Water Powers on the Mersey River, N. S.—By W. G. Yorston, C. E., City Engineer, Sydney, N. S.

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The province of Nova Scotia is the second smallest of the provinces composing the Dominion of Canada. It comprises about 21,000 square miles of territory in a shape of a rather narrow peninsula about 350 miles in extreme length, and with an average width of less than 100 miles. Owing to its shape the province cannot boast of any very large rivers, but in some of those rivers that we do possess nature has placed in our hands rather valuable forces, which have up to the present time been only partially made use of, partly from the lack of purpose to apply the power to. The resources of the province are rich and varied, and it is especially rich in its mines and minerals. In the last few years a rapid development has taken place in Nova Scotia, and in the course of such development the question of power has naturally forced itself to the front, cheap power being essential to the successful operation of large factories, or even to the mining of any kind of mineral. My own belief is that the development of the resources of the provinces is only beginning, and in a few years time great strides will be taken in the opening up of resources that have already lain for too great a time undeveloped. Believing that such is the case, the question of cheap power becomes at once a large and important consideration, and it is safe to predict that before very long every availbale water-power of any size in the province will be producing energy for the operation of factories and other purposes for which power is required.

Our neighbours in the south have for many years recognized the value of their water-powers in connection with the development of the country, and have created a special depart-

ment with the object of measuring and tabulating the quantity of flow of all the principal streams of the country. This engineering department, which is called the Hydrography Division of the Geological Survey, embraces among its members many of the best well known and foremost men in the profession. They have already accomplished very much, and the statistics gathered as to the flow of streams, the evaporation from water surfaces, etc., are found to be invaluable. Data such as are collected by this corps of men are of great value, as the researches cover a period of time long enough to determine beyond doubt that the results given are correct in every detail, and that they can be absolutely relied on.

In making an estimate of a water-power it is essential that accurate information be had on the following points:—

(1), The flow of the stream, both maximum and minimum.
(2), The total fall at the power site selected.
(3), The practicability of providing storage.
(4), A record of the periods of drought.

The flow of the stream is the one thing most apt to be over-estimated, for with a knowledge of a stream covering only a short period of time it seems to be a most natural thing to forget that the minimum or dry summer flow is only a fraction of the average flow of the stream, and consequently if a mistake is made in designing or construction of a water-power it is generally an over-estimate of the power to be derived from the plant installed. Up to the present time no such data regarding stream flow of any kind for Canadian streams have been collected, but I have no doubt but that in the near future the rapid development of the country will lead the government to undertake a work which would lead so directly to the further employment of capital and tend to increased prosperity.

Of Nova Scotia rivers the Mersey is probably the largest, and it is certainly the one best adapted for the development of

water-powers. The main source of the river is in Annapolis county, approximately 15 miles from the Bay of Fundy. Branches to the main stream also come from the counties of Shelburne and Digby. The extent of territory drained by the river is 600 square miles, and on the water-shed are to be found many lakes of large size, of which Rossignol, which has an area of 18 square miles, is the largest. In all, about 40 square miles of lakes are drained by the Mersey, and consequently the river is much more steady in its flow than others of our rivers, due to the large area of lake surface on its water-shed. It will readily be seen that this steadiness of flow particularly adapts this river for the development of water-powers, but after all, the chief recommendation of the Mersey river is the fact that in the last sixteen miles of its length it has a total fall of 260 feet. The river for this portion of its length is really a succession of many rapids or falls, and as the high ground approaches close to the river, on both banks there are many good power sites to be found, capable of development at a comparatively low cost. The portion of the Mersey river which I speak of as being specially adapted for water-powers, is the last sixteen miles of its length, from the point where it leaves the lake (known as Indian Gardens) down to tide water, and I intend giving a short description of the water-powers already developed on this portion, as well as the possibilities of the further development and its application to industries particularly suited to the locality.

