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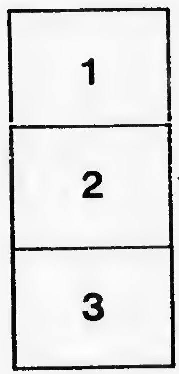

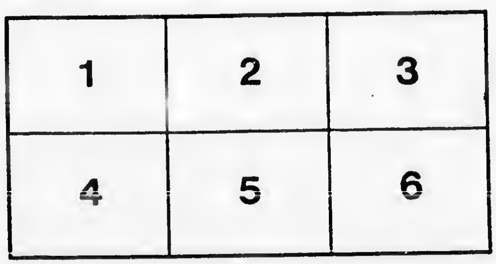

PROCEEDINGS

OF THE

STANDING COMMITTEE

ON

Fire, Water and Gas,

OF

THE CITY OF TORONTO,

IN CONNEXION WITH THE

SUPPLY OF WATFR

TO THE CITY..

TORONTO:
PRINTED BY MACLEAR, THOMAS & CO., KING STREET EAST.

1854.

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1854.

PROCEEDINGS

OF THE

STANDING COMMITTEE ON FIRE, WATER AND GAS,

IN CONNEXION WITH THE

SUPPLY OF WATER

TO THE CITY.

February 14, 1854.

The Committee met.

PRESENT.

Alderman Romain, Chairman.
,, Platt.
Councillor Earl.
,, Graham,
,, M'Conkey.
,, Rowell.
,, Wright.

The subject of furnishing the City with a good supply of pure water having been taken into consideration, the Committee decided upon recommending the Council to appropriate the sum of £150, to be apportioned by the Committee to the parties furnishing the best plans and specifications for that object.

February 17, 1854.

The Committee met.

PRESENT.

Alderman Romain, Chairman.
,, Platt.
Councillor M'Conkey.
,, Rowell.
,, Wright.
Chief Engineer Ashfield.

The different subjects of erecting new Water works, the City purchasing the old ones, the payment for the new Hydrants, the keeping in repair the old ones, the furnishing pure water, and every other matter pertaining to the Water Company were very fully discussed.

February 18, 1854.

The Committee met.

PRESENT.

Alderman Romain, Chairman.
,, Platt.
Councillor Earl.
,, Graham.
,, Rowell.
,, Wright.
Chief Engineer Ashfield.

The subject of providing the City with good pure water, and procuring plans for erecting Water Works, was again taken up, and the Committee confirmed their former decision on the matter, on the following additional grounds:—

Relative to purchasing the present Water Works, the Committee having only, as yet, had a verbal offer of the Works, in bulk, at £35,000, without any satisfactory proof of their value, or capacity for the requirements of the City.

On changing or revising the present contract, which has continued for twelve years, and will expire in nine more, the Committee have had nothing before them to justify them in recommending such a course.

Upon the adoption, by the Council, of the recommendation of the Committee, the following advertisement was issued :—

TORONTO NEW WATER WORKS.

THE Corporation of the City of Toronto, having decided to construct new WATER WORKS,—to be supplied by the Water from Lake Ontario, will receive Plans and Estimates from Civil Engineers desirous to compete,—until the first day of July next. Two Premiums, one of £100, and the other of £50, will be given for the two best plans. The plans to be sealed, and must be accompanied by a note, containing the Signature of the competitor, or a motto corresponding with the plan.

☞ Any further information may be obtainid on application at the City Chamberlain's office.

CHAS. ED. ROMAIN,
Chairman.

Committee Room,
Toronto, March 8, 1854.

July 13, 1854.

The Committee met.

PRESENT.

Alderman Romain, Chairman.
" Platt.
Councillor Earl.
" Rowell.
" Wright.
Chief Engineer Ashfield.

The various plans, reports, &c., submitted in compliance with advertisement, were examined and read.

The Committee ordered that the "Mottos" or keys to the authorship of the several plans be sealed up by the Clerk, and that the Committee adjourn to give time to carefully examine the plans, &c.

August 18, 1854.

The Committee met.

PRESENT.

Alderman Romain, Chairman.
" Platt.
Councillor Graham.

The Committee adjourned in consequence of the necessary absence of several members on the Board of Health.

September 16, 1854.

The Committee met.

PRESENT.

Alderman Romain, Chairman.
His Worship the Mayor.
Alderman Platt.
Councillor Graham.
" McConkey.

The plans, reports, and specifications for the new Water Works were again examined and discussed.

September 18, 1854.

The Committee met.

PRESENT.

Alderman Romain, Chairman.
" Platt.
Councillor Graham.
" McConkey.
" Rowell.
" Wright.
Chief Engineer Ashfield.

After a further examination of the plans, reports, &c., for the construction of new Water Works, it was resolved that the opinion of some competent engineer or engineers (not interested in any of the plans) be obtained to assist the Committee in coming to a proper decision, the same idea having been suggested at a former meeting, the Chairman submitted the names of Jarvis and Baldwin, two eminent engineers in the United States; but in view of the great expense likely to be entailed on the City by consulting engineers so far away, it was ultimately decided that Walter Shanley, Frederick W. Cumberland, and C. S. Gzowski, Esquires, being resident engineers of high standing, would be proper parties in connection with the City Surveyor, John G. Howard, Esquire, to advise the Committee on the plans, reports, &c. PROVIDED that the said gentlemen stated that they were not interested in any of the plans, and that His Worship the Mayor with the Chairman of this Committee, be a sub-committee to wait upon the gentlemen named, to ascertain that they were not interested, and if they would with as little delay as possible assist this Committee with their opinions. The Committee then adjourned to await the report of the sub-committee.

September 19, 1854.

The Committee met at 2 p. m.

PRESENT.

Alderman Romain, Chairman.
His Worship the Mayor.
Alderman Platt.
Councillor Graham.
" McConkey.
" Rowell.
Chief Engineer Ashfield.

The Chairman and His Worship the Mayor reported that they had had an interview with Messrs. Shanley, Cumberland, Gzowski, and Howard, that the three first named gentlemen had stated they were no way interested in any of the plans, reports, &c., except as citizens anxious for the establishment of first-rate Water Works with a due regard to economy, and that they would have much pleasure in assisting the Committee gratuitously; Mr. Howard, City Surveyor, declined on the ground of his being interested in one of the plans.

Messrs. Shanley, Cumberland, and Gzowski, having met the Committee and devoted their whole afternoon to the several reports, plans, &c., unanimously submitted the following opinion:—

To the Chairman of the Committee on Water Supply.

City Hall, 18th September, 1854.

Sir,—Having examined the plans and reports on water supply to the City of Toronto, respectively marked " Ke-secnah Zi-bing", "A. Z." and "Red Cross", we are of opinion that the first rank should be awarded to the report marked "Red Cross", and the second to that marked "Ke-see-nah Zi-bing."

With regard to the former, whilst we consider the system proposed in it, as superior to the other suggested, we should be inclined to demur to the source of supply, to the position and altitude of the reservoir, which if possible should be more central and at a higher level, and to the details of distribution which would seem to be capable of improvement. In such matters of detail, however, careful local investigation and study are requisite before they can be safely determined on; and the corporation will find its most economical as well as its most permanently efficient course, to secure the advice of an experienced engineer from time to time to consult with the person, whoever he may be, to whom shall be entrusted the execution of the system, which should be well weighed in all its bearings before being finally adopted.

We are, sir, your obedient servants,

(Signed)

W. SHANLEY,
C. S. GZOWSKI,
FRED. CUMBERLAND.

The committee having thanked Messrs. Shanley, Cumberland & Gzowski, for their gratuitous and valuable services, awarded the premiums as follows:—

To the plan marked a "Red Cross", found upon examination to have been furnished by George Kent Radford, Esquire, the first preminm of £100.

To the plan marked "Ke-see-nah Zi-bing," furnished by Henry Y. Hind, M.A., Professor of Chemistry, Trinity College, and Sandford Fleming, Esquire, Resident Engineer of O. S. & H. R. R., the second premium of £50.

The committee further resolved to recommend that an additional sum of £25 be granted for the third best plan, marked "A. Z.," found to have been supplied by John G. Howard, Esquire, City Surveyor.

The substance of these proceedings the committee conveyed to the council in the following report:—

To the Mayor, Aldermen and Councilmen, in Council assembled.

The Standing Committee on Fire, Water, &c. beg leave to bring up their report No. 11.

Your committee beg leave to report that they have disposed of the £150 voted by the council for premiums to be awarded by your committee for the best plans, &c., for the erection of new water works. And that they have given the sum of £100 to George Kent Radford, Esquire, as a first premium for plan and report marked "Red Cross," and the sum of £50 to Henry Y. Hind, M.A., Professor Chemistry, Trinity College, and Sandford Fleming, Esquire, Resident Engineer Northern Railroad Company, as a second premium for plan and report marked "Ke-see-nah Zi-bing."

Your committee recommend that the sum of £25 be given to J. G. Howard, Esquire, for furnishing the plan and report marked A. Z, upon the erection of new water works; which plan your committee would have awarded a third premium to, had they not previously decided upon dividing the sum placed at their disposal into two premiums.

All which is respectfully submitted.

CHARLES E. ROMAIN.

To the Worshipful the Mayor, Aldermen, and Commonalty of the City of Toronto, in Common Council assembled.

The Standing Committee on Fire, Water, and Gas, beg leave to submit their Report, No. 12.

Your Committee were unanimously of opinion that the ample supply of pure water, and establishment of new Water Works, in the very best manner, was a subject of such great importance to this City, that they would not hastily recommend any positive steps to be taken in the matter, that there was the least possibility of finding it necessary to change hereafter, and that when the Corporation obtained their Charter from the Legislature, that the first step to be taken would be to employ some Engineer of undoubted ability to make out a full plan, specification and estimate, based upon the best information that could in the meantime be procured, and that said plan, specification and estimate, be submitted to some other undoubted authority for verification, and when the Corporation were satisfied that they had the best plans, &c., and that they could depend upon the services of an Engineer proved to be of undoubted ability and integrity, then to go on with every possible despatch to the completion of said object.

After a good deal of conversation in relation to the establishment of Water Works, Mr. Radford expressed the opinion that the Water could be brought from Lake Simcoe for a sum not to exceed the amount now contemplated to be expended, capitalizing the additional cost per annum of forcing the water up from Lake Ontario, over the expense per annum of the Works if the water was brought down from Lake Simcoe. After a good deal of discussion upon the subject, the Committee unanimously resolved to recommend the Council to place the sum of £100 at the disposal of the Committee, for the purpose of obtaining a preliminary survey and report upon the practicability of bringing in the water for the supply of the City from Lake Simcoe.

All which is respectfully submitted.

CHAS. ED. ROMAIN.

Committee Room, Oct. 9, 1854.

REPORTS SUBMITTED,

WITH THE PLANS, &c., IN COMPETITION.

No. 1, MARKED "A RED CROSS,"

BY GEO. KENT RADFORD, ESQ.

Toronto, June 25th, 1854.

To the Committee on Water Supply:

Gentlemen,

In accordance with your advertisement, requesting plans and estimates for a supply of water to the City of Toronto, and stating that you had determined on taking the water from the Lake, I beg to submit the accompanying plan, &c.

Before entering into a description of the means proposed to effect a proper and sufficient supply of water for the various purposes of domestic and public wants, I must premise, that in arranging the details I have been influenced by a regard for the future wants of a rapidly increasing population, at the same time that I have kept the expenditure within proper limits in reference to the present requirements.

I propose to take the supply from the Bay, at or about the point shown on the plan herewith attached; this will be in at least ten feet water, if not more, and in the choice of this spot, I have been influenced by the observations that I have made during the short time I have had the opportunity of doing so, that the water is the clearest at that point, than any in the vicinity; it is also within the line of the projecting wharves, and out of the track of steamers and craft, I do not of course, bind myself to select that spot, but I do not think any other can be found where a better supply can be procured with a due regard to economy.

To go east is out of the question, from the public wharves, &c., rendering the water foul, and westward, it will be found that the continual washing of the Lake shore produces a constant muddiness, besides necessitating a great expenditure in the rising main.

There only remains an extension southwards, into the Bay, to deeper water, but I am convinced that no advantage will be gained from doing so, besides being liable to get in the track of steamers and craft.

At the position shown in the plan I propose to construct a wharf, this wharf to be at the edge of the intended Esplanade, (if a portion of the Esplanade be granted for this purpose this wharf may be dispensed with,) and thereon to erect the necessary engines and pumps, for forcing the water through the rising main up into the reservoir at the head of Spadina Avenue.

The engines will consist of three in number; one being sufficiently powerful to lift a quantity of water into the reservoir equal to 1,500,000 gallons in twelve hours, being a supply of 25 gallons per day for 60,000 inhabitants.

Two engines of a combined power equal to the above are also provided in case of accident to the larger one, so that while repairs are in progress no stoppage will take place.

It will be at once seen that this engine power gives great margin for extension; thus, the larger engine worked for 24 hours, will give a supply for 120,000 inhabitants.

The large one and a small one will supply 180,000, and the whole together will supply 240,000.

I do not, however, mean to say that this will be accomplished without further engine power, as spare power must *then* be provided, as in the present case, still, it will give an idea of the capacity for extension the work will possess.

These engines will be on the principle known as the Cornish, which consists of admitting steam of a high pressure into the cylinder, and allowing it to expand, producing the effect with a very great reduction in the consumption of fuel, as compared with other engines; thus, this engine will work with 3½cwt. of coal per hour, but the consumption of an ordinary engine averages, for the same power, at least 8cwt. per hour.

The water will be forced through the rising main, which is proposed to be of 24 inch diameter, and although somewhat larger than at present necessary, I consider it true economy to give it this capacity, so as to preclude the necessity of future enlargement for a considerable period.

The water on its passage to the reservoir will be drawn off by the mains right and left down Front Street, Wellington Street, King Street and Queen Street, the remainder passes into the reservoir.

The reservoir is proposed to be situated in a field, the second from the concesssion road, the map not extending far enough north, I have placed it next the road to show its position.

It will be of a capacity of 10,000,000 gallons, and will be divided into two compartments, so that in case of muddiness or sediment in the water after a storm &c., one compartment may be filled and allowed to settle, then drawn off while the other is also settling, also in case of an accident to the rising main, the supply may go on from the reservoir without inconveniencing the consumers.

