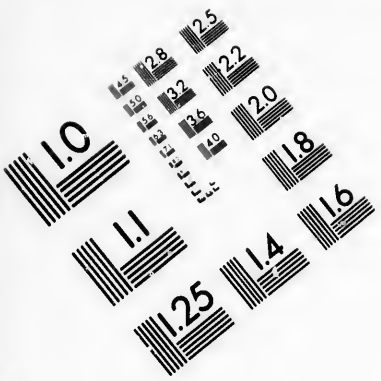

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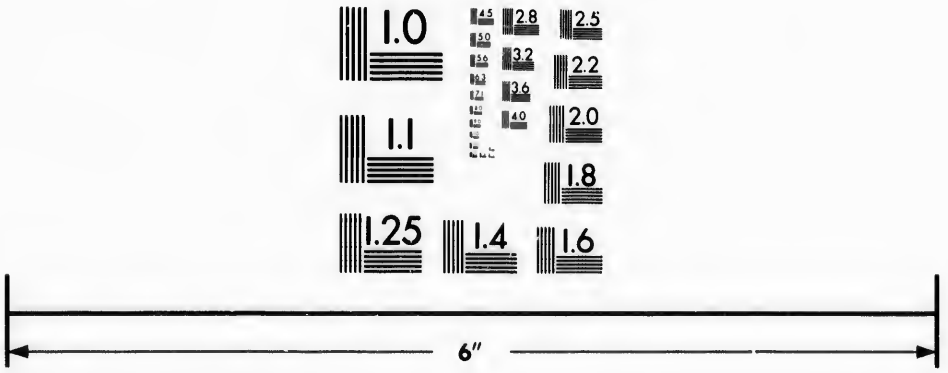

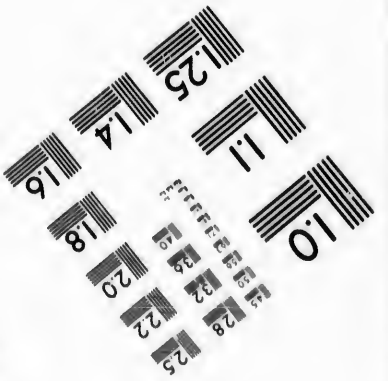

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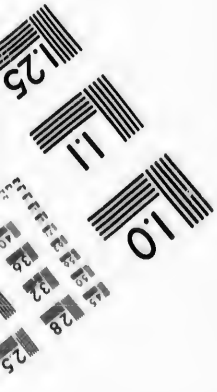

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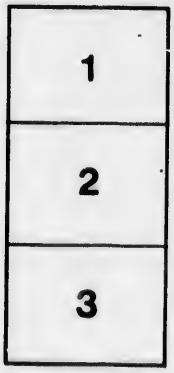

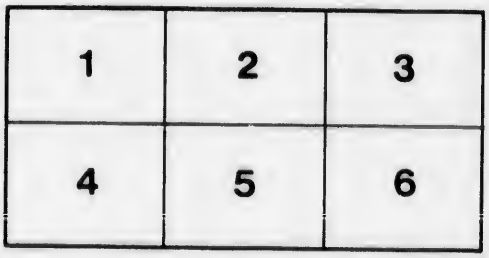

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REPORT

OF THE

CHIEF ENGINEER OF PUBLIC WORKS

ON THE PROGRESS OF

CANAL ENLARGEMENT

BETWEEN

LAKE ERIE AND MONTREAL.

OTTAWA, 1877.

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OTTAWA, 1877.

No. 37.763.

DEPARTMENT OF PUBLIC WORKS,

CANADA.

OTTAWA, Nov., 20th, 1876.

SIR,—I am directed by the Minister of Public Works to inform you that he is desirous of laying before Parliament at its next session, full information relative to the works connected with the enlargement of the canals between Lake Erie and the city of Montreal, as well as of those between the cities of Ottawa and Montreal.

You will therefore be pleased to take the necessary steps to prepare a report on these matters as early as other duties will permit, describing the progress made under the different contracts, together with a statement of what remains to be done in connection with them, and reporting the nature and extent of the works still to be let, also such information as will enable the various matters to be clearly and readily understood.

I have the honor to be, Sir,

Your obedient servant,

(Signed) F. BRAUN,

Secretary.

JOHN PAGE Esq.,

Chief Engineer, P. W.,

Ottawa.

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REPORT

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CHIEF ENGINEER OF PUBLIC WORKS

ON THE PROGRESS OF

CANAL ENLARGEMENT

BETWEEN

LAKE ERIE AND MONTREAL.

OTTAWA, January 30th, 1877.

THE SECRETARY OF PUBLIC WORKS:

SIR,—In compliance with instructions conveyed in your letter, No. 37,763 (copy prefixed) I have the honor to submit the following report on matters connected with the enlargement of the canals, and other works in progress, on the direct line of water communication, between the Western Lakes and the head of ocean navigation at Montreal, &c.

It may, however, first be stated, that all recent general reports on these subjects have had reference to the construction of canals, 100 feet wide at bottom, with locks 270 feet long between the gates, 45 feet in width, and a depth suited to the passage of vessels drawing 12 feet of water. These being the dimensions recommended by a Special Commission, appointed (in November, 1870) to enquire into matters connected with the inland navigation of the Dominion—a conclusion that was subsequently assented to by the Government, and communicated to me officially by your letter of the 22nd July, 1871. These instructions continued to be acted upon until April, 1875, when your letters Nos. 29,863 and 29,864 were received.

The first of these was in relation to the Welland Canal, and directed that all permanent structures on the Summit and Thorold levels, as well as those at Port Dalhousie, should "be adapted to a depth of water corresponding to 14 feet on the "mitre sills of the Locks," and the second directed that "the permanent structures on "the Lachine Canal should also be placed at a like depth."

All the works that were put under contract prior to 1875, were, of course, arranged for a draught of 12 feet of water on the lock sills; they are, however, chiefly on that part of the new line of the Welland Canal, between Port Dalhousie and Thorold, where the walls of the locks, banks of the Canal, and water levels can be raised to give the contemplated depth when required.

The position, nature and extent of the existing works, as well as those proposed for the enlargement, were described in former reports; but provision for the increased draught of water has, in some instances, rendered necessary such changes as will doubtless be more readily understood by drawing attention, not only to the different places, but to the main features of the line and special matters bearing on the respective cases.

It is therefore considered proper to follow this course, although it may result in occasional repetitions of what has been already written on the subject.

The Welland Canal being the first of the series, in descending order, as well as in extent, and certainly not second in importance, it will be brought first under notice, in order following:—

It may be observed that it forms the only navigable connection between the waters of Lakes Erie and Ontario, and that, too, between the nearest available suitable outlets.

The present line is about $27\frac{1}{5}$ miles in length, or about 25 per cent. more than a straight line between its two terminal points.

The difference between the water-surface of the two lakes in moderately calm weather, as near as can be determined, is $326\frac{3}{4}$ feet; but Lake Erie is subject to more sudden fluctuations, and generally to a greater range of variation than Lake Ontario, matters which have more or less influence on the harbors at these places.

The enlarged canal will be about $26\frac{7}{8}$ miles in length, from harbor to harbor. From Port Dalhousie to the upper end of Thorold, an entirely new line is in course of construction, along which the distance is $8\frac{2}{3}$ miles, and from the latter place to Allanburgh, a distance of 3 miles; it is desirable that a new line should also be formed, for the reasons subsequently given.

From Allanburgh upwards, the enlargement for the most part is made, or in course of being made, by widening and deepening the old channel.

Before entering into particulars relative to the progress of the works, it may further be stated that on the 11th of October, 1872, public notice was given to contractors, that tenders would be received for the enlargement of certain parts of the line between Port Dalhousie and Port Colborne, and inviting them to examine the locality before winter set in.

On the 22nd November, 1872, part of the works were advertized, and tenders for them received on the 25th day of January, 1873; but they were not awarded until April of that year.

This delay arose from representations made by parties more interested in other routes than the one recommended in my report of April, 1872, and which, it may be observed, had been directed to be carried out.

These representations led to the appointment of three prominent professional gentlemen, who were authorized to examine the various lines, plans, and other matters, so as to enable them to give an opinion on the subject.

This they did; and on February 1873, advised certain alterations to be made, which on being carefully looked into were not approved, but on the contrary, an Order of the Honorable the Privy Council was passed, authorizing the design submitted in April 1875, to be carried into effect.

At this date, April 1873, Sections Nos. 8, 9, 10, 11, 15, 16, 21, 22, 29, 30, 31 and 32, were placed under contract.

On the 18th October 1873, tenders were received for a number of sections situated at different places on the line, but as many of them were informal, and otherwise objectionable, it was considered best to invite new tenders for the whole.

The works were therefore advertised again on the 29th December 1873, when notice was given "that tenders will not be considered unless made strictly in accordance "with the printed form, and—in the case of firms—except there are attached the actual "signature, and the nature of the occupation and place of residence of each member of the same."

"For the due fulfilment of the contract, satisfactory security will be required on "real estate, or by deposit of money, public or municipal securities, or Bank stock, to "the amount of 5 per cent on the bulk sum of the contract, &c."

Under these conditions tenders were received on the 21st January 1874, and shortly afterwards the contract for the works were awarded for sections Nos. 2, 3, 5, 6, 7, 13 and 14, all of which are situated between Port Dalhousie and Thorold.

It may here be stated that section No. 12 was not let at that time, as it was thought best in the first instance to inform the Great Western Railway Company that the new portion of the canal would cross that part of their line situated on the incline

south east of Merritton. To the proposition of carrying the track over the canal by means of a swing-bridge, strong objections were urged on behalf of the company, which led to considerable delay before anything like a satisfactory understanding could be arrived at. This was, however, at least effected, and the arrangements made will be subsequently referred to, in connection with the works on the section.

On the 24th June 1875, tenders were received for sections Nos. 1, 4, 12, 23, 24, 25, 26, and 36, and the works were shortly afterwards awarded.

In the contracts generally, April, 1877, is fixed as the time for completion, but Section No. 36, Port Colborne Harbor, is not to be finished until June 1878.

The sections are numbered from Port Dalhousie upwards, and are for the most part from a mile to one half of a mile in length.

Appended will be found a full and descriptive report (prepared by Mr. Thomas Monro, engineer in charge of the northern Division of the works executed, and generally what remains to be done, under existing contracts, on the new line between Port Dalhousie, and Marlatt's pond, situated a short distance above the village of Thorold. This, together with the following remarks, will, it is believed, enable a tolerably fair idea to be formed of the nature, extent and present condition of the different parts of this division of the works.

SECTION No. 1.—embraces the enlargement and deepening of Port Dalhousie Harbor, the extension of the east pier 300 feet farther out into Lake Ontario, building docking on both sides of the new part of the basin, enlarging the present waste-weir so as to regulate the water in both the old and new canals, the construction of a lift-lock, with its upper wings extended to form abutments for a swing-bridge, to carry the traffic to and from Port Dalhousie.

The area of the present harbor is about eight acres, but when the works now under contract are completed, it will have an area of sixteen acres, and at the lowest stage of the water, there will be a depth of at least 15 feet, at the tail of the new lock, and 16 feet at the inner end of the entrance channel.

The lower or outlet lock of the present canal is on the west side of the basin, about 900 feet from the landward end of the entrance piers. It has generally a lift of from 12 to 13 feet, and a depth on the lower sill of 12 feet at low water.

The new lock is to be placed on a salient point on the east side of the harbor, and in such a position that the lower wings will be about 1,600 feet south of the inner ends of the piers, and in such a range that when the centre lines through both the old and new structures are produced, they will be 400 feet apart, opposite the lower gates of the old lock, and 550 feet apart, opposite the upper gates of the new lock.

The space between the locks, is chiefly a made bank, from 150 to 250 feet in width, part of which is used for a public road, and towards the eastern end of it, two flouring mills have been built. A small saw mill that stood there, had to be acquired, in order to

obtain space to form a suitable outlet from the Waste Weir—the discharge from which, as well as from the tail races of the mills, is intended to pass through a series of openings, left in the west docking for that purpose.

The bank referred to forms a dam, that retains the water in the valley of the Twelve Mile Creek, and renders it navigable to the second lock of the present canal, near St. Catherines, a distance of fully three miles. The lower part of this reach is a wide, land-locked basin of fully thirty acres area, with a depth generally of at least 16 feet—a sheet of water that can be used advantageously by vessels, for additional mooring space, when the harbor is crowded.

In the new part of the basin, there will be eight hundred lineal feet of available docking on the east side, and nearly one thousand feet on the west side.

The contractor for this section, has succeeded in making favorable arrangements, for the dredging operations required upon it. A large portion of the addition to the harbor, as well as part of the space between the entrance piers, has been already sunk to the full depth. The latter, for the distance to which the work has extended, has been made sixteen and a half feet at extreme low water, for a width of one hundred and seventy feet, or to within fifteen feet of the side piers, which are, throughout, two hundred feet apart.

There is, however, good reason to believe, that the depth, along the western side of the channel has diminished, and that it will continue to get less until some way is adopted, to prevent sand, during westerly storms, passing through the pier.

Occasionally the cribs forming the lower part of it, are several inches apart, and at some places the range of them is inside, and at others considerably outside of the line of the superstructure.

This condition of matters has prevented the sheeting, put on the west side of the pier under the direction of the Canal Superintendant, from answering the purpose contemplated, as the plank at some places cannot be got down low enough, at others there is great difficulty in fastening the bottom of them, and generally they cannot be properly secured.

It is of course desirable that the pier on that side, should in some way be made tight, as the surf along the beach, in a westerly gale, becomes charged with sand and silt ; whilst the water frequently rises so as to form a head of several feet on the structure the result of which is to force a large quantity of sand through it, which is for the most part deposited in, and alongside of the channel,

Contractors were informed, when the works on this section were about to be let, that at several places, the material to be removed, consisted of indurated clay, and cemented gravel ; but it is proper to remark, that a place on the east side of the new part of the harbor, and the bottom of the lock pit, have turned out to be even harder than anticipated, as at these places rock has been found.

This rock is a kind of hard, red sandstone, which, although irregular both as regards the surface level, and nature of the material, will form a good foundation for the bottom timbers of the Lock ; except for a short distance near the north-west corner of the space, where they will have to be placed on a moderately thick stratum of concrete well confined.

There is reason to believe that similar arrangements for securing the mitre-sill platforms will be required at this place, as in other cases where the foundation is rock ; that is to say, instead of ordinary sheet-piles, it will be necessary to use stop-water ttimbers, let into checks cut in the bottom for the depth required, as described in the general specification.

It is to be regretted, that the excavation for the foundation of the lock on this section was not sufficiently advanced to admit of laying the bottom timbers, and building at least one course of masonry, before the time arrived when all such operations, had, of necessity, to be stopped for the season.

All the timber for the bottom has been, however, provided, a large portion of the stone quarried and cut, and such other preparations made, as will enable the work to be proceeded with expeditionsly as early as the weather will admit next spring.

Section No. 2,—is about 2,700 feet in length ; it extends from a point a little south of the main road, between St. Catharines and Port Dalhousie, and continues on a line, partly curved, through what is known as May's Ravine, to a distance of nearly three hundred and sixty feet, into the basin above the first lock.

The works on this section embrace the construction of Locks No.'s 2 and 3, the lower one of which is to be placed on a point, that projects out on the south-west side of the ravine, at a distance of about 1,700 feet above the head of the entrance lock. In this stretch across the basin there is generally a depth of 16 feet of water ; except for about 400 feet adjoining the first lock, where the depth varies from 9 to 15 feet.

When this section was placed under contract, the locks upon it, as in all other cases, were intended for the passing of vessels of a draught not exceeding 12 feet. With a view, however, of carrying out subsequent instructions, it was considered proper to make arrangements, to lower the bottom of the second lock so as to have fourteen feet of water on the lower sills. This was believed to be necessary, as the water level below it cannot be raised without flooding a large extent of low land, in the vicinity, and seriously interfering with existing works.

In order to form a suitable approach to this lock, it was intended to sink a narrow line of pier work, on both sides of the lower entrance, and to form the upper part of masonry; but the bottom was found to give so unequal a bearing, that narrow crib work, when sunk, formed a very irregular line; it therefore became necessary to place the

cribs transversely, instead of longitudinally. This arrangement, although it has not secured straight lines, gives such a general range as admits of placing on both sides, a timber superstructure, on moderately fair lines.

The lock pit has not been excavated to the depth necessary for the foundation; but the greater part of the material required for the structure, has been provided and a quantity of it delivered.

On the east side of the canal, near this place, a regulating weir has been constructed, the upper west wing of which connects with a dam, built across the ravine, on a line ranging with the east upper wing wall of the lock.

This dam is built of coursed masonry resting on a platform, of timber and plank, which is also laid upon a stratum of concrete, placed so as to bring to a level surface, a bed of hard clay and gravel, that was found after removing a considerable depth of soft material, from what appears to have been the bed of a former water-way. The structure is about thirty-eight feet high; but its thickness is much less, than would have been necessary for an unsupported dam of that height; for the reason that it is backed up with material from the excavation, for at least twenty feet in height on the canal side, and for nearly its full height on the lower side.

The reach between the second, and third locks is 1,300 feet long, and, from its occupying the greater part of the ravine, is about 217 feet wide at the surface water line; giving an area of fully 6¼ acres. It was therefore believed that in such a case, the expense of forming an independent supply-race, might reasonably be avoided.

As the third lock adjoins the main road, between St. Catharines and Port Dalhousie, the upper wings of it have been extended to form the abutments of a swing-bridge for the road traffic. And on the same line abutments for a fixed bridge over the race-way have also been built.

On excavating the pit for the foundation of this lock, it was found, at the depth required, the bottom consisted of quicksand, so much charged with water, that, at places, the material yielded in every direction when a person attempted to walk on it. This was looked upon as so serious a matter, that it led at first to the impression, the site of the lock would have to be changed. On, however, considering the matter, it was decided, that, by confining the quicksand, and forming an artificial crust over it of a suitable thickness, a foundation would be obtained which, with other precautionary measures, would be certain to answer all the purposes required.

In order to carry out this plan, a pit was sunk a short distance beyond the lower end of the lock, and connected with channels, cut on each side of the bottom, of a depth which drained the material that had to be taken out. On the water being kept well down at the lower end, the material for a stretch, the full width of the pit at the upper end, was removed to form a place for a stratum of concrete two feet in depth.

This mode of operation was continued until a crust of concrete, two feet in depth, was formed over the entire foundation, at the level suited to receive the floor timbers. The trenches cut for sheet piles at the mitre sill platforms, were also filled with concrete, and a trench cut fully five feet in depth across the lower end of the foundation, was, in like manner, filled with concrete.

The plan adopted, it may be observed, has been quite successful, as the walls have been carried up the full height,—except the coping,—and there is no perceptible crack in them, or any indication of unequal settlement.

SECTION No. 3,—is about 2,500 feet long, and embraces the construction of two lift locks, two regulating weirs, and two towing path bridges, the formation of the canal, and a supply race.

The regulating weirs have been built, as well as several of the abutments, and piers, for bridges over the transverse channels, which form a connection between the supply race, and the respective reaches. The masonry of the upper lock (No. 5), except the coping, is completed, and three-fourths of the masonry of the fourth lock has been laid. All the materials for other parts of the work on this section have been provided, and the excavation is well advanced.

SECTION No. 4,—embraces the cutting, and formation of the canal, for a distance of 3,250 lineal feet,—the excavation and grading required, to form a new line for the Welland Railway, for a distance of 5,944 feet,—also the construction of piers and abutments for two swing-bridges, one for the railway above mentioned, and another for a road leading to St. Catharines.

On this section, the canal line crosses that of the railway, at the place where the track is very little higher than the surface of the ground, and where the surface water of the canal will be about five feet over the ground line. It therefore became necessary, to change the line of the railway, and extend its grade, for a distance of about 1,500 feet, but at the same time to keep the inclination on the line less, than to the northward of where the change is made. This was done so that the track would be, at least, 6 feet over the canal surface, and have a stretch of 1,100 feet level, on the north side of the bridge, and 2,200 feet level on its south side.

This change will be made without interruption to the traffic of the road, and the arrangements throughout, are such that the approaches to the bridge, on both sides, are as advantageous to the road, and safe for the public, as they can possibly be under the circumstances.

The construction of the railway bridge, has not yet been commenced, but the piers, and abutments, for the common road bridge, are well advanced towards completion.

The earth excavation is nearly completed; which it may be stated, greatly exceeds the quantity originally estimated, as a bed of sand overlying the clay, was found to extend a considerable distance along the line.

The sand had not only to be removed, but other materials had to be excavated, and brought on to occupy its place.

SECTION No. 5,—is 3,200 feet in length: it includes the construction of Locks Nos. 6 and 7 (placed 1,500 feet apart), also two regulating weirs, and two towing path bridges, over the openings into the different reaches, from the race-way formed on the east side of canal.

On examining the bottom of both the locks on this section, the material was found to be of a soft yielding nature, when kept for a short time moist; but when exposed to the action of the sun, the surface soon hardened, and seemed to shrink, and leave wide, deep cracks in every direction through it, to such an extent, that it was feared there would be considerable risk, in treating it as an ordinary clay foundation.

It was therefore decided, that a foot in depth of the material, over the entire area of the bottom, should be removed, and a like depth of properly made concrete be substituted for it, and laid to form a uniform bearing surface, for the floor and foundation timbers.

The trenches cut for the reception of sheet piles, at the mitre sill platforms, as well as those at the lower ends of the locks, were filled with concrete, also the spaces between the timbers in the chamber, and at other places, where it could be advantageously used The item of concrete alone, it may be observed, involved an expenditure of upwards of $20,000 for the foundations of the two locks.

The masonry of the upper lock on this section, is now all but completed, and fully one-third of that of Lock No. 6 is laid.

The upper wings of the lower lock, from a foot below the bottom of the upper reach, are to be extended, to form the abutments of a swing bridge, for public travel along Geneva Street of the city of St. Catharines; and the abutments and pier, for a fixed bridge, on the same line over the raceway, are to be built.

The masonry of the two regulating weirs, and of one of the towing path bridges is finished.

It may here be stated, that the operations on this section, furnish a rare instance of sub-contractors, not only pushing on their work expeditiously, but manifesting, throughout, a disposition to execute it in the best and most satisfactory manner.

SECTION No. 6,—is about 7,000 feet long; it embraces the formation of the canal for that distance, the construction of piers and abutments for a swing bridge, to carry the traffic over the canal, that passes by the way of Niagara Street, St. Catharines, and the building of abutments, and a pier for a towing-path bridge.

The excavation and embankment on the section is well advanced, but a like remark as was made relative to section four, is applicable in this case, namely:—a bed of sand was found to extend a considerable distance along the line, which had to be

removed, and other materials excavated, and brought a considerable distance to occupy its place, as well as other precautionary measures adopted, to render the banks impervious to water.

The masonry connected with the swing bridge is in a fair state of forwardness ; but the masonry of the towing-path bridge, has not been commenced.

Section No. 7,—extends from a point a little south of the road between St. Catharines, and Queenston, for a distance of 3,975 feet downward. On it there are two lift-locks, two regulating weirs, two towing-path bridges, and the abutments, and piers to carry the traffic of the road above mentioned.

On excavating the foundation for Lock No. 9, or the upper one on this section, it was found that the bottom was of a nature, similar to that previously described for Locks Nos. 6, and 7, except that when moist it seemed to get even softer, and when dry the cracks through it were larger and deeper.

It was therefore decided that fifteen inches in depth of the material, below the regular line, should be removed for the whole area of the bottom, and a stratum of well made concrete, laid on in layers, substituted for it, so as to form a bearing surface for the foundation timbers.

The sheet-pile trenches at the mitre-sill platforms, and at the lower end of the lock are filled with concrete, also the spaces between the floor timbers.

In the lower lock on this section, a bearing surface, formed of one foot in depth of concrete, projecting inside the line of the walls, is laid on both sides of the bottom, on which the foundation timbers rest.

The piers and abutments for the swing bridge, on the main road from St. Catharines, eastward, are completed. In this connection it is considered proper to state, that the contractors have executed this portion of the work themselves, and that they have done it well.

The walls of the upper lock are finished; except, that part of the coping has to be put on: the lower lock is carried up two courses in height, one of the regulating weirs is completed, and the abutments and piers for the towing-path bridges are either finished, or well advanced.

It is to be regretted, that in carrying on the lock masonry on this Section, some of the leading objections to allowing large, important, works to be sub-let, have been fully manifested; which has led to much dissatisfaction, and caused a vast deal of unnecessary trouble, to get the work even moderately well executed.

Sections Nos. 8 and 9,—are included in one contract; which embraces the formation of the canal, for a distance of 6,338 lineal feet, the construction of three lift locks, three regulating weirs, four bridges over the openings, between the side basins, and reaches,—the construction of abutments, and piers for a public road bridge, and a culvert to pass the waters of the Ten Mile Creek.

The walls of all the three Locks Nos. 10, 11, and 12, are carried up to the full height to receive the coping, a few pieces of which have been laid, and a considerable portion has been delivered and cut. The masonry of all the regulating weirs, and two of the towing path bridges is finished, and the others are in a state of forwardness. The culvert, to carry the waters of the Ten Mile Creek under the canal, consisting of two arched openings, each 8 feet wide, has been in use for the past two years.

The abutments, and piers, for the road bridge have not yet been commenced, but part of the material has been prepared and delivered.

The greater part of the excavation has been done; and the works generally ,are in an advanced state.

On these Sections, the lock masonry has been sub-let; nevertheless it has been conducted in a manner that, with close attention, a very fair class of work has been obtained.

At a short distance, above the head of the eleventh lock, is the termination of a continuous straight line, along the channel, from a point near the fourth lock,—a stretch of about 4½ miles.

From the point above mentioned, the line curves slightly to the west, then it again follows a straight course, for about five-sixths of a mile, on this stretch five of the locks are situated.

Section No. 10,—is 2,107 feet long, and embraces the construction of Locks Nos. 13, and 14,—building two regulating weirs,—the piers and abutments, for the towing path bridges,—forming basins, on the west side of the canal, making up, and grading the approaches to a bridge seat, formed by extending the lower wings of the thirteenth Lock.

After the foundation of the upper lock on this section, had been excavated to the contemplated depth, the material was found to be of a similar nature, to that described for Locks Nos. 6, 7, and 9: it was therefore decided to remove it, for a depth of fifteen inches, over the entire area of the bottom, and substitute a like depth of concrete, on which the foundation timbers were subsequently placed.

Concrete was also used in the sheet pile trenches, at the mitre-sill platforms, and at the lower end of the lock; as well as between the timbers in the chamber, and at at other places where they were laid a few inches apart.

