THE MONTREAL WATER WORKS

Its History Compiled from the Year

1800 to 1912

F. CLIFFORD SMITH

APRIL, 1913

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To

THE MAYOR OF MONTREAL

and

MEMBERS OF THE BOARD OF COMMISSION.

Gentlemen,

Having been commissioned in June, 1912, to compile the history of the Water Works of Montreal, so that it might be of use not only for the present but future administrations, I herewith submit the same.

Yours truly,

F. CLIFFORD SMITH.

Montreal, April 30, 1913.

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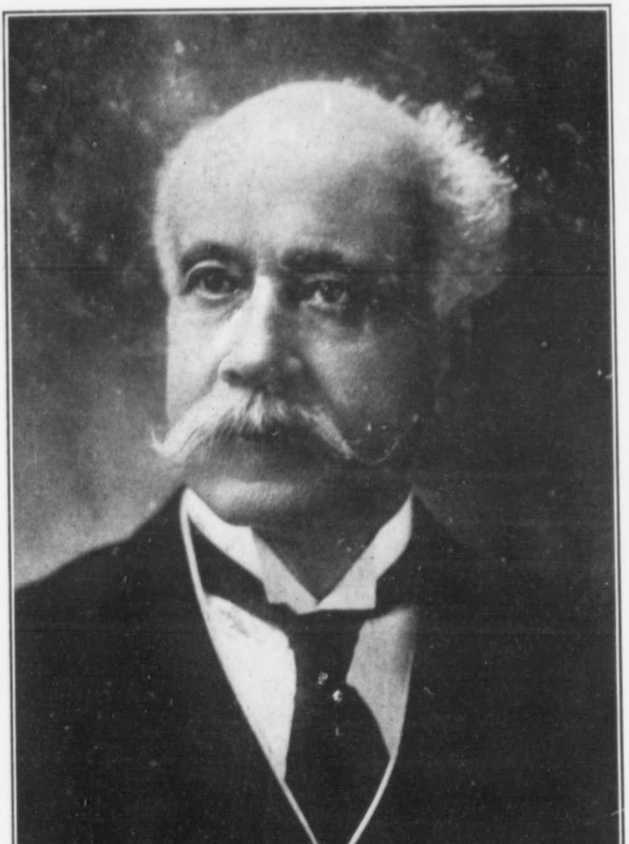
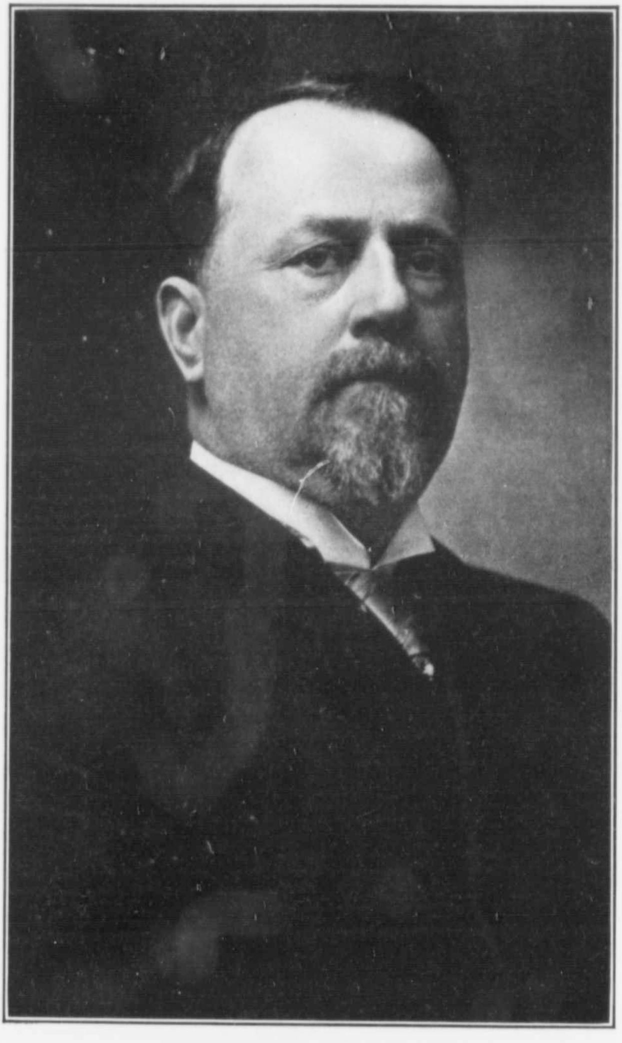
MEMBERS OF THE BOARD OF COMMISSION AND CIVIC OFFICIALS UNDER WHOSE ADMINISTRATION THE MODERN IMPROVEMENTS TO THE WATER WORKS OF MONTREAL, WERE LARGELY CONDUCTED.

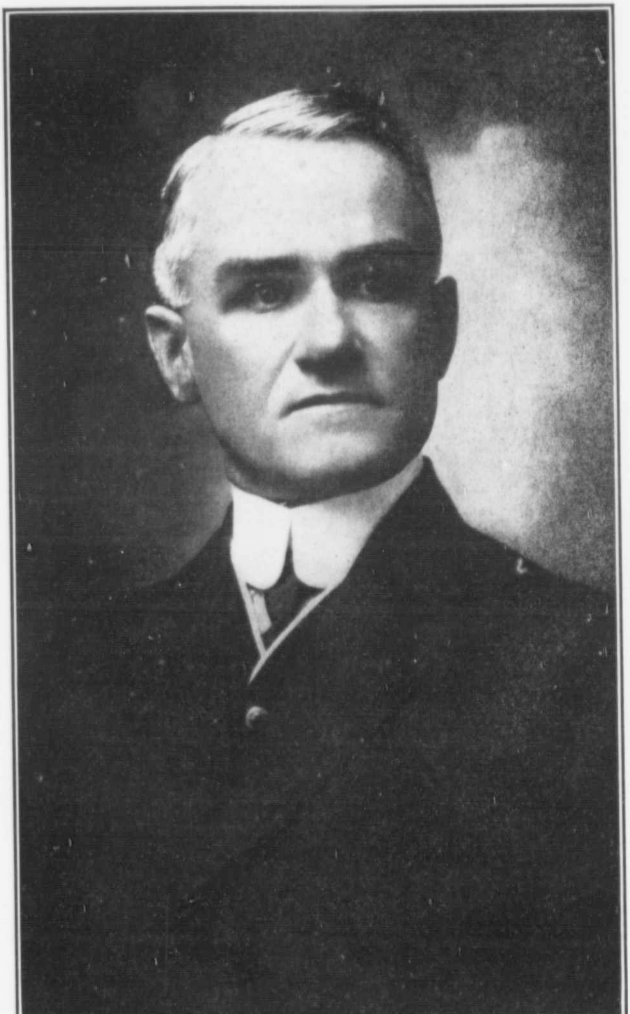
MAYOR — L. A. LAVALLEE
Chairman of the Board of Commission



COMMISSIONER — E. P. LACHAPELLE



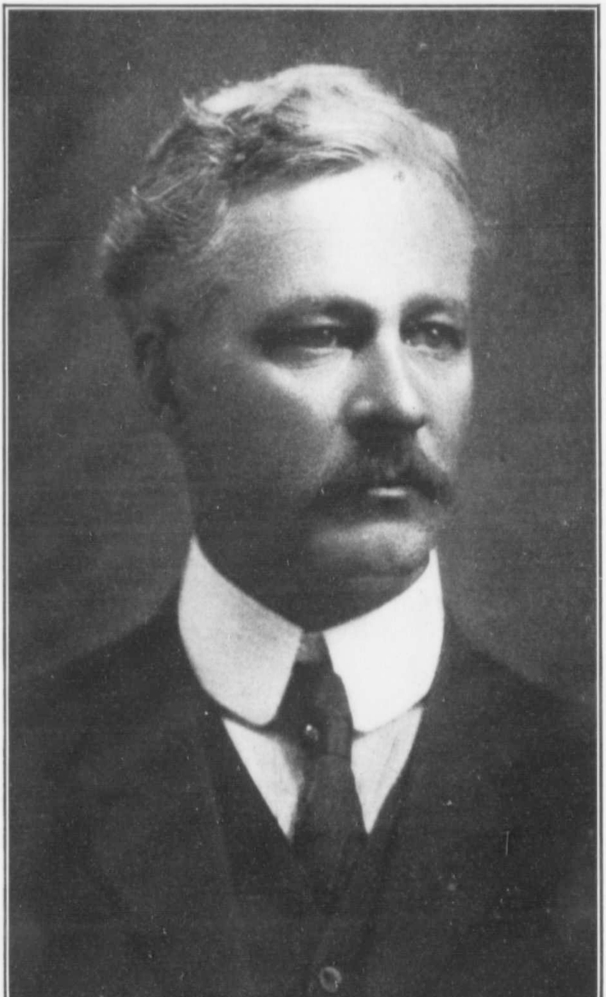
COMMISSIONER — L. N. DUPUIS



COMMISSIONER — JOSEPH AINEY

COMMISSIONER — CHARLES HERBERT GODFREY

MR. GEORGE JANIN
Chief Engineer of Public Works
Who Drafted the Remodelling of the Water Works



MR. THOMAS LESAGE
Superintendent of the Montreal Water Works, who co-operated with the Chief Engineer in the drafting of the plans.

INTRODUCTION

In compiling the history of the Montreal Water Works, from the year 1800—long before the supply was controlled by the city—to the year 1912, I have to thank officials of the Corporation for various documents I was freely given access to; and especially thank Chief Engineer Janin, and T. W. Lesage, Superintendent of the Water Works, for many valuable details of the modern improvements which will so radically remodel the system of distributing water. Past reports of former superintendents of the Water Works, and experts, have been of the greatest use in my work.

In the hope of making the history readable, and easily understood by the lay mind, I have endeavored to use as few technicalities as the nature of the work would permit.

THE AUTHOR.

The Montreal Water Works

THE RAPID INCREASE IN WATER CONSUMPTION

When it is considered that the consumption of water in the city has actually doubled in the short period of from 1903 to 1912, a very good idea is got, at the outset, of the grave difficulties which have had to be met by those at the head of the city's affairs.

That the water supply should, at times, owing to this immense growth, have been unsatisfactory, is not perhaps to be wondered at. Scarcely any great city faces a more serious and trying problem than that of furnishing a sufficient and pure supply of water to a population which is increasing by leaps and bounds. Such have been the troubles of greater New York, for instance, in the matter of getting a supply, that the huge sum of one hundred and sixty-one million of dollars have been set aside towards this end. Very many other big cities in the United States could also be quoted as spending enormous amounts in bettering water conditions.

In Montreal the doubling of the water supply in ten years, as stated, as well as the actual doubling of the population during the selfsame period, have been trying factors, which have called for much serious thought on the part of the administration, as well as considerable feats of engineering skill, both by the city's own engineers and by experts.

Before going into details it may be stated that so extensive are the improvements now under way that, when completed, in a couple of years' time, there will be a pumping capacity available of one hundred and fifty million gallons daily—instead of fifty million gallons as at present. This fine power will be got entirely from hydraulic sources. The city will have at its command ten thousand horse power. This will leave fully four thousand horse power over and above what will be required for pumping, and which it is contemplated will be used to light both the public parks, buildings, etc., as well as the streets. If not used in this way the surplus power can be sold.

At the time of this writing the lateral conduit, which stretches from Montreal to Lachine, has been completed; as has the new intake pipe which taps the waters of the St. Lawrence twelve hundred feet from the shore. The details of these works, with new ones now in progress, will be given later on.

WATER CONSUMPTION IN FIGURES

That the water consumption has indeed doubled since 1903 is demonstrated by the following table:—

COMPARATIVE TABLE SHOWING THE AVERAGE DAILY CONSUMPTION FOR EACH YEAR AND EACH MONTH, FROM THE 1st JANUARY, 1903, TO 31st DECEMBER, 1912.

