a Moille Canal	February 29, 1828
runswick Canal	" 29, 1828
obbescontee Canal	" 29, 1828
mmonusuck Canal,	" 29, 1828
liverian Canal,	" 29, 1828
unapee Canal,	" 29, 1828
innipessogee Canal,	" 29, 1828
asumpsick Canal,	" 29, 1828
ontpelier Canal,	" 29, 1828
utland Canal,	" 29, 1828

George Town Feb. 29 1828

Sir

I have the honor to transmit a report of the several surveys made in pursuance of your orders, in the States of Maine New Hampshire & Vermont.

Most respectfully

I remain Sir

Your obt. servant,

J. J. Abert,

Major & T. E.

Major General Macomb
Chief Engineer
Comdg. U. S. Eng. Dept.

LA MOILLE CANAL.

The object of this canal is to connect Lake Memphramagog with Lake Champlain by the valleys of Lamoille and Black rivers.

We have not yet had time to examine and plot the results of this survey, which forces me to limit my remarks with the opinion, that this route, from a perusal of the field books, appears not only to be practicable but exempt from unusual difficulties.

The survey was made by Lieuts. Macomb and Wilson, and the directions which they received, appear to have been carefully observed.

It is, perhaps, proper that I should remark, that all of these surveys, except the levelling, were done by the compass.

We have no other instrument for detail operations, and the errors to which this is liable, cannot fail to effect the results collected by it.

The errors are so well known and have been so frequently exposed by men of scientific acquirements, that it is unnecessary for me to make any comments upon them. They are inseparable from the use of the instrument, and may be said to form a part of its very theory.

In surveys of Harbours & rivers where a system of triangles, determined by the theodolite, regulates the work, & where the points of these triangles are seldom more than a mile apart, the compass may be used, as its run is so frequently corrected by the triangle points, and any accumulation of error is by that means prevented. But in a long line for a canal or other purpose, and through a country so abounding in iron as ours, the errors from the use of the compass cannot fail to be serious.

The plane table is the only instrument which can be substituted for the compass, and it is well adapted for the collection of the details required from our labours. Its theory is perfect, if I may so express myself. Its results must be without error, or error can be a consequence only of inexcusable carelessness in its use. It has some inconveniences and when the ground is such as to render frequent stations necessary, may

occasion some delay, but these are more than compensated for by its accuracy. And when we consider that the result from the plane table is a map which needs only to be copied, I am inclined to doubt if the loss of time in its use in comparison with the compass, will prove as great as is generally supposed.

Having used a plane table on one occasion, I speak with the advantage of some experience. But even if there were a saving of time in favor of the compass, what can this weigh in the scale against the unequivocally superior accuracy of the Plane Table.

Our labours should, at least, be exempt from those errors resulting from the imperfect nature of the instruments used. Under these impressions, I must request of the Department permission to have two plane tables made and to introduce their use in the operations of my party. The cost of a plane table will not exceed that of a good compass.

It is also proper to state that the measurements of the streams, to ascertain the quantity of water discharged, were made during the period of the survey. And altho these measurements were made at a season when the streams are generally at a minimum, it is yet rather at variance with the practice of more experienced nations to be governed by less than the average result of the observations of many months. With ourselves I should doubt the propriety of constructing a canal, until at least after the average daily observations during the dry

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BRUNSWICK CANAL.

The object of this Canal is to effect a junction between the waters of Merrymeeting and Casco bays.

After examining the ground between these bays, there appeared to be two methods of uniting these waters by a Canal. The first from a summit level with the necessary locks, the second by a dirrct communication or thorough cut.

To effect the first it will be necessary to feed the Canal from the Androscoggin by taking water from above the falls at Brunswick. The second can be accomplished only by the way of the New Meadows.

The ground between the Merrymeeting and Casco bays, admits of a Canal in many directions, on the supposition of a feeder from above the falls, as it is equally uniform in level for a great extent. But after examining the same I conceived it unnecessary to have an experimental line carried over more than two directions, each of which will be the subject of remark.

A short distance above the upper saw-mill, near the falls at Brunswick, the river is confined to a narrow channel, its shore granite rocks, rising above the highest freshets of the river and opposing a barrier insurmountable to its efforts. The width here is 326 feet between the points 2 & 4 of the

plan, and at the height of the water in May. The shore retires gradually and would not add more than fifty feet to the width in rising from fifteen to twenty feet above the level of the water, and which is also about the height of the rocks at the points 2 and 4.

The line of the highest freshets known, as marked and shown to me, is about ten feet above the state of the water on the day of the survey, and the line of the lowest water, about four feet below.

This depression of the water is considered as resulting principally from the defective construction of dam of the sawmill below, which admits the greater mass of the water discharged in dry seasons to pass through, and if the information furnished to me on this subject is correct, a well constructed dam would from its mere savings, supply the water requisite for the uses of the Canal.

The point for taking the water appeared to me preferable at No. 2 of the plan, where the lock could be cut through the bank of granite, and have an immediate deep water communication with the river.

Between the points 2 & 4, which are excellent abutting points, a dam will have to be placed, for the purpose of furnishing a supply of water for the canal, and of raising the

water of the river so far above its level on the day of the survey, that this latter level may be considered as the trace of the bottom of the Canal and the excavation calculated accordingly.

The depth of water between the several points at which the dam may be made is considerable and conformably to the curves 1---3, 2---3, 2---4, of the sheet of profiles. But materials for forming the dam are conveniently situated on the banks of the river, and the excavation of the communicating lock could not be better disposed.

Leaving the water at the point 2, and upon the supposition that the line of refferences will be the bottom of the feeder, the ground rises as indicated in the profile from a to b, requiring a deep cutting varying from ten to seventeen feet for about three hundred yards. From thence to the point c, pursuing the dotted line of the plan, a level similar to the dotted line of the profile can be obtained, requiring a cutting of seventeen feet, decreasing gradually down to fourteen feet, in a distance of about 13 hundred yards, and through a soil, apparently of the most easy kind to excavate, a sandy loam..