In Lock No. 13, the space between the foundation timbers, and the sheet pile trenches, were filled with concrete, as the works progressed.

The walls of the thirteenth lock, and the extension of the lower wings for a bridge seat, are carried up to the full height to receive the coping—the regulating weirs, and principal parts of the towing path bridges are completed—about two-thirds of the

masonry of the fourteenth lock is laid, and a considerable quantity of materials has been prepared, and delivered for the completion of the works.

Section No, 11,—extends for a distance of 2,250 feet, and includes the construction of two lift-locks, a regulating weir, two or more towing-path bridges, and a culvert under the canal for a public road.

The latter, it may be stated, is completed, but has not yet been brought into use. It is fourteen feet wide in the clear, and fourteen feet high to the underside of the arch, which is 291 feet long. The total length from the outer end of the wings on one side, to a like point on the other side being 331 feet.

The culvert is situated on that part of the Thorold and St. David's Road, where inclinations to and from it are unusually favorable, and where efficient drainage has been obtained, at very little expense.

It is quite true that the culvert, has cost more than the first outlay, required to build a swing-bridge; but it should be borne in mind, that its future maintenance, will be only a small percentage, of what would have been necessary to keep up a bridge; besides there can now be no delay, either to the navigation, or the traffic of the road; whilst the public safety has been in every way fully secured.

The lower lock on this section, or the fifteenth from Lake Ontario, has been carried up to the height, required for the coping, part of which has been put on, and nearly one-third of the masonry of the sixteenth lock has been laid.

The regulating weir and two towing path bridges are completed; and there is a quantity of materials prepared and delivered for the works.

The upper regulating weir, connected with this section, is really within the boundaries of section twelve, and cannot be built until the line of the Great Western Railway is changed; it is therefore questionable whether it can strictly be considered as a part of the contract for Section No. 11.

It may be stated, that the whole of the works on this section have been sub-let, and, that under the circumstances, there is reason to believe, it is better that this should have been the case; although there has been a good deal of difficulty in getting them properly executed.

Section No. 12,—extends for about 2,115 feet, on the line of the canal, and embraces the formation of the channel, and basins along its North-western side,—the construction of two lift-locks, two regulating weirs, and two towing-path bridges. It also includes all the works connected with the formation of about 7,500 feet of new line, for the diversion of the Great Western Railway, including, for that purpose, the construction of a culvert, or tunnel under the canal.

On this section, the line of the canal crosses the track of the Great Western Railway, at a place where there is a grade of about 38 feet to the mile, for a long distance on both sides of the intersection.

It was therefore urged by the representatives of the company that, under these circumstances, they could not consistently consent to have the track carried over the canal by means of a swing or draw bridge, not only from the delay to which their trains would be subject, but from the danger that must inevitably result to the travelling public.

They, at the same time, submitted a sketch plan, showing that a tunnel might be constructed under the canal, for the passage of the railway traffic, and stated they would be fully satisfied if it was carried out. After considerable discussion on the subject, it was arranged that the line of the railway, should be changed as nearly as possible to that indicated on the plan, that this fact, together with a number of conditions discussed, and agreed to, should be embodied in a written memorandum, and signed by the proper representative of the Great Western Railway Company, and by the Minister of Public Works on the part of the Government.

There was, however, considerable delay in getting this document executed, which, it is believed, could not well be obviated, in the state of the Company's affairs at that time. It is dated the 22nd day of April, 1875, and provides, amongst other matters, that the "Department of Public Works shall construct a tunnel under the Canal at a "point above Lock No. 18, and do all the work required for forming a connecting link of "railway, through and between it and the main line; this connection to be in the "aggregate about 7,500 feet in length."

In no case is the curvature to be "less than 1,443 feet radius, and the gradient "nowhere result in more than 42 feet per mile, either in the connecting link, or in the "adjoining existing line; the cutting to be at least 24 feet wide, and embankments 18 "feet wide on top, and the workmanship throughout to be executed in the best "manner."

"The Great Western Railway Company agree to pay for the necessary right of "way for the new line, other than where it passes through Government property. In "the latter case, the Company to receive a title from the Department of Public Works "to such a quantity of Dominion land as may be reasonably required for the cuttings, "embankment, drainage, &c., of the new line."

"The Railway Company to convey to the Department of Public Works, such of "their lands connected with the present track, as lie between the east and west "boundaries of the property, recently purchased by Government for canal enlargement."

"In consideration of the Government constructing the line of railway, tunnel, &c., "instead of building a draw-bridge, as originally contemplated, the Company agree to "waive all claims for prospective losses, arising from increased length of line, curvature "grade, or any cause whatever, connected with the operation, or maintenance of the line, "when constructed in the position above indicated."

The tunnel is 665 feet long, and including the wings, 713 feet; it is 16 feet wide in the clear, and will be 18 feet high in the centre, over the level of the rails.

Through the tunnel, the track will be nearly level; to the westward of it the grade will be about 21 feet to the mile, and to the eastward it will at no place exceed the inclination agreed upon, 42 feet to the mile.

To obtain these grades, the excavation for part of the distance in the centre of the cutting, varies from 30 to 35 feet in depth, gradually diminishing at both ends of the line.

The present contract embraces all the work to be done on the new line, to bring it to sub-grade, between the points before mentioned.

To guard against injury to the Canal, as well as to carry out, in every respect, the agreement made with the Railway Company, the works throughout are to be of the best and most substantial class.

There is no doubt whatever, that the construction of a swing bridge, would have been the least expensive way of, carrying the railway over the canal; but, keeping in view the heavy grade there would have been on both sides of it, and the great extent of passenger, and other traffic which passes over the line, it will be evident that a course has been adopted, by which the probability of accident is greatly diminished, and delays to the communication, both water and rail, fully guarded against.

The masonry forming the sides of the tunnel has been, for the full length of the structure, carried up to an uniform height, over those parts of the foundation, at both ends, and over the middle five hundred feet in length, the height is about eight and a half feet.

The railway culvert, for passing the waters of the Ten Mile Creek, has been lengthened, and a considerable extent of excavation for the new line of Railway done.

The foundation and floor of Lock No. 18, have been laid, and the walls built up to the height of eight and a half feet—a large quantity of stone has been delivered and prepared; but neither the foundation of Lock No. 17, nor the works connected with the weir have been commenced.

The contractors for this Section must therefore be urged to greater expedition for the future.

Section No. 13,—is about 2000 feet in length, it embraces the construction of two lift-locks, two regulating weirs, two towing-path bridges, and the formation of basins on the north side of the canal.

In the upper lock on this section, fully one half the quantity of masonry has been laid—in the lower lock the foundation is completed, and a course of masonry laid for both side walls—the foundation of the regulating weir laid and secured, and the works, as a whole, are well advanced.

The works on this section are sub-let, and the parties in whose hands they now are require no great pressure to push on the operations; although they have to be persistently reminded about the class of work covered by the contract.

SECTION No. 14,—is 1775 feet long: it includes the construction of Locks Nos. 21, and 22, two regulating weirs, and three towing-path bridges, besides the formation of the channel, and basins on the north side of the line.

On excavating the foundation of the upper Lock (No. 22), part of the bottom was found to be of rock and part clay. The rock being a soft shale ranging obliquely across the pit, the upper part of it, for a depth of six inches, was taken off, and the clay, for a depth of 15 inches was also removed. The height to form an uniform bearing surface for the foundation timbers, was afterwards in both cases, made up with concrete.

The trenches for the sheet piles, the spaces between the floor timbers, as well as the space between the side walls and rock, were also made up with concrete.

The masonry of the twenty first Lock, from Lake Ontario upward, was finished in the latter end of May 1876.

It was the lock first completed on the new line of canal.

All the other structures on the section have since that time been finished, except one of the regulating weirs, the stone for which has been prepared.

SECTION No. 15,—is about 2050 feet in length. It is situated to the east of the town of Thorold, in a ravine which appears to have been to a great extent formed by the head waters of the Ten Mile Creek.

It includes the formation of the Canal for the distance above stated—cutting a supply race on the east of the channel—forming a new water course for the creek, and all the excavation necessary to admit of moving the track of the Welland Railway, about one hundred and twenty feet to the westward.

It also embraces the construction of two lift locks, two regulating weirs, piers, and abutments for a road bridge, retaining walls, &c.

The principal part of the ravine above-mentioned is owned by the Welland Railway Company, and the central portion of it, at the time of commencing the works. was occupied by their track.

This line having been considered for many reasons the best for the Canal, provision was made in the contract to cut a sufficient width off the west bank, to admit of moving the railway track to a position, where it would be outside the range of the canal works, and at the same time be beneficial, rather than otherwise, to the line itself.

This work was necessarily the first undertaken, and from its extent and nature occupied considerable time; but the change was ultimately accomplished, even to the

satisfaction of the railway authorities, with whom, it may be stated, arrangements were made to find both the ballast and the iron, and do all the work necessary over sub-grade.

Before changing the railway line, a channel of sufficient capacity had to be formed to carry off the waters of the Ten Mile Creek, which rise to a considerable height, and come down rapidly during snow-floods, and rain storms of long continuance.

This channel is between the railway and canal works; both sides of it are of a good class of dry rubble masonry, and where the bottom does not consist of rock in position, it is made of closely-laid pitched-stone, having throughout an inclination of 83 feet to the mile, or about the same grade as that of the railway.

The space through the ravine, although wide, is not of such dimensions as admits of forming, what may be called a basin between the two upper locks; still, the canal itself is over the general width, and there is a race-way outside 58 feet in width, which connects with it at several places.

It may be observed that, although the supply in rear of Locks Nos. 23, and 24, is on the east side of the Canal, and the weir at No. 22 is on the north-west side, there will not be an oblique current in that reach due to the full supply, as part of it will pass on the south-east side of the latter lock, through a conduit made for that purpose.

In the pit excavated for Lock No. 23, the dip and irregularities were such that, the southern end was 22 inches lower, than at a point 260 feet farther north, where the rock was at the right height; consequently, an average of 11 inches in depth of concrete, for the entire width of the pit, and for the distance above-mentioned, was necessary, to form a proper bearing for the foundation timbers. Concrete was also used between the floor timbers, and in the transverse trenches, and at places adjoining the rock in rear of the walls.

The masonry of this lock is considerably more than half laid.

When the pit was excavated for the foundation of Lock No. 24, the rock was found to be broken, and so very irregular, that its surface varied from 3, to 36 inches, below the level suited for the floor timbers. This space for the full width of the pit had to be made up with concrete, of an average depth of fully 18 inches. Concrete was also used between the timbers, and for the trenches across the foundation.

The walls of this lock, together with the extension of the upper wings, to form abutments for a road bridge, are carried up to the full height to receive the coping.

In this connection, it may be stated, that in order to avoid constructing a separate high bridge, for the macadamized road between Thorold and Clifton, it is proposed to change the line of the road slightly, on the east side of the canal, so as to cross immediately above Lock No. 24, by means of a swing-bridge, and on the same line over the raceway, on the east side, and Welland Railway on the west side, by means of high level fixed bridges.

This line will enter Thorold nearer to the business part of the village, and from the east end of the range of bridges, a road will be formed along the east side of the ravine for the convenience of parties residing in that vicinity, as well as affording access to the Thorold cemetery.

The regulating weirs on this section are not yet commenced, and there is still a considerable extent of the retaining walls to be built. It may therefore be said that, although a large extent of work has been done on this section, it is still far from completion.

Section No. 16,—is 3500 feet long. The work upon it consists chiefly of such, clay and rock excavation, as may be necessary to form a channel way of the dimensions required by the position of the line—the construction of a syphon culvert to pass the waters of the "Ten Mile Creek"—building slope and retaining walls, &c.

It passes through the same ridge as the present line of canal above the village of Thorold; but the rock cutting upon it is of greater extent longitudinally and of course transversely, besides the surface inclination being toward the east, the cutting is deeper than upon what is called the "Little Deep Cut."

The culvert under the canal has been completed, which together with the channel way from it, as well as that part formed on Section 15, have all been in use for the past two years.

About three-fourths of the dry wall has been built. The clay excavation is well advanced, but there still remains fully 40,000 cubic yards of rock to be removed to complete the work on this section.

From the upper end of Section No. 16 to the north end of the "Deep Cut," south of Allanburg, the work for several important reasons, has not yet been placed under contract.

On turning to a general report made in 1872, on the subject of the enlargement of this canal, it will be found stated that "in order to obviate the necessity of lowering "the bottom of the reach below Allanburg, it is proposed to raise the water level two "feet."

This suggestion was made from a moderately clear recollection of the difficulties encountered, in deepening this reach in the winter of 1843–44, and the succeeding winter; but especially with a view of avoiding the necessity of removing the three culverts which are on it, and constructing others at a lower level.

On the new line, the bottom of the reach above Lock No. 24, has been fixed, under the impression that the present water level would be raised as above recommended.

The conclusion having been since arrived at, that all permanent structures on the summit level, are to be placed to admit of the canal being made of a depth suited to the

passage of vessels drawing fourteen feet of water, it becomes quite evident, that the reach between Thorold and Allanburg is not in the same relative position, as the levels below it; inasmuch as the water-level cannot be raised any higher, without doing a great damage to property at a considerable distance inland, while to lower the bottom, will be attended with all the difficulties, it has hitherto been the principal object to avoid.

The old line having been closely examined, with a view to enlargement, its objectionable features became even more evident, than from the general survey previously made.

Its crookedness, it may be observed, is well known to be at times, a great drawback to the class of vessels at present in use; hence the improvement of its alignement for large vessels, is looked upon as no less essential, than that of increasing the capacity of the channel. To do this even to a very limited extent, several high embankments would have to be removed, a kind of work that could only be done during the season of navigation, by first making an independent outer bank, a mode of proceeding that would of course greatly increase the quantity of work.

On the other hand, to move the material of the present banks, so as to make up others during winter, would, in such positions, and for such purposes, be an undertaking it is to be feared, attended with very unsatisfactory results; besides there is reason to believe, that to form proper connections between the old and the new parts of the banks, whether for the purpose of heightening, or strengthening them, would be found in winter, to be both difficult, and very uncertain.

Removing the culverts, constructing others in the same, or in similar positions would also, under the most favorable circumstances, be attended with a vast deal of difficulty between the months of December, and April of any one year.

These different matters, especially the tortuousness of the line, and the certainty of being unable to materially improve it, rendered a thorough examination of the adjoining country desirable, in order to ascertain whether a new line, less objectionable than the old one could be obtained, and, if so, the probable difference in the expense of construction.

It was soon found, that by continuing the summit level down to near Thorold instead of descending by a lock at Allanburg, a very considerable outlay for deepening would be avoided, and at the same time a very fair line, although not a straight one, could be obtained. This new, or independent line commences at a place a short distance above the Guard Lock at Allanburg, and continues in a straight line west of the village, along the old or original canal, to what is called the Holland Road. For a distance of half a mile, it then curves slightly to the north-west, until near the road between Allanburg and Thorold, when it continues on a line nearly parallel to that road, for about three-fourths of a mile. Thence it curves slightly towards the north for about four-sevenths of a mile, to near a school house situated on the south side of the road, leading to what is called Marlatt's Bridge.

It then continues in a north-easterly direction, until it intersects the macadamized road from Thorold to Allanburg, at the south-east end of the bridge across Marlatt's pond.

Thence it bears more to the east, and at a distance of little more than a quarter of a mile, connects with the upper end of Section No. 16.

In carrying out this plan it is proposed, to place Lock No. 25, on the south-west side of the macadamized road, at a place near the bridge over Marlatt's pond, and at a point about seven hundred feet south of the Lock, to construct a set of Guard Gates to supply the place, both of those that would be required on the enlarged channel at Allanburg, and on the reach above Lock No. 24, of the new line.

To the north of the Lock, a culvert will be constructed under the canal, of sufficient capacity to keep the pond on both sides of it, at the same uniform height.

The lower wings of the Lock may be extended, to form the abutments for a swing bridge, to carry the traffic of the macadamized road.

Near the lower end of Section No. 17, the line of the Welland Railway crosses Marlatt's pond, on a bridge constructed for that purpose.

This pond is canal property, under the direct control of the Department of Public Works, but in this Office, no record can be found, of permission having been granted, for the Welland Railway to pass through, or occupy any portion of it.

The new line of the canal, crosses that of the Railway at a point in this pond; it therefore appears that if the Railway Company are allowed to continue to enjoy the privilege of a crossing at this place, they must provide, at their own cost, and expense, such a bridge as will enable them, to cross the new line of canal, in a manner subject to the approval of this Department.

There will of course have to be a swing bridge over the new line, leading to Marlatt's crossing of the old canal: this, it may here be stated, is the only additional structure, that will be necessitated by the new line, which arises from the fact that the bridge over the old canal will still have to be maintained. Opposite this however, may very fairly be placed a set of Guard Gates dispensed with on the more direct line.

In this connection, it is believed proper to state that a separate swing bridge, for the Holland Road adjoining Allanburg, would, in either case, be the same.

The present regulating weir at Allanburg will have to be taken down, and another one built above, and to the west of the Guard Lock, for the purpose of passing a supply of water for the old canal.

On the east side of the guard gates, and lift Lock, or west side of the proposed new channel, a retaining wall will have to be built, to separate the new line, from the old

one; as the space is insufficient to admit of forming a suitable clay bank, and on the east or Allanburg side, the bank will be made, for some distance, with a steep slope, and faced with pitched stone.

Some of the advantages to be derived, from the formation of the new line, may be briefly stated as follows:

1st. It would obviate the necessity of interfering with the existing water level, between Allanburg and Thorold, and thereby avoid all claims for drowned land, and questions of that nature.

2nd. It would be a little shorter, and the alignement decidedly better, than that of the old canal could possibly be made.

3rd. The culverts could be built, and embankments formed in summer, when less risk would be incurred and a better class of work executed.

4th. The summit level would be extended about two and a half miles, and would form a continuous line, without a break, from Lake Erie to near Thorold.

5th. It could be constructed at less expense, and, as a whole, be made more secure, and better adapted to the large class of vessels, likely to be used on the line.

The construction of the new line, from the North end of the "Deep Cut," to the South end of Section No. 16, including the right of way, is approximately estimated to cost *$850,000.*

To enlarge, and deepen the present line, build the necessary structures, purchase the right of way required, is, on a similar basis as the above, approximately estimated to cost *$950,000.*

In short, there is reason to believe, that in regard to economy of construction, certainty of securing the best class of workmanship, having the shortest route, and least objectionable curvature, the new line promises advantages which could not, at any cost, be obtained by an enlargement of the old canal.

It is true that its construction involves, the maintenance of the present line also; still there is very little doubt, that the interest on the difference of the cost, will more than meet the outlay required for that purpose.

It is therefore in every respect desirable, that the new line, from Marlatt's pond to the north end of the "Deep Cut," should be adopted, and the works upon it placed under contract, as soon as the necessary arrangements can be made.

Between Port Dalhousie, and Allanburg, there are to be twelve bridges for common road crossings; four of which are to be over the upper wings of locks—two over the lower wings, and six separate, or detached structures: besides there are two railway bridges.

At all the detached bridges, the water-way is to be in four divisions, which, in the aggregate, will have a sectional area equal to that of the canal.

The two centre openings are each to be forty-six feet wide, and are to form the navigable channels.

The piers, and abutments, are to be of masonry, laid in hydraulic cement mortar, on a foundation of timber, and plank placed one foot below canal bottom. The centre, and rest piers, are invariably to be parallel to the centre line of the canal; the former to be from 16, to 18 feet square, and the latter from 15, to 17 feet in width, and 9 feet in thickness, and, in all cases, an arched culvert varying from 6, to 8 feet in width, and 8 feet in height will be made through the centre of them, on a line ranging with that of the canal. The piers to form the seat of the swing portion of the bridge, and the abutments are also to be of masonry.

Stone parapet piers are to be carried up, at all the four corners of the bridge, one of which at each end of the structure, is to be hollowed out to receive machinery, and the wings of the abutments are to be carried up the same height as the parapet piers.

Between the centre and rest piers, as well as above and below them, crib-work is to be constructed to form bearings for fenders on each side, and for protection of the respective parts of the work. Through the middle of the cribs, longitudinally, a clear waterway is to be formed, and transverse openings are also to be made adjoining the centre and rest piers, and elsewhere, of such shape and dimensions as may, together with the centre openings, give an area equal to at least that of archways formed in the masonry.

The seat piers are to be protected by means of piles, or framed bents, sunk into the bottom, on which strong cap-pieces are to be secured, and connected with suitable anchor-timbers let into the bank.

For the protection of the structure and guide piers, clusters of piles are to be driven,—within the range of the centre and rest pier,—at suitable distances above and below them.

The Superstructure of all the road bridges are to be on the "Howe Truss" principle. The movable portion of detached structures, will be made of a length to span the two navigable channels, and those at locks are to be of a length suited to circumstances.

In all cases the lower chords, floor beams, and stringers, are to be of wrought iron, formed in pieces of uniform and convenient length, and so arranged that they can be readily replaced in case of accident.

The top chords, diagonal braces, and such stringers as required to fasten the flooring to, are to be of timber.

By this arrangement, those parts of the bridges most liable to accident, can be readily repaired, or replaced by the workmen usually employed on the canal. Besides provision being made for the floor system, which is the most subject to decay, to be of iron; the structures will be more durable, and at the same time possess all the advantages that could be derived from a bridge built chiefly of wood.

The "Galley Frames," to form centre bearings for the suspension cables, are to be of wood and iron combined, and on the cross-beams between them, a signal light can be exhibited to serve for both road and canal.

For the safety of the public, it is intended that a self-acting gate shall bar the road-way, when a bridge is open for the passage of vessels, and which will not be wholly removed, until the bridge is again in position, when a crossing can be safely made.

This gate will also serve the purpose, of carrying the towing-lines over the parapets, and raised portions of the stationary parts of the structure.

The machinery for turning the bridge, will be placed on one side of the centre, and so arranged that it can be readily worked by one person.

In all cases the turn-tables will be of the same pattern, and the respective principal parts of the superstructure of all the bridges will be alike, so that to keep a comparatively small supply on hand, of the different parts of each kind, will be likely to meet all the requirements.

The fixed part of the roadway over side channels, is to be formed by means of joists, on which to carry and fasten the floor plank; there is also to be a rolled girder on each side and a hand rail on top with a truss between them.

It is proposed to place the bridges under contract early next spring.

Sections Nos. 21, & 22,—extend over a distance of about one and nine-tenths miles, embracing that portion of the canal between Allanburg and Port Robinson, and known as the "Deep Cut." They form the northern part, of what is called the Southern Division, which extends to Port Colborne, and is under the immediate charge of Mr. W. G. Thompson, whose report on the works is hereunto appended and marked B.

These Sections include the lowering of the bottom, to three feet below the level of the mitre sill of Port Colborne Lock, and increasing the width chiefly on the west side to one hundred feet at that depth. The side of the canal below the level of the towing path, to have slopes of two horizontal to one vertical, and the west bank above that line, is to have a slope of two and a half horizontal, to one vertical. To do this, the removal of 1,400,000 cubic yards of material, was estimated as necessary; about one half of which was over the level of the towing path, and one half under it.

The flat slope on the upper part of the bank was intended to lighten it, and in some measure guard against sliding, or settlement, to which the banks of this cut have been liable at times, ever since the canal was first made.

The upper part of the work is nearly finished, and about three-quarters of the material below the level of the towing path has been taken out, still a large portion of the quantity remaining extends over the entire bottom.

A considerable part of the material dredged out, has been taken down the Welland River in scows, to Chippewa and dumped in the rapids of the Niagara River, above the Falls.

It may here be stated, that the cut through this ridge has been a source of greater anxiety, than any other part of the line; resulting from the slides, and settlements, that have from time to time taken place in its banks, which are at some places nearly sixty feet over the canal bottom.

These slides have in some cases shown so slight a yielding at first, that they could scarcely be distinguished from sun cracks, which continued gradually to increase for years—in other cases they have occurred suddenly, and at places where no indications were before observed, and in one instance where the bank had been closely covered with sods, for a period of over thirteen years.

The east bank of the cut has been lightened also, by the removal of a strip of about forty feet in width from the face of it, and increasing the slope: under a contract for those purposes..

In this case, during the progress of the works, it was considered proper, to transport a large portion of the material to the north, or lower end of the cut; instead of purchasing valuable land for spoil ground, or interfering with the macadamized road between Allanburg and Port Robinson.

Since the banks have been lightened, the water of the canal has been at times quite as low, as ever it is likely to be during the season of navigation; still no indication of slides have been observed.

These conditions are doubtless new ; but the fact of the banks remaining stationary for a time, or even for a series of years is not new ; so that although the conditions are changed, there is no absolute certainty that the existing state of matters will continue.

It is no doubt true, that increasing the slopes, to some extent, lightens the bank ; still it exposes a greater area to the action of rains, and the cutting effect of surface water during thaws.

They may, however, after having been a few years under the direct influence of the atmosphere, be again with advantage overhauled, when an attempt might then be made, to seed them down with some prospect of success ; but it is barely possible that any seed would grow on material of the nature found in this cut when it is first exposed.

SECTION No. 23,—is about one mile in length; it extends from a point near the south end of the "Deep Cut," to a little south of the floating towing-path bridge above Port Robinson, and embraces the construction of abutments, and piers for a swing-bridge, together with the works, and arrangements necessary for a set of guard gates near the north end of the section, besides the deepening, and widening, of the channel, removing the abutments of the present swing-bridge, and the walls, gates &c., connected with the old guard lock.

The principal object of constructing guard gates in the vicinity of Port Robinson, is to keep the water in the northern part of the canal, in case the upper or southern part might, from any cause, be emptied, and to effect this it will be evident that they must be situated, to the north of the outlet to the Welland River.

Keeping these facts in view, a site for them has been selected near the south end of the "Deep Cut," and, in order to be certain of having persons constantly in attendance at that place, it is proposed that the swing-bridge should also be located there.

This arrangement will doubtless be found of great importance to the interests of navigation, but it may be a little inconvenient to a few persons who reside on the west side of the canal; still, when it is borne in mind that direct roads will be formed, to and from the bridge, there is reason to believe that the change will be found fully satisfactory to the public.

The water-way at this place will be in four divisions—the two middle openings are each to be forty-six feet in width, at the assumed Lake Erie level, and the side openings are each to be eighteen feet wide. The side walls are to be of masonry, carried up to a height to form bearings for the swing-bridge, and fixed structures at both ends of it.

The gate for each opening is to be in one piece, and the whole is to be arranged in such a manner that the gates, when not in actual use, are to occupy a horizontal position in the recesses formed in the bottom for that purpose.