Month	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Jan......	23,542,348	26,496,502	28,832,718	28,553,531	32,507,081	32,694,091	35,499,010	37,256,346	41,044,850	45,692,293
Feb......	23,661,544	27,260,690	30,205,679	30,634,541	33,432,591	37,182,021	40,617,334	37,619,614	42,413,782	48,913,065
March....	23,535,014	27,135,786	30,135,371	29,532,158	29,859,717	34,309,719	34,862,971	37,373,753	40,937,127	46,948,661
April.....	23,563,253	26,100,900	29,528,318	32,970,316	32,048,147	34,074,356	30,312,696	37,005,706	40,631,535	46,007,158
May......	24,781,331	27,225,649	28,788,091	28,820,956	33,028,795	34,752,346	36,833,585	36,150,977	40,902,958	44,319,596
June.....	25,061,286	28,942,790	29,735,267	30,764,787	35,321,216	37,700,762	37,582,154	38,634,237	43,098,605	46,926,174
July.......	26,668,567	29,065,558	31,621,981	33,155,508	37,744,269	38,954,410	37,304,326	41,172,303	44,587,396	49,608,370
August...	25,158,543	28,783,469	34,066,536	34,233,793	34,736,000	36,216,214	43,616,833	40,674,482	46,235,876	48,043,414
Sept......	25,577,168	28,716,992	31,981,992	34,621,201	35,458,367	37,806,794	40,269,779	40,048,102	44,150,964	49,463,958
Oct......	24,903,143	27,050,384	30,262,925	33,122,478	36,874,233	36,559,731	37,706,269	39,566,358	45,659,572	44,704,340
Nov......	23,983,555	27,198,482	28,568,905	31,684,345	34,628,606	34,470,555	33,895,026	38,671,510	42,762,680	44,686,800
Dec......	24,388,196	28,588,076	28,220,612	32,764,078	33,317,212	33,448,485	32,426,335	38,465,010	41,285,099	52,896,459
Av'g.....	24,568,662	27,713,759	30,189,435	31,755,190	34,081,889	35,671,707	36,743,860	38,634,444	42,814,079	47,350,856

ANNEXATIONS SINCE 1883

The very rapid growth in the area of the city, and why the city now lays claim to the title of Greater Montreal, is shown by the following table of annexations:—

Name of Municipality	Year Annexed	Acres
Hochelaga	1883	1230
St. Jean Baptiste	1886	308
St. Gabriel	1887	330
Cote St. Louis	1894	850
Villeray	1905	60
Petite Cote	1906	185
Ste. Cunegonde	1906	124
St. Henri	1906	450
Sault au Recollet	1906	863
St. Laurent	1907	960
Sault au Recollet	1908	313
Rosemount	1908	249
Cote des Neiges	1908	1143
De Lorimier	1909	391
Rosemount	1910	1431
Longue Pointe	1910	4551
Ahuntsic	1910	726
Bordeaux	1910	868
Paroisse St. Laurent	1910	877
Cote des Neiges	1910	1420
Notre Dame de Graces	1910	2536
St. Paul	1910	263
Emard	1910	951
Cote St. Luc	1912	373

The city when these annexations took place, in 1883, was composed of 3,494 acres. Mount Royal was not included in this and was 464 acres.

INCOME FROM WATER

In the table given here it is shown that the income from water, from tenants, has practically doubled since 1902, and this in spite of the fact that, four years ago, the rate to tenants was reduced by one third:—

Year	Income
1902	$ 662,467.11
1903	706,285.49
1904	737,518.15
1905	792,649.33
1906	849,222.70
1907	885,686.24
1908	786,825.16
1909	860,925.60
1910	934,362.14
1911	1,037,436.56
1912	1,076,539.14

While, in 1900, there were only 200 miles of streets, the estimated area in 1912 is 470 miles.

The assessed valuation of property in 1912 was $643,988,370, as compared with $505,091,410, in 1911.

In 1902 the population was estimated at 277,829; while in 1912 the estimate is in the neighborhood of 600,000.

Despite the fact that the Montreal Water & Power Co. supplies nearly a third of the population with water (both inside and out of the city limits), the Consumption of water in Montreal has doubled, as noted, in the wards which the Corporation supplies.

PUMPING PLANT IN 1912

As it is now the city's intent to do all of the pumping by hydro-electric power, it will be of interest to note, especially for the future, what is the steam pumping plant of to-day.

The plant situated at the low level pumping station, Point St. Charles, is here seen:—

Engine No. 1, erected in 1886, 10 million gallons, high duty, Worthington.

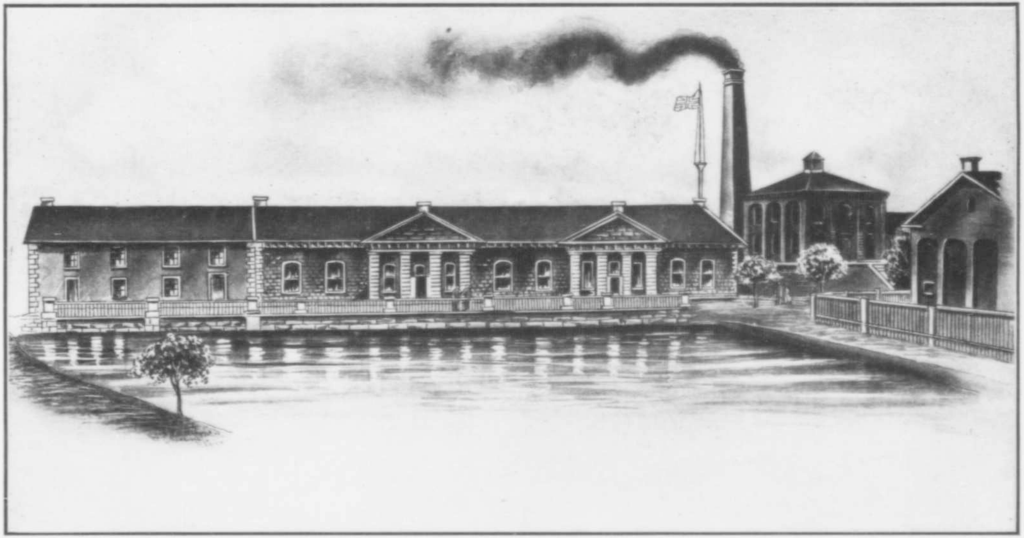
Engine No. 2, erected in 1894, 10 million gallons, high duty, Worthington.

Engine No. 3, erected in 1875, 8 million gallons, low duty, Worthington.

Engine No. 4, erected in 1905, 12 million gallons, high duty, Worthington.

Engine No. 5, erected in 1909, 12 million gallons, turbine with Bellis-Marcum engine.

Engine No. 6, erected in 1912, 12 million gallons, turbine with Bellis-Marcum engine.



View of Low Level Pumping Station which is being Remodelled

HIGH LEVEL

McTavish St. engine No. 1, erected in 1889, 3 million gallons, Gilbert steam pump.

McTavish St. engine No. 2, erected in 1906, 5 million gallons, Electric turbine.

Papineau St. engine No. 1, erected in 1911, 6 million gallons, Electric turbine.

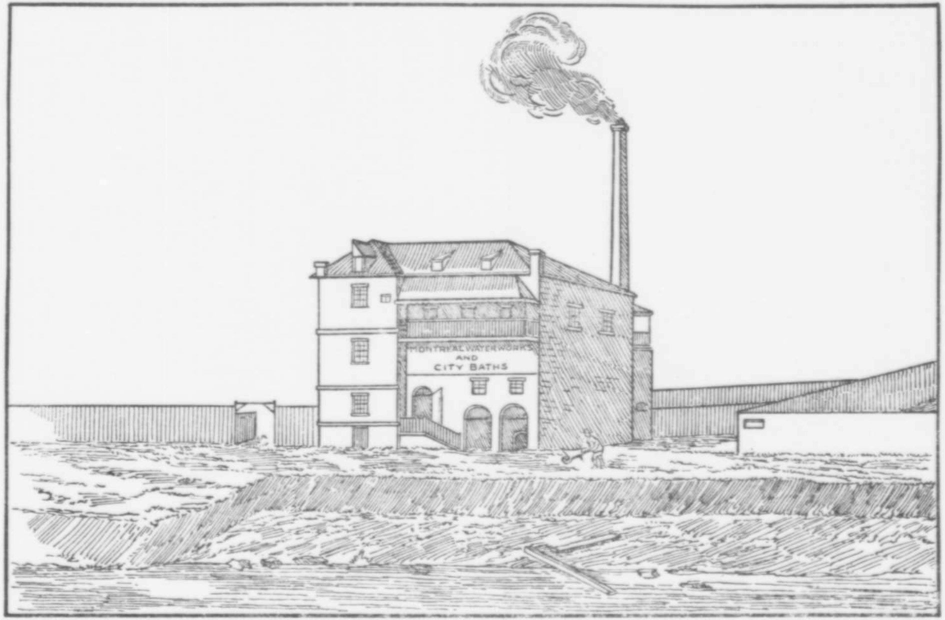
The above brief details may perhaps serve as a good background for the primitive efforts that were made to obtain a water supply over a century ago.

THE YEAR 1800

At the beginning of the present century, when Montreal was a town of about nine thousand inhabitants, who lived mainly within the old fortifications, or, in other words, within the area bounded by the sites of McGill street, Fortification lane, Berri street and the St. Lawrence, the only means provided by the municipality for the supply of water consisted of public pumps at Place d'Armes, the Market Place (now Place Royale), Notre Dame street near the Court house, St. Jean Baptiste near St. Paul street, and a couple of other points. For the rest the citizens supplied themselves with water from private wells and cisterns, and by watering carts from the St. Lawrence, and the creeks, the principal of which was the Petite Riviere which ran where Craig street now is. The selling of water in big puncheons was a common and quaint custom of these early days.

BEGAN TO TALK WATER WORKS

In 1800, after considerable talk about forming a water works, an act was passed incorporating Joseph Frobisher (one of the founders of the Northwest Trading Company and builder of Beaver Hall) and his associates, under the title of the Company of Proprietors of the Montreal Waterworks. The capital invested was six thousand pounds with power to increase to forty-eight thousand pounds. An exclusive franchise was given for fifty years. The system decided upon was that of gravitation. Water was obtained from a pond in the rear of the present Cote des Neiges village, and was brought to the city through wooden pipes laid around the southern slope of the mountain, via Monklands and Cote St. Antoine road, to cisterns which were placed one on the corner of Guy and Dorchester streets, and the other on Notre Dame street, just west of Dalhousie square.



MONTREAL WATER WORKS — Steam-mill and Baths—It was in use in 1833 and stood on Commissioners St.

The company's trouble soon began. The supply, which was from a well, was most precarious, while the frequent bursting of the wooden pipes finally resulted in the enterprise becoming a failure.

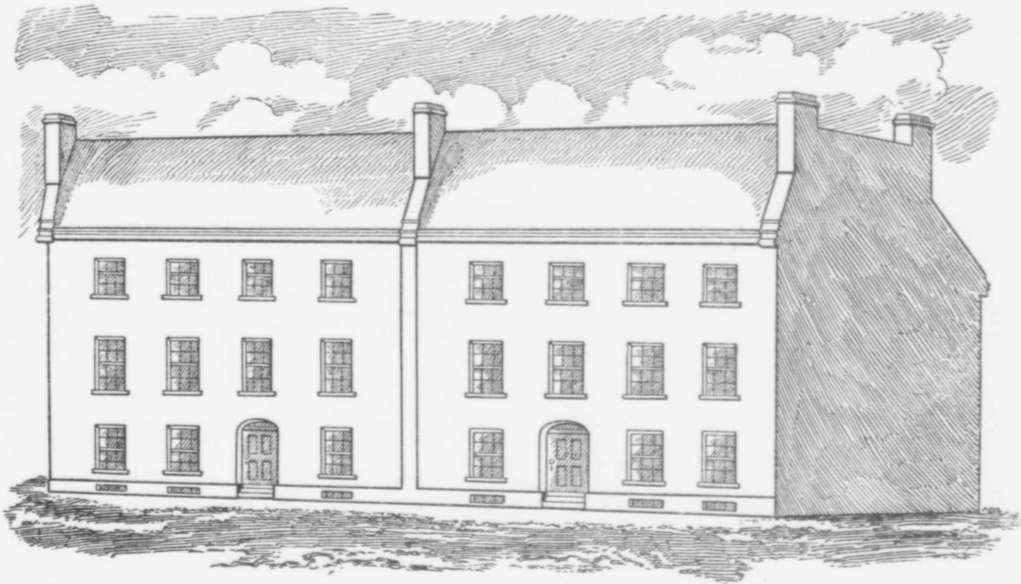
In 1816, the water works, and unexpired franchise of thirty-five years, were offered for sale; and in the year 1819 they were purchased by a new company under the management of Mr. Thomas Porteous for five thousand pounds. This company abandoned the gravitation supply from the spring and instituted a steam pumping plant, the engines of course being very primitive. The supply was got from the St. Lawrence in the near vicinity of the city. Instead of wooden pipes, four-inch iron pipes were substituted, and wooden cisterns were then erected on Notre Dame street east of Bonsecours street. The cisterns were found to be very weak and were finally replaced with other wooden cisterns, but they were lined with lead. The capacity of the cisterns was 240,000 gallons. The pumping engine was placed on the West corner of water and Friponne streets. The amount expended by Mr. Porteous was about forty thousand pounds. The four-inch pipes put down soon proved insufficient; other troubles ensuing, this company also sold out. The plant was advertised for sale and was bought in by Mr. J. Haynes for sixty thousand dollars. Mr. Haynes quickly floated a new company which replaced the small pipes in the streets by pipes of ten inches diameter and installed a more powerful engine. In 1843 two engines were at work with a pumping capacity of 93,000 gallons. By this time there were laid in the streets fourteen miles of pipes.

In 1843 also the first agitation was started for the city to own the waterworks. It was kept up till 1845, when the municipality made an offer of fifty thousand pounds for the plant which was accepted.

