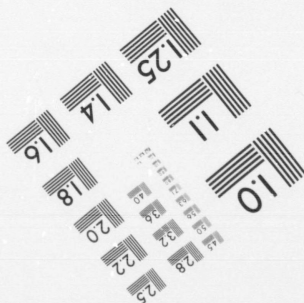
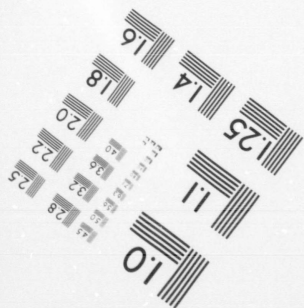
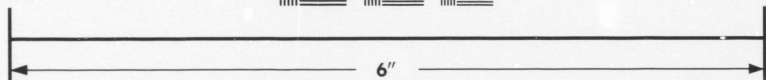
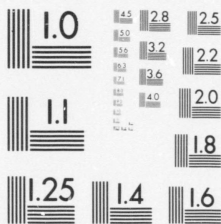


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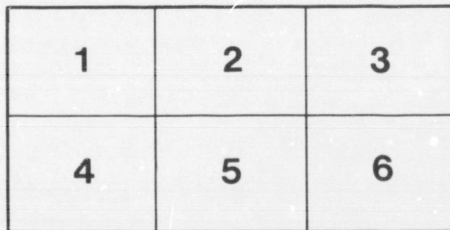
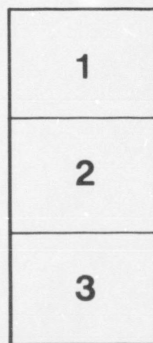
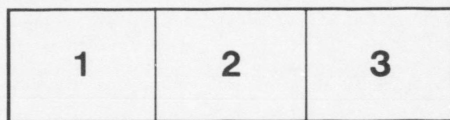
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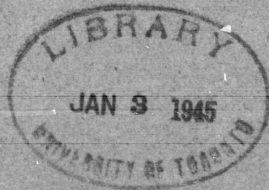
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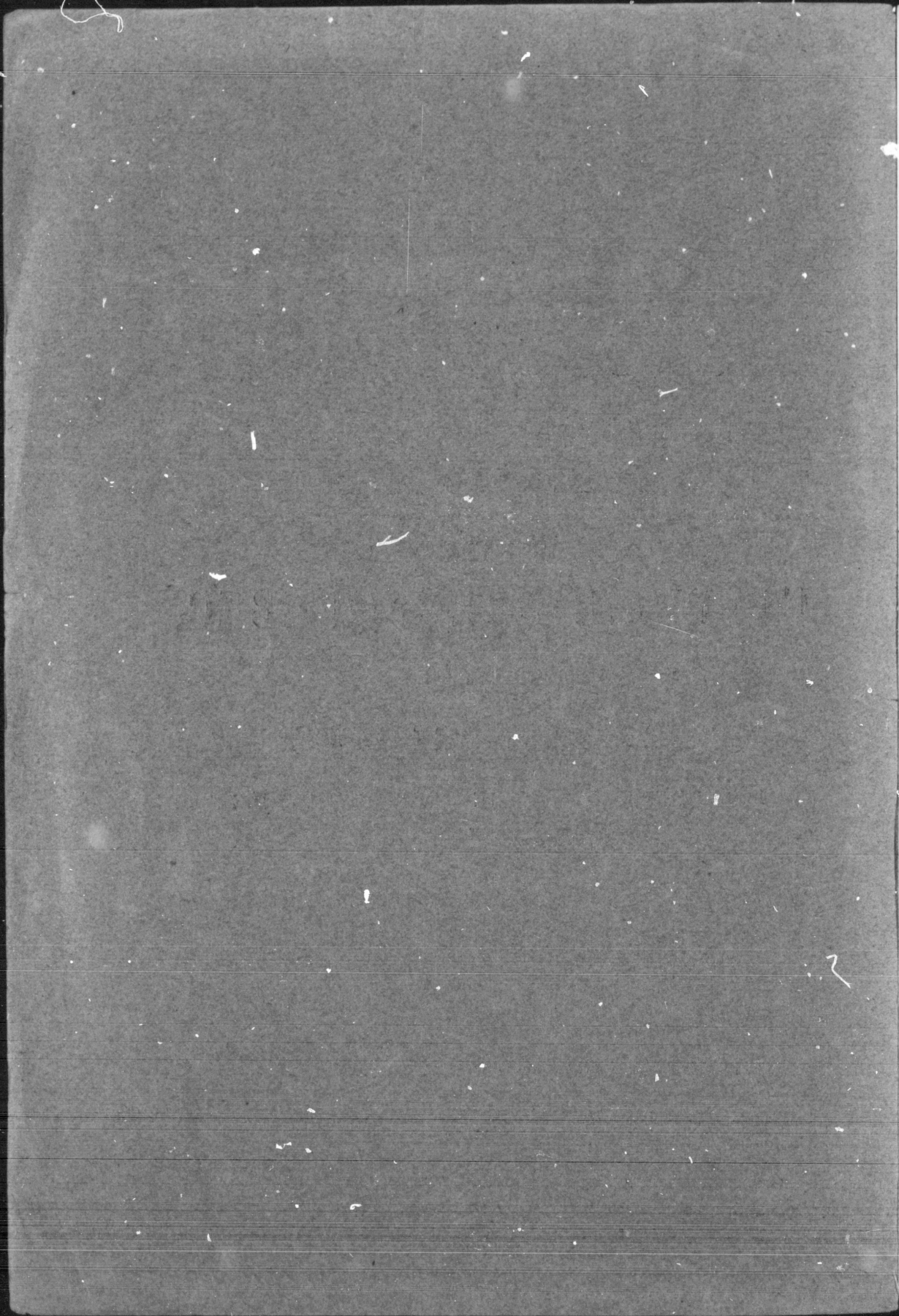
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[*Baillarge, Charles P. Florent*]