Considerable quantities of timber, stone, and other materials have been provided, delivered, and prepared for the foundations, walls, &c., of the guard gates and arrangements made for proceeding with the works. But on a decision having been arrived at, that the water would not be taken out of the canal this winter, the preparation of materials was discontinued.

It may, however, be stated that under the impression, it might be an object to proceed with the works this winter, suggestions were made to place a dam on each side of the site of the structure, and to cut a channel around it for the water to pass; but the probability of failure in carrying out, between the closing, and opening of navigation, such an uncalled for hazardous undertaking—apart from the expense inseparably connected with it, prevented the proposition being entertained.

The excavation for the enlargement of the channel has been proceeded with at a moderately fair rate—a large portion of that over the water surface is nearly completed,

and about one-third of the quantity of material in the widening, and deepening of the prism, has been removed, and deposited at places to make up low ground in the vicinity.

SECTION No. 24,—is about one mile in length. The works upon it consist chiefly in widening, and deepening the prism of the canal, forming towing-path, and banks, cutting ditches, offtake drains, &c.

Fully one-half of the excavation over water surface has been done, and at least one-third of the quantity of material necessary for the widening, and deepening has been removed, and such arrangements made as lead to the conclusion, that the operations are progressing fairly.

SECTION No. 25,—embraces the widening and deepening, of the channel for a distance of fully one mile, forming towing-path, and banks, cutting, ditches, removing the abutments, fenders, &c., connected with the present two swing-bridges, and the construction of the piers, and abutments for a new bridge to carry the traffic of the Quaker Road.

There are at present two bridges within the limits of this section; the upper one called the Burgar Bridge, is really of very little use, except as a convenient means of communication, with a comparatively small area of land, lying between the Welland River and the canal. This bridge has long been looked upon as an outlay, both for construction and maintenance, from which few derive any benefit; so that the question of its removal, when presented in a distinct, positive form, left little doubt as to the soundness of the conclusions arrived at.

It was therefore agreed, that if satisfactory arrangements could be made, for the purchase of the land on the east side of the canal, and that no formidable objections were raised by the public, the bridge might be done away with altogether.

After a time matters were arranged, the land purchased, and that part of the road allowance, between the Burgar and Quaker Bridges, was authorized by the Township and County Councils to be sold; consequently a bridge at Burgar Road will be no longer required.

This, although a matter of little direct interest to the locality, is nevertheless of great importance to the navigation, and will considerably reduce the present outlay on the works, as well as diminish their future maintenance.

A large quantity of stones have been delivered, and part of them prepared for the abutments, and piers of the bridge at the Quaker Road; but general arrangements for proceeding with this part of the works were discontinued, when it became known that the water would not be taken out of the canal this winter.

All the excavation on the section has been proceeded with rapidly: the greater part of that over the water surface, is already done, and fully one half the quantity of material, in the widening, and deepening of the channel, has been removed.

SECTION No. 26,—consists principally in widening, and deepening the channel for a distance of about a mile, for the lower one fourth of which the increased width is to be taken off both sides; thence upward, there being for the most part only a bank between the canal, and the Welland River, the widening will be taken wholly off the west side.

This part of the work has been proceeded with at a moderately fair rate, since it was placed under contract in August last, and so far the material has been found easier to excavate, than anticipated at the time tenders were received.

SECTIONS Nos. 27, & 28,—have not yet been placed under contract,—they embrace the enlargement and deepening of the channel for a distance of nearly two miles, including the building of several large, and important structures, all of which are in some way effected by the contemplated deepening, for the passage of vessels drawing fourteen feet of water.

On turning to the general report, on the subject of the enlargement, and deepening of this canal, previously referred to, it will be seen that it was proposed to lower the bottom of the present aqueduct over the Welland River, to admit of the passage of vessels drawing twelve feet water, and to build a separate structure to pass the necessary supply of water, "so arranged that its bottom would be about the level of the river surface."

There is every reason to believe, that this proposition could have been successfully carried out; but it is probable at an expense larger than warranted. in view of a greater draught of water being required within a comparatively short time.

It was then proposed to cut down the crown of the arches from ten, to twelve inches, for a space of twenty feet in the centre of the channel, and afterwards secure them with strong bands of wrought iron, let into the stone, &c.

The arch stones having two and a half feet width of bed, they might be reduced for the depth, and to the extent stated, but it certainly appears, as if these are the extreme limits to which the process could be judiciously carried.

If this be correct, of which no reasonable doubt can be entertained, it will be evident, that the only way of effecting the object, will be the construction of a new aqueduct, adapted to all the requirements of the enlarged scale of navigation.

The present structure is supported by four arches, each forty feet span, and seven feet rise, the under side of the centre parts of which, are fully five feet below the ordinary surface of the stream, so that it as a whole really forms a sort of dam, with openings through the lower part of it, of such capacity as barely admits the necessary volume of water to pass.

The river, although for the most part a dull sluggish stream, in which the water at times is even higher on the east, than on the west side of the aqueduct, still during

snow-floods and freshets, there is frequently a very considerable rise on the west, or up stream side. There is no other way for the river to pass than through under the canal, moreover its usual volume must pass at the time the new structure is in progress.

It may further be said, that the course of both the river, and the canal, together with their relative positions to the town of Welland, after a close examination of the locality, lead to the conclusion that the only place which can be judiciously selected is the bed of the river itself, at a place seventy or eighty feet west, or on the up stream side of the existing structure. In this position the northern entrance to it will be about the place at present occupied, by the lock between the canal and the river.

The archways through it will have to be about three feet lower than those of the present one, and the foundation will also have to be deeper, in order to provide a sufficient area for the water of the river to pass freely.

The body of the new structure, or that part of it which forms the prism of the canal, will require a mean width of about eighty two feet, and the bottom line of it will be five and a quarter feet, below ordinary surface water level of the Welland River.

The guard against obstructing the water flow, and, at the same time admit of laying part of the bed of the stream dry, when the works are in progress, it is proposed to widen out the channel on its northern side, by dredging, to such an extent as may be serviceable, and circumstances will admit, and at the same time deepen the entire area to be occupied by the works, to within twelve or eighteen inches of the contemplated foundation line

The new structure is to have six archways, and be built in two divisions, or at two different times. The first division to embrace the south abutment, and wings, and three, or may be four of the arches. The northern pier to be what may be called—in the absence of a better term—an abutment pier, of such dimensions as to resist the thrust of the arch, and so arranged as to prevent any tendency to move or slide on its foundation.

The space to be occupied by the first division of the structure, to be properly enclosed by coffer dams, care being taken to make the north end of the dam as well as that on the east side, as narrow as the requirements and circumstances will admit, so as to leave as great a width as possible for the water flow of the river.

There is reason to believe that by following this course, the foundation can be satisfactorily laid, and the masonry of the abutments, piers, and arches built, and part of the side walls carried up to over high water mark, when the haunches can be made up, and after being allowed a short time to set, the centres may be struck—the space under the arches secured, and the dams removed so that the water can pass on that side.

The second division may be then enclosed by dams and the space unwatered—the foundations laid, and the masonry carried up the same height as that first built, and connected with it.

The carrying out of the work in this way, will doubtless be attended with some degree of risk, but the building of such a structure must under any circumstances be an undertaking, which cannot be altogether free from difficulty.

There is, however, every reason to believe from the borings which have been made, that a good foundation can be obtained at the required depth; a fact which of itself is of so much importance as to leave no doubt, whatever, as to the successful accomplishment of the object.

The lock at this place must be removed, as it now occupies a position considerably within the line leading to the proposed new aqueduct: if therefore this branch of navigation has to be maintained, as no doubt it will, another lock will have to be built.

This, it is believed can be done by placing it on the same side, and on the same course, but farther up stream than the present one, and by making a slight bend within the entrance leading to it.

It is probable that the approach to the southern end of the new aqueduct, may necessitate changing the site of the swing-bridge at Welland, to a place farther up, or to the south of its present position, and of arranging the piers so that it can be made with a double span, as is to be done at other road bridges.

The culvert which passes under the canal a short distance south of the present bridge at Welland, must be taken out and either lowered, or a new outlet formed into the river on the east side, for the back ditch which leads from near the junction, downward.

In the enlargement of that part of the canal between Welland and the junction of the main line with the feeder, the widening, for the greater part of the distance, must be done on the west side; which at some places will require the space at present occupied by the old canal, now used as a head race for the water-power leased.

In fact either a new head race will have to be cut for the greater part of the distance, otherwise the mills will have to be bought out; a matter well worthy of consideration, as it is not at all improbable that the latter might be found the best course to adopt.

By an Order of the Privy Council, dated 9th May, 1871, the Canada Southern Railway Company were granted permission to construct, and maintain a swing-bridge across the Welland Canal, near to its junction with the feeder, and also the right of way through the canal property, on certain terms and conditions, amongst which are the following:—

"The Company to construct a proper centre pier, and abutments of masonry, the "plan of which shall be submitted for the approval of the Minister of Public Works, "whenever the Government may require the works to be done."

"That if so determined by the Department of Public Works, the Company shall

"be bound to build a swing-bridge of such construction, as to leave whon open *two clear* "*spaces*, each at least 45 feet in width between the centre pier and abutments."

"That the Company shall execute, at its sole expense, all the work of excavation "necessary to make and maintain these two channels, of a depth suited to canal naviga- "tion, as well as provide for the construction of a centre pier, abutments, guard piers, "and other works required."

"That both these channels shall be made through the ground occupied by the "Railway, and for such a distance on either side of it, as the Department of Public Works "may deem necessary, for the easy and proper passage of vessels."

"That the company construct and maintain all works directly, or indirectly "connected with the bridge, and form such an extent of the channel of the width and "depth required for navigation, as the works of the company may, in the opinion of the "Department of Public Works, render necessary, and shall grade a towing-path on both "sides of the canal across the space occupied by the bridge, or other works connected "with it, at their own sole cost and expense."—&c.,—&c.,—&c.,—&c.

On the 11th November 1876, the company were informed by letter from the Secretary, "that in order to enable permanent piers, abutments, and other works connected "with a bridge to be constructed at that place, the water of the canal will be lowered (as "much as circumstances will admit) at the close of navigation 1877.

"It is therefore imperative that your Company should make the necessary "preparations. and arrangements to execute the works, between the time above montioned "(December 1877) and the opening of navigation in the spring of 1878.

"The sectional area of the waterway of the new canal at all permanent bridge "structures, is to be 1,900 square feet, and the foundation placed so as to be at least 15 "feet below the surface water line."

"Tho movable or swing portion of the bridge, should be arranged to rest on a pier "placed on the centre line of the canal, on both sides of this pier there should be a clear "opening of at least 46 feet in width for the passage of vessels ; the greater sectional "area required for the waterway, may be made by openings on each side, over which the "bridge may be fixed." * * * * * * *

"It is to be clearly understood that the Company are to submit to this Department "(within four months from this date) for approval, a plan showing in detail the piers "abutments, &c. together with a description of the class of work they propose to adopt."

The enlargement of the channel at the Junction, together with the proximity of the railway crossing, to the bridge for ordinary road traffic, renders a change in the site of the latter desirable, for the safety and convenience of the public, as well as for interests of navigation.

This it is believed might be done by placing the bridge, at a point immediately south of the outlet from the Feeder ; where the general travel could cross on a continuous line with the bank above, and without the necessity of passing over the swing-bridge across the lock near that place.

Sections Nos. 29, 30, 31, and 32,—are situated between the Junction and Ramey's Bend ; they include a distance of full three and three-quarters miles, the works upon which for the most part, consist in taking a continuous strip of about fifty feet in width off the west bank, and lowering the present bottom of the canal, from two to three feet throughout—placing the material excavated on the west side of the canal, at a proper distance from the centre line, forming a towing-path, cutting back ditches, &c., &c.

Section No. 29,—has been completed, and the works on Section No. 30 are well advanced, except the bottoming, the principal part of which has still to be done.

On the latter Section the Air Line (so called) of the Great Western Railway, crosses the canal by means of a swing-bridge, built for that purpose.

The Company were, by an Order of the Privy Council, granted permission to construct, and maintain a swing-bridge across the Welland Canal; also the right of way through canal property, on similar terms and conditions as previously mentioned for the Canada Southern Railway.

On the 11th November last, the General Manager of the Railway was notified that the Company was now expected to make arrangements, for proceeding with permanent piers, abutments and other works stated in the conditions, under which permission to cross the canal was granted.

Section No. 31,—is also in a forward state—the widening over the water surface as well as that below it is nearly finished ; but there still remains from two to four feet of the bottom material in the channel, for the greater part of the distance, which it will take a considerable time to remove.

Section No. 32,—in December last was nearly in a like advanced state as Section No. 31. but on the 5th of the present month (January 1877). a slide occurred near the upper end of the Section, which has materially changed the condition of matters. A large portion of spoil placed on the west side has settled down, and the bank has been shoved forward twenty feet or more into the canal. At about 300 feet south, and 700 feet north of where the greatest quantity has been displaced, all indications of settlement cease.

The quantity of material forced into the canal, has been estimated at 23,400 cubic yards.

Various causes are assigned for this movement of the bank—one of which is, the height of the spoil, and its proximity to the side of the cut—another is said to be, the unsafe nature of the bottom; but the principal cause is represented to be the lowering of the water to the level of Lake Erie, before the dredged material placed on the banks had been consolidated.

The culvert for carrying the water of Lyon's Creek through under the canal on Section No. 31, has to be removed; but it forms no part of the present contract.

The old one is believed to be too small, to discharge the necessary volume of water during freshets, so that a new structure of larger capacity, will have to be built and placed at a lower level. It will also have to be of a peculiar construction, capable of resisting the upward pressure of the water passing through it, in case the canal should at any time be emptied.

Sections Nos. 33, 34 & 35,—are situated between Ramey's Bend, and to the north of the harbor at Port Colborne—a part of the works still to be let—they are in the aggregate about two and two-fifths miles long, fully three fifths of this stretch is in rock cutting, where the present bottom is from 15 to 18 inches higher, than the mitre sills of the entrance Lock, and at that level the cut is from 56 to 58 feet wide.

The entrance lock being situated at a place, where the streets, running north and south, along the sides of the Harbor at Port Colborne, do not afford space for the formation of race-ways of sufficient capacity, to pass the necessary volume of water for the canal supply; it was considered proper to examine the locality fully, with a view of enabling a conclusion to be arrived at, as to the best course to adopt in the premises.

The various places that were found to be anything like favorable will therefore be referred to, in ascending order as follows:—

1. Immediately below the village of Stone Bridge the canal has a course nearly south-west; then it takes a more southerly direction; the angle thus formed seemed to offer a site for a lock, that would admit of executing the principal part of the work during summer; and the adjoining bend in the channel was looked upon, as nearly sufficient to allow the water supply to pass freely.

By the adoption of this arrangement, the water flow between Port Colborne and Stonebridge would be unchecked; except at the bridges, of which there would be three between Lake Erie and the lock.

It is, however, to be feared that the frequent and sudden variations of the water level, to which the cut would then be subject, might endanger the stability of the sides, especially, as at some places the material is of clayey nature, and at other places there are intervening layers of hardened clay between the beds of rock.

2. The next place where the object could be effected, without much interference with private property, was found to be a short distance below the closely occupied part of the village of Port Colborne, where the Government owns a considerable stretch of land on the west side of the canal.

At this place a channel might be cut on the west side and the navigation, turned through it, so as to admit of dams being constructed, and a lock built in the present canal during summer.

This temporary channel might form part of a supply race, after the new lock had been brought into use.

There would doubtless be a good deal of difficulty, in making the coffer-dams stanch, as well as risk connected with them, and in other respects, unwatering the works, but there is every reason to believe that it could be done.

This location, however, would be liable to some of the objections mentioned as due to the lower site, but they would be less in degree. There would still be two bridges between the harbor and the lock—one belonging to the Buffalo and Lake Huron Railway, which cannot be changed without great trouble and expense,—the other is a road bridge, to the position of which many of the inhabitants of Port Colborne are so strongly attached by ties of interest, as well as of convenience, that it is questionable if they would willingly consent under any circumstances, to have the site of the crossing altered.

Attention has been drawn to these two places, chiefly to show that there are difficulties to be met with, in carrying out this portion of the works, in even the most favorable position, that under the circumstances can be selected.

It has been already stated, that the comparatively narrow space between the streets on the east and west sides of the canal, is insufficient to admit of forming raceways of the capacity required to pass the volume of water, necessary to supply the canal.

It might be therefore well to leave the present lock undisturbed, and to build a new and enlarged lock, between it and the east bank, at the same time acquiring as much of the adjoining property, as would be sufficient for a street.

By adopting this course, there is every probability, that there would be no necessity to form a dam across the basin, and that the lock could be built during the season of navigation, when the weather is most favorable for that purpose. The saving thus effected would warrant a considerable expenditure, if required, in the purchase of property.

To secure the means of passing the necessary supply of water, an independant channel might be made, on either the east or west side of the harbor and canal, where the most suitable and best arrangements can be made for accomplishing the object.

A swing-bridge can be constructed to span both the new lock and the present one, and placed so as to work on the centre pier between them.

The Buffalo and Lake Huron Railway, (now leased to the Grand Trunk Railway), have a bridge over this canal, near the lock at Port Colborne. Previous to its construction, there appears to have been (in 1852–53), a considerable correspondence between the Company, and the Board of Railway Commissioners, on the subject of the crossing at that place.

The Railway Commissioners, however, strongly objected to it, and warned the Company that, "as soon as the Lake Erie level should be adopted, the Railway will be "materially obstructed, by the constant passing of vessels into the inner basin," * * * * "that the navigation of the canal cannot be interfered with;" * * * * * * * * * and conclude by stating that "the Commissioners, while "entirely objecting to the proposed site of the bridge, think it proper to say that, should "the company persist in erecting it near the Guard Lock, it should be at least 180 feet "distant from the wing of the lock."

There does not, however, appear to have been any permission granted by the Department of Public Works, for a railway crossing at that place; although this Department, under thePublic Works Act, has the sole control of the Welland Canal, and the lands connected with it.

The only reference made to the subject, is in the Annual Report of the Commissioners of Public Works, dated August, 1852, which states that:—

"On their late inspection of this work," (the Welland Canal) "the undersigned "found that it was intended, that the line of canal should be crossed by two railroads, "now in progress in that section of the province: the Brantford and Buffalo Railroad, "and a continuation of the Great Western Railroad, from Hamilton to the Niagara "frontier—the former to cross the canal twice, and the latter once."

"The mode and plan near Port Colborne lock, at which it was proposed the "Brantford road should cross, has been considered objectionable, and as tending to "obstruct the navigation; the other point of crossing by this road is not deemed objec- "tionable."

It therefore appears, that as the time is now all but arrived, when preparations should be made for introducing the waters of Lake Erie; and as a much larger area of opening, to furnish the supply, is necessary, than there is at present: that the Railway Company, if they are allowed to continue to enjoy the privilege of such a crossing—must provide at their own cost, and expense such other bridges, and works, as they may require for their purposes, subject, however, to the approval, by this Department, of plans of the structures, which the company may intend to carry out.

A new swing-bridge, together with the necessary piers, and abutments, will also have to be constructed, at the Village of Stonebridge.

In all rock cuttings on these Sections, where the sides have only a slight inclination, the channel will be made a mean width of 126 feet.

It is proposed that the various works referred to, as well as all others connected with this part of the canal, shall be placed under contract as early as circumstances will admit.

SECTION No. 36,—embraces the enlargement and deepening of Port Colborne Harbor, or Lake Erie entrance to the canal, including the extension of the west pier about four hundred feet farther into the Lake—deepening the entrance channel, from the lake, inward—re-building the superstructure, of part of the west pier, and the whole of that on the east side—constructing a Beacon, on the south-east side of the entrance (near the place where a buoy used to be moored), and building four detached blocks of pier-work, between it and the outer end of the present east pier—removing and re-building about seven hundred feet of the west docking, from the Ferry recess outward—deepening and enlarging the basin, &c., &c.

The channel from the lake, northward, to about the southern line of the contemplated enlargement of the basin, is to be sunk to a depth of seventeen feet below low water line, and from the latter place to the north end of the basin, the depth will gradually diminish to sixteen feet, at a time when the water stands at twelve feet over the mitre sill of the present Lock.

Previous to receiving tenders for the works, contractors were informed that the material to be removed from the bottom of the channel and basin, embraced two kinds of work, "one of which can be executed by means of an ordinary dredging machine; but "the other consists of a hard class of rock, with numerous nodules of flint interspersed."

In excavation through rock, the mode adopted has been to drill, and blast from the deck of a vessel held in place by anchor timbers resting on the bottom, and subsequently removing the loosened material by an ordinary scoop dredging machine.

This system has so far been quite successful, owing no doubt, in a great measure, to the use of nitro-glycerine as an explosive, and the skilful arrangements made by the contractor, in conducting the operations in all their different stages. Still, with all the care and precautions adopted in storing and handling the nitro-glycerine, an explosion in some unaccountable way occurred on the 30th of October last, by which one man was killed; and some damage was done by the concussion to property in the village of Port Colborne.

Fully one-third of the quantity of rock has been removed, and a considerable extent of ordinary dredging has been done.

The west pier has been carried to the full extent, and nearly to the height contemplated—the beacon to mark out the end of the eastern reef is in position, and carried up to twelve feet over the water surface; and two of the detached blocks, on the east side of the entrance, are in place and completed.

When the beacon was first placed ; public notice was given through the newspapers, as well as by printed hand bills, distributed by the collectors at both ends of the canal.

A like course was followed when the extension of the west pier was commenced, and at the same time a low small light was exhibited at its outer end, of which due notice was given.

The works have been proceeded with in an energetic and generally in a satisfactory manner, from their commencement up to the present time.

As previously stated, the time fixed for completion of the works, on the different sections of this canal, is stated in the respective contracts to be April, 1877.

Although they are for the most part of considerable extent, there is reason to believe that under ordinary circumstances, the object could have been effected within the time agreed upon.

It was soon ascertained, however, that quarries were more difficult to obtain than was at first anticipated, and that when found the stones, although of the best kind, are of a nature that unless for some time exposed, to the action of the atmosphere before winter sets in, they are liable to burst or be broken up by frost. This limited the time to which quarrying operations could be safely carried on, to about six months in the year.

Another serious cause of delay was the repeated strikes amongst the workmen, which were sometimes brought about in a way nearly, if not altogether, beyond the contractors' control.

These and other causes of a like nature, led the contractors to make an application in May, 1876, for a longer time to complete the works.

It was then quite evident that an extension of about one year would have to be granted ; still, it was not considered judicious to take any direct action in the matter, so long in advance of the period originally fixed upon.

It is now, however, desirable that arrangements should be made with the contractors, and their sureties for that purpose, as soon as circumstances will admit ; or, at latest, before the first day of April next.

GALOPS RAPIDS, RIVER ST. LAWRENCE.

At ordinary stages of the water of the St. Lawrence, descending vessels of all classes, pass *viâ* the river from Prescott to Dickenson's Landing, in preference to passing through the Williamsburg Canals. This is considered to be an advantage, not only from it requiring barely one-third of the time, to make the trip between these places; but from the fact that vessels are less liable to injury in the river than in the canals.

It may also be said, that vessels of sufficient power to ascend the Galops Rapids, occupy about one-third less time on the upward trip, between the same places by the river, than they do when obliged to pass through the canals.

The rapidity with which the downward trip can be made, when the water is at its usual height, has long been looked upon, as an important feature of the route,—a fact brought out more prominently, in a comparison with periods of extreme low water, when it cannot be taken advantage of.

It is true, that even at these times, the present class of vessels can, with very great care, make the downward passage under the management of a skilful pilot; but all vessels, even light passenger steamers, must then ascend by way of the canals.

Various plans have been from time to time suggested, with a view to obtaining a greater depth of water in the different rapids; and in a general report on the Navigation of the River St. Lawrence, between Lake Ontario and Montreal, dated July 1874, the matter is again brought under notice. This was done under the impression that the question, important at all times, pressed itself still more forcibly on the attention at a time when matters, connected with the enlarged scale of navigation, were under consideration.

It has been fully ascertained that from Kingston to Dickenson's Landing, those parts of the river at, and in the vicinity of Galops Rapids, are the only places which bar the channel to vessels of greater draught, than the class at present in use.

To meet the case, for a line of twelve feet navigation, it was proposed to contract the channel below the "Chute," by means of wing-dams, constructed at "McLaughlan's Point," and at a point on "Galops Island" opposite Little Bay, and in this way raise the water above, as well as spread the current over a greater range. It was further proposed to construct a dam through the passage called the "Gut," between Galops, and Adam's Islands, which it was thought would have the effect of throwing the current, more towards what is called "Pier Island," and thus enable the deep-water channel, alongside of Adams' Island, to be advantageously used, and thereby avoid the necessity of cutting a line through "Flat Rock Shoal."

To carry out these plans, would doubtless be attended with considerable expense, and some degree of risk, both in the way of execution, and the actual results of the undertaking. It was, however, believed, that a series of well directed efforts, would have been ultimately successful in forming a channel, adapted to the passage of vessels of the draught contemplated.

This having been effected, it was presumed that, by a system of submerged chain towing, such as that in use elsewhere, the upward passage of vessels could be facilitated, without interfering with those descending.

In favor of this course it was stated, that a direct pull from a fixed point, is a more effective means of hauling a vessel up a current, than any method in which the propelling power applied, depends solely upon the resistance of the water, as a fulcrum, to effect the forward movement of the vessel.

It was further stated, that the successful application of a system of a chain towage, at other places below, in a great measure depended upon the depth of water, that could be obtained in the Galops Rapids. Moreover, it was evident then, as well as now, that if the improvements at Galops were effected, and arrangements made, by which vessels could be towed upwards, through all the rapids, from the head of the Cornwall Canal to Prescott, that the enlargement of the Williamsburg Canals, other than the lengthening of the locks, would not be required.

It is deemed proper again to state that the scheme above alluded to, had a direct reference to a depth of water suited to the passage of vessels 12 feet draught.

The decision afterwards arrived at, in April 1875, that the permanent structures on certain of the canals, should all "be adapted to a depth of water, corresponding to 14 "feet on the mitre-sills of the Locks," seemed then as now, to indicate clearly, the desire of eventually making a line of 14 feet navigation throughout.

In this view of the matter it became quite evident that the extent of the works would not only be greatly increased, but that a number of changes would be necessary in the design submitted in the general report made the year previous. These remarks apply to all the canals between Prescott and Montreal, and to many places in those parts of the river between them ; but they are especially applicable to the works required to be done, in order to obtain a greater depth of water in the Galops Rapids, and the shoals in that vicinity.

