93 " |
| Breweries and Malt houses | 154 " | Miscellaneous | 606 " |
| Stables | 498 " | Total | 1976 meters. |

As instances of the saving of water effected by meters two cases are cited: one large hotel which on the first application of the meter, was found to be consuming or rather wasting 115,000 gallons of water daily, is now reduced to 45,000 gallons, and another has fallen from 80,000 gallons to 24.000 gallons daily.

*Great waste takes place in private houses.* A portable waste gauge devised by Mr. B.S. Church, Resident Engineer of the Croton Aqueduct, indicates accurately the quantity of water per hour running into the house. A large saving of water will thus be effected The knowledge of every householder that the Departement has the power at any time, night or day, to ascertain the measure of waste going on and for which proper penalty will be exacted, will induce all to protect their plumbing and to avoid all drafts upon the water except for necessary purposes. The great object is to bring a moral pressure on householders to avoid waste and an unseen agent in the shape of a waste gauge will accomplish this.

The Croton delivers 95,000,000 gallons daily and if one-third of this can be saved by the above mentioned appliances, the effect will be to increase pressures in all parts of the City and to postpone for several years the construction of an expensive aqueduct.

*The meter system has been sufficiently tested to demonstrate beyond all doubt its beneficial effects* in saving large quantities of water From the best obtained data we have saved by the increased use of meters the amount of increassd consumption of water by railroads, new buildings, manufactories, &c. during the year 1879. The use of meters shows that what one considers waste and saves, another keeps on using and is willing to pay for, so that the quantity of water required will eventually be 100 gallons per capita per day when the supply is sufficient.

In his report for the quarter ending June 30th 1880, it is stated that:

During the quarter 532 meters were placed on various kinds of buildings, making the total number in use to date 2,344, and, at the present date 3000 which will be increased to 4000 by the close of the year.

The house inspections to detect leaks and waste have also been continued: 7,672 inspections were made, and 1592 leaks in fixtures and 261 cases of wilful waste were discovered.

Average daily consumption now 93,600,000 gallons or 78 gallons per capita for the population of 1,208,000; or, making allowance for manufactures, shipping and other business, the consumption for domestic purposes is about 60 gallons per capita.

Meters in dwellings are furnished and set at the expense of the city while in all other cases the expense falls on the owner of the premises and is a lien on the property.

The Chief Engineer of the Brooklyn N. Y. Water Works, in his report of 1880, says:

"I do not now urge the meter system, because our people will not tolerate the measuring out of water; but if the citizens of Brooklyn intend to consume and waste water as they now do, we must extend our works."

"I admit that our people could, by care in the use of water, void the necessity of an immediate enlargement of our water works;

but the privilege of using water is in their hands, and they will waste. We cannot stop this waste unless we meter every house, and charge for the water the same as is charged for the use of gas."

The Superintendent of the Menneapolis, Min. W. W. in his report for the year ending April 1st. 1880. says:

"I am satisfied that the only just way of supplying water to consumers is through a meter at a low price per 1,000 gallons. By so doing the consumer pays for just what water is used, which I think would greatly lessen the quantity of consumption and increase the revenue; and I would recommend that all large consumers be required to meter their water."

The Commissionners and Superintendent of W. W. of Pawtucket R. I. in their annual report for the year ending Feby. 1st. 1880, say:

"Meter measurement is the only device that makes the owner pay for, and consequently avoid needless waste, and that secures to the careful the advantages resulting from econominical use.

"We find, in some of the large cities like Boston, Brooklyn and New York where they have comparatively but few meters, an excessive waste of water and it is impossible to arrest it, except by meter measurement. In this way the waste will soon diminish and the revenue increase to an extent that will surprise the most incredulous.

Pawtucket, Central Falls and East Providence have now 1,065 meters that have been paid for by proprietors.

The City Engineer of Worcester Mass., in his annual report for the year ending Nov. 30th. 1879, says:

"That water is now wasted in large quantities no one can deny. Our present cosumption is about 50 gallons daily for each person, while, Fall River, Providence, R. I. and Milwaukie, Wisconsin, and other cities that have a system of meter measurement use 20 gallons and under for each inhabitant: Meter measurement has been eminently successful in other cities, and I can see no reason why it cannot be made a success here."

The Watuppa Water Board of Fall River, Mass., in their annnal report for 1879 :—

favors the use of meters as the most equitable for both parties.

There are no meters in public buildings, but meters are now attached to 58 per cent of the private service pipes, and the small amount of water pumped per capita in this city is believed to be due principally to the large number of meters in use.

" *The meter system is gaining in favor each year and must eventually be almost universally adopted* in order to prevent the enormous and inexcusable waste of water which is every year becoming an object of greater importance and dread. The fairest and most natural way of accomplishing this, is to charge each one for just what he uses, and although meters are not perfect and will sometimes stop and get out of order, still they furnish the most satisfactory means of obtaining the desired end."

The Trustees of the W. W. of Columbus, Ohio, in their annual report for the year ending march 31, 1879 show that

" While realizing but 6 cents per 1,000 gallons for all water pumped, they have received 13 cents for all metered water. The cause is waste; the remedy meters.

" The account of nine out of every ten customers changing from the assessment plan to meter water is reduced, and on the other hand, not one in ten meter customers would consent to go back to the assessment plan. Were both classes supplied by meter, the revenue from the sale of water would be reduced below what it now is.

" While this is undoubtedly correct it is also true that the City would be saved the cost of procuring and distributing this large excess of water, and be relieved entirely from the expense of all detective measures in regulating the use of water, thereby effecting a saving so great as to completely offset the loss and cause the net revenue of the works to be largely increased."

The same Trustees in their report for the following year admit

" that while the wastage of water could be much decreased by the adoption of more severe penalties, carried out by detectives employed for the purpose, such measures have generally been proven too costly and have been in almost all cities, abandoned after a trial for a long or short period of time as impracticable. Meters are undoubtedly the surest method; but these are expensive and liable to get out of order, espicially in private residences; still their use, on the whole, is decidedly advantageous to the consumer as well as to the department."

" In our city five hundred meter customers pay a revenue but slightly less than is received from fifteen hundred assessment customers. It is a clearly established fact that cities having the greatest number of meters in use can show the largest receipts per 1000 gallons distributed."

" When it is possible to obtain a reliable meter at such a reasonable cost as to permit of the adoption of the plan in use by the gas company of placing a meter in every house and establishment at the cost of the department and receive a fixed rent therefor, it will be possible to deal out exact justice to all and so regulate the water rates in exact accordance with the needs of the service as to the cost of management and the required extensions, to maintain its full efficiency.

The Water Commissioners of Taunton, mass., in their annual report for the year ending Nov. 30th. 1879, say :—

" Your commissioners are inclined to look with favor upon the prospect of an increase in the number of customers at meter rates."

The Executive Board of the Water Works of Rochester N. Y. in their annual report for the year ending April 1st. 1880, say :

" The policy of the board in charge of the water works during the past year has been to continue the introduction of water meters in cases where it is difficult to determine the amount of water used or where it is intended to be used intermittently.

The Collector of water rates in his report to the Board of Public works of the City of Milwaukee, wis., dated Jany. 25th. 1881. says :

" In this connection I wish to call attention to the constant excessive waste of water by consumers in this city. It is an unmitigated evil, which is rapidly growing more formidable and perplexing, as the service extends, notwithstanding the constant efforts of this office to limit such waste."

*The careful man pays for the criminal waste of his improvident neighbour.* The injustice is illustrated by the opportunity which is too often indulged in, of one consumer with a small family, using and wasting as much water as half a dozen families of a similar size which pay into the public treasury six times as much water tax."

" During the year 1879, at one cent per 100 gallons, the amount the city should have realized is $ 338,700.00, instead of the paltry sum it did receive, to wit $ 121,555.00. The difference between these amounts, or $217,145.00 per year, very nearly represents the loss or waste and adds nearly that sum to the annual tax roll.

" There is but one way to stop this enormous and unnecessary waste, and that is to require the use of meters at all places where they can be safely used.

Inspection of the following table will show:

FIRST—The city of Providence with a population about equal to Milwaukee and with 585 more service connections, uses but 2,500,000 gallons per day; while Milwaukee uses 10,603,867 gallons.

SECOND—Providence uses 25 gallons per day for each inhabitant; Milwaukee uses 124 gallons per day for each person.

THIRD—Providence consumes each day for each service, 337 gallons; Milwaukee 1,551 gallons.

FOURTH—Providence derives a revenue of $200,039 for 2,500,800 gallons; while Milwaukee gets $121,555 for 10,603.867 gallons.

FIFTH—Providence receives $219 per million gallons; Milwaukee $31.

SIXTH—Providence consumes 17,367 gallons per mile of pipe; Milwaukee 123,300 gallons.

The reason for this vast and important difference in results is this: Providence had in use 3,203 meters, Milwaukee was content with 101.

With us, this great consumption of water is not due to growth in population nor leakage in the public mains. It arises principally from allowing water in yard hydrants, house fawcets, water closets and urinals to run without any use being made of it.

A quarter inch fawcet will pass at our average pressure about 10,000 gallons in 24 hours.

Families which use water only for ordinary domestic purposes consume about 10 gallons per capita per day.

## Robert Surtees, City Engineer, Ottawa, report for 1880, page 21.

Daily consumption increased from 42 gallons per head of population supplied in 1875 to 124 gallons per head of population in 1880.

The excessive consumption and wasting of water has, for a number of years past, and still continues to be a great source of anxiety and complaint amongst those having the management of water works I notice in nearly all the reports received from other cities and towns that the trouble is not confined alone to this city but that it is general and widespread and everywhere attributable to extravagant use and thoughtless waste.

There can be no doubt but the only satisfactory manner in which the water could be fairly distributed and its waste prevented, would be by adopting the system of payment by measurement through meters; but the difficulties to be considered in the way of doing so to any great extent would be the first cost of meters, and the additional tax upon consumers for the rent and maintainance of the same, as well as the question of the policy of surrounding with too great restrictions the free use of the water to consumers taken in a sanitary point of view.

The Springfield Water Comrs. state :—

"The fairest mode would undoubtedly be to charge by measure upon a basis of Cost; by doing so, however, the very class of persons who most need to use the water for the preservation of personal cleanliness and health, would refrain from the free use of it and the public health might be endangered thereby."

In a recent report of the Chief Engineer of the Fall River Water Works, where meters have been exclusivey introduced, he says: "The revenue is steadily increasing every year and the policy of recommending meters in every case, is still adhered to although the revenue may be somewhat lessened thereby; for not only is this the only equitable method of assessing the water tax, but it is considered a wise policy to run the risk of losing one dollar of revenue if, at the same time, two dollars can be saved in the cost of pumping."

The consumption in the City of Chicago having increased from 32.8 gallons per head, with 19.5 inhabitants to each tap, in 1858, to 122.7 gallons per head with 7.1 inhabitants to each tap in 1878.

Mr. Chesbrough, the City Engineer of Chicago referred to the same in his report of 1878 as follows: "That for all legitimate purposes whatever, in a city like ours, it should require a hogshead and a quarter of water for each man, woman and child, is not possible, and is simply evidence of enormous waste. How to prevent it has become, in this as well as in all other cities, a great and perplexing problem.

Every where the conviction is gaining strength that nothing but meters can do this within available means. So far as used here, they bring a revenue twice as great in proportion as the frontage and other rates for the balance of the water furnished the City. Yet they are not popular and various objections are made to them, none well grounded, however, against their accuracy or the strict justice of charging according to their registers. Their immediate and universal adoption would cause a serious decline in the total water revenue but a few years however would restore the revenue and be accompanied by other and lasting benefits.

## APPENDIX X.

### Sundry notes and Extracts.

1 Experiments made at Carlshrue in Germany for the purpose of finding the least flow which would be sufficient to prevent pipes from freezing. It was found that in a one inch pipe 42.6 ft. long, a wastage or run of 7.9 wine gallons, little more than 6 imperial, per hour, kept it from freezing. This wastage costs 95 cents for a cold term of 100 days or about 3 months, while the ordinary wastage of 5,000 gallons a day costs $25.

