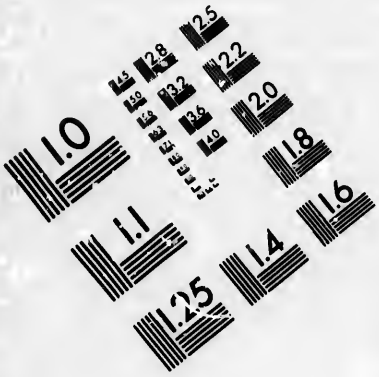

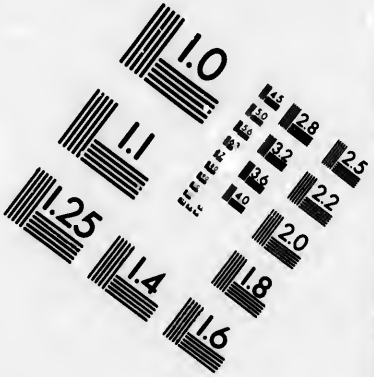

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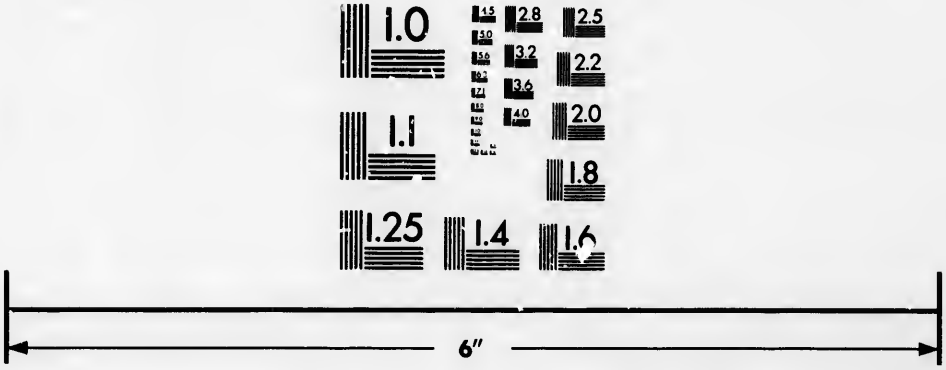

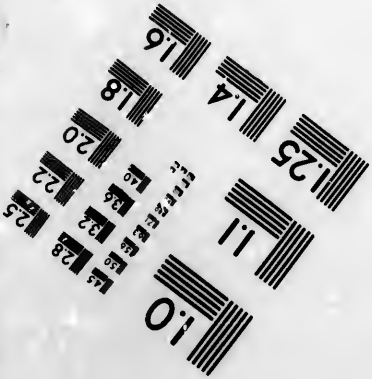

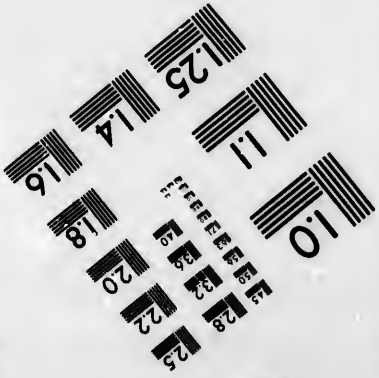

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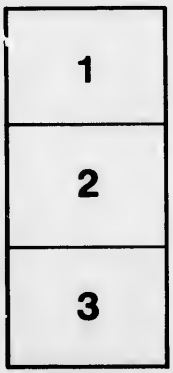

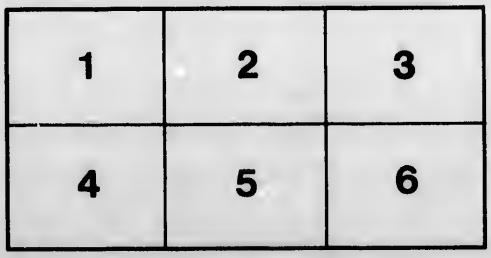

THE

CANALS OF CANADA

(Read before the Royal Society of Canada, 1893.)

BY

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THE CANALS OF CANADA

INTRODUCTION.

The Bridgewater Canal, which inaugurated a system of inland navigation that gave to Britain above five thousand miles of artificial waterways before the railway era, and established the reputation of James Brindley as the Father of English Hydraulic Engineers, was authorized by the Parliament of Great Britain in the same year in which Wolfe scaled the heights of Abraham and made Canada a British possession.

The opening of the Liverpool and Manchester Railway in 1830 was followed by the opening of a Canadian railway in 1836, which connected the navigable waters of the St. Lawrence with those of Lake Champlain. In like manner (but at a much earlier date) canal construction in England was followed by canal agitation in her new possessions upon the St. Lawrence.

Silas Deane, a Connecticut man, who had been a member of the first Continental Congress, and was with Franklin in Paris (in 1776), brought the matter of a canal from the St. Lawrence to Lake Champlain, *via* Chambly, before Haldimand and his successor, Lord Dorchester, governors of Quebec, as early as 1775. He appears also to have advocated a canal making this connection above Montreal — a project since known as the Caughnawaga Canal. Lord Dorchester expressed the opinion

that such a canal "would be practicable and useful both in a commercial and political view." Adam Lymburner, in 1791, renewed the proposal, as needed for an outlet for Vermont and Northern New York. Ira Allen, in 1796, addressed the Duke of Portland "on behalf of the State of Vermont" upon the same subject. Some one in the Duke's office was apprehensive that such a canal might "tend to disseminate republican principles among His Majesty's Canadian subjects"; but it may be assumed that the needs of the St. Lawrence route, rather than fear of political consequences, relegated this canal scheme to a later period.

The first lock canals in Canada were built upon the St. Lawrence around the upper and lower of the three rapids between Lake St. Francis and Lake St. Louis, at the Coteau and the Cascades. They were promoted by Haldimand, then governor of Quebec, and were built by Royal Engineers between 1779 and 1783, both for the transport of military stores and for commercial purposes. The locks were of stone less than 40 feet long and only 6 feet wide, and with but 30 inches of water, which was as much as could be used in the then condition of the rapids elsewhere; and sufficient for the only boat, beside canoes, then in use, which was the bateau — a flat-bottomed, sharp-pointed skiff about 5½ feet beam and 35 feet long—about the proportions of the Venetian gondola. These locks were enlarged (1800–1804) to 110 feet in length and 12 feet in width, so as to pass a "brigade" of six bateaux at one lockage. The depth of water was increased to four feet. This provision for flotilla lockage is now our latest development at Sault Ste. Marie—a return to first principles, which, it is to be regretted, cannot be carried out upon other canals with heavy traffic and a short navigable season. These enlarged locks displaced the bateaux by inviting the "Durham" boat, an American barge, which carried 350 barrels of flour—about ten times as much as the early bateaux. Before the construction of the Erie Canal, Northern New York, as well as Vermont, exported *via* the River St. Lawrence. Hundreds of thousands of barrels of flour and bushels of wheat were shipped from the St. Lawrence in the

closing years of the last and the opening ones of this century.

The first lock between Lake Huron and Lake Superior was made by a Canadian company in the closing years of the last century. One of the North west Fur Trading Companies of Montreal cut a roadway 45 feet wide across the portage on the north or Canadian side of the Sault Ste. Marie and opened "a canal upwards of 300 feet in length, with a lock which raised the water 9 feet." This lock, 38 feet long and eight feet and three-quarters wide, was built like a flume, the posts of which at the lower end were high enough to permit boats to pass under their caps. A windlass raised the lower gates, but the upper ones were "folding," with sluices therein to fill the lock. A planked flume the width of the lock, 300 feet long and 6 feet high, conducted the boats into this lock. A round log cribbing extended the whole length of the canal, 12 feet in width, forming a tow-path for the oxen used in dragging the boats up stream. As the whole fall at the Sault is 18 feet, and the lock only dealt with half of this, the canal or channel above must have had a surface inclination of three feet in a thousand. It was completed in 1798. In July, 1814, this post was pillaged and burned by Major Holmes at the head of 150 Americans, when it is supposed that this lock (with the wooden banks of its canal) was "burned to the water's edge."

In the first year of the eighteenth century, Catalogne, military engineer to the King of France (who was probably the first engineer sent to Canada), commenced a channel from the St. Lawrence at Lachine to a marshy lake on a direct route to Montreal, from which lake it was connected with and followed the "Little River" to its outlet in front of the city. This, like the boat canal of 1798 at Sault Ste. Marie, was intended for a combined canal and mill-race, but without any lock. This work was undertaken by Dollier de Casson, Superior of the Seminary of Saint Sulpice,—but his death in 1701 arrested it. In 1717 it was resumed, but after an expenditure of 20,000 francs it was abandoned on account of the cost of the necessary rock cut at Lachine. This was, in all probability, the first rock excavation for canal purposes upon the St. Lawrence. For the rock exca-

vation in connection with the first locks built by the English, more than half a century later, Cornish miners were procured.

Provincial Efforts.

The Lachine Canal was taken up by the Legislature of Lower Canada after the war of 1812, and money voted in 1815 therefor, but nothing was then done. In 1819 a company was incorporated, which did not proceed. In 1821 Government commissioners were appointed and the work was completed in 1825. This first canal was 28 feet wide on bottom, 48 feet wide at water surface, and four and a half feet deep. The locks were seven in number, 100 feet long, and 20 feet wide in chambers, and built of excellent masonry. The total rise from Montreal to Lachine is 45 feet. The canal had been projected and its construction advocated by Adam Lymburner in 1791, but the reason why locks were first constructed higher up the St. Lawrence (at the Cascades and Coteau) was because Lachine is only seven miles from Montreal, and was the starting point of the brigades of bateaux, the loads for which could be carted from Montreal.

The first Lachine Canal was doubtless built as part of a system, because a joint commission for Upper and Lower Canada had in 1818 reported in favour of a canal system for the St. Lawrence, with 4 feet depth of water, that being the depth of the Erie Canal. Within a year after the opening of the Lachine, Col. By — the Royal Engineer then constructing the Rideau Canal — recommended for the St. Lawrence longer and wider locks, with double the depth of water, and, in 1832, Upper Canada voted for a minimum of 9 feet water. Nevertheless, twenty years elapsed after the opening of the first Lachine Canal before the last of the St. Lawrence canals was completed, and this was then on a scale as to dimensions of locks and depth of water more than double that of the old Lachine.

The next in order of time of construction, although not of position upon the main line of the St. Lawrence navigation, was:

The Welland Canal.—A joint committee of both Houses of

the Parliament of Upper Canada was appointed in 1816 to report upon inland navigation, and in 1821 a commission was named, which in 1823 reported in favour of constructing the Welland Canal (which had been agitated before 1818 by the late Hon. W. H. Merritt) for the class of vessels then navigating the lakes. Instead, however, of being undertaken as a Government work, a joint stock company was formed in 1824, and ground was broken the same year. Their first proposal was a boat canal combined with an inclined railway, instead of locks, and with a tunnel through the summit. This was abandoned the following year for an open canal with locks. It was opened in 1829 (with 40 wooden locks, 110 feet long by 22 feet wide in the chambers, and 8 feet depth of water) by the passage of a British and an American schooner from Lake Ontario into Lake Erie by the route of the Welland, and of the Niagara River into which it flows,—above the Falls of the latter. In 1833 this canal was extended upon the direct line to Lake Erie, but was fed from a higher level in consequence of slides in the summit cut, which took place in 1828. The Grand River, which was the feeder, was deficient in dry seasons; after the Union, therefore, when the canal was purchased by the Government, it was determined (in 1843) to lower the whole summit level (which is more than half the length of the canal), so that Lake Erie could become the feeder. This undertaking proved to be the work of several decades, carried on, as it necessarily was, subject to the maintenance of the navigation, and the necessity of deepening the summit cut (from which the water could not safely be withdrawn) by dredging, and the towing of much of this dredged material half the length of the canal in order to dump it into Lake Erie. The dredging could only be done during the navigation season, and the deepening, elsewhere, only in winter. It was, therefore, not until 1881 that Lake Erie became the feeder. This canal was 27 miles long with 346 feet of lockage, or 16 feet more than the difference of level between Erie and Ontario; but since 1881 the lockage has been reduced by that much and is now the minimum.