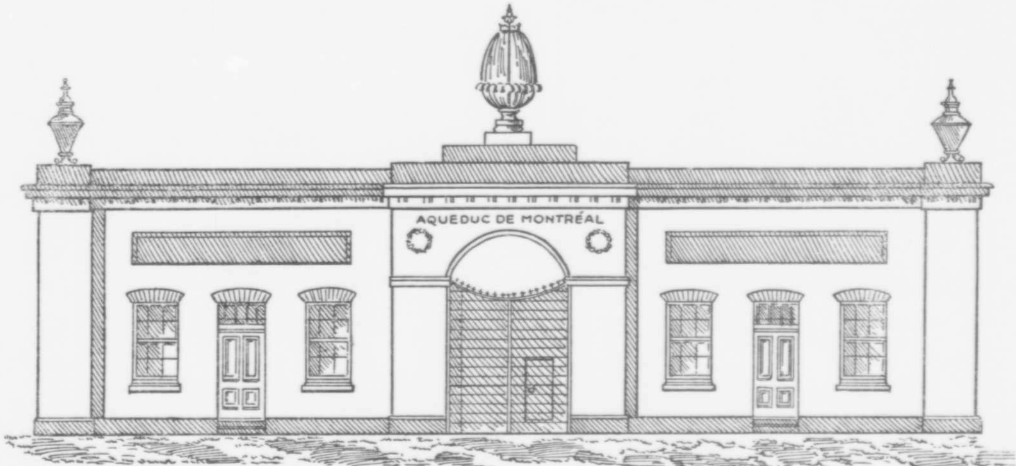
HISTORIC OLD STRUCTURES

For the sake of posterity it will be interesting to produce sketches of the quaint buildings that were used in the early days for the storing of water. The peculiar looking structure here shows a combination steam mill and bath as it stood in 1833. It was an old mill and was situated on Commissioners street near Friponne. It was pulled down some years ago to make room for the C. P. Ry. The building was four stories in height. Water was pumped at the structure from the river near the bank.

The three story house was occupied, in the year 1883, both as a storage for water and as a dwelling. The building almost



MONTREAL WATER WORKS — In use in 1833 and stood facing the Notre Dame Hospital, Notre Dame St.



MONTREAL WATER WORKS — **The Private Company's Offices and Workshops which stood on Notre Dame St. in 1833**

faced the present Notre Dame Hospital. The two upper stories were altered so they could contain two large cisterns, each containing about one hundred thousand gallons of water. The lower floor was used as a dwelling house.

The sketch showing the gateway with the windows and a door on each side, was what was termed the corporation's offices. Over the gates are the words Montreal Water Works. The structure in 1833 stood on Notre Dame street exactly next to the house where the cisterns were. The building has long ago disappeared.

HISTORY UNDER CIVIC CONTROL

In 1847, two years after the civic authorities of Montreal had taken over the primitive plant, the Water Committee made a report to the City Council suggesting that a premium be offered for the best plan to force water from the St. Lawrence into a reservoir on the mountain. The idea was to get water power from the Lachine Canal. The suggestion was deemed unpracticable and not acted upon.

In the year 1849 the city constructed a reservoir on what now is St. Louis square. Its height was 130 feet above the St. Lawrence and its cost was three thousand pounds. By the year 1850 the corporation had laid nineteen miles of iron-pipe and six miles of lead pipes. The reservoir had a capacity of three million gallons.

In the year 1852, the year of the great fire when much of the waterworks system had been destroyed, the services of Mr. Thos. C. Keefer were procured by the city to draft a plan whereby the city could get an entirely new water supply. The plan he proposed was adopted and has practically been in operation up to the present, when it is being drastically changed. The system consisted in an open canal having the entrance about a mile and a half above the Lachine Rapids. The canal, or aqueduct, which was 4¾ miles long, ended at a building called the Wheel House. This building contained two vertical hydraulic wheels operating a set of six pumps having a capacity of four million gallons a day. The water was raised through a main of twenty-four inch diameter, and ended at a reservoir where the present McTavish reservoir stands. The construction of these works lasted until 1856 and cost $280,236.53. The elevation of the aqueduct was 37 feet above the level of the harbor. The dimensions of the aqueduct were 40 feet wide at the water surface and eight feet deep. The canal furnished more than sufficient power to develop 300 horse power, and to raise 200 feet above the level of the water, in the harbor, 5,000,000 imperial gallons of water, being at the rate of 40 imperial gallons per capita. The hydraulic motive power was utilized by two breast wheels working six pumps. The old works were of course abandoned, and the pumping engines and reservoir on Notre Dame street, with their sites, were sold for the very modest sum of $23,320. The whole new system had been well devised and the supply of water, indeed, was sufficient for a population twice as large as it was then; but troubles soon cropped up. Owing to the blocking up of the ice in the aqueduct, the formation of frasil and the annoyance caused by the backing up of water in the Little St. Pierre river, the supply in winter frequently only averaged three million gallons. The channel of the Little River St. Pierre was deepened in 1857 and 1858, but not sufficiently to get rid of the back water in question. In the winter of 1863 a tailrace was cut to the river which greatly ameliorated conditions. In 1862 and 1863, owing to increased population and ice blocks at the entrance of the intake, however, the supply of water became so uncertain that the ancient custom of supplying water in puncheons had to be resorted to. This state of things naturally caused a great deal of trouble and annoyance, to say nothing of the additional expense to the city. In 1866 the consumption had actually reached five million gallons a day, with the result that the supply was once more quite inadequate. In this year the superintendent of the Water Department made a strong plea for the purchase of steam engines; he held it was the only way that the water famines, through which the city was passing, could be prevented. Had there been a sufficient head of water in the aqueduct to get enough power, the plea for steam would not have been made, owing to its very heavy cost.

It was in 1868 that the first steam engine was installed, and some relief was experienced.

Little by little other steam pumps were added, but so steady was the growth of population that there were constant fears of a shortage of water.

CONSTRUCTION OF THE RESERVOIRS

The pressure on the pipes having been constantly unsatisfactory, and owing to the city expanding towards the higher levels, the construction of the present reservoirs had been decided upon. The reservoir called the McTavish reservoir is of oblong shape with semi-circular ends, and so placed in the mountain slope that the surface of the rock is about level with the water surface on one side, and with its bottom on the other. The natural rock was used as a wall on the upper side, but on the lower side the water is maintained by a masonry wall which

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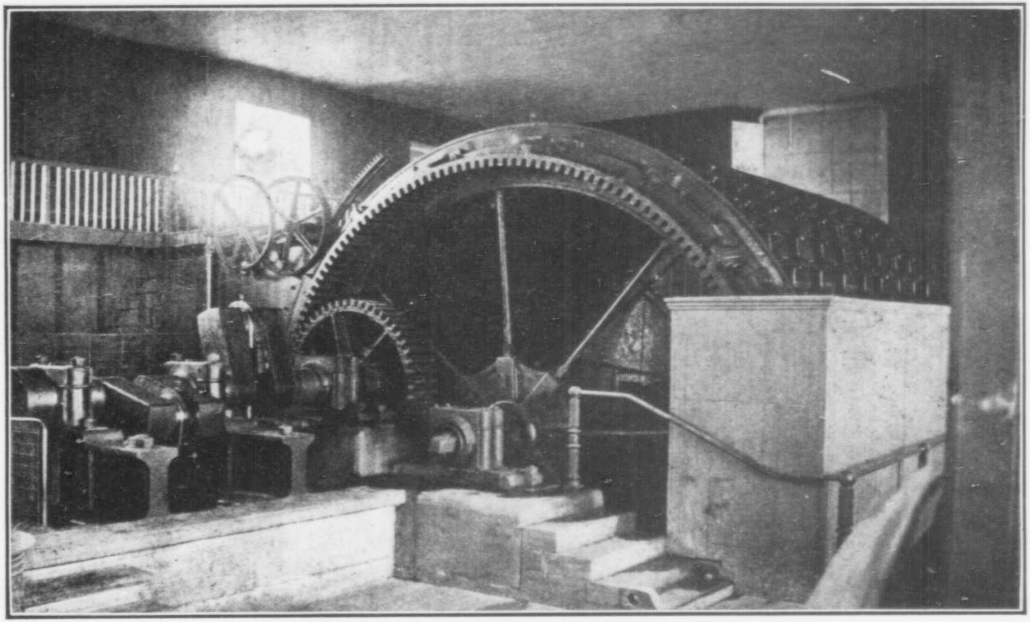
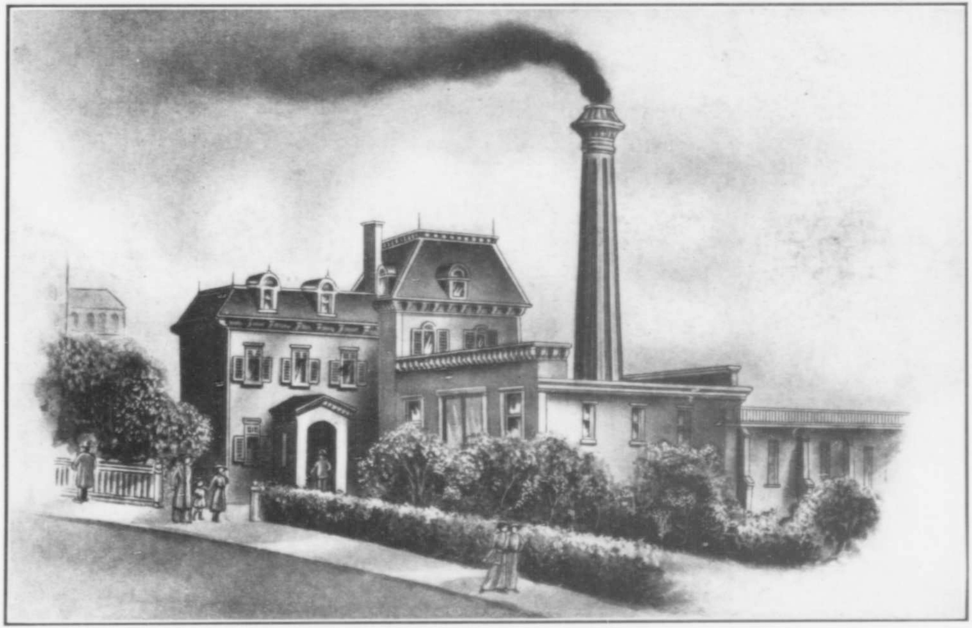


BREAST WHEEL, MONTREAL WATER WORKS



The Present Upper Level Pumping Station, McTavish Street

is solidly banked. The reservoir was divided transversely into two equal parts by a masonry wall, and when first completed contained thirteen and a half million gallons. Later on extensive enlargements were made, until to-day its capacity is thirty-seven million gallons. Its elevation when full is 204 feet above the harbor. The entire cost of the reservoir is about one million dollars. Under the gatehouse, which stands on the reservoir wall, is a well or distributing chamber. Into the bottom of this well the main pipes from the pumps are led, and opposite to them is a separate passage to each division of the reservoir. The pipes and passages are all controlled by gates, and by their means the water is turned off and on each division or main pipe, as may be desired. The water from the pumps at the Wheel House does not go first to the reservoir and thence to the city; the reservoir merely takes the overflow water from the pumps at the Wheel House and stores it for further use. In other words it is a safety supply which the city can depend upon in the event of sudden breakdown of pumps. But the big reservoir, even when full, could not supply the city now for two days.

What is termed the High Level reservoir is considerably farther up the mountain than the McTavish reservoir. It was found necessary to construct this in order to supply the district above Sherbrooke street; as the McTavish reservoir was at such an altitude that it could not give the required pressure for the more elevated districts of the city. The High Level reservoir draws its supply from the McTavish reservoir. Its pumping station is at the McTavish, and it is equipped with one five million and one two million gallon pumps. At the pumping station at the Wheel House there are six steam pumps. The High Level reservoir is two hundred and twelve feet higher than the McTavish, or four hundred and thirteen feet above the harbor. Its capacity is one and three quarter million of gallons. Like the McTavish it is built in the solid rock and is a most substantial structure.

VARIOUS PROJECTS OF ENLARGEMENT

Having described the construction of the two mountain reservoirs, and their equipment to date—1913—it will be necessary, in order to give a clear idea of the progress in improving the water works, to go back to 1868 when the first steam engine was put into commission. As stated the population at this time was such that the five million gallons, which the aqueduct supplied, was again found to be insufficient, and dearth of water was again complained of by the populace.

After much discussion, in which expert opinion was employed, and after the lapse of considerable time, the five following schemes were submitted to the city in order to greatly augment the supply:

1. Securing of additional motive power by means of the Lachine Rapids.

2. Bringing water by gravitation from the heights of the Laurentide mountains by means of gravitation.

3. Blocking up the area of the river between its right bank and the Heron Island.

4. A new covered aqueduct parallel to the existing one.

5. Building cribs along the river, for a distance of two miles, for the purpose of obtaining an additional fall of three feet.

This last project was submitted by Superintendent Lesage, and consisted in opening the entrance to the existing aqueduct about three thousand feet higher up the river, and in widening to 100 feet the water line of the aqueduct along its entire length—over four and a half miles. The water surface was to be 130 feet; 78 feet wide at bottom and 14 feet deep. The dimensions would have provided sufficient power to supply thirty million imperial gallons. The work of constructing this greater aqueduct was divided into three distinct sections. The first section from the mouth of the "intake" was to be 4,800 feet in length. The second section, known as "the rock cut," was to be 9,400 feet, and the third and final section, which was to end at a big reservoir at the Wheel House, was to be 11,700 feet. The entire work was to cost $1,850,193.

In 1877 the work on this plan was at last begun, the new entrance to the aqueduct was made, but only the first section was ever completed—that was 4,800 feet. The cause of the interruption of the work was the constant change in the membership of the City Council, lack of funds and various other causes. At this time it was also proposed that two additional storage reservoirs, capable of storing a month's supply of water, should be built; but the idea was not favored.