A main pipe goes from the reservoir along the concession road to the head of Yonge Street, of a capacity equal to the carriage of a supply sufficient for the whole district bounded on the north by the concession road, south by Queen Street, east by the Don, and west by College Avenue, and in case of accident to rising main will also supply the whole city, although of course on a smaller scale.

The main then descends Yonge Street sending off branches to the streets on either hand and supplying the house services on its own route, it diminishes in size until it terminates at the the Front Street main. It is connected with the Queen Street, Richmond Street, Adelaide Street and Wellington Street mains.

The other mains are carried through every street at present inhabited, and are of capacity to give supplies to a greatly increased population, indeed the principal one I consider will never require increasing, the only increase being in the smaller pipes and in extending new ones into new streets. The supply that can be given is calculated on a consumption of 25 gallons per head, this is the quantity now settled as the required supply by the best authorities in England, &c., and provides fully for domestic, manufacturing and public wants.

It has been found, that under the "constant system" or that wherein the pipes are constantly full and ready for use the consumption takes place in a few hours and the pipes have consequently been calculated to deliver the whole quantity in 6 hours, this will give good margin in case of excessive demands, such as fires, &c., and as regards present cost, will but slightly increase the minimum expenditure requisite to supply the present wants.

It is proposed to carry the water up to the exterior of every house, and to use wrought iron pipes for this purpose instead of the lead now used, this will effect a considerable saving both in material and labour as no joints will be required to be made, a simple screw joint being all that is requisite; the estimate, therefore, includes the cost of furnishing every house within the city at present in the rate book, with a supply up to the exterior wall, the tenant or landlord making the further additions, and here I may take occasion to advise that the corporation undertake this portion, also charging a rental for the use, which to the poorer portion of the population, will be a great advantage in saving them the immediate outlay.

Stand pipes are provided for fixing at every junction of streets, and wherever otherwise requisite, and fire cocks of an improved and perfect pattern will be fixed at every 83 yards, this being found from experience to be the maximum distance for efficient work.

There will also be provided a sufficient number of loose stand pipes at the various engine houses, so that on an alarm of fire, the hose and one of these stand pipes may at once proceed without an engine and be fixed, and throwing a stream of water varying from 30 to 100 feet in height in 10 minutes after arriving at the fire.

These cocks and pipes will afford the means of watering and cleansing the streets, by means of spreading jets, &c., thereby saving a great expense in carts and horses, and affording streets now suffering from dust the benefit of water.

NOTE.

Should the committee consider it necessary that a supply at a greater height than 10 feet above the level of concession road and Bloor Street be provided, it will be requisite either to increase the depth of the reservoir or carry the rising main and reservoir on to the high land further north, in the direction shewn by the arrow, the latter in such case would be the preferable course, but I should not advise any such increase, as I do not consider that the giving a supply at a greater height to the comparatively few houses in that district most of which are only one story high, would compensate for the primary additional cost (£6000) and subsequent annual charge for working expense (£280 per annum) and interest on capital.

The height of the reservoir above the city, although not so great as I should wish, will still, from the favorable slope of the ground, afford great facilities for getting a jet of water of considerable height, I consider that it may be fairly calculated on giving a supply at 10 feet above the level of the road along the concession road and Bloor Street, increasing rapidly until at Carlton Street it becomes between 30 and 40 feet, and at Queen Street 60 feet, increasing to 90 or 100 feet at Front Street.

Taking the case of Philadelphia as an example, we find that with a head of 93 feet at six miles from the reservoir, a jet of water will rise, during the night, to between 45 and 50 feet, during the day, when the consumption is very great, to 25 feet. Now as, in the present case, we have the greatest distance of any point from the reservoir at 4½ miles, and the head is on say King Street, at the Don Bridge, (the extremity,) 139 feet, we may fairly calculate on half as much more, if not double that of Philadelphia.

This would enable a fire to be extinguished without the assistance of an engine, in the lower portions of the Town, say south of the liberties, and even in the upper parts the labour will be so much diminished as to render fire engines almost unnecessary.

In submitting the estimate of this work I have to remark, that it is based upon present prices.

The engines are *bona fide* tenders, received from the best makers in England, and therefore are to be relied on; the pipes are also actual tenders, for the present time, but of course, will be subject to the fluctuations of the market until the time of ordering, still, I do not think this item will be increased.

The other portions, such as buildings, &c., are calculated on prices paid for such work here, and consequently may be presumed to stand good at the time of letting.

I estimate the cost of the entire works, (exclusive of damages or cost of ground for pumping station at the Esplanade,) as follows:—

	£	s.	d.
Pumping Engines, House, Wharf, &c.	26,116	0	0
Reservoir	11,500	0	0
Mains, Stand Pipes, Cocks, House Services, &c.	63,958	0	0
	101,574	0	0
Add Engineering contingencies, &c.	13,426	0	0
	£115,000	0	0

The cost of working the engines, and staff requisite for keeping mains, &c., in order, I calculate as follows:—

FOR A SUPPLY OF 60,000 INHABITANTS.

	£	£
Depreciation on Engines, Houses, Reservoir, &c., £38,000 at 2 per cent..................................	760	
Ditto Mains, 64,000 at ¼ per cent....................	160	
		920

	£			
Coals, 312 days, at 2 tons = 624 tons, 30s.	936			
Stores	234			
Repairs	100			
	——	1270		
Salary of Resident Engineer	400			
Superintendent of Mains	200			
Assistant	150			
Collector of Rents	200			
Reservoir Keeper	150			
	——	1100		
Engineer at Engines	200			
Stokers	300			
Labourers	100			
	——	600		
		——	2970	
			£3890	

Say £4000.

Now, as the present number of houses is 5900, for an assumed population of 45,000, this gives 7·63 inhabitants per house, (a very high proportion, it being only 5 in England,) therefore 60,000 will require 8,000 houses, being a charge of 10s. per *house*; but if taken on the families assumed to be in the City, at the opening of the works, which may be taken at 10,000, the charge will be 8s. per family, exclusive of amount for interest on capital, and the necessary work inside the house, connected with the supply.

This charge would diminish as the population increased, and to show what it would be for a supply of 120,000, I have made the calculation.

	£	£
Depreciation of engines, &c.	760	
Ditto Mains, (consequent on increase)	222	
	——	982

	£		
Coals, 312 days, at 4 tons = 1248 at £1 10s.	1872		
Stores	468		
Repairs	200		
		2540	
		1800	
Engineers, &c.			4340
			£5322

Say £5,500.

This, on 25,000 families = 4s. 5d. per family.

In comparing these works with others on this continent, it is difficult to find a similar case, the nearest being Chicago; they have to pump from the Lake, through a stand pipe, into artificially raised reservoirs and ranks, with about thirty miles of pipes; at present, the works cost, in a favourable time for price of pipes, &c., £90,000, with engine power for 100,000 inhabitants, only when at full power; my plan gives engine power for 240,000 inhabitants, with 46 miles of pipes, with a difference of £2 per ton in iron, in their favour.

To dilate on the many advantages to the City from having such a constant supply of water as may be procured from these works, is quite unnecessary, but I may mention what a reduction may be effected in the rates of insurance, which ought to be such as to fully repay the cost of working at least, and the comparative safety from fire, and certainty of preventing its spreading, should be sufficient to return to the ratepayers more than the extra rates required of them to pay its cost.

(Signed,) "A Red Cross."

REPORT

NO 2, SIGNED "KE-SEE-NAH ZI-BING."

BY H. Y. HIND, M. A., AND S. FLEMING, C.E.

To the Committee on Water Supply:

Gentlemen,

An unlimited and unrestricted supply of pure water has always been esteemed one of the greatest and most desirable blessings of life. The efforts of enlightened people at all periods of history have been directed towards its attainment and preservation. Some of the most enduring monuments of ancient times, as well as many stupendous modern structures, testify to the zeal with which this pervading blessing has been sought, and its successful acquisition. It is the most pressing necessity of human life, as health is of human happiness. It is always a subject of anxious individual care; yet, too frequently meets with deplorable abuse among populous and prosperous communities. No want of society has been so urgently advocated, so thoroughly investigated, or so wretchedly neglected. With every periodical visitation of an epidemic, its virtues are lauded, and its absence deplored; especially where the indolence or the cupidity of man refuses the small exercise of his energy which would suffice to bring it to the threshold of the poor, as well as of the rich; of the hospital as well as of the palace. Its influence upon morality is as powerful as its influence upon health. Among the masses of mankind, uncleanlinesss is always associated with vice; and where unavoidable uncleanliness exists, demoralization is sure to prevail. There is no more positive indication of human progress—in the simple and rational acceptation of that commonly mis-applied phrase—than a due attention to those inestimable blessings which accompany a copious and unrestricted supply of pure water.

SOURCE OF SUPPLY TO THE CITY OF TORONTO.

In discussing the conditions involved in the supply of water to a large city, the first, and evidently the most important consideration, is, the source of the supply. In very many instances, this preliminary problem embraces practical difficulties which stand in the way of its solution.

Among these may be cited :—1st. An inconvenient distance from a sufficient source, involving great expenditure (and even engineering difficulties) in bringing the supply to the point of its distribution. 2nd. The chemical impurities it may contain; rendering it unfit, unless purified, for the numerous purposes to which it is applied. 3rd. Topographical, or social impediments, which may oppose its efficient distribution.

Happily for the City of Toronto, none of these difficulties can be said to arrest, for one moment, the great work of furnishing its inhabitants, both poor and rich, emigrant and stationary, with an abundant supply of the purest water.

The Corporation of the city, with a wise discrimination, have indicated the great source from which the supply must be taken. Lake Ontario, almost unrivalled for the chemical purity of its waters, is to be the source of supply. No selection could have been more judicious, no limitation more advantageous, for the general interests of the city. The source is unlimited in capacity, the water it offers is of exquisite purity,* and by a careful selection of the point of supply, may be made to maintain its natural qualities until it ministers to the health, enjoyment, and security, of the inhabitants of a great city.

THE PURITY OF THE WATER OF LAKE ONTARIO.

It is impossible to judge by the eye alone of the purity of water. A piece of recently burnt chalk, thrown into water, will give to it a surprising brilliancy and clearness; but, at

* "The water of Lake Ontario is of most extraordinary purity." Professor Croft—see page 154, Canadian Journal, Vol. 1.

the same time, those valuable detergent qualities, which commend it to the Laundress will be destroyed, and its adaption to culinary and manufacturing purposes completely suspended.

Neither is the taste to be trusted, in estimating the purity of water. Persons accustomed to drink hard water, even when it contains as much as 16 grains of earthy impurities to the gallon, cannot comprehend the nature of the distaste exhibited by those who have been habituated to pure water.—Coolness is a very treacherous quality:* it masks the presence of pestilential organic matter and noxious impurities. A little consideration will show how this delightful, though deceitful quality, (when artificially produced) may present itself to the imaginations of the citizens of Toronto. The chief sources of the ice with which their drinking water is cooled in summer are the Bay, and a mill-pond situated some two miles north of the city. The Bay is the receptacle of the sewerage of a city containing 40,000 inhabitants. The mill-pond is not free from putrifying animal remains, nor from multitudes of frogs, aquatic beetles, &c., besides vegetable growth and decay in various stages. †

Soft water recently drawn from a close but clean tank loses its mawkish flavour by merely allowing it to flow through a few feet of air from the rose of a common garden pan.

A perfectly clear and apparently pure water, may, and frequently does, contain *in solution*, pestilential organic matter which breeds dysentery and other dangerous diseases.

During the late cholera in Glasgow, one parish well supplied with pure soft water furnished but few cases.

In other parts of the city, the epidemic was very severe. "The unanimous opinion of the medical society was that their

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* Reports of the London Board of Health, p. 35.

† It is a relief to think, that the thousand impurities of a mill-pond lose all their repulsiveness when presented to us in the form of spring water ice.

comparative immunity was to be attributed to the soft water supply." (Gorbal's Gravitation Works.)*

Absolutely pure water does not, as is well known, exist in a natural state. Pure water in the sense of the application of the term to the fluid we consume so largely, and which is so essential to our existence and happiness, always contains atmospheric air, carbonic acid, and small quantities of earthy particles, perhaps two or three grains in a gallon of 70,000 grains. Such are the celebrated soft water springs of the Surrey Sands, England, although a few of these do not contain carbonic acid.†

The following table will shew the comparative amount of saline and earthy particles held in a state of solution in different waters foreign and Canadian.

		Grains in 1 gal. of 70,000 grains.
London Water Supply.	Thames at Chelsea, London, England,‡	19.7
	River Colne,..................................	21.3
	New River,..................................	19.2
	River Lea,..................................	25.4
	Tring Station..................................	18.8
	Thames Water, London, Canada West,§	10.5
	Lake Ontario,..................................	7.9
	Water supplied by present Toronto Water Works, very variable, sometimes completely clouded and milky, with mechanically suspended impurities; when quite clear it has been found to contain about..................................	11.0

An inspection of the foregoing table serves only to convey an idea of the relative quantities of solid mineral ingredients in a gallon of 70,000 grains, a more minute examination of the chemical properties of those ingredients will throw additional light upon their relation to the purposes of domestic economy to which we apply water.

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* Report of the General Board of Health on the supply of water to the metropolis, p. 55.

† Ibid. ‡ Reports of the Board of Health. § Professor Croft.

The hardness of water is due to the presence of the salts of lime, magnesia and iron. Water may contain common salt, but the presence of that body in small quantities (3 or 4 grains to the gallon) does not materially affect its hardness; neither will the potash and other soda salts usually found in potable waters. Magnesia is not generally to be observed in drinkable waters in any quantity which renders its presence injurious. Lime in the form of the bi-carbonate is in ninety-nine cases out of one hundred, the real cause of the hardness of water. The quantity of the bi-carbonate of lime found in the waters above specified is as follows:—

	Grains in one gallon.
Thames at Chelsea,...............................	16.5
River Colne,............	18.1
New River..	14.7
Tring Station,..........	14.72
River Lea,.......................................	10.2
Lake Ontario, ...	4.6*
Clear water at present supplied to Toronto,...	6.3

The hardness of water is estimated by the number of grains of bi-carbonate of lime which it contains in one gallon. Thus the Thames water is 16 degrees of hardness, each grain of lime representing one degree of hardness; the New River 14 degrees of hardness; the water of Lake Ontario $4\frac{1}{2}$ degrees; the present water supply $6\frac{1}{3}$ degrees of hardness.

