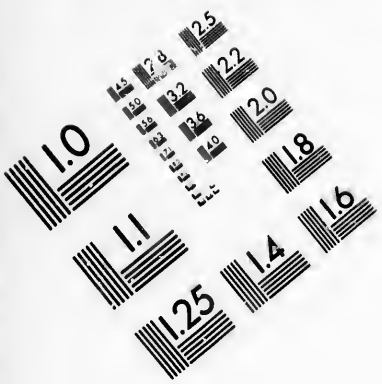

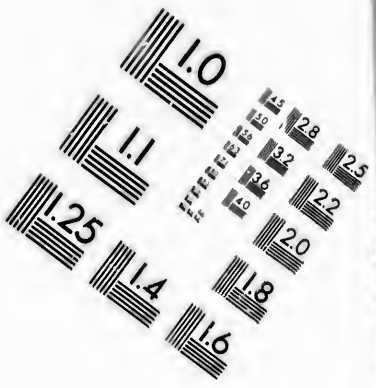

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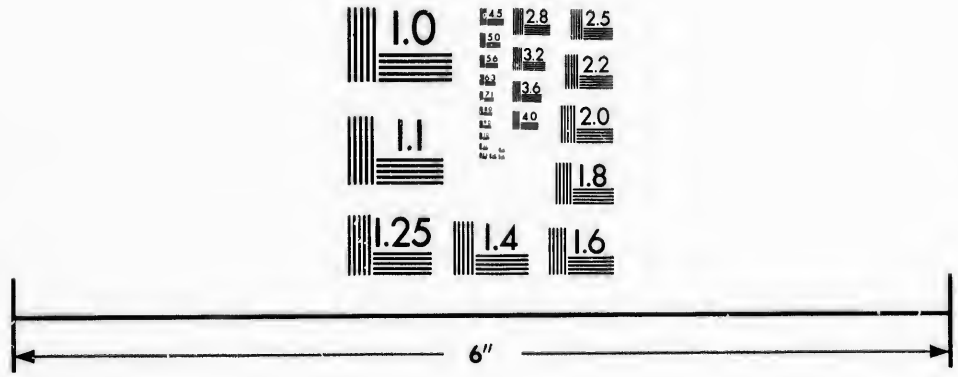

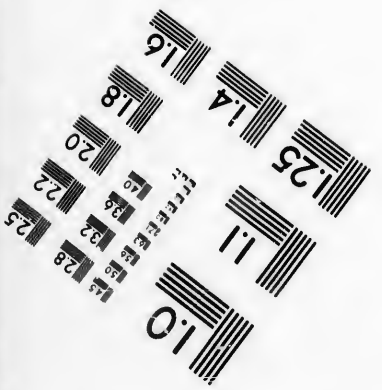

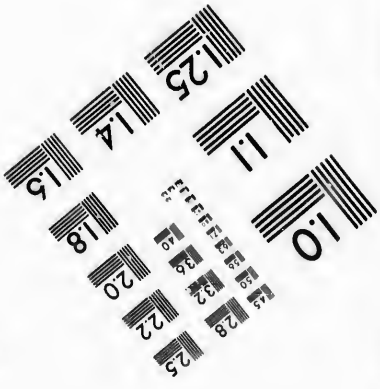

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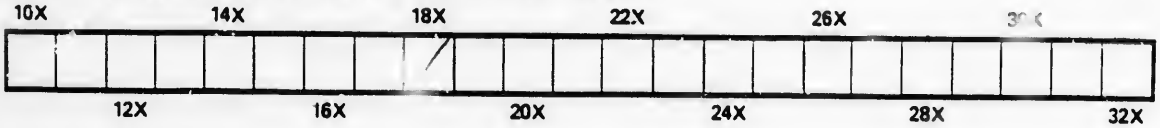
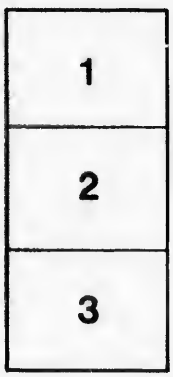
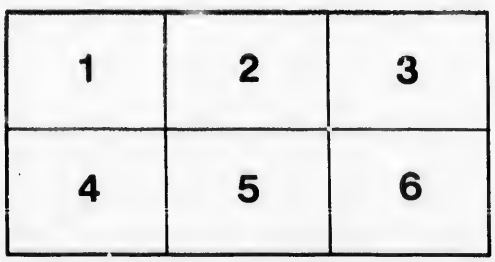






6.

REPORT

ON

DREDGING IN LAKE ST. PETER,

AND ON THE

IMPROVEMENT OF THE RIVER ST. LAWRENCE,

BETWEEN

MONTREAL AND QUEBEC,

(WITH CHARTS,)

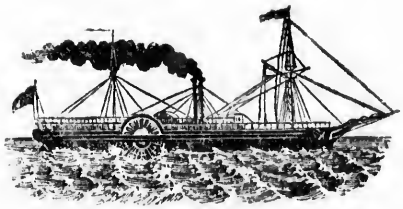
BY

THOS. C. KEEFER,

ENGINEER, MONTREAL HARBOUR COMMISSION.

Published by Order of the Montreal Harbour Commissioners,

HON. JOHN YOUNG, CHAIRMAN.



Montreal:

PRINTED BY JOHN LOVELL, ST. NICHOLAS STREET.

1855.

ENGINEER'S REPORT.

MONTREAL, 1*st March*, 1855.

TO THE HONORABLE JOHN YOUNG,

Chairman Harbour Commissioners, Montreal.

SIR,—I have the honor to acknowledge the receipt of Mr. Glass' letter of 6th January, transmitting the reports of Capt. Bell, Superintendent to the Commission, with a request that I should report upon the same—review the past progress of the works—and give my views with reference to future operations.

The documents published in February, 1853, give a clear and connected history of the operations of the Harbour Commissioners up to that date. Since then, two working seasons have elapsed—the scale of operations has been materially enlarged by a decision to carry a depth of *twenty* feet at low water through Lake St. Peter, instead of one of *sixteen* feet, which was the maximum aimed at in the instructions to the Board of Engineers in October, 1850; and the question of the enlargement of the Harbour of Montreal has been presented in a manner which indicates that this work cannot be much longer postponed. Moreover a survey of the River has defined the nature and extent and demonstrated the practicability of the removal of *all* the obstacles to the attainment of a depth of twenty feet at low water, above and below Lake St. Peter.

Under these circumstances the present appears to be a proper occasion for reviewing the proceedings of the past, as the best means of explaining, as well as of vindicating the arrangements for the future.

I will endeavor, (at the risk of repetition,) to present the question so that strangers, without the aid of charts, may be able to appreciate the extent and importance of the work.

The rapids of the River St. Lawrence terminate at the City of Montreal,—from which point to the sea the *current* of the River offers no obstruction to the ascent of ocean craft.

The influence of the tides is felt within fifty miles of Montreal, but their regular rise and fall is not perceptible until we deseend about one hundred miles below this City. At the first point below this City, where the influence of the tide has been observed, the river expands into a lake about twenty miles in length by nine in width, called Lake St. Peter. This lake is crossed by three "banks" or "bars" which enclose between them two "pools" in whieh the depth exceeds twenty feet; the first of these pools is one and a quarter miles in length, and 800 feet in average width, and the lower one, four and a-half miles in len th and nearly half a mile in width. The ship channel is in the general direction of these pools, and near the centre of the Lake; between it and either shore there is a broad margin of shoal water, averaging two miles in width on the north and three and three-fourth miles on the south of this channel.

The main "bank," which divides these two pools, is known as the "flats of Lake St. Peter," and measures, from a depth of twenty feet at low water in one pool to the same depth in the other, *eight and seven-eighth miles.* The top of this bank is very level, having a uniform depth of eleven feet at low water, for a distance of four and a-half miles measured on the line of the ship channel. Across the head of the upper and the foot of the lower pools are two bars which separate the main channel,

entering and leaving the Lake, from the two pools above described. The least depth on the Upper Bar, (or *Batture du Lac*,) was twelve feet at low water, and the distance across this bar, between the depths of twenty fee at low water, is nearly one and a-half miles. The depth on the Lower Bar (opposite Nicolet River) is sixteen and a-half feet, and its extent, between twenty feet soundings on the line of the channel, is one and a-fourth miles.

The aggregate length of dredging at the Upper Bar, the Flats, and the Lower Bar, for a depth of twenty feet at low water, will be about eleven and a-half miles, measured on the line of the old ship channel.

The average depth in the channel of the River St. Lawrence, between Montreal and Lake St. Peter, with the exceptions hereafter to be described, may be taken at thirty feet. Below Lake St. Peter the depth in the channel is generally thirty to forty feet, increasing, as we approach Quebec, to sixty and one hundred feet and over, with the exception of that portion of the River opposite Ste. Anne de la Pérade, where there is a general depth of twenty-four feet at low tide, and where the bed of the River is strewn with huge rocks or boulders. Here there is a narrow bar of blue clay with only sixteen feet water upon it at low tide. At this latter point there is a tide of six and a-half feet at springs, and four feet at neaps, so that, at high water, there is no obstruction to a twenty feet draught.

It is not to the purpose here to discuss the origin of the Flats of Lake St. Peter, further than this question bears upon the important one of the permanency of the artificial channel now in progress through the lake.

If the fine clay of which the flats are formed has been swept out of the numerous channels formed by the islands above Lake St. Peter, this has taken place at so remote a period, that the supply from which the flats were then formed has been exhausted,—and the River, having cut out its required dimensions of channel, has protected these from further encroachments by a lining of stones,

sand, or gravel. The action of the ice upon the bed and slopes of the River lines the shores with a facing of boulders—just as the ocean and the lakes heave up shingle and sand as barriers to their own further inroads on the land.

The direct action of the ice, in this climate, has more influence on the permanence of any artificial channel, than this indirect action in staying the descent of detritus. Wherever large masses of ice are grounded upon a yielding substratum they act as temporary islands, diverting the course of the current, increasing its intensity, and concentrating its energy on the open spaces between the grounded bergs of ice. To this cause is to be attri
the "shifting of the channel" through sand b
which the ice rests: but, notwithstanding the desc
those immense quantities of ice which "pack"
"ground" so as to alter the current during winter below Montreal, it is satisfactory to know that no difficulty is to be apprehended from such action of the ice in Lake St. Peter. The winter level of the Lake is raised six feet and upwards, before it freezes over, by the accumulation of ice and the consequent obstruction made to the discharge of the River below the Lake. The ice forms of even thickness, and as the depth near the channel is seldom less than eighteen or twenty feet the winter current is consequently weaker than the summer one. The dredged channel through the Lake occupies nearly a central position, both with respect to length and breadth; it is therefore too far removed from the mouths of the lateral rivers flowing into the Lake to receive their detritus; and as regards any deposits from so clear a stream as the St. Lawrence, these could only reach the excavated channel by the aid of such a current as would carry them on through the Lake.

The oldest known charts shew that little change has taken place in Lake St. Peter, and from more than half a century's experience we may come to the conclusion that the maintenance of the artificial channel now in

progress is not seriously threatened by the action of any natural causes. An examination of the old dredging done by the Board of Works in 1844, '45, '46, and '47, after a lapse of seven to ten years, shews that the ridges left between the "trench cuttings" are still well defined,—and no perceptible change either for better or worse is to be discovered in this part of the Lake.

STRAIGHT AND NATURAL CHANNELS.

With respect to the question of the route for an artificial channel through Lake St. Peter, that may now be considered as settled; and, as there is now a navigable channel, two hundred and fifty and three hundred feet wide with sixteen and a-half feet depth at low water, over the flats, where there was formerly only eleven feet, the propriety of the route adopted by the Harbour Commissioners need not be vindicated. The recent determination, however, in favor of a twenty feet navigation, instead of one of sixteen feet, (which was the maximum where the question of the "straight" and "natural" routes was discussed,) may fairly be claimed as one of the most important results of the decision in favor of the "old channel." To explain this it is necessary to refer to the history of the operations in the Lake.

It will be remembered that in 1844 the Government commenced to dredge a straight channel about ten miles in length, from a point below Stone Island, (at the head of the Lake,) to the head of the lower pool heretofore described. This would have avoided both the Upper Bar and the Flats, and have shortened the route through the Lake nearly one mile. After working until September, 1847, when £73,955 had been expended for outfit and operations, in removing what now appears to have been less than 350,000 cubic yards, measured in excavation, the scheme was abandoned. In 1850, the two dredges were transferred to the Harbour Commissioners of Montreal, who commenced operations in the following year, in the "old," or "natural" channel, and up to 1st January, 1855, have dredged 1,818,110 cubic yards, mea-

sured in the scows, (or 1,298,650 cubic yards, measured in the cut,) and removed by harrow 85,436 cubic yards, at a total cost of £74,000 for operations and outfit,—in which is included a sum of £[illegible]5,000, as the value of the two dredges obtained from the Board of Works.

In the one case, four years of time and nearly £74,000 in money were expended without any practical result,—the straight channel remaining now as when abandoned; in the other, each successive season since the commencement has increased the draught and tonnage of sea-going vessels arriving at Montreal. This difference in result is owing chiefly to better management, and to a superior system of dredging established by Captain Bell, Superintendent to the Harbour Commissioners; and in some measure to the adoption of the old channel, where by taking advantage of the existing pools of deep water a less length of dredging is required, and therefore an additional depth to the channel is sooner given.

Although the "straight channel" would have shortened the route through the Lake, yet as it was wholly an artificial one there was a greater amount of work to be done in it. Captain Bayfield, in 1846, estimated the dredging in the straight channel, for a depth of only fourteen feet at low water, 260,000 cubic yards more than that required to produce the same result in the old channel. In extending the work, however, to a depth of twenty feet, the economy of the old channel is much more apparent. The number of cubic yards to be removed, in order to give three hundred feet in width with twenty feet water in the "straight" channel, is no less than 1,180,000 *more* than is required to produce the same result in the "old" channel;—which, at 7½d. per cubic yard, (or one-half of Captain Bayfield's estimate,) makes a difference of £36,875 in favor of the route chosen by the Harbour Commissioners.

ANNUAL PROGRESS IN LAKE ST. PETER.

The Harbour Commissioners commenced operations on the 12th June, 1851, with one dredge and the harrow, and

on the 3rd of November, in same year, a channel seventy-five feet wide, two feet deep, and four miles in length, was cut through the highest part of the flats. On the 8th of November the ship "City of Manchester" was loaded down to *fourteen* feet—the depth on the Flats then being *twelve* feet—and taken through the lake without slacking speed. Thus, in less than five months, *two feet* were added to the draught of sea-going vessels trading with Montreal. In the spring of 1852 the harrow was employed during high water, in May and June, upon the Upper Bar, the depth upon which was thereby increased about three feet, leaving a channel one hundred and fifty feet wide and fifteen feet deep at low water—or four feet deeper than the flats. Two dredges worked on the flats from the latter part of May until the 16th of November, by which time they had widened the channel (from seventy-five) to one hundred and fifty feet, and deepened it (from two) to four feet. The length of the channel of 1851 was also increased (from four miles) to five and a half miles,—this additional length of dredging being required in consequence of the increased depth. Thus at the close of the second season, or in less than eleven months of actual work, a channel of one hundred and fifty feet in width and four feet of additional depth was cut through the "Flats" and the Upper Bar, at a cost of £47,250 for operations and outfit, (in which £10,000 is allowed for the dredges;) or, in other words, a channel of the same width and one foot greater depth, than that which the Government had failed to secure in the new route with a far greater expenditure of time and money. The Harbour Commissioners were notified, in November, 1852, by the Superintendent that he was then prepared to take a vessel through the Lake, drawing four feet more water than any which had hitherto left Montreal at that season of the year. Throughout the season of 1852 the sea-going vessels made use of the new channel, and many of them were loaded down two feet deeper than the water on the flats.