In our climate 200 days at 200 gallons per day would cost $4.00 for the term, while the actual wastage of 5,000 gallons per day costs $100.

2 Water pipes are found to be eaten by rats. The City Engineer, Quebec was handed one by overseer Corrigan now 30 years in the department, in which a hole has been gnawed 2 inches long and an inch in width, the pipe being of ¾ inch bore and ¼ inch thick. This pipe laid under a floor and to get at it, the rats had gnawed a hole upwards through the burnt clay pipe on which the water pipe rested, and thence through the lead pipe.

3 Experiments made on the water system of Worcester show average No. of gallons consumed per individual to be, in residences 18 gallons; dwellings 12½ gallons; tenements 12 gallons.

4 Montreal (L. Lesage, W. W. Manager) one rising main 30 inches diameter 1⅛ " thick, two do.—24 " diam. 1 to 1⅛" thick,

5 Keefer—His report on Quebec Aqueduct 1860. " From experiments made in 1860 at New-York and Jersey City on mains of 36 " and 24 ", the first, 2 miles long, the second 6 miles

long,—it is found the computed delivery should be reduced by 30 to 33 per cent, due to tubercular corrosion, collection of air at high points, sedimentary deposits at lower levels."

6 New York Herald Nov. 6. 1876. "The water famine." Commissionners of P. W. compelled to ask president of police board to issue instructions to patrol-men to use their utmost diligence to prevent waste of Croton water—orders issued to stop sidewalk and street washing with hose, also waste in stables, hotels, dining rooms, saloons, water closets, etc.—ball cocks ordered for all cisterns or reservoirs—report offenders and cut off their supply.

Portion of New York without water for one or two weeks except in basement; at same time water enough to drive a mill running from artificial lakes in "Central park." Places where w[illegible] wasted: Bakeries, baptistries, barbers, bars, baths, bathing [illegible]ablishments, beer bottling establishments, breweries, distilleries, dyeing establishments, ferries, fish stands, fountains, green houses, Hanson rams, horse boxes, hotels, laundries, manufactories, malt houses, marble yards, milk depots, oyster boats, packing houses, photographic galleries, pickle factories, skin dressing establishments, slaughter houses, smoke houses, soap refineries, soda fountains, soda water factories, steam engines, stone sawing establishments, street washers, tripe cleaning, water closets, etc.

7 Gale, Engr. Glasgow report on two pipes one of 37 years standing, the other 10 years, both diminished to about half the calculated delivery, chiefly due to tubercular deposits. In Glasgow at present 3 separate pipes to as many different levels, shall soon have 4. With second line of pipe, can safely do without reservoir. Long lengths of 4" pipe unfit for fire pressure, should not be less than 6", am putting down many 9" now in Glasgow.

8 Keefer page 2 report of 1860 on Quebec W. W. "If two reservoirs, 14 hours to lower and 10 hours to upper one, increase of only 23 per cent in delivery, but supply must be shut off lower one while upper one is filling, so that Lorette may as well remain the reservoir during night, but while upper reservoir is filling, lower town will be without water."

9 Keating, City Engr. Halifax. Halifax two distinct sources of supply: a 15" for high service from Spruce Hill lakes 360 ft. above tide level, 10 miles from town designed by T. C. Keefer —low service 24" main from lakes 3 miles distant, 200 ft. above tide level. The 24" pipe calculated to deliver 5,000,000 gallons is taxed

to its utmost capacity. The high service can deliver 2,000,000 a day but is not worked to its full capacity.

10 Rainfall, lake Cachituate Boston for the 10 heaviest years from 1851 to 1876—varies from 42.71" to 64.34," the average being 57.6" per annum. The percentage delivered varies from 25 per cent to 74 per cent, the average being 32 per cent.

11 R. D. Wood & Co. Engrs. &c. of Philadelphia. —Their circular for 1881. "In the early part of the present century—(therefore long before Baldwin's report of 1848 on Q. W. W.) it was found that tubercular secretions had formed so freely upon interior of pipes as to seriously diminish the volume of flow throug 3, 4 and 6 inch mains. City Engineers', Boston, report of 1852, tubercles after 8 years—$\frac{3}{4}$ inch thick and 2" area, corrosion of pipe $\frac{1}{16}$ inch—corrosion thereafter diminishes from year to year.

12. G. R. Baldwin, Report on Q. W. W. 1865, page 19. In regard to the necessity of a reservoir (460 x 160 x 20 ft. 12,000,000 gallons, 2 days supply) as a substitute for a *double set of* pipes, I do not see that one would assist in the least unless by shutting off the City during a certain portion of the night to be opened in the day time to aid the general supply; to turn the present feeding-main into one would not fill it; the water would run out as fast as it intered with a considerable loss of head into the bargain. In the night in case of fire, the streat mains would be all empty and a long time would elapse before water could be had where wanted most. It is important that all the street mains should be under pressure at all times, that no delay may occur on the outbreak of a fire.

*I do not see therefore that a reservoir would be of much, if any, use under the present circumstances.* Another pipe is the only sure remedy and I therefore recommend one to be laid down that should have a calibre of at least 28 inches as given in the estimates. Such a pipe laid, I have no doubt but all would be satisfied with the result; provided at the same time the waste were checked by the most stringent means.

13. At page 15 of same report Baldwin says: A considerable increase in the supply to the City would arise by increasing the capacity of the feed main of Lorette, as far down the line as the head of the "Misere" road, where the pressure would not require a pipe of extra thickness, I will propose in this arrange-

ment a 34 inch-main to be laid down from the Chateau d'Eau, alongside the existing 18 inch-main for a distance of 4550 feet, where it would be reduced and joined to a 28 inch-main that should be laid down thence to Mount-Pleasant at junction of De Salaberry St. With St. John Street. Existing 18 inch-main up aqueduct hill to be taken up and relaid along Arago St. towards Crown St.

Champlain ward could probably be better supplied through the Upper town by a new pipe from Grande Allée across the cove field above Mariner's Chapel. Supply 8,000,000 imp. gallons.

14. American water works Association, 1st annual session, St. Louis, Missouri, March 1881, page 21 Evidence unanimous in favour of cast-iron mains for general service The objection to wood or cement-mains was the difficulty of making a tap without causing leakage.

15. Page 23. M. Whitman said they (St. Louis) had a large number of meters in use chiefly the "Worthington," also a number of "Crown" and "Union" all of which gave satisfaction. President Foster said he was using the "Worthington" exclusively and they were giving fine service. Mr. Whitman said he had always found the Worthington meter just to the consumer; it had been in use thirty years and had always given satisfaction, out of 400 meters in use in 1879 they only had one hundred repair items and they were mostly of a trifling charecter.

16 Mr. Kelly, St. Louis, W. W. "Waste, located principally in water closets. After stopping them, waste reduced by 190,000 per day. "*Whitman*," least consumption night—52 and up to 70 per cent of that at mid-day, running through pipes left carelessly or wilfully open and mainly in water closets.

17 Whitman to Hon. Mr. Overstolz mayor St. Louis—"Contract between City and consumer violated in the most shameful manner. In the dead of night when nearly the whole population is asleep, water is running to waste through the house service pipes at a rate which is from 60 to 80 per cent of that at mid-day due to loss through water closets and hydrants--14,000,000 gallons wasted daily out of a mean consumption of 25,000,000—cost to city $300,000 a year for pumping water which returns to river without being utilized. A single water closet or hydrant left running will in 24 hours discharge from 2,000 to 5,000 gallons of water according to the pressure on the street mains. Taking the lowest

figure, it needs only 700 taps or one twenty-seventh of the total number to be left open to account for the whole 14 million gallons waste.

18 *The only detective worth anything against wilful waste of water is a meter* which is always on the ground, and which tells a story that cannot be gainsaid.

19. "Feeling very much against any ordinance enforcing the use of meters. As an instance of what might be saved by placing a meter Mr. Whitman cited a case where a year ago a meter was placed into a house where the tax allowed a consumption of 400 gallons per day. It was found by meter registration that 2800 gallons were being used, then orders were given by the resident to stop the waste but in no way stint the supply and the result was that but little more than 400 gallons per day were registered.

20. Whitman stated that one objection to the general use of meters was, that many persons might, through fear of penalty, limit the use of the water so that their premises would not be kept in cleanliness and thus commit an offence against the public health.

21. The *rate per capita* was from 110 to 115 *gallons* each per diem, yet Ball's tables show instances where families of ten or twelve persons used only 40 gallons each. Such a state of affairs would save the water but would breed disease and alarmingly increase the doctors' bill.

22. Mr. Watts thought the greatest objection to the use of meters would be their expense—$500,000 for St. Louis.

23. Professor Smith said it was not proposed to put meters every where nor was it necessary. The moral éffect of 2000 meters would be as great as 40,000.

24. O'Donnell—report on Q. W. W. of 1869. Difference between mid-day and midnight discharge into city only 3282 cubic feet on over 150,000 ft., the one being 156,550 ft. in 8 hours, the other 153.268 ft. in the same time, or night discharge, 98 per cent of day discharge due to letting taps run to prevent freezing and thus save plumber's bills for repairs to bursts, and waste in water closets, etc. Considering the demands made for extension of works into sections of city not yet fed with water, the necessity of increasing the supply, by a second line of feeding main, is the more

apparent. Every house should be provided with a self acting ball cock cistern. Supply 2,720,060 gallons, population 25,000 ; consumption per head 109 gallons.

Contract with Boswell brewer for 6000 gallons per day—The meter showed consumption to be as high as 60,000 gallons.

25 Gilbert Murdock—valuable and exhaustive report on Charlottetown. P. E. I. W. W. 1881. " One class says: limit the supply ; Another : why limit that which is so essential to life, health and comfort. Furnish water to all without stint or limit ; give it freely, cheaply, copiously that all may learn to wash and be clean. And there is no doubt, the drift of public opinion is towards the latter view.

26—" *In olden times* when the sanitary value of water was less known and appreciated than it now is, from 5 to 10 gallons a day were considered a liberal unit of supply and 15 were spoken of as extravagant. Then, however, cities' supplies were mostly intermittent and much of the water used was drawn from " Stand pipes " exposed in Courts or other open places for common use. Baths and water closets were, generally speaking unknown and few had learned the value of water as a labour saving as well as a health preserving agency.

27 " *Forty years ago* the unit had risen to 30 gallons and was adopted by the able engineer of the Croton W. W. for the supply of New York. Under this impression the works were designed and executed, with a supposed capacity to meet the wants of the city for 25 years or 30 years, but they had not been in operation 10 years when it was discovered that it would be not only impossible for them to do this ; but to maintain the supply to a population less than one half of that originally contemplated, further expenditures of millions of dollars would have to be made.

28 " *The experience of New York* in this respect, has been the experience, to a greater or less extent, of Boston, Brooklyn, Philadelphia, Chicago, Detroit, Hamilton, Toronto, Montreal Halifax, St, John and Quebec. The history of one is the history of all.

29—" *Under the constant supply system* (which is the only one ever thought of now) the daily per capita consumption has advanced steadily till 60 gallons is now accepted as a moderate average, and the indications are that it will yet rise above this.

30—"*In view therefore of the experience of the past* and of the habits of our own times in regard to the use and waste of water, I would not recommend a smaller "unit" for Charlottetown than 60 gallons per day for each individual within the City's bounds, and in doing so I feel assured that large as this may appear, it will not be found extravagant, when your City is sewered, your houses fitted up with baths and water closets, and your people have learned the use and value of water as a labour saving and health giving agent.

31—" *For fire extinguishing purposes* 8 streams playing simultaneously must be allowed for—requiring 1000 gallons per minute (or at the rate for fires only of 1,400,000 gallons per day.

