1872

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REPORT

ON THE

WATER POWER

OF THE

RICHELIEU RIVER

AT

CHAMBLY,

IN THE PROVINCE OF QUEBEC,

BY

CHARLES LEGGE, ESQUIRE,

CIVIL ENGINEER,

MONTREAL, JULY 1872.

MONTREAL:

PRINTED AT THE "GAZETTE" JOB OFFICE, CORNER OF CRAIG AND ST. FRANCOIS-XAVIER STS.

1872

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FOR

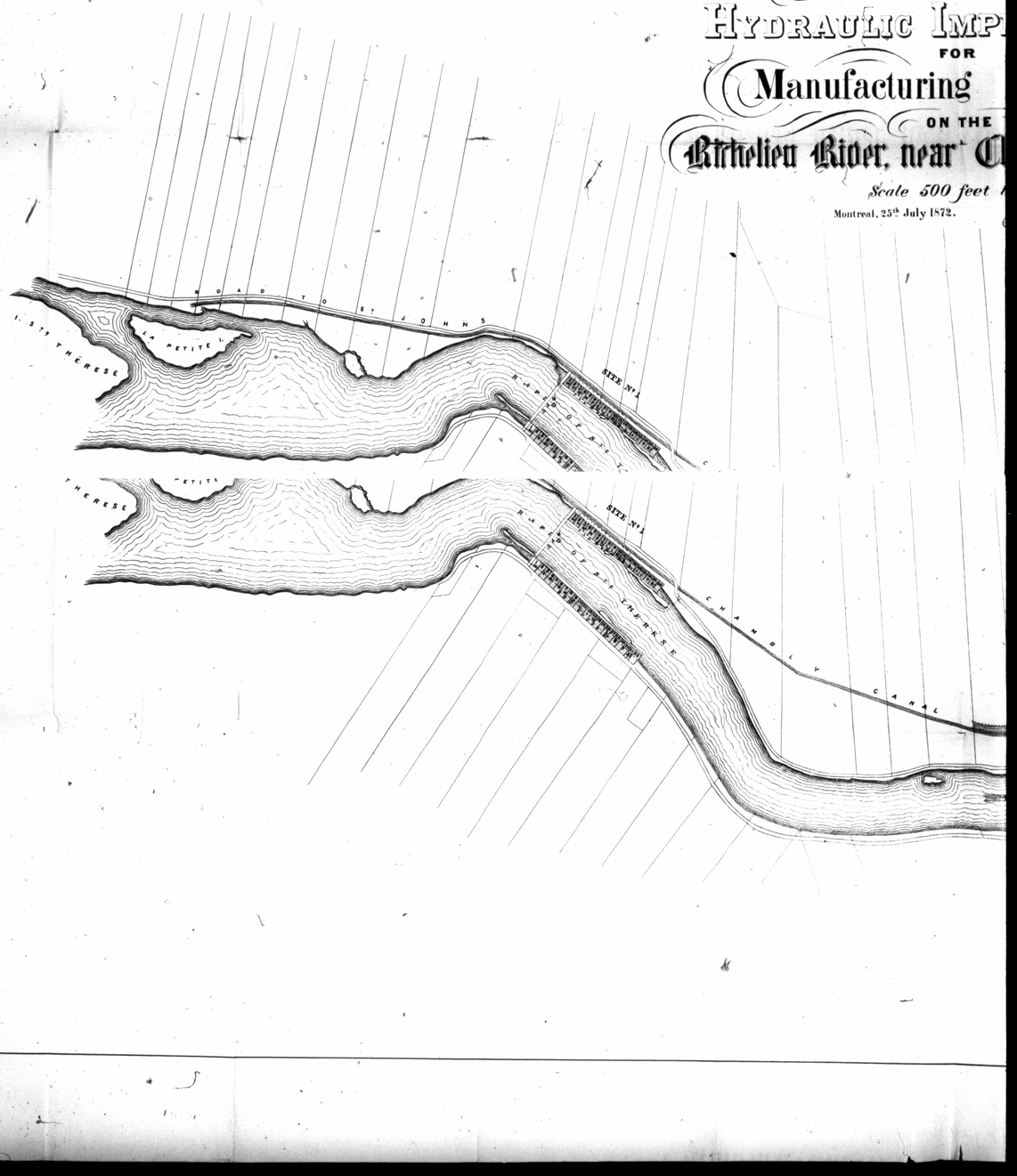
Manufacturing

ON THE

Richelieu River, near C

Scale 500 feet t

Montreal, 25th July 1872.