REPORT
OF THE
CITY ENGINEER, QUEBEC,
ON THE
PROPOSED DRY DOCK
IN THE MOUTH OF THE RIVER ST. CHARLES.





REPORT
OF THE
CITY ENGINEER, QUEBEC,
ON THE
PROPOSED DRY DOCK
IN THE MOUTH OF THE RIVER ST. CHARLES.

CITY HALL,

Quebec, April 21st, 1876.

*The Mayor and City Council of the Corporation
of Quebec.*

GENTLEMEN,—As joint engineer, on part of the City, of the proposed docks and harbour improvements in the mouth of the River St. Charles, I beg to submit the following information which Mr. Steckel as resident engineer has also reported to G. F. Baillairge, Esq., Assistant Chief Engineer of the Department of Public Works at Ottawa.

Nearly 400 soundings have already been taken at distances apart varying from 250 to 500 feet.

The borings, some 20 in number to date, reach to depths varying from 22 to 72 feet below mean low water mark. Clay and hard pan have been reached at a moderate depth inside the ballast wharf, and clay at a few feet below low water level outside of La-roche's wharf, one of the proposed sites for the graving dock, as already reported by Mr. Morris. There can therefore, in my opinion, be no further doubt as to the possibility of building the dock at this point, and in the ordinary way, with coffer-dam and from a solid bottom.

The borings proceed simultaneously at two different points, two sheds or houses having been erected for the purpose and each of them supplied with a double set of boring tools, which are now worked day and night, as the operation of boring is long and tedious.

Much trouble and delay was at first experienced in removing the material from inside the boring pipes, the inside diameter of which is but $2\frac{1}{2}$ inches, until Mr. Steckel and myself devised a mode of so doing by using an inner tube and pump by which water is forced down the annular space between the two pipes and brings up the sand, clay and pebbles with it through the inner pipe.

Boring artesian or other wells on *terra-firma* is as nothing to the trouble experienced on a sheet of ice which constantly rises and falls with every succeeding tide to levels constantly varying with each ebb and flow of the moon; to say nothing of the fact that the whole ice floe, however compact and apparently immovable to the eye, is as constantly shifting its position by such a number of inches as to necessitate the displacement of the boring house and apparatus at each flow and ebb of the tide to bring the ram to its required position over the boring tube.

The accompanying photographs will afford some idea of the structures, tools and pump-

ing apparatus just alluded to. At the inner angle of the ballast wharf is another shed or house answering as a shelter to the man whose duty it is to note the height of tide at intervals of ten (10) minutes during the day and who is relieved by another party who continues the observations during the night.