From this point, and through a similar soil the level decreases gradually to 7 feet in a distance of seventeen

hundred yards, to the point d. From d to a, in a distance of 1000 feet the ground rises regularly to eighteen feet, at which point it intersects the line levelled across to effect the communication from bay to bay.

If the feeder were curved from the point d, directly towards g, as in the dotted line of the plan, it would very soon encounter the depth of cutting of the point f and which continues to g. But as it would reduce the distance between these two points to about one half, it might be considered the preferable course.

This will constitute the whole length of the feeder for that line of communication which may be stated as possessing the most advantages, not only in relation to the facilities which it may afford to the inhabitants of the immediate vicinity, but also in relation to the continuation of the navigation to Portland.

From f to h, a distance of three thousand two hundred and thirty feet, the level varies but little from the height at f. From h, there is a gradual descent to the ravine of mare brook in a distance of two thousand four hundred and fifty feet. The edges of the ravine are about ten feet above the line of reference, its bottom twenty two feet below, and its greatest width from e to k about 600 feet. Through this ravine mare brook passes, in its course to middle bay, part

of the waters of Casco. It is not subject to violent rises, and I should suppose that an arched culvert of about 15 feet cord, the spring of the arch about five feet above the bottom of the ravine, would be sufficient to pass its waters at any season.

After passing this brook, the ground continues of as favourable a consistency as heretofore, with a scattered growth of small pine to 1, a distance of fifteen hundred feet. From this to the point m, a distance of six thousand six hundred feet, the line will encounter a swamp, filled with birch, alder and hemlock, exhibiting a case of difficult grubbing and clearing.

The instrument throughout this distance had to be kept above the level of the swamp and near its edge, for the benefit of an open passage, as in running a line merely to determine the practicability of a canal, it was not considered necessary to loose the time required, and encounter the expense necessary in cutting out a path in the exact line which the canal may follow in its ultimate location. This will however vary but little in horizontal position from the one plotted, and from an examination of the swamp and the determination of several points, the vertical projection of its surface, as exhibited in the dotted line of the profile may be considered as correct. By this it will be perceived that it rises

gradually from about 2 feet below the line of reference at l to twenty six feet in a distance of four thousand three hundred, and then declines to m, five feet above the line of reference, in a distance of two thousand three hundred feet farther. At m there is a small stream issuing from the swamp, and discharging itself into middle bay. From m to n, for the reasons before stated, the dotted line is the correct profile of the most probable route of the Canal.

Through about half of this distance from m there is a very thick growth of hemlock, and in the whole the ground is wet and a clay soil. It will be seen by the profile that in this distance of five thousand 100 feet, there is very little difference of level. From n to a medium high tide of middle bay, a distance of three thousand one hundred feet, the soil a stiff clay, the fall below the line of refference was found to be 38,61 feet, at Capt. Pennels wharf, the vicinity of which also appeared to be favourable for the debouch of the Canal.

In this last distance the locks will most probably have to be located, and if one is placed at n and the remainder towards the termination of the line, it will reduce the excavation for this object, to its least dimensions.

A difficulty occurs in the debouch of the Canal into the bay, which is however unavoidable. This is occasioned by the

great extent of flats, left bare at low tide, and which would render necessary a construction over these flats of considerable length, to effect a low tide communication with the waters of the bay.

The exact extent of these flats and the rise & fall of the tides were not determined, because knowing the Department already to possess a survey of this bay, in which these facts were without doubt, well ascertained, it appeared to me an unnecessary loss of time and repetition of labour.

But I do not consider a low tide communication as requisite at present. If the canal were to be conducted to the edge of the water and were to communicate with it at medium tides, it will in that state greatly accommodate the country and meet all existing exigencies of the trade. And to avoid encumbering the canal above the locks, with boats ready to pass when the tide may serve, a small basin might be constructed at its termination, into which boats could be passed and there await the tide.

A favourable place for this is to be found a short distance west of Pennells wharf in a small cove, in which case the line of the canal, would have to pass in the rear of Capt. Pennells house, and nearly in the direction of the dotted line, keeping in the valley of the brook indicated at the point n and the descent from the point n is also in this direction, more gradual.

Returning back upon the line to the point h, the line from bay to bay, may pursue the dotted course from h to f with very little variety of level, the point h being twenty one feet above the line of reference and the point f nineteen. The distance between these two is three thousand seven hundred feet. From f (profile B) in a distance of eight hundred and seventy five feet, the level decreases to six feet above the line of reference at the point p it continues at about that 1100 feet farther and from p to r, in a distance of seven hundred & fifty feet, the level descends to thirty six & a half feet below the same line. From thence to a in a distance of four hundred & fifty feet, the fall below the line of reference is 44.83 feet which was also the low tide mark of that day, at an old ship yard on the Androscoggin. The water is here deep close to the shore, the point of junction sheltered from currents drift and winds, forming a good harbour, and rendering easy any access to the Canal.

I was informed that there is always a difference between the tides of this river and those of Casco bay, but we did not remain sufficiently long in that neighbourhood to ascertain correctly the amount of this difference, by repeated observations through a course of tides.

The locks for the fall at this end will also have to be located together and between the point p and the extremity of

the line.

This route has the advantage over either of the others, by accomplising the connexion, between the waters of the two bays without sea exposure. Materials for construction are convenient, labour is cheap and the inhabitants industrious and enterprising. At the lower end of Mare brook is an extensive brick yard.

On an examination of the profile it will be seen that the cutting will be deep for some extent. The only method by which this may be reduced, is by raising the water of the Androscoggin, so that the bottom of the feeder would be about five feet above the line of reference. This would involve an increased expense in the dam, some additional lockage, and damage some low meadows on the river, to which would be a sett off in the reduced excavation. Or by taking the water from a fall in the river a few miles above Brunswick, the whole of the deep excavation might be avoided. But as no survey was made to determine the peculiarities of the feeder under this latter view of the subject I cannot speak positively of its advantages; from representations however which were made to me, I should think its difficulties from increased length and the nature of the ground over which it would have to pass, and a part of which I examined, would occasion an expense much greater than

that of the excavation made necessary in taking the water from the falls at Brunswick. The feeder should also be a navigable canal, to extend its advantages to the river trade.

