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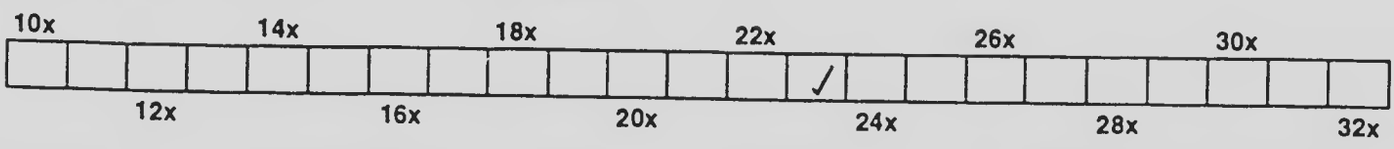

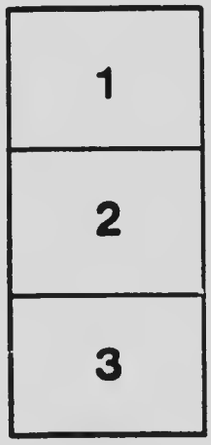

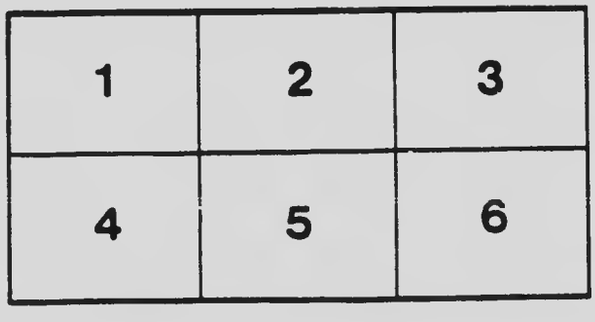

Discussion on the St. Lawrence River and Great Lakes

also

Some Observations in Regard to Transportation Problems in Canada

By HENRY HOLGATE
Consulting Engineer
Montreal

Reprinted from "The Canadian Engineer"

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ST. LAWRENCE RIVER AND THE GREAT LAKES

Review of Treaties Affecting the St. Lawrence — The International Joint Commission — The Canal System and Contemplated Development — Growth of Canal Navigation — Ultimate Depth of Channel — Power Development.

By HENRY HOLGATE
Consulting Engineer, Montreal

IN many ways the River St. Lawrence and the chain of Great Lakes is one of the greatest of Nature's wonders, and the first fact that will impress the ordinary observer is the bigness of the system. Many of you, no doubt, can see the river from your office windows, and some of us are accustomed to seeing the river every day, but when you realize the volume of water passing seawards, you begin to understand what a stupendous stream the river is, for on an average of 8,500 tons of water pass Montreal every second, and this quantity is exceeded during part of the year.

The romantic history of the river, and the part it played in the early development of the country, is so well described by writers with whom you are familiar, that details are not necessary, but I am sure that there are no more thrilling stories than those that relate to the early settlements along the shores of the Great Lakes and of the river itself, for the early history of the river is the history of Canada; the river was the great highway for white and red men, and little was known beyond its banks.

As the river played such an important part in the early settlement of the country, so as years passed and as improvements were made to meet changing conditions, we realize more and more the useful part the river occupies, and must be impressed with the great future value that still lies dormant there, but which coming generations will turn to economic uses.

You cannot think of the St. Lawrence River without associating with it the names of those daring men to whom it was familiar—Jacques Cartier, who gave the river its name in 1535—Champlain who explored it and reached the upper lakes by way of the Ottawa River in 1615, and La Salle—these were wonderful men and history does not record more adventurous spirits.

In 1700 the French instituted a series of forts along the river, and the military route followed the St. Lawrence and the lakes, while the Ottawa was used as a short cut to the upper lakes, preferred by the fur traders on account of the shorter route, and which suited the transport facilities of those days.

Thus you see that at a very early date the idea of a canal connecting the Georgian Bay of Lake Huron, with the St. Lawrence River at Montreal was forecasted; indeed Champlain was the first to place himself on record as suggesting such a route, but though such a route is physically possible, the commercial conditions of transportation do not warrant the undertaking of such a scheme at present, and it will probably not be carried out, at least not in this generation.

From the head of Lake Superior to Gaspé, the distance is 2,100 miles, and the area drained by the river is 510,000 square miles, of which 322,000 is Canadian territory. At Montreal the drained area amounts to about 480,000 square miles, or more than four times the area of Great Britain and Ireland.

The yield of water from such a vast area would in most of the great rivers of the world cause tremendous fluctuations in flow, and instances of sudden and extreme changes developing into disastrous floods are of common occurrence, in rivers such as the Mississippi, the Columbia and other great streams. These extremes are totally absent in the St. Lawrence River, and the reason is that the Great Lakes serve as immense storage reservoirs, the effect of which is to render the flow more regular throughout the year than any great river in the world.

Drainage Area of Lakes

The area of lake surface as compared with the area draining into the lake bears directly on the regulation of the lake surface levels, and the larger proportion of lake surface to drainage area, the lower the limits will be in lake surface fluctuation.

These conditions exist in an eminent degree in the great lakes, and the following table will illustrate the proportions. The drainage area tributary to the lakes is 287,688 square miles.

Lake	Area of lake surface in square miles	Drainage area, including lake surface in sq. mil.	Ratio of lake area to drainage area
Superior	32,060	76,134	1: 2.37
Michigan	22,236	65,799	1: 2.95
Huron	22,978	72,008	1: 3.13
St. Clair	503	6,194	1:12.31
Erie	9,968	34,573	1: 3.47
Ontario	7,213	32,980	1: 4.55
Total	95,088	287,688	1: 3.02

These facts produce the results shown in Table No. 1.

In the Table No. 2 are given the average and the extreme variations in the discharge of the outlets for the period 1860 to 1907; c.f.s., meaning cubic feet per second:--

The ratio of maximum discharge to minimum discharge in an average year for the Ohio River is 28.22, for the Missouri 29, for the Upper Mississippi it is 10.29, while for the St. Lawrence River it is 1.91, and these figures show an approach to absolute regularity of flow which is wonderful.

No work of man ever has approached or ever will approach this perfection of regulation.

I hope I have conveyed some idea as to the proportions of the river and its marvellously regular flow, and it will be at once appreciated that these characteristics would naturally tend towards its usefulness as a commercial highway, and eminently so as a steady producer of hydraulic power.

Before, however, going into the subject of the commercial uses of the river, I would like to explain the position of the St. Lawrence River in the various treaties that have been made between Great Britain and the United States.

Treaties Between Great Britain and U.S.

In the Treaty of Paris, 1783, which confirmed the peace between Britain and the United States, the boundaries between Canada and the United States were defined. After tracing the boundary from Nova Scotia to the northwestermost head of the Connecticut River, it goes thence down the middle of that river to the 45th degree of north latitude, thence due west until it strikes the River Iroquois or Cataraquy; thence along the middle of said river into Lake Ontario, and thence along the middle of the lakes and their connecting rivers to the head of Lake Superior. You will notice that at that date the river above Montreal was not known officially by the name St. Lawrence, this name applying only to the river below that city.

Attention may be drawn to the view of the British Government as to the effect of the war with the United States of 1812-14 upon previously existing treaties between the two countries, declared by Earl Bathurst, His Majesty's Principal Secretary of State for Foreign Affairs, in a note addressed to John Quincy Adams, the United States Minister in London, on October 30, 1815.

The United States in that year having supported a pretension for their citizens to continue the enjoyment of fishing privileges within British sovereignty conferred by the Treaty of 1783 on the ground that that Treaty was of a peculiar character and could not be abrogated by a subsequent war between the parties, Lord Bathurst in repudiating the pretention employed the following language:

TABLE No. 1

	Superior feet	Huron feet	Erie feet	Ontario feet
Extreme range 1860-1907	3.32	4.64	3.89	5.54
Maximum range in 1 year	(1869) 2.67	(1876) 1.94	(1892) 2.28	(1867) 3.65
Minimum range in 1 year	(1891) 0.49	(1879) 0.59	(1895) 0.87	(1907) 0.79
Average annual range	1.18	1.21	1.56	1.93

"To a position of this novel nature, Great Britain cannot accede. She knows of no exception to the rule that all Treaties are put an end to by a subsequent war between the same parties."