Before hard water can be applied to the purposes of the laundress, all the lime it contains must be neutralized. This is done by the destruction of a certain quantity of soap, each grain of lime requiring one quarter of an ounce of soap to neutralize it. This portion of the soap employed becomes not only absolutely valueless for washing purposes, but actually prejudicial by its mere presence. The hardness of water is also detrimental to all culinary operations, and it is of great injury to machinery and most manufacturing processes, such as dyeing, tanning and brewing, and to the wear and tear of linen, &c. It also involves the consumption of an additional

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* This estimate is probably too high.

quantity of fuel, for each degree of hardness in the production of steam and in the elevation of the temperature of water to the boiling point for any purpose whatever.* This question has of late years been so prominently brought before the public in various forms that it does nor appear to be at all necessary to amplify objections here, patent to all, against the use of hard-water. But, where, as in the present case a supply of singularly *pure water* can be reached with the utmost ease, it becomes imperative that we should employ every artifice suggested by experience and reason to preserve that purity until we apply it to our use, and not by negligence in its collection, storage or distribution neutralize those natural qualities which especially commend it to our selection.

THE POINT OF SUPPLY.

Having thus adverted to some of the excellent qualities of Lake Ontario water, and its admirable fitness for domestic and manufacturing purposes, we proceed to consider the situation most suitable for procuring a supply.

This is evidently a very important question, and will forcibly present itself, in its minutest details, to the Corporation and Citizens of Toronto.

It is perfectly clear that no portion of the Lake shore, in the direction of the Humber Bay, offers advantages which would recommend it to selection. The sloping nature of the beach; the argillaceous character of the Lake bottom near the shore; the clay cliff's approaching the water's edge; the readiness with which the water, for some distance Lakewards, becomes exceedingly turbid during storms; its exposure to City impurities, by one wind, and to River Humber impurities, during freshets, by another, are sufficient to outweigh any advantages which position might confer. During a third of the year pure water could not be obtained from that locality, and it is not to be supposed that any large

* See page 74, &c., of the Reports of the London Board of Health for a full discussion of this subject.

expenditure would be incurred for procuring any other but pure water, when that desirable acquisition lies within our reach.

The South Peninsula Beach is manifestly the only spot, where in quiet weather, the pure water of Lake Ontario could be made available for the purposes of the Citizens of Toronto. We say in *quiet weather*, for even there, notwithstanding the vast extent of those washed sand shoals, which form the Lake extension of the Peninsula, during easterly storms a very marked turbidity is distinguishable, far into the Lake. The origin of this turbidity is twofold. First, it arises from easterly storms, which sweep the detritus of the Scarboro' Cliffs over the whole extent of the south Peninsula shoals, and even discolour the water on the westerly shoals. This detritus is of an argillaceous character, and not readily deposited. Second: The violent surges raised by southerly winds, which are capable of agitating the bottom, and stirring up fine sediment, or producing discolouration by the attrition of larger particles, to a depth *exceeding* seventeen feet.

If we examine the topographical conformation of the Peninsula in its subaqueous extension, we shall find, that due south from Toronto it spreads out, Lake-wards, in the form of vast sloping fluctuating shoals, covered only by a varying depth of water, within twenty feet limits, even as far as one thousand yards from the beach. The same shoal formation, although not so extensive, is to be seen at its westerly subaqueous development. At the Lighthouse point, however, the topographical conditions are vastly different; there the shoal descends suddenly and very precipitously into forty feet water, not 200 yards from the beach, while at twice that distance, the water is 120 feet deep. This peculiar conformation will be better understood by an inspection of the Map which accompanies this Report.

The blue lines indicate the position of the shoal at depths of 20, 30, 60, &c. feet water. The relative distances of these depths from the beach may be ascertained by comparison with the scale.

Let us suppose that any point on the great southern shoals were selected for the position of the supply pipe, as, for example, a little to the east of the Peninsula Hotel. The question which immediately suggests itself, relates to the distance the mouth of the supply pipe would require to be introduced into the Lake in order to lie beyond the fluctuating shoals, which would inevitably cover it with sand, if it were to be placed within the range of their ever changing positions or of their *annual growth* by accessions of material from the Scarboro' Cliffs.*

It has been ascertained, beyond a doubt, that the waves of the Lake affect the bottom to a depth exceeding fifteen feet. This information has been obtained by watching the progress of shoals at different depths after storms, and after the lapse of certain periods of time. It is the result of personal observation on the shores of the Peninsula, and affords in itself a striking illustration of the instability of portions of that remarkable formation. The existence of these fluctuations has long been known to fishermen, and might easily have been predicated by a study of the relations under which they exist. But they acquire a new interest and a special importance, when their bearing upon the water supply of the City of Toronto becomes a question under consideration. In order to carry the mouth of the supply pipe beyond the influence of these shoals, it must be conveyed into water at least 22 or 23 feet deep, which depth, by inspection of the chart, will be seen to be attained at a variable distance of from 800 to 1200 yards from the beach, east of the Light-house point.

The plan is certainly practicable, but highly objectionable, on account of the large expenditure it would involve, not only for the length of pipe required, but also for the necessary precautions essential to shelter its mouth from the probable introduction of those mechanical impurities which abound on

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* See Premium Reports on the preservation of Toronto Harbour, for its history and mode of formation, 1st & 2nd.

the shoals during storms. It may be urged that a well of convenient dimensions might be fenced in a few yards from the Peninsula beach. A well constructed for the purpose would require to be in full communication with the water of the Lake, so that a continuous supply might be preserved within it to satisfy unusual demands.

The supply within the well must necessarily be furnished from the Lake *by filtration*, for if not, the mechanical impurities deriving their origin from the Scarboro' Cliffs, as well as those occasioned by attrition during gales, would have free access, and at once take from the Lake water its most important recommendation. The subsidation of foreign particles could not take place in a well open to the Lake, with the necessary rapidity, for it must be remembered that those foreign particles, derived from the Scarboro' Cliffs, which render the water turbid, are argillaceous, and it is well known that days are required for their deposition.

One remarkable property of pure water is its power of holding in mechanical suspension finely divided argillaceous matter. If we shake a small quantity of clay in a bottle containing pure water, many days will elapse before its clearness is restored. The introduction of a piece of alum for a few moments would cause the deposition to take place in a few minutes. The Chinese, from time immemorial, have adopted this expedient for the purpose of clearing the waters of their turbid rivers, before using them for domestic purposes. It is manifest that no such ingenious artifice could be employed in clearing water from clayey particles for the supply of the City of Toronto. Ordinary rapid filtration through coarse sand will not arrest this species of impurity, and no other method of filtration would enable a sufficient supply of water to percolate into the well, without it were made to expose a very considerable extent of surface. A well would require to be quite closed against the light, otherwise organic forms would rapidly establish themselves in its comparatively quiescent waters. It would have to be protected from the effects of ice, which, if the well were situated on the beach, would materially and dangerously arrest filtration during the winter months. If, to avoid the influence of the frost, it were constructed in water six or eight feet deep, it would serve the mechanical effect of a groyne, and soon arrest the travelling beaches which constitute the formative process by which the Peninsula grows under our daily observation.* It would also be liable to all the destructive effects of masses of ice which, during some winters, accumulate in great magnitude on the southern shoals of the Peninsula. A subsidation reservoir, constructed within the limits of the City of Toronto, on the main land, would require to be of vast dimensions in order to provide against the prolonged effects of easterly storms during the spring of the year, the water on the shoals being frequently turbid for weeks, at that season.

It is manifest that the arguments adduced against the establishment of the mouth of the supply pipe on the southern fluctuating shoals, apply with equal force to the westerly shoals, a position open to the additional objection of the passage of impurities from Toronto Bay, during the prevalence of certain winds, as well as to the obstruction which the works protecting its mouth and its rearward extension from the anchors of small craft would cause to navigation.

Driven by these facts and arguments from the selection of any part of the fluctuating shoals east of the Lighthouse point, or from any part of the westerly shoals north of the same locality, we proceed to consider the adaptation of the only remaining spot on the peninsula beach to the purposes we have in view, the Lighthouse point itself.

Fortunately for the full success of the water supply of the city of Toronto, as we believe, the point in question presents not only conditions which secure to it immunity from many impurities or dangers, but also positive advantages in connection with the coolness and constancy of the supply which may be obtained from it, precisely those conditions which are so

* See Premium Reports on the Harbour, for the discussion of the formative process, by which the Peninsula increases, 1st & 2nd.

instinctively sought after by man in his eager pursuit of this bountiful necessary of life.

A supply pipe opening into water of a depth of forty feet would have its mouth situated about two hundred yards from the present Lighthouse beach. When duly protected by simple contrivances, the entrance of foreign particles would be almost impracticable. It is however to be observed, that an honest and scrupulous examination of the conditions under which it would act reveals one objection common to any and every point of the peninsula beach or of the main coast. This objection, insignificant indeed, when compared with those which weigh against other localities, will be at once understood if we examine the laws which affect the distribution of turbid water in its passage into and through masses of pure water.

It has already been observed, that during prolonged easterly storms, the water over the south peninsula shoals becomes very turbid from the argillaceous particles which are washed out of the cliff detritus of the Scarboro heights, and impelled in a westerly direction by the force of the winds, a portion of this foreign matter is deposited upon the shoals, to be again and again disturbed by southerly winds until it reaches a depth of water where the waves have no effect upon the bottom. What becomes of this turbid water as it passes over the profound depths at the Lighthouse point?

At certain seasons of the year it *sinks*, at other seasons it *floats*. Temperature and specific gravity determine whether it shall sink or whether it shall float. As soon as a volume of turbid water coming from the east reaches the precipitous descent at the Lighthouse point, it immediately sinks in cloud masses, if its specific gravity be greater than that of the deeper water. It sinks, however, beyond the *influence* of wind and wave and slowly distributes itself down the steep hill side of the lake bottom at the Lighthouse point. It passes over this gulph on to the westerly shoals and towards the Humber Bay, if its specific gravity be less or equal to that of the deep water.

As a general rule during the summer and winter months, the turbid water, if not too highly charged with foreign impurities, will float over the deep water. During the spring and autumn months it will sink and be conveyed away into the profound depths of the lake.

Here we recognize one of those beautiful laws of nature which in their constant operation are levelling every hill and filling up every valley, and always seeking out the lowest depths into which to deposit the spoils of abrasion and disintegration.

For the reasons before mentioned, much of the sewerage of Toronto steals along the bottom of the bay, finds its way out of the mouth of the harbour and spreads itself uniformly between the westerly peninsula shoals and the Humber Bay. Soon after its passage out of the harbour it reaches water 20 and 25 feet deep, thence on to 90 feet opposite to the garrison common, where it is probably, with some of the detritus of the Don slowly accumulating.*

It will be well to submit a simple plan for the preservation of the purity of the water from the Lighthouse point at all seasons of the year. This will be considered when we come to speak of the termination of the supply pipe in a tank or reservoir on the Bay shore.

The temperature of water taken from a depth of 40 feet would be nearly uniform throughout a great portion of the year, and would generally be found to be about 40°. This would be a consequence of that property of water which enables it to acquire its greatest density at about 39.6 degrees. The change in temperature occasioned by its passage through the mains and service pipes would be of small amount. The mouth of the supply pipe being securely placed in about 40 feet water at the Lighthouse point, its continuation to the north shore of the Bay near the Queen's wharf is the next subject which invites discussion.

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* Note in Appendix.

It is proposed to carry the supply pipe along the western boundary of the peninsula, three feet below the surface of the lowest lake level, so that it may remain permanently under water, thus securing it against the action of frost, although that contingency is remote in the extreme. Leaving the peninsula the pipe would traverse the shoal along its extension towards the Queen's wharf until it reached the boundary of the shoal, or any artificial boundary formed by the possible construction of a groyne by the harbour commissioners for the purpose of preserving the entrance to the harbour. It would then be made to descend and traverse the mouth of the harbour in an excavated trench at least six inches below the present or future (in case the mouth of the harbour should be deepened) depth of water existing at the entrance.

Leaving the bay the supply pipe would be continued to a suitable engine house situated somewhere in the neighbourhood of the northern railroad engine house on the immediate shores of the bay, and terminate in a well sunk 30 feet below the lowest level of Lake Ontario, and into this well the pure lake water would rise according to the simple natural law which induces water always to seek its own level.

A section on the line of proposed supply pipe accompanies this report, shewing the nature of the bed of the lake from the Lighthouse point to the pumps.

GENERAL DESCRIPTION OF THE PLAN.

The remarkable increase which has occurred during the last few years in the wealth and population of the city of Toronto; the astonishing expansion of its commercial and industrial system, the certainty (humanly speaking) of the stability of its present relations and the probability of its future progress being commensurate with its past, furnish grave subjects for contemplation in devising a plan which shall answer the requirements of a progressive and expanding community. Perhaps there is no single subject of social interest which so strikingly presents itself to each individual member of society as the importance, or rather the necessity of an abundant water supply. Yet, anomalous as it may appear, there is no subject which has generally met with such corporate inflexibility as the one we are now discussing, except it be sanitory reform in its broadest and most generous acceptation.

It is with some degree of pride that we can discern no trace of that selfish and unchristian apathy in our own fellow-citizens, which has so long fatally misled those of many older and far more populous cities. We are satisfied that it requires but the recognition of a great principle, to insure its practical application, if called for, and within our reach.

In submitting a scheme for so grand an object as the one which now arrests public attention, we should feel it a disheartening acknowledgment of the future prospects of this city, were we not at liberty to offer a plan which might grow with its growth and expand with its wants, meting out to those who will be among us ten years hence the same measure of comfort and security, which we hope soon to witness and possess, whether it be foreshadowed by our own humble efforts, or by those of more worthy contributors. We start with the conviction, that whatever scheme of water supply for the city of Toronto be adopted, it must satisfy the full demand that may be made upon it during the next ten years. It must be capable of great extension at all times, and fully susceptible of those decennial or quinquennial additions which the increasing population of the city may require. We are prepared to acknowledge and to advocate the claims which sanitory measures present, and to keep in view all those great social advantages which security from destructive conflagrations confer.