By carrying the entrance of the aqueduct farther up the river, however, and by constructing the first section to the stated width and depth, there was a distinct improvement in the supply; but even this was not of a lasting nature. As years went by successive Water Committees discussed various other means of increasing both the quantity and quality of the water. A feature of the changing conditions was the necessity of adding additional steam pumps, at a greatly increased cost in pumping.

As troubles in regard to the supply continued right up to 1904, when Chief Engineer Janin outlined plans for a drastic remodelling of the whole system (which were adopted), it will make it more clear at this juncture to give a concise and comprehensive idea of what the plans actually were; later on explaining their details and the great engineering work and thought they entailed.

SCHEME OF IMPROVEMENTS OUTLINED

The schemes of improvements which were outlined by Chief Engineer Janin to the City Council from time to time are as follows:

Jan. 5, 1904—Report asking Council to take steps so action could be taken for the studying of a plan for the enlargement and widening of the present aqueduct, and the construction of a new lateral conduit.

Feb. 10, 1904—Report to the Mayor again asking for study of plan.

Nov. 22, 1905—Report containing the approximate estimate of the cost of enlarging the aqueduct, and also of producing sufficient electric power to pump at least fifty million gallons of water in twenty-four hours. With this report was outlined the economy which would result from the project, demonstrating that it would provide for the payment of the interest on the capital of two million dollars, and the reimbursing through the sinking fund of the loan in less than forty years.

March 18, 1906—New request from the Water Works Committee for funds to make a study of the project. The voting of $2,000 to make the preliminary study.

Dec. 12, 1906—The Legislation Committee approves the proposal for borrowing two millions to start on enlarging of the aqueduct. Action of this committee sanctioned by the City Council.

Feb. 20, 1907—The Private Bills Committee of the Provincial Legislature sanctions the borrowing of the two millions, but subject to the vote of real estate owners.

Feb. 29, 1907—Legislative Assembly confirms the action of the Private Bills Committee.

March 9, 1907—The Legislative Council amends the measure not making it necessary to submit the proposal, as to the borrowing of the money, to the real estate owners.

March 18, 1907—Report to the Montreal City Council giving further details of the enlargement and asking for a sum of $2,332,000.

March 19, 1907—Council authorizes the Water Committee to employ experts to report on said plan of enlargement. Appointment made by Water Committee of Messrs. Kennedy and Marceau.

May 6, 1907—Report of Messrs. Kennedy and Marceau approving of the enlargement.

Oct. 3, 1907—Signing of contract for new lateral conduit by P. McGovern.

May 28, 1909—Report to Council on the necessity of enlarging the old aqueduct as the lateral conduit was near completion.

July 13, 1909—Voting by Council of five hundred thousand dollars to commence the enlargement of the aqueduct.

Sept. 21, 1909—Voting by Council of a further appropriation of $315,690 for enlargement, and awarding contract for same to Quinlan & Robertson.

July 2, 1910—Report of experts, Messrs. Hering & Fuller, on a scheme of supplying a purer water supply.

Nov. 3, 1910—Report to Council on the scheme to improve the purity of the water; together with another estimate for the enlargement of the aqueduct to increase the volume of water in the aqueduct so that 10,000 instead of 5,000 horse power could be got. Also pointing out that the greater power would enable the city to do a large amount of electric lighting.

Nov. 21, 1910—Council endorses the schemes as submitted. On the same date Council also voted $1,500,000 for the commencement of a filtration plant in order to purify the supply, and for going ahead with the scheme of widening the aqueduct on broader lines.

Four reports from Nov. 29 to Sept. 21, 1911, on plan of constructing boulevards along the banks of the aqueduct.

THE PROBLEM OF SECURING PURE WATER

All through the history of the supplying of the city with water, one of the most prominent features noticeable was the years of study which were given by various superintendents of the Water Department, expert engineers, and finally Chief Engineer Janin, to securing a satisfactory supply. From the very commencement of the supply complaints were heard from citizens as to the quality of the water given them, and the complaints but increased with the passing of years. On unnumbered occasions the water was blamed for outbreaks of typhoid. Tests of the water were frequently made, especially of later years. From the day the city constructed the aqueduct from the Wheel House, in St. Gabriel ward, to Lachine, and got water from the St. Lawrence, which on account of the intake being close to shore resulted in Ottawa river water being largely pumped, there was increased dissatisfaction with the supply. That there were good grounds for complaint was demonstrated by an exhaustive report that the late Dr. Wyatt Johnson made fifteen years ago. After long and interesting tests he wrote:

"Although our water supply is taken from the north shore of the river St. Lawrence, it is composed, during the greater part of the year, of the water of the Ottawa river, which discharges into the St. Lawrence about twenty miles above the entrance to the aqueduct, and forms near the bank a cleavage of water quite distinct from the pale green of the St. Lawrence, even while the latter undergoes displacements governed by the direction and force of the wind, and by the level of the water of the two rivers.

"During the winter, probably by reason of the pressure of the ice, the water from the Ottawa passes to the north of the Island of Montreal, so that the water supply of the city consists, during the months of January, February and March, almost entirely of the waters of the St. Lawrence."

A ONE YEAR'S TEST OF WATER

The following comparative table, prepared by Dr. Wyatt Johnson, showing, as it does, the number of bacteria found in the water, during the period of one year, is also very opportune and valuable.

					Bacteria per c. c.			
		Temperature of the Water. ° c.	Level of the water at Lachine in feet.	Reservoir.	Basin at rest.	St. Cunegonde.	St. Lawrence.	Average of the whole.
Dec. 1,	1890	4°.	12.0	8	313	473	265	204
Jan. 5,	1891	0°.	11.1	31	44	30	61	41
Feb. 2,	—	0°.	10.9	20	89	63	29	50
March 15,	—	0°.	12.2	185	164	316	577	310
April 13,	—	0°.	13.0	171	347	363	161	270
May 4,	—	10°.9	15.0	79	121	156	324	167
June 2,	—	13°.0	13.0	42	189	130	210	142
July 2,	—	18°.3	11.5	30	481	197	81	275
August 3	—	21°.0	11.5	92	119	101	85	99
Sept. 7,	—	18°.3	10.1	21	81	53	53	52
October 1,	—	13°.1	10.1	40	55	29	43	42
Nov. 25,	—	4°.	10.5	143	1132	1883	363	930

In explanation of the above table the doctor said:—

"The table shows that during the greater portion of the year the number of bacteria per c.c. of water varies from 100 to 200. At the commencement of the summer and in the middle of winter, the number falls considerably under 100, and during the spring and autumn this number rises to 1,000 and 2,000. This temporary increase coincides with the period of the heavy rains, which precede winter, and with the melting of the snow in springtime; that is to say, the increase coincides with the rise in the river." In conclusion he said that in case of epidemics, the water at certain seasons would become a most propitious vehicle for the breeding of disease.

In another report, made about the same time by Mr. McGill, analyst of the Dominion Government, occurs the following statement: "The water of the St. Lawrence is made almost dangerous by the waters of the Ottawa mingling with it." Before going further into the history, in connection with getting a pure supply, it may be said that the important works which are now in progress (1913) is to entirely do away with the citizens drinking the waters of the Ottawa River.

TO GET WATER FROM THE LAURENTIAN MOUNTAINS

As early as 1852, Mr. Thomas C. Keefer, with other experts, took up the idea of bringing water to the city from the Laurentian mountains, but the plan was declared infeasible on account of the immense cost it would entail. Superintendent Louis Lesage of the Water Department reported as follows in regard to the matter in 1871: "Although an abundant water supply can be got from the lake district, the cost to bring it to the city would be so enormous that it cannot be entertained." Mr. Lesage made a personal survey of two lake routes, the first from the River Ouareau, which was to be dammed eight miles above Rawdon, or forty-eight miles from Montreal, which had an elevation of 560 feet above the harbor of Montreal. He carefully detailed the route—which is not necessary to give here—by which the water was to be brought in pipes to Montreal. The second scheme was to get a supply from Lake Kilkenny, thirty-five miles from Montreal, which had an elevation of 830 feet above the harbor of Montreal. A third project, made by Mr. Charles Legge, an expert, was that water should be got from St. Jerome. St. Jerome is estimated as 277 feet above the harbor. The cost of the three projects was roughly estimated as follows:

St. Jerome	$ 9,325,000
Lake Kilkeny	10,592,000
River Ouareau	11,957,000

Reporting on the three schemes, Mr. Legge said that it would be far more feasible to get a supply from the St. Lawrence at some suitable spot.

LATER SURVEYS OF LAKE DISTRICT

Proposals to tap the lake districts for "pure" water continued up to 1897, when Superintendent J. O. Laforest touched upon it in his report; but no later survey was made till the year 1910 when Messrs. Janin, Lesage (present superintendent of the Water Works), Fuller and Hinckley made a five days' inspection. They went to St. Agathe, on the River du Nord, River Ouareau, and various upper lakes, and then down to Rawdon. It will be seen that their report showed conclusively that the "pure" water idea was a fallacy. They demonstrated that along the River du Nord there had been erected various industrial plants, and that small villages along the river "polluted" the water. It was declared to be a far less suitable source of supply, as regards quality, than the St. Lawrence river at the shore, or at any place off shore. This lake water indeed would actually have to be filtered. To filter a supply sufficient for Montreal would cost more than the cost of pumping water from the St. Lawrence and filtering it. In the watershed district, near the lakes, it was estimated there was a population of 3,500. There was also a large summer population. In the drainage area there were a large number of swamps. These draining into the lakes caused marked discoloration. The water was also contaminated by the logging industry. Samples of water were taken for chemical, bacteriological and microscopical analysis. The following brief table, compiled by Messrs. Hering and Fuller for the city, showing the analysis of the water, demonstrates its constituents.

RESULTS OF ANALYSIS OF SAMPLES OF WATER COLLECTED FROM LAKES AND FROM OUAREAU RIVER AND TRIBUTARIES.

Sample Number	Date (1910)	Parts per Million							Bacteria per Cubic Centimeter
		Color	Oxygen Consumed	Free Carbonic Acid	Alkalinity	Incrustants	Magnesium	Chlorine	
1	May 22	26	7.4	3.0	4.5	0.0	0.2	0.6	15
2	" 23	23	5.9	2.0	10.0	0.0	1.2	1.8	95
3	" 24	33	6.5	0.5	7.0	0.5	0.0	0.8	575
4	June 7	60	8.9	1.0	7.0	0.9	2.3	3.0	450
5	" 15	53	7.0	1.0	14.0	0.5	1.8	3.2	460
6	" 25	47	6.0	2.0	9.5	15.0	0.5	1.7	130
7	May 22	—	—	—	—	—	—	—	28
8	" 23	—	—	—	—	—	—	—	1,900
9	" 23	—	—	—	—	—	—	—	660

NOTE—Source of Samples: 1, Lake Ouareau; 2, Lake des Isles; 3, Ouareau river above Rawdon; 4, ditto; 5, ditto; 6, ditto; 7, Lake Archambault; 8, Jean Vienne river; 9, Ouareau river above junction with Jean Vienne river.

TYPHOID FEVER GERMS

In this lake district typhoid fever, in scattered cases, was found. Owing to the increase of population there was a danger of the disease being still more dangerous to the water supply. In conclusion these experts say: "This water would not be of a safe hygienic character for a municipal water supply." What it would cost to develop 100 million gallons for a daily supply to the city from the water shed is demonstrated by the following table:

Dams and reservoirs at and above Rawdon.......	$ 1,620,000
Filtration plant near Rawdon....................	2,470,000
Steel pipe lines, Rawdon to Montreal............	10,040,000
Damages to water power due to diversion........	1,050,000
Damages to lumber industries...................	500,000
	$15,680,000
Contingencies and engineering, 15%.........	2,352,000
	$18,032,000

It will be seen later on that by the improvements which are now being conducted, citizens will get filtered water from the middle of the St. Lawrence at enormously less cost.

As a final word on the long-drawn out discussion in regard to bringing water from the Laurentides, it may be said that in 1911, Chief Engineer Janin said in a report: "The legend of the lucid water of the Laurentides lakes will have to be laid aside because its price would be extravagant, and its supply would certainly not be superior to the present supply. I would remark that the pollution of these lakes is so notorious that Professor Girdwood himself, in his testimony before the Royal Commission, declared that the members of his family had contracted typhoid fever during a sojourn in the region, having used lake water."

REMODELLING THE ENTIRE SUPPLY

It having been demonstrated, after years of research, that it would be most unwise to spend enormous sums in getting an unsatisfactory supply from the Laurentides, we are now brought to the year 1904, when the City Council seriously considered various proposals from the Chief Engineer of the city, Mr. Janin, to do away with old conditions of supplying water and inaugurating new ones. As it has already been shown, in condensed form, the various reports Mr. Janin submitted on the subject, and as they can be obtained as per the dates specified, it will be more simple, and consequently more easily understood, if the history of the modern improvements is given with as few tiresome technicalities as possible.

Complaints, then, both against the quantity and the quality of the water being continued right up to 1904, the City Council, early in the year, asked the Chief Engineer to report on the advisability of establishing a filtration plant, the probable cost of same, and what species of system would be the best for the city to select.