2nd route.

The second route pursues the same plan and profile of the feeder to the first, to the point d. The rise at e may be avoided and the level of d maintained by passing a little to the north of e, and continuing to the edge of the ravine which is about four hundred feet from the point f, in all a distance of three thousand two hundred feet. This ravine would have to be passed by the feeder to the second line. Its bottom is twenty five feet below the line of reference and its edges about twenty feet above the same. The stream which passes through it is very small - a three foot culvert would be sufficient for its discharge at any time.

Soon after passing the ravine the ground falls gradually, as indicated by the profile, from the eastern edge of the ravine, to six feet above the line of reference at the point 1, 5800 feet from D, and from thence to the point 2 in a distance of seven thousand three hundred feet, frequently coincides with and occasionally passes from three to five feet above and below the same. At 2 there is a ledge of rocks, extending about 700 feet in width, and rising to a height of twenty feet, nearly at the

middle of the ledge. This can be avoided by a passing a short distance to the north. After passing this ledge the ground falls gradually to a low table land, extending from the waters of the Merrymeeting to the New Meadows River.

The whole of this last described section is through a light soil, sandy loam, occasionally covered with a small growth of spruce, birch and pine. The instrument was kept, for convenience to the work, in the road, but the ground is of the same character and height on each side.

After descending to the point 3, fourteen hundred & fifty feet from 2 and twenty four feet below the line of reference, the line of canal across from water to water was commenced, and kept in the table land before mentioned. From 3 to 4, a distance of four thousand nine hundred feet the line passes through an open meadow. At 4 there is a ledge of rocks rising gradually to about thirty feet, and leaving a narrow bottom from 20 to 30 feet wide, between the base of the rocks and flats of the New Meadows covered at high water. This narrow bottom extends about nine hundred feet, and maintains a height of twenty feet below the line of reference, from whence it rises to eleven feet below that line, distant fifteen hundred & thirty feet from 4. At 5 there is a deep ravine, two hundred feet wide & twenty one deep, through which the water passes at high

tide. At 6 about nine hundred feet from 5 and twenty five feet below the line of reference, and to which the ground descends gradually, there is another high tide passage, extending to 7, seven hundred and fifty feet wide and eight feet deep. The point 7 is thirty two feet below the line of reference. At one hundred feet farther the junction with the New Meadows was effected. The low tide mark of the river on that day was 49.24 feet below the waters of the Androscoggin at the starting point of the feeder. The debouch is here directly into deep water, the shore a granite rock.

Returning now to the point 3 and pursuing the route to the waters of the Merrymeeting, we find that this part of the route is also through favourable soil. A small brook will have to be crossed in the course requiring a culvert and, from 3 to 8, a distance of eleven hundred and fifty feet the ground is open meadow. From 8 to 9, a distance of three thousand nine hundred feet - the course lies through a thick growth of birch, spruce & hemlock. From 9 to the debouch at Tobys point, a distance of fifteen hundred and fifty feet, the ground is open, except near the point which is wooded & rocky. The channel passes close to this point, the shore a ledge of granite rocks, but the position is much exposed to the current and tides, which would frequently render the entering of the cannal very difficult.

By this route it will be seen that the feeder will have to descend, and if made navigable as it should be, it will also have several locks, which will render a reservoire necessary to supply the canal across from the waters of each bay, or an enlargement of the canal over the table land to answer the purpose of a reservoire.

It has the advantage over the first route, of a deep water debouch at each end, but it increases the distance from Brunswick, without adding any accommodation to other places, and altho' this route accomplishes the connexion between the waters of the Merrymeeting and those of Casco bay it does not ensure a communication with Portland without sea exposure. The pass inside of Ragged island (mouth of the New Meadows) is too dangerous from its many sunken rocks, to be attempted by any but the most skilful pilots and in the most favourable weather. It also at all times feels the swell of the ocean, which would render it impracticable for canal boats. On this account vessels of any burthen are obliged to pass outside of the island, and the necessity which these circumstances would occasion, of reloading in different vessels at the outlet of the canal, would much diminish its advantages and increase the expenses of its use.

A pass inland might be effected through the narrow channel which seperates the maine from great Sebascodiggin island,

and communicates with Harpswell bay. But a lock would have to be made in this passage in consequence of the violence of the tide in passing through, or it could only be passed with the tide or during still water. After getting through however the boats would have to double Harpswell point, still exposed to the swell of the Atlantic and which may be again considered an outside navigation.

To effect a more complete inland navigation and communication without sea exposure with Casco bay proper, a cut would have to be made across Harpswell neck, over which high tides occasionally flow.

The cut across the neck would be short, but the flats of Harpswell river are bare about seven hundred feet out at low water, and would require the work to be extended from three to four hundred feet farther, before a depth of four feet at low water could be obtained. The extent of flats in middle bay, with which this cut would communicate are still greater, and as no passage inland to middle bay could be effected from the New Meadows without this cut and the consequent constructions over the flats, it will be seen that this route of fewer facilities than the first would greatly exceed it in the cost. The two routes, including the feeder, are about the same length, exclusive of the cut and constructions over the flats in the second route by Harpswell neck.

Or in the first route the distance from bay to bay is about 4m. 9/8ths. The feeder to this which is 2 2/8th and intercepts it in a distance of 3 miles and 6 eighths from Casco bay, and 1 mile & 3 eighths from the Androscoggin which empties into the Merrymeeting making the length of the canal line from the feeder above the falls at Brunswick to Casco bay 6 miles. And from the same, commencing point of the feeder to the waters of the Merrymeeting 3 miles & 5 eighths.

In the second route, the distance the debouch in the New Meadows to that at Tobys point is two miles 6 eighths. The feeder of this route is 4 miles & 5 eighths long, and intercepts it at a point which would make the entire length of the canal, from point before mentioned above Brunswick to Tobys point 5 miles & 2 eighths, and to the debouch in the New Meadows six miles 1 eighth. To this last length must be added, as before stated the cut & constructions over the flats at Harpswell neck.

Third route.