It is not in any accordance with the generous spirit of the times to limit a great social project to present demands and ignore the claims which, half a generation hence, may be made against us. We endeavour, therefore, to invest our projects with the true and just importance which is their due, for we are persuaded we have to deal, ineffectually perhaps, but still we hope not unworthily, with a great social want, and in order to overcome it, we must meet it face to face.

Since it will be necessary to elevate the water supplied to the city to a height equal to the tops of the highest buildings, the only means at command commensurate with the undertaking are evidently those of *pumping*, and as the locality affords no natural power at all suited for the purpose we are compelled to have recourse to *steam*. Nor is there any cause for regret that the natural advantages of the neighbourhood do not furnish us available water-power for the object in view. By the judicious application of steam power all probable contingencies may be provided for, and a perfectly safe method of elevating the constant and large quantities of water required for daily consumption secured without difficulty.

RESERVOIRS.

The ground on which the city of Toronto is built, possesses no peculiar advantages for the location of reservoirs, in the midst or in the immediate neighbourhood of the most thickly occupied portions.

The land rises gradually from the bay shore northward, and nowhere assumes an elevation great enough to afford the necessary "head" until we reach an altitude of 130 feet, about $1\frac{1}{2}$ miles from the bay.*

Being fully persuaded of the necessity of establishing proper receptacles for the storage of surplus water, with a view to afford an immediate and powerful flow on the breaking out of fires, it is proposed to construct the necessary reservoirs on or near the north city limits at an elevation of 140 feet above the lake.

These reservoirs as shewn on the plan are seven in number and form the fountain head of the supply to each of the seven water districts into which it is proposed to divide the city. They are designed to be covered in, the inner walls of sandstone, the floor paved with Malone flagging. They need not be of large dimensions, as their chief purpose is to afford an

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* See note B in appendix.

immediate overflow of water on the first outbreak of a fire, the engine power feeding them being supposed to be capable of affording an ample supply for this as well as for ordinary purposes; liable, however, to possible contingencies neutralizing its efficacy for a time but provided against by the supply contained in the reservoirs. The dimensions of each reservoir are proposed to be the same, 60 feet square and 12 feet deep, which will enable each to contain 250,000 imperial gallons. This quantity of water would enable the seven reservoirs when unaided by pumping, to give a constant supply to ten of our most powerful fire engines in constant operation for 30 consecutive hours. Each reservoir would be able to supply 5 of the most powerful fire engines for a period exceeding eight hours. Although established chiefly as a provision against fire, they would be of the utmost service when repairs or additions were going on in any of the proposed water districts.

ENGINES, PUMPS AND STAND PIPES.

It is proposed to employ three vertical condensing beam engines with reciprocating pumps attached, any two of which shall be equal to the maximum duty required. The boilers of each engine to be in duplicate, and everything connected with the machinery to be of the most perfect description and construction. The precise locality of the engine house is not of much consequence, although it is desirable to have the pumps as near as practicable to the reservoirs and ultimate destination of the water. Yet, as the selection of this point depends upon the facility in obtaining land for its erection, the vacant space at the foot of Brock Street is recommended conditionally. The engines are to pump from a water tight well sunk 30 feet below the surface of the lake, and into which the supply pipe from the lighthouse point will discharge lake water by simple hydraulic action.

To counteract the violent shocks which the piping of the city would sustain by the action of the pumps, it is proposed to erect a tower for stand pipes, in addition to proper air vessels situated in the engine house. The situation of the tower to be at the intersection of Queen Street with Spadina Avenue. It will be of important service on the breaking out of fires as hereafter explained, and the stand pipes will have the effect of equalizing the pressure on the mains.* A small tank is to be placed on the summit of the tower into which the stand pipes discharge and from which the "rising" and "auxiliary" mains radiate.

THE MAINS.

The arrangement of the leading mains is a most important consideration, for unless this be done with proper care, many points, even with a good head and amply supplied for ordinary domestic consumption, will be found deficient in supply, on a sudden demand for a great flow of water in their immediate neighbourhood.

The friction occasioned by the flow of water through distributing pipes of ordinary dimensions and subject to a number of deflections in their course increases very rapidly with their length, so that after a certain distance, the entire pressure is consumed in overcoming friction.† This is almost invariably the case when water is distributed over large areas from a distant source through a single set of mains, unless pipes of unusually large bore be employed. To guard against this most fruitful evil and to insure an abundant supply of water with good head at all points in cases of emergency is a distinguishing feature of the present plan.

WATER DISTRICTS.

It is a condition of the utmost importance that the mains and distributing pipes throughout every portion of the city should be so arranged that when repairs are required in any one locality the supply should not be cut off from the other

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* Note C Appendix. † See note Appendix B.

portions of the city, or that the construction of additions to the works should not interfere in the least degree with those portions already in active operation. With this view and for other minor reasons, it is proposed as before remarked, to divide the city into districts. These districts, seven in number, will embrace the whole area within the city limits. It is only proposed, however, to recommend at present the construction of works to supply four of these districts, which is assumed to be sufficient for the next ten years.

District No. 1 is bounded on the west by the west city limit; on the south by Lake Ontario; on the east by a line dividing the farm of Col. Furlong into two equal portions, longitudinally, and terminating southward in Lake Ontario, where it intersects the south boundary; north by the north city limits. It is supplied by a reservoir situated in a line with all the other reservoirs as shewn on the map, and due north of Queen Street opposite the Lunatic Asylum. This district being for the greater part still farm land or common will probably require no further notice in connection with a system of water supply for many years to come, except in so far as the present wants of the Lunatic Asylum may be supplied by the auxiliary main 12 inches in diameter, which intersects all the districts in its course through Queen Street.

District No. 2; boundaries—north, north city limit; west, eastern boundary of first district; south, Lake Ontario and Toronto Bay as far as engine house at foot of Brock Street; east, Brock Street as far north as Adelaide Street, then west as far as the West Market square, then north as far as Richmond Street, then west as far as Portland Street, and then north as far as north city limits. The reason why the east boundary of the second district takes the indirect course described (and better seen on the map) is to avoid as far as possible interfering with the action of the pumping mains, so that these important links in the chain of works may not be liable to those contingencies to which the auxiliary and rising mains are occasionally exposed.

District No. 2 is supplied by a reservoir situated along the extension of Tecumseth Street and in a line with all the others as shewn on the map. As the area within this district is still largely occupied by farm land it is not proposed to extend the water supply to it further than that which is embraced by the auxiliary main on Queen Street.

District No. 3; boundaries—north, north city limit; west, east boundary of second district; south, Adelaide Street from market square to Peter Street, Richmond Street as shewn on the map; east, a little west of Beverly Street in its continuation to the north city limits.

This district is evidently one of the most important of the whole as in it the most expensive works would have to be constructed, such as the pumping mains, the hydraulic tower and the engine house. It is supplied by a reservoir situated on the continuation of Spadina Avenue northward, and in a line with the other reservoirs. Into this reservoir the supply of all the reservoirs would be introduced by means of the main leading from the tower at the intersection of Queen and Brock Streets.

District No. 4; boundaries—north, north city limit; west, eastern boundary of third district, south, bay shore as far as Jacques & Hay's factory; east, a line due north from the factory to north city limit, supplied by a reservoir north of William Street.

District No 5; boundaries—north, north city limit; west, east boundary of fourth district; south, bay shore as far as Maitland's wharf; east, from Maitland's wharf to north city limit. This district is the most populous and thickly inhabited of any. It would be supplied by a reservoir north of Yonge Street, at Yorkville.

District No. 6; boundaries—north, north city limits; west, eastern boundary of district No. 5; south, bay shore as far as Small's wharf; east, Small's wharf to north city limits.

The lower portion of this district is thickly inhabited, and it would be one of those to which it is recommended to apply the supply at the present time. It would be fed by a reservoir situated north of George Street in a line with the other reservoirs west.

District No. 7; boundaries—north, north city limits; west, the eastern limit of the sixth district; south, the bay shore; east, the Don. It is not proposed to extend the works to this district at present. It would be supplied by a reservoir situated a little to the south of the other reservoirs near the north western corner of the Cemetery, and north of Parliament Street, the main passing down Pine Street.

The general distribution of the mains, is as follows:—First, two pumping mains from engine house to the tower; here the water will attain an elevation of 100 feet above Queen Street and may be distributed by simple pressure without any further aid to the following points.

(A) Directly to the reservoir No. 3 (the number of the reservoirs corresponding to the number of the district) and from reservoir No. 3 to all the other reservoirs constructed, whence it may be delivered throughout their respective districts.

(B) The communication between the tower and reservoir No. 3 being supposed to be arrested by a burst,* or by the necessity for additions or repairs, the water may be made to traverse the auxiliary mains on Queen Street to district main connected with reservoir No. 4 by opening the necessary valves provided for the purpose and shewn in the map, and from reservoir No. 4 reach all the other reservoirs, or through the district main connected with reservoir No. 5 or 6 according to circumstances.

(C) Let it be supposed that it became necessary to isolate any particular portion of the city for the purpose of repairs or otherwise, say a portion on Yonge Street in the neighbourhood of Richmond Street; this can easily be effected by shutting the valve on district main No. 5 north of Queen Street, and the other north of King Street, by opening the valve on the connecting main along King street between dis-

* See note in Appendix C.

tricts No. 4 and 5, the lower part of district No. 5 would be supplied by the King Street connecting main while the upper part of this district would be supplied directly from its reservoir; if at the same time it should be found necesssary to isolate a portion of the same district at any other point (say Gerard Street) this can similarly be effected, while the intervening portion between Queen and Gerard Streets can be supplied by the connecting main laid along Agnes Street. In like manner the supply to any section or any number of sections, in any particular district or any number of districts, can be at any time suspended without interfering in the slightest degree with the general service of the whole city.

The advantages of this system cannot be overrated; should a fire break out in that part of a district where the works were undergoing repair or receiving additions (and this would be taking a case of the worst possible kind,) water can always be found in abundance in all the adjacent sections until the pressure be let on in the section in question.

UPPER SERVICE WORKS.

By reason of the level nature of the country on which Toronto is built there will be a strip of land averaging 1600 feet in width, along the northern boundary of the city requiring a higher service than that afforded by the level of the proposed reservoirs, although that level gives ample "head" for the greater portion of, indeed we may say for all the space (except the neighbourhood of Yorkville) now occupied by buildings. Yet as the limits of the city expand northward it will become necessary to make provision for an increase of "head" for this upper district. It is proposed to effect this object simply by the erection of wrought iron reservoirs on stone walls immediately over and fifty feet above the others, these upper reservoirs to be supplied from the lower by a sufficient auxiliary engine power situated at Yorkville.

Although the demands of the village of Yorkville may warrant the early construction of one upper level reservoir, it will doubtless be many years before an extension of the whole upper service system is fully required.

DUTY OF THE ENGINES.

It will be observed that the plan described embraces the whole area of the city and provides water supply for hundreds of acres as yet farm land, but which in a few years may gradually become occupied by buildings. The duty of the engines depends of course on the quantity of water to be raised which again is governed by the consumption or the number of inhabitants. Toronto now possesses a population of about 40,000; when the scale of works here contemplated shall be fully required, she may have 100,000. The usual provision for public as well as private consumption as already stated, is 30 gallons per head, per diem; and at this rate the daily supply when the population increases to 100,000 will be 3,000,000 gallons. 3,000,000 imperial gallons raised 140 feet, the height of the reservoir, in 24 hours, is equivalent to 2,916,620 lbs. raised one foot high per minute.

Weight of water to be raised one foot high per minute	* 2,916,620 lbs.
Friction of 3,000,000 gallons passing through mains and supply pipe from Lighthouse point calculated at	1,150,000 "
Friction of pumps and machinery	580,000 "
Total	4,646,620 "

These several amounts give a total duty of the engines at 4,646,620 lbs, to be raised 1 foot high per minute, which is equal to 140 8-10ths horse power.

That a liberal provision of steam power may be made to overcome the labour daily required of it and making allowances for all inferior contingent requirements we will assume

* Note B, Appendix.

that engine power of 150 horses is necessary barely to perform the work. To make further provision for repairs and examination of machinery, spare engine power should be had in reserve equal to two-thirds the daily working, which addition would give a total of 250 horse power.

This force is proposed to be divided equally among five condensing engines of 50 horse power each, three of which to be constantly at work, the remaining two ready for any emergency.

A smaller number of engines of greater power would be more efficacious and more easily maintained, but as only a portion of the works comtemplated will require to be constructed now, and as spare engine power is desirable from the first the above arrangement is considered the most economical and the best. It is proposed to establish two 50 horse power engines for the present wants of the city, (hereafter referred to) and as the population increases to add one 50 horse engine for every additional 20,000 inhabitants.

ESTIMATED COST OF THE WHOLE WORKS

As shewn (with the exception of the smaller distribution mains)* on plan No. 1.

Owing to the great fluctuation in the value of iron and the price of labour, it would be very difficult if not impossible, to give an accurate estimate of the cost of work, the entire completion of which (being contingent on the advance in population of a city from 40,000 to 100,000 inhabitants) extending over a period of perhaps thirty years or half a century, and in addition to this five-sixths of the area embraced by the scheme being as yet unoccupied by streets and buildings. By making proper allowances in an approximate estimate for an ordinary high rate of labor and material we are enabled to give the following:—

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* The distribution mains though included in the estimate are not shewn on the plan, in consequence of the streets they would occupy not being laid down as yet.

SUMMARY OF COST.

Double supply pipe	£32,000
Engines, buildings, pumps and wells	16,000
Double pumping mains	9,150
Tower and stand pipes	2,000
Upper main connecting reservoirs	10,500
Rising main	7,300
Seven covered reservoirs	13,000
Six district mains	29,000
Auxiliary mains, East and West	10,500
Connecting mains	14,700
Distribution	58,000
Contingencies, engineering and management	20,200
	£222,350

PRESENT REQUIREMENTS OF THE CITY.

(*See Plan No. 2.*)

The portion of the works at present recommended embraces districts No. 3, 4, 5 and 6; it will be observed that these districts comprehend a large area which is not as yet occupied, and although it is manifest that the minor distribution mains will not be at present necessary, the estimate attached nevertheless includes distribution for the whole area amounting to about 1500 acres, since a very large portion of it may be filled up with villas during the next ten years.