In replying to this it was necessary for the Engineer to open up the subject not only of the purifying of the water, but of the following urgently needed improvements as well:

1. Building of a lateral conduit from the Wheel House to Lachine.

2. Enlargement of the aqueduct to ensure a greatly increased supply.

3. Extending the intake pipe out into the middle of the St. Lawrence.

4. Substitution of steam power for hydraulic power in pumping, thereby effecting an immense saving.

5. Construction of boulevards on both sides of the widened aqueduct.

6. Finally, as already mentioned, plans for filtering the whole of the supply from the new intake; construction of filtration basins, etc. The whole of these proposals (except the building of the boulevards, which is still pending) were approved of by Council. As more than one scheme was discussed by Council at a time, it will be more simple to take up each project separately, and show the action taken upon it, than give the complex manner, with tiresome dates and details, which Council found it of course necessary to adopt.

THE FILTRATION PROBLEM

As the Chief Engineer was first asked to report on filtration plans the history of this will be first dealt with.

After showing that filtration had been urged by past administrations, Mr. Janin went into considerable details as to the various methods in vogue, and saying there were two particular systems which would be suitable for the city to select from. The first plan was the purifying of water by percolation through sand. With sedimentation basins the cost of same would be about $700,000.

The second method was "mechanical" filtration. This plan was much more expensive than the first; but was becoming more and more popular. After making various other reports on the matter he finally asked that filtration experts should be appointed to study his plans and report on their feasibility to Council.

Council acted on the suggestion, and Messrs. Hering and Fuller of New York were engaged for the purpose. In their exhaustive studies they fully endorsed the various recommendations made by Mr. Janin.

SOURCE OF CITY'S SUPPLY

Prior to taking up the report of Hering and Fuller a short sketch of the source of supply from the St. Lawrence will be opportune.

This great river, from the junction of the mouth of the Ottawa river, drains the large area of 510,000 square miles. Its average width is about two miles. From the city's intake it expands into Lake St. Louis, which is from four miles to seven miles in width. Another lake, Lake St. Francis, is some thirty-five miles above the intake. Its average width is eight miles. Above this lake are a series of important rapids. The water of the St. Lawrence is normally quite clear. It is somewhat hard, however, and its alkalinity averages about 95 parts per million. The ordinary stream flow of the St. Lawrence is estimated at the great volume of half a million gallons per second.

The Ottawa river, of whose waters the city had largely to consume prior to the remodelling of the system, is far less satisfactory than the St. Lawrence, for domestic use. The area the Ottawa river drains is about sixty thousand square miles, and it has an average width of a little over half a mile for a distance of 100 miles above Montreal. A considerable portion of the waters of the Ottawa flow to the north of the Island of Montreal through the Back river. The Ottawa has highly colored waters due to the logging industries, swamps, timber lands. Sawdust deposits are quite noticeable in the river. It will be seen by the following table the percentage of Ottawa and St. Lawrence water which the city tapped, at different months, at the old intake:

Month. 1904	Percentage Ottawa River Water.	Percentage St. Lawrence Water.
November	76.4	23.6
December	56.5	43.5
1905		
January	60.7	39.3
February	10.1	89.9
March	4.4	95.6
April	93.7	6.3
May	90.0	10.0
June	50.0	50.0
July	28.5	71.5
August	36.0	64.0
September	34.2	65.8
October	42.2	57.8

The above table, coupled with what has been said about the waters of the Ottawa river not being suitable for cities, readily demonstrates the necessity there was of this city doing away with the old intake and of filtering its water.

As might have been expected, owing to the unsatisfactory water supply, the number of typhoid cases in the city for many years past has not been as low as could have been desired, when compared with many of the large cities of Europe where hygienic conditions are more perfect. The following table gives the number of cases of typhoid, and deaths, from 1900 to 1912 inclusive:

Year.	Cases.	Deaths Percentage.
1900	123	42.6
1901	130	43.7
1902	86	30.9
1903	90	31.4
1904	94	31.8
1905	55	18.1
1906	130	37.0
1907	122	33.2
1908	126	33.2
1909	212	53.6
1910	192	42.12
1911	124	26.35
1912	94	19.40

It will be observed that in 1909-10 the disease assumed the form of an epidemic.

FILTRATION DESIRABLE

That filtration of the city's water was desirable was readily admitted by Messrs. Hering and Fuller after an exhaustive study of the matter, and upon which they founded a most comprehensive report. The various methods of filtration were explained to the City Council and Board of Commission with clearness and comprehension.

In this study it is shown that in regard to sand filtration it has been practised in Europe for over fifty years, and for some thirty-five years in America. The system consists essentially in allowing water to flow downward through beds of sand of medium sized grains. Generally speaking the land layers or beds are from three to five feet in depth, and water of a similar depth is ordinarily maintained at a constant level above the surface. In large installations the sand beds are usually divided into units of about one acre each. Generally such filtration basins are covered with masonry, which are most useful to prevent impurities contaminating the water, and which makes it easier to cleanse the plants. The rate through which the water flows through the sand beds varies in the case of different plants. In the majority of cases the flow corresponds to a range of from about four to eight inches vertical velocity, per hour—equal to about 2,200,000 to 4,300,000 imperial gallons per 24 hours. The compositions of various waters, however, had much to do with the problem as to what kind of a filtration system would be the most useful; this particularly applied to Montreal which was taking its water near the shore, but which contemplated a new intake further out into the river where the quality of the water was much different. The popularity of filtration was shown by the fact that, to-day, some thirty-two millions of people in Europe were using filtered water; in fact there were very few important cities which did not filter their supply. In the early years the simple sand filters, which was being discussed, were regarded largely as "strainers" only; though it is now known they produce a beneficial effect upon its quality as well. The establishment of the "germ" theory of disease with "water" born diseases gave an entirely new complexion to the whole question of water purification by filtration. Sand filters are no longer regarded as mere clarifiers. It is now known that they remove not only silt, clay, surface washings, etc., but a considerable amount of vegetable stain as well. Simple sand filtration has also demonstrated its ability to remove disease producing germs to a very large degree. This has been proven by extensive studies both in Europe and on this continent. A number of instances are quoted by the experts in question to demonstrate this.

The removal of bacteria by sand filtration is of course one of principal importance. There have been filtration systems which have removed as much as 98 and 99 per cent.

The short table here given shows the marked manner typhoid fever was reduced in three cities which have installed single filtration plants.

DEATH RATES FROM TYPHOID FEVER PER 100,000 POPULATION IN CITIES USING FILTERS

City.	Plant Completed.	Years in Average.		Typhoid Fever Death Rates.	
		Before Filtr.	After Filtr.	Before Filtr.	After Filtr.
Albany, N.Y....	1899	10	9	90	22
Lawrence, Mass.	1893	7	15	114	25
Pittsburgh, Pa..	1907	8	1	133	47

Much interesting information is given by Messrs. Hering and Fuller as to the method of cleaning filtration plants, but being of a technical nature will not be necessary to dwell upon here.

MECHANICAL FILTRATION

The second system most in vogue, mechanical filtration, is then taken up and explained. The single method is first gone into.

Mechanical filtration also employs sand in water purifying, but in a different manner to the simple system of purification. The layers of sand in mechanical filters varies from 30 to 36 inches in depth. The water passed through these filters is of a much more rapid rate than in the plain filters. The ordinary rate for mechanical filters is about 1.7 imperial gallons per square foot per minute, corresponding to a vertical velocity of 16 feet per hour, or about 104 million imperial gallons per acre daily. This process consists in allowing filtered water to pass upward through the sand at a sufficient high velocity to float the sand grains of the entire layer, and to remove the greater portion of the suspended matter attached to the grains, by a stirring process accomplished either by means of compressed air under low pressure, or by revolving rakes, or by the use of a high velocity of the applied wash water. The origin of mechanical filters is traced to the United States some thirty years ago. At the present time there are some 350 such plants in operation in America. The following table shows how typhoid has been cut down in cities of considerable population, by the use of mechanical filters.

City.	Plant Completed.	Typhoid Fever Death Rates.	
		Before Filtr.	After Filtr.
Binghamton, N.Y.	1902	47	15
Cincinnati, Ohio.	1908	50	16
Columbus, Ohio.	1908	78	20
Paterson, N.J.	1902	32	10
Watertown, N.Y.	1904	100	38
York, Pa.	1899	76	22
Hoboken, N.J.	1905	19	14

DOUBLE FILTRATION SYSTEM

So the Board of Commission and the City Council might be in a still better position to judge of what system was the best to select, the experts went into what is termed the double mechanical filtration method. By this plan, in brief, the water is filtered twice instead of once. The fluid, to be more explicit, first passes through a preliminary filter and then through a final filter. Sand beds of course are used.

The important question of cost of a plain and of a double system is then treated. The plain system, having a capacity of 50 million imperial gallons daily, would entail a cost of $1,692,800, as here shown:

Low-lift pumping plant, complete	$ 102,000
Sand filters, 11 acres, including sterilization equipment	1,115,000
Office and laboratory	25,000
Filtered-water reservoir	105,000
Piping connections between conduit, pumping station and filters	75,000
Drains, conduits, roads, walks, heating and lighting	50,000
	$1,472,000
Contingencies and engineering, 15%	220,800
Total estimated cost, exclusive of land	$1,692,800

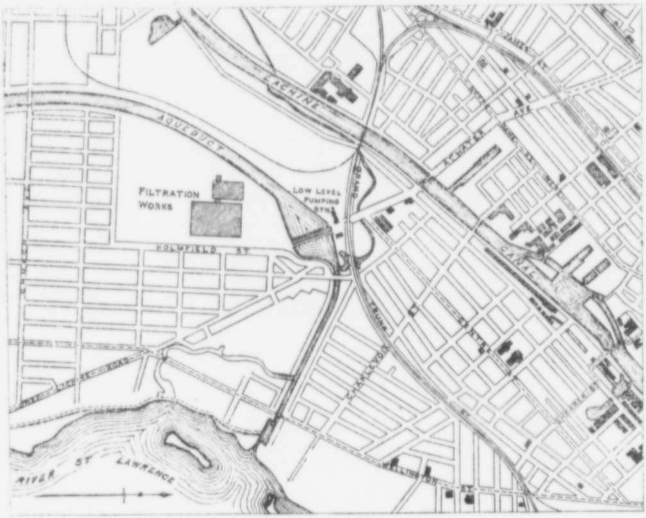
As the double mechanical system was recommended and adopted it will be especially interesting to give its cost:

Low-lift pumping plant, complete	$ 102,000
Preliminary filters and filter house	260,000
Wash-water equipment	25,000
Final sand filters, 6 acres, including sterilization equipment	615,000
Office and laboratory	25,000
Filtered-water reservoir	105,000
Piping connections between conduit, pumping station and filters	75,000
Drains, conduits, roads, walks, heating and lighting	50,000
	$1,257,000
Contingencies and engineering, 15%	188,500
Total estimated cost, exclusive of land	$1,445,500

The cost of operation of such a system with St. Lawrence water was put down at $130,900.

LOCATION OF THE FILTRATION WORKS

The site of the filtration plant will be mostly in the town of Verdun adjoining the low level pumping station, and will occupy an area of about 85 acres. After being conveyed to the filtration pumping station the water will be lifted to the prefilters, then flow by gravity to the final filters to the filtered water reservoir, and will finally reach a new hydro-electric pumping station, and from there it will be pumped up to the reservoirs on Mount Royal and distributed through the city. Apparatus will be provided in the "wash tower," for the treatment of the filtered



KEY MAP
SHOWING
LOCATION OF FILTRATION WORKS

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water by hypochlorite of lime. When the final filters become clogged the sand will be washed by the most modern and efficient type of machinery known—the Blaisdell Washing Machines.

The filtration pumping station will be equipped with motor driven centrifugal pumps, to lift the raw water to the prefilters, and the filtered water to the wash tower. This station will also contain a chemical and bacteriological laboratory for the daily testing of all waters supplied to, and delivered from the filters.

The prefilters will be divided into 16 units each, 29 x 52, built above and supported by the roof of the filtered water reservoir. The final filters will cover six acres of ground and will also be divided into 16 units, each 340 feet long and 57 feet wide, arranged on either side of an operating gallery 450 feet long and 22 feet wide, and containing a complete operating equipment.

As to the filtered water reservoir it will be about 230 feet wide, 426 feet long, with a capacity of six million imperial gallons.

Seven gate houses and numerous conduits complete the main structure of the filtration works. All structures will be of substantial and permanent construction, reinforced and plain concrete being used whenever possible. The superstructures of the pumping station, prefilter gallery, wash tower and gate houses, will be reinforced concrete, with red tile roofs laid on cinder concrete—this presenting an artistic and pleasing appearance.

The filtered water reservoir, and the final filters, are to be partly below and partly above the present surface of the ground; but both will be covered and banked about with earth as a protection against cold weather. It is the intention to beautify the entire surroundings by planting shrubbery. The vicinity will be made attractive for park purposes.

The original wheel house will be entirely removed, and in its place will be built a new hydro-electric structure. The building will be approximately 600 feet long and 50 feet wide.

The designs and specifications for these contracts were prepared by Messrs. Hering and Fuller. These gentlemen also acted in an advisory capacity during construction.

Chief Engineer Janin and Superintendent T. W. Lesage have direct supervision of the work for the city.

Commenting in a report to the Board of Control on this big filtration project, Chief Engineer Janin, who proposed these and other important undertakings in regard to remodelling the supply, said: "The whole of the filtration work when completed will give Montreal the largest, best equipped and most modern filtration works in Canada."