This route is by the way of the New Meadows into gracies cove, Kennebec river, or into Butlers cove, Merrymeeting bay. The profile D indicates the cutting that will have to be made, and the greater part through a soft and deep mud.

In gracies cove the canal would have to extend some distance from the shore to insure a low tide communication, and

in Butlers cove over flats bare at low water to a great extent. The most economical plan for this route would be to erect a dam and locks at the bridge over the New Meadows, holding back a high tide, and cut from the pond so created to either of the above coves. The high tides would cover a great extent of the low meadow above the bridge, and render the construction of a tow path expensive and difficult. It would be of but little use for canal boats, and scarce any coasting vessel would choose this passage, in prefference to that of the Kennebec river, and particularly when it is borne in mind, that the New Meadows is shoal in places, and very narrow for about two miles below the bridge, and not to be attempted by an adverse wind within that limit.

It would also be exposed to all the difficulties of an outisde navigation in communicating with Casco bay, and to the dangerous and extensive shoals of the Merrymeeting before a junction could be effected with the Androscoggin.

The surveys of these several routes were made by Lieuts. Findlay, Bennett and Wilson.

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Respectfully submitted,

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Major & T. E.

The following is a list of the drawings which accompany this report:

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Brunswick Canal 2 sheets	exhibiting plan and profile of the three routes surveyed..

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George Town Feb. 29 1828

Sir

I have the honor to transmit a report of the several surveys made in pursuance of your orders, in the States of Maine New Hampshire & Vermont..

Most respectfully

I remain Sir

Your obt. servant,

J. J. Abert,

Major & T. E.

Major General Macomb
Chief Engineer
Comdg. U. S. Eng. Dept.

COBBESECONTEE CANAL.

This object of this canal is to connect the waters of the Kennebeck at Gardner with those of the Androscoggin at Leeds, by means of various ponds and streams lying between the same.

The summit pond of communication is the great Androscoggin. This Pond is very large covering a great extent of land, deep, and discharging itself, by means of a stream called Dead River, into the Androscoggin River, in the Township of Leeds. The stream has very little fall and as low down as the second bridge is without visible current. This point affords an excellent position for a dam and lock: The dam for the purpose of maintaining the Lake at a given height, and the Lock to complete the communication with the River. No work between this and the river is considered as at present necessary, as wherever the river is sufficiently deep to admit of navigation, the waters of dead river are also sufficiently raised by those of the Androscoggin, to admit of a free passage to the dam & lock. Nor could this dam be allowed to raise the water more than 3 feet, without injury to works on the streams which empty into the pond. The river here is 175 feet wide, and the distance between the banks, 12 feet above the level of the water, 319. The river in high freshets frequently backs up

into the Lake, and raises its water from 4 to 6 feet.

The Androscoggin Pond was not surveyed but is protracted from the Map of Maine, as is also the case with all the other ponds or lakes which form a part of the communication.

The passage across this and the other ponds, can be advantageously effected by steam boats, to the use of which they are well adapted, either as freight or tow boats.

Between the Great Androscoggin & Wilsons Ponds there is no natural water communication, but it will have to be effected by an artificial or independent canal. For this purpose two experimental lines were surveyed: one, the shortest route which the examination exposed, through Mr. Bladsdales land; the other, longer, by way of the great bog, commonly called the Bog route, and which I was led to believe would more than compensate for its additional length, by the reduced cutting it would require. But the survey proved this supposition to be erroneous, and that to about twice the length of the shorter communication, the digging throughout the whole extent would be as difficult and deep, as exhibited in the profiles. I feel therefor justified in recommending as the best and most practicable route the one delineated in the plan and profile A-----B.

A is the commencing point, at the level of the water on that day, in great Androscoggin pond, and which was found to

be 32.5 feet above a similar state of the water in Wilsons Pond.

It may be proper to remark that the water in all three ponds was considered at about its lowest state during the period of the survey & that they rarely rise more than four feet.

The distance between A---&---B, the points of connexion of the two ponds, was found to be about one mile 3/8ths + 560 feet.

If a line is drawn from the point A towards B and parallel to the level of the water at A, the following are the peculiarities of the ground.

In a horizontal distance of five hundred and fifty feet from A the surface of the ground rises regularly to a height of 59 feet above the level of the water of Androscoggin pond. Thence in 1/8th of a mile, this elevation increases to nearly seventy feet, and maintains this level 1/8th of a mile further. Thence the slope is gradually decreasing in a distance of 2/8ths of a mile, at which point the surface of the soil is about 54 feet above the level of the pond before-mentioned. The termination of the next two-eighths is at about the same height, but in this latter distance there is an additional rise of fifteen feet upon a base of 700. From the last 8th noticed the

slope decreases gradually in a distance of 2/8ths of a mile + 250 feet, where it intersects the level of the line of reference. From this intersection to its junction with the waters of Wilson's pond being 2/8ths plus 375 feet, the slope of the surface of the soil is gradual, and favorable for the disposition of the locks, which will, in all probability, have to be located within that limit.

The deep cutting which this section will require, is certainly great and will be expensive. In a distance of three-fourths of a mile it cannot average less than sixty feet through a clayey soil, occasionally exposing large boulders of granite, which rock, I am inclined to think, will be found in mass a few feet below the surface. To this depth of the cut must be added that requisite for the canal. As we could not procure boats, I cannot state at what distance it will be necessary to conduct the work in the water to ensure a depth of four feet, but from appearances it would not be great, probably not more than 100 yards in each pond.

Our examinations exhibited no route more favorable than the one pursued.

The line of navigation has now to cross Wilson's pond to its outlet into South Winthrop by means of Wilson's creek.

The fall of this creek as ascertained by Lieut. Jacomb

who conducted the level in this survey, is seventy feet in a horizontal didtance of six thousand, two hundred, which being too great for a system of dam and lock navigation, will make a seperate or independent canal necessary. The soil is clay and the peculiarities of its slope may be ascertained from the profile, its topography from the plan.

It was so near a dead water from this point to South Winthrop, that the bed of the stream might be used to complete the connexion. This and all the other streams of this route have their freshets so regulated by the ponds with which they communicate, that the received objections to the use of their beds as lines of Canals, where the fall is not too rapid, do not apply with their usual force.