" The leading and distributing mains must be sufficiently large to convey this quantity of water to the place of danger.

" *The fire hydrants* should be large, well drained, properly protected, readily accessible and sufficiently near to each other in the dense parts of the City to require not more than 200 feet of hose on ordinary occasions.

32. " *The question of improved water supply* is one of pressing importance from a protective point of view alone, and can not be delayed indefinetely without your city paying the penalty of procrastination in some form or other. Insurance companies may be generous for a season, but they cannot continue to ignore the law of average with impunity and are too intelligent and keen sighted to do so beyond a limited time. A general increase, I have been assured on reliable authority is sure to follow in a relatively short time if your city resolves to leave its water supply as it is.

33 E. H. Keating, City Engineer, Halifax, report for 1878-9. Due to extravagant waste our W. W. are in a most unsatisfactory condition and matters are daily growing worse, Water pressure decreasing year by year; in some places the water will not now rise to nozzles of hydrants. At different points the water has ceased to flow from the taps in the cellars of buildings. The high service works which were designed solely for the use of the high parts of the town; have almost ceased to be worthy of the name as the water is now diverted into the low districts, and some dozens of stop cocks have had to be partially or entirely closed in order to give a supply to houses which otherwise would have none.

34 *When a fire now breaks out,* the water has to be concentrated in that locality by shutting it off from the other parts of the City. Needless to say this would not have to be done if waste were stopped and if not stopped, the majority of the citizens must be prepar-

ed before very long to submit not only to a short supply but to increased rates of insurance.

*Halifax supply* 6,000,000 gallons daily, though this is much below the calculated capacity of the pipes. Population 27,000, consumption therefore 207 gallons per day per head, more than five times greater than required for all purposes and far exceeding the demands of any other modern City in the new or old world.

35—*The* 12 inch *pipe first laid down* as recommended by Jarvis, Engr. of the Croton W. W. in 1845, *was supplemented* in 1856 by one of 15 inches which nearly trebled the original supply, but even this was soon found greatly insufficient. In 1861, the city replaced the 12 by a 34 inch main giving nearly six times as much water. Notwithstanding all this, the draught upon the pipes continued to increase so greatly that, latterly it was found necessary to nearly double the capacity of Long Lake, our great low service reservoir.

Thus while the population has increased only 40 per cent, the consumption of water has increased 1500 per cent.

36 *Three principal methods have been adopted in other cities to control the consumption and waste of water* within reasonable limits.

1st Thorough inspection from house to house with power to shut off the water or exact a fine wherever waste is detected.

2nd. The enforcement of laws prohibiting the use of faulty and objectionable fittings and requiring the plumbing to be done subject to inspection, by licensed persons only.

3rd The application of meters to all places where large quantities of water are supposed to be used or wasted.

In Halifax there is great need for the adoption of all three. I know of no town which has resorted to the sale of water by meter measurement only. As few restrictions as possible should be put upon the the legitimate use of an article which ought to be furnished to the public at the cheapest possible rate.

37.—The general and indiscriminate use of meters, besides involving a very heavy outlay, would necessitate the addition of several permanent hands to the staff of the department, and in all probability, many meters would be destroyed annually by the frost.

38.—*In the City of New York, large or wasteful consumers are obliged to provide and maintain meters at their own cost* wherever notitified to do so by the department of public works. A fair meter rate would be 2 to 3 cents per 100 gallons, with ¼ cent deduction where a consumer supplied his own meter.

39.—*Hopper closets should be taxed $20 each to get rid of them.* In Boston 3 hopper closets in 12 months consumed 1,253,470 gallons The substitution of pan closets for those reduced the consumption to 19,859 gallons.

40.—For several years past, attention has been called, in the annual reports and in other ways, to the disadvantages under which we labour for the *want of a complete and accurate plan of the pipe system of the City,* which should also show the position of all the valves, connections, exits and hydrants. The interests involved are so many and so great that this work should not be deferred.

41.—C. Baillargé, City engineer Quebec report of 1868. We no doubt have a fine supply of the best water poured into the city through the aqueduct, but I am sorry to think *how much more abundant the supply could and* should *have been made at the time at the same outlay.* The result has disappointed expectation from the calculations being founded on improper data.

42. *Defective supply in Daiguillon Street* due to small size of pipe, only four inches, which should be replaced by one of increased diameter, and in many other localities in the city are the mains two small in proportion to their length and now especially that they are incrustated to such an extent.

43. *All service sewers or branch pipes are at the charge and expense of the property drained*; the corporation being responsable only for the maintenance of the main sewer running through the centre of each street.

44. *That portion of the aqueduct above the leved at which the water is poured into the City, should have a diverging or increasing diameter towars Lorette.*

45. *Freezing of pipes* due in some cases to insufficient depth; elsewere to the stony nature of the filling over them, but generally originates in ill protected cellars; due also to wells or pits for sliding slutters. Much trouble is experienced where houses along the river side are built on open crib work.

46. *Pipes where exposed and accessible, thawed by applying hot water. Where inaccessible,* we remove the cellar cock and insert, in the lead service pipe, a smaller pipe of block tin, with funnel attached into which and through the auxiliary pipe, the hot water reaches & thaws out the ice in the service.

47.—*All stone filling over pipes should be and is now removed and replaced by well conditionned earth.* The numerous cases of excavating the streets to get at pipes and thaw them out where wriggles in them would not allow of introducing the thaw pipe, are now greatly reduced, as no freezing takes place where the filling is of proper material and the depth sufficient.

48.—C. Baillargé. Report of 1870. Since the date of my last report another unsuccessful attempt has been made to put a tax on baths aud water closets, such a tax or water rate as exists in every other city supplied with water from an aqueduct.

49.—The *complaints of inadequate supply* or of the water not rising above the basement floor of houses or other buildings are every day increasing in number and becoming more and more persistent. *Loss of head* due greatly to Ridgeway water closets of which there are hundreds in the city and in every one of which the water is allowed to run continuously during the whole time it is turned on from the mains.

50.—*Corporation not legally bound to deliver water above basement level.*

51.—*The necessity of putting a prohibitory tax of* $15 *on Ridgeway closets as there is in Montreal*, where their number has in consequence been reduced from five hundred down to five, must ere long force itself on the attention of the City Council.

52-H. O'Donnell. W. W. Manager—report of 1879.

Subsiding reservoir filling up with a deposit of fine sanday matter from river, Depth of reservoir originally 8 feet, now considerably less, only 18 inches water over sand, was dredged out partially but is again accumulating. This sand passes into culvert, well and pipe.

53– *The* 18 *inch feed main in use since* 1853 *now equivalent to a new clean pipe of* $14\frac{3}{4}$ *inches.* The 4 inch sub-mains in use since 1853 and 1854 are now only equal in capacity to $2\frac{1}{2}$ inches smooth bore. Other sizes also all reduced in capacity.

54.—Such being the present state of the interior of the pipes, the time is not far distant when il will be *necessary to take up the* 4 *inch pipes and substitute others for them.*

55.—*Leaks in the* 18 *inch main,* average five yearly since the beginning and often require the water to be turned off to repair them, due to there being but one feeding main.

56—C. Baillairgé—report of 1872. *Leak in pipe under river St. Charles.* Originally (supposed to be) a sand hole, gradually enlarged to 1½ inches (under a 485 feet head and 210 lbs. pressure to the square inch) by the force of the stream of water from it, together (it is also supposed) with fine sand and sediment. Could the water alone, if free from any solid substances produce such an effect and in what length of time? The jet from this hole ate into the wood work of the surrounding box to a depth of 3 inches out of 4½ and one of the ribbon pieces, some 7 inches square, was nearly cut through by the force and duration of impact.

57.—*The above mentioned leak repaired* by surrounding the pipe over the hole with a 4 inch wide, inch thick iron band in two halves bolted and leaded. Leak broke out again and in less than a year ate through edge of the inch iron band to an extent of some 2 inches broad and an inch deep and through whole thickness of ring. Finally had to cut out the defective pipe and put in a new one in two lengths with thimble joint.

58.—*As a precaution against the recurrence of a leak or of any other accident to the pipe under the bed of the river*, a bridge has since been erected, an arched superstructure between two abutments 120 ft. span. The 18 inch main is also thrown up into an arch, so that, the bridge being of wood, it may be self sustaining should the wood work be burnt or rotted away from around it. This was done after a design by the author of these notes.

59.—*Supply very defective through the 4 inch pipes* which should have been at least 6 inches; and it would have been wise to make them even larger so as to act as reservoirs. Chicago has lately replaced a 10 by a 24 inch main almost all around the city, thereby improving in a most marked manner the pressure in all the branch pipes connecting with it; and in many other cities are these small bore pipes being now and for some years past, taken up and replaced by others from twice to ten times the capacity.

60.—*Defective distribution.* A single 4 inch pipe from the 14 inch St. John St. main leads down Glacis Str. and into two other 4 inch pipes, while the Daiguillon St. branch is further tapped by another 4 inch pipe leading into St. George St. to St. Augustin St. There are therefore, so to say, three 4 inch pipes supplied by one pipe of the same bore, wherefore the pressure at the hydrant in St-George St. is so feeble as to be almost useless in case of a fire in the vicinity.

61. A report of mine in 1867 was embodied in one to City Council recommending the imposition of *rates on steam engines, water closets, factories of all kinds and generally the increase of special*

*rates.* It remained in abeyance, but we must now be up and doing, we must face the matter fearlessly and cease to hide our heads under a bushel ; both ends must be made to meet and there must be an end to the system of robbing Peter to pay Paul.

62. *Some 50 educational, charitable and other establishments* in the City, together with the Court House, Post office, Marine Hospital, Jail, Masonic Hall, Commissariat, Boswells and McCallum's breweries *pay together only* $3,642.16 for the water they consume. This is unheard of in any other city. For instance the large establishment of the Systers of Charity yays $20, Asylum of Good Shepherd $15 while it would cost each of them at least $500 if they had to haul the water from the river. They now admit that $100 would not be too much. These two asylums now (1881) pay increased rates.

63.—*Probable increase* derivable from the additional water rates proposed by me in 1767 see page 103 of my report of 1872—baths, water closets, steam engines, tanneries and some other industries—$15,000.

64.—E. Lullin, ingénieur, Rhone et Arve, Notice sur le Développement du service des eaux et de l'Industrie en général, à Genève, mémoire couronné par la Société des Arts de Genève, 1er Juin 1876.

Quel établissement nouveau serait-il utile de créer dans le canton de Genève pour favoriser le développement de l'Industrie Genèvoix dans son ensemble ou au moins d'une de ses branches importantes.

Concours ouvert par la classe d'Industrie et de commerce.

65.—*A Genève, la vente de l'eau n'a lieu qu'au litre* c'est-à-dire, que l'abonné paie un certain prix (48 fr.) par année pour un filet d'eau coulant continuellement et donnant *un litre* d'eau par minute (1440 litres dans les 24 heures, soit 360 gallons impériaux ou 60 gallons par tête d'une famille moyenne de six personnes) chacun pouvant, du reste, s'abonner pour un nombre de litres plus ou moins fort et payant à proportion de ce nombre de litres.

66—*La vente de l'eau à discrétion, présente sur la vente de l'eau au litre des avantages incontestables* au point de vue de la commodité, de la propreté et de l'abondance.

67—*Machine hydraulique de Genève* 16,000 litres par minute (23,040,000 litres—soit 5,760,000 gallons impériaux par jour.)

68—*Ce n'est plus seulement de l'eau qu'on demande de nos jours, il faut le reconnaître ; c'est de l'eau en abondance ; ce n'est plus seule-*

*ment à* L'USAGE DE L'EAU *qu'il s'agit de fcire face, c'est au* LUXE DE L'EAU, *et ce luxe si sain, si utile, si agréable, si gracieux, Genève ne voudrait pas en être privée*

(OFFICIAL.)

## Special Meeting of the City Council.

Friday, October 6th, 1876.