A vessel of sufficient capacity could not be obtained (at that late season of the year,) to test the capacity of the channel in November, 1852, but this was done on the 24th of August, 1853, by the Barque "California," which was loaded down to sixteen feet two inches, when there was only twelve feet on the flats, and taken from Montreal through the Lake without delay or difficulty.

At the close of the season of 1853 the channel of 1852 was deepened, throughout, one foot six inches, giving sixteen and a-half feet at low water; and a part of it was widened (from one hundred and fifty feet) to two hundred and fifty, and three hundred feet.

The operations of 1854 in the Lake have been confined to widening the channel, and there is now, with the exception of about ten days work, a channel through the Flats two hundred and fifty to three hundred feet wide, and having in it sixteen and a-half feet at low water. This has been effected at a total cost of £74,000, including £10,000 as the value of the two dredges obtained from Board of Works. Thus, within the same period of time, and for the same sum of money as has been expended on an ineffectual attempt to obtain a channel *one hundred and fifty* feet wide, with *fourteen* feet water on the straight line, one of *two hundred and fifty* and three hundred feet in width, with *sixteen and a-half* feet at low water, has been given through the Flats, and one of one hundred and fifty feet in width, with fifteen feet water through the Upper Bar.

OBSTRUCTIONS ABOVE AND BELOW LAKE ST. PETER.

No subsequent testing of the channel, to that by the "California" in 1853, has since been made, for the following reasons:

About thirty miles below Montreal, between Lavaltrie Island and Isle Platte, a broad shoal stretches across the River, consisting of blue clay covered with gravel and boulders. The original depth over this shoal, on the line of the channel, was the same as on the flats of Lake St. Peter, viz: eleven feet at low water.

While the dredges obtained from the Board of Works were employed in the Lake, the Harbour dredge was brought down from Montreal, in 1851, and on the 18th August, 1852, she had cut a channel through this shoal two hundred and fifty feet wide, and four feet deep. This dredge was then removed to a small bar opposite Isle du Lorier, or St. Laurent, (a little below Varennes,) which she redueed to the same depth, in that year. When the "California" was taken down, drawing four feet more water than usual, it was found that she "touched" at Pointe aux Trembles, Varennes, Isle à la Bague, Ste. Sulpiee, and Lavaltrie Island, although the Pilots maintained that she followed the deepest channel in the River. Before any additional advantage, therefore, could be gained for the trade by increasing the depth in Lake St. Peter and at Isle Platte, it became necessary to ascertain the nature and extent of *all* the obstruetions between these points and Montreal; and, partieularly, whether the channel known to the Pilots, and defined by the River lights and beacons, was really the best that could be obtained.

It will be apparent, that so long as the flats of Lake St. Peter were the guage of the draught of vessels ascending the St. Lawrence between Quebec and Montreal, no vessel drawing *more* than eleven feet at low water had ever navigated the River above the Lake. The channel known to the Pilots, therefore, had never been tested for any inereased draught, and as soon as this was done, (in consequenee of the deepening in the Lake,) the Pilots' channel became obsolete,—beeause their aetual experienee of the River did not extend to a draught greater than eleven feet at low water.

On the sixth of September, 1853, I was requested to report the best means of dealing with the obstruetions revealed by the "California" on her passage outward, in the preceding month; and, in reply, reeommended an examination of the River, for the purpose of comparing the existing channel with others indicated on Bayfield's

Charts, and of ascertaining *what scale of navigation was within the reach of the Commission*, in case that, from the success of previous operations in the Lake, it might prove desirable to continue these to a greater depth than originally proposed. This recommendation was adopted, and immediate steps were taken for carrying it out, so that the examination was completed, and on the 25th of October I reported the result.

It was found that between Varennes and Lavaltrie Island, and between Cap Madeleine, (below Three Rivers,) and Isle Bigot, the route lighted and marked by the Pilots did not afford more than sixteen feet at low water, and was not in the main channel—or the deepest part of the St. Lawrence.

The obstructions at Pointe aux Trembles were found to be clay, and of trifling extent; but, from Varennes to Lavaltrie, the north channel at present navigated is studded with numerous "*pouls*" caused by loose rocks or boulders, having narrow channels with sharp turns between them, and exposed to cross current of the Ottawa, the greater part of the waters of which flow over into the south channel, and pass by Verchères. The channel south of the Verchères Islands was then examined, and found to have a depth of thirty to sixty feet, with the exception of one point opposite Cap St. Michel, where this channel appears to have been partly closed up by a land slide, which, together with the fact that the north channel has had hitherto sufficient water for any vessel which could pass Lake St. Peter, account for its disuse. The bank at Cap St. Michel was bored, and found to be clay, much more easily removed than the "*pouls*" of the north channel. In every respect the south channel is superior to the north one; its greater depth giving less current, and its bold shore and high banks making it more easy of navigation at night or in a fog.

Below Three Rivers the south channel, in front of Becancour, gives a depth of thirty to forty feet, without any obstructions requiring more than lights, buoys, and

beacons. By adopting this channel, the shifting sand bar known as the "Provenché Shoal" will be avoided. This is of great importance, as this sand bar appears to have been formed by the River St. Maurice, and is still acted upon by it, making it doubtful whether a channel could be maintained, for a greater depth than heretofore used, without continual dredging. That the present ship channel over the shoal is not the channel of the St. Lawrence is evident from the fact that the dark waters of the St. Maurice are found in it unmixed with the blue water which flows by Becancour.

The only place below this where twenty feet draught can not be used at all times of tide is at Pointe à Levraut, (opposite Ste. Anne,) where the bar of blue clay before alluded to is found—insignificant in extent and over which vessels can always pass, drawing twenty feet, by waiting for the tide.

MODE OF DREDGING.

On comparing the operations and expenditure of the Board of Works in the four seasons from 1844 to 1847 inclusive, with those of the Harbour Commissioners in the four seasons from 1851 to 1854, we cannot fail to be struck with the difference in the cost of dredging per cubic yard, as much as with the immediate and beneficial results to the trade, arising from the later management. While much is no doubt to be ascribed to the selection of the old channel by the Harbour Commissioners, it cannot be doubted that the system of dredging established by Captain Bell, had it been applied to the straight route, would have resulted in opening that channel to the trade long before the period at which it was abandoned by the Board of Works.

The importance of this system, as well as its bearing on future operations, is such as to call for a description of its advantages;—while the fact that a greater amount of work has been done and a greater result produced in less time and at less cost by the Harbour Commis-

sioners, under Capt. Bell's system and superintendence, than in any other dredging operations heretofore undertaken—makes it a subject of the highest interest to the profession, as well as to corporations or other public bodies or departments requiring a large amount of dredging to be done.

Under the old system the dredge was moored to its work by two chains laid out forward in the direction of the channel to be excavated. In going ahead a ditch was cut the width of the buckets, (and of a depth proportional to the hardness of the material,) as far as the length of the chains would permit; the buckets were then lifted, and the dredge dropped back to the place of beginning, when the process was repeated by cutting a similar and parallel trench until the proposed width of channel was attained. Between these parallel trenches a ridge from one to two feet in width was left,—it being impossible to cut these trenches without leaving a ridge to sustain the "tumbler," which otherwise would have carried the buckets out of cutting into water, bringing them up empty. After the channel had thus been "grooved" or "fluted" by the "trench cutting" system, the removal of the intermediate ridges was commenced. To steady the buckets upon the narrow space guys were employed, and in working ahead to feed the buckets the direction of these guys was necessarily altered whereby the dredge immediately lost her hold of the bottom. The bucket frame was then lifted, the vessel again steadied upon another ridge, and, after all, the bottom instead of being uniform in depth was left like the teeth of a saw. When it is remembered that these operations were carried on in a wide lake exposed to wind and sea, with a current of about one mile per hour, the great loss of time in raising and lowering the buckets, in "dropping back," "guying out," and "steadying" over the ridges, the cost of fuel, wages and provisions during this loss of time, —the cost of these items for each dredge with her tender being about £30 per diem,—and the utter impossibility

of doing anything like true work under such circumstances—will be appreciated; nor can we resist the conclusion that, under such a system, with any appropriation which Parliament would sanction, failure was inevitable where a channel ten miles in length and three hundred feet in width, with sixteen feet at low water, was attempted.

When making the Survey of the Lake upon the ice, in March, 1854, I caused to be measured and sounded the channel excavated by the Board of Works, taking cross sections at every five hundred feet. I annex a cross section of the bottom in this channel, taken in January of this year, and also one (taken at the same time) of the channel dredged by Captain Bell, by which the difference in execution of the two systems is strikingly illustrated. The condition of the Board of Works channel, after the lapse of seven years, is satisfactory so far as it indicates that little change has taken place, judging from the clearness with which the ridges are still defined, although from the great discrepancy in the measurement of the excavation done, as made in 1854 upon the ice, compared with the returns made after the suspension of the works in 1847 and 1848, would go to shew either a large error in one of the measurements, or an extensive "silting up" in this channel. I cannot learn that any measurement was made, on the suspension of this work, in the manner since done by me, but have understood that the quantities supposed to have been removed were arrived at by calculations as to the contents of the buckets, scows, and the "average work" of the dredges.

I find the quantity removed in the Board of Works channel to be 332,044 cubic yards, instead of 734,945 cubic yards, which is the sum of the two returns in the Reports of the Commissioners of Public Works in 1847 and 1848. The difference may in some measure be accounted for by the assumed length of dredging, as determined by the buoys and a nautical survey, proving considerably more than the actual length as measured on the ice. I found that the distance across the Flats,

between known points in the old channel, measured half a mile less (in a distance of six and a-half miles) on the ice than on the charts. A similar miscalculation may have been made in estimating the Board of Works channel; but this would only account for a portion of the discrepancy. If we deduct the whole of the outfit (making no charge for depreciation,) it would still appear that about £33,500 were expended "in operations" in the new channel. Taking the present measurement of 332,044 cubic yards, and setting off any work done in piling groins, &c., against the depreciation of outfit, the actual cost of that dredging, measured in the cut, cannot be set down at less than two shillings currency per cubic yard.

To have secured a channel on the "straight line," of the same dimensions and with the same water as that which has now been made by the Harbour Commissioners on the old route, would have required the removal of 1,750,000 cubic yards, in addition to the 332,044 removed, which at the same rate of cost (two shillings per cubic yard) would have amounted to £175,000, making the total cost of the new or straight channel £249,000 against £74,000, the actual cost including outfit, of an equally efficient channel upon the old route.

But, inasmuch as the amount of excavation in the new channel would exceed that required in the old, (for the three hundred feet in width, and sixteen and a-half feet in depth of water,) by about 750,000 cubic yards—if the cost of this amount be deducted, the figures would stand £174,000 against £74,000, as the cost of an equal amount of work in the two channels. If, as appears from present measurements, 2s. per c. yard was the actual cost in the straight channel, the difference of £100,000 is the measure of the amount of economy in favor of the improved system of dredging adopted in the old channel, which system I now proceed to describe.

The system employed by Captain Bell, on assuming the charge of operations in the Lake, is that known as "radius cutting," as distinguished from the ordinary or "trench

cutting" method. The dredge is moored on chains leading from the bow and stern in the direction of the channel, and also by four chains at right angles to the channel, one out from each quarter of the vessel. In this position, she may be compared to a *turtle*, chained by the head, tail, and the four legs, and floating over the channel to be cut. Instead of cutting a continuous trench, by hauling ahead on the bow chain, the buckets take a feed of two or three feet, after which this chain remains taught, and the dredge is breasted over, by means of the side chains, broadside on, from one side of the channel to the other, the buckets crossing the whole width of a channel of 150 feet, and leaving the bottom true and even. When the opposite side of the channel is reached she is heaved forward for another feed, and recrosses the channel in the same manner, cutting from left to right and from right to left alternately. Her bucket frame, sweeping across the channel, acts as a huge plane with revolving cutters; thus, from the very nature of the system, there is a guarantee that when she has once gone over the ground no obstruction above the level to which the buckets were lowered *can* have been left behind. The four side winches are worked by the engine. The adaptation of the old Board of Works dredges to this mode of working is due to Captain Bell, and to this arrangement chiefly I attribute the great advance made in dredging. I am not aware of any similarly efficient gearing in use elsewhere.

In the "trench cutting" method, it is necessary to heave ahead on the bow chain in order to feed the buckets while the latter are cutting. This strain is avoided in the "radius cutting" plan, where the bow chain is only wound up when the dredge has crossed the channel, and remains of the same length while the buckets are cutting. Again, the irregularity of the working of the buckets, when removing the ridges in the trench cutting system, was productive of greater wear and tear on the machinery than occur in the improved method where they are constantly in full work.

COST OF DREDGING.

In order to estimate the cost of the dredging, accurate surveys were made on the ice early in 1854, and soundings were taken at Pointe aux Trembles, Cap St. Michel, and Lavaltrie, as well as in Lake St. Peter, by which the quantities to be removed for successive draughts of water have been calculated; the estimate is appended to this Report.

I have analysed the cost of dredging in Lake St. Peter, from which it will be seen that the cost per cubic yard, *measured in the scows*, for raising and depositing at the distance of half a mile, is under five pence. This price excludes the cost of outfit, which for work already done has amounted to £18,000. The cost of new outfit for the 20 feet draught will amount to about £19,000. As this machinery is available for many years work it is only the depreciation which is needed to shew the whole cost of dredging. If, however, we assumed that the present outfit, (the charge for repairs being embraced in the above annual cost of dredging,) will be annihilated on the completion of the work, that is when about 6,000,000 cubic yards, measured in the scows, has been dredged, the charge per cubic yard, on account of this outfit, would be under three half pence per cubic yard. As, however, one of the dredges embraced in the above calculation is perfectly new and has not yet commenced work, and both the others are being lengthened and strengthened, there is every reason to believe that the dredging fleet, on the completion of the channel three years hence, will be in a thoroughly efficient state. I consi , therefore, that an allowance of *one penny per cubic yard* will be at least a sufficient charge for the depreciation of the outfit, which, added to the average of 4½d., makes the total cost of dredging 5½d. per cubic yard, measured in the scow. If an allowance of forty per cent. be made for the difference between the measurement in the scows and that in the cutting, which

allowance I find to be ample, the highest cost of raising and depositing (at a distance of half a mile) a cubic yard of solid excavation will be about 7¾d.,—a price lower than the same work could be done, under the most favorable circumstances, upon dry land, and far below the cost of dredging, and depositing under such circumstances on any work known to me. No account has been taken of the interest on loans for carrying on the work, which interest is paid out of revenue;—an addition of three half-pence per cubic yard, upon the quantities already dredged, covers this item,—making the whole cost 9¼d. per c. yard measured in excavation.