In the early days the Mersey river was used by the Indians as a means of communication with the Atlantic coast. The route followed was up the Lequille river to its source in a lake about 14 miles back, and thence by a short portage of about one mile to the head waters of the Mersey, from which point it was comparatively easy to descend by canoe to the ocean at the mouth of the Mersey. That this route was used extensively by the Indians there is abundant evidence in the relics to be found on the shores of some of the lakes on the river, and

guides will now point out what are known as the "picture rocks," so named because of the rude Indian drawings made with some hard tool on the flat surface of the rocks on the shore of "Kidjmie Kidjie" or Fairy lake.

The water-shed of the Mersey is covered with a good growth of nearly every variety of our native trees, and the many branches of the river afforded such an easy mode of transporting the logs that lumbering operations on the river have always been prosecuted with vigor since the days of early settlement, and up to the year 1893 this was practically the only use made of the splendid water-powers on this river. As the great consideration of the owners of saw mills was to deliver the sawn lumber as near navigable tide water as possible, and as the quantity of power required was not large, they were content to utilize heads of 8 to 10 feet, and leave the larger power developments for the future. Accordingly the saw mills were built on two dams about one mile apart, the lower dam being situated just above the tide water at Milton Falls, about 2¼ miles above the town of Liverpool, from which place the lumber has always been shipped.

In the year 1883 an engineer named Emil Vossnack, made surveys and plans for the development of the water-power at two sites immediately above the flowage of the Potanoc or upper saw-mill dam. His purpose was to construct two dams, one at Cowie's Falls, and another at the head of Rapid Falls, and his estimate of the power to be obtained from both was 10,000 horse-power. A company was organized in London to undertake the construction of the two dams, and the necessary mill buldings, etc., for the manufacture of pulp and paper. This company acquired all the necessary lands, etc., for the construction of its dams and factories, but for some reason construction was never started, and nothing further was done until the year 1893, when the Acadia Pulp and Paper Company, recognizing the very cheap power to be got, and the great possibilities of its adaption to the manufacture of

mechanical pulp, acquired the rights of the old company, and commenced the building of a pulp mill at the Rapid Falls site. In the year 1900 the same company extended their operations by building a second dam and mill at Cowie's Falls, immediately below the first one.

For the purpose of supplying power to generate electric current for its lighting system, and motive power for manufacturies, the town of Liverpool in 1903 acquired the water-power on the river immediately above the Acadia Pulp Company's property at the falls known as "the Guzzle," and have constructed an up-to-date electric plant operated under a 20 foot head. This plant owned by the town was a much more costly plant to develop than those below it on the river, as the dam and power-house are over three-quarters of a mile apart, still even with the heavy cost of construction, the cost of power to the town of Liverpool per horse-power is comparatively light, and the town is operating a successful and up-to-date plant.

I give below a short description of the water-powers at present on the river, beginning at the one lowest, and going up the river.

Water-power of the Mersey River.

Milton Falls.—Situate in Milton, just above tide-water, 2¼ miles from Liverpool. Two good wharves within one mile of the mills. Total height of the fall at low tide 13 feet. Height of dam 7 to 8 feet. Total head developed, 8 to 10 feet, according to height of water in the river. Dam is the ordinary style of timber dam, built of cross sills and pointers.

Mills on these falls are as follows:—

(1), John Milliard's saw mill, two rotaries and one gang, with all the necessary machinery for doing general mill business. Handles lumber, laths, and box stuff of all kinds. Does a large business in dimension timber. Mill cuts from 30 to 35 thousand per day.

(2), Tupper's gang saw mill, purchased by Lewis Miller, of Ingram Port. This mill runs mostly on custom work. Cuts from 10 to 15 thousand per day.

(3), Power-house of the Milton Electric Power and Manufacturing Co., Ltd. Provides power for lighting the village of Milton, also for Claude Hartlen's wood-working factory and John Wolker's turning shop. 100 horse-power developed.

Total power developed on these falls, 400 to 500 horse-power. Can be greatly increased by the addition of more water wheels.