Present:—His Worship the Mayor, and Aldermen Chambers, Dinning, Gauthier, Henchey, Norris, Poitras, Rinfret and St. Michel; Councillors Bresse, Brousseau, Brunet, Burns, Convey, Coveney, Gingras, Huot, Marcotte, McLaughlin, Peachy, Russell, Smith, Vallerand and Vallieres.

The minutes of the last meeting were read and confirmed.

Read, the 310th report of the Water Committee, which being put to the vote was passed, and it was therefore

*Resolved*,—That the City Engineer receive instructions to submit a report involving the following points: *

1. The capacity of the river and lake St. Charles in view of the possibility of a second line of aqueduct pipe, and at what cost the lake can be dammed if necessary or other works done to secure the required supply of water.

2. The present delivery of water into the city, both over Mount Pleasant and over the Grande Allée, and to what extent, if at all, such delivery has been modified within the last twelve years or since Baldwin's report of 1865.

3. To what extent the present line of pipe from Lorette and those throughout the city are incrustated, and whether such incrustation has increased if at all, and to what extent since 1865.

4. How a continuous supply of water can best be given to all parts of the city.

5. Size of present distribution pipes in the city, and what improvement in the water service might be effected by the substitution therefor of pipes of greater capacity, also the cost of so doing.

6. In how far the present pipes could be cleaned out, by what process and at what cost, and in how far such removal of the incrustation would better the supply. The cost thereof.

7. Whether any and what means can be applied to obtain addi-

* These resolutions drawn by Mr. Baillairgé at request of Committee.

tional pressure and better the supply through the present line of pipes; also the cost thereof.

8. Whether there is any certainty that the pipes in their present condition will stand and continue to stand the additional pressure if any, which they may be subjected to by carrying out such work as may be required under No. 1.

9. And generally any suggestions the City Engineer may deem fit to offer bearing on the several points herein above set forth, or on other points affecting the supply of water to the city, with the cost of all suggested improvements.

Certified and signed L. A. CANNON,

City Clerk.

CITY HALL.

Quebec, 12 Sept. 1881

At a special meeting of the Council of the City of Quebec held on the twelfth day of August one thousand eight hundred and eighty one at which were present:

His Worship the mayor; Aldermen Gingras, Guay, Hearn, Henchey, Rhéaume, Rinfret and Vallerand and Councillors Archer, Chouinard, Hagens, Langevin, McLaughlin, McWilliam, Peachy, Roy, and Samson, It was resolved:—

That the report of Chevalier Baillargé, City Engineer, presented this evening and just read by him in so far as it relates to the Water Works department be printed and distributed to the members of the Council, insurance agents, to the press, to the principal citizens, and to all those in Canada and abroad who have so readily furnished the necessary information on the subject. That 300 copies of the said report be printed in English and the same number in French and the cost be taken from the contingencies.

Certified

L. A. CANNON,

City Clerk.

CITY HALL,

Quebec, 12 th. sept. 1881.

At a special meeting of the council of the city of Quebec held on the tenth day of June one thousand eight hundred and eighty one at which were present:—

His worship the Mayor, Aldermen Bourget, Guay, Hearn, Henchey, Rhéaume, Rinfret, and Vallerand and Councillors Chouinard, Gunn, Hagens, Johnston, Langevin, McWilliam, Peachy, Roy, Russell, Samson and Vallée. It was

*Resolved*,—That the water-works Committee be requested to have prepared forthwith a report on the actual condition of the aqueduct and the supyly of water now furnished this City, on the urgent repairs and improvements that might be made thereto so as to secure the greater efficacy of this important service.

That the Water-Works committee is requested to procure at the same time the probable cost 1st. of the construction of a reservoir on the hights; 2nd of the sum required to lay down a second pipe from the Chateau d'eau to Quebec or from any other place; 3rd of the cost of these two improvements combined; 4th or any other effective system. The whole with a view of securing a constant and much more efficacious supply of water than obtained under the present system.

Certified L. A. CANNON

City Clerk.