It must be admitted that the material is as favorable for dredging as it possibly could be, and the one circumstance most conducive to economy is that the buckets are always in full work. On the other hand, the working season is short—the price of coal is high, and there has been much detention from wind and high water. In order to show the actual working time and the delays from every source, I have prepared tables taken from the Superintendent's books which shew the extent of daily interruption and explain the cause of it.

The investigation and analyses exhibited in the tables are presented for the purpose of sustaining the estimate I have made of the probable cost of completing the channel through the Lake. The principal item which influences the cost, and in which any important fluctuation may be expected, is the price of coals. In this, as well as the items of labor, provisions, &c., I have provided for the extreme high rates of 1854, which are not likely to be exceeded, and from which some diminution may reasonably be expected. It will be seen that the actual cost of dredging in 1854 was four pence half-penny per cubic yard measured in the scows, and as the quantity remaining to be removed is measured "in excavation" and not "in spoil," I assume seven pence half-penny

per cubic yard as a fair estimate of the probable cost, exclusive of interest, depreciation, or outfit.

In January and February, 1854, I measured "in excavation" the whole amount of dredging done by Captain Bell, and found it to amount to 815,000 cubic yards, at a total cost of £22,000, or about six pence half-penny per cubic yard, exclusive of outfit, interest, or depreciation. The return by scows up to this time was as follows:

In 1851	from 10th July	to 14th November,	1	dredge	filled	1124½	scows,
1852	" 22rd May	to 16th "	2	"	"	7159	"
1853	" 21st May	to 23rd "	2	"	"	7943	"

giving a total of 16,226½ scows, at seventy cubic yards per scow, equal to 1,135,855 cubic yards.

The return by scows of 1,135,855 cubic yards, as corresponding with the measurement of 815,000 cubic yards of solid contents, missing from the channel, shews that the excess of the measurement "in spoil" is forty per cent., or that fifty yards "in excavation" will measure seventy yards in the scows.

The number of scows filled in 1854 was 9663, equal to 676,410 cubic yards, making the total quantity dredged to close of 1854, 1,812,265 cubic yards measured in scows, or 1,294,475 cubic yards measured in excavation, and if to this be added 85,436, the amount removed by harrow, we have a total of 1,379,911 cubic yards, measured in excavation, removed for an outlay of £74,000 (including the full value of outfit,) or nearly thirteen pence per cubic yard. The cost exclusive of outfit is £42,300, or about seven pence per cubic yard.

A similar measurement and calculation, applied to the straighter Board of Works channel, shew the present result of the operations there to have been attained at a cost per cubic yard, *four times greater* than that in the old.

In the four full months of 1854, July, August, September and October, the two dredges averaged twenty-five working days each month, and filled 7,523 scows, (raising together seventy-five scow loads daily,) which at

seventy cubic yards per scow, gives 526,610 cubic yards in one hundred days, or 5266 cubic yards per diem. In 1846 the daily work of these same dredges in the "straight" channel was reported as "most satisfactory," when removing on the average 2321 cubic yards per diem. In the last year of operations in the straight channel the work of the dredges was considerably improved, and they were reported as averaging together forty-four scow loads, or about 3000 cubic yards, daily.

In order to show the remarkable superiority of the foregoing performanee of dredges working on the radius cutting principle, I give some data of the ordinary method furnished by a friend in Plymouth, England:

"A forty-horse-power dredge at Holyhead, (with a "double set of buckets,) working in thirty-five feet of "water, raised one hundred and ten tons in forty minutes. "A Government dredge of thirty-horse-power, now work-"ing here, is said to raise ninety tons of mud per hour, "—depth of water from four to twenty feet. This ma-"chine was built at Southampton.

"Another, belonging to a contractor, has been "working here for three years; it is called a thirty-"horse-power (cylinder two feet six inches, stroke three "feet 6 inches,) and has raised sixty tons of mud per "hour, but its average work in that material, during three "hours, has been only 2000 tons per week.

"One of the Clyde dredges (sixteen-horse-power, cost "£2800,) raised in twelve hours, 160 tons of hard clay.

180 " of gravel.
230 " of sand.
250 " of mud.
300 " of soft clay.

"It consumed in twelve hours one ton of coal, or eleven "and three-quarters pounds per horse-power per hour. "Twelve men worked the machine; fourteen the punts.

"A twenty-horse-power dredge, built at Newcastle, "raised 2000 tons of mud per week, at a cost of six "pence per ton, (unloading included.)"

The Holyhead *double* dredge raised at the rate of one hundred and sixty-five tons per hour. The Clyde single dredge raised at the rate of twenty-five tons per hour. The other performances are under one hundred tons per hour. These may be considered the best work of the dredges quoted. The new forty-horse-power double machine, started in the Clyde in 1851, has raised for the last year 106,848 cubic yards in 1822 hours working time—less than sixty yards, or about one hundred tons per hour.

The ordinary work of the dredges in Lake St. Peter is to raise two hundred and eighty-nine tons per hour, estimating the material dredged to weigh one hundred and twenty pounds per cubic foot, while the best work of these single dredges has been to raise four hundred tons per hour for the whole day: that is, they have filled fifty-six scows in ten hours, each scow containing seventy yards in spoil, or fifty of the solid deposit.

I have also prepared a statement shewing the number of vessels, their dimensions and crews, from which the magnitude of the operations may be estimated; and for the purpose of comparison, I give some statistics of dredging in the Clyde, where the largest operations of this kind have been carried on. From these it will be seen that a greater amount of work has been done in one year at a much less cost in Lake St. Peter than has been done in any one year in the Clyde, or elsewhere.

A table showing the fluctuations in the depth of water on the Flats of Lake St. Peter, for the last four years, is appended, for the purpose of showing the dates and duration of the period of low water.

SURVEY AND ESTIMATE.

I have already explained the more important objects of the exploration of the different channels, obstructions, &c., above and below Lake St. Peter, made in September and October, 1853, and the subsequent winter survey, on the ice, in the Lake and at points above it; but in vindication of the expenditure for such a step, I will here allude more fully to it.

When I assumed the office of Engineer to the Commission, we were in possession of no other information with regard to our operations in the Lake than was to be obtained from Bayfield's Charts, and the annual Reports of the Superintendent. In consequence probably of the failure of previous operations in the straight channel, there was some doubt thrown on the statements made as to the depth and width of the channel already dredged on the old route, and although I had satisfied myself of the correctness of the Superintendent's Reports, yet, as the work extended over many miles of surface,—was all under water and not easily tested without considerable time and labor,—I considered it indispensable that there should be placed on record a chart shewing *the exact position* of the work done, as well as its extent. Moreover, without such a chart, none of the future changes which might arise out of our operations, could be traced and estimated; nor without an actual measurement of the excavation, as determined by the dimensions of the channel, could we establish the ratio of the measurement as computed from the number of scows filled, or ascertain the actual cost of the work done, so as to refer it to a standard by which the value of the work remaining to be done could be estimated. Thus, it is clear that the work remaining to be done must be measured "in excavation," while that already done, had been measured in the scows; and as every hundred yards measured in the bottom makes about one hundred and forty yards when measured in the scows, forty per cent. must be added to the price per cubic yard of that already dredged, (when measured in the scows) in order to obtain the value of that remaining to be dredged. In all preceding measurements and reports referring to Lake St. Peter, I cannot find that this obvious distinction between the two modes of measurement has been taken into consideration, and this single circumstance alone may account for many of the discrepancies in the returns, and failures in the estimates for the straight or Board of Works channel.

Lastly, it was highly important, before the full width or depth was given to the proposed channel, to ascertain whether it was uniform in depth and width, and straight in its direction, in order that any necessary trimming or widening could be taken wholly off of one side, or both, as would prove requisite; and most especially was it desirable that the direction of this new channel should be accurately ascertained *with reference to the deep pools* with which it communicated. The boundaries of these pools had hitherto been loosely defined by the few soundings to be found in Bayfield's Charts, but for the purposes of a work of this magnitude it was important that their contour should be fully developed, which has now been done in the most accurate manner by surveys and soundings on the ice; and the result shews the correctness of the alignment of the dredged channel with reference to deep water above and below it.

The charts of the shoals at Pointe aux Trembles, Cap St. Michel and Lavaltrie, with the measurements and soundings made on the ice, shew the nature and extent of the dredging required. From the strength of the current at these places this result could not have been arrived at as certainly or as economically by means of boats.

The large chart of the St. Lawrence between Montreal and Quebec has been prepared for the purpose of enabling the public to see at a glance the general capacity of the channel, and to shew that the attainment of a draught of twenty feet at low water is as practicable as it is desirable.

From the estimate annexed it will be seen that the cost of a channel three hundred feet wide, through all the obstructions met with between Montreal and Quebec, is estimated as follows:

For a depth of	18 feet	at low water,	£41,743	5	1
Additional for	19 feet	" "	21,907	19	0
" "	20 feet	" "	25,009	5	3
Total,			£88,660	9	4

Or say £90,000, including the bar at Pointe à Levraut, &c., and adding expenditure already made by the Commission, (including £19,000 for new outfit for the twenty feet line,) at £93,000, we have a total of £183,000 as the cost of adding *nine* feet to the draught of vessels coming to Montreal. Of this expenditure £40,000 is for outfit, which will be in good order on the completion of the work.

However large these figures may appear the sum in my judgment bears no proportion to the magnitude of the object to be attained.

CLYDE NAVIGATION.

As the best introduction to the commercial bearing of the deepening of the channel of the St. Lawrence between Montreal and Quebec, I give a short statement of what has been done in the Clyde.

One hundred years since, vessels drawing three feet three inches to three feet six inches only, could ascend the Clyde to Glasgow. In 1773 certain improvements were commenced, for the purpose of assisting the action of the tide, and, in 1806, vessels drawing eight feet six inches could ascend to Glasgow. In 1824, when the first steam dredge (No. 1*) commenced work, the depth had been increased to eleven feet. The second dredge was started in 1826, a third in 1830, a fourth in 1836, a fifth in 1841; and, in 1850, a depth of seventeen and a-half feet at neap tides had been gained. The value of the working machinery for the improvement of the Clyde was estimated at £39,000 sterling, in 1845, since when an additional sum of about £18,000 has been expended in new plant. The total expenditure for the River and Harbour, by the Clyde Trustees, within the last hundred years, has been about £2,000,000 sterling.

In deepening the Clyde about 6,000,000 cubic yards, have been removed, 2,000,000 of which were previous to

* In 1851 a new double dredge of forty-horse-power was substituted for No. 1.

the commencement of the dredges in 1824, chiefly by the scour of the tide, aided by dykes and jetties. Of the remaining 4,000,000, about 3,500,000 have been removed since 1840, at an average cost of about thirteen pence sterling per cubic yard. The annual expenditure for dredging, since 1840, averages about £15,000 sterling—the sum of £212,537 sterling having been expended for this purpose since that date.

The depth secured is twelve feet at low and eighteen feet at high water, and the width of the excavated channel in the narrowest parts is less than one hundred feet. To preserve this depth an annual dredging of 160,000 to 180,000 cubic yards, and an outlay of about £8000 stg. per annum, for dredging and repairs, are required on a river eighteen miles in length. A single bank near Bowling accumulates so rapidly that it has cost £1200 a-year to keep it down. The cuts through the several banks are three hundred feet wide—the same width as proposed in Lake St. Peter. The "plant" consists of five dredges, aggregate power one hundred and sixteen horses, one eighty horse-power tug (iron,) two hundred and sixty-two punts, forty boats, a diving bell, and thirty-four buoys with screw moorings.

The financial and legislative history of the Clyde navigation is not less interesting.

In 1758 the first Act was obtained for improving the River upon Smeaton's plan. A lock was to be built, with a dam across the channel at Marlinford (four miles below Glasgow,) by means of which four and a-half feet depth of water was to be secured upward to the Harbour. Fortunately this plan was not carried out, and in 1768 Mr. Golborne recommended the plan of jetties, &c., to assist the action of the tide. In 1770 an Act was got to deepen the whole stretch of the river, from Dumbarton up to Glasgow, to a depth of seven feet at neap tides. Powers were given in this Act *to levy dues upon shipping* to be applied towards improving the River, and in the same year a revenue of £147 sterling was drawn. In 1771 the revenue, amounted to £1071 sterling.

In 1809 an Act was got to deepen to nine feet at neap tides, and *to borrow* £30,000 *on the credit of the trust.* Previous to this the monies necessary to carry on the work had been advanced by the Town of Glasgow, but at this time had all been repaid out of the trust revenues. In 1824, when the first steam dredging machine was set at work, the River had been deepened to eleven and a half feet, the revenues had reached £8500, the size of the ships was increasing, and Glasgow owned one hundred and eleven vessels, amounting to 14,000 tons. In 1825 a fourth Act was got for deepening to thirteen feet at neap tides, and in fifteen years therefrom vessels of three hundred and four hundred tons, drawing twelve and thirteen feet water, were numerous in the Harbour, although they could not pass the River in neap tides. The number of vessels had increased three-fold, their tonnage five-fold, and the revenues had increased five fold, amounting to upwards of £40,000 per annum. In 1840, therefore, an Act was obtained defining bold lines of River and Harbour improvement, and for deepening to seventeen feet at neap tides.

In 1846 an Act was obtained for increased Harbour accommodation; the number of vessels belonging to the Port then amounted to 512, and their tonnage to 134,603 tons. The trust revenues had risen to £51,198 sterling; the total amount drawn since 1770 being £906,554 sterling, and the total expenditure £1,253,951 sterling.

In 1850 the revenues amounted to £64,000 sterling. The customs of the Port of Glasgow have risen from £3000, in 1811, to £640,000 in 1850.

It has been remarked, that under the first Act obtained for the improvement of the Clyde, (that is, for the construction of the lock and dam upon Smeaton's plan,) no dues were to be levied until after the works were completed, thus requiring a heavy outlay of capital before any return could be made—conditions which placed the work in a position similar to that held by our railways. The second Act, however, which authorized the levying of dues on ship-

ping, created an immediate fund, and the primary cause of the *financial* success of the Clyde improvements is ascribed to the system of removing ford after ford, and gradually deepening the channel as the revenues increased.