The necessity for these tide gaugings has already been made manifest from the fact that whereas the greatest range of high and low water level was supposed by many to be but eighteen to twenty feet, it has already been found to extend to twenty-five feet and may possibly go beyond that figure with the high waters of the following month. But apart from this all-important information as relating intimately to the proposed levels of the sill and upper surface of the dock, it must be apparent that it is only by comparison of the precise moment of time at which the gauge was read and any depth of boring reached below the floating ice, that such boring and all other borings and soundings can be reduced to one uniform datum level.

Mr. Steckel's report to head quarters, of course, goes no further for the present than a mere recital of what has been done and how done, with the cost of the survey to date which, I believe, is some \$3,500.00, though much of the apparatus may be again utilized by the Government in similar operations elsewhere; but it behoves me, I think, at this juncture to set aside all doubts and fears as to the possibility of building the proposed graving dock at the mouth of the St. Charles and at the very point where I have located it on the plan which I lately had the honor of submitting to the Council and of which copies have since been forwarded with the Mayor's compliments to the Governor General and to the Honorable Mr. Mackenzie at Ottawa, as also to the Quebec Board of Harbor Commissioners.

It is a grievous error to suppose, as some do, that such a structure as a graving dock must necessarily be built from and rest upon

a foundation of rock or even clay. We have such massive blocks as the Marine Hospital, here, with nothing but a sub-soil of sand for its support; the Parish Church of Notre Dame in Montreal with its towers 215 feet high rests upon the sand ridge which divides Craig street from the St. Lawrence. There is hardly a dock in England built on anything more solid than clay and sand. I have seen more than thirty feet depth of sand and pebbles below the stateliest and heaviest piles of New York City. Renaud's new block and our Custom House are not on rock. The very ballast wharf itself rests on a shelving bank of sand and yet it holds its own against wind, weather, and waves, against ice and current, and is likely to do so for all time.

It is plain that if an attempt were made to erect a structure of any kind on a mere bank of sand which stood above the level of the adjoining soil and not confined in any way to prevent it from spreading, such structure must sink and settle down, as a vessel on a wave will do in mid ocean till it reaches the level of the surrounding water; but confine that sand between four impermeable walls, and, as a wave of water within the precincts of a canal lock is incompressible and will support the mightiest vessel afloat with its burden of 10,000 tons or more, so will the sand, and *a fortiori*, remain motionless and incompressible beneath the heaviest structure ever dreamed of.

This truth is of too elementary a nature to require proof or further explanation, and I must be pardoned if I have thought it necessary to allude to it in any way, except that it behoves me to make the matter clear to the general public as well as to their more enlightened representatives in the City Council.

What I am about to propose will now be fully and easily understood, nor is it anything new (thousands of structures the world over are founded in this way) excepting, may be, in point of size, and this very element of

size is what will make assurance doubly sure; for, as a matter of course, the broader the foundation, the more stable the structure.

The depth and nature of the soil over the proposed site of dock precludes the possibility of anything like an ordinary coffer-dam, and even if this could be secured the cost of going to such a depth would render the undertaking far beyond the means at our disposal. This is not like the pier of a bridge where an immense weight of masonry rests upon a comparatively small surface, and must therefore be sunk to a more solid bottom to prevent settlement, as at New York, to 86 feet, and at St. Louis to 110 feet below the river.

On the contrary, the difficulty is rather to make the dock heavy enough to prevent the water from floating it when once it reaches bottom. I avoid the necessity of a dam by building a caisson wherein to construct the dock and sink it gradually as it progresses to such a depth only, previously dredged out and levelled, as may be necessary to secure the desired depth of 7 feet at low water over the sill or bottom of the dock; but previously to doing this I dredge to a depth of say 25 feet below low water level, and of sufficient breadth, a trench or channel-like space wherein to sink a wharf or wall of timber and stone filling, around the site to be covered by the dock and caisson, and at a hundred feet or more therefrom. This wharf or wall, its outer face close jointed, and sheathed if need be to make it doubly sure against filtration of either sand or water, will confine the soil on which the dock and caisson rests in such a way as to preclude the possibility of settlement of any kind. Nor need it be apprehended that any action of the water on the soil beneath the surrounding wall or wharf can prove injurious, as the only effect could be to cause a subsidence of the wharf itself without the possibility of affecting the level of the soil within the enclosure. No such wash however is likely to occur, for as I said before, I sink the wharf to 25 feet