CONSTRUCTING THE CITY'S NEW INTAKE

With the system which will soon be in vogue of filtering the entire water supply, it will hence be opportune to explain the steps which were taken to greatly improve the quality of the supply by carrying the intake pipe from the shore to the middle of the St. Lawrence. On January 2, 1907, the Chief Engineer urged Council—among other improvements proposed—to do away with the old intake near the shore and put it far out into the river. He showed that from tests he had made, a much purer supply could be got about the middle of the St. Lawrence, and that a better quality of water would make the cost of filtration very much less; besides being beneficial in various other ways, The proposal was adopted by Council, and Messrs. J. H. Harrington and Thos. L. Hickey, experts in water filtration plants. were engaged to make careful tests of the water. They erected a sampling station twelve hundred feet from shore, the point selected by the Chief Engineer as the best spot to lay the new intake pipe.

The experts prepared a number of tables dealing with the composition of the water, which it is scarcely opportune to produce here. It will be well worth while quoting, however, the main comments of these gentlemen as to the result of their labors. They said:

"The data now available show clearly that the water 1,200 feet from shore is superior to the water near shore in every particular, except in hardness. As to the hardness, the water in the upper St. Lawrence is generally considered to be reasonably satisfactory for household and steam raising purposes. In fact it is very similar to the water of the majority of the Great Lakes, which provide the supply for Chicago, Milwaukee, Detroit, Cleveland, Buffalo, Toronto, etc. At certain times during the winter, ice gorges above the old intake causes nearly all of the Ottawa river to be diverted through the Back river to the north of the Island of Montreal.

"Bacterially the water from the outer 1,200 feet station is superior to that near shore, as it is free from shore pollution, and of the shore wash due to the action of the winds stirring up the water along the comparatively shallow depths near shore. Except as regards hardness, the shore water offers no material signs of improvement or superiority over the water of the Upper St. Lawrence. It has decided disadvantages in being quite highly charged with organic matter and dissolved vegetable stain, which it would be beyond the reach of plain sand filters to remove to a satisfactory degree, so as to give the water consumer a clear and colorless water. As to the merits of establishing pipe lines from the shore to an intake 1,200 feet therefrom, we are clearly of the opinion that this would be advisable. In our judgment, construction should go forward without delay, carrying out the project of Mr. Janin, which we have examined and approved.

"We have given considerable attention to the question of whether or not the frazil or slush ice would make any complications as regards the entrance of the river water through submerged ports, protected by wooden slats or screens. A considerable number of personal observations by Messrs. Janin and Lesage have been made by holding a screen in the water in this vicinity at times when frazil is known to occur at other places. Available data indicate the comparative absence of complications as to frazil. In recommending the construction of an intake 1,200 feet from shore we beg to state that we have considered this matter with respect to the purification of the supply. Taking everything into consideration, we are convinced, as above stated, that it will be wise to carry out Mr. Janin's recommendations for the outer intake."

These experts also showed that, when it was deemed necessary, the city might continue the treatment of the water with hypochlorite of lime, a successful process adopted in many cities for the better purification of water. The process was a most valuable one for the removal of objectionable bacteria. The lime was an essential oxidizing agent and gave up oxygen in a nascent form with such energy as to make it comparable with ozone in the matter of intensity of action. This valuable system had been some eighteen years eliminating the effect of sewage pollution from certain tributaries of Croton Lake, now forming the present main supply of New York. In Germany, it had been made the subject of most extensive studies, and in cholera infected districts, the treatment of the water by lime had produced the most beneficial effects. Hypochlorite of lime is a mixed salt of calcium, containing equivalent proportions of chloride of calcium and hypochlorite of calcium. When dissolved in water, the mixed salts appear as separate and independent salts, together, of course, with the impurities, consisting chiefly of quick lime.

The city's supply will be subject to this treatment as is thought the quality of the water, at various seasons of the year, demand.

WIDENING OF AQUEDUCT—LATERAL CONDUIT

As the widening of the aqueduct, which necessitated the construction of a new lateral conduit, constituted the most important of the various improvements, it will be necessary to go back to the time of Superintendent Louis Lesage, when a proposal was made to construct a new aqueduct alongside the old one. The widening of the aqueduct (Janin scheme) now under way, does away with steam pumping, supplies energy enough to light the streets and public places, and supplies sufficient water for decades to come.

As far as possible, the various reports to Council, in regard to the widening, will be touched upon for future reference, and in order to give a comprehensive idea of the steps which had to be taken before a final decision was arrived at.

In the year 1873, when the daily consumption of water was less than six and three quarter million gallons, and when the total cost of the water works was only three and a half millions, Mr. Louis Lesage, Superintendent of the Water Department, wrote in the following strain to the Water Committee.

"Notwithstanding all that has been done to improve our water works, and the heavy sacrifices which the city has been subjected to in order to maintain this important branch of the civic service, it is manifest to all who have paid some attention to the subject, that our works, which were considered by their originators sufficient for the present generation,are now powerless to provide the city with an abundant supply of water. Hence the necessity of looking the question squarely in the face, and adopting a large and comprehensive scheme, that will remove doubts and fears, by placing our works on such a footing as to secure a permanent and reliable supply." A scheme was then submitted by Mr. Lesage to the Water Committee, at the time, for the construction of an entirely new aqueduct, running from Lachine to the Wheel House. It was to be constructed in three sections. The first section was to start from what was known as Frazer's Hill and form a junction with the old aqueduct, 3,400 feet below the entrance. This section was to be 78 feet wide at the bottom, and 130 feet wide at the level of the water, with a depth of fourteen feet when the St. Lawrence would be at its summer level.

The second section was called the "rock cut," it being nearly all through a solid ledge of rock, extending from the junction in question to a distance of about 9,400 feet, following in a parallel line the south side of the present aqueduct. The width of the bottom of this section, being through rock, was only to be 60 feet.

The third section was to extend from the second section down to the reservoir at the Wheel House, a distance of about 11,700 feet, also following the south side of the old aqueduct in a parallel line. The width at the bottom was to be fifty feet. The inclination of the bottom, all through the sections, was put down as three inches per mile.

"This aqueduct," continues the report, "will be able to discharge, when covered with ice, two feet thick, enough power to the pumps to raise thirty million imperial gallons per twenty-four hours to the level of the present reservoirs." In summer, with the aid of both of the aqueducts, it would be possible to raise 100 million gallons. The estimated horse-power was 5,000.

The cost of these three sections, with a subsiding reservoir, was estimated as follows:

First section	$ 479,850
Second section	739,019
Third section	412,457
Reservoir	218,867
Total	$1,850,193

In a further report, additional improvements were urged which showed the total cost would amount to a trifle over four millions. The necessity of a new aqueduct was again urged at the conclusion of the report.

It was not until the year 1877 that the first section was opened to a width of 114 feet at the water line; but the other sections were left unfinished.

In the year 1888, Superintendent McConnell sent a carefully prepared report to the City Council, on the project of enlarging the aqueduct. It was partially based on the scheme of superintendent Lesage, in 1873. It consisted in continuing the new aqueduct, the first section of which had been completed as already noted, by the side of the old aqueduct to the Wheel House.

The figures of this project were as follows:

(Section 1 being already built)	
Section 2, excavation, bridges, stop gates, fencing, etc.	$ 945,000.00
Section 3, excavation, bridges, stop gates, fencing, etc.	480,000.00
	$1,425,000.00

With certain other improvements, which have now been adopted, the total cost of the scheme was brought up to over three millions.

THE MODERN IMPROVEMENTS

It was in 1905 that the first decisive steps were taken not to build a new aqueduct, but to greatly enlarge the old one. It will be seen that in order to do this the necessity was shown of constructing, from Lachine, a concrete lateral conduit capable of delivering to the city, apart entirely from the old aqueduct, from fifty to eighty million gallons a day. Other improvements were also proposed which have already been touched upon.

In February, 1907, Chief Engineer Janin wrote to the Water Committee as follows, in regard to the once more pressing necessity of increasing the supply:

"The ever increasing consumption of water in the city makes it incumbent upon me to no longer delay in reporting on this subject, and suggesting the most practicable means of meeting this increased consumption."

It was then shown by the writer that during the past five years, the consumption of water, from 1900 to 1905, had gone up from twenty to twenty-seven million gallons a day—that is it had increased by actually one-third. It was shown it was reasonable to expect this rate of consumption would go on for years to come; hence it was necessary, in planning for the future, to arrange at the outstart for at least fifty million gallons a day. The fact was dwelt upon that former superintendents of the Water Department, as well as various engineers, including Messrs. Keefer, Shanly and McAlpine, had strongly urged that the city's pumping should be done by hydraulic power. This was one of the main reasons in proposing the construction of a new aqueduct. After these explanations, Mr. Janin then proposed that the city should first begin to entirely remodel its water supply by first constructing a lateral conduit. In support of his contention he submitted the following arguments: "The influences which have led up to the consideration of constructing a new lateral conduit parallel to the old one were occasioned by the difficulty of keeping up the water supply to the pumps, while the works of widening and deepening the old aqueduct were being carried out. In our new project, in order to get over this difficulty and enlarge the aqueduct on our own land, doing away with expensive expropriation proceedings, we proposed the construction of a permanent reinforced concrete fresh water conduit alongside the present aqueduct.

This lateral conduit will be of sufficient capacity to discharge 50,000,000 gallons daily. By extending the conduit out into the River St. Lawrence, opposite the entrance of the aqueduct, the intake would be placed where there would be no risk of pollution.

This conduit will have the great advantage, also, of bringing the water under cover to the pumps, and thus doing away with the oft-repeated objections to the present aqueduct. The widening of the old aqueduct, after the construction of the lateral conduit, would, instead of requiring the expropriation of 250 arpents of land, only require the purchase of a narrow strip of some 20 arpents in all."

DETAILS OF COST

The following figures explained what the costs of the improvements, as then contemplated, would be:

1. Lateral conduit in reinforced concrete to discharge 50 millions gallons daily............	$ 660,000.00
2. Suction well for pumps at lower end of conduit..	20,000.00
3. Extending the conduit out into the St. Lawrence by means of two pipes, with intake pier.	75,000.00
4. Excavations (sections 2 and 3), dry stone walls, pudding, farm bridges, stop gates, fencing, etc.	817,000.00
5. Purchase of land, section 3, 20 arpents at $1,000	20,000.00
6. Widening or deepening of Tail Race..........	45,000.00
7. Wheel House, new pumping machinery, buildings, etc................................	300,000.00
(The cost of new force mains is not chargeable to the project, for, in any case, these force mains will be required when the 50,000,000 daily consumption is reached.)	
To this estimate there must be added, however, for the time the carrying out the works would take, say three years, the cost of pumping by steam power, the water at present pumped by water wheels, viz: about 2,616 million of gallons yearly, at the price of the cost for steam pumping, less the cost of pumping by water, that is $8.75 per million, say..................................	$ 95,000.00
The total cost of the project would then be..	$2,032,000.00
The interest on this sum, at 4% per annum, would make an annual charge of..........	$81,280.00

WHAT THE ECONOMY WOULD BE

To justify the adoption of the project above described, you will find enumerated below the various items of economy that might result:

1. From the first year of the working of the widened aquduct: The water pumped by steam power in 1904 was 6,530 millions of gallons. Basing the increase in consumption on that shown by the last five years, the pumping will be in three years time, 8,710 million of gallons at $8.75 (the present difference between steam and water pumping), the amount saved therefore by doing this work by water power will be.............. $76,213.00

   On the same basis the total water to be pumped will be 37,000,000 gallons daily, which will require in effective H.P......... 1,480

   On the 2,000 effective H.P. that the new aqueduct will afford at all times, there will remain to be utilized an effective H.P. of.... 520

   From this amount, about 400 H.P. could be utilized to produce electric power for pumping at the High Level station, for which operation the City has at present a yearly contract for about.................................. 8,000

   There would thus remain to dispose of in H.P.................................. 120

COULD LIGHT PUBLIC BUILDINGS AND PARKS

This would be sufficient to furnish the electric lighting to a number of the City's public buildings, parks, etc., for the lighting of which it costs the City now $10,000 per annum. It is reasonable to estimate the saving by using our own power as above as ¼ of the amount, or...................... $2,500.00

Besides, the surplus power produced during the summer season from April to November could be utilized to furnish, at a reduced price, light or power to firms only requiring it at such season.

Taking this surplus power at only half its estimated quantity of 3,000 H.P., would leave 1,500 H.P. at the very low rate of $5.00 per H.P., a further sum of................ $7,500.00

Total realizable savings, say............... $94,000.00

Brought forward........................	$94,000.00
That is, when the consumption of water will have reached 50 million of gallons daily, which is 40 million more than the mean daily capacity of the present water wheel pumping.	
In the event of the projected widening of the aqueduct not being done, these 400 million gallons would have to be pumped by steam power under the following conditions:	
That is 24 millions by the present steam plant, at the price of $8.75 (being the present cost of steam pumping, after deducting cost of pumping by water power), this would be for 365 days, 8,760 million at $8.75.	$76,650.00
The remaining 16 millions daily would be pumped by new pumps of higher duty than the old ones, at a cost per million gallons, $4.50 (being the estimate with high duty steam pumps), after deducting cost of pumping by water power, this would be for 365 days, or 5,840 millions at $4.50............	$26,280.00
There would remain about 1,500 H.P. available in the summer season, which could be disposed of at a minimum of............	$7,500.00
Total realizable savings, say...............	$110,000.00

TO PAY OFF LOAN BY SINKING FUND

On the progressive increase in consumption, from the last five years, the daily consumption of 50 million of gallons would be reached in eleven years from the present, or eight years after the completion of the widened aqueduct, if the widening is gone on with at once.