The revenues of the Clyde Trust for the year ending 1st July, 1854, were:

From Tonnage dues,	£50,772	4	3		
" Quay "	11,582	1	4		
" Shed "	8,798	0	6		
" Crane "	923	11	2		
" Weighing "	1,943	10	11		
				£74,019	8 2
And from miscellaneous sources,.....				12,560	17 9
Making a total of.....				£86,580	5 11

The progressive gross revenues since 1850 have been:

In 1850,.....	£64,243
" 1851,.....	68,875
" 1852,.....	76,077
" 1853,.....	77,919
" 1854,.....	86,580

The gross receipts since 1842 have been £774,703; the expenditure in the same period has been £1,422,438 of which the following are items:

Interest on loans,.....	£270,823
Land for enlargement of Harbour,	349,685
" " widening of River,....	100,798
Construction of works in Harbour,	222,517
" " " " River,...	33,895
Dredging in River and Harbour,.	126,012

The debt has increased from £219,119, in 1842, to £811,480, in 1854, the interest on which is £29,742. The surplus revenue of

1851 was,.....	£17,574
1852 "	19,065
1853 "	19,899
1854 "	21,623

I have quoted at this length from the history of the Clyde improvement, because there is a manifest analogy in the position and action of Glasgow and Montreal. Mr. Walker, C. E., reporting to the Clyde Trustees in 1852, says: "Mr. Ormiston states that 'many of the Glasgow outward-bound ships load at Glasgow to about 15 feet 6 inches, and either call at Greenock, or anchor at the Tail of the Bank, where they load up to about 18 feet; seldom, if ever, above 19 feet.'"

That "the lighter ships have, (with the exception of the very largest,) nearly all left Greenock and Port Glasgow, and have come up to Glasgow," and "that, although Greenock has fewer vessels, the tonnage of these is greater. Vessels drawing 22 feet are common enough, and 2 feet more is not extraordinary." "This," he observes, "shows that all vessels come up to Glasgow, which possibly can, and the larger ones might reasonably be expected to follow, if encouragement were given them, as Greenock and Port Glasgow are, after all, only the deep sea port of Glasgow."

IMPORTANCE OF THE WORK.

It may be argued that there is little comparison between the population and commerce of Montreal and Glasgow; and it may be doubted whether the Clyde improvements have made Glasgow, or Glasgow the commerce of the Clyde; yet it is evident that the one cannot now exist without the other, and also that Montreal is in a much better position than Glasgow was when the Clyde improvements were commenced. In the trade of the St. Lawrence and its great Lakes, we have a future most promising, and a commerce within our own reach, which must be as far before that of the Clyde as the area of the valley of the one River exceeds that of the other.

The commerce of the Lakes *west of Buffalo* is now estimated at $200,000,000, of the Mississippi $150,000,000, and the steam commerce of the Ohio at $80,000,000. The Mississippi and Ohio are connected with the Lakes

by canals and numerous railways, made and making, the yearly tendency of which is to draw up commerce from the lower Mississippi to the St. Lawrence, giving this commerce an outlet to the Atlantic States, and the seaboard, viâ Buffalo, Oswego and Ogdensburgh, in preference to the natural route viâ New Orleans. Moreover the propeller is rapidly taking the place of the sailing vessel, and (the St. Lawrence being now open to American trade) the day cannot be far distant when Montreal will become an entrepôt, during the season of navigation, for that trade which is rapidly overgrowing the capacity of the enlarged Erie Canal, and of all the railways which debouche on the Atlantic—from Portland to the Capes of Virginia. The lake propeller will then meet the ocean screw steamer at the head of ship navigation on the St. Lawrence—wherever that may be. This point must either be Quebec or Montreal, and it may be supposed that it is a matter of indifference to the Province at large which becomes the favoured locality, and that therefore the deepening of the St. Lawrence between these two cities is a local or Montreal question. This consideration appears to have influenced the Legislature, in 1847, in abandoning the Provincial attempt to deepen Lake St. Peter. The subsequent granting, however, of powers to levy dues *upon the trade of the St. Lawrence* for this purpose was an acknowledgement of the Provincial importance of the work, and it may not be out of place here to endeavour to show how Canada is interested in extending her deep seaport one hundred and fifty miles further into the interior. This involves the consideration of the problem, "where can the sea and inland trade of the St. Lawrence most economically meet? whether should the lake propeller (the smaller craft) descend to the lowest possible point, to meet the Atlantic ship, or whether the latter (the larger vessel) should ascend to the highest possible point?

If we were considering only the *through* traffic, it would become simply a question whether three or four

lake craft could make the additional voyage from Montreal to Quebec cheaper and quicker than one ocean vessel could ascend the additional distanee between Quebec and Montreal; and, *the relative facilities for transhipment at the two ports.* But praetically the oeean vessel may wish to diseharge part of her cargo at Quebec, and a still greater portion for loeal consumption or distribution by railways at Montreal, the remainder only being in transitu for more western ports. If it be assumed that the delivery to the railways could be done at Point Levi instead of Montreal, there would be only the Montreal goods subjeeted to an extra transhipment, and the additional cost of railway,—over water borne—transport between Quebec and Montreal on the railway delivery.

There are, however, two loeal considerations which affeet the general question, which are of mueh importance and, in my judgment, conelusive as to the superior advantages under whieh the Provineial import trade can be carried on through Montreal as compared with Quebec; and where the imports are landed, the exports can be most advantageously shipped, exeepting, of course, the timber trade and its peculiar requirements.

The oeean trade is limited to a certain number of voyages which may be made between May and November, and the number of these long voyages cannot be influeneed by the comparatively trifling addition of the aseent to Montreal. It may be assumed, therefore, that the same number of ships will do the same business whether they eome to Montreal, or stop at Quebee, but this cannot be said of the inland voyage. A greater number of inland eraft, therefore, will be required to bring down the same amount of produee per annum, if taken to Quebec than if left at Montreal.

Praetically, when lighterage is avoided, the same rate of freight may be expeeted to obtain between Montreal and European ports as for Quebee, and thus Canada West is brought virtually 160 miles nearer the Atlantie; and Lake Erie has a sea port, on her own waters, at least one hundred miles nearer than New York.

The second consideration is the relative advantages of Quebec and Montreal, for the particular trade now enjoyed by each.

The all-important advantage of a high tide will ever give Quebec the preference as the timber shipping port. This trade can be best accommodated by vessels anchoring in the stream, their cargo being floated to them by every tide, while the broad beaches laid dry by every ebb serve as dressing gound on which the timber is prepared for shipment. The great demand for space for such a peculiar traffic will make coves more profitable than wharves; and without expensive docks a large commercial business cannot be carried on to the same advantage as in the undisturbed level of the tideless Harbour of Montreal.

From Captain Bell's Report it will be seen that a depth of sixteen and a-half feet throughout may be obtained for vessels ascending to Montreal, in September, 1855, and one of eighteen feet in the same month of 1856, provided the south channels at Becancour and Verchères are lighted and buoyed.

The completion of the channel to a depth of twenty feet *may* be effected in 1857, but need not be delayed beyond the summer of 1858.

To Captain Bell's Report with respect to lights and buoys, I have nothing to add. On the completion of the deep channel permanent instead of floating lights will probably be established in the Lake.

The requirements in the Harbour of Montreal, I propose to make the subject of a separate Report so soon as the plans for the same are matured.

I have the honor to be,

Sir,

Your obedient servant,

THOS. C. KEEFER,

Eng. Harbour Com.

IMPROVEMENT OF ST. LAWRENCE NAVIGATION BETWEEN MONTREAL AND QUEBEC.

Estimate for a channel 300 ft. wide with a depth of 18 ft., 19 ft. and 20 ft. at low water.

Locality.	For 18 feet depth.					Additional for 19 feet.					Total for 19 feet.			Additional for 20 feet.					Total for 20 feet.			
	Cubic yards.	Rate.	£	s.	d.	Cubic yards.	Rate.	£	s.	d.	£	s.	d.	Cubic yards.	Rate.	£	s.	d.	Yards.	Cost.		
		s. d.					s. d.								s. d.					£	s.	d.
Lake St. Peter.....	1,117,561	0 7½	34,923	15	7½	575,632	0 7½	17,988	10	0	52,912	5	7½	661,256	0 7½	20,664	5	0	2,354,449	73,576	10	7½
La Valtrie.....	57,541	1 10½	5,394	9	4½	40,087	1 6	3,006	10	6	8,400	19	10½	51,346	1 3	3,209	2	6	148,974	11,610	2	4½
Cap St. Michel.....	12,341	2 2¾	1,375	16	1⅝	9,318	1 9	815	6	6	2,190	16	7¾	12,661	1 3	791	6	3	34,320	2,982	2	10¾
Pointe aux Trembles	198	5 0	49	10	0	488	4 0	97	12	0	147	2	0	1,969	3 6	344	11	6	2,655	491	13	6
Pointe Levraut, &c..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,339	10	7½
	1,187,641		41,743	5	1⅝	625,525		21,907	19	0	63,651	4	1¾	727,232		25,009	5	3	2,540,398	90,000	0	0

At all points above Lake St. Peter the estimated price per cubic yard is reduced as the quantities are increased.

THOS. C. KEEFER, Engineer,
Montreal Harbour Commission.

Montreal, 1st March, 1855.

STATEMENT shewing the cost of Dredging in LAKE ST. PETER for each Year, from 1851 to 1854.

Year.	Vessel.	Fuel.	Wages.	Board.	Oil and Tallow.	Cordage	Repairs	Incidentals, Salaries, Winter outfit.	Cost of dredging exclusive of outfit.	No. of Scows filled.	No. of Cubic Yds. lifted, 70 Yds. per Scow.	Per Yard measured in Scow.	Cost of outfit.	Per Yd. including outfit
1851	Dredge No. 2.	£277	£500	£122	£51	£45	£586	£1193	£4034	1124½	78715	s. d. 1 0¼		
	Tender.	588	375	187	83	27								
		865	875	309	134	72	586	1193	4034	1124½	78715	1 0¼		
1852	Dredge No. 2.	399	485	168	68	63	131	267	3475	3721	260470	3½		
	Tender.	1160	417	169	84	33	91							
	Dredge No. 3.	287	519	168	68	63	99	267	3537	3438	240660	3½		
	Tender.	1125	573	168	84	33	83							
		2911	1994	673	304	192	404	534	7012	7159	501130	3½		
1853	Dredge No. 2.	553	587	222	68	74	302	1015	5916	4117	288190	4⅛		
	Tender.	1920	614	235	85	38	203							
	Dredge No. 3.	401	569	223	68	74	315	1015	5092	3826	267820	4⅛		
	Tender.	1383	562	197	84	38	163							
		4257	2332	877	305	224	983	2030	11008	7943	556010	4¼		
1854	Dredge No. 2.	592	580	238	68	84	206	1096	5984	4986	349020	4		
	Tender.	1657	722	246	84	44	367							
	Dredge No. 3.	530	597	240	68	84	215	1096	6255	4677	327390	4⅛		
	Tender.	1932	724	264	85	44	377							
		4711	2623	988	305	256	1165	2191	12239	9663	676410	4⅛		
Totals.	Dredge No. 2 & Tender.	7086	4280	1587	591	408	1886	3571	19409	13948½	976395	4⅛	£9606	7d.
	Dredge No. 3 & Tender.	5658	3544	1260	457	336	1252	2377	14884	11941	835870	4¼	8411	6½
	Grand total.	12744	7824	2847	1048	744	3138	5948	34293	25889½	1812265	4½	18017	6¾

Cost of Coal per Chaldron, in 1851, £1 7s. 6d.; in 1852, £1 5s. 0d.; in 1853, £1 17s. 6d.; in 1854, £2 0s. 0d.

STATEMENT shewing the cost of Dredging in the HARBOUR OF MONTREAL for each Year, from 1851 to 1854.

Cost of Dredging at Lavaltrie, ("Isle Platte,") and in the Harbour of Montreal, for each Year, from 1851 to 1854.

Year.	Vessel.	Fuel.	Wages.	Board.	Oil and Tallow.	Cordage	Repairs	Incidentals—Salaries, Winter outfit, &c.	Cost of dredging exclusive of outfit.	No. of Scows filled.	No. of Cubic Yds. lifted, 30 Yds. per Scow.	Per Yard measured in Scow.	Cost of outfit.	Per Yd. including outfit
												s. d.		
1851	Dredge No. 1 & Tender	£192	£441	£147	£52	£15	£519	£353	£1749	510	15300	2 3¾	.....	.....
1852	Dredge No. 1.....	240	617	142	56	37	145	134	1731	1248	37440	11	.....	.....
	Tender.....		360											
	Total.....	240	977	142	56	37	145	134	1731	1248	37440	11	.....	.....
1853	Dredge No. 1.....	382	492	165	56	44	423	217	2464	1200	36000	1 4½	.....	.....
	Tender.....		253	123	41	21	30	217						
	Total.....	382	745	288	97	65	453	434	2464	1200	36000	1 4½	.....	.....
1854	Dredge No. 1.....	330	728	182	55	50	193	282	2592	970	29100	1 9½	.....	.....
	Tender.....		260	137	41	24	28	282						
	Total.....	330	988	319	96	74	221	564	2592	970	29100	1 9½	.....	.....
	Grand total.....	1144	3151	896	301	221	1338	1485	8536	3928	117840	1 5½	2795	1s. 11d.

Cost of Coals per Chaldron, in 1851, £1 7s. 6d.: in 1852, £1 10s. 0d.; in 1853, £2 5s. 0d.; in 1854, £2 0s. 0d. The tender burned wood.

In 1852 the tender to Dredge No. 1, was chartered for a portion of the season at a cost of £360, every thing being found the boat by the Proprietor.
The work of 1851 and '52 was at Lavaltrie and Isle de Lorier,—of 1853 and '54, in Montreal Harbour, where the material is very hard, and thickly interspersed with large "boulder" stones.

Details of Dredging Vessels employed by the MONTREAL HARBOUR COMMISSION in the Improvement of the Navigation of the River St. Lawrence.

No. of Boat.	Length over all.	Length of Keel.	Breadth of Beam.	Diameter of Cylinder.	Length of Stroke.	Pressure of Steam.	No. of Strokes per Min.	Consumption of coal per Hour.	Nominal H. P. of Engines.	Principle of Engines.	Length of Bucket Frame.	No. of Buckets on Frame.	Capacity of Buckets.	No. discharged per Min.	Least depth of Working.	Greatest depth of Working.	Men.		
																	Tender.	Dredge.	Scows.
No.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Lbs.	No.	Lbs.	No.		Ft. In.	No.	Cubic feet in each.	No.	Ft. In.	Ft. In.			
1	97 3	93 0	25 3	2 3	2 6	5	38	225	20	Side Lever....	60 0	34	4	19	7 0	22 0	10	9	4
2	126 7	123 0	25 0	2 Cylinders	4 0	16	40	510	30	Direct action.	49 2	28	6	28	7 0	18 6	18	13	4
3	125 0	125 0	24 8	1 4 each.	4 0	16	40	510	30	Direct action.	49 2	28	6	28	7 0	18 0	17	13	4
4	130 0	126 0	25 0	2 3½	2 6	5	40	—	22½	Side Lever....	64 3	36	7	18	7 0	30 0	17	9	4
Spoon Dredge.	55 7	50 7	23 4	2 Cylinders 6 in. each.	1 2	60	60	151	12	High Pressure. Direct action.	Bucket Handle 38 6	1	40½	1	1 6	25 0		3	2

In the above Statement, the Power of Dredges Nos. 1 and 4 is calculated according to the actual pressure of Steam carried.—The Power of Dredges Nos. 2 and 3 is made up according to "Watt's" calculation of 6 lbs. pressure upon the square inch of the Piston, but they, carrying steadily 16 lbs., of course work up to much more than their nominal Horse Power.—Dredges Nos. 2 and 3 are now being lengthened, to enable them to work in 30 ft. of water.—When finished, the Bucket Frame of each will be 63 ft. 3 in. from centre to centre of shaft, and will then have 34 Buckets.