The dead water from South Winthrop, on the day of the survey extended about two thousand six hundred feet up the creek at which place a small dam & lock may be necessary, to ensure a passage and sufficient depth of water to the canal.

The line now crosses South Winthrop to Arnolds Stream, which is the natural communication between that and Winthrop pond. This distance from pond to pond is about two & 1/4 miles and the latter is only five feet below the former. That is such was the difference between the surfaces of the water of each pond on the day of the survey. The most economical

method here would be to erect a dam and lock at the junction of the stream with Winthrop pond and clear out the bed of the stream and deepen it where required near South Winthrop.

The connexion now extends over Winthrop pond which has a natural communication with the Kennebec at Gardner, by means of the Cobbesecontee river.

A short distance below the pond, in the course of the Cobbesecontee, at the bridge there is a favourable position for a dam. This dam should be constructed so as to raise the water of the pond about three feet, in order that the small bay between the bridge and the pond, which in dry seasons is not more than one foot deep, might have at least a depth of four.

About thirteen hundred feet below the bridge the water is deep and still, in consequence of a dam at the old saw mill exhibited in the plan. In this distance of thirteen hundred feet the bed of the stream will have to be cleared out and deepened, which in conjunction with elevating the dam at the old saw mill so as to raise the water above the same about four feet will ensure a navigation to the dam at the bridge. At the old saw mill a dam and lock will have to be constructed. From thence the navigation is good, or was at the period when examined by me which was represented as a low stage of the water, for a distance of two thousand nine hundred feet, to the point a. At a there is a fall of eleven feet in seventeen hundred and

fifty, requiring a dam and locks. From thence to Crams mill the water is deep and still, it being the pond of Crams mill dam. The fall from this pond to the deep water a that distance below Crams mill is fifteen feet. It appeared to me, that the best method of connecting the navigation in this distance, was by a short canal, two thousand feet long, passing in the rear of Crams house, where the ground is very favourable, and having the necessary locks at its termination. From thence to the iron works, a distance of about ten miles, there appeared to be but two places at which there were falls or rapids. Each of these would require a dam and lock, the lift in each not to exceed six feet. The channel is in many places foul, with loose rocks, which would have to be removed.

The dam at the iron works is about seven thousand two hundred feet from the terminating point of the survey on Gardners wharf, Kennebec river; and the fall to low tide on the day of the survey, below the water in the iron works pond, was found to be very near one hundred and thirty four feet.

So great a fall in so short a distance is certainly an unfavourable feature, and when it is also considered that the very valuable manufactories, situated in this distance require all the water that this stream can supply in dry seasons, the intention of locks must be abandoned, or the industry and

capitol now kept in activity by this water, will have to be sacrificed to their locks.

Inland navigation by canals is unquestionably a great source of increasing prosperity, and has raised the industry and wealth of other countries as well as parts of our own to a height exceeding all anticipation. But still we should not suffer outselves to be blinded be flattering consequences elsewhere, or consider works of this kind advantages when they would probably not prove such sources, or when to construct them it is necessary to destroy other operations, already in prosperous existence, which have given life to the industry of their localities, and poured their profitable results into the laps of those who have steadily and judiciously pursued them.

Under these impressions, as far as my opinion may deserve notice, I give it unhesitatingly against any continuation of this canal beyond the iron works pond which might occasion any divertion of the waters of the Cobbèsecontee for the use of locks, from their present valuable application, between that pond and the Kennebec.

And even if the water were sufficient for all these purposes, considering the number of locks required, the time necessary to pass them, the short distance which would be gained in that time, the expense of construction and consequent heavy

toll for this distance, and that the canal navigation must terminate at the Kennebec, I should doubt if they would bear any than an unfavourable comparison with other methods of completing the connexion.

Making therefore the iron works pond, the terminating harbour for this end of the Cobbèsecontee canal, I think the junction with the Kennebec should be effected by means of an excellently constructed road, which by bringing into activity, all the means of transport already possessed in the neighbourhood, would from this cause keep the charges at a minimum, and result in an economy of time & money to those who might transport on the canal.

The mass of trade, and generally all articles of bulk and weight will be descending.

On examining the country between Winthrop pond and the Cobbèsecontee, there appeared to be a method of uniting the pond with the Cobbèsecontee below Crams mills, by an independent canal, in which much distance might be saved.

Lieut. Macomb was accordingly directed to make a survey of this route, which will also be found delineated in plan & profile, of the drawings which accompany this report.

The distance by this route, proved to be two miles one hundred yards. That from the pond, by the Cobbèsecontee, and

to the same point of that river is nearly three miles and a quarter.

In the short route the ground in about 1/4 of a mile from the pond rises to 23 feet above its level, and continues at about that elevation for two thousand three hundred and fifty feet farther. At this point there is a depression of ten feet, extending for three hundred & fifty feet, when the rise again commences and attains to a height of thirty eight feet above the pond, in a distance of two thousand one hundred. From thence in a distance one hundred & eighty feet it falls gradually to the level of the pond. Between this and the terminating point below Crams mills the locks will have to be located. A more regular surface than that of the profile may be obtained in this last distance, by passing a few feet to the south of the line plotted, through a hemlock swamp.

The soil is clay throughout this distance, and the appearance of the pond rather indicated shallow water for some extent, over which the canal construction would have to extend to ensure a navigation of four feet. Considering this circumstance, and the deep cutting which this line will require, it may be considered as the more costly route.

The discharges of water from the several ponds, were in August, as follows.

Great Andrscoggin	101.6 cubic feet p.sec.
Wilsons pond	27.00
Wouth Winthrop	49
Cobbesecontee at Crams mill	93.00

The positions for the measurements were unvavorable & The two last streams were considered much above a minimum at the time the measurements were made.

The survey of this canal route was made by Lieuts. Macomb Andrews and Wilson.