Upon the union of Upper and Lower Canada in 1841 steps

were taken by the province of Canada to enlarge the Welland (the wooden locks of which were falling into decay) and the Lachine, and to complete the remainder of the St. Lawrence canals, only one of which—the Cornwall—had been commenced by Upper Canada before the Union. The 40 wooden locks on the Welland were, by increasing the lifts, replaced by 27 stone ones, each 150 feet long by 26½ feet wide in chambers, with 9 feet of water on the mitre sill, and the canal was completed upon this scale in 1846. The first enlargement of the Welland was contemporaneous with the completion of the St. Lawrence system, which had been commenced at Cornwall in 1834. The Lachine Canal was a barge canal, used in connection with the military canals of the Ottawa and Rideau route, and the Welland a ship canal connecting Lakes Erie and Ontario. Between these there existed on the St. Lawrence no advance in heavy freight transportation over that of the bateau or Durham boat of 1804. Great improvement in passenger transportation had been made by the introduction of steamers on Lake St. Louis and Lake St. Francis (reaches of the St. Lawrence) and on the river above the Long Sault ; and by their connection by portage roads on which stages were established ; but all the heavy freight was sent by the Ottawa and Rideau route to Kingston.

United Canada.

The St. Lawrence Canals.—The Cornwall Canal was commenced by Upper Canada in 1834, suspended by the Rebellion of 1837, and not resumed until after the reunion, when it was completed in 1843. Its lock dimensions were a great advance upon the old Lachine or upon the new Welland, being 200 feet long by 55 feet wide in the chambers, and the depth of water 9 feet. These dimensions appear to have been adopted to pass the short side-wheel steamers required for quick turning in running the rapids. There was no enlargement of this canal previous to the confederation of the British North American provinces in 1867, because no greater dimensions were established by the province of Canada in 1841 for the remainder

of the St. Lawrence canals. This canal was 11½ miles long with seven locks, and a total lockage of 48 feet. The breadth on bottom of canal was 100 feet and on water surface 150 feet.

Beauharnois Canal.—This canal, entirely in Lower Canada, and the only one upon the south side of the St. Lawrence, was not commenced until after 1841, when (while maintaining the Cornwall length of lock and depth of water) the Government of United Canada reduced the width ten feet for all the remaining St. Lawrence Canal locks. It was commenced in 1842 and completed in 1845. The length of this canal is 11¼ miles, with nine locks 200 x 45 in the chambers, 9 feet water on the sills, and 82½ feet total lockage. It is not being enlarged because a new canal several miles longer, but with fewer locks, is now being constructed (on the enlarged scale adopted after confederation) upon the opposite side of the St. Lawrence.

The Lachine Canal.—The first enlargement of this old canal was in progress simultaneously with those above it, but it was not opened upon the new dimensions (similar to those of the Beauharnois) until 1848.

The Williamsburgh Canals.—The three smaller canals above the Cornwall, at "Farran's Point," "Rapide Plat" and "The Galops," known collectively as the Williamsburgh Canals (so called from their situation in a township of that name), were completed in 1847 upon the Beauharnois scale. These three canals, with a combined length of 12 miles and an aggregate lockage of 31 feet, are not necessary to the descending navigation, and are not used by the passenger steamers going up,—the rapids which they avoid being navigable in both directions by steamers; but for the upper one, "The Galops," a lock has been put in below the strongest current (about 4,000 feet from the head), by which ascending boats may keep the river up to this lock, and thus avoid about seven miles of canal. The section of the Galops Rapids where this heaviest water is has been deepened to 17 feet to provide for the safe passage of descending lake vessels drawing 14 feet while pitching through the swells of this rapid.

Thus, upon the completion of the first enlargement of the Lachine Canal, in 1848, a boat nearly 140 feet long, 26 feet beam, and 9 feet draught could for the first time pass from Montreal to Chicago. The notable feature of the St. Lawrence section of the Canadian canals is that although there are 40 miles of canal and over 200 feet of lockage, steamers of 500 tons and over daily descend from Lake Ontario to Montreal, during the navigable season, without using lock or canal. Though the fall is, in some of the rapids, over 40 feet per mile, all are navigable downwards by boats drawing six to eight feet, according to river level.

The Dominion of Canada.

As the province of Canada, in 1841, commenced the improvement of the inland navigation by the enlargement of the Welland and Lachine, and the completion of the remaining St. Lawrence canals, with uniformity only as to depth of canal between tide water and the upper lakes, so, thirty years later (after confederation in 1867 with the maritime provinces, and the acquisition of the Northwest Territories from the Hudson Bay Company), the Dominion of Canada took up the question of inland navigation.

A canal commission was appointed in November, 1870, which reported in February, 1871, advising a uniform scale of navigation for the St. Lawrence and Welland canals, with locks 270 feet long by 45 feet wide in the chambers, and with 12 feet depth of water upon the mitre sills. Before, however, any locks were constructed, the Dominion Parliament, in 1875, without dealing with lock dimensions, ordered the enlarged canals to be deepened so as to pass vessels drawing 14 feet of water.

In arriving at lock dimensions and draft of water the Commission of 1871 seem to have been governed by the then prevailing size of the majority of the vessels on the upper lakes, as well as by the then depth of water in the harbours. But, while the commissioners recommended 12 feet, they gave the depth of 17 harbours, 12 of which had, or were capable of having, 14 feet and over, and they stated that this draught had then been

reached through the St. Clair Flats, and made the significant comment that "as fast as the channel was deepened the draught of the vessels increased." These considerations doubtless influenced Parliament in increasing the depth. Moreover, while providing a lock for vessels of 250 feet length, the commissioners noted the fact that, in 1871, at least two screw steamers then in commission on the lakes were 265 feet long, and they referred to the lock at Sault Ste. Marie, which had then been fifteen years in with use a length of 350 feet. They thought it "extremely unwise to embark in magnificent schemes with a view of introducing ocean vessels into the canals or lakes," and therefore leaned to moderate conditions as defined by existing traffic instead of anticipating any such expansion as had already enforced two enlargements of our canals.

The commissioners invited opinions from boards of trade and individuals as to lock dimensions and canal depth, and these were so conflicting, and the majority of them so moderate that the result of the average struck by the commission is the less surprising. The then Superintendent of the Welland Canal (who should have been the best informed as to the traffic by lake from Buffalo westward, in which vessels 265 feet long were then engaged) thought that 200 feet between the lock gates would be long enough. The Boards of Trade of Toronto and Ottawa voted for 350 feet, the length of the lock then in use at Sault Ste. Marie. Toledo named 215 feet; Oswego, of all others the most dependent upon the Welland Canal, 250 feet; Milwaukee, 300 feet, with 15 feet water; Detroit, 250 to 275 feet, with 15 to 16 feet of water. Among individuals the most notable was the late Alvin Bronson, of Oswego, who had a life-long connection with the trade of the lakes. He thought a length of vessel of 200 feet and a burthen of 750 tons, "ample for the internal commerce of the lakes, the lower provinces, and New England; longer locks would cause expense and a strong current and delay, not warrantable in order to provide for a few and rare cases where large vessels would desire to pass to and from the ocean."

It may be remarked here that there are vessels now above

Niagara which carry five times the burthen Mr. Bronson proposed as his maximum. The then capacity of the Welland was 16,000 bushels of wheat, and Mr. Bronson proposed an increase of 50 per cent, or 24,000 bushels. The steel steamer, "E. C. Pope," 334 feet long, 42 feet beam, drawing 16 feet water, brought 122,000 bushels of wheat (3,660 net tons) into Buffalo. The same boat took 125,990 bushels of corn from Chicago to Buffalo on 15¾ feet draught of water.

Mr. Charles Howard, of New York, most of whose life had been spent in the commerce of the lakes, said that "it had been clearly established that vessels over 700 or 800 tons were not so profitable on the lakes as vessels of a smaller size. Nature has placed barriers in front of most of our harbours, also wide flats across some of our greatest thoroughfares that will in spite of art, for ages to come, make it necessary to build light draught vessels. Sail vessels over 800 tons could not safely navigate the lakes even if harbours were deep enough." In his opinion the trade would continue to be equally divided between sail vessels and propellers. He fixed a length of 200 feet for the lock chambers, which he said would pass 800-ton vessels, and allow deep-sea vessels of 1,000 tons to pass two-thirds loaded.

The best authority in Canada, the manager of a transportation company in Montreal, thought that "sailing vessels of 20,000 bushels capacity most suitable for present harbours, as well as in reference to length of voyage."

The Secretary of the Montreal Board of Trade wrote that the small lock capacity of the Welland (150 x 26½) was forcing Canadian vessels out of the lake trade; and Messrs. Harvey & Howland, of Toronto, said that the larger Canadian vessels had been generally turned into American bottoms; the limitations of their business to Kingston, which affords no return freight, making them unprofitable.

The commissioners asked for "dimensions, power and tonnage capacity of largest propellers then profitably employed" upon the upper lakes, and it is remarkable that both Chicago and Milwaukee gave the extreme length as 250 feet, while Detroit

gave it as 100 feet more, or 350 feet, the length of the Sault Ste. Marie lock.

These views of the best authorities a little over 20 years ago, are given as showing how all parties were deceived as to the future of the lake carrying trade ; and as the only explanation of the fact that notwithstanding the recent second enlargement of the Welland Canal the conditions are worse now than they were in 1871, there being now a larger proportion (more than half) of the tonnage upon Lake Erie, unable for want of length of lock, to descend to Lake Ontario, than there was at that time.

The final enlargement upon a uniform scale for all except the single lock at Lake Superior is now in progress but is only completed as regards the Welland Canal, which was opened with its new locks and 12 feet of water in 1883, and with 14 feet in 1887. The Lachine enlargement has been completed many years for 12 feet depth, but with its structures founded for 14 feet; this is, however, useless for navigation purposes until the completion of the remainder of the St. Lawrence Canals (all of which are now under contract to be completed in 1895), when steamers about 260 feet length and 44½ feet beam can pass between Montreal and Lake Superior loaded down to 14 feet in the canals.

Sault Ste. Marie Canal.— The Canal Commission of 1871 proposed to extend their uniform scale of lock dimensions (270 x 45 x 12) to Lake Superior, although there was then in operation upon the American side at the Sault two locks 350 x 70 x 12. It is fortunate that the construction of the canal at this point has been delayed until the present decade.