A Tender and two hopper-bottomed Scows are attached to each Dredge, for towing away and depositing the material lifted.—The Tender to Dredge No. 1, which also attends upon the Spoon Dredge, is a 15 Horse Power Horizontal Engine, carrying a pressure of 15 lbs. upon the square inch, and consumes 382 lbs. of coal per hour.—The Tender to Dredge No. 2 has two Beam Engines of 32 Horse Power each, carrying 20 lbs. of Steam, consumes 1539 lbs. of coal per hour.—The Tender to Dredge No. 3 has also two Beam Engines of 30 Horse Power each, carrying 20 lbs. of Steam, consumes 1282 lbs. of coal per hour.—The Tender to Dredge No. 4 is in course of construction, and is to be fitted with two Horizontal Engines of 24 inch Cylinder, and 6 ft. stroke each, to carry a pressure of 30 lbs. of Steam. No. 4. is the new dreege, and has not yet been worked.

1st March, 1855.

JOHN BELL,
Superintendent.

Date. 1851	Ft In
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STATEMENT SHEWING THE WORKING OF THE DREDGES
FROM TH

DATE.	MAY.								JUNE.											
	1851.		1852.		1853.		1854.		1851.		1852.		1853.		1854.		1851.		1852	
	Dredges.		Dredges.		Dredges.		Dredges.		Dredges.		Dredges.		Dredges.		Dredges,		Dredges.		Dredg	
			No. 2.	No. 3.	No. 2.	No. 3.	No. 2.	No. 3.			No. 2.	No. 3.	No. 2.	No. 3.	No. 2.	No. 3.	No. 2.		No. 2.	
			Scows.	Scows.	Scows.	Scows.	ows.	Scows.			Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	
1						16					27								31	
2						24						31							W. 2	
3						43						37							W. 5	
4						46					W.	W.							S.	
5						22					25	Rep.			22	17			W. 13	
6						38					S.		36		W. 11	W. 11			C.	
7						S.					26		40	37	34	31			23	
8						42					24		24	42	W.	W.			33	
9						25					W. 4		28	28	W.	W.			31	
10						29					18		40	44	34	25	R. 1		A. 5	
11						21					24		39	40	S.	S.	R. 12		S.	
12						32					30	26	S.	S.	46	41	A.		21	
13											S.	S.	W. 20	W. 19	32	41	S.		W. 10	
14											30		43	50	46	27	R. 1		24	
15						S.					20		35	45	49	37	R.		34	
16						W.					31	37	49	45	37	44	R. 6		34	
17					High Water.	W. High Water.					38	37	40	R.	25	38	R. 13		28	
18											33	13	31		S.	S.	R.		S.	
19					2						32	35	S.	S.	38	48	R.		20	
20					W.						S.		39		35	36	S.		15	
21					W.	5					41		35	R. to Str.	37	36	R.		13	
22			7	4							A. 17		38		W. 21	W. 19	A. 7		27	
23			S.	S.								23	35		26	44	A.		36	
24			4	W. 7								26	A. 17		40	39	R. 2		28	
25				W. 9							W. 18	W. A. 5	42	24	S.	S.	R.		S.	
26			7	22							W. 18	W. 17	S.		39	29	R.		10	
27				31							S.	S.	34	16	45	39			37	
28				35							35	30	40	44	38	35			37	
29				W. 18							28	2	47	28	A. & B. 20	A. & B. 3			25	
30			S.	S.							35	18	23	29	W. 22	R. D. 3			22	
31				38															28	
Total No. of Scows filled each month.			18	166	5	338					554	337	784	473	697	643	42		601	
Total No. of working days each month.			3	9	1	11					21	14	22	14	21	21	7		2	
Average Scows per day for each month.			6	18.4	5	30.7					26.3	24	35.6	33.7	33.1	30.6	6		23.	

1851.—77 Working Days, 1124½ Scows filled, 14.59 Average per Working Day. 52.—258 Working Days, 7159 Scows, 27.74 Average per Working Day. 1853.—243 Working Days, 7943 Scows, 3

NOTE.—W. signifies Wind, A. signifies Anchors, B. signifies Buoys, R. D. sign s Repairing Dredge, R. S. signifies Repairing Scows, D. by S. signifies Detained by Shine, T. A. signifies T-a

G OF THE DREDGES IN "LAKE ST. PETER," THE NUMBE OF SCOWS FILLED, THE DETENTION, AND C FROM THE COMMENCEMENT IN 1851 TO THE CLOSE OF THE SEASON OF 1854.

1854. Dredges, No. 2. Scows.	1854. Dredges, No. 3. Scows.	JULY. 1851. Dredges. No. 2. Scows.	1851. Dredges. No. 3. Scows.	1852. Dredges. No. 2. Scows.	1852. Dredges. No. 3. Scows.	1853. Dredges. No. 2. Scows.	1853. Dredges. No. 3. Scows.	1854. Dredges. No. 2. Scows.	1854. Dredges. No. 3. Scows.	AUGUST. 1851. Dredges. No. 2. Scows.	1851. Dredges. No. 3. Scows.	1852. Dredges. No. 2. Scows.	1852. Dredges. No. 3. Scows.	1853. Dredges. No. 2. Scows.	1853. Dredges. No. 3. Scows.	1854. Dredges. No. 2. Scows.	1854. Dredges. No. 3. Scows.	SEPTEMBER. 1851. Dredges. No. 2. Scows.	1851. Dredges. No. 3. Scows.	1852. Dredges. No. 2. Scows.	1852. Dredges. No. 3. Scows.	1853. Dredges. No. 2. Scows.	1853. Dredges. No. 3. Scows.	1854. Dredges. No. 2. Scows.
				31	A. 15	39	38	38	21	R. 1	.....	S.	S.	43	47	39	43	A. 14	.....	55	44	41	51	W. 5
				W. 2	W. 2	40	36	S.	S.	A. 12	.....	R.	40	49	28	34	37	W. 1	.....	43	24	44	56	31
				W. 5	W.	S.	S.	33	41	S.	.....	39	20	40	26	52	49	11	.....	W. 10	W. 14	34	R.	S.
				S.	S.	28	36	31	7	W. 1	.....	37	10	56	58	26	39	S. R. 12½	.....	43	37	S.	S.	43
22	17			W. 13	W. 15	A. 2	A. 16	31	43	W. 5	.....	24	30	31	57	46	39	20	.....	S.	S.	23	R.	47
W. 11	W. 11			C.	35	47	45	49	41	A. 16	.....	R.	26	R.	46	S.	S.	A. 9	.....	W. 15	W. 10	39	40	28
34	31			23	.....	49	23	51	42	17	.....	.....	.....	S.	S.	W.	W.	S.	.....	47	44	A. 18	44	37
W.	W.			33	.....	W. 24	W. 24	43	39	23	.....	S.	S.	51	R. 28	46	R. D.	S. R.	.....	31	52	46	17	4
W.	W.			31	.....	W. 25	W. 30	S.	S.	25	.....	.....	13	43	.....	17	...	S. R. 15	.....	31	44	50	37	23
31	25	R. 1	.....	A. 5	21	S.	S.	D.by S. 3	39	S.	.....	10	4	51	.....	47	44	S. R. 10	.....	39	45	W.	W.	8
S.	S.	R. 12	.....	S.	S.	43	48	14	42	R.	.....	13	26	52	54	53	51	R.	.....	36	R. 15	S.	S.	35
46	41	A.	.....	21	22	29	42	45	25	26	.....	44	15	31	52	42	25	W. 12	.....	S.	S.	19	W. 20	41
32	41	S.	.....	W. 10	16	40	47	44	45	R. 6	.....	54	51	34	53	S.	S.	W. 5	.....	36	R.	W.	W.	32
46	27	R. 1	.....	24	21	47	47	46	42	R.	.....	36	29	S.	S.	R. D. 17	32	S.	.....	30	R. 10	39	31	32
49	37	R.	.....	34	22	55	32	35	39	R.	.....	8.	S.	47	41	T. A.	18	20	.....	31	38	W.	W.	11
37	44	R. 6	.....	34	31	37	34	S.	S.	25	.....	36	R.	20	39	55	38	A. 19	.....	R. 14	28	42	35	44
25	38	R. 13	.....	28	15	S.	S.	41	32	S.	.....	46	R.	23	24	34	27	A.	.....	28	51	W. 5	W.	
S.	S.	R.	.....	S.	S.	29	19	35	17	24	.....	21	R.	W. 4	W. 7	46	Dby S. 12	21	.....	42	40	S.	S.	
38	48	R.	.....	20	27	44	47	20	R. D. 18	A. 15	.....	27	7	23	W. 16	35	25	R. 16	.....	S.	S.	43	39	
35	36	S.	.....	15	A. 2	W. 11	W. 11	37	43	20	.....	32	40	32	.....	S.	S.	20	.....	49	W. 20	25	40	W.
37	36	R.	.....	13	18	47	38	21	26	20	.....	40	41	S.	S.	46	24	S.	.....	W. 3	W.	36	30	10
W. 21	W. 19	A. 7	.....	27	15	42	43	33	A. 22	W. 19	.....	S.	S.	28	.....	44	39	W. 19	.....	W.	W.	17	11	
26	44	A.	.....	36	23	50	31	S.	S.	W. 6	.....	46	24	21	5	49	51	W. 17	.....	49	20	30	.....	
40	39	R. 2	.....	28	15	S.	S.	40	42	S.	.....	47	44	29	.....	50	51	A. 7	.....	12	50	W. 11	.....	
S.	S.	R.	.....	S.	S.	38	35	43	45	W. 10	.....	39	9	25	.....	63	53	A. 16	.....	41	44	S.	.....	3
39	29	R.	.....	19	23	24	W. 12	W. 16	W. 14	W. 12	.....	32	33	44	52	41	32	20	.....	S.	S.	25	.....	
45	39			37	21	30	55	47	45	20	.....	41	50	W. 4	W. 5	S.	S.	T. A. 8	.....	41	31	31	.....	
38	35			37	R. 6	47	51	33	45	R. 17	.....	35	46	S.	S.	38	45	S.	.....	40	26	W.	.....	
	A. & B. 20	A. & B. 3		25	R.	51	54	39	27	12	.....	S.	S.	42	46	41	48	19	.....	34	43	22	.....	
	W. 22	R. D. 3		22	R.	40	46	S.	S.	W.	.....	R.	40	40	55	51	T. C. 7	R. 10	.....	41	43	23	.....	
				28	18	.....	.....	W. 22	W. 10	S.	.....	R. 5	50	A. 20	40	47	50	.....	.....	.....	.....	.....	.....	
697	643	42	.....	601	383	964	970	952	882	332	.....	684	648	301	779	1089	961	321½	.....	862	773	964	460	
21	21	7	.....	26	21	26	26	26	26	22	.....	21	22	26	21	25	25	23	.....	25	23	22	13	
33.1	30.6	6	.....	23.1	18.2	37.0	37.3	36.6	33.9	15.	.....	32.5	29.4	34.6	37.	43.5	38.4	14	.....	34.4	37.6	30.1	35.3	

...ay. 1853.—243 Working Days, 7943 Scows, 32.68 Average per Working Day. 1854.—275 Working Days, 9655 Scows, 35.10 Average per Working Day.

...ffers Discharge Dby Ships, T. A. signifies Tenders Absent.

FILLED, THE DETENTION, AND CAUSE OF THE SAME, FOR EACH DA
HE SEASON OF 1854.

	SEPTEMBER.								OCTOBER.							
	1851.		1852.		1853.		1854.		1851.		1852.		1853.		1854.	
	Dredges.		Dredges.		Dredges.		Dredges.		Dredges.		Dredges.		Dredges.		Dredges.	
3.	No. 2.		No. 2.	No. 3.	No. 2.	No. 3.	No. 2	No. 3.	No. 2.		No. 2.	No. 3.	No. 2.	No. 3.	No. 2.	No. 3.
ws.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows'	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.
13	A. 1	.....	55	44	41	51	W. 5	W. 9	A. 11	.....	28	45	35	.....	S.	S.
37	W. 1	.....	43	24	44	56	31	A. 21	R. 19	.....	20	45	S.	.....	36	37
0	11	.....	W. 10	W. 14	34	R.	S.	S.	19	.....	S.	S.	W. 9	.....	40	42
39	S. R. 12½	.....	43	37	S.	S.	43	40	20	.....	38	31	27	.....	W. 18	R. D.
30	20	.....	S.	S.	23	R.	47	48	S.	.....	22	17	W.	.....	38	R. D.
S.	A. 9	.....	W. 15	W. 10	39	49	28	43	R. 2	.....	16	40	W.	.....	37	R. D.
W.	S.	.....	47	44	A. 18	44	37	40	R.	.....	39	31	W.	.....	37	30
D.	S. R.	.....	31	52	46	17	46	49	R. 11	.....	W. 15	W. 14	31	.....	S.	S.
50	S. R. 15	.....	31	44	50	37	23	38	20	.....	24	W. 17	S.	.....	31	42
	S. R. 10	.....	39	45	W.	W.	S.	S.	A. 13	.....	S.	S.	34	.....	38	46
51	R.	.....	36	R. 15	S.	S.	37	44	21	.....	35	41	31	.....	W. 21	23
25	W. 12	.....	S.	S.	19	W. 20	41	37	S.	.....	W. 17	W. 15	W.	.....	42	44
S.	W. 5	.....	36	R.	W.	W.	32	T. A. 13	W. 11	.....	24	32	W. 11	.....	28	30
32	S.	.....	30	R. 10	39	31	32	T. A.	10	.....	32	31	27	.....	26	32
18	20	.....	31	38	W.	W.	41	T. A. 5	22	.....	32	38	W. 13	.....	S.	S.
38	A. 19	.....	R. 14	28	2	35	33	A. 19	20	.....	W. 16	W. 16	S.	.....	29	34
27	A.	.....	28	51	W. 5	W.	S.	S.	A. 18	.....	S.	S.	W. 8	W. 19	37	44
8 12	21	.....	42	40	S.	S.	47	42	22	.....	19	28	.....	42	43	45
	R. 16	.....	S.	S.	43	39	39	45	S.	.....	W. 10	W. 13	.....	31	37	37
S.	20	.....	49	W. 20	26	40	W.	W.	R. 19	.....	34	17	.....	41	34	39
25	S.	.....	W. 3	W.	36	30	41	44	21	.....	34	46	.....	42	32	34
39	W. 19	.....	W.	W.	17	11	47	40	A & W 19	.....	20	34	.....	W.	S.	S.
54	W. 17	.....	40	20	30	.....	29	22	A. 15	.....	26	30	S.	S.	39	34
54	A. 7	.....	42	50	W. 11	.....	S.	S.	W.	.....	S.	S.	W.	W.	32	35
53	A. 16	.....	41	44	S.	.....	33	31	W. 9	.....	34	22	.....	.....	42	37
32	20	.....	S.	S.	25	.....	43	46	8	.....	36	24	35	21	38	39
S.	T. A. 8	.....	41	31	31	.....	43	40	A. 18	.....	34	37	37	26	38	43
45	S.	.....	40	26	W.	.....	42	40	A. 18	.....	33	37	28	41	38	29
48	19	.....	34	43	22	.....	38	35	17	.....	32	39	32	37	S.	S.
C. 7	R. 10	.....	41	43	23	.....	27	A. 17	21	.....	W.	W.	S.	S.	34	44
50	.....	.....	.....	.....	.....	.....	.....	.....	23	.....	S.	.....	37	42	42	41
961	321½	.....	802	773	664	460	905	817	429	.....	670	740	395	342	907	861
25	23	.....	25	23	22	13	25	24	23	.....	25	25	15	10	26	23
38.4	14	.....	34.4	33.6	30.1	35.3	36.2	34	17.1	.....	26.8	29.6	26.3	34.2	34.8	37.4

