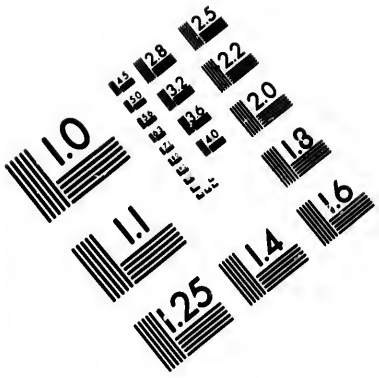

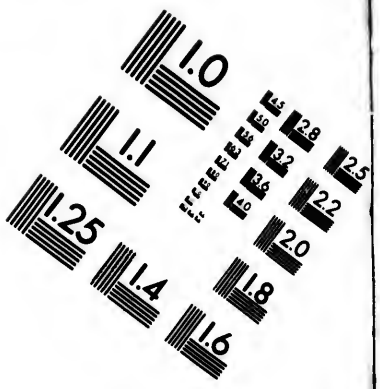

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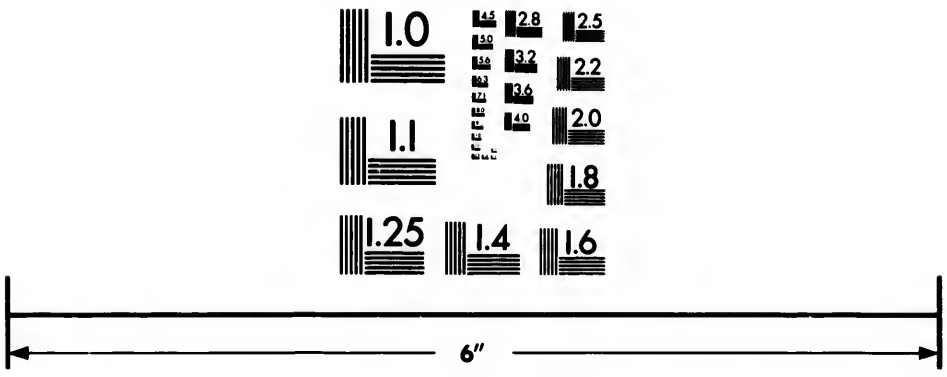

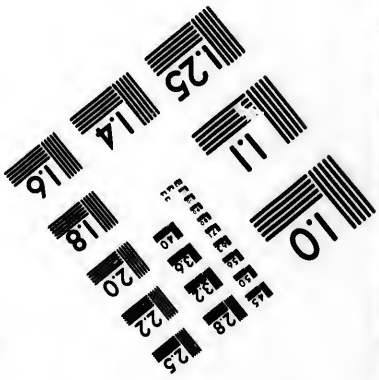

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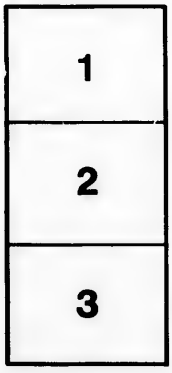

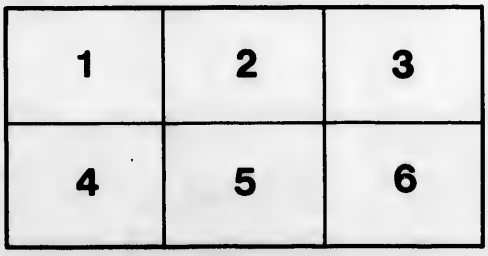

REPORT

TO THE

COMMITTEE

APPOINTED TO

SUPERINTEND THE SURVEY

OF A

SHIP CANAL,

FROM THE NIAGARA RIVER, TO JOIN THE

WELLAND CANAL,

AT THE

SUMMIT OF THE MOUNTAIN.

By THOMAS ROY,
CIVIL ENGINEER.

TORONTO:
Printed at the Courier Office, by G. H. Hackstaff.
....
1837.