The Treaty of Ghent 1814, considering the language of the former Treaty (even if it had any force) rather vague in describing the boundary, provided for a commission to reach more definite conclusions, and to determine the nationality of the various islands in the stream, the term middle of the river not being definite.

The commission reported in 1822 partly as follows on the boundary line:—

"From the point where the 45° of north latitude strikes the River Iroquois, beginning at a stone monument erected by Andrew Ellicott in the year 1817 on the south shore of the river, which indicates the point where the 45° of north latitude strikes the river; thence running into the river, on a line at right angles to the southern shore, to a point 100 yards south of the opposite island, called Cornwall Island; thence turning westerly, and passing around the southern and western sides of said island, keeping 100 yards distance therefrom, and following the curvatures of its shores to a point opposite to the northwestern corner of said island; thence to and along the middle of the main river until it approaches the eastern extremity of Barnhart's Island; thence northerly along the channel which divides the last mentioned island from the Canada shore, keeping 100 yards distant from the island, until it approaches Sheik's Island; thence along the middle of the strait which divides Barnhart's Island and Sheik's Island, to the channel called the Long Sault, which separates the last two mentioned islands from the Lower Long Sault Island; thence westerly, crossing the centre of the last mentioned channel, until it approaches within 100 yards of the north shore of the Long Sault Island; thence up the north branch of the river, keeping to the north of and near the Lower Long Sault Island, and also north of and near the Upper Sault Island and south of the two small islands, to the western extremity of the Upper Sault, etc." The boundary line is thus described in detail as far as Lake Ontario.

Generally speaking the boundary so described keeps to the middle of the river, dividing it fairly equally, but at Barnhart's Island the boundary is nearer the Canadian shore than that of the United States, so that over 90% of the water is in the United States and about 10% in Canada in this vicinity.

This was so noticeable that occasion was taken in drafting the treaty of 1842, the Ashburton Treaty, to insert the following clause (Article VII.). "It is agreed that the chan-

nels of the River St. Lawrence on both sides of the Long Sault Rapids and of Barnhart's Island shall be equally free and open to ships, vessels, and boats of both parties."

This was intended to emphasize the equal rights and ownership of the river by both countries, that all treaties endeavor to express.

By Article IV. of the Reciprocity Treaty of 1854, the right to navigate both the St. Lawrence above the point where it ceases to be the boundary, and the canals in Canada used as part of the water communication between the Great Lakes and the Atlantic Ocean was temporarily secured to the citizens and inhabitants of the United States. By Article XXVI of the Treaty of Washington, of 4th May, 1871, the same right as to the St. Lawrence is secured in perpetuity. By Article XXVII the British Government engaged to urge upon the Government of the Dominion of Canada to secure to the citizens of the United States the use of the St. Lawrence, Welland, and other canals in the Dominion on terms of equality with its inhabitants; and the United States engaged to permit British subjects to use the St. Clair Flats Canals on terms of equality with the inhabitants of the United States, and also to urge upon the State Government to secure to British subjects in the same manner the use of the several canals connected with the navigation of the lakes or rivers traversed by or contiguous to the boundary.

In the Treaty of 1871, and in Article XXVI navigation is especially referred to in this way: "Navigation of the River St. Lawrence, ascending and descending, from the 45th parallel of north latitude, where it ceases to form the boundary between the two countries from, to and into the sea, shall forever remain free and open for the purposes of commerce to the citizens of the United States, subject to any laws and regulations of Great Britain or the Dominion of Canada, not inconsistent with such privilege of free navigation.

For many years the city of Chicago was struggling with its sanitary system and the disposal of its sewage, and in 1889 "An act to create sanitary districts and to remove obstructions in the Desplaines and Illinois Rivers" was passed by the state of Illinois. A large channel was constructed in 1900 from Chicago to Lockport, 32 miles, by means of which water was diverted from Lake Michigan westward, the low "divide" between the basin of the Mississippi River and St. Lawrence basin allowing this to be done. Thus there arose a case of water being diverted from one watershed to another, and which was not contemplated in any treaty. This canal was constructed to carry 14,000 c.f.s. and though this quantity is not used, the effect of the withdrawal of water has had an appreciable effect on lake and river levels from Lake Huron downwards, and navigation has been more or less seriously interfered with, especially in low water years, and many harbors and channels have had to be deepened.

TABLE No. 2

	St. Marys River c.f.s.	Detroit River c.f.s.	Niagara Falls c.f.s.	St. Lawrence River at its head c.f.s.
Average discharge for entire period	82,000	204,000	212,200	254,400
Greatest excess average for any one month	46,700 Sept., 1869, 57%	71,200 July, 1883, 35%	45,600 June, 1876, 21%	96,800 May, 1862, 38%
Greatest excess average for any one year	19,100 1876, 23%	30,200 1885, 15%	26,500 1876, 12%	49,000 1862, 19%
Greatest deficiency average for any one month	33,800 Feby., 1893, 41%	98,900 Feby., 1874, 48%	43,500 Mar., 1896, 20%	102,200 Feby., 1902, 40%
Greatest deficiency average for any one year	16,900 1879, 21%	30,600 1896, 15%	31,800 1895, 15%	62,800 1895, 25%

This action on the part of one of the United States was not consistent with the spirit of the treaties, and was carried out at the time without official protest from Canada. However, this matter is yet under consideration, and though it is not probable that this diversion of water will be stopped, yet it will be made subject to regulation.

Canadian Commissioners' Conclusions

The conclusions arrived at by the Canadian Commissioners who investigated the subject were as follows:—

(1) That there is no imperative necessity for such a large diversion of water from Lake Michigan for sanitary purposes, as is requested in the application.

(2) That the historical facts presented in this brief show conclusively that the sanitary canal cannot be considered as the outgrowth and development of a scheme which has received recognition by the United States Government, or that of the Dominion of Canada.

(3) That the claim that the Sanitary District is entitled as a matter of right to the use of so much of the waters of Lake Michigan as may be necessary for sanitary and domestic purposes, cannot be entertained in so far as it relates to the extraordinary and wasteful use proposed.

(4) It has been shown that very substantial injuries have been made, and are being suffered by navigation interests. Fears for future and more extensive damages, by reason of increased diversion, are exceedingly well founded, and justify the demand that some improved method of sewage disposal, which shall not require the abstraction of any considerable quantity of water from Lake Michigan nor the diversion of other outlets of waters which would naturally flow into it, be adopted.

(5) That the Dominion of Canada has the right to a voice in the disposition of the waters of Lake Michigan for sanitary purposes in so far as such diversion injuriously affects navigation, because her citizens are accorded, by treaty, the right of free navigation in that lake, and, in that no diversion can be made without injuriously affecting her harbors, channels and canals.

(6) It having been shown that the sewage of Chicago can be so treated and disposed of by other means than the present dilution methods, by which great quantities of water are withdrawn from Lake Michigan and discharged through the drainage canal into the Illinois River, it is contended, on behalf of Canada, that the abstraction of water from Lake Michigan shall be limited to such quantity as shall not injuriously affect navigation interests on the Canadian side of the boundary, and, that such limitations shall take effect at the end of such time, as in your judgment, may be rea-

sonably necessary for the sanitary district to instal, and put into use, the works which may be required for disposing of the sewage by other means than by the dilution method now in use.

(7) That, in view of the fact that the sanitary district claims that permits hitherto issued deal only with the flow through the lower portion of the Chicago river, and that it has the right to take any amount of water, without permission, through the canal, provided it is supplied through other feeders, it is respectfully requested that all permits be only for such limited quantity of water as shall not injuriously affect navigation on the lakes and the St. Lawrence River, and be so worded as to state the total quantity which the sanitary district of Chicago may be permitted to withdraw for domestic and sanitary purposes from the drainage basin of Lake Michigan.

We feel confident that the interests of humanity at Chicago, and the levels of the Great Lakes and of the St. Lawrence River, can best be protected by the installation of a modern system of sewage disposal, rather than by using a method which has been shown to be injurious to the navigation and commerce of both nations and, further, that the interests of the public generally will thus be protected and their welfare promoted.