The general system itself being a distributory system involves the laying down of leading mains from which laterals could at any time be made to radiate as required. The actual area occupied by houses which would become immediately benefited service does not greatly exceed one third of the whole area, a considerable reduction in the estimate may therefore be made when the present service alone is taken into consideration. It may, however, be remarked that the extent of the city covered by these four districts is capable of containing a population nearly three times greater than its present inhabitants and then the buildings would not be more thickly scattered than on that portion south of Agnes and Gerard Streets. Such being the case it is plain that if the increase of buildings were limited to the area referred to, the following estimate of cost (with trifling additions) would suffice for a population more than double that of the city at present.

QUANTITY OF WATER.

The average quantity supplied by the present water works does not exceed 230,000 gallons per day. The quantity of water required for all kinds of consumption, computed at the usual allowance of 30 gallons per head for 40,000 inhabitants, gives a total of 1,200,000 gallons as a full supply for 24 hours, being an increase of nearly one million gallons per day on the present water works supply.

1,200,000 gallons raised 140 feet per day, being equal to 1,166,667 lbs., raised 1 foot high per minute; add 518,000 lbs. for friction of supply pipe, mains, &c.; add 233,333 lbs. for friction of pumps, machinery, &c., giving a total duty of 1,918,000 lbs., to be raised one foot per minute, equivalent to 58 12-100 horse power, for which service engine power of 100 horse is to be provided.

SUMMARY OF THE COST OF WORKS PROPOSED FOR PRESENT CONSTRUCTION,

As shown on plan No. 2:

Single supply pipe....................................	£16,000
Engines, pumps, pump well and building..........	10,000
Double pumping mains................................	6,100
Tower and stand pipes................................	1,850
Upper level main, connecting reservoirs...........	4,200
Rising main..	7,300
4 Covered Reservoirs..................................	7,400
Forward.................................	£52,850

Brought forward	£52,850
4 District mains..	19,300
Auxiliary main	5,500
Connecting mains......................................	6,160
Minor distribution mains..............................	17,500
Contingencies, engineering, management, &c. ...	10,100
	£111,410

In the plan of the works covered by the above estimate, ample allowances have been made for a rapid increase of population; and it is believed sufficient provision has been made for the next ten or twelve years.

ESTIMATE OF ANNUAL EXPENDITURE

To supply 3,000,000 gallons of water to 100,000 inhabitants, as per plan No. 1:

	Per Day.	Per Annum.
Pumping (150 horse power for 24 hours, at 4 lbs. of coal per hour,* 6-42 tons per day, at say 24s.)..	£7 14 0	
Wages, Oil, &c. &c....................	1 16 0	
		£3,467 10 0
Management and contingencies..................		1,800 0 0
Interest on £222,350, cost of works, at 6 per cent. per annum................................		13,341 0 0
Total expenditure......................		£18,608 10 0

Which sum, £18,608 10s. distributed over 100,000 inhabitants may be raised by a tax of three shillings and nine pence per head per annum.

ESTIMATE OF ANNUAL EXPENDITURE

To supply 1,200,000 gallons of water to 40,000 inhabitants, as per portion of plan No. 1, shown by drawing No. 2.

* See Appendix, Note D.

	Per Day.			Per Annum.		
Pumping* 58 12-100 horse power for 24 hours, at 4 lbs. of coal per hour, equals 2-04 tons a day, at 24s. per ton	£2	9	0			
Wages, oil, tallow, &c.	1	2	6			
	£3	11	6	£1,304	17	6
Management and contingencies				1,200	0	0
Interest on £111,410, (cost of portion of works), at 6 per cent				6,684	12	6
Total expenditure				£9,189	10	0

Which sum, £9,189 10s., distributed over 40,000 inhabitants, may be raised by a tax equivalent to four shillings and seven pence per head per annum, for the provision of a constant supply of water for daily uses of every description, and ready at any moment for the bursting out of conflagrations.

It may be remarked, that the extent of ground covered by these supplies is capable of accommodating with the greatest ease three times the number of inhabitants over whom the annual expenditure is (as above) distributed. It will thus be seen, that when the several districts become more thickly occupied than now, the cost per head will be proportionably reduced.

We now proceed to consider more in detail such portion of the works as require special notice.

RESERVOIRS.

It would manifestly be an unwise and almost irrational undertaking to provide means for obtaining a supply of water of extraordinary purity, without adopting judicious precautions to maintain that purity until it reaches the lips of the consumer.

It is, however, a singular fact, that in numerous instances we find the grossest ignorance respecting the precautionary

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* See Appendix, Note D.

measures which are required to secure that desideratum. The reports of the London Board of Health furnish us with abundant examples of extraordinary care in the administrative measures adopted to avoid contamination, in ancient and modern times. They also abound with existing illustrations of shameful neglect in the same important branch of a system of water supply.

The construction of reservoirs demands the most exact and scrupulous attention, for it is in those depositories that obnoxious contaminations may occur. We must provide against the possible entrance of impurities from without as well as the generation or absorption of impurities within. It would be very absurd to convey water containing free carbonic acid into a reservoir constructed of limestone, or even exposing considerable surfaces in the form of certain lime cements. Carbonate of lime is insoluble, but water, containing carbonic acid, converts the carbonate of lime into the bi-carbonate, and at once dissolves it. A curious application of the principle involved in this chemical fact is seen in the method employed with success in some parts of England on a large scale. The water deriving its hardness from the presence of bi-carbonate of lime is rendered soft by adding lime water.

The lime contained in the lime water seizes upon the second dose of carbonic acid combined with the particles of bi-carbonate dissolved in the water and both are converted into chalk which is insoluble, and consequently deposits itself at the bottom of the containing water.

The walls of a reservoir should be composed of materials which are not soluble in comparatively pure water, and it may be here remarked, that in relation to a vast number of bodies the solvent power of water increases with its purity. If the walls of a reservoir were constructed of sandstone, there would be little danger of contamination from that source. The floor of the reservoir should be paved, as already recommended, with Malone flagging, or covered with pure white sand. The sand of the peninsula would not be suitable, since it contains in abundance the black magnetic oxide of iron.

The ordinary building sand used in this city generally embodies from 3 to 6 per cent of this oxide. Large quantities of sand may be procured which contains 50 per cent. of this ingredient. It is derived from the drift clay, hence the reason why the wells of this city and elsewhere in Canada West frequently contain marked quantities of iron which increases the hardness of their waters, and tinges linen yellow, when washed in them.

Filtration, so commonly employed in localities where the source of supply is either impure or liable to be contaminated by foreign substances, is not necessary in the present case, where water of the greatest purity can be obtained, as at the Lighthouse point. Where at a depth of 40 or 50 feet it is never rendered turbid by rains or floods, rarely contaminated by shaken up sediment or fine argillaceous particles, never exposed as in the bay to organic impurities, always cool and maintaining a nearly uniform coolness throughout the year; with such conditions, filtration would become a useless and very doubtful method of purifaction.

On page seven* of this report, allusion is made to the possible and even probable occasional turbidity of the Lighthouse point water. This turbidity would only occur to a disagreeable extent during the continuance of easterly storms, and it is highly probable that no consumer would be able to distinguish it, even if he were carefully to examine a glass full after it had passed through the reservoirs, except at periods of fire, when the demand might induce so rapid a change in the contents of the reservoir as to prevent the necessarily slow deposition to take place. This contingency is, however, too remote to serve as an inducement for the construction of deposition reservoirs, and ordinary filtration would not arrest the mechanical impurities referred too.

The reservoirs must be covered and secluded from the light. Under the life arousing influence of that wonderful agent,

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* See page 29.

myriads of vegetable and animal forms, invisible at first to the unassisted eye, but soon to be followed by more tangible and objectionable creatures would spring into existence; organic matter as long as it retains the vital principle is comparatively unobjectionable, but when death has occurred and decay or putrescence is established, poisonous substances rapidly accumulate. But few infusoria increase and multiply in water secluded from the light. This topic is one of extreme importance in our climate. The great heat of the summer months invests vitality with a wonderful force, and organisms spring into existence, die and decay with marvellous rapidity. An inspection of the open reservoir constructed only three years ago for the supply of the city of Toronto will afford a forcible but rather revolting idea of this vital vigor. Frogs by myriads, in all their stages of existence; aquatic beetles from the egg and larvæ to the full grown insect; marsh and water-plants, with countless millions of microscopic animalculæ sporting through the maze of their green and rotting leaves in unmolested security. Most probably the spawn and seeds of the diversified world of life which thrives so generously in the reservoir of the city of Toronto were pumped into their present congenial abode from the bay, a nauseous comment upon the purity of the water which has been doled out to the Queen City of the West for years past. We do not think that the upper open reservoir has been in use for some time; perhaps the occasional changing of the water would have diminished the animal life, although it might have added to the luxuriance of its vegetable denizens. It is not necessary to inquire how the animal world would have dwindled, it is quite sufficient to have a clue to the probable mode of its exit by observing occasionally the passage of a leech from the tap.

It may be here remarked that animalculæ can be seen by the unassisted eye when the water from the tap is examined with care in a clean glass vessel. (26th June, 1854.)

This water we understand was pumped directly from the bay into the reservoir near Queen Street without filtration.

With a view to arrest some of those too tangible impurities which cannot fail to become diffused throughout the receptacle of the sewers of a city containing 40,000 inhabitants; filtration was attempted some time since, the effort failed, however, and the objectionable alternative was permitted, of taking the supply directly from the bay in five feet water. This occurs during the month of June 1854, with cholera in the Atlantic cities and at Grosse Isle. On 26th June several bottles of water were drawn from a tap in a house on Peter Street, and examined as to temperature &c.

The result was as follows:—

Temperature	of water from tap	65.0
"	of air in house	75.0
"	of rain in water tank in rear of house	47.5
"	of water from a well in the yard 30ft. deep	47.5

The tap water was "teeming with life", the unassisted eye could detect numerous animalculæ swimming about in the clear and comparatively soft "supply". It may not be generally known that a certain general law exists in nature in relation to the developement of these minute creatures, as deeply instructive as it is imposing in its grandeur even though it deals with the minutest of forms. With the fame of the illustrious Ehrenberg must our knowledge of this great fact be ever associated, that where animal life in water is visible to the naked eye, there is always a chain of animal life beneath it down to invisible existence.*

These are the scavengers of the earth, but their existence implies light, suitable temperature and food; wherever their presence is required they will appear, and though indicative of pollution, they are the forerunners of purity. Our conceptions of the infinity of microscopic life become more vivid and defined when by holding a glass of bay or reservoir water taken at hazard between the eye and the light we can discover without extraneous aid an infusorial form, and then pause to

* Report on the water supply to the metropolis. (See page 39).

contemplate with a mental eye the unnumbered thousands which must exist within the sphere of that minute creature's action, in order that we may faintly embrace the law which governs its existence.

Light may be said to be life to vegetables as well as to many species of the lower orders of animals. Absence of light will prevent the germination of spores, it will also arrest the incipient growth of spawn. In the presence of day-light with its accompanying blessing heat, the decay of organic structure is very rapid; vegetation modifies the dangerous effects which would result from the daily consumption of water containing putrescent animal or vegetable matter. Living organisms consume the changing materials of dead ones, but living organisms capable of such consumption can only be maintained in the presence of light. It might be urged that a closed reservoir would not be able to purify its own water from minute microscopical forms, from animalculæ which thrive even in darkness. These, however, are so few in number that no objection on that score could be valid. Besides all this there is one great fact connected with the water supply proposed, and its temporary accumulation and preservation in covered reservoirs, which in our humble opinion completely obviates all difficulty, and in fact, sets the question at rest; we prefer to adopt the language of a distinguished reviewer who has ably discussed the question of the water supply of London, England.

At 32° Fahrenheit water takes up scarcely a trace of organic matter, at 40° (which represents the general temperature of the Lighthouse point water at 40 feet deep during a large portion of the year) it begins to take up in 10 or 12 hours a grain or two per gallon, which, however, at this temperature has no deleterious property. An aqueous solution of organic matter so long as its own fermentation is stopped or impeded by a certain degree of cold, is as incapable of exciting fever or diarrhœa as a sound apple or an untainted steak. As the temperature rises toward 60° the solvent power of the water increases, while at the same time a quick rate of fermentation becomes possible, and with every advance of the thermometer towards the highest summer temperature both processes receive a fresh impulse. It is stated on good authority that during the late pestilence the mortality showed a tendency to increase whenever the temperature of the Thames rose above 60° Fahrenheit." [*Mem.*—temperature of water from tap in Peter Street 65 degrees.]

Assuming that the lake water taken from the Lighthouse point contained organic matter, which it really does not in any appreciable quantity, by covering the reservoir two great points would be attained. First, the temperature of the water would remain below that degree which enables it to dissolve an important amount of organic matter, and at the same time, would arrest the fermentation which renders the accidental presence of organic matter dangerous. Second, the introduction of organic matter from without in the forms observed in the new reservoir on Yonge Street, or in forms infinitely less objectionable than "spawn, weeds and filth," would be altogether impracticable.

The current produced in an open reservoir by the consumption of one half its daily means of supply, would not be able during the summer months to arrest animal or vegetable growth, and no sensible man would like to trust his property or his domestic comfort to the dangerous chances which would envelope so small a provision for all contingencies. It is probable that fermentable organic matter is one of the most dangerous impregnations to which water is subject, and a fatal error would be committed if every means were not advocated and recommended to remove to the utmost the possibility of danger from this feculent impurity.

Fortunately the diffusion of knowledge on this subject of late years has become so general, and the attention of corporate bodies so frequently drawn to the necessity of patiently investigating all the conditions under which great public works are to be executed, that when untrammelled by selfish interested motives, or free from the unhappy mist of antiquated prejudice, the discoveries of modern science are not only recognized but carefully studied in their bearings upon the daily wants of man.

ON THE AERATION OF THE WATER.

The water of large lakes is generally considered to be more flat or vapid than that of rivers, the same statement is made in relation to the water of rivers when compared with that of wells. The aeriform substances present in potable waters which impart to them their pleasant agreeable flavour, (absent in vapid waters,) such as recently boiled water, consist of oxygen and carbonic acid; other things being equal, the temperature determines the quantity of air present in any specimen of water under consideration. The higher the temperature the smaller the amount of air present and the greater the vapidity of the beverage.