Potanoc Falls.—Situate in the village of Milton, distance from Liverpool 3¼ miles. The dam at Milton Falls backs water to the foot of this dam. Available head 8 to 10 feet. Height of dam 7 to 8 feet. Dam built of logs, cross sills and pointers. Mills on this dam are as follows:—

(1), Harlow & Kempton's gang and rotary saw mills. Fitted up with all the necessary machinery for doing a first-class saw mill business, capable of getting everything out of the log. Cuts lumber and dimension stuff of all kinds, as well as laths and box stuff.

(2), Harlow & Kempton's wood-working factory, manufacturing sashes and doors, boxes, mouldings, and house finish of all kinds.

(3), L. H. Minard gang saw and planing mill. Besides cutting his own stock this mill also does custom work.

(4), Ford Brothers' rotary mill. Lately purchased by Geo. P. MacLearn. This mill has been principally used in cutting hardwood, for which there is a good demand.

Total power developed on these falls about 450 horse-power. Capacity of mills about 50 thousand daily.

Cowie's Falls.—Situate immediately above the Potanoc Falls, about 3½ miles from Liverpool. The dam at the Potanoc Falls backs water up to the foot of this dam. Height of dam 20 feet, built of logs. Available working head 20 to 22 feet.

Mill owned by Acadia Pulp and Paper Company, manufactures ground pulp. 1500 horse-power developed. Daily output of mill 22 to 25 tons.

Rapid Falls.—Distance from Liverpool 4¾ miles. Height of dam 10 feet, built of logs. Available working head, 32 feet. This power was developed by building a dam at the head of Rapid Falls and diverting the water by means of a canal excavated in the high ground, to a point about 1400 feet down stream, at which place the mill is situated. Total power developed, 2,827 horse-power.

This mill is owned by the Acadia Pulp and Paper Co., and manufactures ground pulp. Daily output, 50 to 60 tons. In both these pulp-mills more power could be developed for a large part of the year if additional wheels were installed.

Guzzle Falls.—Town of Liverpool electric power station. Distance from Liverpool about 5½ miles. Height of dam 6 to 8 feet, built of logs. The dam at Rapid Falls backs water up to the tail-race of this plant.

This power was developed by placing a dam at the head of Guzzle Falls and diverting the water by means of a natural channel nearly one-half mile long, into a basin or reservoir with earth embankments from 2 to 18 feet in height. A timber flume, 350 feet in length, passes the water to the wheels. This plant is laid out for further development, the penstock is built for three sets of wheels, only one of which is yet installed. Head 20 feet. 750 horse-power developed. Power stations contain two 250 K. W. Bullock electric dynamos.

The above are all the water-powers so far developed. They occupy a total length along the river of 3¼ miles, and the total of all the different heads, together with an allowance made for some fall that is unavoidably lost to prevent the flowage of one dam interfering with the tail-water of the mill above it, will be in the vicinity of 100 feet. As before mentioned the Mersey river has a total fall in about 16 miles of 260 feet, so it will

be seen that there is still left undeveloped on this river a total fall of approximately 160 feet, extending over a length of river of about 13 miles. In this length of 13 miles there are at least three possible power sites, namely, Lower Great Brook Falls, Big Falls and Lake Falls. All of these are good powers, and the site at Big Falls is probably the largest water-power on the river. The falls have been named in their order going up the river, and the distances from Liverpool are respectively 8 miles, 12 miles and 18 miles.

Power at Present Developed.

A summary of the power developed on the Mersey river at the present time is given below:—

Milton Falls	.....	400	horse-power.
Potanoc "	.....	450	"
Cowie's "	.....	1,500	"
Rapid "	.....	2,827	"
Guzzle "	.....	750	"

By these figures is meant that wheels to develop the power enumerated here have been installed, or, as in the case of the Liverpool plant that flumes, etc., of capacity large enough for that amount of power have been constructed. What I do not wish, however, to convey is the idea that these plants are developing the amount of power mentioned every day in the year, for they are doing that for probably only nine months on the average in each year, and the minimum power in the dry period is very likely only 25 per cent., or less, of the quantity mentioned. I want to show, however, that each of the power plants at present in operation is capable of much further development when advantage is taken of the immense natural storage that nature has so liberally provided. The question of storage is so intimately connected with the Mersey Hydraulic Company that I must first attempt a description of that company and its powers.