The latter places, presenting the first obstructions to descending vessels, and as their removal would throw open a long stretch of deep water navigation, it was thought best to direct attention to them. But at the very outset, it was found that the nature and extent of the bars were unknown, and that there were no means at command, by which that class of information could be obtained. The most powerful steamer could not remain long enough at one place in the rapids, to enable even the depth of water to be correctly ascertained. It was therefore believed, that a "Chain Vessel" fitted up in such a manner that it could be held steady in position at any place, was the best, if not only way of accomplishing the object. Moreover, it was thought that the equipment of the vessel might be such, that the principal operations connected with deepening the channel, might be carried on aboard of it. At all events the objects contemplated were looked upon as of so great importance that some degree of risk, if necessary, might reasonably be encountered in endeavoring to carry them into effect.

Arrangements were therefore made for the construction, and fitting up of a chain vessel, of such power as would be fully equal to the service of enabling a satisfactory

examination of the rapids to be made; with a view of ascertaining the nature, and extent of the obstructions that would have to be removed, or otherwise overcome.

The vessel is 112 feet long, 27 feet breadth of beam, and 7½ feet depth of hold, from top of floor timbers to top of beams; it is built in the most substantial manner, with double frames of best white oak timbers, twenty-four inches apart from centre to centre.

A heavy Howe-truss connects the keelson and central stringer, under the deck beams, for the whole length of the vessel, with diagonal braces, wrought iron tie-rods, and bolts throughout, fastened in every way likely to increase the security, and strength of the vessel.

The engines are high-pressure and condensing, have two cylinders of twenty-two inches diameter, and five-feet stroke: they are built exceedingly strong, and fitted up with all the latest improvements and equipments, and finished throughout in the best possible manner.

The power is generated in two boilers of ample capacity, the shells of which are of the best "Thorneycroft" plate, double rivetted, fire-boxes of the best Low Moor iron, and the whole well stayed. All necessary mountings are provided, such as guage-cocks, lock-up and open safety-valves, &c., &c.

Provision has been made to keep the vessel steady, when used for drilling or exploring service, by means of anchor timbers or "spuds," which pass down through well-holes formed through the deck, and bottom of the hull, four in the forward part, and two in the after part of the vessel.

The anchor timbers are raised and lowered, by means of heavy rack gearings connected with the sides of the wells, and on the four in the forward part of the vessel, steam (percussion) drills have been fitted up, to work on slides, on the down stream sides of them, and balanced with counter weights passing over pulleys, on the tops of the respective "spuds."

Steam from the boilers is brought to the drills by suitable pipes, carried along under the deck beams, and connected with flexible rubber coupling pieces.

The vessel was built, and all the machinery connected with it, made and fitted up under a contract, for that purpose, with E. E. Gilbert, of Montreal.

The chain on which the vessel works was made to order; the links are of a special length, forged from 1¼ inch iron, and tested at Lloyd's Proving Works, in pieces varying from 293 to 323½ feet in length; each test was 21 tons, 1 cwt,, 1 qr., and five links of three different pieces of the chain were submitted to a breaking strain, and parted at 44½, 44¾, and 46 tons respectively.

A certificate from the Superintendent of Loyd's Proving House, accompanied each length of chain.

On the 20th August last, the contractor delivered the vessel in the Galops Canal, and on the 23rd it was with the assistance of the steamer "Chieftain," engaged for that purpose, taken across the main channel, and moored at a temporary wharf built at the foot of Adam's Island.

From the experience gained in getting the vessel into the eddy, between the north Channel and "Gut," fears were entertained that one steamer would not be sufficient to enable the cable to be laid on the proper line. The tug "Arctic" was therefore engaged to assist, and on the 24th the object was so far successfully accomplished, that the chain was placed, and the vessel stationed on the line intended for the centre of the contemplated channel.

It was then ascertained, that several important parts of the vessel had to be overhauled, and other equipment provided, before it was considered safe to attempt passing the oblique currents, that are opposite two salient points of Galops Island. On these matters having been attended to, an attempt was made gradually and cautiously, to acquire a knowledge of the strength and set of the currents, and their action on the vessel, before exposing it in a degree greater than the circumstances or the locality seemed to warrant.

On information looked upon as reliable, the officers entrusted with the management of the vessel, appear to have been under the impression, that in order to keep on the line, the chain should not only be laid straight, but hauled as tight as possible, and made fast at both ends.

In addition to this, attempts were made by transverse fastenings, to keep it up to the points above-mentioned, still the oblique current forced the vessel so much out line, as to form a sort of bight in the chain, causing it to enter and leave at such an angle, as had the effect of binding the pulleys at both the bow and stern, thus bringing the vessel to a stop when working with the ordinary power.

After many attempts and failures of this kind, it was decided that there should be no unnecessary length of chain used, and that the lower end of it should be left free. On the adoption of this course, it was found that the vessel was at all times under full control, and that in swift parts of the current it could be held nearly as steady as at other places.

On the line of the proposed channel through the rapid, a number of holes were drilled two feet into the rock which forms the bed of the river; and some of them at places where the water at the time was fully fifteen feet deep. It should, however, be stated, that the season of navigation was nearly closed before arrangements could be made to test the drilling operations, and that there were no skilled workmen on hand for that purpose.

Judging from the experiments made, and latterly by the manner in which the vessel could be controlled, there seems to be no reason to apprehend difficulties which cannot be successfully met, especially in view of the improvements which can be readily made in the arrangements for effecting the contemplated object.

As previously stated, the season was well advanced before the chain vessel was got into fair working order; attention was therefore principally directed to determining the position, nature, and extent of the different bars and shoals, in the rapids and their vicinity. This examination was intrusted to Mr. Tom S. Rubidge, whose full and descriptive report on the subject is hereunto appended, marked C.

The line of channel now recommended for improvement, skirts the shoal on the north-east point of Adam's Island, and the north point of the south shoal, at the outlet of the "Gut" channel. The whole of the contemplated width being north of these points, and at the lower one it inclines slightly toward the south-east, until it passes the bar to the south of the chute.

It is believed that this line can be deepened at less expense than any other that could be selected, and when improved will be the best suited for the passage of large vessels as well as for the successful working of a system of chain towage. Moreover *seven-eighths* of the whole of the necessary works, can be carried out without interrupting or being interrupted by passing vessels or rafts.

From deep water below the lower bar, to a point at the upper entrance of the Galops Canal, there are four different places where excavation would have to be done, to obtain a channel 200 feet wide and 16 feet deep at low water, or at a time when there is a depth of 9 feet on the sills of the Entrance Lock.

At all places where deepening or widening of the channel is necessary, it has been found after a careful examination, that the bed of the river is hard limestone rock.

The lower bar extends from Galops Island to the north shore of the river, on the lowest part of which, or where the proposed new channel is to be formed, the water varies from $10\frac{1}{2}$ to $13\frac{3}{4}$ feet in depth, for a distance parallel with the stream, for about five hundred feet. This will require the removal of nearly 15,500 cubic yards of rock.

From the up stream side of the lower bar, to what is called Island Shoal, a stretch of 330 feet the depth of water is from 16 to 28 feet. The latter shoal is about 350 feet across, in line of channel, and the water over it is from $10\frac{1}{2}$ to $13\frac{3}{4}$ feet deep.

To obtain a depth of 16 feet of water on this shoal, will necessitate the removal of 10,400 cubic yards of rock.

For the next 400 feet upward, the depth is from 16 to 27 feet; but for nearly 150 feet at the upper end of this stretch, the deep part of the channel is contracted by two shoals, to a width of very little more than 150 feet, one of which extends from the

north shore, at a place abreast of the guard lock ; and the other on the south side, nearly in line of the "Gut" Channel.

The outer point of the north shoal must be taken off to obtain the necessary width ; although the quantity of excavation for this purpose, will be comparatively small, the set of the current, together with the passing of vessels and rafts of timber, will render the work of a difficult nature.

From the latter place to the upper shoal, which is nearly opposite the entrance to the canal, the distance is 1,150 feet, and the depth of water varies from $16\frac{3}{4}$ to 30 feet.

This shoal is 250 feet long in the direction of the stream ; its average width is about 80 feet, and on it the water is from $12\frac{1}{2}$ to $13\frac{3}{4}$ feet deep.

It lies directly in the main channel, so that the operations connected with lowering the bottom in such a position must unavoidably be attended with considerable difficulty ; still there is every reason to believe that it is quite practicable.

From the foregoing remarks, together with the information contained in Mr. Rubidge's letter (appended), it will be seen that the bed of the river at this place has been carefully examined, and all its principle inequalities, bars and shoals fully ascertained. The result of which shows that in every case where an obstruction exists, there is immediately below it a stretch of water from 8 to 10 feet deeper than required for the contemplated channel.

This in connection with other matters, bearing directly on the subject, leads to the conclusion, that the best, if not the only way of obtaining a channel, suited to the enlarged scale of navigation, is that of lowering the shoals, and bars on the line, and dragging the loosened material into deep water below them.

In order to have in some measure steerage-way, and make an allowance for the settlement and surging of vessels when passing through the rapids; the depth for a fourteen feet navigation should not be less than 16 feet at low water.

To attempt obtaining this depth of water, in any other way than by lowering the bottom, would not, there is reasons to believe, be attended with anything like success. It is quite probable that by a system of wing dams, the water might have been raised to pass vessels drawing ten feet. Further, that by extending the system of wings dams at the rapid, and, in addition to this, closing the "Gut" Channel, the centre of which is understood to form the boundary between the United States and Canada, a depth might possibly have been obtained by which a vessel, drawing 12 feet of water, could have passed at ordinary stages of the river.

The latter project it is presumed, could only be carried out with the sanction of the United States Government, and although it might in some respects be beneficial, it it questionable to what extent. Whilst it will readily be admitted that the St. Lawrence is on too grand a scale for uncertain experiments.

It may, however, be said that the depth of water in a rapid, will not increase to the same extent, as that to which the bottom is lowered, as the surface will be likely, in some degree, to diminish in height.

This is doubtless true, but there is reason to believe, that the difference between the depth of the rock removed and the depth of water obtained, will bear something like the proportion, that the additional sectional area given to the channel formed, does to that of the river, which, in the case under consideration, will be practically very little.

Taking all these matters into consideration, especially the fact that such a knowledge of the bed of the river has now been obtained, as enables a correct estimate to be made of the quantity of material to be removed; and that a vessel can be kept sufficiently steady in the rapids, to admit of drilling and other operations being carried on. It is believed that it might be well to invite tenders for the work.

This course is recommended under the impression, that it can be done cheaper by contract, than in any other way it could be carried on directly under the Department.

If this view of the matter is accepted, the contractor might be allowed the use of the chain vessel, which has been provided and fitted up chiefly for that purpose. This might be done under such stipulations, as could insure its return, in as good condition as when handed over to the contractor—ordinary wear and tear excepted.

CORNWALL CANAL.

In July last tenders were invited by public advertisement, for the formation of a new line of entrance at the lower end of this canal, and on the 9th August, they were received, when the works were shortly afterwards awarded.

The plans, and other documents connected with them, provide for all permanent structures, to be placed at a depth corresponding to 14 feet water on the mitre sills of the locks; as instructed by Letter No. 35,266.

It may here be stated that there are on the old line three Locks near the outlet of this canal, which have an aggregate lift of about twenty-four feet, when the River St. Lawrence is at its ordinary height. The locks are 200 feet long, with reaches of 331 feet between them, and are adapted to the passage of vessels drawing 9 feet of water.

To make them of the dimensions now contemplated, their bottoms would have to be lowered *five* feet, and the side walls lengthened seventy feet, which in reality means, taking down the present structures, and building others.

This could not, of course, be done during the season of navigation, and it is questionable if it could be accomplished at all during winter, unless by incurring an expenditure, greatly beyond what the circumstances would warrant. It being a well known fact, that at a point in the river some distance below the outlet of this canal, an

ice jam almost invariably occurs every winter, which has the effect of raising the river sometimes as much as twenty feet, so that it frequently covers the two lower locks.

Having such a phenomenon to contend with, it is barely within the range of possibility, that the requisite dams could be constructed,—a lock taken down,—another built in its stead, and the dams removed between the closing of navigation, in December one year, and its opening the following May.

This, together with the deficiency of space between the locks, and the fact that it would be still farther reduced by lengthening them, led to the selection of a new line and the adoption of the plan of rising from the river to the Cornwall level by means of two locks, and making the reach between them of such a length, as best suited to the circumstances. At the same time keeping in view the fact, that two vessels each of full canal dimensions, coming out of locks at the same time, but going in opposite directions, could not pass each other freely, in a reach of less length, than two and a half times that of the largest vessels used.

The new entrance channel is to be on the south side of the existing one, and in such a position, that the respective centre lines of the two routes, will be three hundred and fifty feet apart at the head of the present outlet lock, and four hundred and twenty feet apart, opposite the head of what is known as Lock No. 17.

For a distance of fully two thousand feet at the lower end, the line will be straight, and then curve round gradually, until the new south bank corresponds with that of the old canal, at a point nearly opposite the lower end of the landing wharf, at the Town of Cornwall. The whole of this part of the work is let in one Section, which extends from deep water in the river, to within about twenty-five feet of the lower end of the wharf above-mentioned.

In case satisfactory arrangements can be made with parties interested in the adjoining property and the water power at the lower end of the canal, the water on what is called the Cornwall Reach is to be raised about two feet, and the difference between that level and the River St. Lawrence will be overcome by means of two lift locks.

The lower, or entrance, lock on the new line will be placed in such a position, that its lower gates shall be opposite the upper gates of the present outlet lock, and the lower quoins of the second lock, will be opposite the head gates of the third lock of the old canal.

A regulating weir and race-ways will be constructed on the south side of the new line—the weir to be placed opposite the lower gates of the second lock, and the head race to it will connect with the canal at a point about 250 feet above the lock.

The tail-race from the weir will be kept at a height to supply the reach between the locks, and from it an outlet will be formed of sufficient capacity to discharge the surplus water into the river.

This plan of regulating the water levels has been adopted in preference to discharging the surplus water through the present locks, and attempting, from that source, to supply the reach between the two locks on the new line.

By carrying out this arrangement, the old locks, and reaches between them, can be advantageously used as graving docks, for the repair and overhauling of vessels, a kind of accommodation which will, doubtless, on many occasions, be found of great service.

In September last, the works were commenced at the upper end of the section, by preparing a seat for the south bank, through the low ground and outer edge of a bay, near the place, where the new and the old banks connect.

When doing this it was found that a considerable quantity of muck and loose earth had to be removed, before a stratum was reached of so retentive a nature as would be likely to prevent leakage.

The operations were proceeded with slowly for a time, but the force was gradually increased to the full extent, which the circumstances warranted, and the work of excavation carried on, as the weather permitted, up to the latter end of November, when they were closed for the season.

During this time, a sewer, which passes under the old canal, was extended out to the edge of the river, four feet under the bottom of the new line.

The contractors were also engaged searching for quarries, and, about five miles back of Cornwall, were successful in finding a place where very good stone for the bulk of the masonry can be obtained.

The place from which the face-stone of the locks is to be taken has not, however, been fully determined; but there are several good limestone quarries in view.

Before leaving this important link of the canal system, it is deemed proper to draw attention, briefly, to a few of the alterations, which, increasing the draught to 14 feet, will render necessary.

In the general report on this subject, dated July 1874, it was intimated that for a twelve feet line of navigation, the water might be raised between Locks Nos. 18 and 19, so that the dimensions required for the enlarged locks, could be obtained by lengthening and raising the walls.

The arch of the culvert for the road leading to Barnhart's Island, was represented to be of a height, that would admit of lowering the bottom of the channel, but it would have to be lengthened to obtain the necessary width of water-way, whether the water be raised or the bottom lowered.

Further, it was stated that by lowering the bottom and arches, and lengthening the culverts at Mille Roches and Moulinette, they might possibly continue to answer the purpose, although in a less efficient way.

The circumstances are, however, quite changed by the depth contemplated, so that the bottom of the channel from Lock No. 18, upwards, to deep water at the entrance, must throughout be lowered, the channel widened, and new locks, in every case, built.

LACHINE CANAL.

This canal having often been described; its dimensions, and those of the structures upon it frequently given; it is deemed unnecessary to repeat them, or say anything more, relative to its present capacity, than that it has been long looked upon, as inadequate to meet the wants of the trade. This is especially the case, at the Montreal terminus of the line; where the accommodation during busy seasons, has been found so unequal to the requirements, that delays have been often experienced, and, doubtless, loss sustained from this cause, by those engaged in shipping.

It is true the general depression, in all branches of business connected with the carrying trade, for the past two years, has prevented this deficient accommodation, from being felt to a like extent, as was done in previous years; there is, however, reason to hope that the present crisis, like all others which have come before it, will ere long pass away, and that the pressure for more space will return, with even greater force than formerly.

The extremely low rates of grain freights on the western lakes, have prevented any other than the largest class of vessels, engaging in that business successively; small vessels being unable from their earnings to pay the necessary expenses, are in many cases tied up idle.

The experience of the past few years, has already established the fact, that there is little inducement to build vessels, with a view to their employment in the grain trade unless they are made of the largest class, capable of navigating the lakes, and such as may be expected to occupy to the greatest advantage, the enlarged canals now in progress of construction, by the Government of the Dominion.

Some recognized authorities, however, entertain serious doubts, if any sailing vessels can successively compete in carrying grain, with the system introduced within the past few years, of using large barges towed by steam.

It is believed by many, that the depressed condition of business, and consequent low rates of water borne freight, has in some measure been brought about, by the great trunk lines of railway to, and from the west, carrying at unremunerative rates, in order to secure a through business, and compete with each other. This too at a time, when some of them are contending for a bare existence, and some of them are nearly, if not altogether, in a state of bankruptcy.

The evils of this unhealthy competition, are still further represented by many observant, and prominent public bodies, to result in less attention being given to local traffic, and to a system of discrimination which bears extremely heavy upon it.

At all events, the fact remains that the business is done, and the more northern, and longer roads, as well as water routes of limited capacity, are, in a measure, at the mercy of the shorter, and more southern lines of railway.

This, it is believed by many, will cease when the prevailing system has yielded (which it must eventually do), to the more legitimate course of doing business at remunerative rates only, whatever may be its extent. It is, however, presumed that the discussion of all such questions, may fairly be left to those, either directly interested, or who have given special attention to them, and are therefore in a better position, and in every respect better qualified, to deal clearly and fully with the subject.

When the enlargement of this canal was under consideration, the fact was kept in view, that it had to accommodate the trade of the River St. Lawrence, both for export and otherwise, also the lumber trade of the Ottawa River, for both the Quebec and American markets; it was therefore recommended to be made of a greater sectional area, than any other division of the canal system.

At the outset, the most important matters which presented themselves were the entrance at Lachine, and the outlet in the Harbor of Montreal, with the wharfage accommodation at the latter place.

The bottom part of the basin, at the upper entrance of the present canal, was known to be rock, through which a channel about 100 feet wide had been formed, to a depth at low water suited to the passage of vessels drawing 9 feet. It was however found that the fluctuations of the river had not been fully ascertained when the bottom line of the channel was fixed, as at extreme low water vessels loaded down to their full draught could not enter freely. In the years 1855 and 1856 the outer or river pier was extended fully 450 feet further up stream, which, in addition to improving the immediate entrance, had the effect of raising the water fully six inches, and to that extent benefitted the water-way.

When first forming this channel the basin was laid dry, after a water-tight dam had been formed on the south side, and another across the upper end of it.

It was at once evident that between the closing of navigation one year, and its opening the following spring, no such course could be adopted with any prospect of success, especially for the enlarged channel, which required to be sunk fully five feet lower, and made at least 200 feet in width.

To meet the case various lines and places were examined, the highest of which was Leishman's Point, near the place where the Lachine Railway wharf is situated.

At this point a good depth of water was found near the shore, but there is no natural basin nor shelter; neither could any be formed (within the limits of a reasonable

outlay) of an extent that could be called a harbor, or suitable entrance to so important a work.

These, amongst other but less forcible reasons, led to the conclusion that the public interest would not be consulted by the formation of a canal, that would connect with the River St. Lawrence, at a point north of the village of Lachine.

A thorough examination of the present basin was also made, with a view of ascertaining the probable cost of forming a new line, a short distance north of the present channel, and constructing a guard lock on that side; the result of which showed that a very good line could be obtained, but at an expense not warranted by the circumstances; especially as it would greatly diminish the space, now occupied in the basin for other useful purposes.

A careful examination previously made along the south-eastern, or river side of the present channel, shows that the depth of water and bed of the river are both more favorable for the formation of an entrance channel and basin, than any other place that could be selected in that vicinity. On full consideration, it was, therefore, recommended for these, and the following reasons:—

1st. The works connected with its formation and construction can be carried on without in any way interfering, with the navigation of the present canal.

2nd. About three-sevenths of its length, is already of the full depth required for a channel, suited to the enlarged scale of navigation.

3rd. It gives upwards of 20 acres of basin space, in addition to a channel-way 200 feet in width, making in all an area of about 48 acres. To obtain this, no private property is required, except for the purpose of forming a continuation between it and the canal.

From this point downward, various plans have been suggested, with a view to the formation of a channel, of the capacity required for the enlarged scale of navigation. The most prominent of which, at the time, was that of making an entire new line for the greater part of the distance between Lachine and Montreal, and one for the deepening and enlargement of the existing channel.

On the north-east side of the present line is a long stretch of low ground, known as the Lachine Swamp, which, on a cursory examination, is apt to lead to the impression that a new line of canal might readily be made through it. But on looking closer into the matter, it was found that a proper foundation for a bank, could not be obtained without very great difficulty, as the material consists of muck, heavily charged with water, and varying from five to nine feet in depth below canal bottom, for a stretch of fully half a mile, and, even at the depth stated, there seemed very little probability of finding the bottom of so retentive a nature, as would be likely to prevent leakage. Moreover, there is no suitable material for making a water-tight bank, within a long distance of the place

The scheme for enlarging the present canal is looked upon as free from all risk likely to result from leakage through the banks or bottom, and it was ascertained that the emptying of the canal during winter, whilst the operations were in progress, would not be so serious a matter as at first apprehended.

In short, it was urged that one large canal was better as a navigable channel, than two canals of less dimensions, a matter so well known to those acquainted with the movements of large vessels, as to require no further proof than simply to state the fact.

It is, however, deemed proper to remark, that the resistance to a vessel passing through a wide space of deep water, is less than through an ordinary canal. The case, as represented by recognized authorities, seems to be, that resistance rapidly increases as the channel diminishes below about six and a half times the sectional area, of that of the vessel passing through it. This evidently points to the conclusion, that the nearer an artificial channel approaches the capacity above mentioned, or even exceeds it, the better it will serve the purpose contemplated.

All these, and other known matters bearing directly on the subject, having been duly considered, it was recommended that the plan of enlarging the present canal be adopted, and that the summit level between Lachine and Cote St. Paul, be made a mean width of 150 feet, or to a sectional area of 1,950 square feet, which is nearly double its present capacity, and about one-fifth greater than that authorized for the other canals.

From Cote St. Paul Lock, downward to Wellington Street Bridge, the water-way was recommended to be increased to a mean width of 200 feet, and such other arrangements made as will be herein subsequently described.

On the question of the enlarged scale of navigation having been decided, attention was at once given to the lower entrance of the canal, and to increasing the basin, and wharfage accommodation on the Montreal reach, or that between the second and third locks above the harbor.

In the annual reports of the Department since the year 1852, these subjects have been from time to time brought under the notice of the Government, and in the year mentioned (1852), about fifty acres of land were purchased from the Seminary of St. Sulpice, for basins and other purposes connected with that part of the canal.

In the year following it was found that the great number of lockages, that took place at the lower entrance—some of them for vessels that passed up through the two lower locks, and returned without using the canals—led to such delays and complaints, that the question of a new entrance channel, was frequently urged by those taking an interest in the matter, and occasionally referred to in the reports of the Department.

It was then as now generally believed, that the place best adapted for that purpose, lies south of the present entrance, and on the line of the old canal; in fact, there is no other place where a new entrance could be made to connect properly with the harbor, unless a channel was excavated to it.

In addition to these general remarks, it may be stated that there are to be throughout a new tier of locks, each 270 feet long between the gates and 45 feet wide: they and all other permanent structures on the line, from a short distance below Wellington Street Bridge to Lachine, are to be arranged for a depth of 14 feet water on lock sills, and from the former place to the outlet in Montreal Harbor, the locks, and permanent structures are to be placed at a depth, corresponding to 18 feet on the lock sills.

All the works connected with the enlargement of the canal, between Montreal, and Lachine,—bridges and gates excepted,—are divided into eleven different Sections, each of which will be referred to in its order.

Tenders for Sections Nos. 1, and 2; were received on the 8th July 1873: for Section No. 3, on the 5th October 1875; for Sections Nos. 9, and 10, on the 20th January 1876; and for Sections Nos. 4, 5, 6, 7, 8, and 11, tenders were received on 21st March 1876, and the respective works were, in each case, shortly afterwards awarded.

Section No. 1,—includes the construction of a new entrance, from 80 to 100 feet in width, carried out to a depth of 19 feet at low water, on the south-east, or river side of the existing channel,—the construction of two lift locks, placed so as to have eighteen feet of water on the sills; between which, is to be a basin 540 feet long, and 260 feet wide,—the wings of the upper Lock are to be extended, to form abutments for a swing-bridge, to carry the traffic of Mill Street Road; and a regulating weir, with a race-way from it, is to be built in connection with the south-east dock-wall above the bridge.

The entrance lock is so placed, that its upper gate quoins are nearly opposite those, of the present outlet lock, where the centre lines of the old and new channels are 180 feet apart, and at the head of the second lock the respective lines are 100 feet apart.

The piers at the outlet are to be of crib-work, on which will be a continuous superstructure of pine timber, all well secured and filled with ballast.

All the masonry of the locks, dock walls, bridge abutments, and weir, consists of an approved class of limestone, prepared for the respective places, and laid throughout in hydraulic cement mortar.

The upper or second lock occupies part of the site of the combined locks, which formed the outlet of the old or original canal, the north wall of which, when it could be avoided has been left undisturbed, and where necessary it has been under-pinned, and otherwise secured.

On excavating the foundation, to the depth required for the floor timbers of this lock, the bottom was found to be of so soft a nature, it was deemed advisable to remove the entire surface material, for a depth of from six to fifteen inches, and substitute for

it a stratum of concrete, on which to place the foundation timbers. Concrete was also used in the sheet-pile trenches, and between the timbers in the chamber, and at both ends of the lock.

All the works connected with the foundation of this lock are completed, and the walls carried up to the height of twenty one feet over the floor, or fully two-thirds of the quantity of masonry in it has been laid.