Motion is a most valuable agent in promoting aeration; in a condition of violent motion the particles of water are brought into contact with particles of air, which they to a certain extent absorb. The effect produced upon organic matter either in a state of solution or mechanically suspended, is of the greatest interest and value. The turbid dark colored waters of the tributary streams of the Ottawa issuing from the Tamarac swamps, if allowed to descend during the last ten miles of their course in the form of rapids, would enter into their common receptacle pure, sparkling and transparent. The waters of Lake St. John near Lake Couchiching frequently become covered with a mass of noisome green vegetable growth; a single gale of wind suffices to clear the lake. It is probable, however, that in this instance, the minute vegetable forms which so suddenly appear in that singular body of water descend in great part by their own gravitation to the bottom. If exposed to continued contact with air these organic impurities would be oxidized and rendered harmless. These illustrations are merely brought forward to exhibit the powerful effects of contact with air. They do not apply, however, to the pure waters of Lake Ontario, which are destitute of organic matter. The object of aerating the supply for the city of Toronto would be to impart to it the sparkling quality common to well aerated waters, in addition to those of coolness and purity which already characterize it, with this object in view it is proposed to introduce the water from the rising main into at least one of the reservoirs, by means of a long tube perforated with holes throughout the entire length of the side of the reservoir. It is proposed to deliver it from an altitude of two or three feet above the highest water level in the reservoir. The same arrangement might be applied to all the reservoirs although it is questionable whether the loss in altitude would compensate for the effect produced. It is manifest that a most perfect aeration might be obtained by making use of the upper service reservoirs for the purpose, an arrangement practicable at a period too remote from us now to invite further notice. Under all circumstances it will be necessary to make arrangements for the delivery of the water below the ice which would probably form in winter on the surface.

MATERIALS EMPLOYED AND METHOD OF SUPPLY.

The effects produced upon water during its distribution through metallic pipes have always been among the most prominent subjects of discussion, connected with a system of water supply. The evidence collected by the members of the General Board of Health (England) as published in their reports furnishes very minute and satisfactory opinions on this important topic. The whole question appears to be reduced to the simple facts which follow.

1st. When air is permitted to have access to the moist surface of iron or lead pipes, oxidation takes place, generating compounds appreciably soluble in water containing oxygen and carbonic acid. And when the oxide of lead is preserved in an insoluble condition it is swept away by the stream of water, being mechanically suspended in it for a short period of time.

2nd. When air is totally excluded from the surface of iron or lead, water containing oxygen or carbonic acid does not take up appreciable quantities of those bodies, but water containing certain salts (hard water) does possess that property.

3rd. The only safe system of water supply when the use of metallic pipes is unavoidable involves the necessity of keeping the pipes constantly full.

4th. The amount of lead dissolved by hard water appears to have some definite relation to the degree of hardness and the character of the hardness. Salts of magnesia give to the water a greater solvent power than salts of lime. Free carbonic acid also affects the solution of lead.* Sulphate of lime, as formerly supposed does not secure the lead pipes from oxidation.† In conformity with these observations it is proposed to convey the water from the reservoir down and along the streets named in the general description of the plan, or colored red, blue, or black, on the plan itself, through iron mains properly supplied with air vessels and check valves‡ from 18 to 12 inches in diameter (colored red), 8 inches diameter (colored blue), and 6 to 4 inches diameter (colored black). The service pipes are to be of lead (glazed iron if procurable) and of dimensions dependant upon the supply required. The water throughout the entire system to be under a constant pressure of

100 to 140 feet South of Queen Street.
100 " 60 " North of Queen Street to Carlton Street.
60 " 40 " from Carlton Street to upper service districts.

It is proposed that the mains and service pipes shall be kept constantly full in order to prevent oxidation. At the uniform distance of 100 yards fire plugs are to be placed throughout the entire length of the district, distributing and connecting mains, in order that by screwing on a jet, a body of water under high pressure may be immediately available in case of the discovery of fire.

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* Vide reports on the supply of water to the metropolis, page 149.

† See report on the supply of water to Boston, U. S.

‡ See note appendix C.

This system of fire plugs has been introduced with the utmost success in various cities. It requires no arguments to prove the vast importance of a ready and ample supply of water to provide against the spread of destructive conflagrations. A single fire, the work of a few hours, may and has destroyed property in this city to an extent which would cover all the expenses of a judicious system of water supply; experience shows that we are peculiarly liable to sweeping conflagrations in this country; the history of Quebec, Montreal and Toronto, furnish numerous examples of the terrible loss of life and property which almost periodically has arisen from this fearful cause.

From the data we have been able to procure respecting the occurrence of fire in the city of Toronto it appears that during the past three years of almost unexampled freedom from these alarming outbreaks, the average annual number of fires was twenty-seven, the estimated annual loss £10,000, the amount of insurance £5,000, the cost of water £140, and the number of buildings consumed 44.

The following extract from the reports of the chief engineer of the fire brigade, furnishes more minute information for the years 1851, 1852 and 1853.

Year.	No. of Fires.	Estimated loss.	Amount of insurance.	Cost of water.	Buildings consumed.
1851	27	£7,712	£2485	£157	42
1852	33	10,261	3775	196 10s	78
1853	21	12,711	8634	67 10s	16

On the 7th April, in the year 1849, a fire occurred in this city, which destroyed property in a few hours exceeding in value £100,000, sweeping over an area of 12 acres and suspending all business operations in the most thronged portion of the city until the ruin and devastation which it occasioned could be restored or repaired. The annals of every insurance company bear testimony to the evil of fire, and appeal for some reliable remedy. No invention or scheme, however ingenious, has yet succeeded in diminishing the claims which a copious supply of water accompanied with sufficient power to apply it have upon our warmest support. A sense of almost perfect security from the devastating effects of fire would form no small addition to the comfort and repose of the inhabitants of a great city. It would impose a salutary check upon the incendiary, and arrest to a very considerable degree, the commission of that most heartless and detestable crime; a crime which recent experience shows but too plainly, easily finds perpetrators, even within the precints of our own homes. Its effects upon the rates of insurance would be speedily felt and so foster the construction of buildings and ornamental structures which add grace and beauty to the scene of our daily avocations.

The plan suggested would provide an equivalent to a first rate fire engine at every 100 yards of our streets, ready day and night to work without impediment and fatigue, and capable of pouring an irresistable body of water upon any outbreaking flame. In Liverpool, 12 miles of mains were laid in the warehouse district as a security against fires, in a town which contains 400 miles of streets and roads, and yet this small extent of piping had the effect during the first year of its working to cause savings in the premiums of insurance to the amount of twenty-five thousand pounds sterling.* The same system of fire plugs would be of the utmost use in cleansing the streets, yards and alleys, as well as in the laying of dust; the former being a fruitful source of pestilential disease, the latter the cause of immense annual loss to those who are compelled to expose their wares to its destructive effects. There remains yet, one important application of a copious water supply, which will especially commend itself to mechanics and others requiring occasionally small engine power. It is well known that hydraulic engines of one and two horse power can be worked by water from the common service pipes of a large house. The first cost of the engines is insignificant and the cost of maintenance presents a similar disproportion to the cost of the maintenance of a steam

* Report of Board of Health, page 260.

engine of equal power, attendance being unnecessary, and its immunity from danger incident to the application of steam, without question or doubt.

THE PRESENT WATER WORKS.

Although the plan proposed has been arranged without any reference to the works of the present company supplying the city, yet it fortunately happens that many of the mains already laid down in various street may be used for the minor distribution of the proposed plan, should the corporation deem it advisable to arrive at a mutual understanding with the present company. From all that can be learned regarding the pipes we believe that the old mains are generally of sufficient strength for the head of water proposed, and in the event of an arrangement, it would only be necessary in the execution of the work to omit laying down the new pipes when the strength and capacity of those now in use were found to be sufficient.

RECAPITULATION.

We proceed now to recapitulate the general outline of the plan embraced in the foregoing pages.

1. The precipitous sand bank at the Lighthouse point is the only accessible part of Lake Ontario which is free from serious objections as the point of supply for the service of the city of Toronto.

2. The water of the lake at the Lighthouse point at a depth of 40 feet furnishes the necessary conditions of purity, coolness and quantity.

3. The absence of organic matter and the comparative immunity of the water from the chances of discolourations by mechanical impurities passing over or proceeding from the shoals to the east and north are among its special recommendations.

4. The plan to be recommended for its distribution in the city of Toronto must be susceptible of continued extension with

the increase of the city, without involving those additions to, or alterations in, the machinery which would arrest the supply at any time.

5. The plan must be essentially distributary in all its features thereby permitting repairs or alterations to be made in sections without interfering with the general service of the city. It involves (*a*) a supply pipe from the Lighthouse point to deliver lake water into a well on the main shore by simple hydraulic action, (*b*) steam power to lift the water for distribution, (*c*) pumping mains to convey it to the summit of a tower, (*d*) stand pipes and rising mains to convey it to the reservoirs, (*e*) reservoirs for storage and constant hydraulic pressure, (*f*) distributing mains of various dimensions for the service of the city.

6. The construction of closed reservoirs at Yorkville 140 feet above the lake level, are to be recommended for the purpose of obtaining a head.

7. The topograpical features of the neighbourhood do not permit of the selection of any higher point for the situation of reservoirs without involving an enormous expenditure for engine power and mains of great diameter, in order to overcome the loss of "head" occasioned by friction in pipes of great length.

8. It is particularly recommended to distribute the water under constant pressure; with a view to attain this object, the water is first to be pumped from a well near the engine house to the summit of a tower, from which it will be distributed to reservoirs and mains under uniform hydraulic pressure for the same altitude.

9. The city is to be divided into water districts, seven in number. Each water district is to be susceptible of complete isolation from, or perfect connection with, the other water districts as occasion may require.

10. The distributary apparatus, in each district is to be divided into sections; each section is also to be susceptible of complete isolation from, or perfect connection with, all other sections as occasion may require.

10. With a view to the service of the village of Yorkville a system of Upper service works are contemplated in the general plan.

12. Complete provision is to be made throughout the entire distributary system of mains for security against the spread of destructive conflagrations in the city.

13. The works at present contemplated include four districts, and make provision for the daily supply of 40,000 people with thirty gallons of pure water per head.

14. The annual cost of the supply will not exceed four shillings and seven pence currency to each inhabitant, assuming the present population to embrace 40,000, and if the population were doubled over the same area the annual cost would be about one half of the same sum.

15. The estimated cost of the works proposed for present construction, and which are intended to supply all demands which may be made upon them for the next ten years, amounts to £111,410.

16. The details of this plan do not preclude the complete grafting of the present water works of the city upon those which are now under consideration.

17. The estimated cost of the whole works which provide for water distribution throughout the entire city limits and the village of Yorkville, but which will not require completion during the present generation, amounts to the sum of £222,000 currency.

APPENDIX.

NOTE A.

The fine matter brought down by the Rhone is found in mud beneath the still deep waters of the lake of Geneva, many miles beyond the discharge of the turbid waters of he river into that lake. Page 72 De la Beche, Geo. Ob.

Colonel Sabine has stated that at three hundred miles distant from the mouth of the Amazon discoloured water supposed to come from that river, was found with a specific gravity of 1,0204 *floating* above *the sea water* of which the specific gravity was I,0262, the depth of the lighter water being estimated at 126 feet. (Page 89 ibid.)

If the Amazon discharged its waters into Lake Ontario, the turbid stream would have been found below the clear lake water, as is the case with the Niagara river. When this river is discoloured in the spring months or after storms its turbid waters do not penetrate far into Lake Ontario; they sink and steal along the bottom.

The sewerage of the city of Toronto after heavy rains is a serious item in the amount of detritus transported into the lake.

NOTE B.

Nearly one half of the engine power of the present water works is employed in overcoming friction during the ascent of the water to an altitude of 120 feet. It is clear that to avoid unnecessary outlay no greater elevation for reservoirs than 140 feet could be consistently recommended on account of the absence of high land within available distance. The lowest terrace of the Scarboro' heights gives only an altitude of 160 feet above the lake, and the highest ridge six miles from Toronto just exceeds 300 feet. Colonel Well's hill North of Yorkville offers no advantages at all commensurate with the expense of conveying water to and from reservoirs situated there. Indeed without the mains were made of enormous dimensions the friction of the water moving through them would consume all the advantages which the small additional elevation could give. Friction is a very important element to be taken into consideration in estimating the flow of water through pipes under constant pressure. Ample allowances have been made for this retarding force in the calculations embodied in this report.

NOTE C.

A very significant illustration of the dangers arising from sudden shocks in the mains has recently occurred in the city of Toronto.

During the fire which caused the destruction of several houses on Yonge Street, (June 26th,) no water could be obtained from the hydrants.

The engineer attached to the works had been endeavouring for some days previous to find a "burst" which was supposed to have occurred as it was discovered to be impossible to force water to the upper reservoir. The cause of the difficulty was found after much expenditure of labour and time (nearly three weeks) it was then ascertained *that three bursts* had occurred, after or during the fire on March Street, (June 10th). These bursts were without doubt from the sudden stoppage of the current. They exhibited longitudinal cracks in the pipe, which opened with the pulsations of the engine when endeavouring to force water to the upper reservoir.

A proper system of air vessels and check valves as recommended in this report would have effectually prevented this dangerous casuality.

NOTE D.

From careful experiments made on the consumption of fuel by Mr. Wicksteed, Engineer to the East London Water Works; we are enabled to ascertain the probable consumption of coal by the engine proposed to be employed.* The experiments were made on the Cornish pumping engines from 26 to 32 horse power each, they had been constantly at work, had not been overhauled or any thing done to them preparatory to the trials; and the boilers and flues had not been cleaned for many months.

The results of the experiment and calculations are as follows:

Engine at	Holmbush	mine	consumed	1.57lbs.	coal	per	horse	power	per hour.
"	Old Ford	"	"	4.82	"	"	"	"	"
"	Tin Croft	"	"	3.25	"	"	"	"	"
				9.64 ÷ 3 = 3.21lbs.					

Giving a mean consumption of the three engines of 3.21lbs. of coal per horse power per hour.