PLAN

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FOR

anufacturing Purposes

ON THE

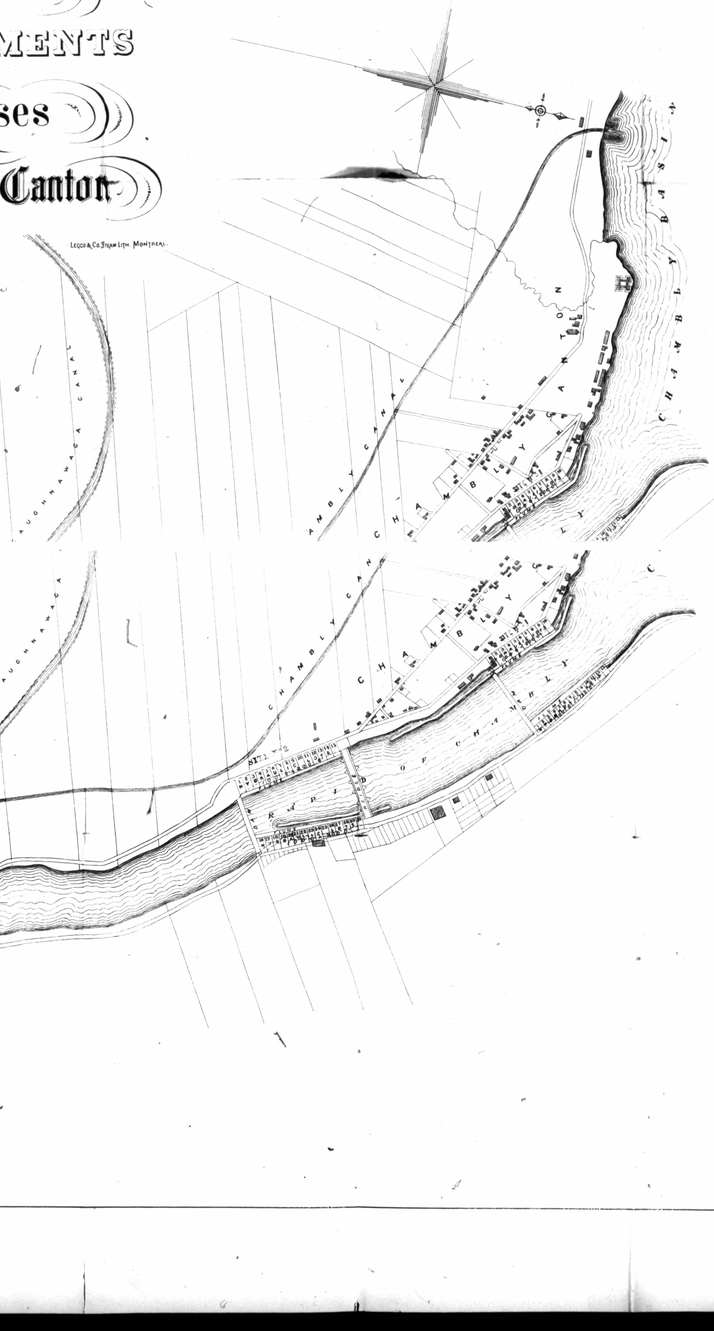
Rivet, near Chambly Canton

Scale 500 feet to One Inch

Montreal, 25th July 1872.

Charles Legge
Civil Engineer

LEGGE & Co. STEAM LITH. MONTREAL



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162 St. James Street,

Montreal, 25*th July*, 1872.

Sir,

In accordance with your instructions I have visited and examined the Richelieu River at, and in the neighbourhood of Chambly, with a view of ascertaining the amount of water power available for manufacturing purposes at that place, and to give an opinion as to the most feasible manner of utilizing it.

Before going into details with reference to the scheme to be suggested, it may be well to give a brief description of the locality, its surroundings and connections with other places, either by water, ordinary roads, or proposed railways.