To R. M. Crysler, Andrew Heron, D. McDougal, John Barker, John Rogers, Esquires, the Committee appointed to superintend the survey for a Ship Canal from Lake Ontario to the summit of the Mountain in Thorold.

GENTLEMEN,

In pursuance of your instructions "To survey a route for a Ship "Canal from the Niagara River, to the Welland Canal at the summit "of the mountain,"—I have examined the River,—the Welland Canal from St. Catharines southward to beyond Thorold—and the ground between these two places, and have fixed upon what I conceive to be the most eligible and the least expensive route between the two points, the outlines of which, and a section of the ground and of the levels of the proposed Canal I now lay before you on the plan which accompanies this Report, also an appendix containing estimates of the expense.

My first object was to fix upon the proper point of departure from the River.

The Niagara River, and the approach to it from the Lake has at all times a sufficient depth of water for any description of vessels which can ever navigate the proposed Canal.

Although the mouth of the River is easy of access, yet it is exposed to the swells of the Lake, especially when the storm is from the north-east. These swells are in part repelled by the current of the River, but are more effectually broken by the point of land on which Fort Niagara is built.

Southward of a line drawn across the River from the Episcopal Church in the Town of Niagara, to Fort Niagara—the water is smooth, and forms a safe and commodious roadstead—extending as far as the point on which Fort George is built. Above this point and onward to Queenston the current of the River is from three to four miles an hour. Below this point the River widens out and this circumstance, together with the repelling action of the Lake water causes the current to decrease, near the western shore opposite to the Church it is found to be under two miles an hour.

The elevation of the ground where our line passes along the common at Niagara, averages forty-three feet above the level of the Lake. The elevation of the ground near the River at the dotted line A shewn

on the Plan (perhaps the shortest practicable distance between the two points) is from 70 to 80 feet. The elevation of the plains to the westward of Queenston is rather over 100 feet, therefore 5 Locks of 9 feet lift would raise up a vessel from the River to the elevation of the plains of Niagara—nine Locks at the point where the line A terminates—and eleven Locks at Queenston.

It is evident from the great elevation to which the Canal would require to be raised at the two last mentioned places, that the ground could not be so well chosen, to avoid cutting and embankment, as it is on the line shewn, and the distance would probably be longer from the last named place because, in order to maintain the level it would be necessary to follow the sinuosities of the Lower Ridge, the base of which, near the Ten-Mile-Creek is of the same elevation as the plains to the westward of Queenston.

Taking all these circumstances into consideration it is evident that by making the place of departure at the mouth of the River, the entrance into the Canal would be exposed to the swells of the Lake. By making it higher up than Fort George the vessels must be detained when the wind is unfavourable, or they must be towed up the River, whilst no decided advantage either in distance or in expense of excavation would be gained.

From these facts I arrived at the conclusion that the point where the Canal should leave the River ought not to be lower down than a line drawn from the Episcopal Church at Niagara across the River to Fort Niagara nor higher up than the point on which Fort George stands.

My next object was to fix upon the best point of junction at the Welland Canal. In order to shew the reasons which induced me to prefer the spot which I have selected it will be necessary (however averse I may be to it, from inclination) to enter into some details concerning that work.

My first attention was given to the Locks on the hill, with the view of recommending the junction of your Canal to the Welland Canal at the base of the hill, if I found these Locks substantial, or at least so placed as to justify such a farther expenditure upon them as would make them substantial and permanently efficient.

The greater part of the Locks are in a ruinous state, and upon a minute examination of those which stand more firm, I found the timbers which appeared sound on the outside to be almost without an exception, decayed internally.

The Canal and Locks here are placed on the side of a steep shelv-

ing bank. The hill on the southern side rises abruptly from the edge of the water to the height of 80 or 100 feet. At Lock No. 27, where the Canal leaves the more even ground, and enters upon this shelving hill-side I found the height of the northern bank to be 57 feet, with a base not at all too wide for its great height. The Canal continues to wind along the side of this hill, the bank on the southern side encreasing in elevation, and the bank on the northern side decreasing, until near the place where it enters into the great Ravine.