The excavation of the pit for the lower lock is not yet completed; but about one-half of the foundation at the upper end of it is in place, and the walls, for fully one-third of the length of the structure, have been carried up to the height of five feet over the floor. This, together with the quantity of stone piled at other places, it is believed, will fully secure the timber that has been laid.

At the level for the foundation timbers of this lock, the material was found to be of a soft, gravelly nature, rendering its removal necessary, to admit, so far as the work has progressed, of forming a bearing surface of concrete, of from nine to sixteen inches. It is, however, from the indications, quite probable that the depth of concrete will have to be increased, as the lower end of the lock is approached. It will also be necessary to use concrete in the sheet-pile trenches, and between the floor timbers.

A large quantity of stone has been quarried, and prepared, but the service ground being limited, the stone is only delivered when it can be placed in the works.

The dock-walls of the basin, between the two locks, are nearly completed; and the excavation is so far advanced, that there only remains to be removed a small quantity, which is required for part of the filling in rear of the masonry.

It may here be remarked, that the time for proceeding with the works, on the lower part of this section is limited, by the high water of the river, to about four or five months in the year. It may, further be stated that considerable difficulty has been experienced in unwatering them, although much less than might reasonably have been expected, from the information conveyed through the medium of the specifications distributed to the contractors before tendering for the works.

Section No. 2,—embraces all the works connected with excavating or dredging basin No. 2, to an uniform depth of four feet below the top of the lower mitre-sill of the third lock, from a point near Wellington Street Bridge, to the head of the second lock—enlarging the basin by the removal of a triangular point of land, that projected north of the road between Wellington Street Bridge, and the weir at Tates' Dock—the deepening of the latter space, and forming a channel 19 feet deep from the head of the second lock, to the south-west side of Wellington Basin. The whole of the material excavated to be disposed of, without passing through any of the canal locks, or in any way obstructing or interfering with the passage of vessels.

It also includes the formation of Wellington Basin, the construction of dock walls of masonry laid in hydraulic cement mortar, on three of its sides, a sewer for drainage, wharves, and such other works as may be required.

This basin is 1,250 feet long, 225 feet wide, and has a depth of 19 feet. This portion of the work is in an advanced state, as only a few pieces of coping and part of the inner ends of the respective walls are required to complete the masonry—the whole area is of the full depth; the sewer is built, and materials for the wharves have been delivered, and part of them laid. The deepening of No. 2 Basin is not in so forward a state, as there yet remains fully two-fifths of the excavation still to be done.

Before leaving this part of the line, it may be stated that the time is close at hand, when a decision will have to be arrived at, as to how the wharf property adjoining Wellington Basin is to be divided, and whether the lots are to be disposed of by sale or lease.

Section No. 3,—Is fully three-quarters of a mile in length, its lower boundary being at a place a short distance below Wellington Street Bridge, and its upper end at a point 700 feet above St. Gabriel Lock.

It embraces the enlargement of the channel to a main width of 200 feet between the dock walls, and to an uniform depth of 13 feet—building piers, and abutments for a new swing-bridge at Wellington Street—the construction of a new lift lock on the north side of the present one at St. Gabriel, with the upper wings of it extended to form the seat, and abutments of a swing-bridge; building a regulating weir on the north side of the new lock; taking down 13 feet or more of the walls of the present lock, and using new face-stone throughout when rebuilding it; constructing a retaining wall on the south side from the lower end of the section upward, and at such places on the north side as may be required, &c., &c.

At the lower end of this section, the increased width given to the channel is taken off the south side, and is continued upward on such a line, that opposite St. Gabriel Basin the cutting for the enlargement is wholly on the north side of the canal, thence upward to near the end of the section, the widening is continued on that side.

Spoil ground for material taken from the excavation is, in a great measure, confined to two places, one of which is on the south side, near the lower end of the section and is of limited extent; the other is on the south side, near the middle of the section Under these circumstances the best that could be done, was to provide in the specifications for raising the spoil banks to the height of about twelve feet, unless the contractor could make favorable arrangements, for raising the ground of adjoining proprietors.

It may be stated, that in addition to taking down the upper 13 feet of the present lock walls, the lower north wing of the lock must be wholly removed down to the foundation, or at least as much of it as projects beyond the rear line of the side walls. This has to be done to admit of forming a water tight connection, between the back or end of the centre retaining wall, and a wall of concrete to be carried up in rear of the north side of the lock for its entire length. The seat of this concrete wall has to be formed, immediately at the back of the old lock wall, and sunk to the full depth of the new structure, or five feet below the bottom of the present lock.

The seat of the centre retaining wall has also to be sunk to a depth, corresponding to 14 feet on the sills of the lock, and the wall carried up, as well as the rear concrete wall, and side walls of the lock, between the present time and the twenty-fifth day of April next, in order to be ready for the opening of navigation.

As the new lock is to occupy the channel leading to the present regulating weir, the latter must be closed before the pit can be laid dry. To admit of doing this a temporary weir, and race-way will be built on the south side of the canal as soon as the walls of the present lock are sufficiently advanced, to allow part of the limited space on that side to be used for that purpose.

The land in the vicinity being for the most part closely settled, there were only about 2½ acres on the north side of the canal, below the lock, and part of the "Island" above it, that could be promised as service ground ; any greater extent required, the contractor has to provide at his own expense.

The works on this section have been proceeded with at a fair rate, a large portion of the excavation has been done at the south end of it, on the south side a separate cut has been formed up as far as the width, to be removed, would admit without endangering the stability of the bank, about 750 feet of the dock wall on that side has been built, and the south abutment of Wellington Street Bridge is well advanced.

At St. Gabriel, the greater part of the lock masonry intended to be removed, has been taken down, and the works at that place in other respects are in rapid progress. The materials required for the centre retaining wall, and for the walls of the present lock, are delivered and most of the stone prepared.

Building operations will be commenced, as soon in the month of March as the weather will permit, so there is every prospect that those parts of the works necessary to be completed, will be ready in good time.

On the 28th January and the 16th March 1871, orders of the Privy Council, were passed, authorizing the Grand Trunk Railway Company, under certain conditions, to build a swing-bridge, adapted to both railway, and ordinary traffic over the Lachine Canal, in line of Wellington Street, Montreal.

The bridge was to be built according to a design, then submitted by the Company, representing that the centre pier on which the fixed part of the bridge, as well as the toe of the swing were to rest, was to be of masonry ; but when the work came to be executed, the pier was built of crib-work. This was permitted rather than run the risk, of retarding the opening of navigation. The Managing Director for the Company was, however, notified by a letter, dated 14th of April 1871, that they (the company) are expected to take the necessary steps as early as circumstances will permit, to carry out the plan and conditions on which the privilege of crossing the canal, was granted by the Government.

In carrying out the works connected with the enlargement of the canal, the present bridge, piers, and other works at that place must be removed.

A good opportunity will therefore be afforded, for the construction of two bridges, one for the railway crossing, and another for ordinary traffic, in case it is thought proper to follow this course ; which some people who are aware of the extent of travel on Wellington street, were of opinion should have been done in 1871 ; still it could not then have been carried out to so good advantage as now.

It is, however, probable that a decision on this point, will in some measure be influenced by the amount which the Grand Trunk Railway Company contribute towards that object, from the fact of not having in the first instance carried out the design agreed upon, and the present bridge having been already six years in use.

Securing greater basin, and wharfage accommodation, at the lower terminus of this canal, being one of the considerations connected with the enlargement, it is deemed proper to state what has been done, as well as what is proposed to be done, towards these objects.

There is now under contract, and recently constructed, basins which afford accommodation as follows:—

Between the first and second lock, under contract	600	lineal feet.
Wellington Basin, under contract	2,625	" "
Basins on Slips Nos. 1, and 2, on north side of canal, above Wellington Crossing, recently constructed	2,960	" "
North and south side of channel, between Wellington Street Crossing, and St. Gabriel Lock, under contract	3,600	" "
Making	9,785	lineal feet.

Wharfage on Basins proposed to be constructed, may be approximately given as follows:—

Mill street Basin, below Wellington street (proposed)	2,700	lineal feet.
Space between Wellington, and Mill street Basins	350	" "
Basins or Slips Nos. 3, and 4, on the north side of the Canal, above Wellington street (proposed)	2,400	" "
	5,450	lineal feet.

The extent of old wharfage between the first lock and Wellington street is about ..... 5,000 lineal feet.

This has been all the accommodation of that kind, the trade has had for the past 25 years.

There is, therefore, about twice as much additional wharfage under contract, and built within the past few years, as has hitherto been used for all purposes, and there is still about as much as the original extent proposed to be built.

Section No. 4, is about 3,800 feet long, its upper end being a little above the Grand Trunk Railway swing-bridge, and its lower near the head of

the "Island" above St. Gabriel lock. It includes the enlargement of the water-way to a mean width of 200 feet, and to an uniform depth of 13 feet, or to 4 feet below the top of the lower mitre sill of the present lock at Cote St. Paul—facing the inside of the banks with pitched stone, laid at right-angles to the face—the construction of piers, and abutments for two swing-bridges, and alterations to the culvert under the canal, for passing the main pipes of the Montreal Waterworks.

The land in this vicinity being for the most part private property, contractors were informed that on the lower two-thirds of the section, there would be no "spoil-ground" adjoining the canal for the material excavated in widening and deepening the channel, or bridge foundations, and as mud-scows would not be allowed to pass the locks at either end of the reach, tenders for the excavation on the section would be received in two ways, viz.:—

1st.—On the understanding that one-third of the entire quantity of excavation on the Section, and in the foundations of the structures, can be used in making up the banks, from the lower end of the section upward, and deposited within a distance varying from thirty, to *one hundred and thirty feet* from the water-line of the enlarged canal, and on the upper one-third of the Section. The other two-thirds of the quantity to be placed at a distance, varying from from *four hundred* to *sixteen hundred feet* from the water line of the canal, at such places as may be directed within a distance of one mile and a half along the canal, from the lower end of the section.

2nd.—On the understanding, that after the banks of the canal are made up to the width, and height required, the contractor shall find, at his own cost and expense, deposit ground for all other parts of the material excavated from the widening and deepening, and from the foundations of structures, &c., as may be required by the Department of Public Works for embankment or for other purposes.

The result of this arrangement has been so far satisfactory: all wrangling about overhaul, bad roads &c., has been avoided—the contractors get the price fixed by themselves for material deposited on canal property, and in like manner when they find the spoil ground themselves.

Contractors were also informed that the principal part of the excavation on this section will be clay; but the lower part of it is of a hard nature, and it is probable that rock may be met with before getting to the full depth; especially in the foundations for the piers, and abutments of the bridges.

The excavation for the enlargement of the channel being chiefly on the south-east side, an independent cut has been formed outside of the present towing-path, for a continuous stretch of fully 1,900 feet, and generally to the full depth specified. For fully two-thirds of this distance, the trench for the seat of the side wall has been sunk to the depth of 15½ feet, below the surface water line of the canal—the face of the bank has been trimmed to the required angle, about 1,300 lineal feet of protection wall carried up to a mean height of eleven feet, and arrangements have been made, for the delivery of a sufficient quantity of stone during the present winter, to raise this part of the wall to the

full height. The abutments of Brewster's Bridge are carried up: stone has been delivered and prepared, and arrangements made for building the centre piers and seat piers, for the swing-bridge, before the water is again let into the canal.

About two-fifths of the entire quantity of excavation has been done, and the works generally, are progressing in a fair way.

SECTION No. 5,—is about four-fifths of a mile long, extending from a point near the Grand Trunk Railway Swing-Bridge, to opposite the lower factories at Cote St. Paul.

It embraces the widening of the channel to two hundred feet, and lowering the bottom to a depth of thirteen feet below the surface water line—building a protection wall of pitched stone along the inside face of the banks, and constructing an inverted syphon culvert, to carry the water of the River St. Pierre through under the canal.

The excavation for the enlargement, on the lower half of the section, is on the south side of the canal, and for the upper half it is on the north side.

There being comparatively little land in this vicinity belonging to the Government, contractors were, at the time of letting the works, informed that on the upper three-fourths of this section, there will be no "spoil ground" adjoining the canal, for the material excavated in widening and deepening the channel, or foundations of structures, and as mud scows cannot be allowed to pass through the lock at either end of the reach, tenders will be received in two different ways. For the form and conditions of which *vide* Section No. 4.

By the adoption of this course, contractors fix the prices at which they are, in either case, to be paid, and thereby, any misunderstanding about over-haul, and matters of that kind, is avoided.

Contractors were also informed that on this section, the principal part of the excavation in both the widening and deepening, will be clay, some of it of a hard nature; rock will, however, be found for a stretch of fully 1,000 feet at the upper end of it, at some places a little higher than the bottom line of the present canal; and, it is quite probable that, at other places rock may be met with before getting to the full depth, or, at least, a class of material composed of clay, gravel and boulder stones, firmly cemented together.

The north side of the enlarged channel, for the greater part of the upper half of this section, being considerably north of the present bank, the contractors commenced their operations there, and, by employing a large force, succeeded in forming a considerable stretch of the channel to the full depth, and making a good bank alongside of it, although part of the line was rather unfavorable for that purpose.

For nearly 1,200 feet, the seat of the side walls has been sunk to the depth of 15½ feet, below the surface water line of the canal, the face of the bank made to the

required angle, and for the distance stated, the protection wall has been carried up to a height of ten feet. The west end of the culvert pit for the River St. Pierre, has been sunk to the full depth, the foundation timbers laid, and the whole well loaded down for the winter. A large portion of the stone required for this part of the work, has been delivered and prepared. At the lower end of the section, there has been a considerable extent of excavation done, on the south-east side of the line, and in other respects, the progress made, and general arrangements are in an advanced state. About one-third of the quantity of excavation on the section has been done.

It may here be stated, that for the facing of the banks on the whole of this reach, a class of wall has been adopted, which admits of forming wharves when required, on both sides of the channel. The inclination of the face is so little, that no vessel lying alongside, could be more than five feet from the water line, and many would not be more than half that distance.

There is a probability that for lumber and bulky articles of that kind, wharves in that vicinity may yet be found serviceable; provision has therefore been made, that when required they can be leased, to parties desirous of obtaining such accommodation. There would be little or no objection to this, so far as navigation is concerned, as it is quite probable that ere long, nearly all vessels passing through that part of the canal, will use steam tugs; consequently paths for tow-horses will cease to be a part of the system.

Sections Nos. 6, & 7,—commence at a point about 700 feet below the present Lock at Côte St. Paul, and extend upward a distance of about 10,000 feet. They form one contract, which embraces the enlargement of that part of the canal, at the lower end of the Section to a mean width of 200 feet, and all the part above Côte St. Paul Lock, to a mean width of *one hundred and fifty feet*, and to a depth of *four and one-fifth feet*, below the mitre sills of the present Guard Lock at Lachine—forming an inverted syphon culvert under the canal—building piers, and abutments, for a new swing-bridge at Côte St. Paul—constructing a new lift lock, on the north-west side of the present one at that place—taking down 13 feet or more of the walls of the old lock, and using new face stone throughout when rebuilding it—building protection side walls where required, &c., &c.

On the lower one-third of the Section, the excavation for the enlargement is on the north-west side of the channel; thence upward, the increased width will be taken chiefly off the south-east side.

Contractors were informed in the specification distributed before the letting, that the principal part of the excavation on the Section will be clay, but part of it is of a hard nature: rock will, however, be found below the lock, at a height a little over the bottom line of the present canal; and at many places in the upper reach, the surface of the rock is either at, or a little below the level of the present bottom; but it generally underlies a hard class of material composed of clay, gravel, and boulder stones, firmly cemented together.

They were also informed that the material, for both the widening and deepening of the prism of the canal, as well as that to be removed from the lock pit, foundations of bridge piers, and abutments, culvert pit, &c., can all be deposited at the upper end of the Section, on the low land on the north side of the canal. But should any of the adjoining proprietors be desirous of having their land raised to an extent, that would render it more advantageous spoil ground, than that above-mentioned, part of the excavated material may be used for that purpose.

The land in the vicinity being for the most part private property, the contractors have to provide at their own cost and expense, all the service ground that may be required for the purpose of placing, and preparing materials, or for the erection of sheds, store houses, or any other buildings, or for temporary roads, or for any other purpose whatsoever.

The same remarks as used in relation to the overhauling of the present lock at St. Gabriel, and the formation of a concrete wall, and centre retaining wall, are applicable in this case, for which (see page 55).

The works on the lower part of Section No. 6, were proceeded with at a fair rate, during the summer and fall months of last year—the pit for the new lock was excavated down to the rock, or to the full depth where rock was not found, and the best of the material was used to form a bank, from the lower end of the section up to Côte St. Paul Road, a distance of about 1,400 feet.

Before making this bank, a seat for it had to be cut through black muck, and marl at some places, for a depth of from ten to twelve feet below canal bottom.

An effort was made to do part of the work on Section No. 7, by means of scoop dredges, but the operations were found less successful than anticipated, from the fact, it is alleged, that the machines employed were not sufficiently powerful, for the work which has to be done.

Since the canal was emptied in December last, the contractors have been proceeding with the work by manual labor, and it is stated that "if there is any difference at all the "material is not as hard as represented by the specification, its solidity is, however, "increased by the frost which extends to the depth of two feet."

About one-third of the bottom excavation has been done on Section 6, and one fifth of Section 7, has been deepened for the width of the present bottom.

All the defective portions of the masonry, and other parts of the walls of the old lock at Côte St. Paul, necessary to be taken down, have been removed, and the works there, are in other respects in rapid progress.

The materials required for the walls of the present lock, and for the centre retaining wall, are delivered and most of the stone prepared. Derricks, and other equipments necessary for moving the stones, and laying the masonry, have been provided,

so that as soon as the weather admits of commencing building operations, this portion of the works can be proceeded with expeditiously.

SECTION No. 8,—is about 7,500 feet in length; it consists of enlarging the channel to a mean width of one hundred and fifty feet, and lowering the bottom to the depth of fully four feet and one-seventh below the top of the mitre sills of the present Guard Lock at Lachine—forming a road along the south east side—building walls at certain places, and at others facing the banks with pitched stone or a rip-rap wall.

When tenders were received parties were informed that for about 2,500 feet at the lower end of this section, the increased width would be taken off the south-east side of the channel, above this, for a short distance the widening would be done on the north side, thence upward the increased width would be taken off both sides.

Contractors were further informed, that, at the upper end of the section, there was rock $2\frac{1}{2}$ feet over surface water line, but that 1,000 feet lower down, the surface of the rock is nearly on the same level as the bottom of the present canal, and continues at that height on other parts of the section; except at places where it underlies a hard class of material, consisting of clay, gravel, and boulder stones, firmly cemented together.

Spoil-ground was stated to be chiefly on the north side of the line, and opposite the lower two-thirds of the section.

On the south-east side of the canal, all the excavation over the water has been done, and the material used chiefly in forming the berm bank and road in the rear of it.

Dredging operations were proceeded with in the latter end of September, October, and November last, but the want of proper equipment, prevented their being carried on advantageously.

Since the canal was emptied in December last, the works have progressed fairly, and arrangements have been made, for proceeding still more rapidly during the present winter, as well as with dredging next summer.

SECTION No. 9,—extends downward 6,000 feet from a point situated about 1,000 feet, below the lower wings of the present guard lock. It embraces nearly all that part of the line known as the "rock cut."

The works upon it consist, chiefly, in increasing the channel to a mean width of 150 feet, and to the depth of 4 feet, below the top of the lower mitre sill of the guard lock, forming a new towing path, and berme bank, and building walls where necessary to support the banks.

Contractors were informed that the greater portion of the material excavated, could be deposited at a distance of from 110 to 200 feet from the centre line of the canal. They were, however, requested to bear in mind that the spoil-ground, in some cases, would not be directly opposite, the place where the widening is to be done, and that the haul of the

material excavated over water surface may at places be 1,000 feet, in order to leave more convenient space, for depositing the side and bottom excavation.

Parties tendering were further informed, that all the works over the water surface on this section had to be done between the time they were awarded, and the opening of navigation in the spring of 1876.

The operations have been conducted in a manner, that showed a desire on the part of the contractors to comply with the conditions,—above mentioned; and, notwithstanding the severity of the weather, and unfavorable nature of the material (old spoil of earth and clay mixed), the greater part of the widening, down to the water surface, was completed in June last.

Removing the surface rock, and drilling ranges of holes, the full depth of the channel, along the line of the enlargement, at the respective places where widening has to be done, occupied the greater part of the summer, and fall months. Pumps, derricks, travellers, railway tracks, cars, and other equipment, have been provided for urging on the works, as expeditiously as circumstances will permit during the present winter; and the contractors seem desirous of doing all in their power to facilitate the operations.

Section No. 10,—is 1,400 feet in length, and is situated on the south side of the present entrance lock, and weir at Lachine. It includes all the works connected with the formation of a new channel; the construction of a new guard lock, with its upper wings extended to form abutments, for a swing bridge for public traffic; building protection walls, where required on the section.

The channel, generally, is to have a mean width of 150 feet; above the new lock it will be made to a depth of six feet; below the top of the mitre sills of the present guard lock, and the lower reach will be made to an uniform depth of four feet below the same point.

This section is a thorough cut, that produces a large amount of material, consisting of old spoil bank, and rock, all of which, except the part suitable for embankment in rear of the lock walls, and bridge abutments, is to be hauled beyond the upper end of the section, and deposited in the river on a continuous line upward, to the south of the contemplated new harbor works.

The greater part of the excavation on this section has been completed, except the rock in the bottom of the lock pit, which has still to be taken out.

From the appearance of the surface of this rock, there is every probability that a foundation of timber will have to be formed, and that instead of ordinary sheet piles, it will be necessary to use stop-water timbers let into checks, cut in the bottom for their reception.

A considerable quantity of stone has been quarried, and part of them prepared, and arrangements made for proceeding with the lock masonry as soon as the foundation is ready, next spring.

SECTION No. 11,—embraces all the work to be done for the formation of a new channel, and basin on the south-eastern or river-side of the present entrance to the canal at Lachine.

They are to be formed by means of a continuous line of pier work, about 6,200 feet in length, alongside of which a channel two hundred feet in width, is to be sunk uniformly to the depth of six feet, below the top of the mitre sills of the present guard lock.

The principal reasons for the selection of this line of entrance, for the enlarged canal, having been given in a preceding part of this report, attention will now be drawn briefly to the works only.

Contractors, previous to the "tendering" for this section, were informed by the specification, that except for a short distance at its lower end, the whole area occupied by the works upon it is in the river, and at some places strong currents must unavoidably be encountered.

They were also informed that the material to be removed, except near the bank of the river, is for the most part rock in position, arrangements were therefore to be made, for unwatering a large portion of the space, so that if possible the bulk of the excavation might be done in the usual way. To enable this to be accomplished about 3,600 lineal feet of the pier, from the bank of the river upward, is to be formed of two ranges of cribs placed six feet apart, and the space between them cleared out, secured, and filled with material of so retentive a nature as likely to prevent leakage.

From a short distance above the place mentioned the cribs will be made thirty feet wide, and be continued at that width to the lower side of the ice-breaker, that is to form the head of the pier.

The superstructure is to be carried to about the same height, as the coping of the guard lock. For 600 feet at the upper end it will be of pine timber, and at other places it is to be of stone, hand-laid, and faced on the channel side, and partly on the river side, with masonry, laid in cement mortar.

At the upper end of the double crib-work, a dam is to be built across the water-way, which is to connect with a puddle wall, supported by a line of rough crib-work, sunk along the south-easterly side of the old pier, from the place mentioned inward to the bank of the river.

Contractors were informed that the clearing of the sites of the piers, and space between them is considered an essential part of the work, which must be properly attended to in order to render the undertaking successful.

It was also stated, that it is quite likely a considerable extent of pumping power, will be required before the space within the exterior dams, or even any great extent of it, can be laid sufficiently dry, to admit of proceeding with the excavation advantageously.

This was looked upon as probable, even with good success in preventing the water entering laterally, as it might find its way "under a head" through seams, and fissures in the bottom.

It was further mentioned, that in order to make a channel 200 feet wide, and increasing it to 300 feet, opposite the upper entrance of the present canal, there are three different places where the bottom is rock, which, together with the removal of any boulders, and the deepening of such other places, as may be found necessary to obtain the full depth of six feet, below the mitre sill of the guard lock, forms a class of excavation that must be done under water.

Attention was specially invited to these matters at the time, that contractors might look carefully into them, and, with a knowledge of the facts, be enabled to determine for themselves, the value of the work to be done.

A contract for this Section, was entered into in the early part of April last; but the progress made since that time, bears a very small proportion, to the extent of what is required to be done.

The site for the dam alongside the present pier, has been cleared for a considerable distance, and the cribs on that line have been sunk for a stretch of 1,000 feet from the shore outward, and a few cribs of the outer pier are in place.

A large quantity of timber has been delivered, and part of it framed, and arrangements made for proceeding with the works, as early as the weather will permit next Spring.

It may here be stated, that full information, as to the works in progress on the Lachine Canal, was furnished by Mr. John G. Sippell, the Superintending Engineer.

Before closing this eport, it is deemed proper to submit a synopsis of the estimates originally made, for the different divisions of the canal system, for twelve feet draught of water; together with the approximate amount required to increase the depth to form a line suited to a *fourteen feet* navigation, throughout.

WELLAND CANAL:

Original estimate for a draught of 12 feet water	$9,240,000	
Adapting canal and the different entrances, to a depth of 14 feet on the lock sills	3,000,000	12,240,000.

ST. LAWRENCE RIVER, AND CANALS:

Williamsburg Canal original estimate	2,110,000	
Cornwall do do do	2,160,000	
Beauharnois do do do	2,450,000	
Lachine do do do	5,920,347	
Deepening the bed of the river at various places	1,520,000	
	14,160,347	
Less amount, if the submerged-chain tug system is found successful, and the Locks on the Williamsburg Canals are only lengthened	1,700,347	12,460,000
To deepen the St. Lawrence Canals, and River between them, to pass vessels drawing 14 feet water, will cost at least an additional sum of		5,500,000
		$30,200,000

WORKS UNDER CONTRACT.

Welland Canal, estimated cost	$7,500,000
Cornwall do do do	560,000
Lachine do do do	4,800,000
	$12,860,000

In conclusion, it may be stated, that, from the general depression of business, and consequent abundance of labor, there is reason to believe that, at the present time, the works can be let on more advantageous terms, than they could have been done at any time within the past ten years.

I have the honor to be Sir,

Your obedient servant.

JOHN PAGE.

Chief Engineer Public Works.