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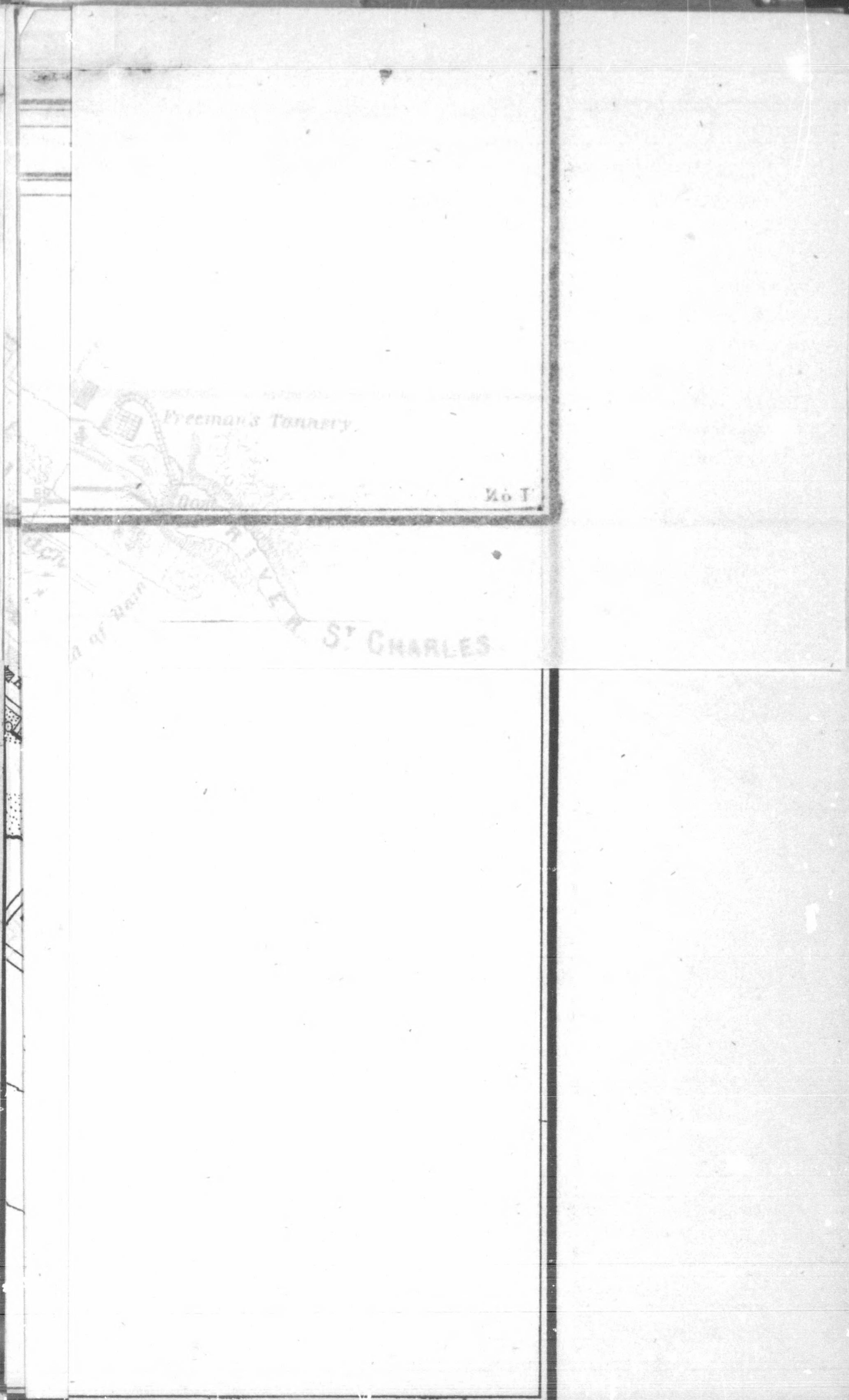
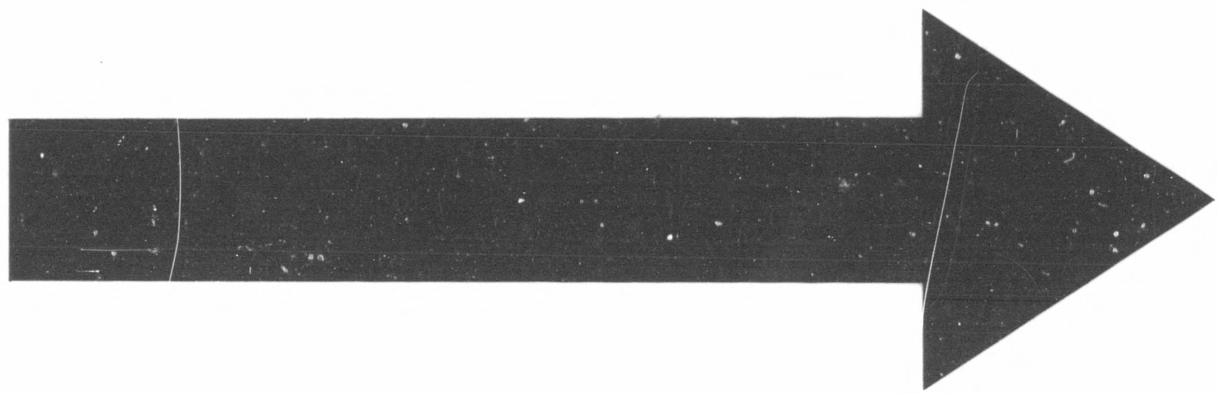
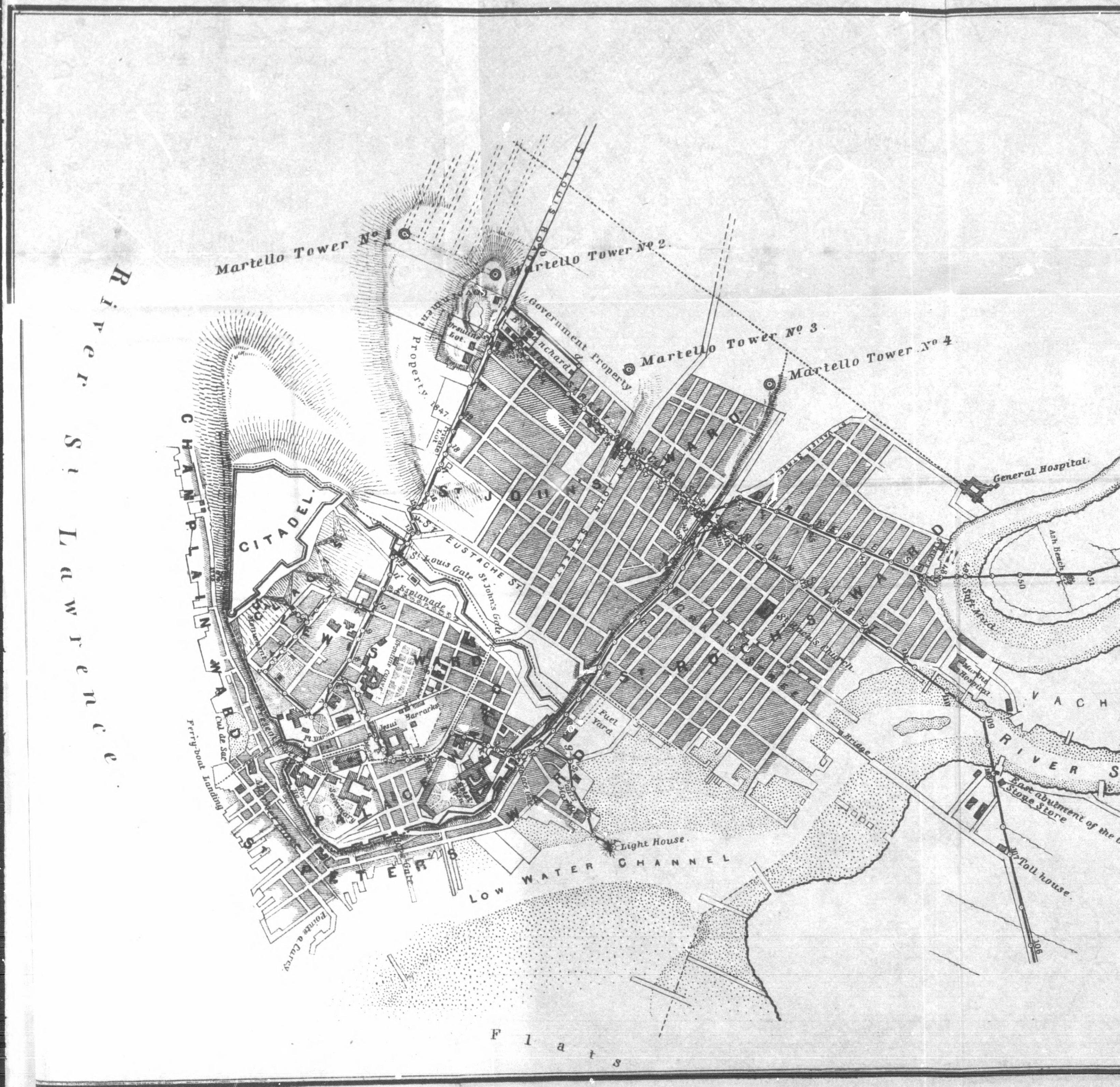
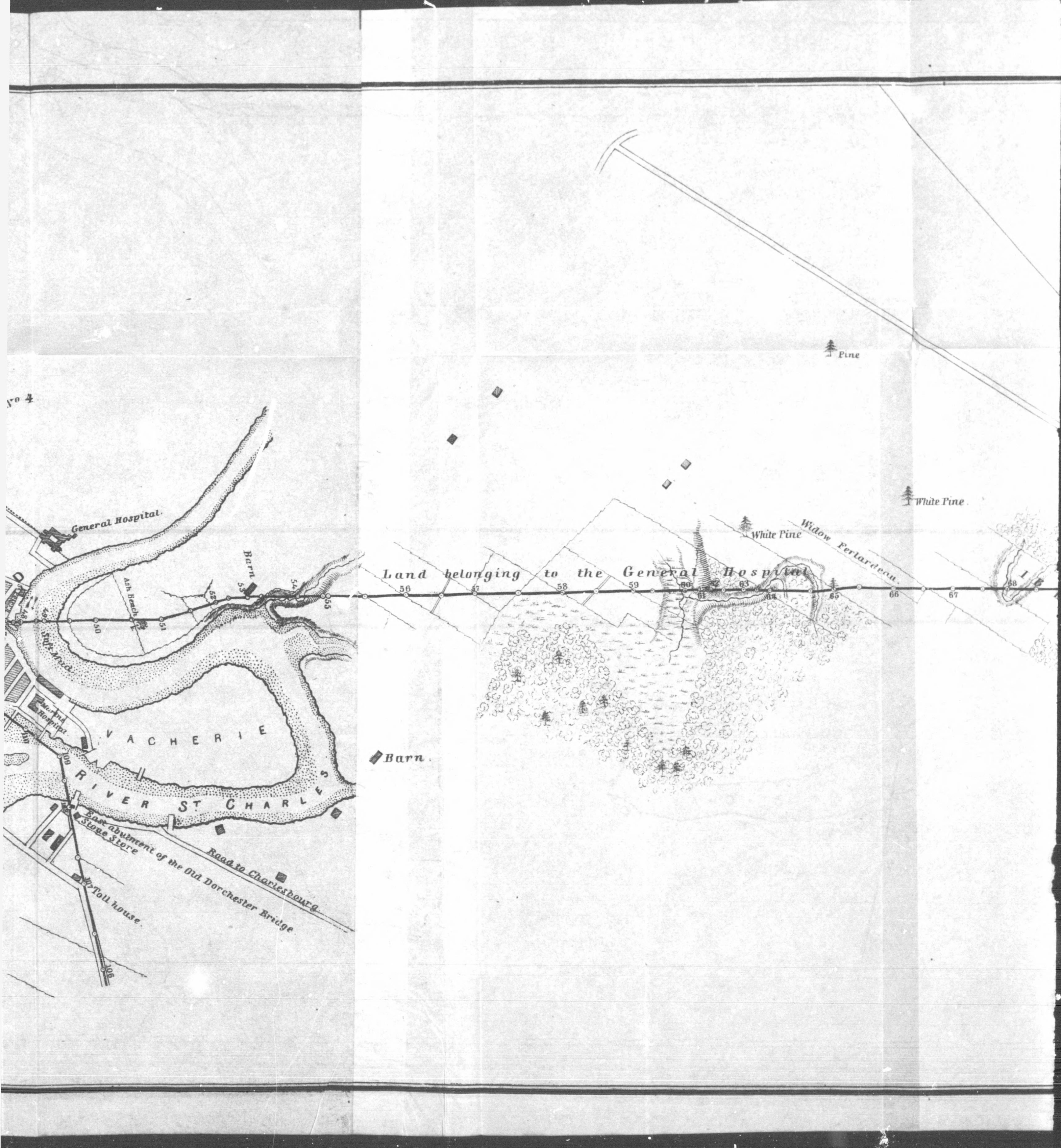
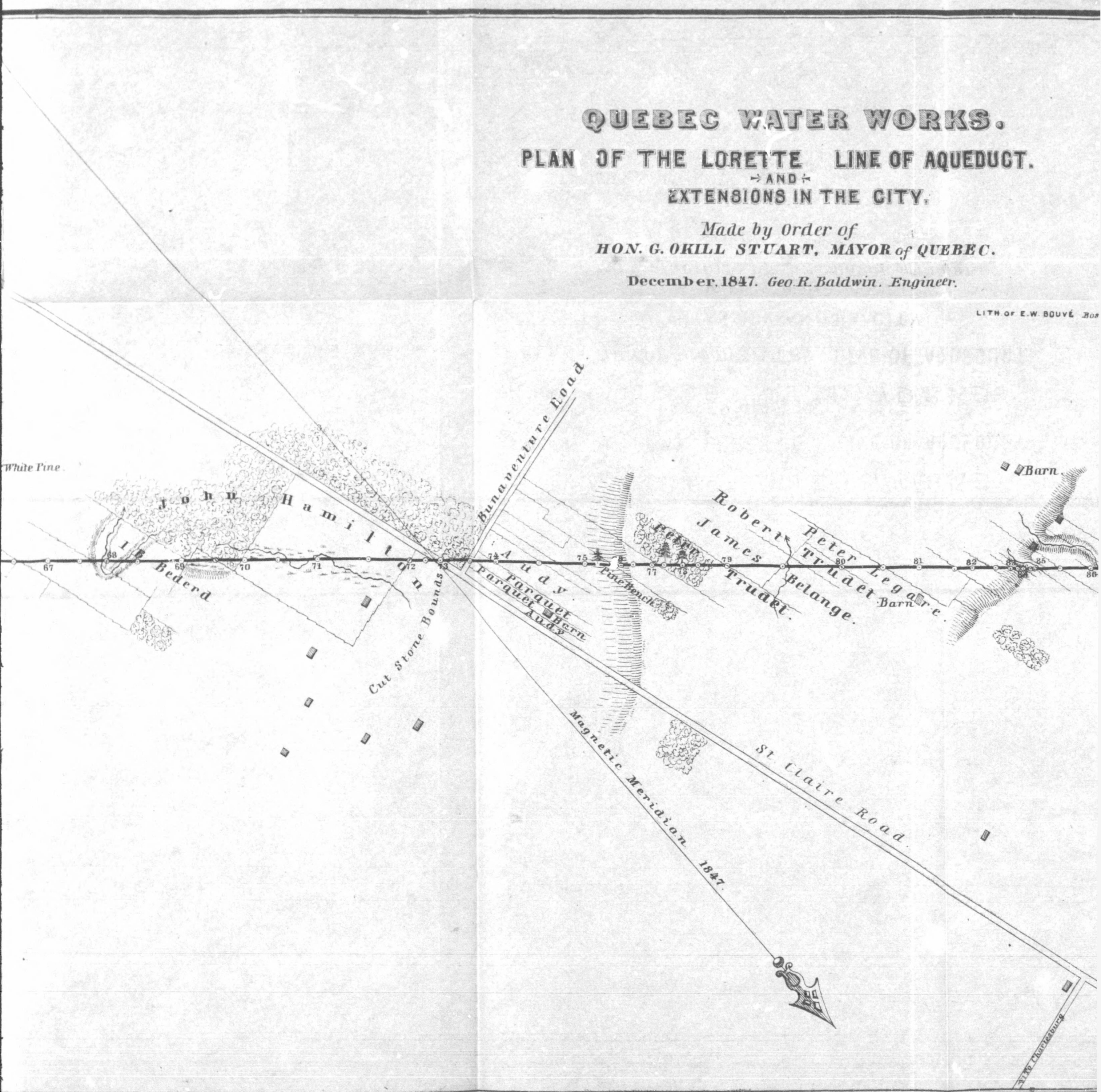
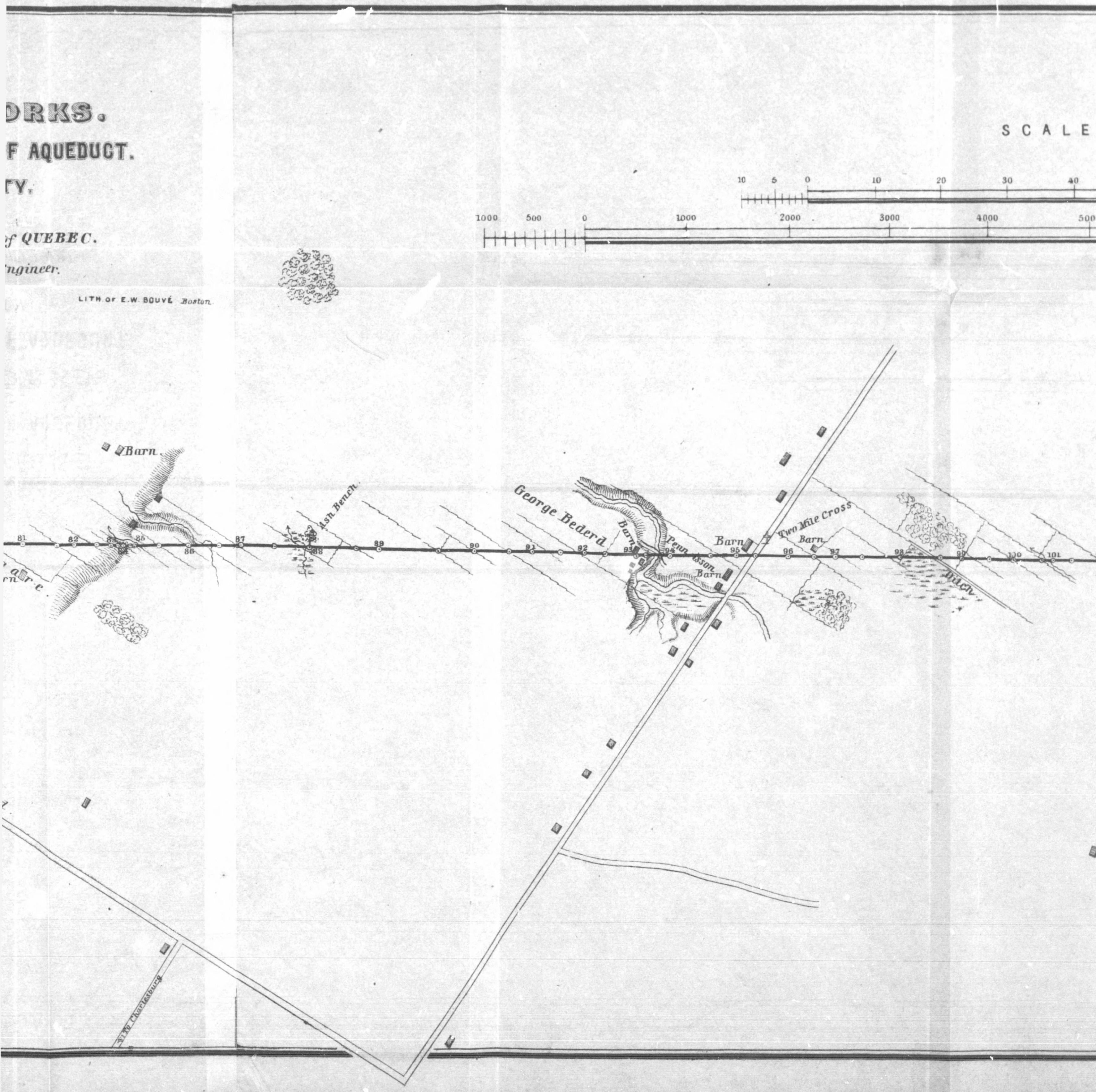