It will be noted that this work was not undertaken by the United States, but was done under authority assumed by the State of Illinois.

Cases involving diversions in boundary waters were now and then arising, and legal machinery to deal with them was not complete; this gave rise to the following clause in the United States River and Harbors Act, 1902:

"The President of the United States is hereby requested to invite the Government of Great Britain to join in the formation of an International Commission, to be composed of three members from the United States, and three who shall represent the interests of the Dominion of Canada, whose duty it shall be to investigate and report upon the conditions and uses of the waters adjacent to the boundary lines between the United States and Canada, including all of the waters of the lakes and rivers whose natural outlet is by the river St. Lawrence to the Atlantic Ocean, also upon the maintenance and regulation of suitable levels, and also upon the effect upon the shores of these waters and the structures thereon, and upon the interests of navigation by reason of the diversion of these waters or changes in their natural flow; and, further, to report upon the necessary measures to regulate such diversion, and to take such recommendations for improvements and regulations as shall best subserve the interest of navigation in said waters."

International Waterways Commission Formed

There followed negotiations between Great Britain and the United States, and in due time the International Waterways Commission was formed, three members being appointed by each country, the first meetings being held early in 1905.

The International Waterways Commission carried on its work in an able and impartial manner, and set at rest many important questions that had arisen in reference to boundary waters, and dealt with the St. Lawrence River at several points, including parts of the river below the 45th parallel, where the river is wholly Canadian territory, thus treating the whole river above Montreal, at least, as an international waterway.

In thus dealing with the river in Canadian territory, the true and intended effect has been given to the spirit of the various treaties which recognize the St. Lawrence as an international waterway from the Great Lakes to the sea.

In the working out of many of the questions that came before the Commission, it soon became evident that boundary waters should be more explicitly defined, and it was thought best to place this definition and other matters relating to boundary waters in the form of a treaty between Great Britain and the United States.

Waterways Treaty Signed

Accordingly, such a treaty was negotiated and the result was the signing of the Waterways Treaty, on the 11th January, 1909.

This treaty was made with the desire to prevent disputes regarding the use of boundary waters, and to settle all questions pending between the two countries involving the rights, obligations, or interests of either in relation to the other, or to the inhabitants of the other, along their common frontier.

This treaty in no way cancels or limits the application of the principles in the previous treaties, but was intended more specifically to define boundary waters. It agrees that the navigation of all navigable boundary water shall forever continue free and open for the purpose of commerce to both countries equally, subject, however, to any laws and regulations of either country within its own territory not inconsistent with such privilege of free navigation, and applying equally and without discrimination to both countries. These rights also extend to Lake Michigan and to all canals connecting boundary waters and now existing, or which may hereafter be constructed, on either side of the line. Articles 3 and 4 read as follows:—

"It is agreed that, in addition to the uses, obstructions and diversions heretofore permitted or hereafter provided for by special agreement between the parties hereto, no further or other uses or obstructions or diversions, whether temporary or permanent, of boundary waters on either side of the line, shall be made except by authority of the United States or the Dominion of Canada within their respective jurisdiction and with the approval, as hereinafter provided, of a joint commission, to be known as the International Waterways Commission.

"The foregoing provisions are not intended to limit or interfere with the existing rights of the Government of the United States on the one side and the Government of the Dominion of Canada on the other, to undertake and carry on governmental works in boundary waters for the deepening of channels, the construction of breakwaters, the improvement of harbors, and other governmental works for the benefit of commerce and navigation, provided that such works are wholly on its own side of the line, and do not materially affect the level or flow of the boundary waters on the other, nor are such provisions intended to interfere with the ordinary use of such waters for domestic and sanitary purposes.

"The high contracting parties agree that, except in cases provided for by special agreement between them, they will not permit the construction or maintenance on their respective sides of the boundary of any remedial or protective works, or any dam or other obstructions in waters flowing from boundary waters, or in waters at a lower level than the boundary in rivers flowing across the boundary, the effect of which is to raise the natural level of waters on the other side of the boundary, unless the construction or maintenance thereof is approved by the aforesaid International Waterways Commission.

"It is further agreed that the waters herein defined as boundary waters, and waters flowing across the boundary, shall not be polluted on either side to the injury of health or property of the other."

This treaty established the International Joint Commission which takes the place of the commission formerly established, and this commission has jurisdiction over matters under Articles 3 and 4 of the treaty governed by the following principles:

Each country shall have on its own side of the boundary equal and similar rights in the use of the waters hereinbefore defined as boundary water; and the following order of precedence shall be observed in the uses to which the water shall be put:

1. Uses for domestic and sanitary purposes.

2. Uses for navigation, including the service of canals for the purposes of navigation.

3. Uses for power and for irrigation purposes.

The Joint Commission is a body to which all matters involving the rights, obligations, or interests of either country in relation to the other regarding boundary waters may be referred, the reference being made by the Senate of the United States, and the governor-in-council of Canada.

The powers of the commission are broad, and the spirit of the whole agreement is broad and common sense, and as it has been administered by capable men on both sides, there is very little chance of any serious disagreement arising as to the use of boundary waters.

From the foregoing, the legal or international status of the river will be understood, and what is not generally appreciated is the fact that the St. Lawrence River is an international highway from the Great Lakes to the sea, and there is the greatest freedom possible accorded to both countries of the use of the river and its improvements in common, a condition which I do not think exists elsewhere.

Since the time of the Indian fur-trader there have been many changes on the river, made from time to time to meet the growing needs of the increasing population, and the history of these improvements in navigation is interesting. It will be observed that these improvements only served the generation that conceived them, and a constant succession of larger works has been the result, so that we find ourselves to-day discussing plans for further expansion of navigation on the Great Lakes and the St. Lawrence River.

Development of Canal System

The first lock canals in Canada were built on the St. Lawrence around the upper and lower of the three rapids between Lake St. Francis and Lake St. Louis. They were built by the Royal Engineers, and finished in 1783. The locks were 40 ft. long, 6 ft. wide, with 30 in. of water on the sill.

In 1815 money was voted by lower Canada for the construction of the Lachine Canal, and the work was completed in 1825. This canal was 48 ft. wide at the water surface and 4½ ft. deep. There were seven locks, each 100 ft. long and 20 ft. wide, built of masonry.

In 1818, a joint commission from upper and lower Canada reported in favor of a canal system for the St. Lawrence, with 4 ft. depth of water, that being the depth of the Erie Canal.

The year after the Lachine Canal was completed, the Royal Engineers recommended longer and wider locks for

the St. Lawrence, with 8 ft. of water, and in 1832 a decision was come to that the depth of water should be 9 ft.

The Cornwall Canal was commenced in 1834, but the rebellion interfered with its completion, and it was not completed until 1843. Its locks were 200 ft. long, 55 ft. wide and it had 9 ft. of water on the sill.

The Beauharnois Canal was enlarged about the same time to similar dimensions, and was opened in 1848.

The canals at Farran's Point and Rapid Plat, and the Galops, now known as the Williamsburg Canals, were completed in 1847, upon the same scale as the Beauharnois Canal.

In 1871 a commission appointed by the Federal Government advised a uniform scale of navigation for the St. Lawrence Canals, with locks 270 ft. by 45 ft. and 12 ft. of water on the sill. However, in 1875, the Dominion Parliament ordered that the enlarged canals should be deepened so as to pass vessels drawing 14 ft. of water, and this was done without regard to the other dimensions of the locks.

The canals were gradually enlarged to these dimensions, and vessels 260 ft. long, 45 ft. beam, can pass between Montreal and Lake Superior, and drawing between 13 and 14 ft. of water. The locks were found to be too short before completion.

The extent of canal and river navigation from Montreal to Lake Ontario is shown in the following table:

	Miles	Locks	Rise	Miles
Lachine Canal	8.50	5	45	....
Lake St. Louis	.....	..	....	15.25
Soulanges Canal	14.00	4	84	.....
Lake St. Francis	.....	..	....	31.00
Cornwall Canal	11.50	6	48	.....
River	....	..	....	4.70
Farran's Point Canal	.75	1	3½	....
River	.....	..	..	10.25
Morrisburg Canal	3.70	2	11½	.....
River	.....	..	....	4.10
Galops Canal	7.60	3	15½	.....
River to Prescott	.....	..	....	7.75
Totals	46.05	21	207½	73.05

In referring to the St. Lawrence canal system it must be remembered that it is only a part of the through system of navigation to Lake Superior. The Sault Ste. Marie Canal and the Welland Canal form the links which connect up the Great Lakes.