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APPENDIX

TO THE

CHIEF ENGINEER'S REPORT

ON THE PROGRESS OF

CANAL ENLARGEMENT

BETWEEN

LAKE ERIE AND MONTREAL.

A.

THOROLD, 6th December, 1876.

SIR,—I have the honor to submit the following report on the state of the works in my charge, on the 30th November, 1876.

These embrace the deepening and enlargement of Port Dalhousie Harbor; together with the construction of twenty sections of the new Welland Canal, stretching from Lake Ontario to Allanburgh, a distance of 12.67 miles; on which the twenty-five locks necessary to attain the level of Lake Erie are situated.

With the exception of the entrance and summit locks, the rise at which will be variable, all the rest are arranged for lifts of either 12 or 14 feet.

The mean difference of level between the lakes is computed to be 327.5 feet; and all heights are referred to a datum of ordinary surface of Lake Ontario, assumed as being represented by a plane 13.54 feet over the mitre sills of the present entrance lock at Port Dalhousie.

Of the twenty sections above referred to, sixteen are under contract, the chief items of work on them being approximately as follows:—

Masonry	325,000 cubic yards.
Earth excavation	3,500,000 do
Rock do	160,000 do
Timber	1,000,000 cubic feet.
Plank	3,500,000 Feet B. M.

Sections Nos. 8, 9, 10, 11, 15 and 16, were let in the summer of 1873; and work was begun on Section No. 15, on the 2nd of August, in that year.

Sections Nos. 2, 3, 5, 6, 7, 13 and 14, were given out in 1871: and contracts were signed for Sections Nos. 1, 4 and 12 last year.

The quantities of the principal items of work done to date, and those approximately required to complete, are as follows:—

Work done.			To be done.		
Masonry	174,568	cubic yards.	.....	150,432	cubic yards.
Earth excavation	2,992,089	do	.....	507,911	do
Rock do	90,645	do	.....	69,355	do
Timber	753,825	cubic feet.	.....	216,175	cubic feet.
Plank	2,516,815	ft. B. M.	.....	983,185	feet B. M.

Value of work done and materials delivered to 30th November, 1876, $3,690,958 $\frac{64}{100}$.

Subjoined is a short description of the condition of affairs on each of the sections.

SECTION No. 1.

Considerable progress has been made in dredging the Harbor of Port Dalhousie, and the entrance channel between the piers; 222,883 cubic yards having been removed to date under the existing contract.

When the works are completed, the area of deep water inside will be doubled; forming a basin of over sixteen acres in extent, with from 16 to 17 feet at low stages of the lake.

The greater part of the excavation is in soft material, but in the entrance cemented gravel is found; and at one place on the east side of the harbor, near the Welland Company's grain elevator, the cribs forming the docking will rest on a bottom of rock for a distance of 240 feet; that material having to be blasted under water in order to obtain the required depth.

The new docking to form the approach to the entrance lock, will be about 750 feet in length on the east side, and 950 feet on the west side of the addition to the harbor. For this, 43 cribs 30′ x 18′, have been framed, sunk, and solidly filled with stone; and the timber for next years work has been delivered.

Six of the cribs for the extension of the east entrance pier 300 feet further into the lake, have been prepared, and the material necessary for the superstructure is on hand. This work will be pushed on early next season. The entrance lock pit is, for the most part, taken out to bottom line, 45,498 cubic yards having been removed. The coffer-dam constructed to shut out the water of the lake has been strengthened; and it is the intention to keep it pumped out during the winter. A reddish sandstone rock forms the principal part of the foundation, overlying which quicksand has been found in several places. The cutting is very heavy; over forty feet deep on the east side; and the rock referred to, slopes off rapidly on the north-west corner of the pit, where the borings show soft clay to a depth of about thirty feet below grade.

About 1,150 cubic yards of backing have been delivered for the lock, and there is a considerable amount of stone dressed in the quarries, which will shortly be hauled by rail to the section.

The upper wings of this structure will be extended across the site of "Andrew's dry dock," to form the abutments of a bridge to carry the main road from Port Dalhousie to St. Catharines over the new canal. The travel is at present diverted along the north side of the dock. In order to give free outlet to the waters of the canal during spring freshets of the twelve mile creek, a saw mill, which stood close by the west end of the present regulating weir has been removed. The extension of this weir to adopt it to the service of both the old and new channels of navigation, will not be begun until next year.

The site for the guide piers to the upper end of the entrance lock, will be in soft mud which seems to cover the whole area of the bottom of the inner basin to a considerable depth. The distance across this basin from the old dry dock to Lock No. 2 is 1650 feet. It contains an area of about 35 acres of water generally from 14 to 17 feet deep.

SECTIONS NOS. 2 AND 3.

There are four locks on these sections, and four regulating weirs ; together with other structures, amounting in all to about 42,113 cubic yards of masonry, of which 31,245 cubic yards have been laid.

Lock No. 2 is located in a high point on the west side of "May's Ravine," which is a small tributary of the valley of the Twelve Mile Creek. Here the old and new canals diverge, the latter following an entirely independent course to Marlatt's Pond, near Thorold.

The east upper wing of the lock will be connected by a stone dam (now nearly completed) with the regulating weir build in the right bank of the ravine. The central part of this dam is 184 feet long, and 36 feet 9 inches high, the bottom of the old creek at this point being so soft as to necessitate the removal of the material for considerable depth in order to obtain a safe foundation. The dam and weir together contain nearly 4,000 cubic yards of masonry.

Lock No. 2 will not be commenced until next year ; but a large amount of earth has been taken out of the pit, the excavation of which will be continued during the winter.

The cribs for the entrance piers to this lock from the inner basin have been sunk in two diverging lines, each 300 feet in length. Owing to the soft nature of the bottom previously referred to, many of them reach to a depth of from 20 to 22 feet below the present surface of the water.

As a similar depth (fourteen feet) will be established at Lock No. 2, to that fixed for the entrance lock ; the foundations will, according to your directions, be sunk two feet lower than at first intended.

Between Locks Nos 2 and 3, the reach is 1,350 feet long, and the canal is generally 165 feet wide at bottom, with a breadth of 217 feet at water line. This basin will have a surface area of about 6¾ acres ; and was readily formed by widening out the sides of the ravine, which for some distance is followed by the present location. This additional width is desirable in consequence of there being a considerable change of direction immediately to the south of Lock No. 2.

Lock No. 3 is also situated in the ravine just north of where the canal line is again crossed by the main road from Port Dalhousie to St. Catharines. On excavating the foundations for this structure, it was discovered that a large part of the area towards the south end, consisted of a bed of quicksand. This has been confined to its place by sheet pile trenches, and the whole extent of the bottom (over half an acre) was, according to your directions, covered with two feet in depth of concrete, carefully put on in layers. The lock walls are now ready to receive the coping, and the foundation appears to be perfectly solid ; not the least indication of settlement or change of any kind being observable. The upper wings have been extended to receive a swing bridge for the road referred to ; which will also cross the race-way a little to the west by a fixed structure.

This race-way is about 3000 feet in length, and is situated on the west side of the canal. It is sixty feet wide at bottom, and leaves the main line above Lock No. 5, rejoining it below Lock No. 3. Three regulating weirs are built across it, and openings are made to permit of free communication with each of the two intervening reaches. This arrangement will doubtless have the effect of avoiding cross-currents in the canal, the surplus water beyond that required for lockages being thus passed by an independent side channel.

The reach between Locks Nos. 3 and 4 is 810 feet in length, and as the canal curves somewhat to the west, the bottom width, in the centre, has been made 150 feet.

Lock No. 4 has its walls 21 feet four inches high, and material has been prepared to finish the structure early next season. The ashler of Lock No. 5 is entirely completed.

Both Locks 4 and 5 were laid up with steam cranes placed on rail tracks running on the outside of each wall. This method worked both rapidly and economically under the circumstances.

All the minor structures are completed, and 356,792 cubic yards of earth have been excavated, so that there will be probably no difficulty experienced in finishing the the work on these sections next year.

Their combined length is 5,220 feet.

From the crossing of the Queenston Road, on Section No. 7, in rear of the City of St. Catharines, the new canal is always more or less in embankment; and as the natural slope is to the north-east, the drainage of the country, for a considerable area, is intercepted.

A large ditch has therefore been excavated on the west side of the canal to convey the surface water to the first convenient point where it may be disposed of. This occurs in the vicinity of Lock No. 3, on Section No. 2, where a branch of "May's Ravine" crosses the main road a short distance to the west. The back ditch terminates in this branch, which is connected with the wide reach or basin between Locks Nos. 2 and 3, previously described.

Section No. 4.

There is no lock or weir masonry on this Section, the only structures being a railway swing bridge and a single track road bridge.

The earth excavation is nearly completed; 161,596 cubic yards having been taken out to date. A portion of this is for the formation of 3,250 feet in length of canal, and the remainder is that required for the Welland Railway diversion.

This line has to be changed to the east, the new track being 5,944 feet between the points of divergence; the work being necessary in order to raise the grade, so as to cross over the new canal where the latter is in ten feet embankment; the present track being nearly on a level with the surface of the ground.

This change will be made without interruption to the traffic of the railway, and the redistribution of grade on the line as now located will not, it is believed, increase the cost of working, whilst the general arrangements are such as to render the approaches to the bridge as safe as possible, there being a considerable length of level on both sides of the canal crossing.

The bridge at this point has not yet been begun. The road bridge at the crossing of Lake Avenue extension, St. Catharines, is however, well advanced, 716 cubic yards of masonry having been laid there this fall. The works embraced on this contract can easily be completed next season.

The quantities of earth work on this Section, and also on Sections Nos. 5 and 6, will be considerably increased beyond those originally contemplated, in consequence of the surface soil being sand in some cases for a depth of from three to four feet. This had of course to be thrown to spoil, and suitable material borrowed in its stead for the formation of the canal banks.

Section No. 5.

On this Section there are two locks, two regulating weirs, &c.

The reach between Locks Nos. 5 and 6, is 4,400 feet in length, and that between Nos. 6 and 7, is 1,500 feet.

The surplus water is passed by the two latter Locks, through an opening in the east bank of the canal, a short distance above No. 7. This opening communicates directly with a small reservoir, about 1½ acres area, in the north bank of which there is a regulating weir, discharging into another side reservoir at a lower level, its surface being

over four acres in extent. From this the water is conveyed by a race-way of 900 feet long, having a bottom width of 60 feet, into the main canal about 250 feet north of Lock No. 6.

The excavation of this Section is now well advanced, 170,840 cubic yards having been taken out to date.

The walls of Lock No. 6 are 10 feet 6 inches high and No. 7 is nearly completed, about one third of the coping being in place. The extension of Geneva street, St. Catharines, will cross the canal on the upper wings of Lock No. 6, the masonry for which has not, however yet been commenced. This street will also have to be carried over the race-way to the east, (previously described) by a fixed structure.

Two regulating weirs are finished, and one towing-path bridge. Under existing arrangements the work embraced in present contract can be entirely completed next year. The amount of masonry of all kinds laid to date is 12,842 cubic yards.

The length of the Section is 3,200 feet.

Section No. 6.

This Section is 7,000 feet long. The work consists almost entirely of earth excavation, and is nearly completed, 256,897 cubic yards having been taken out to date.

There is however a double track road bridge at the crossing of Niagara street, St. Catharines: 685 cubic yards of the masonry of this being built. A towing path bridge to be constructed near the south end of the Section has not yet been commenced.

The work can be easily finished next season.

Section No. 7.

The low gravel ridge, running east from St. Catharines to Queenston, traverses the line of the new canal towards the south end of this Section. The main road, which follows this ridge, will be carried across by a double track swing bridge, the abutments and piers of which are built.

The foundations of Lock No. 8 are laid, two courses of masonry being in place, and flooded to protect the work from the effects of the frost.

Lock No. 9 is partially coped: and one of the regulating weirs is finished, the other having been recently begun. The earth excavation is well advanced; 183,969 cubic yards having been taken out to date. It will, however, require a vigorous effort on the part of the contractors to complete the works of this Section next year.

The masonry laid is 10,960 cubic yards, length of Section 3,075 feet.

Locks No.'s 7 and 8 are 7400 feet apart; but the length of reach between No.'s 8 and 9 is only about 700 feet. To the north of the Queenston Road on the east side of the canal, a reservoir 4.21 acres in extent has been constructed. This is connected with another, the surface of which is on the same level as that of the reach between Locks No.'s 8 and 9, and having an area of 7.43 acres. In its north bank a regulating weir has been built, discharging into a raceway 750 feet in length, with a bottom width of 60 feet. This terminates in an opening in the east bank of the canal, through which the surplus water will re-enter a short distance below Lock No. 8.

Sections Nos. 8 and 9.

The work on these sections is generally so far advanced, that the completion of the present contract can be easily accomplished next season. 316,074 cubic yards of earth have been taken out; but little now remaining to be done. The ashlar of Locks Nos. 10, 11, and 12, is finished, except the copings, a part only of which has been laid. Three regulating weirs and two towing path bridges are built; and a towing path bridge on Section No. 8 has also been commenced. The materials for the fourth, or remaining one, are all on the ground.

The distance between Locks Nos. 9 and 10 is 2,250 feet. The surplus water is passed around the latter structure on its west side. The opening for that purpose above the lock, communicates with a side reservoir of about 2½ acres in extent. In its north bank the regulating weir is built, from whence a raceway, 60 feet wide and 900 feet long, leads into the main canal below. Between this raceway, and the rear of the lock, about 1½ acres of ground have been levelled off and will, from its position, probably prove useful in connection with the future service of the canal.

All the locks from No. 4 to No. 11, inclusive, are on the same right line, the length of which is 4.4 miles. Between locks Nos. 11 and 12 the canal centre deflects 20 degrees to the west and is again straight for about 4,500 feet. On this tangent locks Nos. 12, 13, 14, 15, and 16, are situated.

The distance between locks Nos. 10 and 11 is 3,500 feet. Towards the south end of the reach the canal crosses the ten mile creek, by a double arched culvert of eight feet spans. The stream is liable to heavy freshets in the spring, but the structure which has now been in use for two seasons, has been found amply sufficient for the greatest required discharge.

Between this culvert and lock No. 11. the road from Thorold to Homer is met. Preparations are being made to build a single track bridge at this crossing, some dressed stone having been delivered for that purpose. A quantity of material is also hauled for the extension of the lock wings.

From lock No. 11, southwards to No. 24, the average distance between the structures is about 650 feet, and the canal is flanked by a succession of side reservoirs, some of which have a considerable area of surface. The pond below lock No. 11, and connected with the long reach to the north of it, is about 4½ acres in extent. That alongside the reach between Nos. 11 and 12 covers over 6½ acres of ground.

The aggregate length of these sections is 6,338 feet. Masonry laid to date 26,058.7 cubic yards.

Section No. 10.

The first lock on this section will carry the line between the IX and X concessions of Grantham Township across its lower wings, which have been extended for this purpose. The approach of this bridge from the west is in heavy embankment, through which there is an opening, to connect the upper and lower portions of the reservoir, alongside the the reach between locks Nos. 12 and 13. This pond has an aggregate surface area of nearly 9 acres. There is also a culvert of dry masonry through this bank to the west of the reservoir, to pass the water of a small tributary of the Ten Mile Creek, which discharges into the pond near lock No. 11, on Section 9. The side reservoir for Nos. 13 and 14 has an area of 7 acres. Lock No. 13 and extension are ready to receive the coping; and the walls of No. 14 are eighteen feet high. All the minor structures are completed and 135,885 cubic yards of earthwork taken out.

A large amount of material is prepared and delivered for finishing the locks, so that there is every probability this section will be ready next season.

Length of section, 2,107 feet. Total amount of masonry laid to date, 16,811 cubic yards.

Section No. 11.

On this section the earth work is well advanced; 167,670 cubic yards having been excavated.

Lock No. 15 is partly coped; and the walls of No. 16 are eight feet high. One regulating weir and two towing-path bridges are completed, and a quantity of material delivered on the ground.

Towards the south end of the section, the road from Thorold to St. Davids is passed under the new canal, the levels of the ground being favorable for the purpose. The arched culvert is 14 feet wide, 14 feet high, and 331 feet long. It contains 3,507

cubic yards of masonry, and will, it is believed, prove a satisfactory means of transit in such position. The drainage of the structure is led into an adjoining creek; the approaches are at an easy grade, and the roadways are thirty feet wide.

The side reservoir for the reach, locks 15 and 16, is 7.6 acres in extent. A regulating weir is, as usual, built in the north bank which separates it from the adjoining pond, of 8.6 acres in extent. In the south west corner a raceway 60 feet wide enters, and, through this channel, a connection is made with the side basin to the south. The raceway will cross the St. David's road about 500 feet west of the culvert and connect with a regulating weir to be built in the present railway bank.

Length on section, 2,250 feet. Total amount of masonry laid to date 15,376.54 cubic yards. The work can doubtless be finished next season.

Section No. 12.

This is an important section, embracing some heavy work, both in connection with the proposed diversion of the line of the Great Western Railway, and the construction of 2115 feet in length of the new canal.

It was at first intended to pass the railway over the canal by a swing bridge across the lower wings of Lock No. 17. Strong objections having, however, been urged against this course, a plan shewing the line in the position now located, was submitted by the railway Company, and, having met with your approval, the work as it is being carried out, was sanctioned.

By this, the railway will diverge from its existing position at a point about 3700 feet east of the present intersection with the canal line; and curving to the south, will pass under the latter at the reach between locks 18 and 19. The new track then sweeps around to the north and will rejoin the existing line where it traverses the Ten Mile Creek:—the total length of the diversion being 7482 feet.

This is generally in heavy cutting, the quantity of excavation being approximately estimated at 200,000 cubic yards; a portion of the east end being in stratified rock.

Where the railway passes under the canal, a culvert or tunnel is being built. This structure is located on a curve of 1443 feet radius, the grade through it being level. The central portion is in 35 feet cutting. The total length will be 713 feet, with a width of 16 feet at rail level. The centre of the soffit of the arch will be 18 feet clear of the rails. The culvert, when completed, will contain about 11,500 cubic yards of first-class masonry; and the side walls for nearly the entire length of the arch (665 feet) are now four courses high above the footings.

The east half of the diversion will run along the face of the mountain, and incline towards the culvert at the rate of about 42 feet per mile. Through the culvert the grade will as before stated be level; and westwards to the Ten Mile Creek it will be about 21 feet to the mile.

The inclination of the present track is 38.54 feet per mile where it crosses the canal centre. The new road bed will be 24 feet wide at sub-grade in cuttings, the slopes of which will be 1½ to 1, with a thorough system of drainage along the sides, face and top; your specification also requires them to be sodded if necessary; and generally the work called for in connection with the diversion is of the best description of the respective classes; 91,325 cubic yards have been excavated in the railway cuttings, where it is intended to continue work throughout the winter, the material having to be deposited in the valley of the Ten Mile Creek. To enable the diversion to be completed at this point the arched culvert which carries the water of this stream under the existing railway bank has been lengthened about 40 feet.

Of the canal excavation, estimated at 130,000 cubic yards, 52,061 cubic yards have been taken out, and the earthwork of the section cannot be continued much further until the railway diversion is fully completed. It thus appears that of this work about 44 per cent is finished to date.

Lock No. 17 has not yet been commenced. The walls of Lock No. 18, are 8 feet

6 inches high and have been flooded to protect them from frost. A large amount of dressed stone is on the ground, but none of the minor structures connected with the canal have, so far, been begun. The total amount of masonry to be built is 32,300 cubic yards, and that laid to date is 6,401 cubic yards.

From the above statements it is quite evident that the most vigorous efforts must be made if it is expected to finish the works of this section next year.

The side reservoir for the reach between 16—17, has a surface area of 8.5 acres and that for Locks 17—18 is about 7.7 acres in extent.

Section 13.

Of the 205,000 cubic yards of earthwork estimated for this section, 147,654 have been taken out to date.

The masonry of Lock No. 19 is two feet high and the foundations are flooded to protect them from frost. Lock No. 20 is 14 feet high and the bottoms of both the regulating weirs are in and secured, by having a couple of courses of masonry laid on each of them. One of the towing-path bridges is completed ; the other is not yet commenced.

The side reservoir for the reach between Locks 18—19 has an area of about five acres—that for the reach above 19 is 5.1 acres in extent.

The works of this section have been pushed on well of late, so that under present arrangements, the whole will probably be completed next year.

Masonry laid to date 5786 cubic yards. Length of section 2000 feet

Section No. 14.

This section is nearly completed, Locks No.'s 21—22 are coped and one weir and three towing-path bridges built. There is only one regulating weir remaining to be done, the stone for which is prepared.

181,867 cubic yards of excavation have been taken out, leaving only about 10,000 cubic yards to complete this part of the work.

The side reservoirs for the reaches between Locks 20—21 and 21—22 have areas respectively of 6.4 and 5.4 acres.

The total amount of masonry laid to date is 17,809.64 cubic yards. Length of section 1,775 feet.

Section No. 15.

This section embraces some heavy work through the ravine behind Thorold.

The new canal, between Locks Nos. 22—23 deflects considerably to the east, and enters the valley cut out by the head waters of the Ten Mile Creek, the banks of which are there over 40 feet high.

The centre of this ravine was, at the time operations commenced in August, 1873, occupied by the Welland Railway ; it being clearly the best location by which that line could attain the level of the high land to the south ; although, in order to effect this, a grade of over 83 feet to the mile had to be adopted for a distance of over two miles. The railway through the ravine was shifted 120 feet to the westward of its old position, so as to make room for the construction of the canal, the centre line of which is now the same as that of the former track.

To excavate a road bed for the new position entailed a considerable amount of heavy cutting in the left bank of the ravine, the material of which proved much harder than was anticipated, duallin, or other preparations of nitro-glycerine having been extensively used in order to effect its removal.

It also becomes necessary to provide for the passage of the water of the creek, which is liable to heavy spring freshets. The bottom of the upper part of the ravine being clay, it was decided to form a channel entirely of masonry for about half a mile in

length in rear of the west bank of the canal, and alongside the railway in its new position. This channel has been in use for two years, and has proved amply sufficient for the intended purpose.

The canal, where it passes through the ravine, has a bottom width of 110 feet, and its sides are lined with heavy masonry retaining walls. Those from the west side from the foot of lock No. 24 to the head of No. 22 will be laid in cement mortar. On the opposite side of the canal they will be built of dry rubble with openings through them to secure a free communication between the raceway, and the reaches of the canal.

This raceway is in heavy cutting, and is intended to pass the surplus water from above the head of lock No. 24, along the rightbank of the ravine, in rear of the east retaining wall of the canal.

It is about 2,300 feet long with a bottom width of 58 feet; and, although the reach between locks Nos. 23 and 24 is the only one along the mountain slope which is not in direct communication with a side reservoir, it is evident that the surface area of the raceway will in a measure answer this purpose, being about 1½ acres in extent, whilst, in the position described, with its side openings, it will doubtless have the effect of obliterating such cross currents as would be created were the whole feed water for the lower reaches abruptly turned through the prism of the canal. A portion only of the water passing through this raceway will be admitted into the canal in the reach between locks Nos. 22 and 23. The channel will be sub-divided at that point, and such proportion of the surplus water as may be deemed advisable will be passed in rear of lock No. 22, by a conduit 30 feet wide, excavated in the rock, which shall terminate in one of the side reservoirs on the reach between locks Nos. 21 and 22. That for the reach Nos. 22 and 23 has an area of 2.2 acres.

A considerable amount of rock (51,190 cubic yards) has been excavated; this part of the work being now well advanced. Of earth 247,237 cubic yards are taken out, leaving about 25,000 cubic yards yet to be removed. Lock No. 23 is 16 feet high, and No. 24 is, together with the extension of its upper wings, to receive the bridge at Hoover's Road, ready for coping. This road must also be carried over the railway to the east, and the raceway to the west of the new canal. It is intended to accommodate the travel, to and from the town of Thorold, on the eastern side.

Neither of the regulating weirs on this section have as yet been commenced, and there is a considerable amount of retaining wall yet to be built; so that a large amount of work has hitherto been done there remains much to complete; and this will necessitate a vigorous effort on behalf of those in charge of the contract to finish the whole next season.

Total amount of masonry laid to date, 19,391 cubic yards. Length of section, 2,300 feet.

Section No. 16.

The work on this section consists chiefly of heavy excavation, the new canal being here carried through the ridge which divides the valley of the Ten Mile Creek from that of the Beaver Dams which is a tributary of the Twelve Mile. This cutting corresponds to what is known as the "Little Deep Cut" on the present canal—both passing through the same elevation.

The amounts estimated for the section are 325,000 cubic yards of earth and 80,000 cubic yards of rock. Up to date 269,808 cubic yards of earth, and 34,680 cubic yards of rock have been removed.

The head waters of the Ten Mile Creek are passed under the canal on this section by a double (six feet) arched culvert, 234 feet long. This structure is connected with the south end of the masonry channel referred on Section 15.

From the south end of Section No. 15, towards the dividing ridge, the canal is excavated in clay and has retaining walls or dry masonry on each side, of which 9,553 cubic yards have been built to date.

About 100 feet north of the crossing of the stone road to Clifton some higher layers of the limestone rock, forming part of the summit of the Niagara formation, are

encountered. These strata, as usual, dip rapidly to the south, the deepest cutting (18.34 feet) being at the northern ledge, whence the rock surface runs out to grade near the line between Sections 16 and 17. The rock at its highest point is 326.5 feet over datum, and the ground level is 343 feet over the same plane; the deepest cut being about 35 feet.

A portion of the rock lately excavated on this section has been removed by a steam shovel, the material having been previously shaken up by dynamite or ordinary blasting powder. This system does not, however, appear to work expeditiously, and a much more rapid rate of progress must be established in order to ensure the rock being wholly taken out before the end of next year.

A temporary bridge has been erected over this cutting, in line of the Clifton stone road above referred, for the accommodation of the public travel, until this highway can be connected with Hoover's crossing by a new track to be built on the east side of the canal.

The south end of the section terminates in Marlatt's Pond, where there is a curve of 1,000 feet radius and the canal will have a bottom width of 175 feet.

The length of the Section is 3,500 feet.

The amount of masonry laid, up to the 30th November 1876, 10,484.60 cubic yards.

From the end of the entrance piers at Port Dalhousie to the line between Sections 16 and 17, at Marlatt's Pond, near Thorold, the distance, measured along the centre line of the new canal, is very nearly 9.5 miles. Of this 88·3 per cent is straight and 11·7 per cent curved.

From the foregoing description it will be seen that along the short reaches between Locks Nos. 11 and 21, where the ascent to the mountain is made: the canal is flanked by a chain of extensive side ponds, communicating with each other by regulating weirs constructed in their dividing banks; and with the navigable channel by a series of bridged openings, formed on its western towing path.