The Canadian canal now under construction at the Sault will have a single lock of 18 feet lift, with a length of chamber of 900 feet, a width of 60 feet, and a depth of 19 feet at " lowest recorded water level," which is said to be equivalent to the 21 feet at "mean low water," fixed for the new lock in progress on the Michigan side. The length of 900 feet is " designed to pass three vessels at one lockage ; one of the upper lake type, 420 feet

long, and two of the Welland Canal type, 255 feet long." This official explanation of the length emphasizes the painful fact that the Welland type is not a lake one. No explanation of the width is given. Sixty feet is too wide for one vessel and not wide enough for two. The new American lock will be 800 feet long and 100 feet wide, a width sufficient for two or three craft abreast.

Although Canada is only now constructing a canal to reach Lake Superior, this completion of the Canadian system has always been kept in view. In 1846 and again in 1852, before the canal was commenced upon the Michigan side, the province of Canada made surveys and estimates for a canal at the Sault, and it was included in the scheme of the canal commission appointed by the Dominion of Canada about 25 years later. At neither of these dates was there any Canadian commerce upon Lake Superior, and this is the strongest evidence that the Canadians canal looked chiefly to the northwestern states of the union for their support. This is also confirmed by the history of the Welland Canal, which was first built by a joint stock company having its principal shareholders in New York and England, as also by the fact that the Canal Commission of 1870 were instructed to advise "the best means to attract a large and increasing share of the trade of the northwestern portion of North America through Canadian waters, such as will enable Canada to compete successfully for the transit trade of the great western country."

Submerged Canals Below Montreal.

This historical sketch of the main canal system, Montreal to Lake Superior, would be incomplete without a reference to the great work of deepening the channel of the St. Lawrence from 11 to 27½ feet between Montreal and Quebec. Commenced by the Government of Canada in 1844, it was abandoned in 1847 and taken up again in 1850 by the Harbour Commission of Montreal, and carried on at the expense of the trade of the port. The original low water depth of 11 feet in 1850 was increased in 1851 to 14 feet; in 1852 to 15 feet; in 1855 to 16½ feet; in 1857

to 18 feet; in 1865 to 20 feet. Resumed in 1874 it was in 1878 increased to 22 feet; in 1882 to 25 feet and in 1888 to 27½ feet. The work was then taken over and its cost assumed by the Dominion Government, to the great relief of the Harbour Trust. The total cost is about four millions of dollars, of which over half a million is for dredging plant.

The total length of channel deepened is about 50 miles, of which about 18 miles are in Lake St. Peter. There is a continuous cutting of about 16 miles in the bottom of this lake, 300 feet wide, and ranging from 15 to 17 feet in depth. The total quantity dredged is about 20,000,000 cubic yards. This would show an average cost of 20 cents per cubic yard, but the average for the great bulk or three-fourths of the quantity was about 16½ cents per yard including an allowance of one cent and seven-tenths, per yard, for depreciation of plant. For Lake St. Peter alone the cost has been reduced by improvement and enlargement of the dredging plant from 11½ cents per yard in 1875—when dredging for 22 feet channel, to 2·91 cents, in 1888, for the 27½ foot channel—the average for the whole of the dredging in Lake St. Peter being 4·98 cents per cubic yard. The cost of deep water dredging, in 1889, in shale rock, hard pan and boulders, ranged from 35 to 40 cents per cubic yard, or thirteen times the latest cost for the same depth in the silt formation of Lake St. Peter.

Summary of the St. Lawrence Route.

From Montreal to the head of the St. Lawrence Canals (which is about eight miles below Ogdensburgh) the distance is 111⅝ miles, of which 43⅝ miles are canal, 48 miles lake and 20 miles river. Commencing at Montreal the distribution and the names of the St. Lawrence Canals are as follows:

Canals.	Length.	Locks.	Lockage.		Distance between.
Lachine.....	8½ miles.	5..	45 feet.	Thence to Beauharnois Canal (Lake St. Louis).	15½ miles.
Beauharnois.	11¼ "	9[1].	82½ "	Thence to Cornwall (Lake St. Francis).....	32½ "
Cornwall	11½ "	6..	48 "	Thence to Farran's Point (River)	5 "
Farran's Point.	¾ "	1..	4 "	Thence to Rapide Plat (River)	10½ "
Rapide Plat...	4 "	2 .	11½ "	Thence to Galops (River).....	4½ "
Galops	7⅛ "	3..	15½ "		
	43⅝ miles.	26	206½ feet.		68 miles.

[1] Will be reduced to 5 for same lockage on new Soulanges Canal.

The Soulanges Canal, now being substituted for the Beauharnois, will have the same lockage (with five locks instead of nine) but nearly three miles greater length, the lake distance being decreased to this extent.

From the head of the St. Lawrence Canals to the foot of the Welland Canal the distance is 226 miles, of which 160 is in Lake Ontario. The Welland, as now enlarged, is 26¾ miles long, and has 25 locks, with a total lockage of 326¾ feet, all of which is embraced in the first ten miles from Lake Ontario.

From the head of the Welland Canal to the foot of the Canadian canal at Sault Ste Marie, the distance is about 600 miles. The length of the Sault Canal upon the Canadian side is about 3,500 feet, with one lock of 18 feet lift—but the under water excavation, for deepening the approaches to 19 feet at extreme low water, will be several times the length of the visible canal. The total length of canal and approaches is 18,100 feet. From the Sault to Port Arthur is 266 miles and to Duluth 390 miles. The completion of this canal at the Sault will extend Canadian inland navigation, from the ocean vessel at Montreal, over 1,400 miles of fresh water, with less than 75 miles of canal, and with about 551 feet of lockage to reach Lake Superior, the surface of which is 600 feet above tide.

The locks of the Canadian canals, with the exception of those now under construction at the Sault and the Soulanges Canal, have moderate lifts, and are repetitions of the simple and economical features of the original Welland Canal. The lock floors are of wood, and their upper gates the same height as their lower ones — the filling and emptying being through valves in these gates.

The Soulanges Canal and that at Sault Ste. Marie are new departures. The chambers are filled and emptied by culverts in the side walls or floor which, in the first, is of masonry, and the upper gates rest upon curved breast walls. Electric motors, driven by a water-power current, will work gates, automatic sluices at weirs, as well as swing bridges; which last are without the usual central pivot piers—thus opening the full width of the channel. Portland cement concrete will generally

be substituted for masonry in the Soulanges works. [Plans of these locks accompany this paper.]

The Lateral Canals.

The Chambly Canal.—The Richelieu River, by which Lake Champlain discharges its waters, is, by position and navigable qualities, the most important tributary of the St. Lawrence, with the single exception of the Ottawa. Lake Champlain is over 90 feet above tide, and the summit between it and the Hudson River is only 60 feet more. This lake and the Hudson lie in the same north and south direction upon almost an air line between Montreal and New York. The navigable waters of Lake Champlain are extended northward by the Richelieu River to St. Johns, which is only 25 miles from the St. Lawrence at the point above Montreal where a connecting canal between the two rivers, known as the Caughnawaga Canal, has long been proposed.

At St. Johns the Chambly Canal extends 12 miles northward (and down stream) with 9 locks, each 118 feet long, 23 feet wide, with 7 feet water, and a total of 74 feet lockage. This canal was put under contract in 1831, but was not completed until after the Union of 1841, and has not since been enlarged. Between the foot of this canal and the mouth of the Richelieu at Sorel (a distance of 46 miles) the river is made navigable by a dam and lock at St. Ours, 32 miles from Chambly and 14 from Sorel. This lock of 5¼ feet lift was constructed, 1844–1849, upon the enlarged scale of 200 feet by 45 feet in the chamber, with 7 feet water. The cost of this navigation, with its ten locks and 79 feet of lockage, has been about $750 000.

The Ottawa and Rideau Route.—The St. Lawrence route was, by the Royal Engineers, considered to be too near to the frontier for a military one. The influence of the Imperial Government was exerted in favour of an interior route between Montreal and Kingston, *via* the Ottawa and Rideau Rivers. The Provincial Government of Upper Canada was offered, in 1824, financial assistance if it would undertake the Rideau Canal (which is

within its provincial territory), but declined upon the ground that the St. Lawrence would best serve the commercial interests of the country. The Home Government, in 1826, decided to carry out this inland communication, which had been commenced upon the Ottawa at Grenville, midway between Montreal and the Rideau, in 1819. Seven locks were constructed, 106½ feet by 19½ feet in the chamber, with 6 feet water, but the remaining ones upon the Ottawa were in, 1828, enlarged to 128 x 32, with the same depth of water.

The Rideau Canal was commenced in 1826 and opened in 1832, but not completed until 1834. The locks were increased in length and width over the enlarged Ottawa ones, but the depth of the water was decreased. They are now 134 x 33, with 5 feet water, and have never been enlarged. The rapids at Ste. Anne, 15 miles above Lachine, where the Ottawa joins the St. Lawrence, were not embraced in the scheme of the military canals. There is only 3 feet fall here, and they were navigable at high water by the early boats. There was also a lock to pass them upon the Vaudreuil side, owned by a forwarding company. As the Lachine Canal locks are only 100 x 24 x 4½, compared with 134 x 33 x 5 for those of the Rideau, it is possible that the original intention, before the whole scheme was abandoned, was to reach the St. Lawrence below Montreal by that branch of the Ottawa which passes behind the Island of Montreal, in which case the Ste. Anne's Rapids would be avoided. The Grenville locks were commenced before the Lachine, which probably accounts for their greater length. The first lock at Ste. Anne was built after the union and completed in 1843. It was 190 x 45 feet in the chamber, with 6 to 7 feet of water. A new one 200 x 45 x 9 feet of water has been placed alongside. These latter dimensions are those adopted for the Ottawa and Lake Champlain route.

Measured from Lachine (which is common to both) the distance to Kingston by the Ottawa and Rideau route is 218

miles, as compared with 170 miles by the St. Lawrence. The number of locks is 55, and the total lockage 509 feet (345 rise and 164 fall) against 26 locks and 206½ feet lockage (all rising) by the St. Lawrence. Of the 111 miles of this route between Lachine and Ottawa City, nearly seven miles are canal, and of the 126 miles of the Rideau route between Ottawa and Kingston about 16½ are canal. The lesser length of canal upon the longer and higher route to Lake Ontario is due to the fact that the St. Lawrence cannot be dammed.

The Military Canals, between Carillon and Grenville, were three in number, and overcame a fall in the Ottawa River of nearly 60 feet. Carillon was the lowest, Grenville the highest, and the intermediate one (since abolished) was known as the "Chute-à-Blondeau," anglicized as "Shoot a Blunder." The Carillon Canal climbed 21½ feet over a rocky bluff by two combined locks, the side walls of which were formed by the rock cutting, and then descended 13 feet by one lock to the river, and was supplied by a feeder from the North River. In the recent enlargement a dam at Carillon raises the river 9 feet, drowning out the rapids and substituting 6½ miles of new canal and 7 locks for 7⅝ miles of old canal with 11 locks. There are now only two canals—the Carillon, three-quarters of a mile long, with two locks and 13 feet lockage, and the Grenville, 5¾ miles long, with five locks and 43¾ feet lockage, separated by a navigable reach of river of 5½ miles. These two canals are now enlarged to the scale fixed for the Ottawa and Lake Champlain route, the locks 200 x 45 x 9 feet water; but are useless for this route until the Chambly Canal and that at St. Ours are enlarged and deepened—works which will doubtless be delayed until three is an enlargement of the New York State Canal between Lake Champlain and the Hudson River.