The volume of traffic in the upper lakes has forced the enlargement of the Sault Ste. Marie Canal, and a corresponding enlargement of the Welland Canal is in progress.

This growing necessity must travel downstream, and it is a question of time when the St. Lawrence canals must be enlarged to meet the demand of traffic arising from the west and seeking its outlet at Montreal.

In order to give an idea of the growth and magnitude of the traffic between Lake Huron and Lake Superior, I will quote from a late report of Mr. Sanford Evans, who has made a careful report on the canal situation:

"In tons of cargo and in net registered tonnage of vessels, the traffic through the Sault Ste. Marie canals during somewhat less than eight months of open navigation greatly exceeded the twelve months' total of any other canal or of any single port in the world. Its figures, so far as narrow waterways are concerned, are apparently surpassed only by those of the Detroit River, which, in addition to carrying over 87 per cent. of the traffic which also passes through the Sault Ste. Marie canals, carries traffic to and from Lake Michigan, Lake Huron, and Georgian Bay and local traffic for Detroit River ports. A direct comparison in freight tons with the traffic through the Suez Canal is not practicable, but the net registered tonnage of vessels passing through the Suez Canal in the year 1913 was 20,033,884 tons, while the net registered tonnage of vessels passing through the Sault Ste. Marie canals in the navigation season of the same year was 57,989,715 tons."

Neither the canals of Canada nor those of the United States impose tolls, perfect reciprocity prevails in the use of these artificial waterways.

In 1916 out of 24,000,000 tons of freight carried through the Canadian canals, 16,000,000 tons was United States business, and in like manner much Canadian freight used the U. S. lock at Sault Ste. Marie. At this point the traffic is about 75% U.S. and 25% Canadian business. Canadian wheat carried through the Canadian canal has exceeded 100,000,000 in one year, the total quantity of Canadian wheat and flour passing in 1916 was equivalent to 202,000,000 bushels.

Deep water navigation ends at Buffalo, the Welland Canal having but 14 ft. of water on the sill, and this draft continues in all of the Canals on the St. Lawrence to Montreal.

A new Welland Canal is now in course of construction and will provide for a depth of 25 ft., the locks will be 800 ft. long and 80 ft. wide, and will be built so as to provide 30 ft. of water at some future time.

Thus, you will see, that deep water navigation will soon be an accomplished fact as far as Lake Ontario, but the logical terminus of deep water navigation with the interior of the country is undoubtedly Montreal, so that the enlargement of the navigation system on the St. Lawrence River

will become an economic necessity in order to avoid much trans-shipment or the diversion of Canadian freight to American routes.

Trade will follow the line of least resistance, and an ample canal capacity will provide this, and assure a larger volume of freight reaching Montreal.

By the government of Canada undertaking the construction of a new Welland Canal, it has committed itself to the principle of canal enlargement, and as this canal is one link in the chain of communication, the chain must be completed or the result will be that we will be building the new canal to largely assist American transportation routes, and this can only be corrected by extending ample navigation facilities to Montreal.

Economical Tonnage for Ships

In respect to grain carrying, it is interesting to note that in 1914 there were 1,836,000 tons which passed down through the St. Lawrence canals to Montreal, and in the same year the railways brought down 690,000 tons. In 1916 these canals carried 3,368,000 tons of freight, of which 2,404,000 moved eastward and of which 1,575,000 tons originated above Lake Erie. The limitation is the 2,000 ton ship, as far as St. Lawrence navigation is concerned, with increasing capacity more freight will be carried and order to meet the development in the west, greater carrying capacity will be demanded.

While the carrying capacity of the canals has never been taxed, and the canal system is capable of carrying five times the present amount of freight carried, it must be remembered that the cost of carriage per unit is the governing factor.

A 2,000 ton ship is not an economical unit in lake transportation, and lake transportation conditions must be continuous from the Great Lakes to Montreal, consequently the carrying capacity of lake vessels must be provided for from the lake to Montreal.

This calls for the enlargment of navigation channels, to a point agreeing with the scale of lake carrying vessels, up to at least 10,000 tons.

The development of the port of Montreal has been in progress for many years and has reached a high point of efficiency, with larger possibilities in the future. This development has kept pace with the improvement in the channel below Montreal. This work has begun in 1844 when the channel was only 11 ft. deep. In 1857 it had reached a depth of 18 ft. and in 1888 the depth was 27½ ft. The present depth of 35 ft., I do not consider as the ultimate depth, for a depth of 40 ft. will, no doubt, he eventually necessary in order to reach an adequate development of the port

The deepening of the channel has had the effect of somewhat lowering the water in the harbor, and some scheme will have to be resorted to by which this loss may be compensated for, and probably a plan will be arrived at whereby deeper water will be obtained with a minimum of dredging, and which in effect will be a continuation of the canal system to tide-water. However, this is a matter that will best be settled by hydraulic engineers, but there is no doubt that the conditions can be met within the bounds of economic operation.

Nature has provided us with a wonderful river, and it will be our duty to make the best use of it that is possible in the interests of the progress of the country.

With the opening up of the country and the development of wheat fields and coal and iron mines, the demands on water borne traffic increased in later years, and which resulted in the gradual development of a type of vessel that was found to be best suited to the requirements of the lake and river commerce, so that to-day there exists a great fleet of vessels designed from experience, and eminently fitted for the service they are performing, the like of which will not be found elsewhere.

But while the shipping on the lakes was developing, the system of railways from east to west was also making great strides so that now the cost of hauling a ton of freight parallel to the waterway has been reduced to figures that compel the most strict economy in design and operation of water carriers, and the railways have the eternal advantage of being able to operate for five months in the year more than the lake and river carriers, owing to fixed climatic conditions.

These conditions have been fairly well met by the designers of lake and river carriers, and the type now in service may be considered as satisfactorily meeting the conditions that have been imposed in the evolution that has gradually taken place.

The type of vessel suitable for the lake and river navigation is now eminently suited to its purpose, and is not suitable for sea-going trade.

In like manner the ocean-going traffic has demanded changes in the structure of ships, so that the ocean-going vessels would be out of place in inland navigation, from the fact that the two services are not alike in their demands, and the ocean-going vessels having to be built to a higher grade of specification as to structure and have less cargo space than the standard lake vessel can afford, thus increasing the cost of haul of the ocean vessel in lake traffic, as compared with the type of vessel evolved from the experience of those engaged in lake traffic for many years.

It follows therefore, that the capital investment in a lake-going vessel is less per capacity than in an ocean-going vessel, and it will not only for this reason but also for serious operating seasons, be impossible for the two to compete in the lake carrying trade.

The two fields of activity seem to be clearly defined, that the lake and river vessels must stay in the inland waters, and the ocean-going vessels must ply between ocean ports in order to work out the economic situation.

St. Lawrence River Project

I have been a student of the St. Lawrence for many years. In 1911 I addressed the Canadian Club in Montreal on the subject and in the course of my remarks, I said:

"I think the time has come when such a study of the St. Lawrence should be made, and this, before we should commit ourselves to heavy expenditures on competitive routes. . . .

"The idea of canalizing the river by maintaining the navigation channel in the river and erecting dams below the various rapids locking at each dam, has been the dream of engineers for many years, and this has of late been prominently brought forward by the proposal of a power company to treat the Long Sault Rapids in this way. . . .

"John Kennedy, our best authority on such matters, and whose judgment I would not question, has concluded that works such as are proposed at the Long Sault can be wisely and safely built and maintained, and I think that the same may be said of similar works if constructed at the other rapids. . . .

"I am not now stating that this is the best way of improving navigation so as to create the greatest benefit. The question is a very great one, and of vast importance, and we have not the evidence before us to form a correct opinion. The question is a national one, and I think that it should be carefully studied, so that the future policy of inland navigation may be carried out on more definite lines than the present knowledge warrants. . . .