These reservoirs have an aggregate area of about ninety acres; the surface of the canal itself, in the distance referred to containing about 30 acres, or in all, say one hundred and twenty acres. The average area connected with each of these thirteen reaches is therefore about 9¼ acres: equivalent to a length of 2,645 feet of canal with a breadth at water line of 152 feet.

This arrangement will obviously facilitate the working of the canal, by avoiding rapid currents and rendering the supply to all parts continuous and easy of control.

The item of masonry being by far the most important one connected with the works, I shall now briefly describe the arrangements made, so far, for the delivery of stone, and the localities from whence it has been obtained.

The first quarry used was on the west side of the old canal: and from this place, about two miles distant, the ashlar of Lock No. 21 was hauled:

The rock is a compact limestone, dark blue in color, and generally forming excellent material for the required purpose. This together with a small excavation a short distance further to the west, on Ball's farm; and is what is known as Winton's Quarry, in Pelham Township, are the only points where regularly stratified stone in layers of suitable thickness was, to any extent, procured in this vicinity. Upon getting back from the face, however, the layers seemed to merge into each other and became bed bound, whilst the stripping increased to a formidable extent. These drawbacks, coupled with the very heavy clay roads over which the stone had to be transported, and the extra cost of cutting entailed by its extreme hardness, induced, at an early date, the abandonment of the quarries on the west side, from which probably not more than 10,000 cubic yards have been delivered; the remainder of the 175,000 cubic yards already built, having been almost wholly procured from points in the face of the Niagara escarpment, between Thorold and Queenston.

A short distance east of St. Davids, there is a number of quarries close together, from which the stone has been principally obtained for Sections Nos. 2, 3, 5, 7, 8 and 9, and part of Nos. 10 and 11. This is an excellent greyish limestone, strong and durable, and although somewhat tough, it is much easier dressed than the blue stone above referred to.

These quarries are connected by rail with the Great Western Railway at the St. David's siding, from whence the material is conveyed along the main line to Merritton. It then passes along the Welland Railway, and is conducted to the various sections by branch tracks constructed for that purpose. This mode of transportation is by far the most satisfactory, as is is both cheap and ensures the regular delivery of the stone as required. It also renders the contractors in a measure independent of ordinary labor, the value of which fluctuates considerably, and is sometimes scarcely to be obtained at all. It is quite probable, judging from what has been already experienced, that if the vast masses of material which have so far been delivered on the works had to be carried in ordinary waggons, the roads would long ere this have been so cut up as to be practically impassable.

The quarries from which the face stone for Sections Nos. 14, 15, and 16 were principally obtained was known as "Hutts." This material was conveyed to the works by a tramway operated principally by gravity. Other quarries have been also opened up in the vicinity from which Sections Nos. 12, 13, &c., are supplied.

In almost all these quarries the best rock is found in a bed of from 10 to 12 feet in thickness, and this has, in nearly every case, been proved liable to change suddenly into broken up masses of useless material, so that the cost of obtaining face stone is very variable. Generally speaking, however, the quarries are now well developed, so that the same degree of uncertainty, as to where good stone is to be found, will not be experienced so much in the future as formerly.

The most important point connected with the quarrying of stone in this locality —as far as the progress of the works is concerned—is their liability to crack from the action of frost if taken out before the middle of May or after the early part of November. A large number of pieces of dressed ashlar has been lost already this winter from that cause; and it has now become evident that for six months in the year no stone can be judiciously quarried at those places from which the great bulk of that material has hitherto been obtained.

562,917 bushels of cement have been delivered on the works to date. Nearly all of this has been manufactured from the stratum of hydraulic limestone which is traversed by the line of the new canal in the ravine behind Thorold.

The sand used, so far, has been brought principally either from Lake Erie or Lake Ontario, and is of excellent quality. Some very good sand for backing is, however, found in the ridge referred to in the description of Section No. 7.

No serious interruption to the steady progress of the work since its commencement has taken place, except the strike of stone-cutters which lasted for some time in the spring of this year; and but few accidents have occurred, the only special noteworthy incident of that kind being the death of Mr. John Brown, Contractor for Sections Nos. 14, 15 and 16, who was killed by being thrown from his buggy whilst engaged in superintending his work, on the 27th of last June.

As directed by you, several trial lines have been run between Marlatt's Pond and the north end of the Deep Cut, near Allanburg, a distance of over three miles, with a view of ascertaining the relative cost and advisability of constructing an entirely new line of canal between these points, or enlarging the existing channel.

The plans, quantities, and accompanying explanatory statements in reference to this proposed location on Sections Nos. 17, 18, 19, and 20, having been forwarded to you a short time since. The whole matter is doubtless now under consideration, so that I presume it will not be necessary for me to refer further to the subject at present.

Accompanying this report are two schedules showing in detail the various items and values of work done on each section to date. These have been carefully prepared, and will, I trust, prove useful for future reference.

I have the honor to be, sir, your obedient servant,

(Signed.) THOMAS MONRO,

Civil Engineer.

JOHN PAGE, ESQ.,

Chief Engineer Public Works, Ottawa.

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No. of Sections.	Clearing and Grubbing.	Earth Excavation on Section.	Earth Excavation in Foundations.	Rock Excavation on Section.	Rock Excavation in Foundations.	Dredging.	Pud le.	Concrete.	Timber in Foundations.	Timber in M. S. Pat-
No. 1	.....	18,493	27,005	.....	1,428	222,883	.....	.....	.....	.....
" 2	6·00	93,652	65,492	.....	.....	.....	4,190	2,828	23,624	1,3
" 3	12·17	141,642	56,006	.....	.....	.....	5,974	1,086	37,362	3,.
" 4	7·87	161,353	213	.....	.....	.....	96	.....	1,463	.....
" 5	.....	124,458	42,382	.....	.....	.....	11,562	3,413	36,141	3,.
" 6	.....	256,897	.....	.....	.....	.....	11,284	.....	1,016	.....
" 7	5·40	138,565	45,401	.....	.....	.....	5,909	2,995	34,152	3,.
" 8	12·06	164,904	24,128	.....	.....	.....	5,926	654·50	23,907	1,.
" 9	0·50	95,941	31,101	.....	.....	.....	6,103	998	43,177	.....
" 10	13·74	92,885	46,000	.....	.....	.....	5,790	2,465	10,735	3,.
" 11	10·00	138,766	28,901	.....	.....	.....	6,108	877	31,580	3,.
" 12	3·59	118,325	26,421	20	.....	.....	1,422	190	16,938	1,.
" 13	1·50	117,151	30,500	.....	.....	.....	1,568	1,275	38,664	3,.
" 14	.....	139,856	38,684	954	2,373	.....	6,270	2,028·60	32,822	3,.
" 15	.....	215,103	18,834	40,698	10,582	.....	3,770	4,704	21,025	3,.
" 16	.....	267,030	2,778	34,680	.....	.....	936	.....	3,568	.....
	72·77	2,285,324	483,882	76,262	14,383	222,883	77,208	23,844·10	391,474	33,.

Concrete.	Timber in Foundations.	Timber in M. S. Platforms.	Oak in Mitre Sills.	Crib Timber.	Plank in Foundations and Sheet Piles.	Wrought Iron in Lock Foundations.	Wrought Iron in Crib-work.	Pressed Spike.	Lock Masonry and Bridge Extension.	Weir and Dam Masonry.	Course in Cement.
.....	.....	.....	.....	164,596	.....	.....	40,471	.....	.....	.....	.....
,828	23,624	1,736	648	150,849	169,745	6,128	37,108	8,031	8,756	4,601·50	1,101
,086	37,362	3,480	1,310	.....	257,064	11,151	.....	14,737	14,230	1,469	759
.....	1,463	.....	.....	.....	11,057	.....	.....	.....	.....	.....	.....
,413	36,141	3,472	1,296	.....	233,492	10,765	.....	8,490	11,000	1,463	374
.....	1,016	.....	.....	.....	9,000	.....	.....	156	.....	.....	.....
,995	34,152	3,472	1,296	.....	212,218	11,011	.....	1,278	8,320	865	918
651·50	23,907	1,920	655	.....	159,323	6,596	.....	9,475	7,165	625	143
998	43,177	.....	1,310	.....	261,798	11,295	.....	14,160	14,642	1,250	909·20
,465	10,735	3,486	1,310	.....	262,374	11,631	.....	8,825	14,167	1,250	965
877	31,580	3,180	1,310	.....	218,500	11,220	.....	7,832	10,201	715·70	727·50
190	16,938	1,736	655	.....	86,171	1,310	.....	515	2,557	.....	30
,275	38,661	3,536	1,310	.....	195,170	10,925	.....	975	4,780	512	494
,028·60	32,822	3,480	1,310	.....	215,953	10,229	.....	13,025	15,967	732	1,005
,704	24,025	3,691	1,310	.....	178,579	8,868	.....	905	13,592	.....	775
.....	3,568	.....	.....	.....	16,371	.....	.....	.....	.....	.....	81
,811·10	391,171	33,189	13,720	315,445	2,516,815	114,165	77,579	88,704	125,380	13,518·20	8,272·7

Course in Cement.	Course Dry.	Arched Culvert, and Tunnel Masonry.	Stone Behind Walls.
.....	.....	.....	.....
1,101	113	.....	.....
750	225	.....	.....
.....	.....	.....	.....
374	.....	.....	.....
.....	.....	.....	.....
918	112	.....	.....
143	.....	1,321·50	.....
909·20	.....	.....	.....
965	430	.....	3
727·50	192	3,507·30	18
30	.....	3,814	.....
491	.....	.....	.....
1,005	105·60	.....	.....
775	5,024	.....	.....
81	9,553·60	850	1,89
8,272·70	15,755·20	9,495·80	2,1

Piles.	Lock Masonry and Bridge Extension.	Weir and Dam Masonry.	Course in Cement.	Course Dry.	Arched Culvert, and Tunnel Masonry.	Stone Behind Walls	Stone Filling of Cells.
.....	.....	.....	.....	.....	.....	.....	12,620
931	8,756	1,601·50	1,101	113	.....	.....	.....
737	11,230	1,469	750	225	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....
490	11,000	1,468	374	.....	.....	.....	.....
156	.....	.....	.....	.....	.....	.....	.....
278	8,320	865	918	112	.....	.....	.....
475	7,165	625	143	.....	1,321·50	.....	.....
469	14,612	1,250	909·20	.....	.....	.....	.....
825	11,167	1,250	965	430	.....	32	.....
832	10,201	715·70	727·50	192	3,507·30	185	.....
515	2,557	.....	30	.....	3,814	.....	.....
973	1,780	512	491	.....	.....	.....	.....
3,025	15,967	732	1,005	105·60	.....	.....	.....
905	13,592	.....	775	5,024	.....	.....	1,197·50
.....	.....	.....	81	9,553·60	850	1,896	.....
8,701	125,380	13,518·20	8,272·70	15,755·20	9,495·80	2,113	13,817·50

ORK, &C., TO 30TH NOVEMBER, 1876.

	Stone Behind Walls	Stone Filling of Cribs.	Road Bridge Masonry.	Fence Built.	Total Masonry of all kinds.
		12,629			
					11,571·50
					16,674
			716	348	716
					12,842
			685		685
			745		10,960
50					9,257·50
					16,801·20
	32				16,812
30	185				15,376·54
				176	6,101
					5,786
					17,809·69
		1,197·50		105	19,391
	1,896			61	10,184·60
80	2,113	13,817·50	2,146	693	174,567·98

APPROXIMATE LIST OF MASONRY.

Lock Masonry	200,000	Cubic Yards.
Weir Masonry	17,500	"
Arched Culverts and Tunnels.	17,500	"
Road Bridges	3,200	"
Railway Bridge	1,000	"
Coursed in Cement	52,500*	"
Dry Masonry	33,345	"
	325,045	Sections 1 to 16.

*Of this about 30,000 Cubic Yards in rubble extension of lock walls.

THOMAS MONRO

St. Catharines, 8th December, 1876.

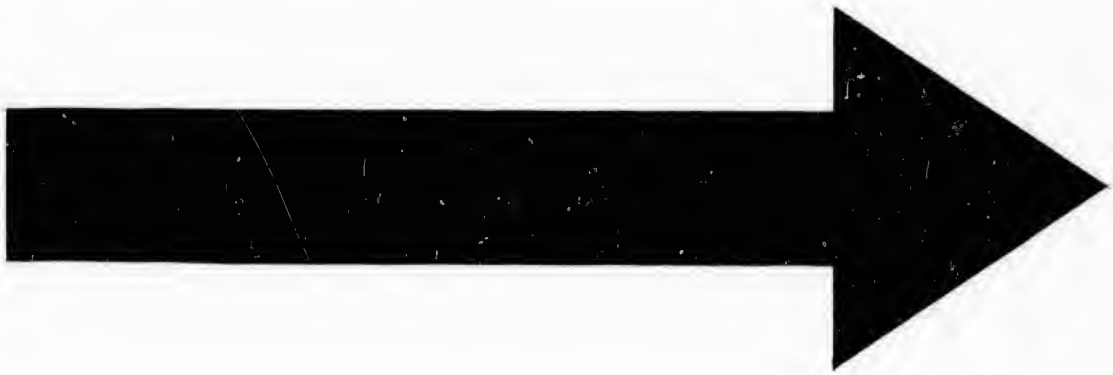
WELLAND CANAL.—Sections No. 1 to 16

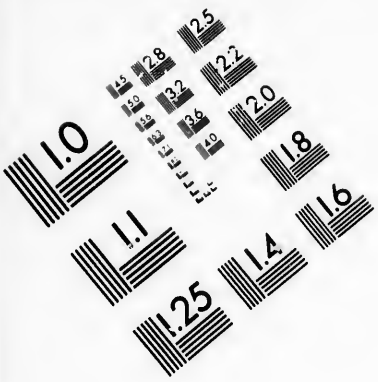
No. of Section.	Clearing and Grubbing.	Earth on Section.	Earth in Foundations.	Rock Excavation on Section.	Rock Excavation in Foundations.	Dredging.	Puddle.	Concrete.	Timber in Foundations.	Timber in M. S. Platforms.	Oak in Mitre Sills.
No. 1	.....	$ 5,547.90	$10,802.00	.....	$4,284.00	$75,992.30	.....	.....	.....	.....	.....
" 2	$ 600.00	28,095.60	22,922.20	.....	.....	.....	$3,352.00	$14,140.00	$11,812.00	$1,041.60	$ 388.80
" 3	1217.00	39,659.76	20,162.16	.....	.....	.....	4,779.20	5,430.00	$20,549.10	2,088.00	982.50
" 4	1,967.50	28,040.98 7,456.68	72.90	.....	.....	.....	76.80	.....	512.05	.....	.....
" 5	.....	43,560.30	15,681.34	.....	.....	.....	11,562.00	20,478.00	10,842.30	1,388.80	1,166.40
" 6	.....	61,655.28 2,490.12	.....	.....	.....	.....	3,385.20	.....	355.60	.....	.....
" 7	810.00	41,569.50	15,891.40	.....	.....	.....	2,363.60	5,990.00	20,491.20	2,256.80	907.20
" 8	2,700.00	41,226.00	7,238.40	.....	.....	.....	2,370.40	1,954.50	14,344.20	1,152.00	393.00
" 9	112.50	23,025.84	9,330.30	.....	.....	.....	2,441.20	2,994.00	25,906.20	.....	786.00
" 10	3,091.50	29,723.20	16,100.00	.....	.....	.....	7,237.50	13,557.50	11,813.15	1,220.10	1,179.00
" 11	2,250.00	41,629.80	10,116.40	.....	.....	.....	3,204.00	3,508.00	12,103.00	1,914.00	786.00
" 12	646.20	7,830.00 27,854.12	(7,768.91 (435.20	21.00	.....	.....	(479.00 (232.00	(1,957.50 (247.50	(5,541.20 (387.10	607.60	262.00
" 13	180.00	44,518.52	12,810.00	.....	.....	.....	1,568.00	6,375.00	12,758.13	1,308.32	1,179.00
" 14	.....	48,949.60	19,342.00	954.00	2,373.00	.....	3,762.00	10,548.72	16,411.00	2,088.00	786.00
" 15	.....	75,391.05	7,535.20	10,608.00	15,873.00	.....	2,262.00	18,816.00	7,207.50	2,214.60	786.00
" 16	.....	77,438.70	972.30	37,801.20	.....	.....	982.80	.....	1,427.20	.....	.....
	$ 13,574.70	$675,662.95	$177,180.71	$79,384.20	$22,530.00	$75,992.30	$50,057.70	$105,996.72	$172,460.93	$17,279.82	$9,601.90

St. Catharines, 8th December, 1876.

No. 1 to 16—Value of Work Done and Materials Delivered to

Timber in M. S. Piat forms.	Oak in Mitre Sills.	Crib Timber.	Plank in Foundations and Sheet Piles.	Wrought Iron in Locks.	Wrought Iron in Crib-work.	Pressed Spike.	Lock Masonry and Br. Extensions.	Weir and Dam Masonry.	Arched Culverts and Tunnels.	Road Bridges.	Coursed in Cement.
.....	.....	$61,204.20	.....	.....	$4,856.52	.....	.....	.....	.....	.....	.....
$1,041.60	$ 388.80	50,142.15	$5,198.10	$ 899.92	5,195.12	$ 722.69	$76,875.00 12,560.00	16,135.00 29,880.00	.....	.....	$9,909.00
2,088.00	982.50	.....	8,664.31	1,561.14	.....	1,326.33	149,415.00	14,690.00	.....	.....	6,750.00
.....	.....	.....	176.91	.....	.....	.....	.....	.....	.....	$ 6,444.00	.....
1,388.80	1,166.40	.....	7,574.60	1,399.45	.....	679.20	143,000.00	16,148.00	.....	.....	3,366.00
.....	.....	.....	234.00	.....	.....	14.04	.....	.....	.....	11,645.00	.....
2,256.80	907.20	.....	7,577.20	1,321.68	.....	89.46	99,840.00	7,352.50	.....	13,037.50	9,180.00
1,152.00	393.00	.....	6,372.92	659.60	.....	568.50	85,980.00	6,250.00	$13,245.00	.....	1,144.00
.....	786.00	.....	10,471.92	1,129.50	.....	867.60	175,704.00	12,500.00	.....	.....	7,273.60
1,220.10	1,179.00	.....	7,446.32	1,512.42	.....	749.25	146,004.00 28,000.00	17,500.00	.....	.....	8,685.00
1,914.00	786.00	.....	8,970.00	1,570.80	.....	704.88	101,529.80	6,711.30	52,609.50	.....	4,729.01
607.60	262.00	.....	1,719.48 90.11	480.60	.....	22.50 8.40	27,871.30	.....	39,900.00 3,579,60	.....	297.00
1,308.32	1,179.00	.....	6,271.62	1,420.25	.....	87.75	50,190.00	5,120.00	.....	.....	4,446.00
2,088.00	786.00	.....	6,308.13	1,636.64	.....	1,302.50	160,468.75	6,807.60	.....	.....	7,035.00
2,214.60	786.00	.....	7,287.39	1,330.20	.....	90.50	99,192.40 7,252.00	.....	.....	.....	4,650.00
.....	.....	.....	491.13	.....	.....	.....	.....	.....	9,120.50	.....	708.75
$17,279.82	$9,601.90	$111,346.35	$84,854.14	$14,622.20	$10,051.64	$7,233.70	$1,363,882.25	$139,094.40	$118,454.60	$31,126.50	$68,173.36





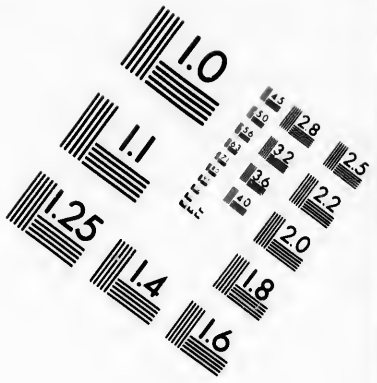
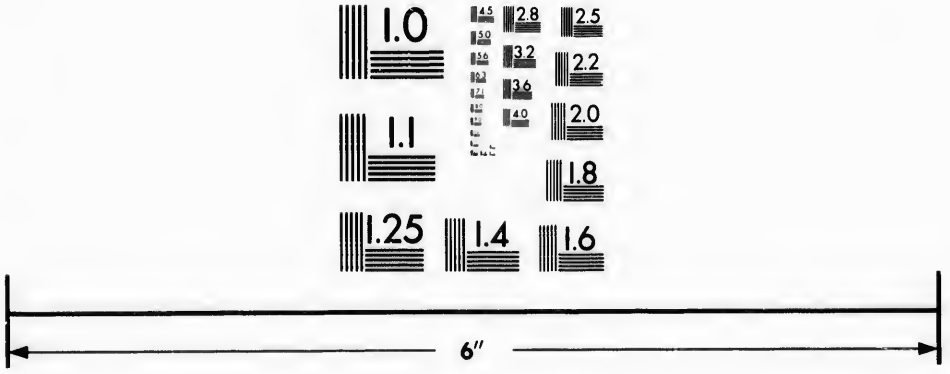
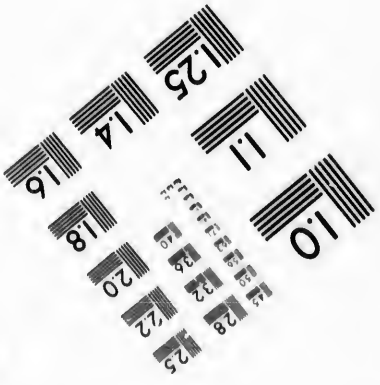


IMAGE EVALUATION TEST TARGET (MT-3)





Photographic Sciences Corporation

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

k Done and Materials Delivered to 30th November

work.	Pressed Spike.	Lock Masonry and Br. Extensions.	Weir and Dam Masonry.	Arched Culverts and Tunnels.	Road Bridges.	Coursed in Cement.	Coursed Dry.	Stone behind Walls, &c.	Stone Filling of Cribs.	
6.52	.....	.....	.....	.....	.....	.....	.....	.....	$15,306.50	...
5.12	$ 722.69	$76,875.00 12,560.00	16,135.00 29,880.00	.....	.....	$9,909.00	791.00	.....	.....	...
....	1,326,33	149,415.00	14,690.00	.....	.....	6,750.00	1,350.00	.....	.....	...
.....	.....	.....	.....	.....	$ 6,444.00	.....	.....	.....	.....	$
....	679.20	143,000.00	16,148.00	.....	.....	3,366.00	.....	.....	.....	...
....	14.04	.....	.....	.....	11,645.00	.....	.....	.....	.....	...
.....	89.46	99,840.00	7,352.50	.....	13,037.50	9,180.00	672.00	.....	.....	...
.....	568.50	85,980.00	6,250.00	$13,245.00	.....	1,144.00	.....	.....	.....	...
....	867.60	175,704.00	12,500.00	.....	.....	7,273.60	.....	.....	.....	...
.....	749.25	146,004.00 28,000.00	17,500.00	.....	.....	8,685.00	2,365.00	112.00	.....	...
.....	704.88	101,529.80	6,711.30	52,609.50	.....	4,729.01	960.00	727.50	.....	...
.....	22.50 8.40	27,871.30	.....	39,900.00 3,579,60	.....	297.00	.....	.....	.....	...
.....	87.75	50,190.00	5,120.00	.....	.....	4,446.00	.....	.....	.....	...
.....	1,302.50	160,468.75	6,807.60	.....	.....	7,035.00	633.60	.....	.....	...
....	90.50	99,192.40 7,252.00	.....	.....	.....	4,650.00	20,096.00	2,395.00	.....	
.....	.....	.....	.....	9,120.50	.....	708.75	60,474.29	2,180.40	.....	
.64	$7,233.70	$1,363,882.25	$139,094.40	$118,454.60	$31,126.50	$68,173.36	$87,341.89	$5,414.90	$15,306.50	$

(*Signed*) TH

. November, 1876.

Stone behind Walls, &c.	Stone Filling of Cribs.	Fence Built.	Unwatering, and sundry items.	Totals, (including Materials.)	Materials Delivered.
.....	$15,306.50	.....	$3,883.50 3,000.00 —Unwatering.	$216,088.62	$34,211.70
.....	.....	.....	4,000.00	321,856.78	27,196.50
.....	.....	.....	4,000.00	295,724.50	13,100.00
.....	.....	$1,218.00	.....	50,215.82	4,250.00
.....	.....	.....	.....	290,646.39	13,800.00
.....	.....	.....	.....	81,464.24	1,685.00
.....	.....	.....	.....	238,080.04	8,730.00
.....	.....	.....	Both Sections— $6,000.00	185,598.52 278,542.66	3,450.00
112.00	.....	.....	.....	316,300.94	20,005.00
727.50	.....	.....	1,000.00	264,373.99	9,350.00
.....	.....	440.00	.....	164,800.32	36,122.00
.....	.....	.....	.....	167,602.59	19,370.00
.....	.....	.....	1,000.00 Unwatering.	292,051.54	1,645.00
2,395.00	.....	420.00	1,452.50 2,000.00 Unwatering	330,959.34	14,100.00
2,180.40	.....	255.00	850.00 Bdg. 500.00 Unw.	193,202.27	.....
$5,414.90	$15,306.50	$2,333.00	$24,686.00	$3,690,958.56	$207,015.20

(*Signed*) THOMAS MONRO.

B.

WELLAND, December 7th, 1876.

SIR,—In accordance with instructions contained in your letter of November 21st, and previous and subsequent telegrams, I beg to report as follows upon the condition of the works of enlargement on the southern division of the Welland Canal.

I have endeavored as directed, to avoid repetition of what is already in print, in connection with the works under my charge, and should the report appear bare, please accept this in explanation.

Commencing at the north end of the southern division, near Allanburgh, the "Deep Cut" (sections 21 & 22) comes first in order.

Work was commenced on this contract in October, 1873, and has been continued without interruption during the working seasons.

The removal of the material above the level of the towing-path is nearly completed and below the towing-path the work is three-quarters done.

A back ditch has been formed on the west side of the canal, from end to end of the "Deep Cut."

The actual quantities of work performed and materials delivered on the different sections, will be found in the accompanying tabular statement.

The removal of the large mass of material, necessary to give the slopes above the level of the towing path, an inclination of 2½ to 1, has so far had the desired effect of preventing the slides which formerly occurred.

In addition to this, since the weight of material has been removed, the surface of the water in the canal, has on several occasions and for weeks at a time, been down to the level of Lake Erie, without causing any movement of the banks.