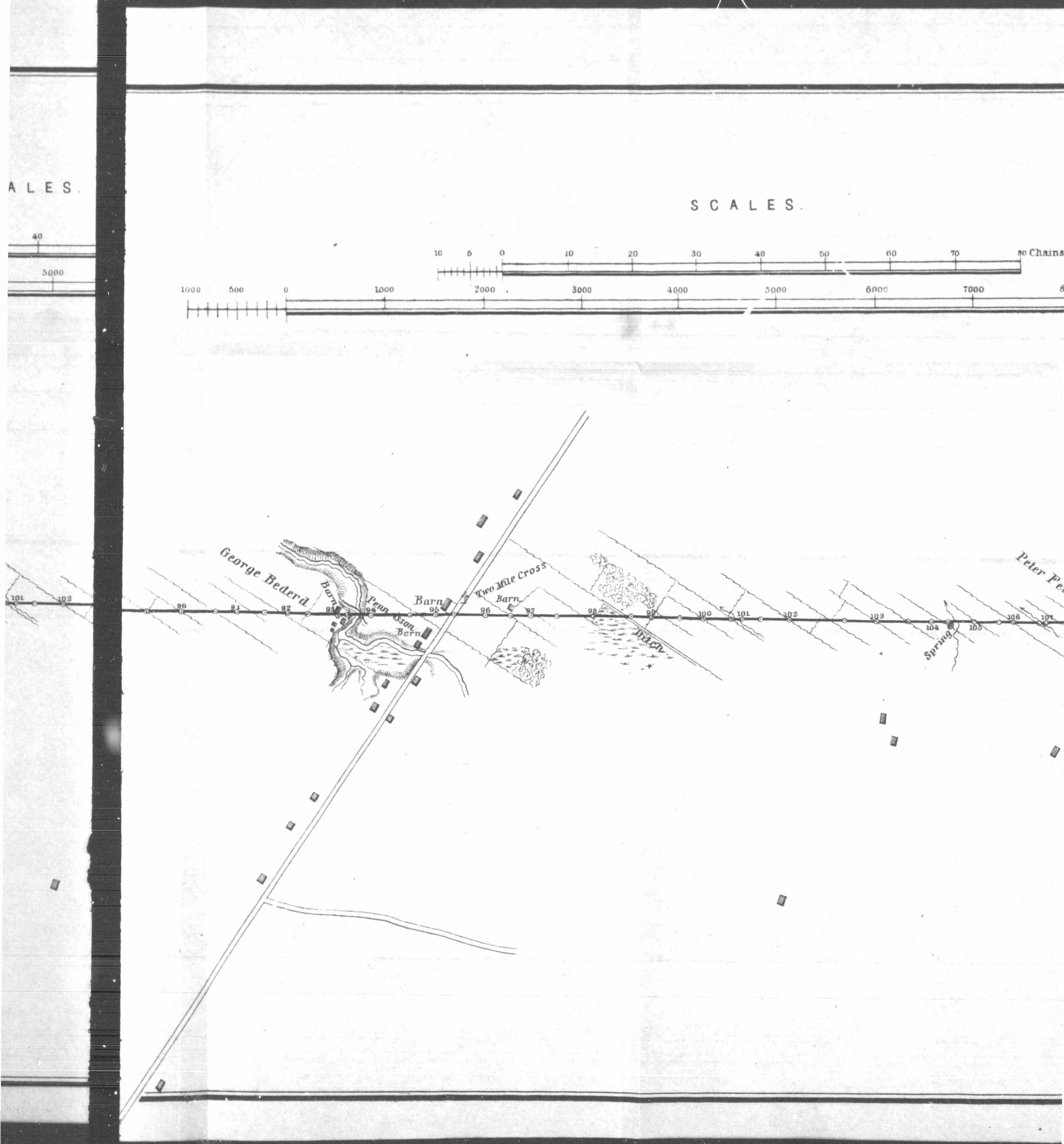

Martello Tower No 1
Martello Tower No 2
Martello Tower No 3
Martello Tower No 4
River St Lawrence
Government Property
Property
CITADEL
CHAMPLAIN WARD
ST JOHNS WARD
ST ROCHS WARD
PALACE WARD
ST PETERS WARD
St Eustache St
St Louis Gate
St Johns Gate
Esplanade
Barracks
General Hospital
Marine Hospital
Soft Mud
Fuel Yard
Bridge
Light House
Low Water Channel
Ferry-boat Landing
Cul de Sac
Pointe a Carcy
Stone Store
Toll house
River St
Flats


No 4
General Hospital.
Barn
Ash Beach
Marine Hospital
VACHERIE
RIVER ST CHARLES
East abutment of the Old Dorchester Bridge
Stage Store
Toll house
Road to Charlesbourg
Barn.
Land belonging to the General Hospital
White Pine
Widow Ferlardeau.
White Pine
Pine
56
57
58
59
60
61
63
64
65
66
67
68

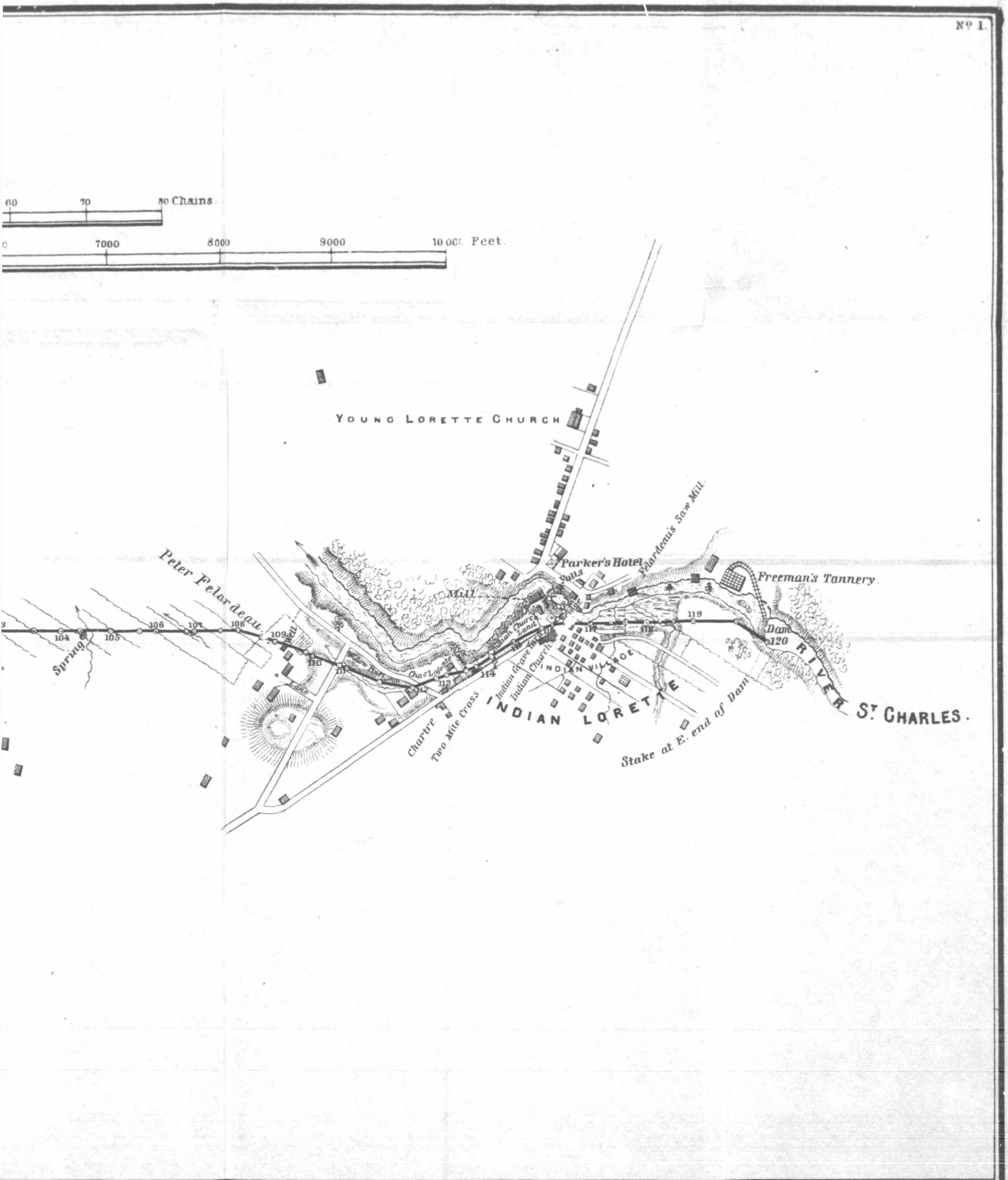

QUEBEC WATER WORKS.
PLAN OF THE LORETTE LINE OF AQUEDUCT.
AND
EXTENSIONS IN THE CITY.
Made by Order of
HON. G. OKILL STUART, MAYOR of QUEBEC.
December, 1847. Geo. R. Baldwin. Engineer.
LITH OF E.W. BOUVÉ Bos
White Pine
John Hamilton
Bedard
Bunaventure Road
Cut Stone Bounds
Audy
Parquet
Parquet Barn
Audy
Pine Bench
Robert
James
Truadet
Peter
Truadet
Belange
Legare
Barn
Barn
Magnetic Meridian 1847
St. Claire Road
To Charlesburg
67
68
69
70
71
72
73
74
75
77
79
80
81
82
85
86