Mersey Hydraulic Company.

The Mersey Hydraulic Company is a company incorporated in the year 1902, and formed for the purpose of improving the water-powers on the Mersey river. It is given power in its act to acquire lands around the lakes, to build dams, etc., and to store water in the lakes on the Mersey river for the purpose of using it or selling it for power purposes, or for other uses. The company has, since incorporation, expended in the vicinity of $20,000 in acquiring flowage lands, building dams, etc., but for some reason unknown to the writer, the dams for flowage are in an incomplete state, and accordingly, it is unable at present to give anything like the increase of power that might be got. A small expenditure of not over $5,000 would suffice to do all the necessary work to enable it to store water over an extremely large area, and when I say that the completion of one dam will store water in three lakes aggregating 22 square miles in area and a depth of six feet, it will readily be seen what large increases of power may be got from storage. Besides, water can readily be stored in other lakes if it is wanted. The effort made so far by the Mersey Hydraulic Company to increase the power on the river from storage, has not been an unqualified success, and the writer cannot explain why this is so. I think, however, it must be admitted that the possibilities of improvement are there, and some change in the management or policy of the company may be arrived at that will benefit and give satisfaction to all the operators on the river. I have heard it advocated that the government should take control of the situation, but that, to my mind, would not be the solution of the difficulty. The great object, first of all, is to get more mills in operation, and when once you have more owners of factories looking for the maximum continuous power to operate their mills, then you will have a board of control that will either dictate to the Mersey Hydraulic Company or merge itself into

the company, or be able to make such strong representations that the government will enact such legislation as will enable the most to be got out of the water-powers. As for the control, I should say it should certainly be in the hands of the owners of the water-powers, both to assess the proportion of expense to be borne by each, and to direct the situation generally. One thing to me seems sure, advantage must be taken of the very large storage before the greatest benefit is obtained from the water-powers on this river. I have already stated that 5,927 horse-power is developed in the river, but for three-month dry period in each year this much is not obtained. Now were the full storage properly developed and distributed, not only could a larger amount of power be obtained every day in the year, but every mill owner would feel warranted in adding additional wheels for the sake of the power to be got for two-thirds of the year.

I would put the estimate of continuous power to be obtained on the Mersey river as follows:—

Powers at present developed..	7,000	horse-power.
Undeveloped powers	8,000	"
Total.....	15,000	

The above is a very conservative estimate, and one I am perfectly sure can be obtained. In making the estimate I am supposing that the storage capacity is fully utilized, and the stored water distributed over the dry summer period. This is a very large amount for continuous power, and were it all fully utilized for manufacturing purposes, this part of the country would become one of the most prosperous and populous in the province. For many manufacturing purposes it is sometimes quite satisfactory if the mills can operate eight or nine months out of the year. This might be the case with saw-mills or even with ground-pulp mills, and if I were to estimate the amount of power that it was possible to develop on the river under that condition I would put it at not less than 40,000 horse-

power. Even at the figure 15,000 the power to be got is enormous, and with the aid of electricity it can be adapted to almost any and all purposes, both close at hand or at a considerable distance away.