Since the termination of this survey, I have received a letter from Mr. Gardner, a very intelligent gentleman of Cardner in Maine, stating that in consequence of the difficulties which he understood had been found to exist in the line from the Androscoggin pond, he spent some time in that neighbourhood with several other gentlemen, examining the country and seeking for a better locality, and that one had been found, entirely avoiding the pond, passing to the north, and joining the river Androscoggin above the Township of Leeds.

This canal route, the Cobbesecontee, forms a part of a great line of inland water communication, contemplated from the Connecticut river at Northerumberland, by the valley of the Ammonusuck to the Androscoggin, thence down this latter river to the point of junction with the Cobbesecontee route, and by means of the last named, with the Kennebec at Cardner. The

two extremes only have been surveyed, namely the connexion between the Connecticut and the Androscoggin, and that between the Androscoggin and the Kennebec. The long line of the Androscoggin is yet untouched, we had not at our command the time necessary to devote to it, nor was it embraced in the orders of the Department.

It will be readily perceived that the national or general importance of these extremes, depend upon the practicability of effecting a navigation in the valley of the Androscoggin. This view early occurred to me, and as the inhabitants of the country were generally of opinion that the river would easily admit of improvement in its bed, by means of dams and locks, having one officer at that time who could be spared from other duties, I directed him to examine the river with this object in view. From his report, as well as from my own observation of many parts of the river, I felt satisfied that this method of improvement was in the present case impracticable, or in other words, without the limit of a reasonable and justifiable expense.

The frequent shoals, rapids and falls of the river, its width, the violent and overwhelming freshets to which it is subject, offered difficulties which might be considered as sufficient to authorize the classing of this river among the many others, which from their physical peculiarities, are entirely

unadapted to this method of improvement..

The only plan then to be considered of uniting by inland navigation the two extremes previously named, is by an independent canal, latteral to the river and in its valley.

To ascertain the practicability of this, no survey has yet been made, nor any examination sufficiently minute to justify the hazarding of an opinion. But as it forms an important link to the surveys which have already been made I would respectfully recommend that the same be ordered. At the time of its execution the new route recommended by Mr. Gardner, from the Androscoggin to the Kennebec, could also be surveyed.

It would, I think, also be desirable to extend the survey in the valley of the Androscoggin, down to Brunswick, as the result might have an important influence upon the canal route already surveyed from that town to Casco bay.

I am under many obligations to Mr. Gardner, a highly informed and public spirited gentleman of Gardner in Maine, for his attentions and the facilities he afforded to the party on this survey, and for his personal aid to myself, in making the reconnaissance.

It is, perhaps, proper that I should remark, that all of these surveys, except the levelling, were done by the compass.

We have no other instrument for detail operations, and the errors to which this is liable, cannot fail to effect the results collected by it.

The errors are so well known and have been so frequently exposed by men of scientific acquirements, that it is unnecessary for me to make any comments upon them. They are inseparable from the use of the instrument, and may be said to form a part of its very theory.

In surveys of Harbours & rivers where a system of triangles, determined by the theodolite, regulates the work, & where the points of these triangles are seldom more than a mile apart, the compass may be used, as its run is so frequently corrected by the triangle points, and any accumulation of error is by that means prevented. But in a long line for a canal or other purpose, and through a country so abounding in iron as ours, the errors from the use of the compass cannot fail to be serious.

The plane table is the only instrument which can be substituted for the compass, and it is well adapted for the collection of the details required from our labours. Its theory is perfect, if I may so express myself. Its results must be without error, or error can be a consequence only of inexcusable carelessness in its use. It has some inconveniences and when the ground is such as to render frequent stations necessary, may

occasion some delay, but these are more than compensated for by its accuracy. And when we consider that the result from the plane table is a map which needs only to be copied, I am inclined to doubt if the loss of time in its use in comparison with the compass, will prove as great as is generally supposed.

Having used a plane table on one occasion, I speak with the advantage of some experience. But even if there were a saving of time in favor of the compass, what can this weigh in the scale against the unequivocally superior accuracy of the Plane Table.

Our labours should, at least, be exempt from those errors resulting from the imperfect nature of the instruments used. Under these impressions, I must request of the Department permission to have two plane tables made and to introduce their use in the operations of my party. The cost of a plane table will not exceed that of a good compass.

It is also proper to state that the measurements of the streams, to ascertain the quantity of water discharged, were made during the period of the survey. And altho these measurements were made at a season when the streams are generally at a minimum, it is yet rather at variance with the practice of more experienced nations to be governed by less than the average result of the observations of many months. With ourselves I should doubt the propriety of constructing a canal, until at least after the average daily observations during the dry

season. If the result is then a sufficient quantity, there can be no cause of fear on this subject.

In the surveys and examination made in New Hampshire, I was aided and accompanied by Colonel P. Carrigan, as commisioner on the part of that state. This gentleman is well known as the compiler of a very excellent map of that state, and as an active promoter of all the subjects connected with its prosperity and improvement. His intelligence and urbanity of manner made the association highly valuable and agreeable, and his zeal induced him after my duties called me elsewhere to remain with the surveying parties in the field in order to assist them by his knowledge of the country, and to facilitate their accomodation by his universal acquaintance with the inhabitants.

He was authorized on the part of the state, to go into the actual location of the routes, and to aid in making the estimates. But as your orders to me were silent on these subjects, and as I knew from the arrangements of your department to divide the labour of these duties, that the business of making the estimates was reserved for another branch, and as also what was particularly ordered required all my time to accomplish, I was obliged to decline his proposition in relation to these objects.

I was also urged on the same subject elsewhere, and for the same reasons had to refuse, which, it appeared to me rather lessened the gratification which our labours generally gave.

But there was no remedy. My orders were the only guide which I could follow, and were the more obligatory when an attention to the subjects of locating the canal routes and estimating their probable cost would have occasioned delays of surveys elsewhere, and where the anxiety of the inhabitants was equally great, to have the surveys made.

For the same reasons also which governed me in declining to locate any of the canals or make the estimates, I have not attempted to delineate upon the maps or profiles the plan of any canal, or to assign places for the locks, leaving this also to the office to which the Department has assigned that duty.