"The question before us now is not the maintenance of present conditions of navigation, but how can these conditions be improved. . . .

"Is it not common-sense to think about this, and to provide for the future as broadly as we can? What I would urge is that a careful study of this whole subject be made now, so that a definite policy may be adopted in order to get the greatest efficiency out of what nature has given us."

Since that time I have had a more intimate knowledge of the rivers through my studies in connection with the Long Sault Rapids and the Cedar Rapids. This, of course, was a

physical study, but it has impressed upon me the bigness of the St. Lawrence, and the very formidable problems to be faced in dealing with this great river, so that I feel that those who speak easily of handling this vast river do so without full knowledge, and it is sometimes a case where "fools step in where angels fear to tread." Not that it cannot be done, but what I mean is that the cost of the necessary works of development has been seriously underestimated.

Confine Ocean Vessels to Ocean Ports

One principle I may state now is that ocean vessels must be confined to traffic between ocean ports and lake vessels to lake and river traffic for the best reasons, which are those of economical operation, and anything else would be unnatural and economically unwise.

We can therefore dismiss the idea of the western lake ports of having ships from Liverpool visiting them, for no ocean liner company, I am convinced, would ever suffer their ships to waste time in navigating the canals and lakes when the same ships could be actively engaged in transporting freight between what are now known sea-ports.

The navigation of canals by large ocean-going vessels is no easy problem, for with such a very restricted channel, a lea wind compels very slow speed and great difficulty in keeping the channel, and the approach to the locks is troublesome, causing great delays and very often other serious trouble.

In my opinion lake and river traffic is so different to ocean traffic that I cannot see how the two can be harmonized to produce satisfactory economic results, and from this I conclude that each must remain in the element it is economically suited to, and which means that freight must be transferred from the ocean vessel to a lake vessel or other carrier at the ocean terminal.

Now, this is what is being done at present, but it is the desire of many that the scale of such traffic should be increased, but the most that can be hoped for is that the carriers of east bound cargoes shall have full cargoes for their return trip.

I may say that some years ago I was very enthusiastic about the idea of a through cargo from Liverpool to Fort William, but serious thought has brought me to the conclusion that it is not possible, purely from the economic reasons that are dominant, and cannot in my opinion be over-ruled, because of practical, physical and economic facts.

After reading the evidence that was presented to the International Joint Commission, and also the expressions of opinion which from time to time have been given by able

men both in favor of and against the proposition, I cannot but feel that the weight of evidence is against the carrying out of the project of ocean carriers travelling inland, both for physical and commercial reasons.

This, however, does not mean that the lakes and St. Lawrence route should not be improved, but the scale upon which improvement may be carried out must be justified by future expansion of business.

Is an International Proposition

The discussion of this question has been widespread and general, and in most cases it has been considered from the standpoint of purely local benefit to the exclusion often, of the principles involved.

The east is generally credited with being lukewarm and even opposed to the project, while the west is very positive in endorsing it and is strong in its advocacy of the project.

The work is international in its character, the river being a boundary between the two countries from Lake Ontario to the 45th parallel of latitude, and under the treaties between Great Britain and the United States, the whole river is an international highway between the Great Lakes and the sea, so that insofar as concerns navigation, the rights of the two countries are equal, and any action towards development must be co-operative, the jurisdiction under the treaty of 1909 being vested in the "International Joint Commission."

The political relations between the two countries are perhaps more cordial than between any other two countries, so that the question can be freely discussed without fear of causing any feeling of jealousy, which leaves it for discussion on its merits only.

I think that it will be admitted by those best informed on lake and river traffic that the existing scale of canal navigation is not of sufficient capacity, and in fact before the completion of the present fourteen feet navigation on the St. Lawrence River, it was realized that the locks had been built too short, and should have been longer.

Size of Canals

The scale upon which the system is proposed to be enlarged is that the locks provide 30 ft. of water on the sill, and that the prism of the canal provide 25 ft. of water which can be subsequently increased to 30 ft., the locks to be of the dimensions already adopted for the Welland Canal.

Having in mind that the public works heretofore undertaken have served only the needs of the generation that built them, and which statement is substantially true, it is

therefore necessary to consider very carefully what scale to determine for the dimensions of future public works, so as to avoid, if possible, building too small, and at the same time not to overburden the works with such high costs as to prevent their being carried out.

From all the evidence we have, it would appear that as a revenue producer in itself, the canal system will not be a success, and any dividends will only be in the expansion of trade in the two countries using the water route.

From the evidence given before the International Joint Commission, it would appear that the western states were confident that the improved water route would be of immense benefit to them, by giving cheaper transportation and greater opportunity for expansion of business.

The west may be over-optimistic in expecting such results as they anticipate, but had it not been for the optimism of the west the two countries would not have made the great progress they have made in the past years.

It is proper to provide for legitimate demands of the future as far as justifiable, but care will have to be exercised to see that we do not go too far.

There is an element that exists which renders the determination of the scale of the work to be done more difficult than at first appears, and that is the length of time intervening before the works can be put into operation, and during which construction will be progressing. This period will be from twelve to fifteen years.

During this period many changes will take place, and the works will have to be designed not only to meet the conditions fifteen years hence, but to meet all probable conditions that may arise in fifty years, and during that period it would be difficult to predict the advance in land transportation, when no doubt, electric power will have firmly established itself on our railways as their motive power, thus reducing costs of transportation and increasing the capacity of the railways. But it must be remembered that the reduced cost of operation of the railways can only come from the production of cheap water power.

After all, can we do any better than our predecessors, who built as wisely as they could foresee?

The same problems are before us to-day except that the question has been extended to include navigation between the Great Lakes and trans-Atlantic ports.

I have seen no evidence which convinces me that this is feasible from economic reasons, and there are strong expressions of opinion by qualified persons that the idea is not commercial.

25-ft. Channel Advocated

Under all of the existing circumstances I think that the wise course to take would be to raise the standard of lake and river navigation to the point where it would appear to be justifiable, and improve the system by increasing the present 14 ft. navigation to a depth of 25 ft. on the lock sill, and which would provide for the vessels that are trading on the lakes and which have proved satisfactory, both as to draft, capacity and economy of operation. Any greater draft than 25 ft. will involve much deepening of channels and harbors, and which could not be justified from a commercial point of view, as far as we can now see.

The cost of a 25 ft. channel, as compared with a channel 30 ft. deep will be very greatly in favor of the lesser depth.

The present canal system of 14 ft. draft has been in operation for 45 years, and it neve has been operated to its capacity and an examination of results of traffic does not show any indication of such improvement.

However, it is after all a question of economic transportation. A 2,000 ton ship can carry its cargo at a certain price, but if the capacity is increased to 10,000 tons, the cost is very naturally reduced per ton.

The cost per ton is the ruling factor and there is no doubt that the greater tonnage of the carrier, the less per ton will the freight be carried, so that by increasing the ton carried capacity up to certain limits, the cheaper will be transportation per ton of freight carried.

The whole of the navigation system from Lake Erie to the sea has been built by Canada at her own expense; this includes 220 miles of ship channel below Montreal. This whole chain of navigation is and always has been operated and maintained by Canada alone.

I regard the report of the International Joint Commission as a very valuable contribution to the study of this great question, and it in no way is convincing that the work it refers to is justified by present demands or future possibilities, on the scale that is proposed.

I speak of the report as a whole, but there are many points in detail which no doubt would be modified by further consideration.

I would say that the improvement in navigation of the St. Lawrence route must sooner or later be undertaken in the natural progress of trade, but that the demand for this work is not imperative at present, nor is Canada now in a position to commit herself to any great expenditure on public works.

Alternative routes have been suggested which would make the terminal at New York instead of Montreal, but it

will be found that the economic route will follow the St. Lawrence River, where nature has already done so much.

Power Development Feature

Up to this point I have dealt with the river from the point of view of its importance as a freight carrying medium. This is its legitimate business, but like many other producers of a certain product, the by-products form a very important source of profit. The by-product in the case of the St. Lawrence River is water power.