The writer made a trip last summer down the Mersey river and was at that time very much impressed with the great possibilities for water-power development, and the more I have thought over it since the greater has been my wonder that it has not been taken advantage of. The Mersey has always been one of our best rivers for lumbering operations, and many millions of feet have annually been shipped away to all parts of the globe. Almost the whole of the lumber, however, has gone in a rough state, and is manufactured in other places; and this is just the point which I cannot reason out, for why should the real manufacture of this lumber be done in other places when the Mersey furnishes power at one-quarter the average cost in other places. It would seem to me that there are almost unlimited possibilities in the manufacture of wooden ware of all kinds. Besides all the articles in hard and soft wood required for the building trade, there are innumerable smaller articles that could be made, such as broom handles, tool handles, pegs and lasts, etc., in fact, no article so small as long as it uses up all the good parts of the wood, and there is no waste as there is when only rough lumber is shipped. There is plenty of room, and lots of the best hardwood for a good furniture factory. Hitherto, immense quantities of hemlock have been cut on this river, and as the logs are stripped of bark before they are rafted, the hemlock bark has been lost altogether, but with a tannery on the river, or even improved facilities for getting it out, another profitable industry could be started. I shall not enlarge on the pulp industry, for it seems to have been well demonstrated already, although perhaps, more mills might be added. I think, however, my remarks about the product of the saw mills might well be applied to the pulp mills also, that is, that the process of manu-

facture should be carried further and paper manufactured. The further the process of manufacture is carried forward the larger the number of men employed, and the more money left in the country for circulation. I should not presume to dictate to our lumber merchants, who I know full well are among our best business men, and yet it may be in certain of our industries we, as Nova Scotians, have got into a "rut." Our neighbors to the south are particularly quick to see a good business opening, and if the Nova Scotians are to keep up in the race they too must keep alive and take advantage of every possible opportunity. This, too, is an age of big things, to get the most out of them, our industries must be on a larger scale, and in the case of these water-powers the ideal state of things would be that one factory should either use the product of another on the river, or some part of the raw material not used by others, and every small particle of our raw material should be manufactured before it is shipped. If we consider the immense tracts of woodland around the Mersey, it can be satisfactorily demonstrated that the forest growth is practically inexhaustible if properly looked after and protected from fires, so that any industry located on the river for the manufacture of anything in the line of wood would be an established fixture. The further the process of manufacture is carried on the less the cut of logs is likely to be, for nothing could be so destructive to our forests as the way they have been depleted for the cutting of deal.

I have said nothing so far about industries connected with anything but lumber, as that seems the most natural use to put the power to, as well as the most profitable. There are, however, other uses for power if transmitted to the mines in the country, for Queens county is rich in minerals, and its gold mines are particularly valuable. In fact, electricity can be so cheaply developed on this river that it can be delivered by long transmission lines at comparatively small cost.

Facilities for Transport.

One of the greatest considerations with the manufacturer of any kind of goods is the proximity of his factory to his market, and the cost of getting his product transported. A manufacturer may be situated at quite a distance from where his goods are sold, and yet, if he has good communication and cheap rates of freight he may be better situated than if he were much nearer his market but had poorer transport facilities. Now I want to show that as regards the powers of the Mersey any manufacture can be readily marketed, and, in fact, I think the situation could hardly be improved, and that it only requires that the conditions become better known to have it promptly taken advantage of. As stated before, the towns of Liverpool and Milton are but 2½ miles apart. Liverpool is the shipping port, while the bulk of the manufacturing has always been done at Milton. There has always been a friendly rivalry between these two places, but to an outsider they are all the same, a people busy, industrious and enterprising to no common degree. That the people of these places have always had faith in their towns, and in their prospects, is evidenced by the uncommon number of neat and pretty residences, and a stranger to the place cannot but be impressed with the care and taste displayed in the arrangement of the grounds and the placing of beautiful shade trees. They have an air of prosperity not always worn by towns of their size. The town of Liverpool has an excellent harbour opening out into the Atlantic, and has exceptional advantages as a shipping port. In the town there is an up-to-date machine shop and foundry, and other factories. They have also a marine railway operated by electric power supplied by the town, and this is the only marine railway on the continent that is so operated. Shipbuilding is carried on extensively in the town, and the products of the ship-yards are in demand as being the staunchest and best models of wooden ships obtainable.