The total new lockage between Lachine and the Rideau at Ottawa is 62¾ feet (of which 3 feet is at Ste. Anne), and is the minimum possible between these points.

The Rideau Canal.—The total lockage on the 126 miles of this route between the Ottawa River (at Ottawa) and Kingston,

upon Lake Ontario, is 446¼ feet. From the Ottawa River it ascends 282¼ feet by 34 locks, in a distance of 87½ miles to the summit level at the Rideau lakes, and then descends 164 feet by 13 locks in a distance of 38¾ miles to Lake Ontario. There are 24 stone dams, two of which are 33 and 68 feet high.

These military canals were handed over to Canada by the Imperial Government in 1853.

Considerable expenditure has been made upon the Upper Ottawa at two points, and also upon the Back Lake System near Peterboro', as well as upon the River Trent, (the outlet of these lakes into the Bay of Quinté), which bay is the head of the St. Lawrence *river* navigation.

Trent Navigation.—This Trent route, like that of the Ottawa River Valley, has long been agitated, locally, for shortening the water route from the sea into Lakes Huron, Michigan and Superior. The total lockage upon this route to Lake Huron would exceed 850 feet, fully 500 feet more than on the Welland route. About 370 feet of this lockage (more than all upon the Welland Canal) would be between Rice Lake and Lake Ontario, and the water route between these lakes is about six times longer than the land route. Everything, therefore, but the timber (for which canals would only be an obstruction) would shun the water route, even if improved, on account of the length and the lockage. The inland navigation of the Trent, therefore, is not likely to "come to the front" in the near future. The Ottawa River route, among other projected canals, was referred by the Government in 1870 to the canal commission, but the Trent route was then ignored, and has since been taken up as a local work. The Trent scale of navigation is that of the Rideau Canal, and the work done there recently has been confined to connecting this extensive inland lake system by locks and dams, —but there are cut-stone locks built over fifty years ago, upon the Trent River, the gates of which have never been hung. The route is too shallow, crooked and elevated to compete with that of the Welland. Over one million of dollars has been expended here, nearly one-third of which was before confederation. This isolated navigation upon the northern slope of Lake On-

tario has no connection with that lake or with Lake Huron.

Upon the Ottawa River, above Ottawa, nearly the same amount has been expended upon the same principle of connecting isolated navigable stretches not connected with any outlet east or west. But in the Ottawa case the works have been abandoned, either before completion or since. The only completed, though unused one, was so leisurely prosecuted that the railway ran past it and rendered it unnecessary. The locks that are built, are of wood, 200 x 45 x 5 feet of water, and are therefore no contribution to a future ship canal from Montreal to Lake Huron.

St. Peter's Canal.—This is a tide level canal about half a mile in length connecting the Bras d'Or Lake, a salt water estuary in Cape Breton, Nova Scotia, with St. Peter's Bay on the Atlantic. The first survey was made by one of Telford's engineers, in 1821, but work was not commenced until 1854. It was suspended in 1858, when the provincial engineer recommended a marine railway instead of the tidal lock. It was, however, resumed in 1864 and completed after confederation, with a lock 122 x 26 with 13 feet of water upon the sill. A new lock 200 x 48 has replaced the old one and the canal has been deepened to 19 feet. The extreme rise and fall of the tide in St. Peter's Bay is 9 feet—the range in the Bras d'Or Lake being about one-third of that outside. The tidal lock has four pairs of gates and the whole expenditure here has been $845,000.

The Shubenacadie Canal.—One of the earliest canals undertaken, immediately after the opening of Lachine, was the Shubenacadie Canal in Nova Scotia, projected to connect Halifax Harbour with the Basin of Minas. Costly masonry was erected, the sum of £60,000 was expended, and the work nearly completed, but it proved a disastrous failure. There was insufficiency of water for lockage, and the tides in the Shubenacadie River are the highest anywhere—said to range 75 feet.

Two short canals without locks connect Burlington Bay at

the head, and Bay of Quinté at the foot, of Lake Ontario, with that lake.

The Burlington Canal.—The Burlington Canal is a short cut through the sand beach at the head of Lake Ontario and gives access to the port of Hamilton. It has cost $433,000.

The Murray Canal. — The other is known as the Murray Canal, projected in the last century when a land grant was set apart for it. It has only recently been opened with 11 feet of water at a cost of $1,216,000 for a length of five miles from end to end of entrance piers.

The Desjardins Canal.—A private company before our railway era opened a canal from Burlington Bay to Dundas at a cost of about $100,000, by which lake schooners could ascend to that town. It was between three and four miles long and was called the Desjardins Canal, but is now remembered only as the scene of a frightful railway accident in 1857.

Grand River Navigation Company.— Another company, by means of dams and locks (and Indian money chiefly) extended a boat navigation in connection with the Welland Canal, sixty miles up the Grand River—after that river was dammed in order to use it as a feeder to the Welland—at a cost of $200,000. This also has been superseded by the railways.

The only new canal undertaken by the Dominion was for the improvement of Rainy River, an affluent of the Lake of the Woods—by a lock and dam at Fort Frances. This was an attempt to utilize the natural water stretches in order to reach the Northwest at a time when the country had not as yet grown to sufficient confidence in its own resources and ability to carry out the Canadian Pacific Railway ; and it was abandoned therefore as soon as that work was undertaken.

There is a magnificent body of inland waters stretching from Lake Superior to the Rocky Mountains, but, where navigable, this is, for the most part, for less than half the year. These may be connected in the future where and when a dense population requires navigation for local traffic—or as a railway freight regulator if such be still needed in the next century.

Projected Canals.

Several canals of considerable magnitude have been proposed for many years, but none of them have got beyond the stage of surveys and estimates.

Baie Verte Canal.—The oldest of these is a tide level canal to connect Baie Verte in the Gulf of St. Lawrence with Cumberland Basin in the Bay of Fundy. These points approach each other within about 15 miles, and that length of canal would shorten the distance between St. John and the gulf several hundred miles. The range of tide, however, in the Bay of Fundy is six times greater than that in the gulf. The scheme was reported upon by Telford in 1825. The water of the bay is too turbid to be admitted into the canal—there was not enough fresh water for a feeder and the cost of feeding from the gulf was such that greater necessity for the canal and greater influence in its favour than existed, were required in face of the conflict of engineering opinion as to the plan. This difficult engineering question has been solved by a Dominion Government subsidy to a ship railway over the same route This latter work when about two-thirds completed has been suspended owing to the financial crash of the Barings.

Georgian Bay Canal.—Another scheme which has been shelved in favour of a ship railway, was known as the Georgian Bay or "Hurontario" Canal, being a proposed canal from Toronto, *via* Lake Simcoe, to Lake Huron. It was persistently, but hopelessly, agitated as a canal route for years. The summit feeder, Lake Simcoe, is 470 feet above Lake Ontario and 130 feet above Lake Huron, or about twice the height above the latter lake as is Lake Nipissing, the summit for the Ottawa route. The lockage would be 600 feet against 326½ feet of the Welland Canal. The summit cut would be nearly 200 feet deep for miles, and no one knows its true inwardness. It has been dropped as a canal, but the route is now advocated by some for an improved water supply for the city of Toronto—which city is at present restricted, as to quantity and quality, to the water of Lake Ontario

Caughnawaga Canal.—Another of these projected cut-offs, which may have an important future, is that of a canal connecting the St. Lawrence with Lake Champlain on the shortest practicable route. This scheme is known as the Caughnawaga Canal. It has been advocated as a substitute for the enlargement of the Chambly Canal, as it would afford a shorter, cheaper and better route for the Ottawa lumber traffic, which has been the chief source of south-bound traffic upon that canal; and also as a route for waterborne western trade with New England. But it has not been undertaken, for the same reasons that the Chambly Canal has not been enlarged, while those on the Ottawa River have been—which reason is that there is not sufficient inducement to undertake it until the same scale of navigation is extended to the Hudson River through the state of New York.

The Richelieu River at St. Johns is 25 feet higher than the St. Lawrence at Caughnawaga, and about twenty-five miles distant upon a direct line. If Lake Champlain be made the feeder, a canal 32½ miles long would be required to avoid high ground upon the direct route. To surmount this high ground, and take the shortest route for the canal would call for a feeder 38 feet higher than Lake Champlain and 16½ miles in length and treble the lockage. This would give 100 feet lockage upon a 25 mile canal, against 25 feet lockage on a canal about 8 miles longer. It has been proposed to take this feeder from the Beauharnois Canal and make it the canal for western traffic, connecting it with Caughnawaga by a branch about four miles long. This would give for the western trade 38 miles of canal with 57½ feet of lockage, against 28 miles of canal with 137 feet of lockage on the Caughnawaga route, because the feeder would start out from the Beauharnois Canal, 63 feet higher than Lake St. Louis, and at a point three miles from the lake. This three miles of the Beauharnois Canal is therefore added to the 26 miles of the direct Caughnawaga route.

This route would make the St. Lawrence the feeder, giving the minimum lockage, as well as distance for the most important traffic—the western trade. The ground upon this route is

favourable for two-thirds its length for a canal of 200 feet or more in width at same cost as for a narrower one.

When this work was proposed in 1847, it was objected to as tending to divert trade from Montreal. A company was incorporated in 1870 for its construction, but could not proceed, doubtless because it is an international project really, which can only become fully effective by its extension to the Hudson River.

It is true that if Lake Superior were brought into connection with Lake Champlain for large lake craft New England and Northern New York would be reached, and Boston thereby obtain an advantage which might induce New York to extend such a navigation to the Hudson River. As this canal is of vastly more importance to the western states and New England than to Canada it must await their action. The interest of the Ottawa lumber trade in this route has been considerably diminished in the last twenty years by the annually increasing quantity of lumber which now takes the rail in preference to the water route.

The Ottawa Route.—This route would shorten the distance between Montreal and Lake Superior about 350 miles, and therefore has been advocated for a ship canal. Surveys were made and reports given in 1858 and 1860 on a basis of 10 feet depth of navigation with locks 250 x 50 feet, and of 12 feet with locks 250 x 45. The first estimate was $24,000,000, and the second, though for deeper water was $12,000,000. In the second there were more dams proposed and less canal—58 miles of canal for the first, and 29 miles for the second.

The distance from Montreal to the mouth of the French River, in the Georgian Bay, Lake Huron, is about 430 miles, of which 308 are in the Ottawa, and the remainder in the Mattawa and French Rivers. About 180 miles would be wide-water lake navigation alternately deep and shoal, and 250 miles of river. The summit at Lake Nipissing is 640 feet above the sea, and is 66 feet higher than Lake Huron. The lockage would be at least 666 feet against 533 *via* Lake Erie.