The relative levels of the lakes may be stated as follows —the figures indicating their surface height in feet above sea level:

Lake Superior	603	
Lakes Huron and Michigan	581	difference of 22 feet
Lake Erie	573	difference of 8 feet
Lake Ontario	246	difference of 327 feet

At Sault Ste. Marie the total possibilities in power development may reach 75,000 h.p.

At Niagara Falls if all the water could be used to its best advantage, it would produce 5,000,000 h.p., but this will be impossible of realization because of the necessity of retaining the scenic effect of the falls, and also because the possibilities of efficient development have been destroyed by the present power plants, which provide the most prominent instances of inefficient development of power that we know of. A plant lately built there makes use of the whole effective head of water, and this should produce power at a low price. However, a very large amount of power can yet be produced at Niagara and which in due time, no doubt, will be produced as the demand arises.

Between Lake Ontario and Montreal harbor, there is a fall of about 232 ft., and a large portion of this fall can be utilized in producing power. This fall is divided between the various rapids, which render the canals necessary. The total fall is distributed about as follows:

Lake Ontario to lower Williamsburg lock	30.5 ft.
Long Sault Rapids	48.0 ft.
Soulanges Canal	
Coteau, Cedars and Cascade Rapids	84. ft.
Lachine Rapids	45. ft.
	207.5 ft.

There is here a possibility of developing more than 4,000,000 h.p., of which 60% would be entirely in Canadian territory, and Canada would be entitled to one-half of the remaining 40%.

At present I would regard the question of water power development on the St. Lawrence as a matter demanding more immediate attention than navigation. The improvement of navigation on the river is an unit of work embracing the whole river from Lake Ontario to Montreal, and no part will be of any value until the whole is complete. The development of water power will consist of several units, each complete in itself.

The improvement of navigation on the river is a unit of work embracing the whole river from Lake Ontario to Montreal, and no part will be of any value until the whole is complete.

It would seem unreasonable to delay the development of water power until the necessities of navigation permitted it, and I can see no good reason why water power should not now be made use of on the river, provided the works are built so as not to prejudice the carrying out of a greater scheme of navigation at a future date, and provided also that the economies of the project are sound.

Several suggestions have been made as to the development of power, and these should be thoroughly examined, and if found to be feasible, the works should be allowed, especially as I understand that private capital is ready to undertake the responsibility of the works and their operation.

When it is realized that to produce one horse power for one year it takes ten tons of coal, you will readily see what the development of large amounts of power will mean in the consumption of coal and in its transportation.

The resources provided by the St. Lawrence should not be allowed to remain unproductive, and international rights as well as state and provincial rights can be safeguarded for the public benefit, and the future of navigation need in no way be prejudiced.

There is a reason why the power development of the St. Lawrence could not be handled by government agencies, in the fact that coincident with the construction of the generating stations on the St. Lawrence, there must be constructed vast distributing systems, by private capital, for the use of the energy when it is ready for delivery. The private capital for these distributing systems will not, in my judgment, be found willing to undertake the financing of distributing systems that are to receive their current at some unknown time when government agencies could complete the work, if they could complete it at all. If the St. Lawrence power development is made by private capital, it will be entirely practical and feasible for distributing companies to make private contracts with generating stations, which contracts, being approved by the public service commissions, and enforcible by law, will therefore be proper foundation for distributing sys-

tem financing. If governments should undertake the construction of the power work in the St. Lawrence, the only way distributing companies could operate would be to wait some indefinite time until the power plants were completed, and such a wait would entail, of course, vast losses of interest.

As to building the locks, this work will have to be in the hands of private management, because the very nature of the work would prohibit the use of two organizations trying to manipulate heavy construction at the same time and place. While the locks and their appurtenant works will have to be paid for and operated by the governments, their construction by the organization which builds the power works can be arranged for on terms advantageous to the governments.

The subject I have tried to cover is such a great one that I feel I can do only scant justice to it, but I hope I have been able to explain matters so that it may arouse a more active interest in the St. Lawrence River than perhaps some of you have heretofore felt.

DISCUSSION ON "TRANSPORTATION ROUTES"

Discussion on Paper Read by F. W. Cowie on "Transportation Routes in Canada" Before the Montreal Branch, E.I.C. Canalization of the St. Lawrence River Difficulties Met in Navigating the Hudson Bay Route.

By HENRY HOLGATE
Consulting Engineer, Montreal.

CHEAP transportation can only be reached under conditions of load approaching maximum capacity, and this condition cannot be reached until there is population sufficient to produce more freight for our transportation routes, so that the question of land settlement and immigration is a most important element in attaining to more favorable carrying charges, and in so far as land carried freight is concerned, it is not reasonable to expect material improvement in freight carrying costs until the bulk of freight to be carried has been considerably increased over what it is at present.

The settlement of Canada has been a very slow process, and of late years it has been particularly so. When one considers the vast areas of available land and the small population, it is disappointing that population does not increase more rapidly, and though we are led to believe that the government is now and has in past years endeavored to increase immigration, the results are not what they should have been, and a more active policy should be undertaken, in order to bring in settlers who will go on the land and not encumber the cities.

The Railways and Land Settlement

The construction of railways in Canada has been carried out on a lavish scale, and it has not been for lack of enterprise in this direction that we have failed to secure a larger population. The railways have been pioneers of settlement and are to-day. They have opened up vast tracts for settlement—land that is fertile and highly productive, and which some day will be populated, but in the meantime the railways are working under the greatest difficulties possible in the sense that the freight they are capable of carrying does not exist, and as this is their one source of revenue, they cannot be expected to carry grain or any other freight at a cost below what will enable them to continue operation.

The haulage of grain is not at present conducted on lines tending towards economy. There is not an even flow of traffic, and at certain seasons the peak load is very high, thus at times tending to congest traffic and involving the railways in enormous outlay for rolling stock and adding

heavily to both capital and operating charges and consequently to high carrying rates.

In order to understand how great a load variation takes place in the several months of the year, the following figures will show—

Percentages of total number of freight cars used in carrying wheat each month—

January, 2.3; February, 0.8; March, 2.2; April, 4.0; May, 4.5; June, 4.0; July, 3.4; August, 1.1; September, 13.4; October, 28.2; November, 23.1; December, 13.4.

The above figures may be taken as typical of what takes place every year.

If spread equally over the whole year the average would be 8.33 per cent., and it will be seen what great variations exist in the rate of haul; in the four last months 78.1 per cent. of the grain carried by railways in the whole year is transported.

The present position is inevitable and the remedy lies in producing more freight to be carried, and we must have the population to produce the traffic, so let us begin at the fundamental cause of high carrying costs by bringing in people to populate the country. I consider this to be the most important business of government to-day, and it is a work that we can well afford to spend a great deal of money on, every dollar of which would pay a dividend.

In regard to endeavoring to equalize the stream of traffic over a longer period of the year, this should be treated in a similar manner as would be adopted in equalizing the flow of a river, that is by creating storage. In the case of grain traffic this storage would be provided by building greater elevator capacity both at way stations and at terminals.

In the ultimate solution of rail transportation, electric haulage must play an important part in the future and will no doubt bring about cheaper operating costs and greater general efficiency, and will avoid the enormous cost of coal handling and haulage, releasing at the same time a large amount of rolling stock now engaged in handling the railway's fuel.

Mr. Cowie shows that the cost of vessel freight on the lakes and canals is a large factor in the through rate and that these rates have increased in greater proportion than railway or ocean rates. I can see no good reason for this, but it must be remembered that here too the traffic suffers from peak load conditions and only a part of the navigating season is actively occupied in carrying grain. At the same time the water borne inland traffic is not subject to laws regulating rates, and perhaps there may be found some way of doing this corresponding to the powers of the Railway Commission.

As in the case of haul by rail so in water-borne traffic, there exists peak load conditions, and in the nine months that vessels work on the water routes, percentages of ships engaged in the carrying of wheat are similarly as follows, in percentage of the total number;

April, 3.4; May, 11.4; June, 4.4; July, 5.2; August, .2; September, 4.4; October, 30.5; November, 24.1; December, 14.8.

It will be observed that about 70 per cent. of the grain carried in the whole year is carried during the last three months of the year.

In water-borne traffic it has been observed that the ratio of east-bound freight to west-bound freight is 2.88 to 1.