The Locks in proceeding down the hill are placed at short and tolerably regular distances from each other, the intermediate spaces, about 250 feet in length and about 80 in width, serving as reservoirs for filling them. There are no waste-water races, but the water continually falls into the chamber of each succeeding Lock from one level to another.

The quantity of water required to fill one of the present Locks is 21,780 cubic feet. The quantity of water required to fill one of the Locks which I shall propose is 36,864 cubic feet. A vessel ascending through the Canal would reduce the depth of water in each of the intermediate reservoirs nearly one foot in filling one of the present Locks—and in filling one of our proposed Locks would reduce the depth 1 foot 10 inches, even if the sides were perpendicular—but if they have a reasonable slope, it would reduce the depth of water more than two feet. a circumstance which would prevent any vessel drawing more than 7 feet water from passing through the Canal, unless it is obviated as it now is by an evil nearly as great, viz—allowing a current of water equal in capacity to the quantity admitted through the valves into the Locks at the time they are filling, to flow constantly through the Canal.

From the description of the situation of the Canal above given, it will be seen, that these reservoirs cannot be enlarged, and waste water races constructed, unless at an expense manifestly much greater than would be sufficient to excavate a new Canal in a more favourable location.

The material of which the Locks are composed, and the manner in which they are constructed render it impossible that they can be made efficient and durable, and I cannot recommend placing expensive and substantial Locks in such a situation.

Having satisfied myself that it is necessary in order to obtain a substantial and permanently efficient work, to carry a separate Canal over the hill, I proceeded to examine the Welland Canal, at and above Thorold, where the long level terminates at Lock No. 35.

The four Locks in the village do not materially differ from those already described, but here the Canal is located in nearly as favourable a situation as the ground affords. Between Locks No. 32 and No. 31 there is a long level on nearly a straight line.

Two points of junction claimed attention, the first at Lock No 31, following the base of the upper Ridge eastward—(as shewn by the dotted red line B on the Plan) and locking down into the Ravine of the Ten-Mile-Creek—or else, to cross it and several smaller Ravines, its branches, by aqueducts and embankments. The first I could not adopt being well convinced of the impropriety of locating Canals in Ravines if it can be avoided—and the second was too expensive if a better line could be found.

I therefore resolved to choose as the point of junction the termination of the straight line above mentioned a short distance southward of Lock No. 31. The Welland Canal from the village to this Lock is favourably situated. There are several embankments on its eastern side which are too weak, these ought to be strengthened, or (if I may recommend on another work,) Lock No. 31 ought to be removed up to near the village, and the Canal at this place excavated nine feet deeper, which would render these embankments unnecessary, and enable us to place our Locks No. 30, 29, & 28 further apart than they are shewn on the section.

In determining the capacity of the proposed Canal, and the size of its Locks, I have not been guided so much by the dimensions of the Welland Canal as it now exists, as by the dimensions to which it will probably be enlarged when it is put into a better state—and by the depth of water in the Locks of the St. Lawrence improvements. Such a Canal as this can never be used with advantage for Steam Boat navigation, at least as these vessels are at present constructed,—therefore it would be an unnecessary expense to construct the Locks of such dimensions as to admit Steam Vessels, and the working Locks of so great a capacity would cause a constant and useless waste of water. I would therefore propose that the dimensions of the Canal should be 44 feet wide at bottom, 80 feet wide at the surface of the water, and 9 feet deep (as shewn by the sectional Drawing No.1) or, I would rather recommend the form shewn by the sectional drawing No. 2. The flat Tables—a—a (shewn on the drawing) 3 feet wide, and 1½ feet below the surface of the water, prevent the earth washed from the upper edge of the Canal, by the surges whether caused by the wind or by the vessels passing through, from rolling down to the bottom. These washings can be cleared off from the Tables as often as they accumulate, by

lowering the water 1½ feet between any two of the Locks. This would make the width of the Canal at the surface of the water to be 86 feet, a decided advantage where the Locks are near to each other.