The report of each survey contains the names of the officers by whom it was made, and each sheet of drawings has also upon it, the name of the officer by whom this duty was done. No better evidence than that which these facts expose can, it appears to me, be adduced to prove how ably and industriously my efforts have been seconded by my several assistants. It is due to them, however, that I should add that during several of the surveys herein reported, severe indisposition prevented my personal superintendance of the work, the effect of which on them was to infuse into their exertions a degree of intelligence, care and minuteness of observation, which has left nothing more to be desired, and has also proved how well they merit the

confidence reposed in them by the government, in assigning them to these duties. In the drawings I have also again had the aid of my old and highly valued assistant Lieut. C. E. Wheelber.

It is also proper that I should bring to your notice the services of Mr. C. E. Anderson. This gentleman finely educated and possessing excellent business and moral habits, joined my parties in Vermont, and rendered important aid to our operations there. During several weeks he filled the part and did the duty of an Officer, in the place of one who from continued exposure to the wet, was confined by a rheumatic affection.

His services had been so essential and were so necessary in forwarding our results, that he has been continued in employ since our return from the field, and by his neatness accuracy and industry, has rendered great assistance in completing the drawings. I have only to regret that the discretion vested in me did not admit of an adequate recompense.

It will no doubt be observed that in the course these reports I have made but few remarks upon the nature of the various soils encountered, and the extent to which each kind would influence parts of the several canal lines.

The reason is that these facts are so minutely noted on the profiles, that remarks upon them in the reports appeared unnecessary; and my object was to make these reports as short as

possible, consistent with a clear understanding of the principal features of each route, without too laborious an investigation of the drawings.

Respectfully submitted,

J. J. Abert,

Major & T. E.

The following is a list of the drawings which accompany this report.

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Cobbiseconte Canal
3 sheets

exhibiting plan and profile of the route surveyed.

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George Town Feb. 29 1828

Sir

I have the honor to transmit a report of the several surveys made in pursuance of your orders, in the States of Maine New Hampshire & Vermont..

Most respectfully

I remain Sir

Your obt. servant,

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AMMONUSUCK CANAL.

The object of this canal is to unite the waters of the Connecticut with those of the Androscoggin, by the valleys of the Ammonusuck and the Dead river.

The survey of this route was commenced at the Dead River pond which may be considered as a natural reservoire, and is nearly on the summit of the line.

The first effort was to ascertain at what point the waters of the Androscoggin could be conveniently commanded as they are necessary to feed the canal.

The plan and profile A------B will exhibit the course pursued. At a distance of nineteen hundred feet from the pond before named, and which distance constitutes a part of the canal line, the offset for this purpose was commenced. From this it will be perceived that in a distance of six thousand one hundred feet, the supply of water is to be had, and at a height of forty one & a half feet above the low water line of the pond. At this point B of the plan and profile, a dam can be easily constructed. There is one already there to supply the water to Greens saw mill.

The height may be greater than necessary, but it is the most favourable position for the take water, as the River from B to C, at which point C the experimental line for the canal

forms its junction with the river below the falls is a continued series of falls and violent rapids, which may be readily inferred, from the fact that in this distance from B to C, of seven thousand nine hundred feet, the entire fall of the river was found to be about one hundred & eighty two and a half feet.

The character of the country through which the feeder will have to pass, as well as that of the line of canal from A to C is extremely rugged, the soil clay & granite rocks.

From the examinations which we were enabled to make, I am inclined to doubt if any path for the feeder, better than the one indicated, is to be found. It may however be proper to remark that the face of the country for nearly half of the length of the canal route from the Androscoggin, is in a complete state of wilderness, covered with heavy timber and a thick growth of underwood, rendering any distant view impossible, that it was examined as well as such unfavourable circumstances would admit, and the course then adopted, cut out & cleared.

The distance from Dead river pond to the Androscoggin in the route surveyed, was found to be seven thousand one hundred and sixty feet, and the fall of the latter, at the point C, below the former one hundred & forty one feet.

Throughout the bottom in which Dead river pond lies, the soil is extremely soft, and of so spungy and loose a texture, that no firm footing could be obtained for the level. The slightest motion in moving about it, disaranged it to such a degree that it was deemed more correct to trust for some distance to the level of the water of the pond, which the officer charged with collecting the details of this survey accordingly did.

From the further point of this point the soil is free from great undulations, and thickly wooded. The small rise indicated in the profile between the 4th & 5th mile (from the Androscoggin) may be avoided, by inclining more to the west. At the 4th & 1/2 mile the valley through which the Dead river flows is contracted to about fifty yards. The valley continues generally free from high or rapid undulations to the Ammonusuck pond. The water of this pond, on the day of the survey, was found to be, 13.32 feet above that of the Dead river pond, which would reduce the height at which the water of the Androscoggin can be most conveniently commanded for a feeder, to 28.18 feet, as the Ammonusuck pond is the summit level of this canal line.

On arriving at this pond, the same reason which governed him in the other case, made it necessary for the officer to

trust to the level of the water of the pond in preference to his instrument. The weather was very calm in both cases & the surfaces of the ponds unruffled. The work was however connected by the chain and compass..

This pond is enclosed by high ground & the valley at its outlet contracts to about sixty yards, where the inclosing banks become reduced to from twenty to thirty feet in height.

As the Ammonusuck pond is the highest and constitutes the summit pass of this canal line, the water drawn from the Androscoggin will have to be emptied into it. To do this independently of the Dead river pond would add considerably to the length of the feeder, and consequently to its expense. Two other methods present themselves, either to depress the Ammonusuck to the level of the Dead river pond, or to raise the latter to that of the former by a dam at its outlet, and to join the two by a thorough cut. In this latter method the feeder would extend only to the Dead river pond, and the whole extent of these ponds & the thorough cut would then form a part of the canal and a summit reservoire. It would also involve the least expense and be on that account the most desirable.

The former would require some deep cutting to unite the two ponds, and would also depend upon the depth of the Ammonusuck, whether or not it would admit of such a depression.

From appearances it is shoal and would not.