There are many points arising from Mr. Cowie's paper that I do not feel competent to discuss with any degree of authority, and I hope that the transportation questions will be dealt with fully by those versed in them. There are, however, two matters that I wish to refer to, one is the improvement in the St. Lawrence River and the other is the Hudson Bay route.

St. Lawrence River Improvements

In regard to the St. Lawrence River canal system, the existing canals have a carrying capacity far beyond the traffic they now carry, but it must be remembered that the capacity of the locks is the 2,000-ton ship and in the grain carrying trade this is not an economical unit. The economical unit is a vessel of very much greater capacity, such as works between Lake Superior and Buffalo, and to induce water borne traffic to come to Montreal, the navigation channels must be made to take this class of vessel. I believe that in this way only, can carrying costs be reduced, and in canal navigation the government cannot at present intervene and regulate freight rates as they can on railways. Could the transportation charges on the lakes and the canals be put under the Railway Commission? This would involve having an agreement with the United States to co-operate in such a measure. At present the canals are free from tolls, but this is not obligatory on either nation, and both countries are free to deal with the situation jointly. It would take from twelve to fifteen years to canalize the St. Lawrence on a large scale, and the scale must be determined first. It is as well to bear in mind that the experience we have so far gained in Canada is that public works only serve the needs of the generation that builds them. This is substantially true; so that careful study must be made before channel and canal dimensions are decided on. My opinion is that the dimensions of the new Welland Canal are greater than necessary. The question of ocean-going vessels using it, was a

factor in deciding the capacity of the locks, but I think there is enough evidence now before us to say that ocean liners will not pass Montreal. It may be that some tramp ships will make the inland voyage, but no others, and locks of less depth than 30 ft. will serve these ships, and the large lake vessels.

The deepest navigation at present on the Great Lakes system is at Sault Ste. Marie, the new American Lock having a depth of 24 ft. 6 in., the Canadian Lock having 18 ft. 3 in. on the sill.

In deciding on the scale of navigation, due thought must be given to the depth of lake harbors and the various channels connecting the lakes.

The matter of lock dimensions is the ruling factor and must be settled. My opinion is that 25 ft. of water on the sill will be ample, and this is a matter for further discussion.

The by-product of a 25 ft. channel from Lake Ontario to Montreal is hydro-electric power, and this amounts to about four million horse power. This is an amount of power that would take many years to absorb, but if absorbed would probably give us the deep channel for nothing.

While the improved canal system would be of no service until it was complete, the various rapids could be developed for power purposes one at a time, each being a complete unit in itself. I can see no good reason why some of the power should not be developed now, as it can be done without prejudice to navigation, and locks can be provided for at any and every site of power development. This will not now be an expense to be carried by the government, as private capital is I understand ready to undertake the work of power development, the construction of locks can be delayed until a later date when it can be carried throughout the whole system. I can see no good reason for delaying such a great work. Surely the two governments can agree on principles, and facilitate the early development of such enormous natural resources. The various treaties between the United States and Great Britain from 1783 to 1909 fully state the respective rights of the nations, and I can see no difficulty in the development of power on the St. Lawrence River, having full regard to the prior rights of navigation. It is as well to remember that the United States has one-half interest in the power development only as far as the 45th parallel of latitude, and below this Canada has full ownership, the consequence being that Canada owns the larger part of the water power rights.

I am strongly in favor of the early development of power on the St. Lawrence River, keeping in mind the prior rights of navigation and protecting these rights in every possible way, and during construction of the power works, making suitable provision for future locks.

Impractibility of the Hudson Bay Route

Mr. Cowie has referred to the Hudson Bay route and has compared it with others as to transport, cost and mileage, but I think we had better forget this route entirely, at least for many years, and confine ourselves to the consideration of practical subjects. We know nothing definite of the cost of transportation by this route, but we do know that the route has not been demonstrated as a commercial one owing to the enormous difficulties and uncertainties that exist.

I can only imagine that Mr. Cowie introduced the Hudson Bay route for discussion, so as finally to settle the question of its practicability, and I am sure he will accomplish his purpose, for it will be difficult to find one argument in its favor, from the commercial viewpoint, and I consider that the money so far spent on this work as absolutely lost, the only chance of any return being in finding some great mineral deposits on the line of the railway so far built, and this is not hopeful. It would be well if the government would now definitely abandon the enterprise. Let what use can be made of the constructed railway if it can be self-supporting, but as to carrying it farther north or developing a port on Hudson Bay, this is out of the sphere of present day requirements. Let us have no doubts about it, and confine our attention to reasonable and commercial lines of traffic, for the Hudson Bay route is apparently an impossible one from a commercial point of view, and improvement of existing routes should receive our attention first.

As far as the railway from La Pas to Port Nelson is concerned, it is not all built yet, and the construction of this railway will no doubt involve building some feeders in addition to the main line. These would only be operated for say five or six months in the year, and all overhead and operating charges will have to be earned in that time. The operating costs will be heavier than on other parts of the railway system, and if the rates charged are the same as apply to the rest of the railway system, then the other parts of the railway system will have to carry the deficiency, thus increasing operating charges on the railway system as a whole and augmenting the deficit, which will have to be met by the taxpayers of Canada.

It may be said that owing to the difficulties of navigation no one but the government would undertake the water transport from Port Nelson to Europe, and that the government would furnish the ships so that this might not be a charge on the grain carried, but we cannot get away from the element of cost no matter what the freight charges are. The same might be said of insurance; the government may carry it.

With these matters undertaken by the government it is possible that grain may be carried from the producing area to

the consuming area at a lower charge to the shipper and the consumer, but the general tax payer will have to make up the deficit, and I cannot but conclude that the actual cost of carrying grain by way of Hudson Bay will be very considerably greater than by the St. Lawrence route.

Money can do almost anything and engineers can do wonders with money, but in this case what is the value of the prospective investment. I cannot express my views too strongly, that investment in this enterprise will, I am afraid, be a perpetual liability.

History of Hudson Bay Navigation

From the time of King Henry VII, when John Cabot made his voyage in 1497, up to the present day, the exploration of the far northern seas has attracted many adventurers. The early explorers in time gathered enough information from their various voyages to render it certain that the Hudson Bay could be reached with reasonable security to shipping at certain short seasons every year.

The mariners who attempted these voyages met with various difficulties, principally arising from the presence of ice. One of the earliest accounts is recorded by Henry Ellis in 1747, when in July one of the Hudson Bay Co.'s ships foundered in the Hudson Strait, when "two large pieces of ice by strong tides setting different ways, were driven together with great force; the ship being between them was so squeezed together, that she sunk as soon as the ice separated" and hence he reasons that ships must be built very strong especially in the bow in order to encounter the ice. The same writer records a similar accident to a ship sailing between York Fort and Churchill. A little later he records that "in this manner we continued much incommoded with ice which would be tedious to recite in particular manner," and on July 30 they reached the western end of Hudson Strait. Ellis sailed on to Port Nelson, and he says "We had blustering weather attended with snow, sleet and thick fogs;" and he arrived in sight of the shoals on August 25.

One of his ships anchored, but the other was blown ashore on the mud flats. In his account, Ellis gives reasons why Port Nelson is the best place to establish a port on Hudson Bay.

In 1814 on May 14, the "Rosamund" sailed from Hoseley Bay, Suffolk—Lieut. Chappell, R.N. in charge. He relates on July 25 being visited by an officer from a Hudson Bay ship, who had made the voyage thirty times, and he attributed the cold weather to the proximity of ice, the latitude then was 58° 46N. and longitude 50° 16W. Large quantities of ice were then coming from Hudson Strait, and ships kept to the northward until they reached the latitude of Cape Resolution, then steer n.w. and keep close to the north shore. The first iceberg was sighted July 27, and they

butted their way through the ice that surrounded it. The writer says that it was miraculous how he escaped being dashed by the ice, for then the icebergs were in all directions. On August 3 the thermometer registered 32 in the sun. On August 6 they were surrounded with ice and continued to be wedged in by ice for some days, snow falling at the same time. They ran a zig-zag course through the ice, striking large blocks now and then which severely shook the ship, and Lieut. Chappell remarks that any ship to sail these waters should have her bows double-planked with oak and heavy blocks of wood bolted to each side of her cutwater, as the blocks of ice may be considered as so many blocks of rock crystal. On August 12, he had to anchor because of the flowing ice, and some left the ship to walk on the ice. This was in sight of Charles Island on the southern shore of the strait, where the strait is about twenty miles wide. Five days were lost here on account of ice. On August 21 the ship was hemmed in by ice and the thermometer registered 29 degrees, and so on 22nd he records that for nearly a month they had been incessantly occupied in endeavoring to push their ship through the never-ending drifts of ice in Hudson Strait.