The estimates for the excavation to the northward of the lower Ridge are cast out according to the form No. 1, and to the southward of that Ridge, where the distance between the Locks is shorter, they are cast out according to the form No. 2. The difference of expense in this Canal where there is no deep cutting, will be trifling.

The Chambers of the Locks I would propose to make 122 feet clear, by 32 feet, with 9 feet lift. That the Locks shall be substantially built with cut stone, well jointed—to be laid in Roman Cement, if it can be procured, and if that cannot be procured in the best water Lime.

Having determined the points of departure from the Niagara River, and of junction to the Welland Canal, and shewn the proposed dimensions of the Canal and of the Locks, I shall next describe the line as it is shewn on the Plan and exhibited on the section, and then describe the position &c. &c. of the Locks.

Upon examination the stratification of the rocks which form the hill at Thorold proved to be horizontal. and the elevation of the surface of the rock to be nearly equal all along its crest. I found also that by continuing out the straight line between Locks No. 52 and No. 31 of the Welland Canal, it passed to the very margin of the hill over good even ground of a tenacious soil, and well adapted to the construction of the canal, and of reservoirs to supply the locks; and that the point where this straight line passes over the hill is as favourably situated for placing the locks as any other. By continuing this straight line onward from the base of the hill to near the place where the canal crosses the Ten Mile Creek; the uneven ground to the eastward near the ravine of the creek is avoided, and also low uneven ground to the westward which is at several places very near the line.

The declination near the base is rapid, which causes the four locks nearest the hill to be too close to each other for the supplying of water to work the locks; but from the formation of the ground, this can be remedied at a trifling expense, by embanking shallow reservoirs connected with the canal, between each of these locks. The surface of the canal, and the surface of each of these reservoirs, together to form an area of 110,592 square feet. Thus the depth of water in the canal will only be reduced 4 inches in filling one of our proposed locks. The soil being a tenacious clay is favourable for this purpose.

When the line drew near to the ravine of the creek, and when the elevation of the ground was found to be rather less than the elevation of the crest of the lower ridge it became necessary to curve the line to such a bearing as would pass the creek at a place where only a small quantity of embankment is required, and where an aqueduct will be easily constructed, and also to avoid a wide ravine on the south-east. After proceeding about one third of a mile on this bearing, the line changes a few degrees more to the south, in order to pass the ground near the ravine and the heads of several branch ravines, and to descend from the ridge at a suitable place. The soil to the eastward of the creek is mixed, chiefly clay; and appears to be sufficiently retentive. The quantity of embankment is small, and the line of the surface of the water in the canal is (excepting only at a few places) lower than the surface of the ground; one small culvert will be required.

After descending the ridge, the line continues on the same bearing for nearly 4 miles. The soil is a firm tenacious clay; the ground remarkably level and well adapted for the purpose of a Canal. Two or three culverts will be required; or it would be safer and not more expensive, to make a small lateral cut on the south side of the Canal to carry the flood water into the Four Mile Creek.

The low swampy grounds to the northward, which are so frequently flooded, being already passed, the line approached the four mile creek, and as a straight line to the point of departure at the Niagara river would avoid the ravines near the Town, I determined to lay out such a line especially as it led to a favourable place for passing the creek. It runs through a fine level country; the soil for a considerable distance is a firm tenacious clay. For the remainder of the distance the sub soil is clay, but in many places thin deposites of sand are strewed on the surface; near the Town there are a few slight inequalities, but they are of little consequence. Descending from the common to the river, the sloping bank is firm clay, very favorable for the foundations of the locks. The margin of the river is sand, and the sides of the canal will require to be protected by walls or piles. At the point of departure there is 12 feet water in the River 30 feet from the shore.

An aqueduct will be required at the Four Mile Creek. As this creek is a permanent stream it may be led out of the Ravine more to the southward and used as a feeder to the canal when required. Five small culverts will be required, bnt I would recommend in preference small lateral cuts to drain off the surface and flood waters, and only to place culverts under the Canal where they are indispensable.