The Canal Commission of 1870 postponed the consideration of this question on the ground of the wide discrepancy in the

estimates, which were made on the basis of 10 and 12 feet. Now that Parliament has adopted 14 feet for the St. Lawrence, and the United States 20 feet for the upper lakes, a revised estimate is needed and a fuller survey to determine what depth of navigation is practicable upon this route. It will probably be found that upon any scale of navigation the increased lockage and the reduced speed necessary upon the greater portion of this route would fully counterbalance the shorter distance. Both the estimates above referred to were based upon raising the summit level, which is Lake Nipissing. The subsequent construction of the Canadian Pacific Railway and the present existence of towns and villages (as well as the railway) on lands intended to have been flooded by this work, render this raising of the lake now out of the question. The Ottawa route would be shortest only for Lake Michigan, Georgian Bay and Northern Michigan and Lake Superior, but not for Lake Erie or the Detroit River. The receipts and shipments at Buffalo, including Tonawanda, are greater than those of Chicago or of any other lake port. Besides Buffalo there are Cleveland, Ashtabula, Sandusky, Toledo and Detroit, the aggregate tonnage of which is greater than either Buffalo or Chicago. These the Welland route reaches, in addition to all which an Ottawa route would reach.

The Ottawa route would be most valuable to Lakes Michigan and Superior ports, as affording much the shortest water route to tide-water at Montreal, and also at New York *via* Lake Champlain, if the barge system of transportation proves to be the most efficient and economical.

Hydraulic lifts, or pneumatic locks, may yet bring the shorter and shallower water routes into competition with the St. Lawrence; but as long as boats are kept in their native element, the broad deep channel of the St. Lawrence will remain the only one which can successfully compete with the railways.

Lock Vacillations.

Models of the Canadian locks built during the last hundred years would fill a considerable section of any museum intended

to demonstrate the progress of ideas as well as of transportation demands.

The successive and variable dimensions were as follows :—

		Length.	Width.	Depth.
1780.	Locks at Cascades and Coteau	35	x 6	x 2½ water.
1804.	do do do	110	x 20	x 4 "
1819.	Military Canals Ottawa River (Grenville)	106⅝	x 19¼	x 6½ "
1825.	Lachine Canal	100	x 24	x 4½ "
1829.	First Welland Canal (wooden locks)	110	x 22	x 8 "
1832.	Rideau Canal	134	x 33	x 5 "
1834.	Grenville Canal (Ottawa River)	130⅜	x 32½	x 6½ "
1834.	Carillon do	126½	x 32	x 6 "
1834.	Chute-à-Blondeau do	131	x 33	x 6 "
1843.	Ste. Anne's Lock do	190	x 45	x 6 "
1843.	Chambly Canal (Richelieu River)	118	x 23	x 7 "
1843.	Cornwall Canal (St. Lawrence River)	200	x 55	x 9 "
1846.	Beauharnois Canal do do	200	x 45	x 9 "
1846.	Second Welland Canal	150	x 26½	x 10½ "
1847.	St. Ours Lock (Richelieu River)	200	x 45	x 7 "
1880.	Culbute (Ottawa River), wooden locks	200	x 45	x 5 "
1890.	St. Lawrence and Welland	270	x 45	x 14 "
1890.	Grenville (Carillon and Ste. Anne)	200	x 45	x 9 "
1892.	Sault Ste. Marie	900	x 60	x 19 "

The Trent Navigation has locks of same dimensions as those of the Rideau, given above.

United States progress in lock dimensions is shown by those of the Erie and the Sault Ste. Marie Canals :—

	Length.	Width.	Depth.
The Erie Locks in 1822 were	97	x 14	x 4 ft. water.
They were enlarged in 1862 to	110	x 18	x 7 ft. "
The two Sault Locks in 1855 were	350	x 75	x 12 ft. "
These were changed in 1883 to one of	515	x 80	x 17 ft. "
A third now in progress is	800	x 100	x 21 ft. "

It will be noticed that in the last enlargement of the St. Lawrence Canals there is no increase in the width of lock, and only about one-third addition to the length, but more than one-half to the depth. We shall see the effect of one and two feet additional draught on the Upper Lake steamers ; and, generally speaking, the capacity varies as the cube of the depth. The cube of 14 is 2,744 ; of 20 it is 8,000 ; so that a vessel drawing 20 feet should carry, other things being equal, nearly three times

as much as one drawing 14 feet water, (and this without proportionate increase of motive power and other expenses) the resistance being in proportion to the immersed area, which resistance is greatest, in proportion to cargo carried, when that cargo is least.

The Germans have materially diminished the cost of transport in their canals (working in competition with railways) by making them deeper than the rivers with which they connect; —increased depth (though not followed by increased draught) so improving traction as to diminish time, and therefore cost; and herein it is where the St. Lawrence route can distance all competitors.

The Upper Lakes.

The United States, as soon as (and perhaps before) the completion of the St. Lawrence Canal enlargement, will have provided a depth of 20 or 21 feet wherever required between Erie and Huron, and between Huron and Lake Superior. Upon this route there are now steamers 350 feet long, carrying freight at a speed of 16 miles per hour. By means of such craft, with triple expansion engines, and by enlargement and improvement in grain elevators, coal and ore *chutes*, a reduction of freight has been attained in the last few years to which there is no parallel elsewhere. The Secretary of the Duluth Chamber of Commerce says that "the consumption of coal upon a number of the typical modern steel steamers was almost exactly one ounce per ton (of freight carried) per mile, and that it costs $26 upon the most favourably situated railway in the United States to do what is done upon the Upper Lakes for one dollar." The cost, he says, upon the steamers between Duluth and Buffalo (called 1,000 miles) is ·015 of a cent per ton per mile against a cost for transport by rail of four-tenths of a cent per ton per mile. The estimate most favourable to the railway is that their mileage rate of cost is only fifteen times greater than that upon these lakes.

At Buffalo there are elevators which can take grain out of a vessel at the rate of 25,000 bushels per hour. One elevator has taken more than 300,000 bushels out of vessels in one day

of 24 hours. At Duluth the largest grain carriers are loaded, by means of spouts to every hatchway, in two to three hours. Ore is poured from *chutes* at Escanaba into vessels at the rate of 2,000 tons in 45 minutes. One steamer has carried 3,167 net tons of ore upon 14½ feet draught, another 3,628 tons on 16 feet draught, and a third 3,737 tons on 16½ feet draught. The necessities of this traffic call for a strength of hull fit to cope with the ocean.

The finest boats are those put upon the lakes by the great railway companies. Some of these, with over 350 feet length, have less than 43 feet beam. Their triple cylinders are 28, 42½ and 72 inches in diameter, with 54 inch stroke, and 2,600 indicated horse-power. The screw is 15½ feet in diameter. If the Canadian locks were about 100 feet longer, these vessels could pass when lightened to 14 feet, but showing at least 18 inches of their screw above water.

That the railways have taken to the water route is a significant fact. It shows that, for freight purposes, the one is the complement of the other upon the great lakes as much as upon the ocean, and that these lake vessels have thus proved their right to connection with the ocean. The iron ore could not come to the east, nor could the coal go so far west, but for the water, and neither the one nor the other could reach or be taken from the water but for the railway. The average freight on coal for 1,000 miles is 30 to 40 cents per ton, and it has been carried as low as 10 cents per ton. The average rate for wheat from Chicago to Buffalo (nearly 900 miles) is two to three cents, and it has been carried as low as one cent per bushel. The rate between Buffalo and Lake Superior is generally less than for the shorter route to Lake Michigan.

The magnitude of the water-borne grain trade is shown by the fact that the Buffalo elevators handled 135,000,000 bushels in 1891 and 138,000,000 in 1892. This is more than was exported from the United States in '85, '87, '88 or '89. There is now more wheat in store at Duluth awaiting the opening of navigation than at Chicago, and the effect of the low rate from Lake Superior is to draw shipment to it from a very large radius—not only the wheat from Minnesota and Dakota—but wool from

Montana. The shores of Lake Superior offer only timber and ores for export, but the geographical position is such that western railways gravitate to them to get their maximum traffic. The extent of this gravitation is strikingly shown by the progress of railroad earnings on Lake Superior railways, which are given as $892,955 in 1889 ; $2,564,430 in 1890, and $4,880,943 in 1891.

The hard coal, of which 2,822,330 net tons were shipped from Buffalo by lake in 1892, was carried 1,000 miles to Duluth for 20 to 30 cents (while the rate to Chicago was 40 to 60 cents), and thence shipped 160 miles by rail to St. Paul at an additional cost of $1.25 per ton. The rail rate from Chicago to St. Paul for this coal before the opening of this route was $5 per ton. At the Buffalo end of this water route the ore pays more freight charge on 145 miles by rail, to reach the furnace, than for the 650 miles by water to reach Buffalo.

The four articles which make up the great bulk of the water-borne tonnage on the Upper Lakes are ore, coal, grain and lumber. More than half the iron ore used in the United States is floated to its destination upon these Upper Lakes. Coal goes west, and with iron and general merchandise gives the bulk of the back freight to the ore, grain and lumber laden vessels coming east. The coal tonnage is so great that the west bound tonnage is about half that of the east bound, while almost everywhere else, it is one-third or less. The proportions of different articles transported upon the lakes in 1890 were :—

Iron ore	9,000,000	tons.
Lumber	8,000,000	"
Coal	7,000,000	"
Grain and flour	5,000,000	"
Miscellaneous	4,500,000	"
Total	33,500,000	net tons.

This amount exceeds by millions of tons all the tonnage entering and leaving New York.

This ore and coal traffic is localized above Niagara Falls, and therefore does not belong to the Welland or St. Lawrence Canals. Lumber may pass the Welland to some extent to Oswego or Ogdensburgh, but this article is more likely to decrease its

present output and shipment east. The west bound coal traffic from American ports on Lake Ontario will continue to increase through the Welland Canal; but for the future of Canadian canals we may look almost wholly to grain and flour as the east bound tonnage from the Upper Lakes.

The receipts at Buffalo (converting flour into grain) were in 1892, 181,769,690 bushels—and looking to the increase from Lake Superior we may estimate probably future quantities afloat on Lake Erie by hundreds of millions of bushels. A reduction of one cent per bushel means one million of dollars upon every hundred million bushels, and as the larger craft and deeper water have already reduced the cost several cents per bushel, we can understand that the increase from 15 and 16, to 20 and 21 feet draught means millions of dollars to the Western States, and therefore we can appreciate their demand or the extension of the system to the Atlantic by an adequate channel—one which is largely in advance of the Canadian system in operation at the Welland Canal. With some patriotic Americans the demand is for a route exclusively within the United States territory—that is a ship canal from Lake Erie to deep water in the Hudson River. For such a canal, Lake Erie would be needed as a feeder, and therefore some 350 miles of artificial channel would be required, against 74 miles of same to reach tide water at Montreal —or about 166 miles of artificial channel to reach New York by the route of the St. Lawrence and Lake Champlain.

An outlet to the ocean *via* Montreal would afford them great relief, but the best and cheapest mode of access to the great home market, of which New York is the centre, is the most important to them, and for this the Erie Canal is the patriotic route, but the commercial one may prove to be that *via* Lake Champlain. Lake Champlain between Rouse's Point and Whitehall is called 120 miles. St. Johns, on the Richelieu River (where the Chambly Canal begins) is 24 miles river navigation from Rouse's Point. From Whitehall, about 66 miles of canal reaches the Hudson River, and from St. Johns 38½ miles of canal would reach the St. Lawrence; about 105 miles of canal between the

Hudson and the St. Lawrence, and between the points of junction on the Beauharnois Canal and Lake Erie, 60 miles of canal.