AME, FOR EACH DAY

OCTOBER.					NOVEMBER.					
2.	1853.		1854.		1851.	1852.		1853.		1854.
es.	Dredges.		Dredges.		Dredges.	Dredges.		Dredges.		Dredges.
No. 3.	No. 2.	No. 3.	No. 2.	No. 3.	No. 2.	No. 2.	No. 3.	No. 2.	No. 3.	No. 2.	No. 3.
Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.	Scows.
45	35	.....	S.	S.	.....	20	W. 25	22	38	31	28
45	S.	.....	36	37	.....	W.	W.	A. 23	44	24	36
S.	W. 9	.....	40	42	.....	17	W. 18	28	33	33	24
31	27	.....	W. 18	R. D.	.....	20	27	W. 7	W. 5	W. 14	W. 21
17	W.	.....	38	R. D.	.....	38	38	30	29	S.	S.
40	W.	.....	37	R. D.	.....	31	42	S.	S.	T. A. 6	T. A.
31	W.	.....	37	30	.....	S.	S.	W. 7	W. 8	27	29
W. 14	31	.....	S.	S.	.....	35	41	W. 13	W. 18	38	R. S. 22
W. 17	S.	.....	31	42	.....	35	46	W. 5	W. 9	W. 19	R. S.
S.	34	.....	38	46	.....	32	28	W. 5	W. 9	37	R. S. 23
41	31	.....	W. 21	23	.....	44	32	37	38	A. 18	R. S. 24
W. 15	W.	.....	42	44	.....	W.	W.	30	37	S.	S.
32	W. 11	.....	28	30	.....	25	37	S.	S.	W. 20	R. S. 18
31	27	.....	26	32	.....	S.	S.	33	39	31	40
38	W. 13	.....	S.	S.	.....	35	38	7	10	45	34
W. 16	S.	.....	29	34	.....	W.	W.	40	40	43	38
S.	W. 8	W. 19	37	44	.....	19	W.	W.	37	37	40
28	.....	42	43	45	.....	.....	.....	36	35	13	33
W. 13	.....	31	37	37	.....	.....	.....	38	20	.....	S. 33
17	.....	41	34	39	.....	.....	.....	S.	S.	.....	42
46	.....	42	32	34	.....	.....	.....	14	W. 14	.....	10
34	.....	W.	S.	S.	.....	.....	.....	20	38	.....	.....
30	S.	S.	39	34	.....	.....	.....	.....	.....	.....	.....
S.	W.	W.	32	35	.....	.....	.....	.....	.....	.....	.....
22	.....	.....	42	37	.....	.....	.....	.....	.....	.....	.....
24	35	21	38	39	.....	.....	.....	.....	.....	.....	.....
37	37	26	38	43	.....	.....	.....	.....	.....	.....	.....
37	28	41	38	29	.....	.....	.....	.....	.....	.....	.....
39	32	37	S.	S.	.....	.....	.....	.....	.....	.....	.....
W.	S.	S.	34	44	.....	.....	.....	.....	.....	.....	.....
.....	37	42	42	41	.....	.....	.....	.....	.....	.....	.....
740	395	342	907	861	.....	332	391	404	464	436	505
25	15	10	26	23	.....	11	12	18	18	16	17
29.6	.3	34.2	34.8	37.4	.....	30.1	32.5	22.4	25.7	27.2	29.7

E DRE CAUSE C
FR

1851.		854.	
Dredges.		edges.	D
. 2.	.	No. 3.	No.
ws.	Scows.	Scows'	Scow
		W. 9	A. 1

Depth of Water on the "Flats" in Lake St. Peter, from 1851 to 1854.

Date.	May.				June.				July.				August.				September.				October.				November.			
	1851.	1852.	1853.	1854.	1851.	1852.	1853.	1854.	1851.	1852.	1853.	1854.	1851.	1852.	1853.	1854.	1851.	1852.	1853.	1854.	1851.	1852.	1853.	1854.	1851.	1852.	1853.	1854.
	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In	Ft In
1	.....	.....		24	.....	17	18 9	.....	.....	.....	.....	14 9	14	14 6	.....	11 6	12	12 3	12	11 3	10 10	12	.....	.....	.....	12 6	12 6	11 6	11
2	.....	.....	17	.....	.....	.....	.....	.....	.....	.....	.....	14 6	14 6	14 6	.....	11 6	.....	12 4	12	11 3	11	12 6	12	.....	10 6	12 6	.....	11 6	11
3	.....	.....	.....	.....	.....	17	18 5	.....	.....	.....	.....	13 9	14 6	14 6	.....	11 3	11 9	12 5	12	11 3	10 9	11	.....	12	10 6	12 6	12 6	11 6	11 3
4	.....	.....	17	.....	.....	.....	18 9	.....	.....	.....	14	13 9	14 9	.....	11 6	11 9	12	.....	.....	11		11	.....	.....	10	12 6	12 6	11 6	
5	.....	.....	17 3	.....	.....	.....	.....	16 6	.....	.....	14	13 6	15	13	12	.....	11 8	11 6	.....	.....	.....	11	12	.....	10 3	11 9	12 6	.....	11 3
6	.....	.....	17	.....	.....	.....	18 3	16 6	.....	15	13 6	13 3	14 6	.....	12 4	.....	11 9	11	11 9	11	10 9	12 3	.....	10 6	11 9	.....	.....	11 3
7	.....	.....	17	.....	.....	.....	18 3	16 6	.....	.....	13 3	13	14	.....	12 4	11 6	11 7	11	11 10	11	10 6	12 3	12	.....		12	12 6	.....	11
8	.....	.....	.....	.....	.....	16	18	.....	.....	.....	13	.....	13 9	.....	12	11 6	11 6	10 9	11 9	11 6	10 6	12 6	.....	11		12 9	12	11 9	
9	.....	.....	17 3	20	.....	.....	18	.....	.....	.....	13	13	13 9	.....	12	11 6	11 5	10 9	.....	.....	10 6	12 6	12 6	11	.....	12 9	12	11 6	
10	.....	19 6	17	20	.....	15 8	18	.....	15	.....	13	13	13 9	12	11 10	11 6	11 6	11 4	.....	11 6	10 6	.....	.....	11	.....	13	12	11 9	
11	.....	.....	17	20	.....	15 8	18	.....	14 8	.....	13	13	13 9	12	11 8	12	11 9	.....	11 3	11 3	10 6	.....	.....	11	.....	13 3	.....	11 9	
12	.....	.....	.....	.....	.....	16	.....	16 6	14 8	.....	13	13	13 9	12 3	11 8	.....	11 9	.....	.....	11	10 9	12 9	12	.....	.....	.....	12 3	11 6	
13	.....	.....	.....	.....	.....	.....	17 9	16 6	14 8	15 6	13	12 4	13 9	.....	.....	12	11 9	.....	11	11	10 6	12 6	12	.....	.....	13 3	12 3	11 9	
14	.....	.....	.....	.....	.....	.....	17	16	15	15 6	12 9	12 4	13 9	.....	.....	12	11 9	.....	.....	11 3	11	12 6	11 9	.....	.....	.....	12 6	12	
15	.....	.....	.....	20	.....	.....	16 9	16	15	15 6	12 9	12 9	13 6	.....	.....	12	11 6	.....	11 9	10 9	11 3	12 6	.....	11	.....	13 3	.....	12	
16	.....	.....	.....	.....	.....	16 6	16 6	15 9	15	15 6	12 6	.....	13 6	.....	11 10	11 6	11 6	.....	.....	10 6	11	.....	11 9	11 3	.....	13 3	12 9	12	
17	.....	.....	18 6	.....	.....	.....	16 6	15 6	14 6	15	.....	12 6	13 3	15	12 3	11 6	11 3	12 2	.....	10 6	11	12 6	11 6	11 9	.....	13 3	12 9	12	
18	.....	.....	18 9	20	.....	.....	16 3	15 3	14	.....	12 3	12 6	13	14	12 3	11 6	11	.....	.....	10 6	11	12 9	11 6	11 9	.....	.....	12 9		
19	.....	19 3	.....	.....	.....	17	.....	15 3	14	16	.....	12 6	12 10	12 3	14 4	.....	10 9	.....	12 3	10 6	11	12 6	11 6	11 4	.....	.....	13	12 6	
20	.....	.....	.....	.....	.....	.....	16	15	14	16	.....	12	12 8	12 6	.....	11 6	10 9	.....	11	10	11	12 6	11 9	.....	.....	.....	13 6	12 9	
21	.....	.....	19 6	.....	.....	16	15 6	15	13 6	16	13	12 9	12 8	.....	12 2	11 9	11	.....	11 9	10	11 6	12 3	.....	11 6	.....	.....	.....	13	
22	.....	19	.....	20	.....	.....	15 3	15	13	.....	13	.....	12 6	.....	12	11 3	11	11 5	11 9	.....	11 6	.....	11 9	.....	.....	.....	.....	.....	
23	.....	.....	20	.....	.....	.....	15 3	14 9	13	15	13	.....	12 6	.....	.....	11 3	11	11 6	11 6	.....	11 6	12	11	11 9	.....	.....	.....	.....	
24	.....	18 6	19 6	.....	.....	16	15 6	14 9	13	.....	.....	12 6	12 6	.....	12	11 3	11	11 3	.....	11	11	12 9	11 6	11 6	.....	.....	.....	.....	
25	.....	18 3	20	.....	.....	.....	15 9	.....	13 6	.....	12 6	12 3	12 6	11 9	12	11 3	11	.....	11 6	11	11 9	12 3	11 6	11 6	.....	.....	.....	.....	
26	.....	.....	.....	.....	.....	16	.....	14 3	13 9	14	12 6	12 6	12 6	12 6	11 10	11 6	11	11 9	11 2	11 3	11	12	12	11 3	11 6	11 6	.....	.....	
27	.....	.....	20 6	.....	.....	.....	15 6	14	13 9	.....	12 3	12 6	12 6	12 3	.....	11	11 9	11	11 3	10 9	12 6	.....	11 6	11 4	.....	.....	.....	.....	
28	.....	.....	20 6	.....	.....	16	15	14	14	.....	12	12	12 4	.....	11 4	10 9	12	.....	11 6	11	12 3	12	11 4	.....	.....	.....	.....	.....	
29	.....	.....	20 3	.....	.....	16	.....	14	14	.....	12	12	12 4	12	11 3	10 6	12	.....	11 6	10 9	12	.....	.....	11	.....	.....	.....	.....	
30	.....	.....	19 9	.....	.....	16	14 9	14	14 3	.....	11 9	12	12 4	.....	11 3	10 9	12	.....	.....	.....	12	.....	.....	11	.....	.....	.....	.....	
31	.....	17	19	19 3	.....	.....	.....	.....	14 3	.....	.....	12																	

STATEMENT, SHOWING THE TOTAL QUANTITY OF MATERIAL DREDGED IN THE RIVER CLYDE AND HARBOUR OF GLASGOW, AND ITS COST, From JUNE 1840 to JUNE 1854—a period of Fourteen Years.

End of the Financial Years.	Total Cubic Ys., considering 8 Yards p. Punt.	Cost of Dredging and Depositing in River and Harbour, Diving, &c.			Price per Cubic Yard.	Cost of Repairs of Dredging Machines, Punts, Bell, &c.			Per Cubic Yard for Repairs, &c.	TOTAL SUM Paid for Dredging and Depositing, including Repairs of Machines, Punts, Diving Bell, &c.			Per Cubic Yard for both.	TOTAL COST For Dredging & Depositing in River & Harbour, including Repairs & New Plant, Diving Bell, &c.			Per Cubic Yard for all.	Leaving for New Plant Supplied.			Prices of Coal p. waggon of 24 cwt., at the Glasgow W. W.	
		£	s.	d.	d.	£	s.	d.	d.	£	s.	d.	d.	£	s.	d.	d.	£	s.	d.	s.	d.
1841,.....	141,248	9,111	17	5	15.5	6,114	10	10	10.4	15,226	8	3	25.9	18,642	18	3	31.7	3,416	10	9	6	6
1842,.....	205,872	11,709	14	0	13.6	6,120	16	9	7.2	17,830	10	9	20.8	21,202	8	3	24.7	3,371	17	6	6	8
1843,.....	247,768	10,576	9	6	10.2	4,223	14	5	4.1	14,800	3	11	14.3	15,504	16	11	15.0	704	13	0	6	6
1844,.....	226,152	9,357	3	9	9.9	3,503	19	3	3.7	12,861	3	0	13.6	12,861	3	0	13.6	...	...	...	5	8
1845,.....	233,944	8,986	19	10	9.2	3,010	19	0	3.1	11,991	18	10	12.3	14,023	18	10	14.4	2,032	0	0	6	8
1846,.....	199,520	8,904	9	11	10.7	463	13	9	3.0	11,368	3	8	13.7	11,368	3	8	13.7	...	...	...	7 11	0 0
1847,.....	202,416	8,387	0	9	9.9	2,447	15	11	2.9	10,834	16	8	12.8	10,834	16	8	12.8	...	...	...	13	6
1848,.....	154,288	7,117	13	11	11.1	2,073	7	10	3.2	9,191	1	9	14.3	9,191	1	9	14.3	...	...	...	9	0
1849,.....	213,168	9,538	12	3	10.7	2,248	14	3	2.6	11,787	6	6	13.3	11,887	6	6	13.4	100	0	0	6	0
1850,.....	278,864	9,143	8	8	7.9	1,735	10	2	1.5	10,878	18	10	9.4	11,140	13	5	9.6	261	4	7	5	0
1851,.....	293,256	12,205	3	10	10.0	2,033	6	8	1.7	14,238	10	6	11.7	20,006	16	5	16.4	5,768	5	11	5	8
1852,.....	376,472	13,841	17	8	8.8	2,566	13	6	1.7	16,408	11	2	10.5	25,149	9	1	16.0	8,740	17	11	6	6
1853,.....	339,464	8,787	7	11	6.2	4,050	11	7	2.9	12,837	19	6	9.1	14,049	5	4	9.6	1,211	5	10	7	3
1854,.....	303,072	10,380	15	6	8.2	3,627	13	6	2.8	14,008	9	0	11.0	16,674	14	10	13.2	2,666	5	10		
	3,415,504	138,042	14	11	9.70	46,221	7	5	3	184,264	2	4	12.93	212,537	12	11	14.93	28,273	10	7		

CLYDE NAVIGATION.