Satisfactory, however, as these facts are, lightening the banks cannot be accepted as having secured the permanency of the "Deep Cut" until the full depth required has been excavated, and the bulk of the material still to be removed under the present contract, lies in the bottom, where it may possibly be acting as an invert, to support the sides.

Some precaution against wash is desirable on the long flat slopes which form the sides of the "Deep Cut," and considering how flat these slopes are (2½ to 1) the experiment of sowing grass seed which failed some years ago on the slopes, might now succeed if done at the right season, after harrowing the surface and applying a good dressing of plaster.

A portion of the slope which was neatly dressed the season before last is now worn into numerous and deep furrows, the material from which has been washed into the canal.

A small portion of the expenditure required to remove one year's wash from the bed of the canal, would give the experiment of seeding the slopes a fair trial, and if successful, might be carried out over the entire "Deep Cut" slopes at a comparatively trifling cost.

The death of Mr. John Brown, the contractor for sections 21 & 22, which occurred on the 29th of June last, did not cause any stoppage of the works, and the system which he laid down for working these sections, is being regularly carried out by those now in charge.

SECTION 23.

Mr. John Carroll the contractor for this section, commenced work in April 1876.

The material above water level has been removed, with the exception of some trimming in different places, and two dredges and derricks have been engaged during the summer, removing the material below water level.

The bulk of material dredged between stations 8 and 26 has been placed on the west bank of the canal by means of the ordinary box derricks, and the remainder of the dredged material has been conveyed in scows to clam shell derricks, one on the north side of the channel leading to the Port Robinson Lock, and the other on the east bank of the canal, at the south end of the section.

The material taken to the clam shell derrick first mentioned, is stiff clay, carried on deck scows, and put to spoil so as to form a bank round the south side of the pond, behind which soft material can be spoiled.

The soft material from the bottom of the canal has been taken in box scows to the clam shell derrick at the south end of the section, and there put to spoil where the natural surface is low and the ground solid.

On the west side of the canal, between stations 18 and 28, a back ditch has been formed.

For 1,500 feet at the south end of the section, on the west side of the canal, the towing path which runs through the backwater has been formed of dry material "borrowed" from the adjoining field, and hauled into embankment when the water was low this season.

The material which has been hauled into this embankment is not included in the quantities in the accompanying table, having come from outside the slope stakes of the canal excavation proper.

The contractor will however reap the benefit of this outlay, in the facilities which it will give him for disposing of the dredged material from the south half of the contract, the excavation from the prism of the canal so far having come nearly altogether from the north half.

The delivery and preparation of materials for the combined guard lock and swing bridge on this section has been carried on actively during the summer, and up to the date of notice being given that the summit level would not be unwatered this season.

The timber work for the platform, recess and gates, has been framed and put together on the bank to make sure of everything being in readiness, and to admit of the different parts being correctly marked before piled under cover until building commences.

The Queenston quarries have supplied the greater part of the face stone, a small quantity of face stone and backing having been brought from the Bay of Quinte.

The remainder of the backing which was quarried early in the season has been supplied from Queenston, and the rock cutting near Thorold, arrangements having been made with the Great Western and Welland Railways to deliver the stone at the Port Robinson Station of the Welland Railway, from which point it has been teamed to the works, a quarter of a mile distant.

Sand and stone for concrete have been brought in scows from Port Colborne and Thorold, the sand carefully screened and roofed over, and satisfactory arrangements made for a steady supply of cement mortar.

A quantity of timber and plank for the dam has been brought on the ground, also a traveller and four derricks, and a steam engine for working the traveller.

The face stone for the pivot pier, bridge seat piers and abutments, up to within two courses of the coping, was ready to go into the work when operations were discontinued.

The fever so general last summer was particularly severe in the neighborhood of Port Robinson, and was attributed by many to the turning up of so much clay on the canal works.

This may have been the cause, but I am more inclined to ascribe it to the larger area of swampy land, covered with decaying vegetable matter, which the low water exposed.

Two properties taken for canal enlargement on this section are still unsettled for. They lie on the west side of the canal, between the swing bridge and the entrance to the old canal, and are owned by A. Brownson and M. Donahoe.

Section 24.

Mr. C. F. Dunbar, the contractor for this section, commenced work in August, 1875. Operations were discontinued at the close of navigation, were resumed in the following spring, and have been continued without interruption to date.

The bulk of the material above water level, has been removed with scrapers, and below water level more than a third of the excavation has been removed and put to spoil on the east bank adjoining by means of a dredge and box derrick.

The embankment for the towing path has been formed across the pond near the south end of the section, and the space behind the towing path will next season be available as dumping ground.

Where the towing path crosses the pond at the north end of the contract, the seat of the embankment has been dredged over to remove any objectionable material, and put the bottom in proper shape to receive the embankment.

Section 25.

Messrs. Ferguson, Mitchell & Symmes, contractors for this section, commenced work in August, 1875, and have since worked uninterruptedly; except during the period of closed navigation.

The greater part of the material above water level has been removed, and below water level the excavation is half completed.

Two dredges and derricks were working on this contract until the beginning of October, when a third dredge and derrick were brought upon the work. They have been working southwards from the north end of the section, and have now reached the Burgar Bridge.

Preparations for the new swing bridge on the line of the Quaker Road were commenced in the autumn of last year, and stone got out west of Port Colborne, was hauled to the canal bank and scowed from that point to Section 25 this summer.

Another quarry was opened this season not far from the reservoir of St. Catherine's water works, and the stone from it was hauled to the canal bank, near Marlatt's bridge, and scowed from there to the work.

A force of stone cutters ranging from 10 to 20 were employed on this contract until notice was given that the summit level would not be unwatered this winter. Since then the delivery of stone has continued, but no cutting has been done.

My proposal to do away with the Burgar Bridge being approved of, provided satisfactory arrangements could be made about land in the neighborhood, I communicated with the Reeve of Thorold Township after the land required for the enlargement in the neighborhood of Burgar Bridge had been purchased, and a by-law was passed by the Township Council, and ratified by the County Council, authorizing the sale to the Government of the road allowance on the east side of the canal, between the Burgar and Quaker bridges, and of that portion of the road allowance, between Lots 229 and 238 from the western boundary of the Departmental lands, down to the river Welland.

The closing of these roads does away with the necessity of rebuilding the Burgar bridge, thereby improving the navigation, and effecting a considerable reduction in cost of work.

Section 26.

Mr. John Carroll, the contractor for this section, commenced work in September last, and has had a large force of scraper teams employed, whenever the weather permitted.

The material above water level on the west side of the canal has been removed with the exception of a portion of the south end of the section, where the contractor has not yet been put in possession of the land, and on the east side of the canal the greater part of the material above water has also been shifted.

Advantage was taken of the low state of the water in September and October, and twenty-five thousand yards of material from below the assumed water level was removed with scrapers.

From the south end of section 26 to the north end of section 29, a distance of 10,538 feet, the works for the enlargement not yet under contract may be briefly described as follows: A supplementary stone aqueduct, a new lock into the Welland River, the removal of the present lock and two swing bridges, and the construction of two new swing bridges. The removal of the culvert under the canal at Welland; the continuation of the covered drain on the east side of the canal, to an outlet at the Welland River; the construction of slope-walls in the neighborhood of the other structures; and the excavation of the necessary earthwork on the west side of the canal.

These are the principal works required by the plan last submitted for this portion of the enlargement.

I have not included the construction of a permanent bridge for the Canada Southern Railway, as the expense of that structure when built is, I understand, to be borne by the Railway Company.

Section 29.

Messrs. John Ferguson & Co., contractors. Work was commenced on this section in September, 1873, and has been carried on since then, during the working seasons, without interruption.

One, two, and sometimes three dredges and derricks have been engaged on this section.

The material, with the exception of the last three feet in depth, has been put to spoil on the west bank of the canal.

The three feet in the bottom just mentioned, has been removed in scows to a clam shell derrick on the north bank of the feeder, a short distance above the entrance to the old canal, and put to spoil on the adjoining low ground.

A back ditch has been formed for the entire length of the section, on the west side of the canal.

This contract is now completed, and the final estimate is in course of preparation.

Section 30.

Messrs. John Ferguson & Co., contractors. Work was commenced on this section in August, 1873, and has been continued without interruption except during the winter seasons.

The material above water has been removed, a back ditch has been formed the entire length of the section on the west side of the canal, and the material below water level has been removed down to within two feet of the bottom.

It is proposed to carry this bottom material to spoil, in the same manner as described in the last section.

The contractors are looking anxiously for a move on the part of the Great Western Railway Company, towards carrying out the enlargement of their bridge which here crossed the canal.

Until this bridge is rebuilt, or adapted to the requirements of the enlarged canal, the contract for this section cannot be completed.

Sections 31 and 32.

Mr. John Brown, contractor. Work was commenced on this contract in August, 1873, and the dredging was continued without interruption through the winter of 1873-4, and until January, 1875, when the severe frost put a stop to the work.

Operations were resumed in April 1875, and continued to the end of the year when the work was closed, until the opening of the navigation in April 1876, and has been uninterrupted to date.

The material above water has been removed, and the dredging also, down to within a varying depth of two to four feet of the bottom, except for a short distance at the north end of section 31, and near the south end of section 32, where the full depth has been obtained.

This bottom material is now being removed in scows to a clam shell derrick on the west bank of the canal and put to spoil in rear of the existing spoil bank.

A back ditch has also been formed from end to end of the contract on the west side of the canal.

The removal of Lyons Creek culvert which is situated on section 31, is not included in the present contract.

When this culvert is rebuilt, to suit the increased depth of water, it will be desirable to increase the size, which at certain seasons is insufficient.

From the south end of section 32 to the north end of section 36, the distance is 12,685 feet, on which the works for the enlargement are not yet under contract.

If the line of the present canal is followed, there will be an aggregate length of 6,900 feet of rock cutting to be enlarged, one railway and two canal swing bridges to be rebuilt, a supply weir and a quantity of slope wall to be built, and the works in connection with the double guard lock which the location of that structure will determine.

Section 36.

Mr. C. F. Dunbar, Contractor. Work was commenced on this contract in August 1875, and has been continued without interruption, except during the winter season.

In the autumn of 1875, the new docking at the south end of the basin was partly put in, a portion of the old east pier was removed, a dredge and scows were engaged in deepening the basin and entrance, where the material was capable of being dredged, and a drill scow with two steam drills, commenced the removal of the rock under water, working outside when the weather was calm, and near the entrance to the Lock when rough.

Nitro-Glycerine the explosive used, shattered the rock sufficiently to admit of its being dredged and carried away in ordinary pocket scows to the dumping ground east of Port Colborne harbor.

This season a new drill scow has been built at Port Colborne, and during the day both drill scows have been working, and the new one in the night also.

From the north end of the section to the Ferry recess, the deepening of the basin is about half completed, including the removal of all the rock near the entrance to the Lock; except some points which are not yet down to the required depth.

Those parts of the basin where dredging has been done, are as a rule down to bottom, and in front of the elevator the required depth has been reached.

From the Ferry recess southwards for two hundred feet, very little has been removed from between the piers, thence southward to the end of the east pier, the entire distance has been dredged over, bottom being made in some places, and not reached by a foot or more in others.

Rock crops out in the bottom, between the points last mentioned, and for three hundred and fifty feet of this distance a cut, averaging forty feet in width has been made through the rock on the west side of the channel, and taken down to bottom.

At two hundred feet south from the point of the east pier the rock is again met with, and from this point southwards, for a distance of one hundred and thirty feet, a cut of an average width of fifty feet, and generally down to bottom has been excavated through the rock on the west side of the channel.

The excavation in the rock commences again about fifty feet north of the range light, and extends southwards six hundred feet, for which distance the cut ranging in width from forty to one hundred feet, and of the required depth, has been made on the west side of the channel.

The winter of 1875-76 was so unfavorable for getting out timber that when work commenced this season, the supply of materials was not what could have been desired. Later in the season the supply improved, and warranted the commencement of the extension of the west pier, the first crib of which was sunk August 28th, and the last November 9th—the number of cribs being sixteen. The extension from end to end resting on the rock, the superstructure was commenced as soon as the cribs had been exposed to some rough weather, and is now nearly completed, the work being still in progress.

The beacon to mark the point of the reef, was successfully sunk into position on the 16th of September, and has since been worked upon whenever the weather permitted, the structure being now up to a height of twelve feet above water.

The superstructure of the docking has been finished across the south end of the basin.

The 1st and 2nd detached blocks of pier work, each 120 x 30 feet, have been completed, and two cribs of the 3rd detached block were sunk at date of last measurement.

A good supply of timber is now on the ground, and should the weather permit, the work will be continued throughout the winter.

On the 30th of October last, an explosion of Nitro-Glycerine occurred, at an isolated crib to the east of Port Colborne harbor, which had been built by the contractor as a small intermediate magazine.

By this explosion a man named Colbert King, (incorrectly called John King in my report dated Oct. 30, 1876), whose duty it was to carry Nitro-Glycerine to the drills lost his life, being literally blown to atoms. The cause of the explosion can only be conjectured.

Windows were broken in Port Colborne and the plaster of some houses near the Lake shore was badly shaken by the concussion, but beyond this and the shattering of the crib, I have not heard of any damage to property.

A crib to replace the shattered one has been sunk to the east of the harbor, but at a greater distance from the shore than the former one, and the contractor has taken additional precautions to guard against accidents in the future.

The present contract provides for the removal of a portion of the superstructure of the west pier, but does not fix the limit.

The superstructure is much damaged in places, especially in the neighborhood of the lighthouses, and if allowed to remain in its present condition much longer will be liable to be carried away by a heavy gale with high water.

I would reccommend its removal throughout, and should this be determined upon, the contractor should have notice given him in time to arrange for the timber this winter.

I have not referred to the existing or required lighthouses, as I understand they are not under the control of the Department of Public Works.

The entire surveys, plans and descriptions of the lands taken for canal enlargement, on the ten miles under contract on the southern division, have been made by myself and assistants, without any additional staff, and have involved an amount of work that could only be accomplished by unusually long hours.

The quantities in the accompanying table are taken from the Progress Estimates for November, which were not out of hand until the morning of the 5th inst.

I have the honor to be, Sir,

Your obedient servant,

(Signed.) W. G. THOMPSON,

Resident Engineer Southern Division
Welland Canal Enlargement.

JOHN PAGE, ESQ.,

Chief Engineer P. W. Dept., Ottawa.

C.

PRESCOTT, 26th Dec. 1876.

JOHN PAGE, Esq.,

Chief Engineer, Dept. Public Works,

Ottawa :

SIR,—In obedience to your instructions of the 22nd inst. I have the honor to report progress during the past season in the surveys and examinations of the Galops Rapids, made for the purpose of procuring accurate data, to enable you to decide upon the nature and extent of improvements necessary to render the passage through these rapids available for the contemplated enlarged scale of navigation.

With reference to the Chain Vessel stationed at the Galops, during the three months ending November 22nd. Inasmuch as our experimental operations are fully described in my report of December 9th ; I need only refer generally to her in connection with the proposed improvements.

The accompanying chart of the Galops, dated December 16th, will serve to explain the position of existing channels and shoals, the proposed new channel, (tinted red) and also the line of chain traversed by the chain vessel. The soundings are expressed in feet and inches, and are redueed to the zero point of the water guage, established at the Galops in 1872, which point is the level of 9 feet above the upper mitre sill of Lock 27.

The outlines of shoals represent a depth of fourteen feet at low water, *i. e.*, the relative level of five feet below the sill of Lock 27.

I will now submit, briefly, the result of my examinations, together with an estimate of the quantities of material to be removed in order to obtain the channel projected upon the chart.

These quantities are for widths of 200 feet, and 300 feet, and for depths at low water of 14 feet and 16 feet respectively.

The Galops Rapids commence at the traverse under "Flat Rock shoal," about 7 miles below Prescott, and extend 1½ miles down stream or to foot of Galops island.

They are caused by an extensive ledge of very hard limestone rock, which forming the bed of the channels, underlies all the islands and extends across the whole river [here 7,800 feet in width measuring on line of Lower Bar, and the south-west point of Galops island.] Of this distance, the island which divides the river into two channels, occupies the central space of 5,000 feet.

The north or main channel [boundary line] 1,100 feet, and the south or American 1,700 feet.

The latter is blocked by numerous shoals below the Rapids, and is not a navigable channel for vessels.

The north is the main navigable channel, but it also is barred in the rapid by the ledge of rock above mentioned, and further obstructed below the traverse by Adam's island, which divides it into two channels the "North" and the "Gut."

The latter although deep, is too narrow and the bends too sharp for large vessels and is considered altogether unfit for the navigation contemplated.

The boundary line between Canada and the United States, runs through the "Gut" to the main channel, therefore the proposed improvements will lie partly in American waters.

The Lower Bar in from 6′ to 12′ water, is the most formidable obstruction in the rapids, it extends across the main channel, from the canal bank at McLaughlin's Point to Capstan Point on Galops island. Its surface forming the bed of the river is solid rock

dipping quickly downstream, but generally uniform across, excepting where masses of rock, apparently dislodged from their natural beds [as in the case of the "Chute" and the "Cave,"] or where, in the intermediate spaces, boulders which have been swept by the current over the shallow and smooth bed of rock above, have accumulated.

When these obstacles are encountered by the undulatory, but smooth and rapid current, running over the upper edge of the Bar, and known as the Pitch, the water becomes broken and turbulent, producing strong eddies and cross currents below.

This description applies only in low and ordinary summer water; in high water the Pitch is almost drowned out by the back water under the Bar, and scarcely any white water is visible.

The eddies and currents below the Pitch vary in strength and extent with the different stages of the river, whilst above they remain almost unchanged.

The "Chute" and the "Cave", so called, are well known and constant Breakers in the Pitch, marking the north and south passages across the Lower Bar.

The usual course of vessels descending the main channel above the Pitch, is to run nearly parallel with the canal bank, entering the swells on the Lower Bar, between it and the "Chute", thence bearing away sharply south through the rough water to beyond mid-channel, avoiding the extensive rocky shoal, which covers fully one-third of the bed of the river for a distance of $\frac{1}{4}$ mile below the Bar.

In running the "Gut" channel, vessels when abreast of the Guard Lock, meet the current setting south, which carries them through the deepest and smoothest water of the Pitch, between the Cave and Capstan Point, and after crossing the Bar, by bearing away north with the current, deep water will be found leading to the main channel, abreast of the "Magnet" shoal, at the foot of the Galops island.

That part of the Gut channel described above, from the bend abreast of the Guard Lock, across the Lower Bar, forms the eastern half of the proposed new channel.

The main channel of the "Chute" although difficult to approach, owing to cross-currents, and hazardous to run at night, has always been, and is still regarded by pilots as deeper and more direct, and having fewer obstructions in it than that by the Cave. I have found that such is not the case, the existing "Cave" channel leads straight across the Bar, the prevailing currents are favorable and the depth of water is as least eighteen inches greater than in the main channel.

The Lower Bar, as stated in a former report, "is practically the sill of the river "above the Cornwall Canal, and limits the draft of water of all downward bound vessels."

For this reason and because too much importance cannot be attached to the formation of a channel through it, to enable the class of vessels contemplated in the proposed canal enlargement to take advantage of the strong current of the river in making their downward trips,—I have spared no effort to obtain correct information relating to the Galops rapids, and now, if not beyond my province, beg to recommend for improvement the channel projected on the chart, and for the following reasons:

It possesses the advantage of being perfectly straight throughout, crossing the Bars and shoals where they are narrowest.

It can easily be defined by range marks and lights on shore, and its navigation thereby rendered perfectly safe by night as well as by day.

It is accessible from all channels, above and below the rapids.

And except immediately at its upper entrance it lies south of, and out of the way of rafts, when controlled by steam tugs.

It presents the best line for ascending the rapids, should the Chain Tug System of Towage be adopted.

The direction of the prevailing current is generally favorable, and it is believed, that when the North and Island Shoals are removed, it will draw straight through the Channel. The closing of the "Gut" channel would also greatly improve the navigation, both at the "Traverse," and below Adam's Island, and would undoubtedly facilitate of blasting operations from the Chain Vessel.

Above and below the Bars, and between them and the intermediate shoals, deep

depressions exist in the bed of the river, into which the debris may be raked, or swept by the force of the current; and in view of its being straight, it is believed, that a width of 200 feet, is ample for the largest class of Propellors.

I will now advert to the Chain Vessel, which furnished with steam drills, is designed to aid in opening a channel through the rapids.

She arrived at the head of the Galops Channel, on the 23rd August, and was at once placed on the line of chain previously prepared for her, by defining it, and by building berths, or moorings, at either end.

The upper berth is situated in the eddy at the foot of Adam's Island, and the lower, in Rolling Bay, a distance of about 4,000 feet below.

The chain was laid on the 24th August, as nearly as practicable on the line, but has been constantly shifted and improved upon during the season; the upper anchorage, however, remains as at first determined upon, and now at the close of our operations, the present position of the chain, seems perfectly adapted for future work upon the "Lower Bar," the "Island," and South Shoals, on all of which the chain vessel has, at various times, been stationed, and has been able to use her drills with effect.

To enable her to work on the North Shoal, and Upper Bar, the chain will have to be re-laid: this, however, is regarded as a work of little difficulty, as compared with the existing line; and should the Chain Tug system be adopted, the permanent anchorage required for it on the north shore, above Boulton's Pt., would be available for drilling operations in the proposed channel. On the 18th November, after a final trial of the drills on the Lower Bar, the Vessel ran down on her chain to Rolling Bay, dropping the lower end in the eddy under Tripod Point, and on the 22nd November she was towed to her winter quarters at Prescott.

With certain alterations to the chain vessel, made by her crew during the working season, it was found quite practicable to anchor her in 15′ or 16′ of water, in the strongest current at the Pitch, and to use the steam drills effectively, also to direct and control her movements in the rapids, when anchored only by the head and assisted by the steam tender alongside.

The following is a description of the proposed new channel, to which is appended a detailed statement of quantities of rock excavation.

The extreme length of channel, from the deep water above, to that below the Bars, is 3,300 feet, and the aggregate length of shoals to be worked over, between those points, about 1,800 feet.

Commencing in the deep water below Flat Rock, and proceeding downwards, the first obstruction encountered is a ledge of rock called the Upper Bar, which extends across the main channel, from the pier-head of the Canal to the foot of Adam's Island. The current over it is about seven miles an hour.

Its general level is six feet below the sill of Lock 27—*i. e.*, there is, in low water, a depth of 15 feet on it, but in mid-channel and at other points, the ledge is elevated from three to four feet above its general level, which would have to be removed.

The operations with the Chain Vessel at this point, and also at the North Shoal, next below, would be subject to frequent interruptions by the passage of vessels. This is also the only practicable route for rafts, which, when passing, (unless towed by steamers) nearly block up the channel.

The "North" shoal lies about 1,300 feet below the Upper Bar, and abreast of the Guard Lock; it is of rock, and extends across the main channel from the Canal bank, facing the Upper Bar, and is the cause of the current, which sweeps the north shore of Adam's Island, dividing and setting strongly south to Capstan Point, and north towards the Chute.

The point of this shoal seems to be the limit of the eddy below Adam's Island. The least depth of water on it is 10 feet 3 inches, or relatively 1 foot 3 inches below the sill.

It is feared that drilling operations here will be very difficult, owing to the strong eddy and opposing current.

Next in order is the South or Caledonia Shoal, lying 150 feet south of the point of North Shoal—its northern edge merely skirts the southern limits of the proposed channel.

South Shoal lies in front of the "Gut" Channel, and together with the North Shoal, is doubtless the cause of the strong eddy below the Island. A dam across the Gut would destroy this eddy, and greatly facilitate the operations of the Chain Vessel.

The "Island" Shoal is 600 feet below North Shoal, and overlaps the deep water between it and South Shoal. A strong current, both from the "Main" and Gut Channels, sets south over it.

Like the other shoals, it is of solid rock. A sounding of 9 feet 9 inches was obtained at one point on it, but its general surface has a depth of 12 feet over it, and is 3 feet below the sill of Lock 27. Owing to the steady current across this shoal, drilling operations will not be difficult.

The "Lower Bar," 750 feet below the Island Shoal is a ledge of rock extending from the Canal bank to Capstan Point.

Here the current in the Pitch exceeds 10 miles per hour.

The edge of the North Channel is distinctly marked by a large breaker, called the "Chute," on the rock immediately above which, the depth of water is only 6 feet, and north of it, in the Channel, 10 feet,

In the southern channel, or that near Capstan Point, the deep water is marked on the north side by a succession of smooth, heavy swells, the first of which is known as the "Cave," on the northern edge of which, a depth of 7 feet 6 inches was found, whilst south, between it and Capstan Point, the least depth was 11 feet 6 inches.

The space between the "Chute" and the "Cave" is shallow, varying from 7 feet to 9 feet, below which the Bar is covered here and there with boulders.

On the bar the water is turbulent in low stages of the river, and although drilling operations with the chain vessel have succeeded here, they are attended with much difficulty and danger, owing to the swiftness of the current both above and below the Pitch, particularly above.

When navigation through the Gut is stopped, (as was the case last season,) no interruption from vessels or rafts passing downwards need be feared, either here or on the Island or South Shoals: and as only passenger steamers ever ascend the rapids, they might doubtless be compelled to use the Galops Canal during the progress of the improvements.

Approximate Estimate of Quantities of Material to be removed to open the straight channel, as projected on the Chart.

Name of Shoal.	Depth of Channel. 14′ at low water.		Depth of Channel. 16′ at low water.		
	Width of Channel. 200′	300′	200′	300′	
	Cub. yds.	Cub. yds.	Cub. yds.	Cub. yds.	
Upper Bar	1,573	2,426	3,146	4,853	Rock.
North & South, or Caledonia Shoal	359	3,443	724	6,316	"
Island Shoal	4,578	4,702	10,364	11,051	"
Lower Bar	6,612	12,478	15,452	25,595	"
	13,122	23,049	29,686	47,815	

ABSTRACT.

Excavation in channel	200	feet wide	14	feet deep	....	13,122	cubic yards rock.
"	"	300	"	14	"	 23,049	do.
"	"	200	"	16	"	 29,686	do.
"	"	300	"	16	"	 47,815	do.

[NOTE:—It has been considered proper in the above estimate of quantities, to allow for the excavation being generally carried below the level specified, it being impossible, under the circumstances, to carry on this work with the same accuracy as on shore.]

In opening out a channel through the Rapids, allowance must be made for the difficulties with which the work will be attended, owing to its novel character—the interruptions caused by navigation to all operations in the Main Channel—danger in boarding the Chain Vessel in the current—delay from accidents &c., &c.

I have the honor to be, Sir,

Your obedient servant,

(Signed) TOM. S. RUBIDGE.