The distance from Lake Erie to New York would be about 216 miles longer than that by the Erie Canal. If the canal from Lake Champlain to the Hudson River were fed from this lake (as the only sufficient source of supply) the lockage would be nearly equal upon the two routes. There would be 216 miles more distance of lake and river navigation on the one route, and 190 miles more of canal on the other, but as the first would be travelled about three times as fast as the second, the time of transit (which is the measure of the cost) would be in favour of the longer route.

The cost of construction upon the two routes would be largely in favour of the longer route. These comparisons are based upon the longer route for the canal between the St. Lawrence and Lake Champlain, which would be fed from the former, and not upon the Caughnawaga route fed from Lake Champlain, in which case that lake might be called upon to feed three canals.

The cost of these routes cannot be compared without surveys and estimates on the scale adopted for the lakes—and especially as to the cost of a ship canal between Lake Champlain and the Hudson River; and the necessity for and practicability of feeding the same from Lake Champlain.

For another and larger ship canal with 20 feet of water, the St. Lawrence route offers advantages to be found upon no other. Montreal is the only city on the route of these Canadian canals. There is not, therefore, that growth of vested interests to be interfered with by enlargement, such as exists upon the Erie route. The banks of the St. Lawrence are everywhere low, and there are two shores which could be occupied throughout for an international system of canals. The Beauharnois Canal on the south shore (which has nearly double the lockage of any of the other St. Lawrence canals) is not being enlarged, but a new canal is under construction on the north shore overcoming the same rapids. When this latter (which is called the Soulanges Canal) is in operation, the Beauharnois route will be freed for

future enlargement, in summer and winter, upon any desired scale.

What the St. Lawrence canals will be capable of has been established by what is doing at the Welland. On this canal, steamers 254 feet long by 42 feet beam, carry 1,825 tons on 14 feet draught through the canal, and 2,300 tons on 15 feet draught through the lakes. About 400 tons are usually lightered, at a cost of 80 cents per ton, involving a detention of from six to eight hours. The capacity of their lower holds is 70,000 bushels, and as much as 112,000 bushels of oats have been carried in the hold and between decks. These vessels are loaded to suit the draught in the St. Mary's, Detroit and St. Clair Rivers, and, as those are deepened, their draught in the lakes and their lighterage at the Welland, and consequent detention there, will be increased. The American craft go to Oswego and Ogdensburgh —the Canadian to Kingston—although they could also go to Ogdensburgh if coming from a Canadian port, or to Prescott, opposite. At Kingston and Ogdensburgh grain is transhipped into barges for Montreal, the lake vessels seldom descending to that city. While the St. Lawrence Canals had only 9 feet of water, the second Welland had more than ten, besides which lightering there was generally resorted to. Within three years it is expected that the Welland class of vessels will be able to proceed to Montreal, and the important question now is: Will they go there? The Canal Commission of 1870, the chairman of which (the late Sir Hugh Allan) was a great ship-owner, referring to the Ottawa route, said that it " will be admirably adapted for a barge navigation, similar to that which now obtains upon the River St. Lawrence, and (as appears by the evidence) by far the cheapest means of transport." The commissioners increased the length of the St. Lawrence locks 30 per cent and the depth in them over 50 per cent, but they did not express any opinion as to whether barges 250 feet long and drawing 14 feet of water would be employed, or whether the lake vessel would descend to Montreal. It is the opinion of some engaged in this transportation that barges, not exceeding 10

feet draught or 50,000 bushels capacity, will prove to be the most convenient and profitable size.

The objection to a barge system, alone, is that on such a route it must be necessarily a monopoly. The Erie Canal has a tow-path and individual boat-owners can travel it as a highway—so had the Welland in the days of horse-power towage—but the lake and river navigation of the St. Lawrence and the Ottawa and Rideau routes, require tug boats. Such a monopoly as existed upon the military and inland route, when there was no other (and no railways) can only exist upon the St. Lawrence as long as it is the interest of the lake vessels to continue it. The lake vessels have outgrown our canals so that lighterage is necessary, and may be increased to the extent of half the cargo, and then it will be seen whether they will, for the St. Lawrence Canals, lighter the whole as at present, a portion only as on the Welland, or none.

Montreal has an exceptional harbour in that its wharfs are under water from December until April, the result of a winter rise caused by the packing of ice below the city. The current of the St. Lawrence meets the tide in Lake St. Peter (although salt water does not come within a hundred miles of it) and the descending ice is first checked there. It then backs up and accumulates so as to raise the harbour 10 to 15 feet above summer level. In settling into its winter bed, and in arousing from it in the spring, the ice shoves landward with such force as to prevent the erection of warehouses at the wharf front. Ocean steamers are loaded at their berths with grain afloat in the harbour, transferred by floating elevators, and it is therefore contended that, for Montreal, and for so long as the present system continues, barges, as floating warehouses, are the most convenient and economical.

Extensive harbour improvements are now in progress, including the elevation of the wharfs and the construction of a guard wall to protect them (and warehouses upon them) from the ice shoves. These improvements will give over four miles front of deep water wharfage, nine-tenths of which will be 25

to 27½ feet deep, and none less than 20 feet, at a cost of about $3,000,000.

The charge for barge transport from Montreal to Kingston, 180 miles, is as great or greater than for 1,000 miles of lake transport, including the Welland Canal. This charge must come down, or the lake vessels will go down. Some of them will undoubtedly go through, and all will do so if sufficient return freight is attracted to the St. Lawrence by its enlarged inland route to the lakes. Tariff and navigation laws may delay and hamper, but when possible ocean rates meet possible inland ones, this route can have no competitor in time and cost; and long before any other is provided it will become indispensable to the rapidly congesting traffic upon the upper lakes.

The Grain Trade.

The grain trade of the St. Lawrence route has, until recently, been stationary, because it was confined to that which Montreal capital brought there. British and foreign capital, British steamers and mail subsidies have assisted New York's enormous advantages, while western railroads and western shipments were controlled by New York and New England, the chief destination of all not exported. The effect of the Reciprocity Treaty while it lasted was to divert Canadian exports for Britain *via* New York and away from the St. Lawrence.

This St. Lawrence grain trade is now increasing, and a greater quantity was shipped in 1892 from Chicago and Duluth on through sales, an indication that the St. Lawrence route is growing in favour with western exporters. The following shows receipts of each kind by rail and river for the last three years:—

Articles.	Rail, 1892.	Canal, 1892.	Total, 1892.	Total, 1891.	Total, 1890.
Flour, brls.....	935,783	51,505	986,888	1,151,421	978,843
Wheat, bushels..	4,092,370	7,082,569	174,939	8,389,687	4,155,970
Corn " ..	28,850	1,783,234	1,812,084	2,130,080	5,302,057
Oats " ..	5,536,818	820,726	6,357,544	1,732,626	1,648,193
Barley " ..	506,259	186,074	692,333	1,352,085	167,996
Rye " ..	52,502	336,272	388,774	2,425,887	282,014
Pease " ..	2,011,843	558,020	2,569,863	2,024,199	1,483,943

The excess of coarse grains, oats, pease, &c., carried by rail, may be due to short hauls and shipments from points where there is no canal competition.

The receipts and shipments in bushels for the last five years were :—

	1892.	1891.	1890.	1889.	1888.
Receipts.....	28,508,007	24,176,289	18,215,063	18.722,865	14,711,465
Shipments.....	24,355,965	18,651,409	13,550,974	15,257,678	10,207 802

In the above flour is converted into bushels of wheat.

The canals of Canada were constructed after the Erie Canal, and their projectors then counted upon some of the splendid financial success of that work. They were begun before the railway era and enlarged at a time when no one foresaw the effect of railway competition. New York at first protected the Erie Canal against that competition by legislation, and it was not until 1851 that the Central was permitted to carry freight without paying canal tolls. Until 1844, railroads paralleling the canals of the state were prohibited from carrying anything but passengers and their baggage. In that year certain roads were permitted to carry freight during the suspension of naviga-

tion, and then, only upon the payment of canal tolls to the state. But it was the great invention of Bessemer, (by which steel has been made cheaper than iron) which brought about the substitution of steel for iron in the rails, that enabled the railways to lower their rates so as to compel the State of New York to come to the relief of her boatmen, in 1882, and entirely remove the tolls.

In 1881 the St. Mary's Canal, Lake Superior, was ceded by the state of Michigan to the Federal Government, and the tolls, which had been levied there since 1855, were abolished. With a free water route from Lake Superior to New York, even the nominal tolls of the Canadian canals, which do not yield one per cent on the cost, cannot much longer be maintained.

The grain arrivals at New York for the last two years were distributed between the railways and the Erie Canal in the following proportions :—

	1891.		1892.	
Routes.	Bushels of Grain.	Per cent of total by each route.	Per cent of total by each route.	Bushels of Grain.
N. Y. Central & Hudson River R.R.	35,724,637	26·00	22·63	44,154,777
N. Y., L. Erie and Western R.R....	31,720,511	19·06	20·09	32,351,353
Pennsylvania R.R.....	7,508,164	4·67	4·76	7,931,871
Delaware, Lackawanna & West. R.R.	4,938,939	2·69	3·13	4,576,395
West Shore R.R.....	24,204,323	16·34	15·33	27,748,835
Lehigh Valley R.R.....	18,260,754	12·42	11·57	21,099,293
Baltimore & Ohio R.R.....	1,469,112	1·19	0·93	2,029,011
Various routes.....	1,018,203	0·51	0·64	858,805
By river and coastwise.....	1,322,767	1·29	0·83	2,194,124
By canal.....	31,710,941	15·83	20·09	26,882,087
Total receipts.....	157,878,351	100	100	169,826,551

It will be seen that while there was an increase of 12,000,000 bushels in 1892, and every trunk line of railway increased their quantities, the canal fell off nearly 5,000,000 bushels. The Canal Superintendent admits that the competing railways can now carry as cheaply as the Erie Canal.

The gross tonnage of the Erie Canal, compared with that of the New York Central Railway, was, in

	Canal.	Railway.
1883.....	5,664,056	10,892,440
1892.....	4,281,995	20,721,752

Three tables are appended showing (1) the Montreal grain trade for the last 47 years; (2) Comparative receipts at Montreal by rail and canal; and (3) Receipts and shipments at five Atlantic ports compared with those at Montreal.

Conclusion.

The railways having revolutionized the conditions under which former canal enlargements have been undertaken, and our canals, instead of becoming an expected source of revenue, now promising to become a charge upon the public purse, it is clear that nothing more can be expected from Canada by her western neighbours than the completion of her unfinished and long-delayed enlargements.

The cost of the Canadian canal system between tide-water and Lake Superior, by the St. Lawrence route, will aggregate about $60,000,000—a sum which, however great, is less than Manchester is now paying for a ship canal not half the length, and with but a fraction of the lockage, of the Canadian system, in order to compete with the oldest railway in the world. The Erie Canal has cost upwards of $50,000,000, but has earned this amount in tolls and is now maintained a free canal, and railway freight regulator, at an annual cost to the state of New York of $720,000.

It may cost as much more as Canada has already expended to carry a canal of the size needed for the largest lake steamer, with over 20 feet water, from Lake Erie to Montreal; but, what-

ever the sum, it would not be more than 20 per cent of that upon any wholly United States route. But there are many reasons why such a work will not be undertaken, unless as an international one, such as led to the improvement of the navigation of the Danube and the Rhine.