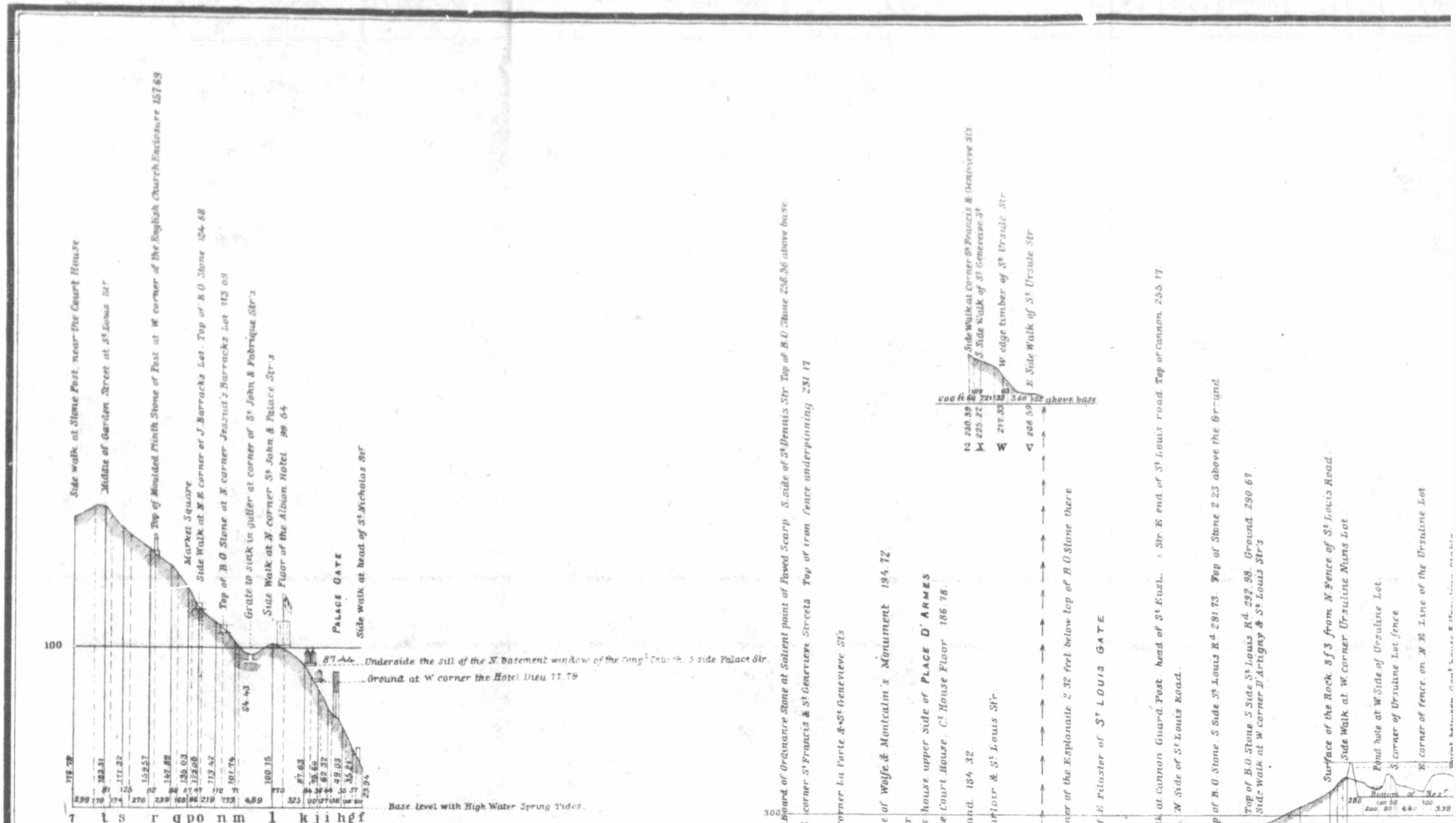
ORKS.
F AQUEDUCT.
TY.
f QUEBEC.
ngineer.
LITH OF E.W. BOUVÉ Boston.
SCALES
10 5 0 10 20 30 40
1000 500 0 1000 2000 3000 4000 5000
Barn
Ash Bench
George Bederd
Barn
Barn
Barn
Two Mile Cross
Barn
Ditch
81 82 85 86 87 88 89 90 91 92 95 96 97 98 100 101



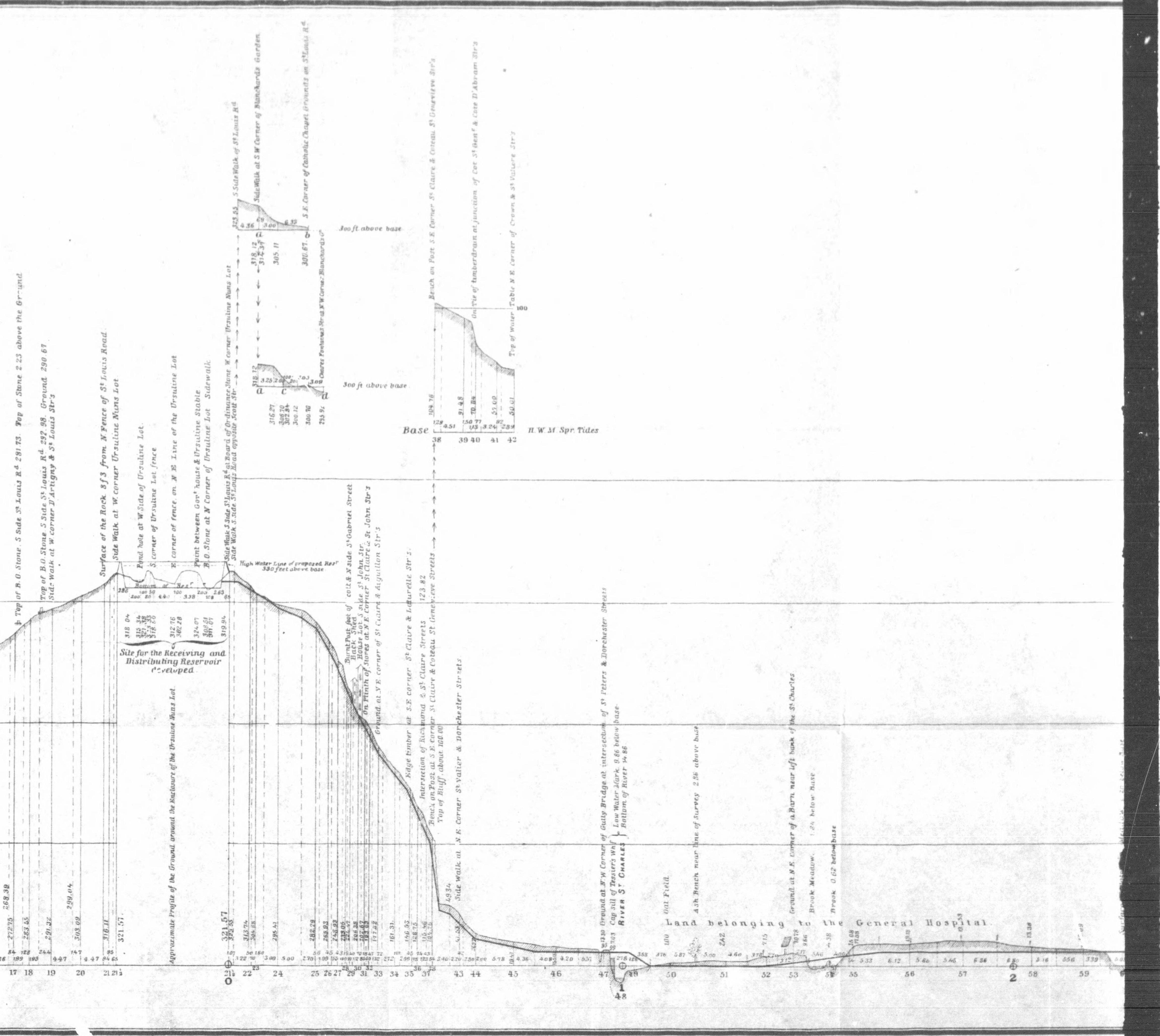
SCALES.
10 5 0 10 20 30 40 50 60 70 80 Chains.
1000 500 0 1000 2000 3000 4000 5000 6000 7000
George Bederd
Barns
Barn
Barn
Two Mile Cross
Barn
Ditch
Spring
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106



Nº 1.
60
70
80 Chains
7000
8000
9000
10000 Feet.
YOUNG LORETTE CHURCH
Parker's Hotel
Felardeau's Saw Mill.
Freeman's Tannery.
Peter Felordeau
Mill
Falls
Dam
120
119
108
109
104
105
106
Spring
Lake
Chartre
Two Mile Cross
Indian Church
INDIAN VILLAGE
INDIAN LORETTE
Stake at E. end of Dam
RIVER ST. CHARLES.



Level of High Water Spring Tides
Base level with High Water Spring Tides
Underside the sill of the N. basement window of the Cong.l Church, S side Palace Str.
Ground at W corner the Hotel Dieu 77.79
PALACE GATE
Glacis
Platform of Durham Terrace ... 172.00
Ground at N.W. corner of old Chateau ... 169.44
Centre of Place D'Arms Green ... 168.39
Side Walk at S.W. corner of Payne's Hotel 194.52
PLACE D' ARMES
ST LOUIS GATE
Site for the Receivi
Distributing Rese
developed
above base



Site for the Receiving and Distributing Reservoir developed.
High Water Line of proposed Res^r 330 feet above base
300 ft above base
Base
H. W. M. Spr. Tides
Land belonging to the General Hospital
River S^t Charles
Surface of the Rock 3f 3 from N. Fence of S^t Louis Road
Side Walk at W. corner Ursuline Nuns Lot
Approximate Profile of the Ground around the Enclosure of the Ursuline Nuns Lot
Side Walk at N.E. Corner S^t Valier & Dorchester Streets
Ground at N.W. Corner of Gully Bridge at intersection of S^t Peters & Dorchester Streets
Low Water Mark 9.86 below base
Bottom of River 14.86
Oat Field
Ash Bench near line of Survey 2.56 above base
Ground at N.E. Corner of a Barn near left bank of the S^t Charles
Brook Meadow 1.24 below Base
Brook 0.62 below base
Intersection of Richmond & S^t Claire Streets
Edge timber at S.E. corner S^t Claire & Lafurelle Str's
Top of Bluff about 100.00

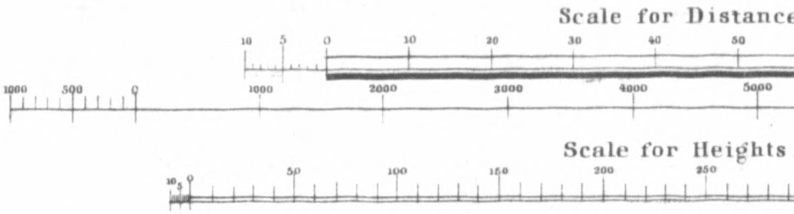
# QUEBEC WATER WORKS.

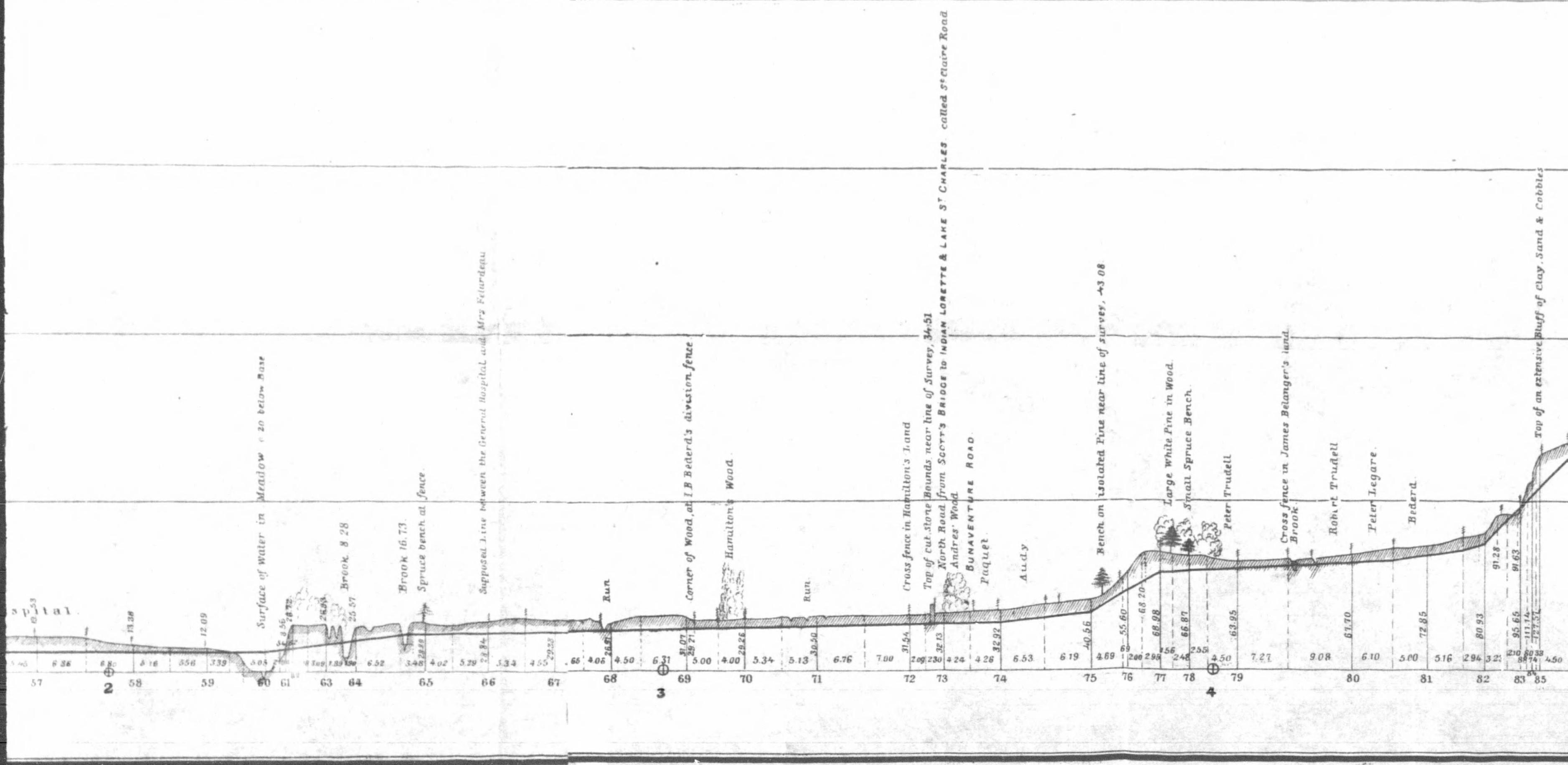
## PROFILE OF THE LORETTE LINE OF AQUEDUCT, AND EXTENSIONS IN THE CITY.