Milton occupies both sides of the river where it has been broadened out by dams, and is one of the busiest places to be found in the province. The buzz of machinery is heard all over the place, and everybody appears busy and contented. Soon after the starting of the pulp mills a steam tramway was built up the left bank of the river, connecting the mills with the different wharf properties in Liverpool, and has been used to ship the products of the mills, although pulp has been the staple freight outward and pulp-wood inward. I am of opinion that this tramway could be more economically and best operated by electricity, and I feel there will not be any great difficulty in extending this line up the river as far as Indian Gardens, and if this were done every water power on the river could be profitably utilized, for, with more patronage for the road, cheaper freight rates could be had, and with cheaper freight rates and plenty of freight to carry, both tramway and the manufacturer should make money. It does not seem that a factory situated anywhere on the Mersey would pay any more freight per ton for its product delivered on the wharf ready for shipment than many concerns not so favourably situated do for truckage. Now, the rates for water carriage are, as a rule, very much below the rates for rail carriage, and any concern so situated as to be able to ship by water has an immense advantage in marketing its product. As Liverpool harbour is open all the year round, no better shipping port could be desired, and manufactured products from any mill or factory situated in Liverpool or vicinity should be able to successfully meet in competition with those from any other place.

The town of Liverpool supplies electricity for power purposes at a very low rate as an encouragement to manufacturers. There is still room for industries requiring a moderate amount of power in the town, and there seems to be every advantage in the location, cheap power, cheap water and light, and low rate of taxation. Since starting this paper I have learned that construction is already started on a paper box and paper mill at

Milton. It would seem that the manufacture of these articles in the place would be an added inducement to other factories which use paper boxes to hold their product, to locate here, as they must get this part of their material at a cheap rate.

The counties of Queens and Shelburne were so long without railway communication that hitherto their natural advantages were not so widely known as they should have been, and there was perhaps some excuse for the undeveloped state of this part of the country. There have been, perhaps, a further excuse that there was no useful work for these great natural powers to do, but now that the old state of things is no more, and there is good and free communication by rail with all parts of the province, coupled with the fact that at present there is a decided activity in Canada in all industrial pursuits, the magnificent water-powers on this river should not lie idle any longer, and I think it is safe to predict that with a little judicious advertising to make the situation known, all the water now going to waste will be harnessed to some useful work, and the Mersey river, from its mouth to the Indian Gardens, will have a succession of large mills and factories along its banks, making all kinds of goods for shipment abroad, and disbursing enough in wages to sustain many times the present population.

Although the Mersey is undoubtedly the best water-power stream in the province, yet it must not be forgotten that there are many other excellent powers on other streams, and even in the same county of Queens there are several water-powers both developed and undeveloped. The Mersey powers, however, are exceptionally well sustained, both as regards getting the raw material to the factory, and the shipment of the manufactured product, and this fact would, I think, commend them to anyone looking into the situation. I may say that I hold no "brief" to speak for anyone or for any interest on the river. I have, however, had it impressed upon me as the result of a few weeks

spent in this vicinity, that the powers on this river are likely to become important factors in our commercial life, and a source of wealth and profit to the owners as well as to our native province.

I think that we as Nova Scotians are beginning to realize that our province is rich in its resources, and I am firmly convinced that we as yet have only begun to find out how very rich they are. We hear much of the boundless possibilities of western Canada, and are, perhaps, too apt to give too little attention to the development of the eastern portion, but there is no doubt that if we would only emulate the push and energy displayed in opening up the west, and at the same time take full advantage of all the great natural advantages at our disposal, this fair province could be made as prosperous and populous a country as any part of the British dominion.

In preparing this short paper I have been forced to put several friends under tribute for information needed. I am indebted to the provincial engineer, Mr. MacColl, and to the Hon. Justice Forbes, for much help, but I am especially indebted to Mr. John S. Hughes, pulp manufacturer of Milton, for much detail information that could only be acquired by one who had a long and intimate acquaintance with conditions on the river.