Canada, of course, could not consider it while her enlarged canals are incomplete on the St. Lawrence, and their value not tested, especially as against the barge system in operation there. For her own wants her new canals will be an outlet better than she can find elsewhere. Her need of the Welland Canal has been less than has been that of the United States for the same work, because the peninsula of Ontario, the richest portion of the Dominion, though bounded by three great lakes, can ship from the lower one, below the Welland Canal. But her recent developments in her prairie provinces will make Lake Superior her greatest grain-shipping centre, and her distant prairies will then need the most rapid and economical water route to the sea.

There is, moreover, not the same unanimity in Eastern Canada as in the north-western states, as to the benefits to be derived from a through commerce, for which Montreal and Quebec would be way stations. Lastly, there is disagreement as to the economy of extending the voyage of the lake vessel to Europe; and of its practicability under all circumstances, with a fresh-water crew.

Whenever the 14-feet draught is obtained, whatever may be the outcome of the barge question, there will be lake vessels descending to Montreal, and vessels coming from and going to sea *via* the St. Lawrence and Welland Canals. Colliers will come from Nova Scotia into Lake Ontario, if no further; and fruit vessels from the Mediterranean and the West Indies will penetrate to Lakes Michigan and Superior, and will not fail to get return cargo. Quebec is nearer to the Mediterranean and is a shorter water route from Gibraltar to Chicago than any other.

The next further enlargement which may be undertaken by Canada with respect to canals will be confined to lengthening

the locks, which is practicable at reasonable cost. When this is done, nearly every lake craft now afloat could pass out to sea with 14 feet draught, and load down to 20 feet at Montreal. There are over 2,500 steamers in Lloyd's Register of less width but of greater length than the Canadian lock chambers. The modern proportions of length to beam are 8, 9, and 10 to 1. The Canadian Commission adopted the proportions of Noah's Ark and made the lock chambers 6 to 1. At present the tendency is towards an increase of beam in proportion to length, and there may be a return to these scriptural proportions in future naval architecture; but this will not increase the capacity of those locks, though it may prove that they are not too short for their width or too wide for their length.

[The profiles accompanying this paper show the comparative elevations of all the routes, opened or proposed, between tide water and the Upper Lakes, including the Erie and the Champlain routes.]

APPENDIX No. 1.

QUANTITIES OF FLOUR AND GRAIN RECEIVED AT AND SHIPPED FROM MONTREAL DURING A PERIOD OF FORTY-SEVEN YEARS.

YEARS.	FLOUR.		WHEAT.		CORN.	
	Receipts.	Shipments.	Receipts.	Shipments.	Receipts.	Shipments.
	Barrels.	Barrels.	Bushels.	Bushels.	Bushels.	Bushels.
1846.....	582,922	202,821	439,177	376,852	.....	.....
1847.....	627,137	271,559	540,957	560,858	.....	.....
1848.....	546,292	154,908	482,645	130,187	44,150	.....
1849.....	485,901	535,593	357,900	481,768	50,514	.....
1850.....	483,603	182,988	845,277	71,359	51,965	5,719
1851.....	510,738	255,546	443,477	129,114	96,030	26,912
1852.....	575,938	215,524	724,056	307,656	92,199	300
1853.....	595,698	244,400	906,989	485,609	83,421	.....
1854.....	484,684	97,724	431,785	122,636	651,149	146,748
1855.....	433,011	53,383	634,317	45,707	622,208	28,629
1856.....	589,757	196,731	1,340,705	774,167	437,154	158,234
1857.....	573,445	239,301	1,667,724	859,912	330,084	28,631
1858.....	609,064	197,742	1,774,464	669,241	105,087	14,967
1859.....	575,810	105,973	635,424	58,005	71,430	3,015
1860.....	577,196	277,567	2,622,602	1,645,209	138,214	24,387
1861.....	1,005,339	605,042	7,738,084	5,584,727	1,555,477	1,477,114
1862.....	1,174,602	597,477	8,534,172	6,500,796	2,661,261	1,774,546
1863.....	1,193,286	616,021	5,509,143	3,741,146	862,534	638,281
1864.....	858,795	858,071	4,194,217	2,406,531	158,564	21,974
1865.....	782,216	637,001	2,648,674	787,938	935,421	734,849
1866.....	704,376	595,198	773,208	83,278	1,117,208	1,870,223
1867.....	738,518	569,021	2,939,295	1,576,528	891,605	681,708
1868.....	790,311	683,612	2,426,869	1,081,958	1,086,152	682,497
1869.....	975,295	966,057	7,462,033	5,595,332	141,982	108,018
1870.....	1,061,273	975,513	6,508,315	5,973,048	83,656	6,043
1871.....	951,760	908,844	8,224,805	7,680,834	3,171,757	2,870,998
1872.....	921,973	832,931	4,665,314	3,818,450	7,656,440	7,546,390
1873.....	1,130,666	863,569	9,788,730	8,225,649	3,544,514	3,520,918
1874.....	1,075,353	830,256	7,692,284	7,556,566	2,803,284	2,561,375
1875.....	1,023,551	810,699	8,615,238	7,117,159	1,804,010	1,724,220
1876.....	915,331	842,885	6,388,130	5,097,694	3,932,031	3,834,602
1877.....	823,873	749,247	7,218,092	5,848,363	4,017,015	4,226,296
1878.....	916,379	716,793	7,390,095	6,802,822	6,117,326	5,664,835
1879.....	771,384	725,109	11,313,634	10,461,221	4,389,291	4,052,307
1880.....	735,596	739,007	9,637,124	9,084,266	7,772,549	7,622,161
1881.....	826,167	632,821	7,599,825	6,554,622	3,817,006	3,359,084
1882.....	866,066	775,862	8,273,678	6,913,290	708,279	672,850
1883.....	1,012,706	776,242	6,080,911	5,008,167	4,866,151	4,530,731
1884.....	1,152,789	844,019	5,301,137	3,967,457	3,590,535	3,316,053
1885.....	800,788	679,426	5,566,247	4,221,283	2,419,581	2,378,827
1886.....	888,712	736,968	7,445,413	7,035,122	4,858,667	4,545,503
1887.....	919,682	922,565	10,678,714	9,168,893	1,264,921	1,206,678
1888.....	933,121	785,638	5,048,809	2,171,534	2,895,924	2,808,276
1889.....	968,876	874,667	3,836,166	2,356,494	6,908,467	6,720,830
1890.....	978,843	824,752	4,155,970	2,233,666	5,302,007	4,970,236
1891.....	1,153,421	795,452	8,389,687	6,230,224	2,130,080	2,252,662
1892.....	980,888	1,036,187	11,174,939	8,603,379	1,812,084	1,813,843

APPENDIX No. 1.

QUANTITIES OF FLOUR AND GRAIN RECEIVED AT AND SHIPPED FROM MONTREAL DURING A PERIOD OF FORTY SEVEN YEARS.

YEARS.	PEASE.		OATS.		BARLEY.	
	Receipts.	Shipments.	Receipts.	Shipments.	Receipts.	Shipments.
	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.
1846	1,350	94,360	.....	30,992	489	.....
1847	50,184	86,069	15,505	155,074	10,213	24,120
1848	59,035	64,678	12,001	.....	7,201	200
1849	48,637	6,985	18,243	12,001	2,911	357
1850	21,256	98,006	3,677	1,061	512	350
1851	22,770	59,921	29,189	.....	2,372	.....
1852	60,592	98,514	21,873	7,494	1,239	734
1853	75,654	175,847	38,894	.....	7,415	37,770
1854	10,098	67,264	11,197	.....	21,457	.....
1855	33,956	105,215	49,728	9,366	17,938	1,799
1856	52,932	218,116	43,063	8,643	24,194	2,075
1857	16,773	186,142	15,007	120	19,410	4
1858	177,908	423,018	113,566	32,160	23,881	300
1859	113,186	344,189	63,093	12,600	27,925	29,068
1860	776,129	1,298,845	37,637	206,732	27,483	252
1861	1,409,879	1,529,136	122,399	1,040,085	132,749	Incomplete.
1862	534,679	711,192	106,792	979,639	236,930	
1863	668,265	745,414	403,972	3,086,835	307,261	709,230
1864	357,207	499,629	232,616	3,437,810	371,055	854,770
1865	436,751	681,910	163,694	3,251,566	317,688	1,010,392
1866	1,036,315	1,141,733	2,122,305	3,383,536	336,951	427,322
1867	1,302,306	1,761,960	309,268	1,425,950	413,320	901,037
1868	520,305	663,545	215,075	903,024	267,416	451,366
1869	550,984	576,984	84,086	330,738	66,238	163,372
1870	892,969	1,747,723	172,449	635,830	40,465	250,609
1871	292,308	796,143	122,946	86,818	83,256	57,601
1872	652,649	1,175,026	211,684	436,446	129,064	118,496
1873	455,799	917,761	163,069	331,439	194,872	153,362
1874	1,144,739	1,763,306	283,004	261,377	175,652	45,426
1875	1,157,010	1,544,065	258,098	343,565	181,935	176,950
1876	1,030,043	1,362,731	2,616,171	3,022,874	270,677	201,796
1877	810,901	1,127,245	323,075	400,142	1,230,486	1,091,473
1878	1,611,433	2,226,792	723,103	957,376	429,416	5,846
1879	2,026,379	2,021,592	490,541	645,485	365,789	8,375
1880	2,617,656	3,081,674	1,191,531	1,853,829	357,176	293,023
1881	3,015,544	3,133,203	1,447,813	1,211,221	284,212	133,824
1882	2,099,607	2,204,674	926,996	545,962	247,532	128,451
1883	1,635,398	1,666,334	495,742	155,431	239,180	142,354
1884	1,971,271	1,943,103	844,168	259,067	238,664	98,327
1885	2,449,846	2,562,329	1,580,897	1,469,016	155,227	79,767
1886	2,602,933	2,800,312	1,970,464	2,037,054	181,159	14,581
1887	2,343,198	2,605,758	1,107,292	514,273	138,021	59,792
1888	1,055,454	1,016,654	649,690	78,806	189,598	14,166
1889	1,274,353	1,016,491	924,007	95,700	282,903	12,829
1890	1,483,943	1,458,191	1,648,193	298,245	167,996	10,367
1891	2,024,199	2,075,591	1,732,626	817,675	1,352,085	814,382
1892	2,569,863	2,368,337	6,357,544	5,082,295	692,333	407,040

APPENDIX No. 2.

RECEIPTS OF GRAIN, FLOUR AND MEAL BY RAIL AND CANAL AT MONTREAL AND NEW YORK.