*Made by Order of*
***HON. G. OKILL STUART, MAYOR of QUEBEC.***

December, 1847. *Geo. R. Baldwin Engineer*

LITH. OF E. W. BOUVÉ BOSTON.



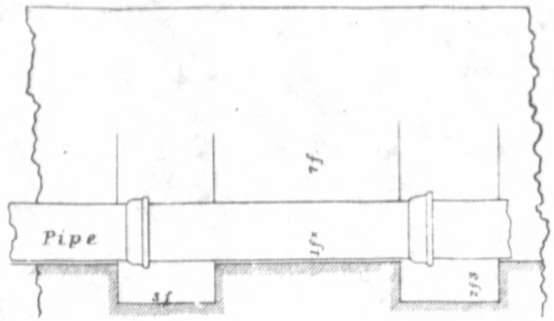
RKS.

AQUEDUCT,

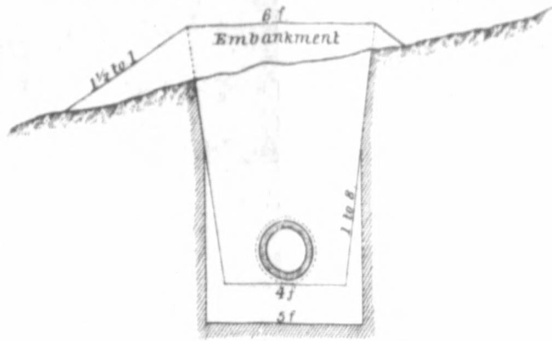
QUEBEC.

neer

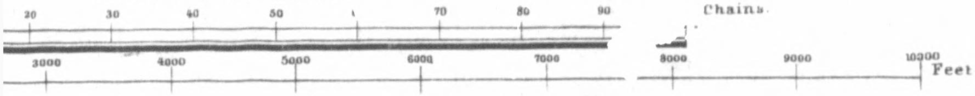
Side view of Trench.



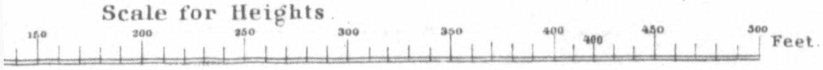

Section of Trench with Pipe in place

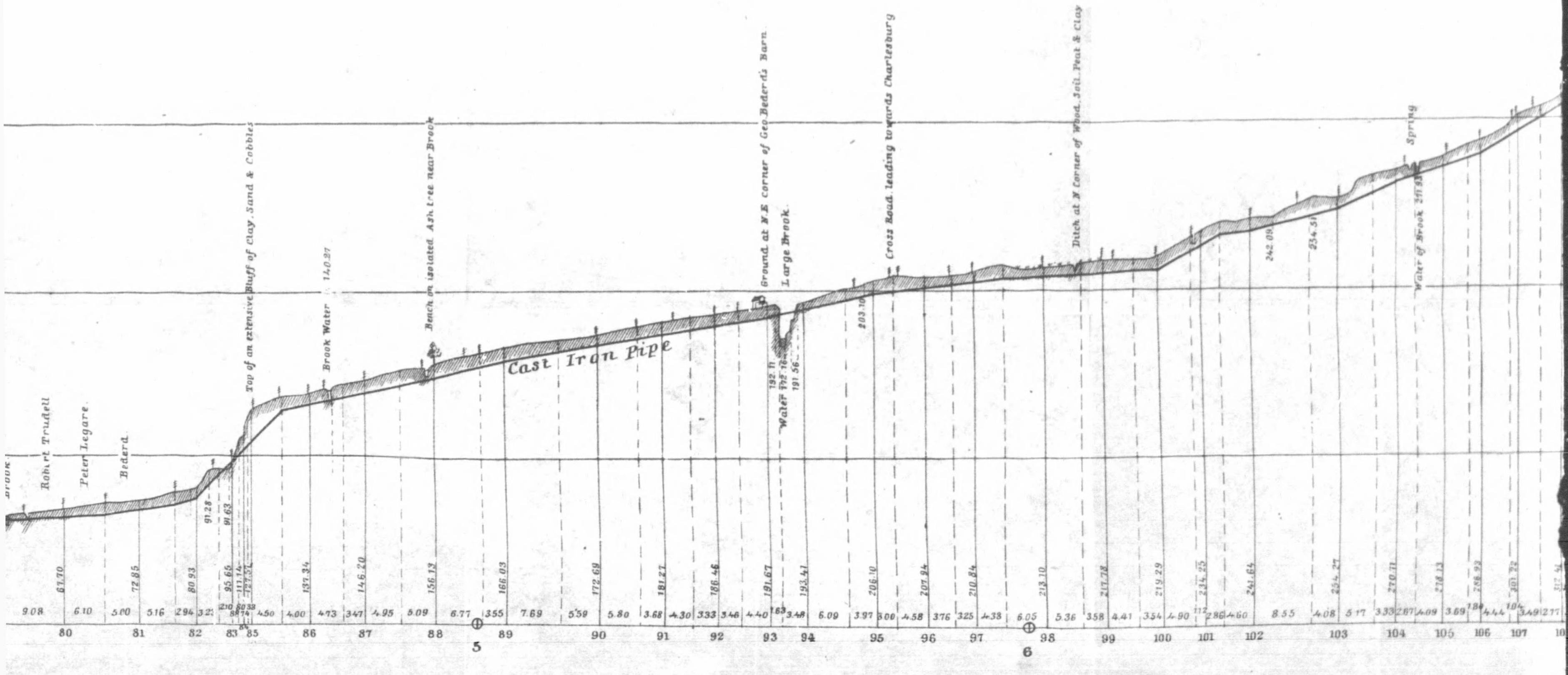



Scale for Distances

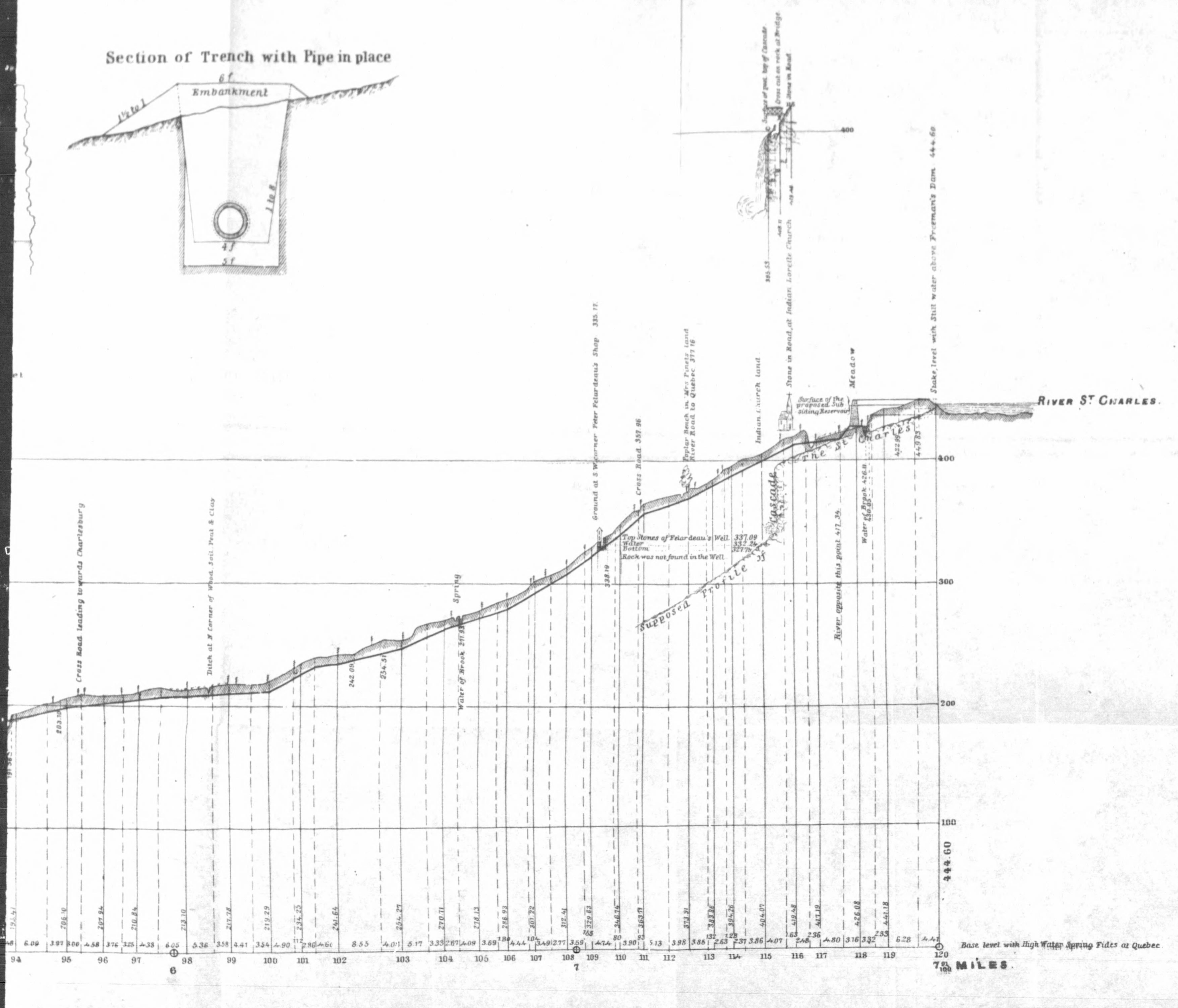



Scale for Heights



Nº 2.


Section of Trench with Pipe in place
Embankment
6 f
1½ to 1
1 to 8
4 f
5 f
River St Charles.
Stake, level with Still water above Freeman's Dam. 444.60
Meadow
Surface of the proposed Sub siding Reservoir
Stone in Road, at Indian Lorette Church
Indian Church land
Poplar Bench in Mrs Pinets land
River Road to Quebec 371.16
Cross Road 357.96
Ground at S W corner Peter Felardeau's Shop 335.17
Top Stones of Felardeau's Well 337.09
Water
Bottom
Rock was not found in the Well
Supposed Profile of the St Charles
Cascade
River opposite this point 417.35
Water of Brook 426.11
Spring
Water of Brook
Cross Road leading towards Charlesburg
Ditch at N Corner of Wood, Soil, Peat & Clay
400
300
200
100
444.60
Base level with High Water Spring Tides at Quebec.
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
6
7
MILES.