Chambly may be divided into two sections; the first, known as Chambly Basin, is a beautiful village at the mouth of the Chambly and St. Johns Canal, and on the banks of a picturesque bay in the Richelieu River. It is the outlet of the trade of Lake Champlain with the Province of Quebec, and has a considerable business during the summer months. The nearest station of the Grand Trunk is within nine miles, and the city of Montreal but sixteen miles distant, the two places being connected by a macadamized road over a perfectly level country. A continuation of this village, known as Chambly Canton, is beautifully situated on the Richelieu Rapids, where are to be found sites for the hydraulic privileges presently to be described. The entire village contains a population of about 1400 souls, and is surrounded by the oldest and most thickly peopled sections of Canada.

There are now in existence at this place extensive Saw, Grist, Carding and Woollen Mills, with a large foundry. Here is also a

large hospital belonging to the Ladies of the Grey Nunnery of Montreal, well adapted for the reception of the poor and sick, and a College with an extensive library. Telegraph and Post Offices also exist. The extensive ruins of an ancient French fort in the village connect it with the past, while Rougemont, Belœil, Rouville and other conically shaped mountains, rising at different points in the surrounding level country, like giant sentinels, give diversity to the scenery.

The Richelieu River upon which this charming village is placed, flows from and forms the outlet of Lake Champlain in the United States, a sheet of water about 100 miles in length, and from one to twelve miles in width, receiving the drainage of the greatest portions of the northern parts of the States of New York and Vermont. Chambly is twenty-nine miles from Rouse's Point at the outlet of the lake, and ten miles distant from St. Johns, a railway centre of considerable importance, and situated on the same river; the two places being connected by a canal. This canal will eventually be greatly enlarged, and form a part of the Caughnawaga Canal, for uniting the waters of the St. Lawrence and Lake Champlain; the latter canal forming a junction with the existing one a short distance above Chambly and following its course to slack water navigation at St. Johns, and thence into Lake Champlain.

From Chambly the course of the river is northerly and falls into the St. Lawrence at Sorel. The river for this distance is navigable for vessels of a large class, and is the route for the present extensive traffic between Canada and the United States, *via* Lake Champlain.

Several lines of Railway are now projected, (one in course of construction,) which when built will connect Chambly with Montreal and the net work of Canadian and American railways in all directions.

This line will run from Sorel, a town on the St. Lawrence, to Chambly, and thence to Montreal,—uniting at that place with the Grand Trunk Railway,—and other lines to the West and North. From Chambly the road will be carried to St. Johns, and connect with the New England system of Railways on the South and East. A second very important and independent rail connection will be had, *via* "The South Eastern Counties Railway," with the New England States, in one direction, and Montreal in another. This road is now built, and running between West Farnham in the Province of Quebec, and Richford in the State of Vermont, a distance of 34 Miles, and in course of construction to Newport, Vt., an additional length of 28 miles, to be opened for traffic during this season. A junction is made at Newport with the "Connecticut and Passumpsic Rivers

Railway" and its connections. From West Farnham the line of the "South Eastern Counties Railway" will be continued to Chambly and thence to Montreal. The right of way has been partially secured for this latter section, a large quantity of ties delivered, and preparations made for construction of the work, which will be of a light character, owing to the very level country traversed by the line. It will therefore be seen that Chambly is destined to become a Railway centre of considerable importance, and in conjunction with its navigation connections with all the leading cities and seaports of the Dominion, the vast water power it possesses will be in a position to be utilized to the greatest possible extent, and under the most favourable circumstances.

With the foregoing introductory remarks, I will now give a general description of the several hydraulic sites selected, referring you occasionally to the accompanying map upon which they are shown, for the purpose of more fully illustrating the subject.

From a point three miles above the bridge in the upper village there exists a fall in the river to the basin below the lower village, of about 63 feet in a total distance of four miles. This fall, or declivity, is distributed over the entire length, the water flowing over a rocky bottom with an average width of channel of one thousand feet The adjoining banks are sufficiently high to permit of dams of 10 or 12 feet high being placed at any point on the river, without risk of the water overflowing the land.

In a river of this magnitude and draining so vast an extent of country, with Lake Champlain as a reservoir for equalizing or regulating the flow of the water, the power developed by its fall through that height, at all seasons of the year, must be very great.