CLYDE NAVIGATION.

STATEMENT showing the Quantity of Material dredged by the Clyde Navigation Dredging Machines during the last ten years; also, the Hours the Engines of the Dredgers worked during the said period.

YEARS.	(Old) No. 1. Single Machine. 12 H. P.		(New) No. 1. Double Machine. 40 H. P.		No. 2. Single Machine. 16 H. P.		No. 3. Single Machine. H. P.		No. 4. Single Machine. 20 H. P.		No. 5. Single Machine. 24 H. P.		TOTAL.	
	Hours.	Cb. Yds.	Hours.	Cb. Yds.	Hours.	Cb. Yds.	Hours.	Cb. Yds.	Hours.	Cb. Yds.	Hours.	Cb. Yds.	Hours.	Cb. Yds.
1844-45,.....	5	44,584	.....	.....	2,236	58,976	1,777½	41,560	1,271	32,632	2,021	56,192	9,200½	233,944
1845-46,.....	,171½	*26,912	.....	.....	1,534	38,016	1,738	39,184	1,913	46,104	1,967	49,304	8,323½	199,520
1846-47,.....	.....	.....	.....	.....	1,527½	45,944	1,841½	44,760	2,225½	66,000	1,857	45,712	7,451½	202,416
1847-48,.....	.....	.....	.....	.....	941½	28,864	1,076¾	29,176	1,983½	45,592	1,781½	50,656	5,783	154,288
1848-49,.....	.....	.....	.....	.....	1,858	62,176	2,121½	71,336	923½	28,360	1,767½	51,296	6,670½	213,168
1849-50,.....	.....	.....	.....	.....	2,371½	83,288	1,427	38,632	1,552	52,688	2,189½	84,256	7,540	278,864
1850-51,.....	.....	.....	.....	.....	2,243½	74,200	2,376½	80,704	2,376	59,256	2,483	79,095	9,479	293,256
1851-52,.....	.....	.....	1,655½	†69,384	2,547	95,464	2,423	62,576	2,408½	61,072	2,654	87,976	11,688	376,472
1852-53,.....	.....	.....	1,843½	104,448	2,282	70,640	1,944½	40,488	1,667	43,536	2,421½	77,352	10,161½	339,464
1853-54,.....	.....	.....	1,822	106,848	1,879½	59,336	1,272	48,648	1,065	40,736	1,664	47,504	7,702½	303,072
Total,.....	3,066½	71,496	5,324	280,680	19,420½	616,904	17,998¼	517,064	17,385	478,976	20,805¾	629,344	84,000	2,594,464
Coal consumed in 10 hours,.....			36 Cwt.		20 Cwt.		20 Cwt.		20 Cwt.		24 Cwt.			

* Five months work. † Nine months work.

NOTE.—The number of Cubic Yards has been made up from the number of Punts filled by the Dredgers, and on the supposition that each Punt load will measure eight Yards in the Deposit.

The Clyde dues are 1s. 6d. sterling per ton on iron, —about 1s. 10d. on flour, and 1s. 6d. on ashes. The Montreal Harbour and Lake St. Peter dues combined are less than half these rates.

The number of persons employed by the Montreal Harbour Commissioners in Dredging operations in 1854, was 111. In 1855, the number will be about 145. The value of the five Steam Dredgers with the four Steam Tenders, and the Scows, is £50,000.


B. Mashnoes
EAGLE I.
Bank of La Carpe
UPPER POOL
1st Buoy
Upper Light Vessel
UPPER BAR
BANK
FRANCIS
STRAIGHT
FLAT I.


River
Ivory
POOL
OLD
CHANNEL
2nd Buoy
Lower Light Vessel.
DREDGED
BY
THE
MONTR
FLAT
THE
BOARD
OF
WORKS
COMMENCED
BY
THE
STRAIGHT
CHANNEL


Muchiche
R. Muchiche
FLATS
LOWER
DGED BY THE MONTREAL HARBOUR COMMISSIONERS
THE BOARD OF WORKS
White Buoy
Lower Buoy

Lake St. Peter

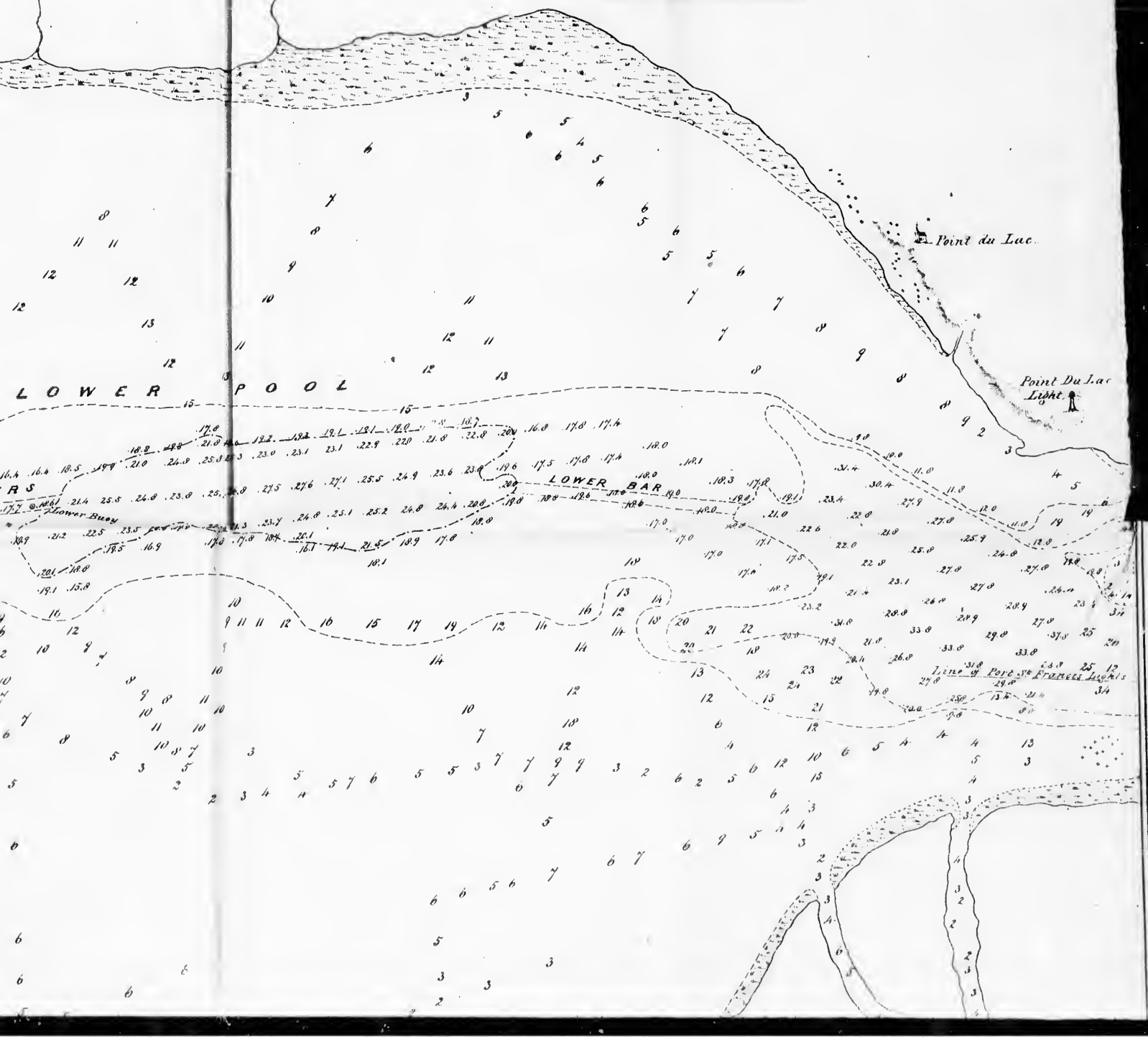
SURVEYED FROM BATTEAUX.

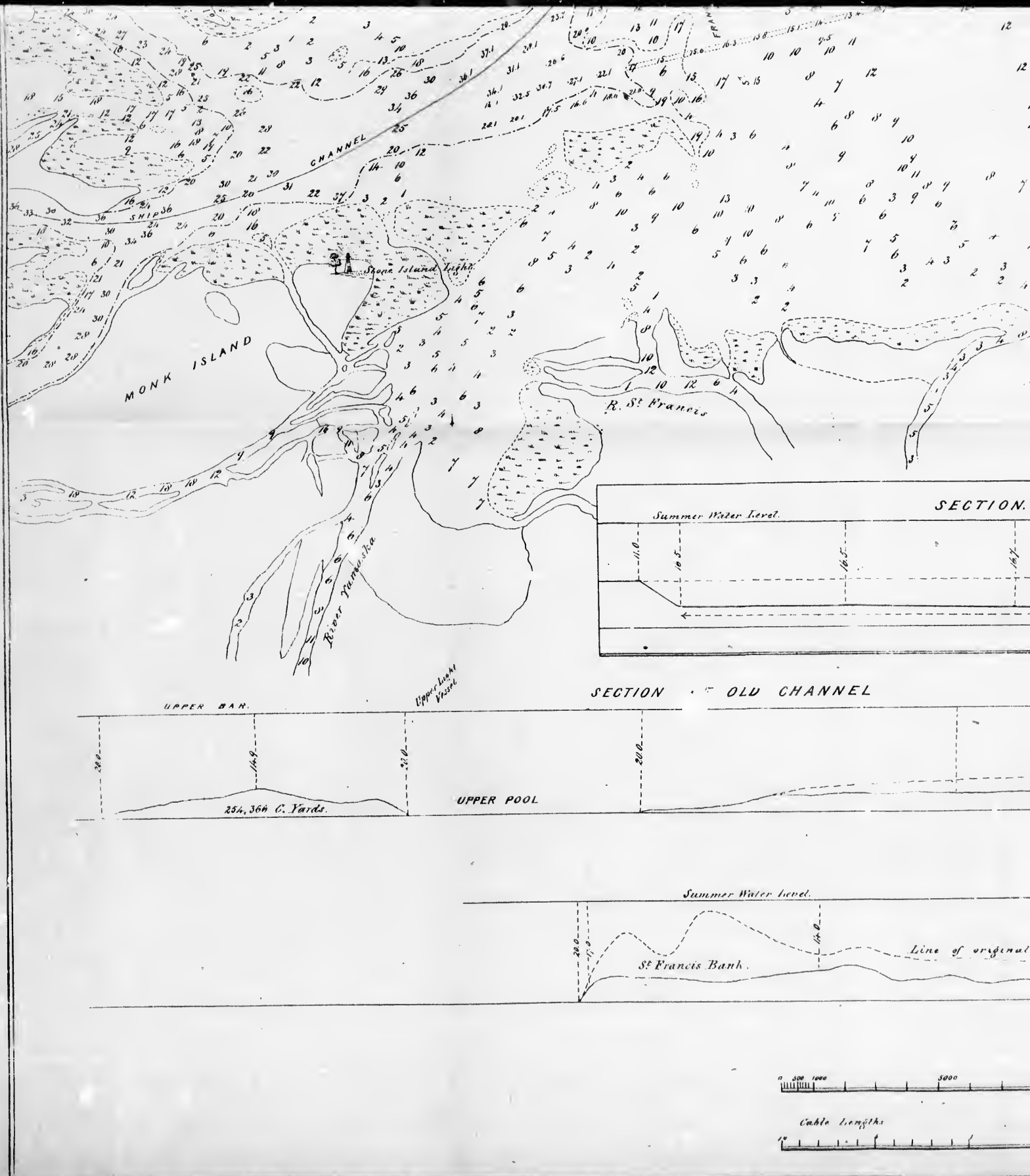
Shewing Dredging Operations.

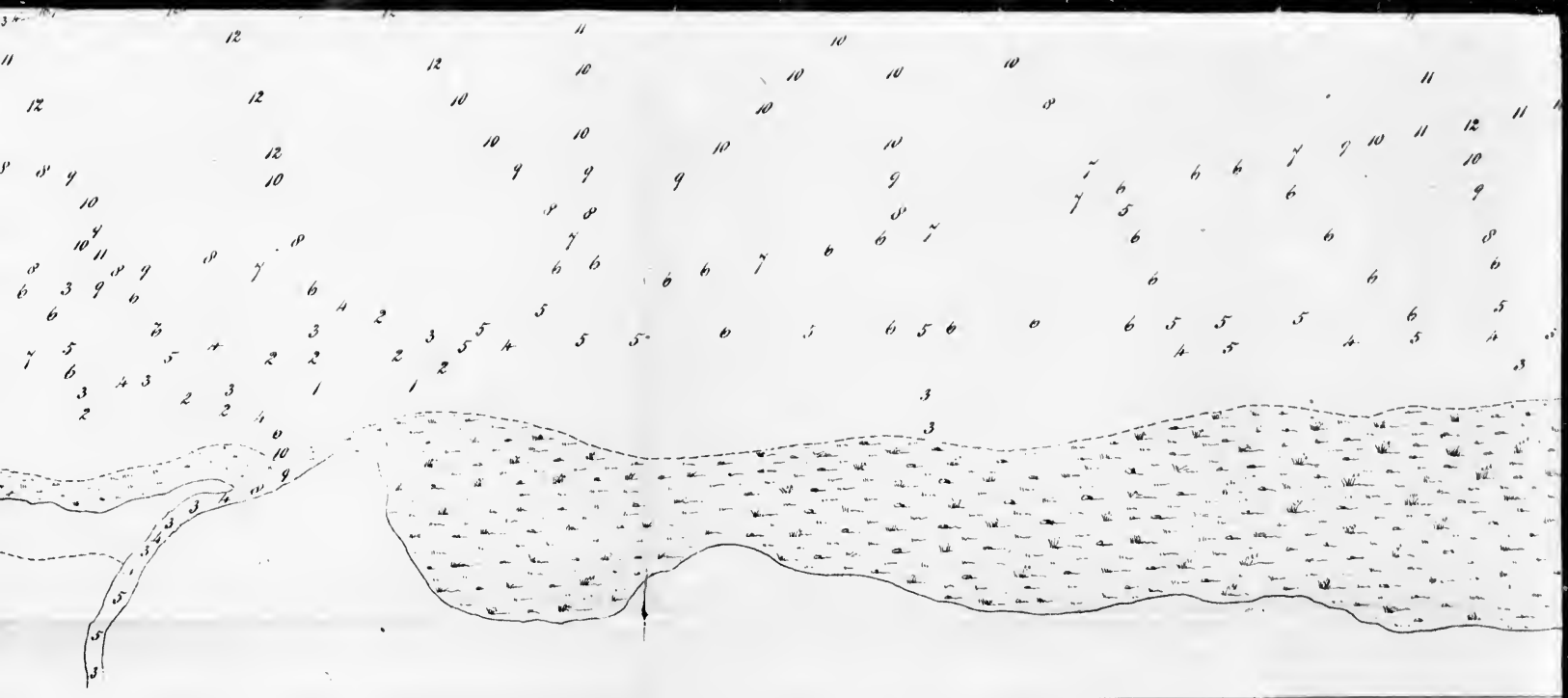
and

Winter Survey on the Ice, for Harbour Commissioners.