From the figures given above, it is easy to perceive that the economy of the project which I lay before you would consist especially in assuring to Montreal, under its absolute and perpetual control, a better source of water supply, in sufficient quantity for the future, and at the lowest price; for not only will the interest on the cost of the improvement be realized, but the increased savings would, as a sinking fund, extinguish a capital account in less than 40 years."

Action was taken by the Water Committee on the above report on March 18, 1906, when it recommended Council to vote the sum of $2,000, so preliminary surveys could be made.

On March 18, 1907, the Chief Engineer sent another communication to the Water Committee again asking for the construction of the lateral conduit and the widening of the aqueduct, and again pointing out that expensive steam pumping should be done away with, and replaced by hydraulic power. He also asked that experts be appointed to study and report on the important proposals he had made.

The request for experts was granted, and Messrs. John Kennedy and Ernest Marceau were appointed. Their report was sent to the Water Committee on May 6, 1907, and was as follows:

FAVORABLE REPORT OF EXPERTS

We are instructed by a resolution of the Water Committee, passed on March 22nd, 1907, to report upon the following questions regarding the proposed enlargement of the Water Works aqueduct, and works connected therewith:

1. If Mr. Janin's plan is feasible?
2. By the plan will it be able to supply the 50,000,000 gallons as claimed by Mr. Janin?
3. Will it be able to supply 5,000 horse power, as claimed by Mr. Janin?
4. Are the estimates made by Mr. Janin in connection with his proposed plan correct?
5. If frazil is likely to interfere with the proper working of the proposed improvements?

THE FEASIBILITY OF PROJECT

The essential features of Mr. Janin's project, as set forth in the information supplied to us by him, are:

1. The construction of a closed conduit along the north side of the aqueduct, from the pumping station to the bank of the St. Lawrence, just above the entrance works of the aqueduct, and its extension out into the river to an intake point where it will be supplied by St. Lawrence water unmixed with shore water from the Ottawa river. The shore part of the conduit is to be of water-tight concrete construction, and about 57 sq. ft. area of internal section, and to have a fall of one in 5,000.

2. The enlargement of the aqueduct, from its intake at the river to the pumping station to a cross sectional area of not less than 1,000 feet below the under surface of the ice at low water, which is assumed to be at elevation 33 ft. above water works datum at the entrance and having a fall of one in 8,333.

3. The remodeling and increase of the hydraulic power pumping machinery at the pumping station to a capacity of at least 50,000,000 imperial gallons per 24 hours, and connectious for supplying the pumps from the new conduit, and also connec-

tions with the pumping mains leading to the city, as well as the re-arrangement of the steam power pumping machinery, to conform to the new conditions.

4. The enlargement of the tail race to the capacity necessary for the discharge of the water from the enlarged aqueduct.

5. Well, waste gates, and other works, requisite for the proper working of the enlarged aqueduct and increased pumping machinery.

"We are of the opinion that Mr. Janin's plan, as thus outlined, is entirely feasible, and also that it is an excellent one for improving the quality, increasing the quantity, and reducing the cost of the city's water supply."

CAPACITY TO SUPPLY 50,000,000 GALLONS PER DAY

We are of opinion that the projected works will supply water power to pump to the city 50,000,000 imperial gallons per day of 24 hours, under the most favorable conditions—that is at the lowest recorded stage of the river in winter and when the aqueduct is covered with ice, which is in the capacity stated in Mr. Janin's report.

Mr. Janin, in his report, states that the enlarged aqueduct will develop 5,000 H.P. in summer. We are of the opinion that this estimate of power is correct for the most unfavorable summer conditions; that is, the enlarged aqueduct will furnish water to develop 5,000 effective horse power at the water wheels, when the river at the entrance of the aqueduct is at its lowest recorded depth of 35.85 above datum. Under ordinary summer conditions, that is, with higher water, the power which can be developed will, of course, exceed 5,000 horse power.

We have checked the estimate of cost of the conduit from the river bank at the intake to the well at the pumping station, and we are of opinion that Mr. Janin's estimate of $660,000.00 is correct."

WORK COMMENCED ON LATERAL CONDUIT

The sum of two millions having been set aside to begin work on the lateral conduit and the aqueduct—the Janin project having been adopted by Council—the Chief Engineer, on May 28, 1909, informed the Water Committee that there was every likelihood that this conduit would be completed in the autumn of the following year; and that hence the time was close at hand when work must be commenced on the big undertaking of enlarging the aqueduct. He also drew Council's attention to the fact that additional amounts, over and above the two millions mentioned, must be voted to continue the improvements. As the total cost of these works has already been shown, it will not be necessary to give any lengthy details of the voting of amounts in detail. On the date in question, Mr. Janin also informed the Water Committee that, in the event of any difficulty over funds, the aqueduct might be widened at a much lower cost—under what was known as "A" plan than "B" plan.

In the summer of the following year, 1910, at the request of Mr. Janin, Messrs. Hering and Fuller having been commissioned to report on the proposed widening of the aqueduct, and the construction of the lateral conduit, informed the Board of Commissioners (Commissioners having been elected by a popular vote of the people) as follows: " We have closely examined the plans and checked the same, with respect to the lateral conduit. We rate its carrying capacity as 80 million imperial gallons daily with low water stage of the river, elevation 35.0, and when water is withdrawn from the conduit at the lower end, at about elevation 28.0; allowance being made for the loss of head due to the entrance of the water into the aqueduct from the proposed intake, 1,200 feet from shore. At higher levels of water in the river the carrying capacity of the conduit will be in excess of that above stated.

With respect to the enlarged aqueduct our examination leads us to the conclusion that there will be regularly available, upon the completion of the enlarged aqueduct, about 2,500 horse power. This power is the maximum that can be made available during the most unfavorable winter conditions. The amount of power that will ordinarily be available during the warm season of the year will be practically double that available during the most unfavorable winter conditions—or about 5,000 horse power. This should be available about nine months each year.

Further, we desire to make it plain, that the sound business basis for the enlargement of the aqueduct holds true regardless of whether the available water power is utilized for pumping water through the mains, or whether the power is used by the city for generating of electricity or other purposes, or marketed in other ways than by its utilization for municipal requirements. This water power development is a sound business proposition, and there should be no concern, on the part of taxpayers, as to the wisdom of this improvement."

The above report having satisfied those at the head of the city's affairs, Mr. Janin, on Nov. 3, 1910, wrote to the Board of Commissioners, asking the voting of still further funds for these public works, and submitting a plan for the widening and deepening of the whole of the three sections of the aqueduct; so that instead of five thousand horse power being available, there should be no less than "ten thousand horse power." The following figures were submitted by Mr. Janin, in support of the feasibility and wisdom of this greater plan:—

ACQUIRING OF 10,000 HORSE POWER INSTEAD OF 5,000

To produce a minimum of 10,000 H.P. in all seasons by the widening of the aqueduct, that is 7,000 H.P. more than according to the project at present being carried out, allowing 4,000 H.P. to be used for other municipal purposes than pumping.

Cost of producing 7,000 H.P. more than provided for in present project, that is, 4,000 H.P. more to be used for municipal purposes other than pumping, as follows:

Enlargement of aqueduct	$1,900,000.00
Enlargement of tail race	50,000.00
Machinery, turbine, pumps, etc.	250,000.00
Buildings, foundation, weirs, etc	100,000.00
	$2,300,000.00
Capital cost of producing 4,000 H. P. may be taken as four-sevenths of $2,300,000.00	$1,314,300.00
Annual cost:	
Interest, 4% on $1,314,300.00	$52,572.00
Sinking fund, say 1%, say	13,143.00
	$65,715.00
Operation of plant:	
Superintendent	$ 2,000.00
Attendant and oilers (2 shifts 3 each)	$ 9,000.00
Repairs on machinery, 1½% on $250,000.00	3,750.00
Depreciation on machinery, 4% on $250,000	10,000.00
	$90,465.00
On the other hand, as the plant, as provided, can furnish during nine months of the year at least 10,000 extra H.P., it is reasonable to value this at $4.00 (with due allowance for the necessary power producing machinery, and the period of only 9 months usefulness), therefore 10,000 H.P. at $4.00	$40,000.00
	$50,465.00

Thus the cost per H.P. per year for 4,000 H.P. would be

$$\frac{50,465}{4,000} = \$12.62 \text{ per year.}$$

By the changing of the final plans, so that ten thousand horse power could be acquired, the aqueduct will be widened at the water surface from 150 to 174 feet; concrete walls will take the place of the sloping earth embankments. The excavated channel will be sixteen feet. The additional cost is estimated at two millions.

In urging the above project, the fact was dwelt upon by the Chief Engineer, that the city would have a surplus energy to the amount of 4,000 horse power, which could be sold at $25 per horse power, while its cost would only be $12.62.

The entire project was accepted by the Controllers and the City Council.

STEAM PUMPING vs. STEAM POWER

As one of the great reasons which induced the Board of Commission and the City Council to vote some seven millions for these improvements was that of inaugurating a cheaper system of pumping than that of steam, it will be interesting to trace the efforts which were also made, years ago, to have all the pumping done by water power. While the Corporation, in the early days, utilized water wheels and breast wheels for pumping, these had, as time went on, to be done away with and steam power used owing to troubles connected with ice blockings in the aqueduct, frazil, and various difficulties with the Tail Race.

In 1873, Superintendent Lesage, in a letter to the Water Committee, made the statement that, from the experience the city had had in hydraulic and steam pumping, he was in a position to show that the relative cost per million gallons by steam and water pumping was actually as follows:—

For water power........................	$3.41
For steam power........................	25.00

He asserted this discrepancy would no doubt go on increasing year by year in proportion to the increased cost of fuel and the added price of labor. He then urged that the city should take steps so the aqueduct could be remodelled and the whole of the pumping done by hydraulic means.

At a still earlier date, when it was proposed a single steam engine should be purchased to aid in the pumping, Mr. Walter Shanly, a consulting engineer, sent to the Water Committee a carefully compiled statement contrasting steam pumping with hydraulic pumping. Its main features are well worth giving.

"I learn," he said, "from the annual report of your superintendent, that the actual pumping expenses by water, one year with another, averages $3 for each million gallons of water raised to the reservoir.

"The same work done by steam would cost in the neighborhood of $20, — supposing your engines to be of the most improved construction and supposing coal would always be got at $5 a ton. The cost of repairs and renewals to machinery, too, would be in favor of water wheels.

"Assuming the average consumption of water to have reached fifteen million gallons, a comparison of actual pumping expenses, including superintendence, etc., would result as follows:

Water expenses per day	$ 45,000
Water expenses by the year	16,425
Steam pumping per day	300
Steam pumping per year	109,500
Difference in favor of water	93,075

A sum which represents, at seven per cent, a capital over $1,300,000.

"In view of these figures, and in consideration of the fact that no city in the world is more munificently endowed with the means of water power than Montreal, I could not advise the use of a steam engine save as a temporary expedient."

Mr. Lesage, as a final appeal for water pumping, submitted the following table, demonstrating what it would mean to the city to pump from seven to sixteen million of gallons daily by water and by steam:

For an Average daily consumption of 7 millions of gallons, or 2,555 millions yearly, viz.	2,081	Millions of gallons by water power, at $3.41....	$ 7,096.21
	474	" " steam " 25 p.c.	11,850.00
			$18,916.21
For an Average daily consumption of 8 millions of gallons, or 2,920 millions yearly, viz.	2,081	Millions of gallons by water power, at $3.41....	7,096.21
	839	" " steam " 25 p.c.	20,975.00
			$28,071.21
For an Average daily consumption of 9 millions of gallons, or 3,285 millions yearly, viz.	2,081	Millions of gallons by water power, at $3.41	7,096.21
	1,204	" " steam " 25 p.c.	30,100.00
			$37,196.21
For an Average daily consumption of 10 millions of gallons, or 3,050 millions yearly, viz.	2,081	Millions of gallons by water power, at $3.41	7,096.21
	1,569	" " steam " 25 p.c.	39,225.00
			$46,321.21
For an Average daily consumption of 11 millions of gallons, or 4,015 millions yearly, viz.	2,081	Millions of gallons by water power, at $3.41	7,096.21
	1,934	" " steam " 25 p.c.	48,350.00
			$55,446.21
For an Average daily consumption of 12 millions of gallons, or 4,380 millions yearly, viz.	2,081	Millions of gallons by water power, at $3.41	7,096.21
	2,299	" " steam " 25 p.c.	57,475.00
			$64,571.21
For an Average daily consumption of 13 millions of gallons, or 4,745 millions yearly, viz.	2,081	Millions of gallons by water power, at $3.41	7,096.21
	2,664	" " steam " 25 p.c.	66,600.00
			$73,696.21
For an Average daily consumption of 14 millions of gallons, or 5,110 millions yearly, viz.	2,081	Millions of gallons by water power, at $3.41	7,096.21
	3,029	" " steam " 25 p.c.	75,725.00
			$88,821.21
For an Average daily consumption of 15 millions of gallons, or 5,475 millions yearly, viz.	2,081	Millions of gallons by water power, at	7,096.21
	3,394	" " steam "	84,850.00
			$91,946.21
For an Average daily consumption of 16 millions of gallons, or 5,840 millions yearly, viz.	2,081	Millions of gallons by water power, at......	7,096.21
	3,759	" " steam "	93,975.00
			$101,071.21

Messrs. Hering and Fuller having been asked to report on the question of pumping by steam, or by hydraulic power, declared the pumping by hydraulic power would mean such a great saving that it ought to be inaugurated as soon as possible.