	MONTREAL.		
	RAIL.	CANAL.	TOTAL, Rail & Canal.
	Bushels.	Bushels.	Bushels.
1892.. 7 months open	15,144,771	11,045,835	26,190,606
5 " closed	4,054,511	.....	4,054,511
Total	19,199,282	11,045,835	30,245,117
1891.. 7 months open	8,619,750	11,318,833	19,938,583
5 " closed	3,977,806	.....	3,977,806
Total	12,597,556	11,318,833	24,916,389
1890.. 7 months open	6,620,758	8,702,185	15,322,943
5 " closed	2,890,116	.....	2,890,116
Total	9,510,874	8,702,185	18,213,059
1889.. 7 months open	6,690,220	10,062,338	16,752,558
5 " closed	1,970,307	.....	1,970,307
Total	8,660,527	10,062,338	18,722,865
1888.. 7 months open	6,357,429	6,114,399	12,471,828
5 " closed	2,240,117	.....	2,240,117
Total	8,597,546	6,114,399	14,711,945
1887.. 7 months open	7,231,720	9,615,844	16,847,564
5 " closed	3,948,412	.....	3,948,412
Total	11,180,132	9,615,844	20,795,976
1886.. 7 months open	5,658,726	10,868,935	16,527,661
5 " closed	4,706,513	.....	4,706,513
Total	10,365,239	10,868,935	21,234,174
1885.. 7 months open	5,795,142	6,559,994	12,355,136
5 " closed	4,211,919	.....	4,211,919
Total	10,007,061	6,559,994	16,567,055
1884.. 7 months open	4,806,877	7,448,877	12,255,754
5 " closed	6,201,725	.....	6,201,725
Total	11,008,602	7,448,877	18,457,479
1883.. 7 months open	4,143,202	10,678,180	14,821,382
5 " closed	4,328,581	.....	4,328,581
Total	8,471,783	10,678,180	19,149,963
1882.. 7 months open	3,175,686	9,999,832	13,175,518
5 " closed	3,355,323	.....	3,355,323
Total	6,531,009	9,999,832	16,530,841
1881.. 7 months open	3,437,339	12,432,250	15,869,589
5 " closed	4,398,607	.....	4,398,607
Total	7,835,946	12,432,250	20,268,196
1880.. 7 months open	3,407,483	19,280,017	22,687,500
5 " closed	2,565,078	.....	2,565,078
Total	5,972,561	19,280,017	25,252,578

APPENDIX No. 2.

RECEIPTS OF GRAIN, FLOUR AND MEAL BY RAIL AND CANAL AT MONTREAL AND NEW YORK.

		NEW YORK.		
		Rail.	Canal.	Total, Rail & Canal.
		Bushels.	Bushels.	Bushels.
1892..	7 months open	83,593,042	25,496,287	109,089,329
	5 " closed	57,157,298	1,385,800	58,543,098
	Total	140,750,340	26,882,087	167,632,427
1891..	7 months open	79,423,035	30,846,641	110,269,676
	5 " closed	45,421,608	864,300	46,285,908
	Total	124,844,643	31,710,941	156,555,584
1890..	7 months open	46,938,752	30,082,900	77,021,652
	5 " closed	43,279,598	102,500	43,382,098
	Total	90,218,350	30,185,400	120,403,750
1889..	7 months open	43,114,456	33,606,695	76,721,151
	5 " closed	33,003,598	389,200	33,392,798
	Total	76,118,054	33,995,895	110,113,949
1888..	7 months open	40,199,970	33,155,475	73,355,445
	5 " closed	28,356,506	865,800	29 222,306
	Total	68,556,476	34.021,275	105,577,751
1887..	7 months open	45,341,417	45,675,100	91,016,517
	5 " closed	34,733,679	335,900	35,069,579
	Total	80,075,096	46,011,000	126,086,096
1886..	7 months open	48,209,284	43,660,022	91,869,306
	5 " closed	36,531,886	376,500	36,908,386
	Total	84,741,170	44,036,522	128,777,692
1885..	7 months open	48,046,096	29,433,387	77,479,483
	5 " closed	44,922,444	497,200	45,419,644
	Total	92,968,540	29,930,587	122,899,127
1884..	7 months open	44,338,001	37,502,157	81,840,158
	5 " closed	30,738,846	423,100	31,161,946
	Total	75,076,847	37,925,257	113.002,104
1883..	7 months open	42,511,801	40,822,008	83,333,809
	5 " closed	36,878,290	398,900	37,277,190
	Total	79,390,091	* 41,220,908	120,610,999
1882..	7 months open	49,143,815	31,172,793	80,316,608
	5 " closed	30,630,111	977,613	31,607,724
	Total	79,773,926	32,150,406	111,924,332
1881..	7 months open	62,800,037	37,469,030	100,269,067
	5 " closed	35,774,211	723,700	36,497,911
	Total	98,574,248	38,192,730	136,766,978
1880..	7 months open	56,505,548	69,421,695	125,027,243
	5 " closed	38,909,274	19,206	38,928,480
	Total	95,414,822	69,440,901	164,855,72

* New York canal tolls abolished this year.

APPENDIX No. 3.

RECEIPTS AND SHIPMENTS OF GRAIN, FLOUR AND MEAL (IN BUSH.) AT MONTREAL AND FIVE ATLANTIC PORTS.

		Boston.	New York.	Philadelphia.	Baltimore.
		Bushels.	Bushels.	Bushels.	Bushels.
1870..	Receipts.....	13,102,703	62,921,175	15,307,011	13,819,101
	Shipments...		29,455,814		
1871..	Receipts.....	15,037,943	89,543,673	20,102,425	17,389,443
	Shipments...		43,595,502		
1872..	Receipts.....	17,068,086	90,930,336	24,117,150	20,571,499
	Shipments...		45,901,493		
1873..	Receipts.....	17,926,202	92,137,971	24,949,157	19,099,517
	Shipments...	2,145,364	54,278,072	4,807,620	9,049,545
1874..	Receipts.....	18,000,002	107,273,158	24,625,591	24,936,208
	Shipments...	3,186,318	66,088,650	6,671,334	12,555,090
1875..	Receipts.....	18,321,063	93,095,082	22,452,400	22,048,569
	Shipments...	3,987,959	50,599,710	8,846,515	11,407,489
1876..	Receipts.....	22,753,698	95,949,242	30,310,565	35,255,176
	Shipments...	6,043 298	55,253,686	22,016,515	24,761,307
1877..	Receipts.....	23,215,457	103,313,782	25,420,545	35,346,470
	Shipments...	6,178,145	62,815,405	13,595,345	25,579,827
1878..	Receipts.....	27,291,781	152,853,306	45,474,650	47,075,240
	Shipments...	12,041,359	107,819,044	29,876,327	39,724,954
1879..	Receipts.....	32,798,829	163,124,890	47,398,455	66,799,926
	Shipments...	15,891,088	123,513,859	32,748,462	55,383,865
1880..	Receipts.....	37,091,005	159,042,362	49,255,163	60,631,426
	Shipments...	21,739,738	134,871,315	31,587,649	50,693,486
1881..	Receipts.....	35,423,047	139,898,188	28,854,555	43,341,929
	Shipments...	17,138,078	96,278,033	16,421,614	34,310,178
1882..	Receipts.....	29,903,006	114,430,473	19,412,735	29,022,468
	Shipments...	10,145,712	70,508,777	7,593,698	21,037,266
1883..	Receipts.....	37,527,022	125,530,047	22,333,384	35,847,124
	Shipments...	13,779,300	73,065,928	11,902,485	27,322,398
1884..	Receipts.....	34,520,298	116,257,633	20,339,131	33,119,610
	Shipments...	16,117,232	67,940,496	8,995,022	23,877,515
1885..	Receipts.....	31,166,369	126,331,468	23,188,449	34,299,861
	Shipments...	13,304,613	68,202,212	12,946,313	23,321,591
1886..	Receipts.....	35,769,884	130,910,066	21,554,692	38,772,444
	Shipments...	16,247,165	71,282,779	10,957,686	32,137,067
1887..	Receipts.....	31,921,497	127,500,804	25,038,809	39,252,205
	Shipments...	17,432,841	74,080,940	12,914,525	31,749,038
1888..	Receipts.....	29,401,549	106,052,370	17,158,523	30,275,840
	Shipments...	11,249,794	44,438,371	4,958,080	19,472,831
1889..	Receipts.....	30,189,053	112,550,356	18,588,142	42,349,047
	Shipments...	13,528,467	58,496,531	7,511,471	31,779,116
1890..	Receipts.....	30,815,742	122,013,670	35,214,826	46,435,135
	Shipments...	12,165,965	64,324,034	21,346,268	36,207,554
1891..	Receipts.....	32,943,222	157,878,351	30,101,650	42,811,978
	Shipments...	13,887,982	88,069,260	15,178,966	32,226,296

APPENDIX No. 3.

RECEIPTS AND SHIPMENTS OF GRAIN, FDOUR AND MEAL (IN BUSH.) AT MONTREAL AND FIVE ATLANTIC PORTS.

		New Orleans.	Montreal.		Totals.
		Bushels.	Bushels.	Per cent of Total.	Bushels.
1870..	Receipts	15,480,179	13,106,630	9·31	140,736,799
	Shipments		13,601,310	....	
1871..	Receipts	14,601,922	16,808,108	9·69	173,483,514
	Shipments		16,186,484	....	
1872..	Receipts	15,256,805	18,115,670	9·73	186,059,546
	Shipments		17,522,957	....	
1873..	Receipts	13,214,226	19,989,094	10·67	187,316,167
	Shipments	1,433,278	17,912,572	19·98	89,626,451
1874..	Receipts	12,295,333	17,676,188	8·63	204,806,480
	Shipments	2,394,476	16,739,580	15·55	107,635,438
1875..	Receipts	9,669,296	17,324,137	9·14	189,453,477
	Shipments	774,927	15,363,184	16·87	91,066,475
1876..	Receipts	9,544,194	19,086,600	8·75	218,190,865
	Shipments	2,145,818	18,167,642	14·12	128,634,738
1877..	Receipts	10,025,381	18,825,184	8·72	215,697,367
	Shipments	3,101,232	17,346,678	13·53	128,157,263
1878..	Receipts	14,529,304	21,934,170	7·09	309,167,315
	Shipments	7,606,427	20,899,187	9·54	218,867,298
1879..	Receipts	14,895,836	23,192,749	6·66	348,210,685
	Shipments	7,065,416	22,755,946	8·82	257,886,437
1880..	Receipts	20,357,867	26,192,784	7·22	362,570,607
	Shipments	17,438,914	27,200,905	9·59	285,532,007
1881..	Receipts	20,143,339	21,222,982	7·34	288,884,040
	Shipments	12,564,510	18,567,360	9·56	195,279,773
1882..	Receipts	14,921,391	16,975,541	7·55	224,665,614
	Shipments	6,664,302	14,878,923	11·37	130,828,678
1883..	Receipts	18,373,230	19,462,963	7·49	259,013,770
	Shipments	12,171,824	16,533,397	10·68	154,775,332
1884..	Receipts	12,981,300	18,579,079	7·88	235,797,351
	Shipments	5,921,210	14,775,655	10·73	137,627,130
1885..	Receipts	14,656,472	17,210,265	6·97	246,853,884
	Shipments	8,173,632	15,266,781	10·80	141,305,142
1886..	Receipts	12,799,310	21,234,174	8·13	261,040,570
	Shipments	9,534,141	20,884,173	13·03	160,143,311
1887..	Receipts	16,853,936	20,795,976	7·95	261,363,227
	Shipments	12,453,542	18,701,767	11·19	167,043,653
1888..	Receipts	12,030,865	14,711,945	7·02	209,631,092
	Shipments	6,923,892	10,207,802	10·49	97,250,770
1889..	Receipts	20,812,159	18,722,865	7·61	243,211,622
	Shipments	15,105,709	15,257,678	10·77	141,678,972
1890..	Receipts	21,575,442	18,213,059	6·64	274,268,474
	Shipments	13,951,463	13,550,974	8·39	161,546,258
1891..	Receipts	20,708,814	23,916,389	7·75	308,360,404
	Shipments	12,790,883	18,651,409	10·31	180,804,796