Throughout the whole line (excepting only the cutting for the foundations of the Locks on the hill) there is no rock excavation.

From the base of the lower Ridge downward the excavation is reduced to the smallest posible quantity by placing another Lock so soon as the depth of excavation yields a quantity of earth sufficient to form an embankment on each side of the Canal 15 feet wide at top. The sides of the embankment to have the same angle of declination (67°) externally and internally as the sides of the Canal.

The tenacious nature of the soil renders this system perfectly secure, very little puddling will be needed, but at several places the vegetable matter—and at other places the deposites of sand must be cleared off from the surface of the clay before the foundations of the embankments are laid.

The proposed Canal throughout the whole line can be kept entirely free from flood-water.

The whole distance is 11 miles—4 furlongs—559 feet.

The rise from the River to the level ground at the Town of Niagara requires 5 Locks. Two ways for placing these Locks presented themselves. The first by locating the Canal in a Hollow or Ravine which the line shewn crosses 2617 feet from the River following out the sinuosities of this Ravine to its termination at the Government Wharf and placing the Locks at such distances as could be obtained, using the intermediate spaces as Reservoirs to supply them with water. The second is that which I have adopted. By the first the distance from Lock to Lock could not have exceeded 600 feet, therefore the width of the Canal at the surface must have been 170 feet to fill one of our proposed Locks without decreasing the depth of water in the Canal more than 4 inches, or Reservoirs must have been constructed. The Ravine is within the Town—there is not space for Reservoirs—neither would it be desirable to form them there. The entrance to the Canal would also have been exposed to the swells of the Lake.

By the plan which I have adopted one of our proposed Locks can be filled from the level above (4180 feet in length) by only reducing the depth of water in the Canal one and one-third inches—and if the Wharves shewn on the Plan were formed the surface of the water would be so much encreased, that the depth would be only reduced one inch.—(These Wharves however I do not recommend to be made part of the works of the Canal.) The first plan would probably be somewhat less expensive, but taking into consideration the great influx of trade which will take place whenever this Canal is opened, it

is desirable that there should not be any delay or want of water at its entrance.

I would therefore recommend that five double Locks be constructed on the ascent from the River, as shewn on the section.

It is not requisite to say anything concerning the next six Locks, which raise the level of the Canal to the elevation of the base of the lower Ridge. An inspection of the section will shew that the long levels between each afford the greatest possible facility for working the Locks and navigating the Canal.

The Locks Nos. 12 & 13 by which the lower Ridge is ascended are situated at the termination of a level 5194 feet in length, the filling of both these Locks from which will not reduce the water in the Canal so much as two inches.

Lock No. 14 has a level above of only 1200 feet in length, the filing of the Lock from which would reduce the water in the Canal 4½ inches. As 4 inches is the maximum to which I propose lessening the depth of water at any Lock, the embankment to be formed from the Lock southward must be so widened out as to enclose an additional space of shallow water having a surface of 10,600 square feet. This deficiency might be remedied by placing the Lock farther northward, but it would then interfere with the curve near the Ten-Mile-Creek.

Locks Nos. 15 & 16 have each a level above of 1400 feet in length. This presents a surface of water equal to filling these Locks without reducing the depth of water in the Canal more than 4 inches.

Locks Nos. 17, 18, 19 & 20, owing to the rapid descent of the ground have none of them a sufficient level surface of water above for the purpose of working the Locks.—No. 17 will require a shallow Reservoir having a surface of 40,072 square feet.—No. 18 one of 52,972 square feet.—No. 19 one of 70,172 square feet.—No. 20 one of 66,887 square feet. The ground is favorable for the connstruction of these Reservoirs, and the earth to be excavated from the Canal is in each case more than sufficient to form the embankments—(see note.)

Note.

It may appear from what is said above that in drawing off water for working these Locks the depth of water in the levels will be reduced to 8 feet 8 inches. Thus is the case, but by placing the boards of the waste-water weirs 2 inches higher than their true position, and adding the depth of water flowing over these boards, and the increase from the feeding water let in by the races, it is obvious that the water in every one of the levels can at all times be kept up to the full depth of 9 feet.

