Table Showing Increases in Consumption of Water at Montreal

Year.	Million Imp. gals.	Percentage of increase.
1903	24.5	
1904	27.7	13.0% over 1903
1905	30.1	9.0% " 1904
1906	31.7	5.5% " 1905
1907	34.0	7.2% " 1906
1908	35.7	5.0% " 1907
1909	36.7	5.5% " 1908
1910	38.6	5.2% " 1909
1911	42.8	10.9% " 1910
1912	47.3	10.5% " 1911
1913	52.0	9.5% " 1912

In 1916 the average quantity of water pumped per day was 54,625,462 Imperial gallons. The percentage of increase in the water consumption between 1903 and 1913 is 112%, and the percentage between 1904 and 1913 is 88%.

Our calculations are based on an increase of 86% above the quantity of water pumped last year, and we have estimated that such an increase will take place in from 5 to 10 years.

It is this increased quantity we have called the "future needs of the city."

Power Actually Used for Pumping and Lighting and Future Requirements.—From the information we have been able to obtain, we give, in the tables at the bottom of page 454, the amount of power actually used for pumping and lighting by the city and the adjacent municipalities of Outremont, Westmount, Maisonneuve and Verdun, including the power needed for the filtration plant as now built.

Considering the rate of increase in the consumption of power which has taken place during the last ten years, we have also estimated the probable needs of the city and adjacent municipalities for the near future, say, within the next five or ten years. This is also in the statement below. It will be seen that the city and surrounding municipalities mentioned above, now use practically 20,000 h.p. for pumping and lighting, and that the requirements for the near future will not be less than 30,000 h.p.

Definition of the Term "Horse-power."—To avoid misconception of the term "horse-power" in our report, the letters h.p. represent the horse-power or energy due to falling water without any losses.

As this water passes through turbines and puts machinery in motion, to be transformed into electrical energy and sent over distribution lines to do useful work, some of the original energy is lost step by step, and all our calculations are based on the following table of efficiencies in horse-power for pumping and lighting.

The electrical horse-power available at the power house, or delivered according to present contract at 2,200 volts, will be indicated by e.h.p., and for the power delivered at other places, the name of the place will precede the letters h.p. and e.h.p. (See tables of efficiencies at the bottom of this page.)

Project as Designed.—We are indebted to the chief engineer of the city and his staff for copies of all documents and hydraulic data bearing on the Montreal aqueduct. These studies are exceedingly well made and have been found to be correct in agreement with assumptions made.

We cannot consider, however, as permissible, the high velocities assumed for the headrace, and we differ somewhat as to the co-efficient for retardation of flow due to the character of the canal bottom, factors which affect the quantity of power to be derived from the development.

In the information given it is stated that the flow in the canal has been obtained by means of the Kutter formula, assuming a slope of 3.3 in 27,000 feet, and a value of 0.02 for the co-efficient "n" (earthen channel in good order). The same co-efficient of 0.02 has evidently been assumed for the upper surface of the water when covered with surface ice.

Tables Showing Lighting and Pumping Efficiencies in Percentages of Water Horse-Power

LIGHTING.

Item.	Efficiency.	Overall efficiency.
Power at fall	100%	100%
Turbine	82%	82%
Generator	93%	76.26%
Outgoing lines	98%	74.73, say 75%
Lines to central distributing station	91%	68%
Rectifier	92%	62.6, say 62%
Line	96.8%	60.6, say 60%
Switchboard, power house to lamp	$\frac{60.6\%}{74.73}$	= 81%
Switchboard, main distributing station to lamp	$\frac{60.6\%}{68\%}$	= 89%

Efficiencies differ according to the machinery employed to transform the energy of falling water, and the above table is given only to show the value of the efficiencies which we have used in our calculations.

PUMPING.

Low Level Pumping, Atwater Avenue.

Power house switchboard	75%	
Motors	90%	67.5%
Pumps	80%	54%
Filtration plant, efficiency transformer and line	96% × 75%	72%

High Level Pump Efficiency, McTavish Reservoir. Smaller Units.

Motor and pump	68.8%, say 69%
Efficiency at switchboard	68% 47%

Papineau Avenue Pump Efficiency.

Motor and pumps	64.4%
Efficiency at switchboard	68%, say 44%

From this table it follows that:—

To produce:	Requires:
1 e.h.p.	1⅓ h.p.
1 lamp h.p., 746 watts	1⅔ h.p.
1 pump h.p. at Atwater Avenue	1.85 h.p. or 1.39 e.h.p.
1 pump h.p. at McTavish Res'voir	2.13 h.p. or 1.60 e.h.p.
1 pump h.p. at Papineau Avenue	2.28 h.p. or 1.71 e.h.p.