or more below low water level, and as this wharf itself is further protected by the present ballast wharf which lies outside of it, and by another section of breakwater, 600 feet or more to the north east of the proposed dock, which is part of my scheme for harbour improvements; far from there being any wash or deepening of the bottom of the tidal basin within the breakwater, the effect is much more likely to be in the future as in the past, a gradual filling up or shallowing of the space surrounding the graving dock. This filling up however of the space just alluded to, after it has once been dredged out as proposed to secure a depth of 25 feet for vessels to lie in at low water, need not be apprehended. True, it has gone on rapidly within the present breakwater or ballast wharf since its construction some fifteen years ago; but this is due to the silt and sediment brought down by the St. Charles River and when once cut off as it will be most thoroughly and effectually by the proposed jetty from the Palais, the filling in will not in all probability be more than to require dredging out the tidal dock once in fifty or a hundred years.

Kinipple & Morris in estimating, as they do, the additional cost of building the graving dock in the mouth of the St. Charles as compared with the rock site at Levis, at some 50 to 60 per cent, had not conceived the idea of a caisson and naturally enough, as in England where timber is scarce and costly, such a gigantic structure of wood, would not likely occur to any one. Their mode of construction, see page 9 of their "Report on sites for a graving dock in the harbour of Quebec" Sept. 1874, consists in dredging out the sand to a depth of 10 or 12 feet below the bottom of the dock and filling in this space with liquid Portland cement. "It is possible," they say, "to dredge out an area in the form of a dock, and deposit concrete over this space for 10 to 12 feet in thickness and to bring up roughly the sides to low water mark. By continuing the sides up to coping level, a shell of great strength

could be formed out of which water would be pumped, and the whole of the bottom and sides lined with masonry, together with the entrance works in the usual way; this method of constructing a dock would avoid the use of a coffer-dam and if properly done would give a water tight dock, and sufficient weight to resist any pressure that could possibly be brought to bear upon its outer surface."

"A dock of this description," they go on to say, "could be formed on any doubtful foundation, even though it were covered by many feet of water at low water."

Kinipple and Morris therefore conclude that a dock may be made in the mouth of the St. Charles or, even as they have it, "on any doubtful foundation," and this without any protection wharf around it to prevent the washing away of the sand or soil from beneath the concrete and the possible settling down and breaking of a portion of the dock when left unsupported from beneath, while my plan of surrounding the dock site by a wharf renders it certain that no such wash can occur, and as I have said before render assurance doubly sure.

But this concrete caisson of theirs, if I may so call it, would cost of itself about \$264,000 while the one I propose, inclusive of the concrete within it to cause it to become heavy enough with the masonry to withstand any pressure from without, would not cost more than \$126,000. The coffer-dam at Levis, the rock excavation and the guide pier would equal in cost the last mentioned sum, if, indeed, it did not greatly exceed it; so that, in reality, by carrying out the project as proposed by me, the graving dock in the St. Charles would cost no more, if even as much

as it would if built at Levis; and if it did, the city is already pledged to pay the difference; so that if it be not built in the St. Charles, reasons other than those of a pecuniary or engineering nature must avail to deprive Quebec of what she is most undoubtedly entitled to. It is not necessary for the present to go into further detail, my only object being to convince the Council and citizens of Quebec, as I am myself convinced, that the proposed graving dock can be built in the mouth of the St. Charles, and that a much greater advantage in every respect is to be had at Levis, at less cost, and in much less time; for the surrounding or protection wharf or wharves form part of my scheme of harbor improvements or wet docks, and are chargeable to another fund. Of this, however, more hereafter.

I have the honor to be,
Mr. Mayor and Gentlement,
Your obedient servant,

CHAS. BAILLAIRGE,
Joint Engineer on Dock and
Harbor Improvements.

P. S.—I have just received a letter from General W. H. Newton, of the United States, in answer to my enquiry in relation to the probable cost of dredging in the St. Charles, and I am happy to state that, as already inferred by me, this dredging, which has usually cost from 20 to 40 cents a yard when done with the usual dipper dredge, as on Lake St. Peter and elsewhere, is not likely to cost more than 5 cents a yard if done by the new process of pumping up the material, as now carried on by General Newton under his contract with the United States Government, and as is also now being done in the harbors of Dunkirk, in France, in California, and elsewhere.

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