The next seven Locks conjoined to each other are placed in the crest of the hill.

Here we have an almost perpendicular ascent of 60 feet to overcome. There are two ways of doing it. First by short levels and separate Locks. The Welland Canal is formed upon this principle.

The line shewn by the dotted red line B on the Plan, which passes into the Ravine of the Ten Mile-Creek, does not afford greater facilities for this purpose than the line of the Welland Canal. The second way is as shewn on the section. I have already proved the inefficiency of Locking a Canal down a high and steep hill by making short levels to serve as Reservoirs between each Lock on account of the decrease in the depth of water in these levels, where the area of the surface does not bear a due proportion to the size of the Locks. If it is attempted to correct this deficiency by introducing a large current of water into the Canal, the waste which it will cause by washing the sides,—by forming deposites in the bottom,—and by other injuries to which the works will be exposed from its effects, as well as the encreased power and cost of traction which it will cause, are circumstances calculated to mar the usefulness of the Canal, and eventually to become sources of expense which will not a little lessen its profits.

The number of vessels which may reasonably be expected to use this Canal as soon as it is opened, will require every possible dispatch. I have no hesitation therefore in recommending seven Double Locks to be placed on the hill as shewn on the section—to be constructed in such a manner as to economize the water as much as possible.

On the summit of the Hill threre is a large extent of ground generally even, and sloping from South to North. The soil is tenacious clay. On this ground extensive Reservoirs should be constructed, for working these double Locks.

If these Reservoirs were formed on different levels, and made to communicate with each other by self-acting valves, the four upper Locks could be filled directly from the Reservoirs, when vessels were ascending, and when the vessel had passed the water could be drawn off from the higher part of each Lock into another Reservoir on its opposite side to be used again—an extension of this process might be made to fill the three lower Locks, and thus single Locks could be used. But from the delay and the waste of water which these would cause—and the expense which would be incurred in making and adapting these Reservoirs. I am firmly convinced that Double Locks ought at once to be constructed.

From these seven Locks, to the point of joining the Welland Canal, there are four Locks necessary, (see Section) but as some arrangement must be entered into with the Welland Canal Company before these are placed, it is useless to discuss their proper point of location at present. I shall therefore state what appears to me to be the best arrangement for the eight Locks which raise your proposed Canal, and the Welland Canal, from the elevation of the crest of the hill, to the elevation of the long level southward of Thorold, I would propose to place the Locks Nos. 35 & 34 together as far south as the nature of the ground will admit of. Lock No. 33 I would place as near to these as a surface of water can be obtained bearing the same proportion to the size of the Lock as we have calculated, the area of the Reservoirs from, on the short levels to the north of the hill. Lock No. 32 I would place as near to No. 33 as a similar surface of water could be obtained. Lock No. 31 I would place as far southward as possible, for reasons already given. Our Locks Nos. 30, 29, & 28, could, when these arrangements are made, and the distance which they and their levels are to occupy, is known, be placed in the most favorable position which circumstances would admit of. But in every case, I would hold it as a principle, not to be departed from, that a surface of water, equal in area to that above mentioned, shall intervene between every two separate Locks—and if the level itself does not afford the necessary extent of surface, that it shall be increased by shallow connecting Reservoirs.

At all the Locks waste-water weirs and races to be constructed.

The number of Bridges required over the Canal cannot now be exactly determined. By the notes of the Survey it appears that the line crosses 18 Roads—perhaps arrangements may be entered into which will render it unecessary to place a Bridge at every one of these—but it is probable that in the wooded parts of the country there are public Roads not yet cut out, where Bridges will be required. Under this uncertainty I have framed estimates for 18 Bridges.