BOULEVARDS ALONG THE AQUEDUCT

In connection with the final widening of the aqueduct, a plan was submitted by Mr. Janin to the Board of Commissioners, in which it was asked that both sides on the aqueduct should be formed into wide boulevards for the convenience of electric cars, autos, carriages, pedestrians, etc. On each side of these boulevards there would in time, no doubt, be erected fine residences, which would make the entire district one of the most attractive in the city.

In figures submitted in explanation of the scheme, it was shown, the total land required for such widening would amount to 2,349,331 feet. Proprietors on the lines of the aqueduct had proffered to cede gratuitously to the city, 1,094,948 feet. This would mean the Corporation would have to acquire, by expropriation proceedings, 1,254,383 feet at an estimated cost of a quarter of a million.

In order to enlarge the aqueduct, without the boulevards, it would be necessary for the Corporation to secure 956,972 feet of land, the estimated cost of which was $191,000. If the widening took place, the city would get the immense amount of land ceded free as already stated. Figures were also shown demonstrating that contractors would be in a position to tender very much lower for the widening, if they could dump the earth, which was estimated at 2,285,000 cubic yards, on both sides of the aqueduct to widen it; instead of having to pay the cost of haulage to distant dumps. This saving alone to the city was estimated at $45,700. The entire cost to the city, in brief, in accepting the boulevard plan, would only be $727,700.

In conclusion the following comment is made in the report: "I may say that in the cost of the establishment of boulevards, the levelling, macadamizing, etc., cannot be considered as a charge against the city, for the reason that the entire stretch of the boulevards would, in the near future, be annexed to the city, and when residences are erected on both sides the city will get remunerative taxes therefrom."

By the isometric plan here given, a clear idea is got of the entire scheme of the widened aqueduct, filtration plant, filtration basins, hydro-pumping plant, boulevards, etc.

COST OF THE IMPROVEMENTS AND THE CONTRACTORS

The successful tenders for the improvements, and the dates the contracts were awarded by the city, is herewith given.

Lateral Conduit:—Contract awarded September 6th, 1907, to P. McGovern.

Intake:—Contract awarded September 27th, 1910, to Lemoine Fils & L. A. Désy.

Filtration Plant:—Contract No. 1, awarded July 17th, 1911, to the "British Electric Plant Co.," for the supplying and installing pumping machinery, blower and crane.

Contract No. 2, awarded July 24th, 1911, to F. H. McGuigan, for constructing final filters and appurtenances.

Contract No. 3, awarded October 9th, 1911, to F. H. McGuigan, for constructing prefilters and filtered water reservoir.

Contract No. 4, for final deepening and widening of aqueduct, awarded July 5, 1913, to the Cook Construction Company.

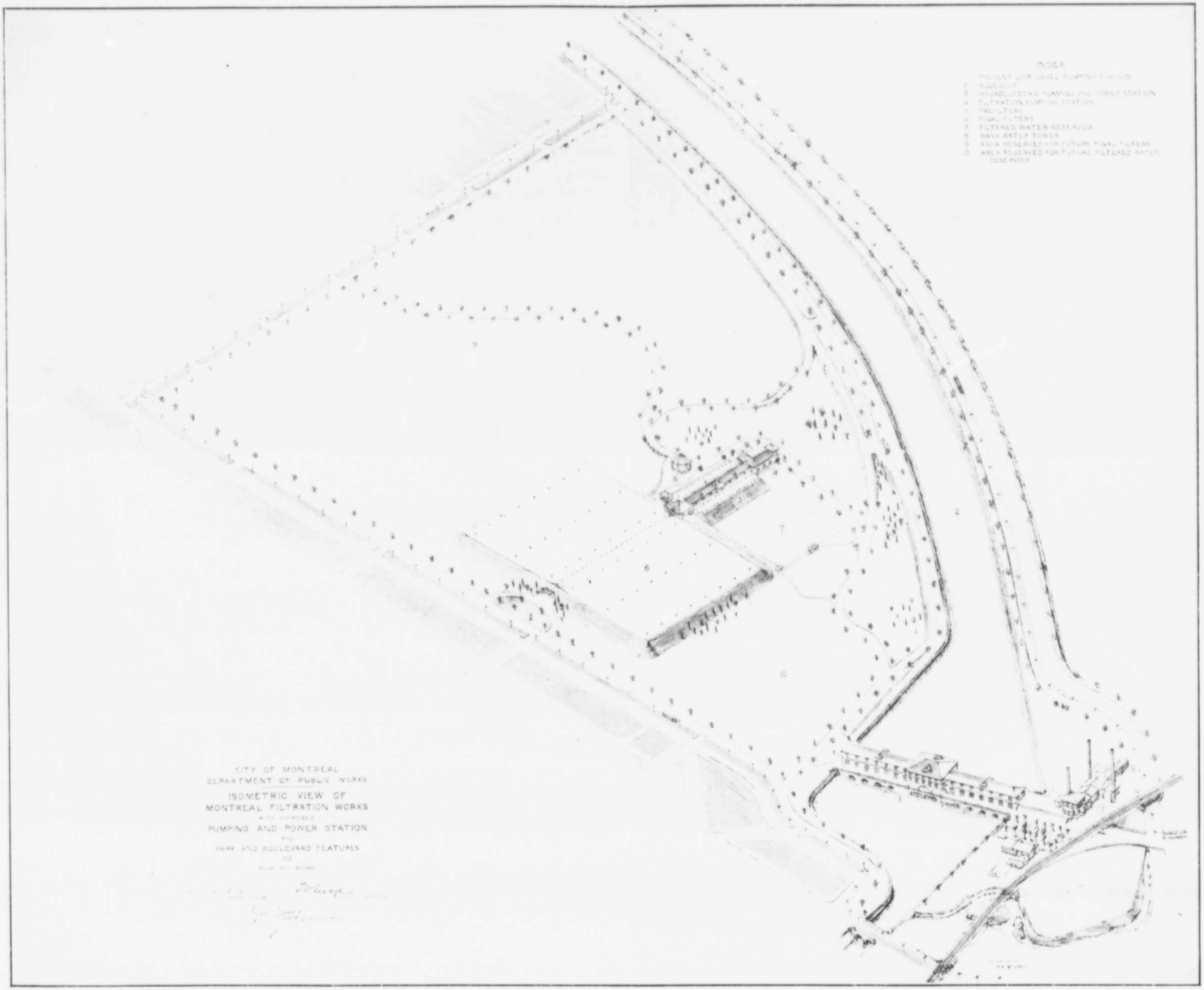
On Oct. 1st, 1912, a transfer was made of the works of Mr. McGuigan to Mr. Norman McLeod.

FINAL ESTIMATED COST OF PRESENT IMPROVEMENTS WHEN ALL COMPLETED

Lateral conduit	$ 785.000	(Work done)
Intake	$ 124,000	do do
Widening of Aqueduct:—		
Contract No. 1	$ 856,000	(Work done)
Surveying and Supt's	$ 80,000	do do
Contract No. 2	$2,970,000	(Estimated cost)
Engineer and super	$ 80,000	do do
Pumps and power house	$ 425,000	do do
Filtration Plant:—		
Contract No. 1	$ 40,000	(Work under contract)
Contract No. 2	$ 673,000	do do do
Contract No. 3	$ 485,000	do do do
Contract No. 4	$ 400,000	(Estimated cost)
Eng. and super	$ 80,000	

When to the above is added the probable cost of purchasing of land for the aqueduct, the entire completion of the system is estimated at seven million dollars.

When all of the above work is done the total value of the water works of Montreal is estimated at $19,000,000. In this sum is included of course all kinds of mains and pipes in the streets.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6 FINAL FILTERS
7 FILTERED WATER RESERVOIR
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9 AREA RESERVED FOR FUTURE FINAL FILTERS
10 AREA RESERVED FOR FUTURE FILTERED WATER RESERVOIR
CITY OF MONTREAL
DEPARTMENT OF PUBLIC WORKS
ISOMETRIC VIEW OF
MONTREAL FILTRATION WORKS
WITH PROPOSED
PUMPING AND POWER STATION
AND
PARK AND BOULEVARD FEATURES

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By the doing away of steam pumping (except in emergencies), the annual coal bill, for steam coal, of $192,000 will be cut out.

Should the 4,000 spare horse power be utilized for street lighting, and it is estimated it will be sufficient, an expenditure of $250,000 a year will be curtailed.

The per capita consumption of water in Montreal is 122.32 imperial gallons.

The income from water in 1912 was as follows:

From assessed rentals	$ 1,075,044
Meter rates	375,942
Miscellaneous	20,859

WATER MAINS LAID SINCE 1905

The water mains put in the streets from 1905 to 1912 are:—

	1905	1906	1907	1908	1909	1910	1911	1912
6″	1,718	2,434	1,537	1,524	1,507	144	293	2,496
8″	16,396	6,526	4,714	19,926	47,714	31,104	113,019	122,051
10″	268	....	....	3,057	5,598	1,949	16,125	9,034
12″	16,907	1,276	2,350	9,437	8,793	5,622	5,833	23,933
16″	3,629	....	....	....	....	10,071	10,118	18,913
20″	50	....	....	....	....	557	36	....
24″		....	....	1,728	3,738	5,207	9,769	..
30″		....	....	7,180	7,005	4,779	24	....
Total	38,968	10,236	8,601	42,852	74,355	59,433	155,217	176,427

Grand Total............568,750 feet of main pipes were laid since 1905.

TOTAL FEET OF PIPES LAID IN STREETS

The accompanying table shows the total feet of pipes laid by the city since taking hold of the water works:—

30″ main-pipes	50,496
24″ "	87,537
20″ "	18,783
16″ "	76,531
12″ "	326,713
10″ "	192,074
8″ "	525,738
6″ "	280,969
4″ "	283,326
Lineal feet	1,842,167

MAIN PIPES LAID IN 1912

There was laid in the year 1912, 175,427 feet of main pipes as follows:

16″ main-pipes	18,913
12″ "	23,933
10″ "	9,034
8″ "	122,051
6″ "	2,496
	176,427

SYSTEM OF CHARGING FOR WATER AND TARIFF RATES

All tenants and occupants of dwelling houses are charged five per cent per annum on the assessed rentals;

Stores, warehouses and other places of business, four per cent on the assessed rentals;

Churches.—The charge is four per cent. on what is considered a rental on the assessed value. Churches pay no realty tax.

Hotels, taverns and restaurants, a uniform rate of ten per cent on assessed rentals;

Hospitals with 100 beds and over a fixed rate of $25.

Hand hose $2.00.

BUILDING MATERIALS

For every thousand bricks used, the water therefor	$0.60
For every cubic yard of masonry, concrete or terra-cotta	0.03
For every hundred superficial yards of plastering	0.30

Private fountains per 1,000 cubic feet	$2.00
For public baths, a charge per tub of	6.00
Baths in dwelling houses paying an assessed rental of $150 or over	1.00
Charge per horse for water	2.00
Per cow	1.00
Per each water closet in store or shop	4.00
For business places	4.00
For each closet running continuously	15.00
Urinals	1.00
Urinals running continuously	15.00
High pressure steam engines, not paying by meter	6.00
Distilleries, dye houses, manufactories, etc., a uniform rate of $1.13 per thousand cubic feet.	

Water is supplied to some 75,000 dwellings and to some 16,000 other buildings.

THE "MONTREAL WATER & POWER COMPANY"

For some twenty years past, a company designated "The Montreal Water & Power Company" has been supplying water to quite a large number of municipalities contiguous to, but not all annexed to the City of Montreal. This company, up to 1912, has been supplying to the suburbs about half as much water as the city itself. The Montreal Water & Power Company draws its water from the River St. Lawrence. It has a steam and an electric pumping station, located near the mouth of the St. Pierre river. This is about 4,000 feet from the municipal station near the foot of the tail race. The top of the company's intake pipe is located about 9.5 feet under the water, about 2,000 feet from shore, and approximately three miles from the foot of the Lachine Rapids. It is estimated that, in 1912, the company furnished some 200,000 persons with water.

For some years past, the project has been before the City Council and the Board of Commission of buying out the Company, and thus having a municipal water supply only. The problem of the purchase is still unsettled on account of the difference of opinion between the company and the city as regards the value of the plant. The merits of the case do not come of course within the scope of this history. It may be said, however, that the company has demanded to be expropriated as a going concern, and values its plant at between seven and eight million dollars.

The city's attitude has been that it will not negotiate as to the purchase of the plant until it is permitted to make a physical examination of the same, and is also allowed to make a private investigation of the company's books. At the time of this writing the company has not consented to the city's proposal.

During the past five or six years the city has annexed several adjacent wards to which the company supplies water. On account of the annexations there is no longer a uniform rate of water in all of the city's wards. This is due to the fact that the corporation's rate, to the older wards, is five per cent. on the assessed rentals; while the company's rate, in the newly annexed wards, which it still continues to supply, is seven and a half per cent. One of the reasons why the city is inclined to purchase the plant of the company is because of this complexity in charging for water.