Leanord's Mechanical principia gives 84lbs of Anthracite coal as the consumption per horse power in 24 hours, equal to 3.50lbs per horse power per hour, which agrees very closely with the mean of Wickstead's calculations.

We have no information regarding the quality of the coal used in the above mentioned trials as compared with that which would be employed here. We will however be safe in assuming that the quality of the coal to be used by us is inferior to the English, and, therefore, increase the consumption per horse power per hour to 4lbs instead of 3.21.

* Vol. I., transactions of Society of Civil Engineers.

REPORT NO. 3, SIGNED "A.Z.,"

BY JOHN G. HOWARD.

GENERAL DESCRIPTION OF DESIGN

FOR SUPPLYING THE CITY OF TORONTO WITH PURE WATER FROM LAKE ONTARIO.

THE City of Toronto is beautifully situated, sloping from north to south, having a fall or inclined plane of 115 feet in about a mile and a half, namely from Yorkville to Front Street, on the bay shore.

As the supply of water is to be obtained from the Lake, two miles, at least, south of Front Street, and to be forced up the said inclined plane by force pumps, driven by a steam engine, the first thing to be done by the engineer is to construct such a Reservoir as will effectually overcome the necessary friction in the pipes caused by driving the water up hill, and the necessary turns in the said pipes, at the same time to connect the pump to the supply pipes of the reservoir as near as possible to the level of the water in the Lake, so as to be under the immediate inspection of the engineer managing the establishment.

The first thing to guard against is frost. Secondly, great care must be taken, in laying down the pipes across the Bay, so as not to impede navigation, and also to prevent the pipes from being disturbed by vessels coming to anchor, for which purpose I have availed myself of the plan adopted in Scotland, for supplying the city of Glasgow with water from the Clyde. The water is conveyed from the opposite bank of the Clyde in flexible pipes, (similar to those shown on the plan at C D E,) sunk in the bed of the river, and though they have laid there for several years, ships passing and re-passing over them, they have been found to answer the purpose admirably; there is also a large well for filtering the water which in this case will not be required as the water of the Lake is always pure. The pipes will simply require strong cribwork to be sunk in the Lake to protect the ends of them.

I have prepared a rough tracing of the city of Toronto, the harbour, and Peninsula; the blue lines show two layers of pipes across the Bay and Peninsula to the Lake; one marked A A denotes the two ends of the supply or service pipe, the reservoir to be erected on Lot No. 7, corner of Trinity Palace and South Park Streets, the pipes to be conveyed from thence, south, down Trinity Street, thence easterly, along the margin of the Bay, thence across the river Don, with the flexible pipes, thence along the eastern margin of the Bay, across the Peninsula into the Lake, the end of the pipe to be surrounded with cribwork; this point in the Lake can be carried more to the east in case the eastern entrance is formed to the Harbour.

B B denotes the two extremities of the other layer of supply pipe, the reservoir to be erected near the present Water Works, at the foot of Peter Street, the pipe to be conveyed from thence, across the Bay, to the north-west point of the Peninsula, thence across the Peninsula, and south-westerly, along the margin of the Lake, to the south-west point, where it enters the Lake, the end of the pipe to be surrounded by cribwork. This line will require three quarters of a mile more flexible pipe than the other; the whole must be sunk a sufficient depth in the sand to protect them from the frost. I should recommend the eastern line, as it only requires about fifteen chains of flexible pipe, and I consider it will be more out of the way than the other.

The blue lines show the 12in. main laid in the different streets, the red lines show the 9in. main, the yellow the 7in. main, and the dotted lines show the 5in. main. I contemplate 150 hydrants of 3in. bore.

I have designed two descriptions of reservoir, one in the form of a cone, built of brick and stone, 150 feet high, enclosing a wrought iron tank, capable of containing 3,600 puncheons, or 303,400 gallons, this plan I consider best adapted to this climate, their being no danger to be apprehended from frost as the tank is completely enclosed, and as the steam boiler and steam engine are below, a sufficient supply of warm air will be generated in the upper story to prevent the water freezing in the tank. This building will have a good appearance and will take up but little room, as the machinery will be altogether inside; only a small wood yard will be required I propose to bring the water across the Peninsula in a 12in. main and connect it direct with the pumps. as near the level of the Lake as possible. Rooms are found in the building for the engineer and assistants, and above the tank a floor is to be laid, and six dormer windows are to open upon the roof, which will enable the watchman to see what quarter a fire is in, and as soon as the alarm is given he at once fires up and commences pumping, by which means the tank will be kept full.

The present defects in the Water Works of this city, as regards supplying the hydrants at fires, is solely attributable to the want of head of water in the reservoir, or perpendicular fall, together with the small size and bad quality of the pipes, as they will not bear any pressure, and unless there is a sufficient vertical pressure it is almost impossible to force a continuous stream of water through small pipes.

To obviate this difficulty, and to get a good and sufficient supply of water at fires, it is absolutely necessary to get, at least, from 25 to 30 feet vertical pressure, after allowing for friction and turns in the pipes. Elevated reservoirs enclosed in brick cones are the best for this purpose, and have been adopted in England and at Detroit, both of which have been in operation many years, and have answered the purpose well.

The surface of the water in the present reservoir, when full, is only 106 feet above the surface of the water in the Bay; deduct 15 feet for the height of the bank in Front Street, and it leaves only 81 feet fall, which resolves itself into an inclined plane of 81 feet in little more than a mile and a quarter, 2 feet 6 inches of which is required to overcome the friction in the pipes, supposing they were straight, but as they are of various sizes and have a great many turns in them, 15 feet more, at least, may be deducted. My motive for going into these details is to show that a sufficient supply of water, particularly at fires, can never be obtained through small pipes, with only an inclined plane; as well might a person attempt to drive a saw or grist mill from the current of a common stream, they must have a dam and a head of water at least 10 or 12 feet to do any amount of business.

Again, the elevated iron tank or reservoir is not likely to get out of order, and the whole of the machinery will be under the immediate eye of the engineer. The vertical fall from the bottom of the reservoir is 100 feet above the ground on which the building stands, and 115 feet above the water of the Lake. The reservoir is 50 feet high with a 12 in. main, which would supply the inhabitants of Yorkville, providing the reservoir was always kept full. Yorkville is 135 feet above the level of the Lake.

The other reservoir, marked No. 3, is circular, built with Lake stone, laid with hydraulic lime, 100 feet in diameter by 20 feet deep, 15 feet of which stands out of the ground: the best situation for it, in my opinion, is on a lot of land belonging to T. G. Ridout, Esq., situated near the north end of Sherborne Street, at the height of 137 feet above the Lake, which, with the 15 feet head, makes 152 feet, just 13 feet lower than the head of water in the reservoir shewn at A, and 20 feet lower than that shown at B. There is a great drawback to this kind of reservoir: first, the pump house and steam engine must be erected on the Bay shore; secondly, there would be scarcely any vertical fall or head of water, as the friction in the pipes, caused by the necessary turns, would very much impede the water in its passage through the pipes; thirdly, being in the open air, it would be liable to get out of order from the frost, though built ever so well;

fourthly, the pipe necessary to supply the said reservoir would be nearly equal to the 12in. main laid on Queen Street.

Lastly, in most cases, with the reservoir A or B, there would be very little occasion for the fire engines at any fire which might occur from the whole parallel of Queen Street, from Trinity Street, east, to Peter Street, west, to the Bay, but simply to screw on the hose to the hydrant, which would propel the water from the branch 50 or 60 feet; on the contrary, the stone reservoir at the head of Sherborne Street would not throw the water on King Street above 20 feet from the branch.

The accompanying estimates show that the reservoir A A, with 49½ miles of pipe laid will cost, when in complete working order, £100,000; B B about £2,240 more, in consequence of the extra length of flexible pipe required; No. 3, the stone reservoir, will cost about the same price as A A.

I have given my opinion of the annual cost of working the establishment, likewise the annual amount to be realised from the said working. The balance sheet shows a clear annual profit of £5,500 which will increase every year.

The estimates may appear high, but it must be remembered that 46 miles of the pipes will be laid in the public streets, which, if done well at first, will last for thirty years or more, without any material repairs, by which the necessity of eternally breaking up the streets to repair bad pipes will be avoided.

About half the sum, say £50,000 will be sufficient for the first five years. Providing the eastern line A A is adopted, smaller pipes could be substituted, but I should strongly recommend that the sizes described should be used, as in five or ten years they will be found small enough, and to substitute less would reflect discredit upon all concerned.

I have the minute details from which the estimates were made, and should my plan be found worthy of being adopted, I shall be most happy to give any further information.

All which is most respectfully submitted by,

Your obedient servant,

(Signed,) A. Z.

Detailed Estimate of the cost of constructing Water Works for supplying the City of Toronto with Water from the Lake, &c., &c., &c.

	£	s.	d.
Brick Cone and Reservoir marked A. A. on the general plan of the town ¼ of an acre of land, being number seven, on the corner of Trinity Street	500	0	0
The Brick and Stone Cone complete	5953	0	0
The Wrought Iron Reservoir complete	3500	0	0
110 feet of Crib-work in the Lake	330	0	0
Total for Reservoir	£10,283	0	0

	£	s.	d.
6380 yards lineal of 12 inch cast iron pipe 33s 6d	10686	10	0
Dressing and fixing flexible pipe, &c., &c.	330	0	0
15048 yards lineal of 9 inch cast iron pipe 23s 6d	17681	8	0
Excavating and laying said pipe	1504	16	0
41756 yards lineal of 7 inch cast iron pipe 17s.	35500	5	0
Excavating and laying said pipe	2087	16	0
23892 yards lineal of 5 inch cast iron pipe 10s.	11946	0	0
Forward	£90,019	15	0

	£	s.	d.
Brought forward	90,019	15	0
Excavating and laying said pipe	1194	12	0
To 150 new hydrants fixed at £30	4500	0	0
To a twenty horse steam engine	1000	0	0
To a wrought iron boiler, pumps, &c	1000	0	0
Contingencies	2285	13	0
	£100,000	0	0

If the reservoir is erected at B. B. it will cost £2,241 0s. 0s. more.

The stone reservoir at No. 3 including the land on Sherborne Street, and the engine house on the lake shore, £10,276 11s. 0d.

There is only a difference of £6 9s. 0d. between the cut of A. A. and No. 3.

Annual expense of the Toronto Water Works in supplying the City of Toronto with Water from the Lake, &c. &c. &c.

	£	s.	d.
£100,000 at 6 per cent	6000	0	0
Managing Clerk, &c., &c	350	0	0
Engineer	250	0	0
Two labourers, £75 each	150	0	0
Watchman	50	0	0
Collector	150	0	0
900 cords of wood	450	0	0
Contingencies	100	0	0
	£7500	0	0

PER CONTRA :—

	£	s.	d.
3500 Private Houses, £3	10500	0	0
100 Taverns and Hotels, £5	500	0	0
10 Bath Houses, £25	250	0	0
10 Brewers and Distillers, £25	250	0	0
10 Insurance Offices, £50	500	0	0
150 Hydrants at £5	750	0	0
25 Conduits for Carters, £10	250	0	0
	£13,000	0	0

THE COMMITTEE ALSO RECEIVED THE FOLLOWING

VOLUNTARY SUGGESTIONS

ON THE

SUBJECT OF THE WATER WORKS.

Montreal, 24th June, 1854.

SIR,—In consequence of an advertisement published in the Montreal Herald, inviting competition plans for the water supply of Toronto from Engineers in this quarter, I am induced to address you. I will take the liberty first of explaining why I do not become one of the competitors sought for, and why I cannot comply with the conditions of your advertisement.

Plans and estimates for a work of such magnitude as the water supply of Toronto cannot be understandingly given without the expenditure of time and money in preliminary surveys and examinations, and office work which no Engineer would make or could be expected to make for the inducements offered. The plans of the most important structures cannot be prepared until excavations are made to shew the character of the foundations, neither can the position of these structures be fixed without elaborate surveys for the purpose of securing the good and avoiding the bad foundations.

Secondly, If the work to be done were a design for a public building, or a single work or structure for a particular spot, instead of a system of works necessarily scattered over miles of surface, persons at a distance might compete, but I believe the information which the City of Toronto should be in possession of before deciding upon so important a question will cost at least ten times the sum offered; and, therefore, I find it impossible for me to furnish the required plans and estimates.

Having passed several years of my life in Toronto, I am familiar with the position of the City as affecting the question of water supply, and I am in possession of such information as to distances and levels (derived from my survey of the Grand Trunk Railway between Montreal and Toronto) as enables me to form a decided opinion as to the plan which I think the City should adopt.

Having had an opportunity within the last twelve months of inspecting the best steam pumping works in England, and these are the best in the world, and having been in connection with the large pumping works now in progress for the supply of this City, given a good deal of attention for the last two years to this subject, I feel that I can offer considerations with reference to this important question which will be worthy of serious investigation, and I shall be sufficiently repaid if I can induce the principal city of my native Province to adopt the best system extant, and secure works which will leave nothing hereafter to be desired or regretted, and which I am sure her present position and future prospects both warrant and demand.

There is no class of works which require to be more thoroughly and efficiently constructed than the water works of an important city. It is better to be without them than to have them on an inefficient scale, because where they exist the population become in a short time so wholly dependant upon them that unless they be adequate to every demand the consequences will be disastrous in the extreme.

The Corporation of your City has decided on procuring a supply from Lake Ontario, and there remains only for the engineer to determine the best point from which to take the water and the best mode of elevating and distributing it.

The City stands upon ground varying from 15 to 125 feet in height above Lake Ontario. The high ground at Yorkville is barely sufficient to afford reservoirs sufficiently elevated to command the lowest parts of the City. The private residences of that class which will be the largest consumers and best water tenants cannot be adequately supplied from reservoirs at this elevation as the majority of these houses will be but little below the level of such reservoirs. The City will extend in every direction, and there is no ground at Yorkville in my judgment sufficiently high for reservoirs to supyly that part of the City northward of Queen Street.

A stand pipe can be used which will give a delivery at the required height as long as the engines are working; but no system of supply should be entertained which does not embrace large storing and distributing reservoirs sufficient to carry you through any extensive conflagration or any accident to your machinery which will stop the pumps for one or more days.