I hesitate what description of Bridges to recommend, Cast Iron Swivel Bridges are undoubtedly the best, but the first cost is too great taking into account the number required on this work, and I have misgivings concerning the tenacity of the metal during the severe frosts of this climate. The Swing Bridges in common use here are clumsy and not easily managed, I have furnished a Drawing of a Timber Bridge on different principles, the cost of which is placed in the Estimates.

The estimates next require attention—their gross amount (including

10 per cent for contingencies is £337,035 4 4.—The excavation and embankment together amount to £65,562 4 5,---10 per cent to be added for contingencies. The cost of the Locks, which is the heaviest item is £224 382 11 0, but it ought to be borne in mind that 12 of them are Double. The estimated cost of a Single Lock, with gates &c. &c. is £6,217 2 6. The various items forming all these estimates have been carefully calculated.—The amount of pressure external and internal.—The specific gravity of the materials &c. &c. have been computed, and the formation of the walls (shewn on the Drawing) is such as to require the least quantity of material and labour consistent with absolute security.

It may be noticed here that these Locks raise the Canal to the elevation of 279 feet, therefore 6 Locks more—2 of 9 feet lift, and 3 of 8 feet lift would raise the Canal to the level of Lake Erie. Or that the sum of £37,302 15 0 would complete this system of Lockage from the level of Lake Ontario to the level of Lake Erie.

The other items put down under the designation of subordinate expenses, do not in several cases furnish data for very accurate estimates, but I feel confident that the sums specified £14,450 17 8 with 10 per cent to meet contingencies (see appendix No. 3) will be sufficient for these necessary works.

In framing the estimates I have not put any value upon the stone to be obtained from the Rock excavation on the hill—should the lower beds of that Rock prove fit for building the Locks, a saving of several thousand pounds will be effected, whether this should be the case or not the stone even of the upper beds is suitable for the mason work Races &c. comprehended under the designation of subordinate expenses.

As nearly all the proprietors on the line have given up their title to the land required for the use of the Canal, it is unnecessary to estimate its value.

Before I close this Report I conceive it to be a duty incumbent upon me to draw your attention to two things by which the usefulness of the Welland Canal is greatly abridged, and consequently the value of your work will be proportionably lessened, as in the southern part it is intended to use that Canal. These are 1st. The flood-water which is allowed to flow into the Canal and 2nd. The immense body of water which constantly flows through it for the purpose of driving machinery. A full supply of water is absolutely necessary in every well regulated Canal, but this supply ought to be entirely under the controul of the persons having charge of that Canal, and ought not to be increased by

floods—nor to be diminished by allowing the smallest portion of it to be drawn off for any purpose whatever unconnected with the Canal.

It is shewn above that the sum of £37,302 15 0 in addition to the sum required to be expended upon your Locks would complete the system of Lockage up to the level of Lake Erie. This sum must be expended upon the upper Locks of the Welland Canal to make it serviceable. Therefore the sole advantage which the Welland Canal offers to you is the excavation in the state in which it at present is burthened with the above named drawbacks. By the appendix No. 1 the estimated expense for excavating upwards of 11½ miles is £67,562 4 5, that is more than half the distance from Thorold to Lake Erie—and I am convinced that by cutting in a different direction through the Ridge which everywhere divides the head waters of the Creeks from the head waters of the Chippewa River—the excavation would not be found very formidable. The full value of the advantage to be obtained by using the Welland Canal, after putting it in order, would not probably exceed £50,000 or £60,000—therefore unless the present system of making the Canal a mill-race is abandoned, I would earnestly recommend the construction of an entirely new Canal throughout, and upon no account to permit on so stupendous a work, any minor consideration to interfere with its great ultimate design.

THOS. ROY,
Civil Engineer.

January 6th, 1837.

Summary of the estimated expense of constructing these works, as they are severally specified in the appendix.

Excavation and Embankment,	£67,562	4	5
31 Locks, 12 of them Double,	224,382	11	0
Subordinate Works, including Aqueducts, Bridges, Water Races, Towing Path, &c. &c.	14,450	17	8
Contingencies, 10 per cent,	39,639	11	3
Total,	£337,035	4	4