For the present purpose it will be prudent to ascertain the minimum flow of water, and base the calculations accordingly. This low stage of the river will naturally be found in the autumn when the level of Lake Champlain will be reduced after the dry season of summer. On the 16th of October 1858, I had an opportunity of accurately gauging the quantity of water passing down the river at this place, (when the level was at the lowest point) From these measurements it was ascertained that 4257 cubic feet passed a certain point in each second of time.

This quantity of water falling through the entire distance of 63 feet will develop a power of 30,476 horses or more than three times the amount of water power at the City of Lowell in the United States.

Each foot of fall will therefore equal about 484 horses :—figures which will be serviceable in determining the heights of the dams.

On referring to the accompanying map it will be seen that three points have been selected provisionally as suitable sites for dams, the upper one on a rocky reef a short distance above St. Therese, nearly half a mile above Hatt's mill ; the central one on a reef of a similar character, at the upper end of the village, or some fifteen hundred feet above Yule's Bridge, while the lower one is half a mile below the bridge, or nearly opposite Willet's Mill.

In the adoption of those sites several governing considerations have to be kept in view in order to obtain the maximum amount of benefit from the expenditure incurred in construction of the dams, and available power furnished by them. A number of those leading points will be briefly indicated as follows :—1st—The selection of a site which will give a rock foundation for a dam of a minimum height and consequent cost, while at the same time yielding a good working head for the water wheels of the factories in the immediate neighbourhood of the dam, and without flooding the adjacent lands above. 2nd—A site which will furnish an ample space of ground below the dam at each end for factory purposes, and for the development of the power, year after year, as it is required to be brought into use. 3rd—A configuration of grounds, or bed of river to admit of head and tail races being constructed at the least possible expense, and planned in such a manner as to admit of extension from time to time with the growth of factories and mills, spreading this portion of the expense of the water power development over the entire time required for bringing the total power into operation. 4th—Ready access to all the factories by wide roads or approaches for railway, boat, and ordinary traffic. 5th —Convenient and cheap building lots for the houses of artisans, &c., in connection with factories.

Based on requirements of the foregoing character the plans for the three sites have been prepared and arranged for being carried out in sections, as demanded by the increased growth of the population, or trade of the country, one portion working in harmony with another and forming eventually a whole, complete and uniform in all its parts.

The following general description of the dams and their adjuncts will be given, followed by statements of approximate cost and revenue to be derived from sale or lease of power.

The dams in use at the present time in this locality are known as "Wing dams"; leaving the shore a short distance, and running

parallel with it up stream until a sufficient head is attained for the mill at the lower end, or point of junction of the dam and shore.

A very considerable amount of money has been expended at Chambly and neighbourhood in the construction of works of this character, which are very objectionable in several particulars. 1st—The limited amount of factory space and power which can be employed in proportion to the cost of the wing dam. 2nd—The upper end of the wing dam, forming a bell mouth entrance in running water, permits the entrance of floating ice and *frazil* into the head race, or canal, and interferes seriously with the water wheels of the factories. It is a well known fact that *frazil* is the product of shallow running open water, and not germinated in deep still water covered with ice. This fact at once points to the necessity of the dams being placed at right angles to, or across the river, raising up and forming still water above. From this reservoir of dead water with an ice covering in winter, the main head races leading to the factories at each end of the dams are supplied, without *frazil* or floating ice, as in the case of the wing dam, therefore obviating that difficulty.

The main dams at each of the three sites will consist of crib work, fitted as accurately as possible to the rocky bed of the river and filled with stones. They will be of the general height of ten feet above the rock, ten feet in width on top, and sloping on each side with an inclination of one to one, forming a base of thirty feet on the bottom; the side and top timbers will be suitably prepared for the reception of sheeting, which will be securely pinned or spiked to them. The upper side will be made water-tight by brush, clay, gravel, and stones; the surplus water of the river not required for the factories will flow over the top of the dam. The formation of the shores not permitting of the excavation of head races, or canals for carrying the water from the ends of the dams to the factories below, except at great expense, it is proposed to use large wooden flumes for this purpose. These flumes will connect by bulk heads and gates with the main dams near their ends, and run down stream, between the factories and the river. The flumes, while carrying the same level of water as above the dams, and with foundations resting on the bed of the river below, will have their bottoms about two feet above the rock, to permit the escape of the water from the wheel tail races to the river. Factory lots at right angles, and abutting on those flumes, with a depth of from 150 to 200 feet, and frontage of 100 feet each, extend down the river on both sides, at the various dams. Wide

roads are also laid off at the opposite ends of the lots for access to the factories.