If it be possible, therefore, within the limits of any reasonable expenditure to obtain a site for the reservoirs which will command the whole city, including Yorkville, this ought to be done!

I am of opinion that the supply should be taken either from Ashbridge's Bay or a point on the Lake east of this, and pumped directly up to the nearest ground of sufficient height into large storage reservoirs, and from thence be led into the city by an iron main, traversing it from east to west on the line of Queen Street.

By this plan the distance which the water would be pumped would be the shortest possible, thus avoiding the increasing cost of power to overcome the friction and curvature of a long line of pumping main. The engines would work under a regular and constant pressure. There would be no connection between the pumping main and the distributing pipes by which the latter could be strained and the joints made to leak from the impulsive action of the pumps and the irregular pressure to which the pipes would be subjected if in connection with this main. From your receiving reservoirs the supply of the City would be a gravitation, one partaking of all the security and regularity of the best mode.

An ample extent of ground for the reservoirs could be obtained in this direction at a low price, and the economy on this head would probably cover the additional cost of mains for leading the water into the City. These reservoirs would be removed from the dust and soot of the City. The water stored in open country with the wind sweeping over it would be kept in the best condition.

The general features of the plan being determined on the most important particulars are the kind of engine and pump to be employed. As on the judicious selection of these the economy of working expenses and efficiency of the system will depend on this point, I would merely remark that I am convinced the general adoption of the Cornish Engine for the recent steam pumping works erected in the United States is a mistake, and I would advise the city to make full enquiries before adopting this mode of pumping.

In New York, Boston, and Philadelphia, which are as well supplied with water as any cities in the world, there is a great deficiency of pressure, not from any defect of the plans, but because the reservoirs could not be obtained at a higher level than they are; but in Manchester and many other cities of Britain the use of Fire Engines has been superseded, the pressure from the mains being sufficient to throw the water on the highest buildings.

In Montreal our reservoirs are 200 feet above the Harbour; I think that Toronto will require very nearly thes same elevation above the Lake, and then, while every house in the city will be fully commanded, you will have fire pressure sufficient to protect (without the intervention of engines) the warehouses and valuable property in the heart of the city, as well as the shipping at your wharves.

It may be objected, why pump up the whole supply to a height sufficient to command Yorkville, (and overcome the loss of head in the pipes between the city and the high ground to the eastward of the Don,) when the greater portion of the city can be commanded by a much less height. It may therefore be proposed to have two reservoirs, at different elevations, by which arrangement no part of the water will be pumped higher than necessary. This arrangement would call for two sets of distributing pipes, one for the higher and the other for the lower district. Inasmuch as a pressure which will command the whole city will not be too much for the lowest parts of it, but will be beneficial and most needed there. I do not think that the inconvenience of reservoirs at different levels, and two sets of pipes, disconnected, should be preferred, especially since there are strong reasons in favour of the plan I have proposed, which may make it even the more economical.

In the first place, I think it may be necessary to go to Ashbridge's Bay, (or as great a distance in the other direction) for the water.

One of the greatest practical difficulties in taking the water out of the Lake is, that from constant agitation, the water, for some distance from the shore, holds large quantities of fine sand in suspension, which, if not precipitated before drawn into the pumps, will be most destructive to the valves.

It would seem that Ashbridge's Bay, which is probably in healthy communication with the Lake, through the natural filter bed which separates them, is precisely what is wanted to aid in overcoming this great difficulty. But, if on further examination, this is found not to be the case, it will propably be found necessary to construct a basin, into which the Lake water can be admitted, and freed of sand before it reaches the pumps.

Whether the water be taken out of the Lake from the eastern or western end of the city, it can only reach reservoirs in the neighbourhood of Yorkville, through a long line of main, generally following the streets, and with more or less curvature. If traversing the city in its course this main would probably be tapped, for economy.

Now the power required for pumping depends upon the following considerations:—

1st. The height to which the water is to be elevated.

2nd. The length of the pumping main.

3rd. The diameter of the same.

4th. The number and intensity of the changes of direction, or, in other words, the amount of curvature in the main.

5th. The speed at which the water is to be driven, or the quantity required, in a given time, through a main of given dimensions.

Thus it will readily be perceived, that the power required to raise the same quantity of water per diem, through a short straight and large pumping main, to the high ground near Ashbridge's Bay, may not be any greater, or even as great, as that required to drive the same quantity through a long crooked and smaller main to Yorkville: the shorter the pumping main the larger it could be afforded, whereas, with a very long one, there is every inducement to diminish the size, although this length calls for increased diameter. If the supply be taken off this main, the interruptions to the flow thus produced, will call for an increase in its dimensions. If the main is not tapped, (as it should not be,) there may be but little difference in the first cost of the ascending and descending mains, whether the reservoirs are at Yorkville or eastward of the Don, and this will probably be made up by the economy in construction at the latter point, while in the one case the town is only partially commanded, in the other wholly so.

If this reasoning be admitted, the best plan may prove as cheap, if not cheaper than any other which will fulfil the requirements of the case.

With regard to the cost, I cannot venture on estimates, where so much is undetermined by surveys, although I have sufficient knowledge of distance and levels to enable me to estimate the cost of pipes, and, knowing the power required, could fix the cost of the engines and their accompaniments, allowing a suficient sum for reservoirs, and works in connexion with the pump wells, as well as for all other contingencies. I am satisfied that the cost would not exceed a sum which the citizens ought, and, I think, will not hesitate to expend, for such a purpose, and one which cities of less flattering prospects have not shrunk from encountering. The only course which can with safety be pursued in a matter of such moment is, to have careful surveys, plans, and estimates prepared, and a report thereon submitted for public consideration.

These can be ready as soon as the legislative and financial arrangements are perfected, so as to be prepared, if desired, for the prosecution of the work without loss of time.

I have the honour to be, Sir,

Your obedient servant,

THOMAS C. KEEPER.

To the City Clerk,
Corporation of Torouto.

TORONTO WATER SUPPLY.

To His Worship the Mayor, Aldermen and Councillors of the City of Toronto.

GENTLEMEN:

It is not my intention to enter on the subject of a water supply for your city with a view to competing for the premium offered by your advertisement, because I altogether object to the mode of obtaining the supply as determined by your body, in comparison with that more perfect and less costly system, by self gravitation, which I believe to be practicable, and which it is my present design respectfully to submit to your notice.

No doubt, when it was resolved to have recourse to pumping from the lake, the determination was arrived at from what was considered to be conclusive evidence of the difficulty or impossibility of securing a supply by other means; nevertheless, I venture to think that the suggestions I have to offer may be found worthy of serious consideration before you are finally committed to a system which at the best is only an expedient to be adopted from necessity.

As a stranger I feel that my suggestions could have little weight without some assurance being given to you that I was competent to speak professionally on the matter, and, therefore, (although under the circumstances I should willingly have avoided speaking of myself) it is right perhaps to mention that for several years past I have been engaged in England exclusively in drainage, general hydraulic and sanitary operations, and that on the passing of the public health act, I was in consequence one of those whom the General Board of Health consulted as to the carrying out of that important measure. I had also been appointed some few years previously an assistant commissioner under the general drainage acts, and which appointment I held when I left England last summer. It was also my good fortune for some years prior to his death to enjoy the confidence and co-operation of that well known and eminent authority on such subjects, the much lamented Mr. Smith, (of Deanston,) who was one of the parliamentary commissioners to enquire into the sanitary condition of the kingdom, and from whom I received much valuable practical information.

In the communication with which I was then honored, the General Board of Health speak of the qualifications required in engineers of sanitary works in the following significant terms, "the Board have been made deeply sensible from the fact of their existence, and by the extensive failures and the worse than waste of public money in works of town drainage that have been planned and carried out by engineers and architects of even very high professional standing and general ability, that the qualifications required for carrying out new drainage areas, for conducting works of house and land drainage and water supply, and the application of refuse as manure, *are very special and demand a peculiar kind of scientific knowledge and practical ability*," and which are probably equally applicable on this side of the Atlantic.

Now as respects the two modes of pumping from the low level and self-gravitation from a sufficiently elevated source, experience has shewn that in every instance the first cost of the works, and the annual rate under the former plan is invariably double that of the latter, whilst in point of efficiency it (the latter) has also a greatly preponderating advantage.

Amongst a host of other instances that could be readily adduced, compare the recently completed works at Manchester on the self gravitation principle, where the supply is brought from a distance of about 30 miles in sufficient abundance for every purpose domestic as well as public, at a cost of about ten shillings per head of the pupulation, and an annual average rate of not exceeding two pence per house per week, or eight shillings and eight pence a year, with those at York, Wakefield, &c., where the first cost has never been less than twenty shillings per head, and frequently as high as thirty shillings, and the annual rate from fifteen to eighteen shillings per house; and yet the works and machinery at these places are of modern construction and fuel is comparatively cheap. On the score of first outlay and annual charge then these facts must be deemed conclusive of the superiority of the gravitation mode of supply.

Whether such a supply can be obtained for your city is the question, and without at this stage entering into details which must be for subsequent settlement, I think I can take upon myself to give an answer in the affirmative.

It is admitted on all hands, and I believe rightly, that the best quality of water for all purposes is that from the great lakes; we know moreover, that according to the best authorities, the level of Lake Erie above Ontario, if from 320 to 350 feet, amply sufficient by a line of suitable sized pipes to convey the water to Toronto for high service and so save the annual heavy cost of pumping to the required elevation.

The route which seems to present the greatest facilities for the purpose, is that from Port Dover on Lake Erie down the graded road from that place to Hamilton, and thence along the line of railway now in course of construction between that city and Toronto.

In order to take full advantage of the plan and to bring the cost within due limit to your city, I propose to supply the city of Hamilton *en passant*, leaving a service reservoir at that place wholly independant of the continuation pipe to Toronto, where of course there would be a distributing reservoir of suitable capacity.

Looking at the present requirements of the two cities, and their probable rate of increase for some years to come, I regard it as essential that (if even at an outlay beyond what may possibly be anticipated) *the supply should be abundant for all purposes*, for it must be remembered, that the demand for private and domestic uses will be amongst the least that such works will have to meet, and that as far as mere quantity is concerned, more water will be needed for the various public purposes of flushing sewers, cleansing and watering streets, the extinction of fires, supply of fountains and public baths and wash-houses, than for household purposes. I propose, therefore, to have the supply pipe from Port Dover to Hamilton of not less than 12 inches internal diameter and the one forward to Toronto of not less than 9 inches. If these pipes are of cast iron, I estimate that the cost of the work might be taken (as an approximation) thus, say

40 miles of 12 inch pipes, and laying from Hamilton to Port Dover at £3000 per mile.............	£120,000
Works on the lake shore at Port Dover.............	5,000
	£125,000
Toronto proportion of above sum.......................	£60,000
40 miles 9 inch pipe and laying from Hamilton to Toronto at £2000 per mile.........................	80,000
Service reservoir, &c., &c., at Toronto................	10,000
	£150,000

This is assuming cast iron pipes to be used, but I am of opinion from some experience that throughout the greater proportion of the distance well manufactured earthenware pipes of suitable stoutness, could be substituted safely for iron if properly laid and secured at the joints, in a manner that I could point out, and under the circumstances the cost would be reduced to £100,000 or under, a sum by no means extravagant when it is considered that all the annual charge of pumping is thereby saved, and the expense of management brought to the minimum point.

But assuming, for the sake of being on the safe side, the larger outlay, as the basis of estimate for the annual rate at which the water can be supplied there would require to be raised for interest at 6 per cent. £9000

Annual expenses, say.................................. 500

£9,500

Present population, say 50,000
At 5s. per house 10,000 houses
Increase, say 2,000

12,000 at 16s. per annum £9,600

or under 4d. per week, per house, and exclusive of any revenue from the extinction of fires, baths, or warehouses, &c. &c.

I have said that the consumption of water for domestic uses will be almost insignificant compared with that of public purposes, because it has invariably been found that, once possess the means of street watering, sewer cleansing, &c., with an abundant and never failing supply of water, and the benefit makes its extension a necessity of daily life, limited only by the means of application. This is found to be the case in England with regard to the use of public baths and wash houses, where until the public had the advantage placed within their reach personal cleanliness was not among their virtues. In support, however, of the appreciation of these things when obtainable, on reasonable terms, I may be permitted to quote a passage from a report of committee to the corporation of Newcastle, a seaport town in the north of England; where the habits of the people were usually considered to be anything but favorable to success. "During the thirty-eight weeks ending 31st December, 1851, that the baths and wash houses have been opened 15,806 bathers have used the baths, and 3914 persons have used the tubs. The average receipts per week have been £6 16s. 1d., and the only outlay including interest has averaged £6 3s. 5d. weekly. From the opening of the wash house there has been a gradual but constant increase in the amount of revenue derived from that part of the establishment. The first month's receipts were £2 10s. 1d., whereas in December for washing alone, £21 4s. 2d. was received. Your committee have a conviction that the establishment will be not only self sustaining but a source of profit.

As regards street watering and the flushing of sewers, it may be sufficient to remark that in all cases where circumstances have obliged the pumping system to be restored to, a scanty and hypoeconomical use of the water is observable for such purposes, declaring in unmistakeable terms that every gallon pumped has its appreciable cost and must be used accordingly.

Apart from absolute survey, which I have not thought necessary at present but from information from practical men well acquainted with the proposed route, I have reason to believe that there is no engineering difficulty which ordinary and inexpensive means will not surmount, and I am therefore the more solicitous respectfully to press the subject on your consideration assured that from its position and influence the city of Toronto may well assume the initiative in such an undertaking and set an example to the Province of works planned and executed in accordance with the most approved system of the times in which we live.

If on consideration of what has been advanced your honourable board should deem it desirable to have further and detailed particulars I should be much gratified by being favoured by any instructions you may think proper to give, at the same time let me say I have no desire to interfere with any other Engineer to whom possibly you may feel yourselves engaged and to whom if you wish it, I shall be ready to afford every information in my power to accomplish the desired object; but of course, like every other professional man, if the field be fairly open I should feel greatly honoured by having an opportunity given to me of proving the practical value of the suggestions which I have thus imperfectly ventured to lay before you.

I have the honour to be Gentlemen,

Your very obedient servant,

JOHN H. CHARNOCK.

City of Hamilton, C. W.,
30th June, 1854.

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