The history of the Hudson Bay Co. abounds in evidence of the difficulties of navigation, and demonstrates the shortness of the season when navigation is possible, though the navigators were fairly fortunate, their long experience teaching them the safest channels and they understood the currents and other peculiarities attached to navigating Hudson Strait and the great inland sea. Up to this period only sailing vessels were used.

In 1884 the Dominion Government sent an expedition to Hudson Strait to examine into the question of the feasibility of navigation, and a good description of conditions is given by F. F Payne in his paper describing the seasons of the year in that latitude. The description of spring reads like a pretty bad winter, an improvement taking place late in June when there was only moderate frost, the average temperature being 39 , the last snow falling on 17th.

July 1 is considered the first day of summer, with only occasional frosts. During July masses of ice passed westward into Hudson Bay, packing the ice on the south side of the strait, leaving open water channels on the north side. Late in July the water was generally open but the ice often packed tightly when the winds and tide were favorable, and this again would scatter. On July 30 the ground was frozen 48 in. deep. The average temperature for July was 40 and there were frequent fogs, which were confined to the strait and did not cover the land, thus rendering navigation of the straits very hazardous.

About August 25 the summer may be considered as over, the average temperature for the month being 43°. The temperature of the water was about 34° and the bays were often filled with drift ice, occasional bergs coming eastward from Fox Channel. Soon ice began to form and accumulate, and large masses of ice came from Fox Channel, and by November 30 the water was permanently frozen, and very low temperature and frequent blizzards followed. On November 8 the ice was 20 in. thick; on December 14 it was 22 in.; and on 27th it was 27 in. thick; and on the following May 3 it was 66 in. thick. These observations cover the years 1884, 1885 and 1886.

Early Attempts at Navigating Strait

We are not lacking in well-written information in regard to the navigation of the Hudson Strait and Hudson Bay, for we have the records of Frobisher, 1576-1577-1578; John Davis, 1586; Capt. Weymouth, 1602; Hudson, 1610; Sir Thos. Button, 1612; Gibbons, 1614; Robt. Bylot, 1615; Capt. Hawkesbury, 1616; Luke Fox, 1631; Capt. James, 1631; Capts. Knight and Barlow, 1719; Capt. Middleton, 1741; Capt. Coates, 1727-51.

Coates stated in his narrative that "you should be at the mouth of the strait about the 6th July," but "that on the 3rd of July, 1736, the ice was so large at the entrance of the strait that being enclosed, we had our ship crushed to pieces." "In 1739 we attempted to enter the strait six times between the first and twelfth of July, and could not effect it so complete and close a body of ice lay across the entrance, which obliged us to stand out to sea." He further states that "it is very hazardous to enter the strait before the beginning of July for ice, and it is dangerous to be in that bay after the middle of September."

The expedition of Ellis, Moore and Smith in 1746, Franklin and Back, 1819; Capt. Parry, 1821; Capt. Lyon, 1824; Capt. Back, 1836; Dr. Rae, 1846, give information generally confirming previous experiences.

More Recent Expeditions

Later exploration has been carried on under the supervision of the Department of Marine and Fisheries. The steamship "Diana" in charge of Wm. Wakeham, explored in 1897.

In 1906-07 Capt. Bernier sailed in the "Arctic" and in 1908-09-10, Capt. Bernier made similar expeditions.

In 1911 an examination was made of Ports Nelson and Churchill with a view to finding a desirable terminus for a proposed railway. In the course of this report you will note that on July 22, the ship struck the edge of the largest ice field met with on the voyage, this was continuous for 200 miles. The ship was piloted by Capt. Bartlett.

Other instances of meeting large fields of ice earlier in the season are recorded. Snow began to fall September 9. This survey was continued in 1912. The schooner "Bedeigh" entered Hudson Strait on July 27, but she had so much buffeting with ice that Capt. Butler feared for her safety, and returned to Halifax. The "Minto" which accompanied the schooner went into Hudson Bay.

In 1913 the "Minto" made a second trip. She sailed from Halifax on July 24, reaching Port Nelson on August 6. This trip was uneventful. The expedition of 1914 reported ice conditions somewhat similar to previous reports.

The expedition of 1915 reported that the ice left the Nelson River about the middle of June, and although the "Acadia" managed to get through the ice without injury, it was quite sufficient to cause serious trouble to any freight steamer.

In regarding the various government reports there are references to ice in Hudson Bay during the summer and fall seasons. This was brought to the attention of the marine department first, when the "Chrissy Thomey" was sent to Hudson Bay to do work in the James Bay, but since then this floating ice has been regularly observed, and it moves about Hudson Bay during the whole summer. The "Chrissy Thomey" was given up for lost, when she suddenly arrived in James Bay too late to do any work during that season (1913). When she was caught in the north end of this ice field the steamer "Beothic" was caught in the south end of the same field and detained for a long time. They reported the ice off the entrance to James Bay on October 1 was 90 to 100 ft. thick.

The presence of this floating ice field is a serious menace to any navigation in James Bay, and as there are some who contemplate operating ships between Port Nelson and a James Bay port, trans-shipping the grain to rail and thence to Quebec, this feature should be seriously considered before further commitments are made. This route would form a duplicate track to the one through the Great Lakes in so far as distance is concerned, but cannot be compared in any other way.

As the present routes are not overtaxed and as they are capable of expansion, the proposed new routes apart from their danger and high cost, are certainly not necessary.

The records of navigation through the strait and Hudsen Bay are numerous. They are spread over a period of more than three hundred years, and are available to anyone desiring to study the matter in detail. There is no report that I have found which contradicts the facts reported by so many explorers that navigation of the strait and bay is absolutely dangerous, except for probably two months in the year.

All explorers agree that a ship of ordinary construction runs a tremendous risk in venturing into these waters. The cost of transportation on this water route cannot be accurately stated by anyone. In the first place, a special class of ships would have to be used in order to resist the ice; the navigating season is uncertain and very short; the ships engaged in such traffic would have difficulty in finding work to do when they were not engaged on this route, owing to their special construction.

Due to the uncertainty of time occupied in a voyage, a larger quantity of fuel would have to be carried than under ordinary navigating conditions, as all records show the delays en route are inevitable.

I have not any information of a definite character which would indicate the expense of insurance on ships and cargoes, except that it would be higher than the rates charged on the St. Lawrence route after November 25, when navigation is supposed to close.

There will be little return cargo for this shipping, and this must add to the cost of one-way cargoes.

The larger proportion of grain produced on the prairies and shipped via Nelson will have to be held in storage at Nelson over winter, and shipped during the next season beginning with August, and as this long inaccessible storage will prevent the grain owners taking advantage of the market, I cannot see what inducements this route holds out to grain shippers.

Any port facilities at Nelson will have to be on a large scale, prepared to do in three months what Montreal does in seven. This means an enormous development in docks and elevators, and a tremendous fleet of uncommon ships to carry the cargoes.

Demurrage on ships too will be a very considerable drawback, tending to increase rates, for from the experience of every navigator, delays have been met with and are looked upon as the ordinary conditions of navigation in that latitude.

The coal or oil will take up a large proportion of cargo space; the necessarily heavy construction of the ship will also tend to limit cargo space, so that altogether a set of conditions arises which prohibit economic operation as compared with other navigating routes, and after reading carefully all the available reports, I cannot but come to the conclusion that this route has not any commercial features to recommend it.

This is not a local question, but one which affects Canada as a whole, and I can only emphasize what I have already said, that we as Canadians should bend our efforts to improve the present safe and sure routes of traffic and under no pressure whatever lend our support to schemes which are doubtful and which would divert our energies from practicable lines.