On reference to the plan it will be seen that *Dam No.* 1, near St. Therese, has 22 hydraulic lots of 200 feet, and 18 of 150 feet by a frontage of 100 feet each, or 40 lots in all.

Assuming an average working head of 10 feet at this dam, there will be a total power of 4840 horses or 121 horses for each factory.

At *Dam No.* 2 we find space for 30 hydraulic lots of 200 feet in depth by 100 feet frontage each, and, with a similar head and power, each factory will have the power of 161 horses—at this dam, however, there is no difficulty in obtaining an increased total head to the extent of 18 feet, without interfering with the works at Dam No. 1. This head will develop a power of 8712 horses or an average for each of the 30 factories of 290 horses.

Dam No. 3 can furnish space for 10 hydraulic lots, 200 feet, and 13 of 150 feet in depth by 100 feet frontage each, with a 10 feet fall. These 23 lots will have a total power of 4840 horses, or 210 horses each.

Condensing the foregoing results, we have for the three dams 93 large hydraulic lots, with an aggregate power of 18,392 horses, or an average of 198 horses for each factory.

The foregoing brief sketch, explanatory of the plans, will give you a general idea of the proposed scheme and its extent; you will now naturally ask for information on an important point, viz:—at what cost can the whole or a portion of the work be carried out, and the probable revenue to be derived therefrom.

In endeavoring to reply to this query the following approximate estimate is given of the cost of the dam and flumes at site No. 2, selected as a medium one of the three.

Crib work, 5,200 cubic yards @ $3.00, ...	$15,600
Sheeting, 8,000 feet B. M. @ $20 00, ...	160
Earth and gravel filling, 2,600 c. yards @ 20 cents, .	520
Stone pitching, 3,500 c. yards @ 75 cents, ...	2,625
Brush, &c., say, ...	100
	$19,005
Add Superintendence and contingencies, ...	995
Cost of Dam, ...	$20,000
Cost of flumes 50 feet wide, average width of 30 feet:	
Total length of 3,100 feet @ $30, ...	93,000
Total cost of dam No. 2, with flumes, &c., when completed.	$113,000

It may be interesting to institute a comparison of the relative value and cost of steam *vs.* water power at Chambly, based on the above estimated cost of dams and flumes; taking in one case a steam engine of 25 horse power, in the other a water wheel of the same power, and estimating 300 working days per annum.

Engine, with fixed boiler complete, $2,400 @ 7 per cent	$168.00
Depreciation if worked 24 hours continuously, 20 per cent per annum,	480.00
Engine men,	600.00
Tallow, oil and waste,	81 00
Coal, at the rate of 4lbs. per H. P. per hour, 321 tons @ $6.00 per ton,	1,926.00
Total expenditure for 25 H. P. per annum,	$3,255.00

or about $130 per horse power.

By the preceding calculation it has been shown that each horse power of water will cost $13.00.

25 horse power × $13.00 = $325 @ 7 per cent,	$22.75
Add depreciation of flumes, which will last 15 years, $\$\frac{93,000}{8712}$ horse power, = $10.67 × 25 horse power $\$\frac{266.75}{15}$ years,	17.77
Tyler wheel with shaft 20 feet long, will cost $400, @ 7 per cent,	28.00
Depreciation and attendance, 10 per cent,	40 00
Total expenditure for 25 horse power wheel,	$108.52

or at the rate of $4.34 per horse power.

The comparison will consequently stand as follows:—

Annual cost of steam per horse power,	$130.00
" " " water " " "	4.34

Taking 24 hours work in a day is really the correct method of comparison, as the water power would otherwise be running to waste during the night, while there are many branches of manufactures which are continuous. If however, twelve hours per diem be the working time, the following will be the state of the case.

Annual cost of steam power, per horse power,	$68.00
" " " water " " " "	3.48

An additional saving would be effected in insurance of factories, as it would be less with water wheels than if steam engines were employed. These calculations are sufficient to show the vast differ-

ence in cost in favor of water power as a motor, which alone should be employed as long as the Richelieu flows before your doors, with such admirable facilities for its use.