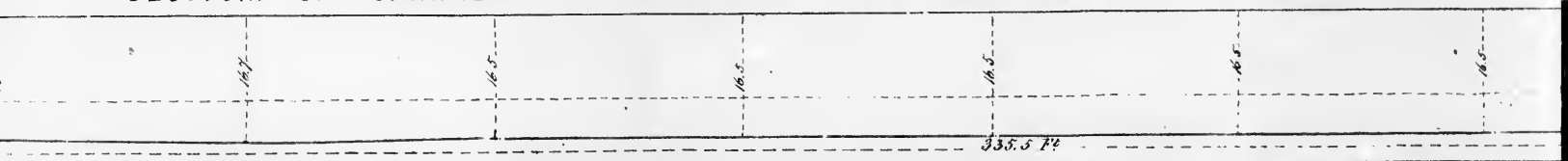
Hon. John Young, Chairman.




CHANNEL
SHIP
Stone Island Light.
MONK ISLAND
R. St Francis
River Yamaska
SECTION.
Summer Water Level.
11.0
16.5
16.5
16.5
SECTION OF OLD CHANNEL
UPPER BAR.
Upper Light Vessel
22.0
14.9
22.0
20.0
254, 366 C. Yards.
UPPER POOL
Summer Water level.
20.0
14.0
St Francis Bank.
Line of original
0 500 1000 5000
Cable Lengths
1/2



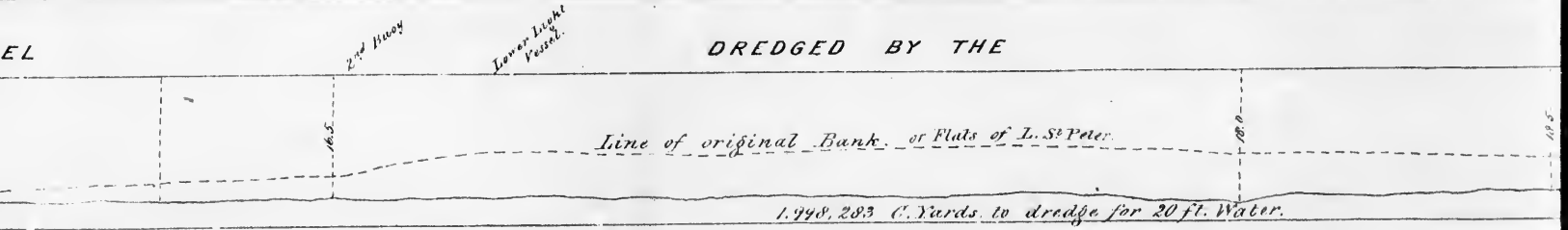
SECTION. OF CHANNEL AS DREDGED BY HARBOUR COMMISSIONERS, "RADIUS CUTTING"



Scale, 20 feet to the Inch.

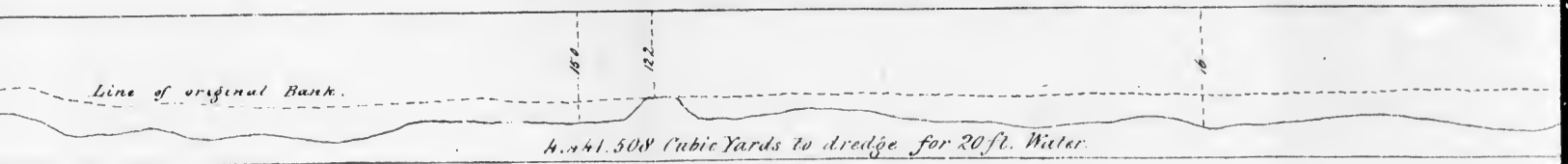
EL

DREDGED BY THE



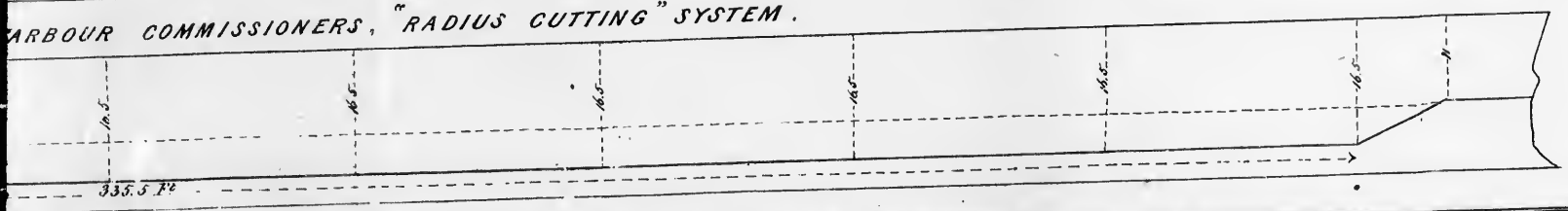
1.998,283 C. Yards to dredge for 20 ft. Water.

SECTION OF CHANNEL DREDGED BY THE BOARD OF WORK



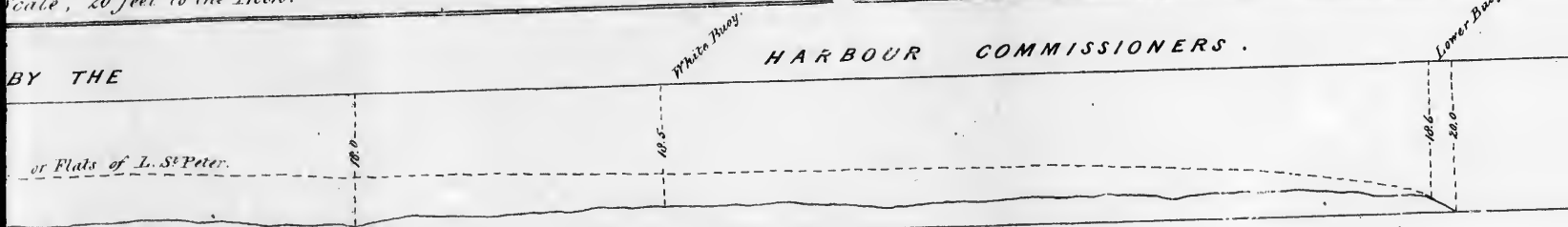
4.441.508 Cubic Yards to dredge for 20 ft. Water.

ARBOUR COMMISSIONERS, "RADIUS CUTTING" SYSTEM.

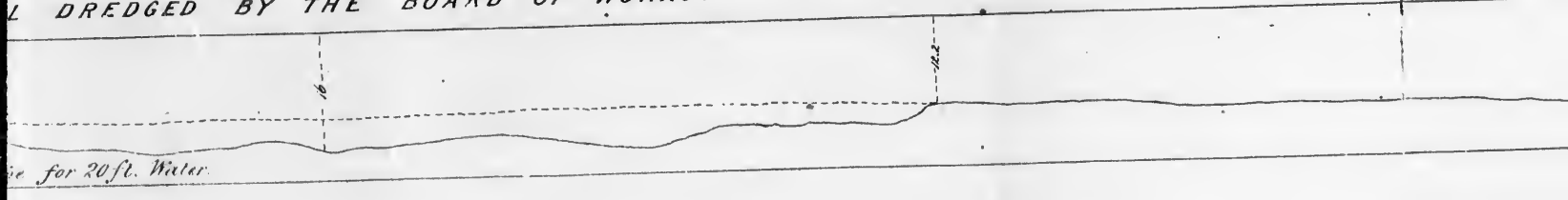


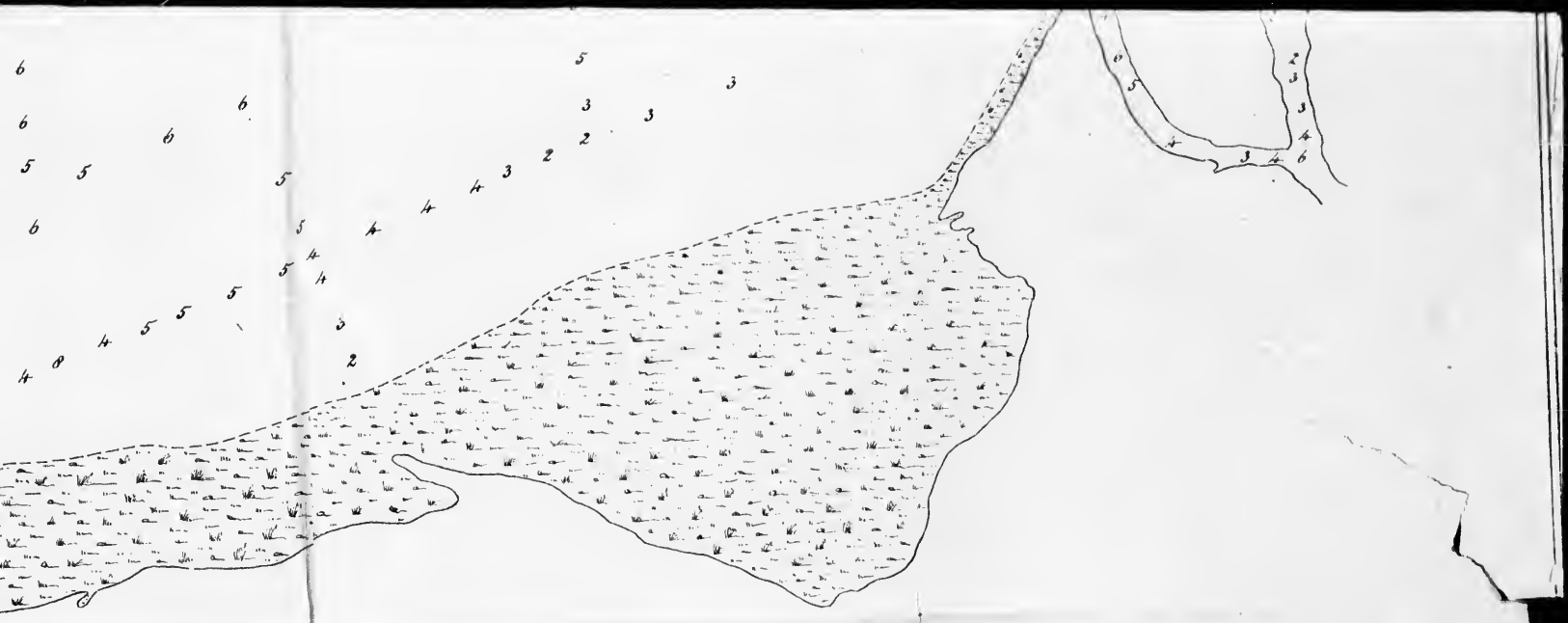
Scale, 20 feet to the Inch.

BY THE HARBOUR COMMISSIONERS.

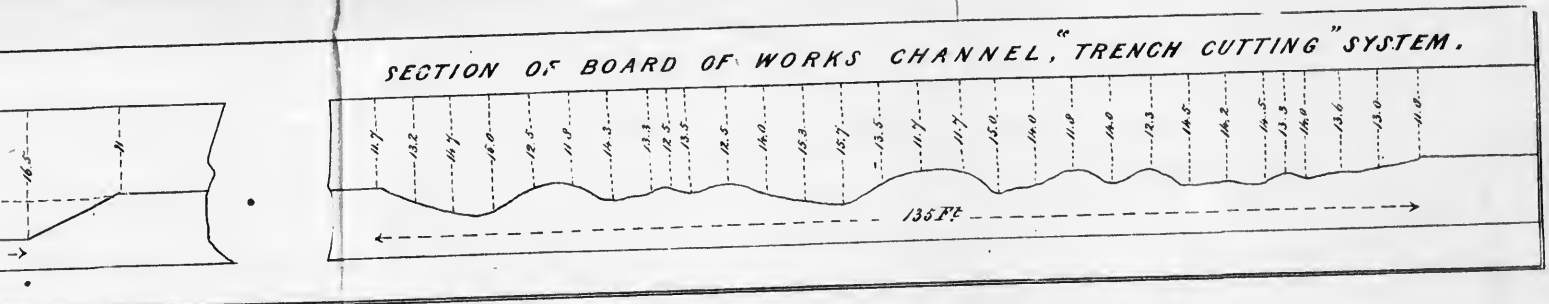


L DREDGED BY THE BOARD OF WORKS.

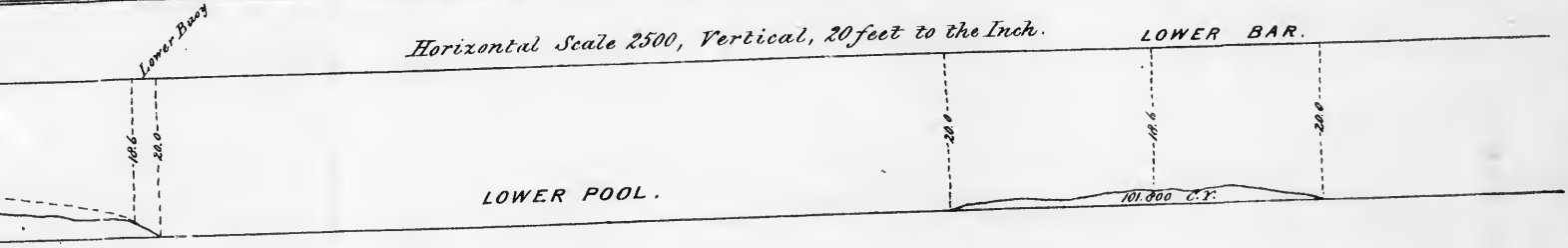


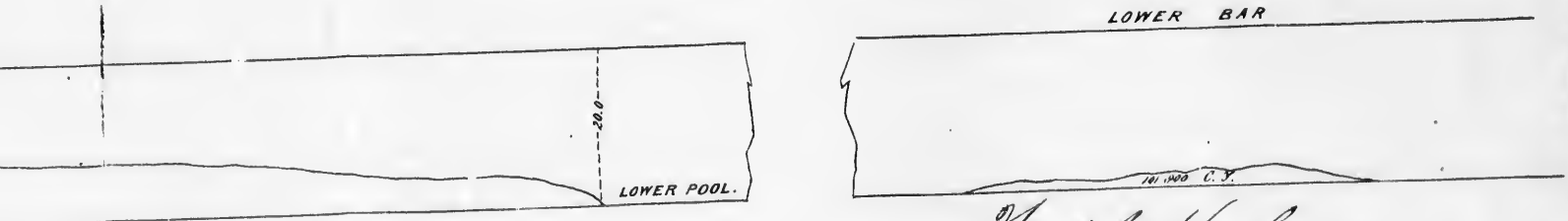


SECTION OF BOARD OF WORKS CHANNEL, "TRENCH CUTTING" SYSTEM.



Horizontal Scale 2500, Vertical, 20 feet to the Inch.





50.000 60.000 FEET

9 10 11 NAUTICAL MILES.

Thos. C. Keefer.

Engr. Harbour Commissioners,

29 Great St. James' Street

Montreal March 1st 1855.