In estimating the commercial value of this power we may be safely guided by the original value placed on similar power at Lowell, when but a village like Chambly, or some 25 years ago on the Lachine Canal by the government. At Lowell the annual rental amounted to about $10.00 per horse power, and at Montreal to $8.00. At the present day, in either of the above places, this same power could not be purchased under the cost of steam power, or probably twenty-five times the original cost.

For our present purpose we will adopt the original Montreal rate of $8.00 per horse power, per annum, and at a low estimate, the value of the hydraulic lots to be disposed of may be placed at an average of $1000 each.

The total horse power at the three dams, 18,392, @ $8 00 per annum, ...	$147,136
Total number of hydraulic lots, 93 × $1000 @ 7 pr c.	6,510
Total annual revenue, ...	$153,646

An approximate estimate of the cost of the three dams and flumes complete, may be placed as follows:—

Dam No. 1, ...	$140,000	
" " 2, ...	113,000	
" " 3, ...	89,000	
Total cost, ...	$342,000	
This amount at 7 per cent will require, to meet interest, the annual sum of		$23,940
To which must be added the annual depreciation of flumes		18,600
Or a total annual outlay of		$42,540

To meet this charge we have the estimated annual revenue of $153,646, leaving a profit, after meeting interest and depreciation, of $111,106, or at the rate of nearly 33 per cent on the total cost.

In the foregoing estimate, the present values of the hydraulic lots have not been taken into account. They occupy the bed of the river to a considerable extent, and do not, I presume, possess much

value apart from their connection with the improved hydraulic properties of the river.

Such is a view of the scheme taken as a whole, but, from its very magnitude, it may not be realized for many years. It therefore may be well to take it in sections, and ascertain if it possess any value under that form.

Dam No. 2, no doubt will furnish the most eligible site for a commencement, and may be adopted as the point of crossing for the Sorel, Montreal, Chambly and St. Johns Railway. The cost of the dam with a sufficient extent of flumes to accommodate a factory at each end, will be as follows :—

Cost of dam, ...	$20,000	
Cost of necessary flumes, say,	7,000	
Total cost, ...	$27,000	
At 7 per cent, will require..	$1,890	
Annual depreciation of flumes	400	
Total yearly expenditure,...	$2,290	
Rental of water power 580 horse power @ $8.00 . .		$4,640.00
Interest on sale of hydraulic lots, $2000 @ 7 pr c. . .		140.00
Total revenue, ...		$4,780.00

Leaving a profit, after meeting the interest on total cost, and depreciation, of $2,490, or at the rate of about 9 per cent., per annum on the outlay. The dam being common to all the hydraulic lots, the only extra expenditure in bringing additional ones into the market is the extension of the flumes or head races at an expense of about $30 per running foot.

It is thought sufficient evidence has now been given to establish the character of the scheme as a "paying one," either in its entirety or in its parts. Its indirect influence on the village and surrounding country, in the enhanced value it would give to real estate, increase to the population, and consequent markets which would be created for the surplus agricultural productions, with demand for labor and increased circulation of money, few can realize.

In preparing the plans and estimates, I have endeavored to give you a scheme perfect in all its features. The amount required to carry out the work, will compare most favorably with the cost at

which similar works have been executed in the United States and Canada.

In a work of this character and magnitude, a "penny wise and pound foolish" policy should not for a moment be entertained, but everything in connection with the dams and flumes be built in the most solid and substantial manner, and with ample space to develope the power. Numerous joint stock companies have been formed for working mines in the Eastern Townships in past years, with considerably larger capitals than that required to develope this mine of wealth. Mineral mines, with the most flattering prospects of paying large returns, may, after being opened up, prove of no value; but in this legitimate enterprise there is no uncertainty, for as long as the Richelieu River tumbles down its rocky bed, so long will drafts on its exchequer be honored at par.

With even one of the dams built and in operation, the commanding position of Chambly as a manufacturing and distributing point, will soon attract the attention of capitalists and manufacturers. It therefore does not require much prophetic skill to foretell its future progress, and the no very distant day, when it will become to Montreal and Canada, what Lowell now is to Boston and the New England States.

I am Sir,

Your obedient servant,

CHARLES LEGGE,

Civil Engineer.

JOHN YULE, Esqre.

Seigneur &c., &c.

CHAMBLY.