The utter impracticability of procuring means in a vicinity so destitute of inhabitants, rendered it impossible to make the necessary examinations to ascertain this depth accurately, and not having been previously aware of this circumstance, the party was not furnished to supply the deficiency. Should it be desirable to determine the facts connected with this question more positively, it will be necessary that the party which may be sent there, should have the tools & workmen capable of constructing some kind of a boat; and it also should be supplied with tents or means of constructing shantys to shelter them, as during the previous operations in that quarter, the party had to sleep upon birch boughs and without protection from the weather.

The valley of the Dead river pond is wide at its outlet, requiring an embankment not less than half a mile in length, to raise its waters to those of the Ammonusuck.

Commencing again, at the further end of Ammonusuck pond, which forms the origin of the river of that name, the profile soon indicates a rise of ground, which can be avoided and a gradual slope coinciding with that at the 7th mile be obtained. But the country was so thickly wooded that this was not perceived until passed. So many difficulties were encountered

from this cause, that altho' every possible care within the means of the party, was employed to avoid them, they nevertheless occasioned a great consumption of time, which may be readily admitted, when I assure the Department, upon the report of the Officer charged with this survey, that the number of days occupied in opening a path for the instrument, from the Androscoggin to the more open land of the Ammonusuck, in which the whole strength of the party was engaged, was greater than that required to make the entire survey. More of this kind of work would however have been done had not our axes proved good for nothing, breaking immediately when used, and forcing the officer, after arriving on the ground, to send many miles off and borrow others from the scattered inhabitants.

The hill indicated in the 8th mile can also be avoided by keeping in the valley of the river, but the valley was so impenetrable from the thick undergrowth that the level had to be kept upon higher and more open ground. But between the 8th mile and the base of the hill, there are ridges which jut bold upon the stream and cannot be avoided. They are composed of clay & loose stones and will render a side cutting necessary.

From the termination of this last hill to within 3/8ths of the 13th mile, the bottom lands are swampy, thickly wooded and occasionally overflowed by the river, as indicated by the

high & low water lines of the profiles. The few elevations encountered in this distance have all a gentle slope to the water.

The hill at the 13th mile has also a gentle slope, the bottom land between that and the river, soft but not a deep marsh.

At 4/8 beyond the 13th mile the south branch of the Ammonusuck is passed. This is a fine stream and would make a valuable feeder. It was ascended some distance and is exhibited in plan and profile.

From the 13th to the 18th mile the ground is very favourable, much of it an open meadow. Part at times overflowed as exhibited by the water lines of the profile. The soil is a loam, clay but not very tenacious and occasionally sandy.

By keeping nearer the river between the 18th & 20th miles, the elevations exhibited in this distance may be avoided, and a level similar to that at the 18th and 20th mile be maintained. But the hill slopes so gradually from the 15th to the 18th mile, that the canal may easily be kept at a height to pass over the plain between the 18th and 20th, which I consider the preferable course. In much of this distance the path of the instrument lies in the bed of the stream. The bottom land was so thickly covered with underwood, that the officer could not see ahead or

connect his work with any accuracy but by occupying the more open view which he obtained by wading the river.

The hill between the 20th and 21st mile will occasion a side cutting. The instrument was carried over its summit by which its entire elevation is known. Its slope to the water was at an angle of about thirty degrees, and it appeared to consist of clay gravel and loose stones.

On the opposite side there is also a low hill close in upon the shore, forming a gorge through which the river passes, called Hammatts gorge. It offers a favourable locality to dam for a take water, should it be found necessary.

3/8 beyond the 21st mile a small but fine and constant stream, called mill brook, crosses the line. The profile of this shows how easily it can be commanded for a feeder if required.

From this last point to the 25th mile, the path of the instrument will be found frequently to cross the river, which was rendered necessary from the continued, and impenetrable character of the bottom undergrowth, which forced the officer to take advantage of every opening on either side, notwithstanding the wetting which this course occasioned, as the party had in all cases to wade. The river was also extremely crooked. The bottom land is favourable throughout this extent, and the

side hills of a gradual slope. The rise at the 25th mile may be considered as a second bank of the river. A narrow valley of about fifty feet extends around this rise and next to the river, by which it is occasionally overflowed from 2 to 3 feet. The slope from the second bank to this valley is very rapid.

The ground continues favourable, the side hills generally of a gradual slope, except on the south side of the river at the 26th mile where the mountain is close upon the river and of a steep declivity.

The freshets of the Connecticut are felt as high up the Ammonusuck as roaring brook, which is a small and unsteady stream, and of no value as a feeder.

The hill just beyond the 30th mile may be passed on its side. The slope is however in places as great as thirty degrees. Then a small bottom succeeds and continues to a clay bank at 2/8 before arriving at the 31st mile. This bank consists of a very stiff clay, it closes in upon the river and maintains itself at a slope nearly perpendicular. It will have to be cut through.

Immediately after passing this bank the line enters upon an alluvial bottom of the Connecticut, overflowed at times to a height of eight feet. The bottom on the opposite side of

the Ammonusuck is liable to the same accident. The width overflowed is about three thousand three hundred & fifty feet. The line crosses this bottom to the Connecticut, which by the survey is about 31 and a half miles from the Androscoggin.

The line of reference of the profiles is the level of the waters of Ammonusuck pond, and the waters of the Connecticut on the day the survey was completed & which was represented as their lowest state, were found to be 231.5 feet below the same.

The distance from the north end of Ammonusuck pond to the Connecticut is nearly 24 miles and a half, and from the south end of the same to the Androscoggin, in the course of the survey, about 5 miles and 1/8. The fall in this latter distance 154.32 feet, making a lockage up and down of 385.82 feet, which however may be reduced by depressing the level of Ammonusuck to that of Dead river pond, as previously proposed.

The entire distance between the two rivers may also be somewhat reduced in locating the canal, by lessening the many angles of the survey, which from the condition of the country as before stated, were in fact impossible to avoid, without devoting the whole season to this line alone, which I did not consider myself as justified in doing, as the object was only to ascertain the practicability of uniting these rivers, in

that locality by inland canal navigation, and which from the facts herein exposed and also in the plan and profiles, is unquestionable.

But this reduction of distance cannot be great, as the design, which I endeavour in all cases to fulfill, of making the line of experimental survey to coincide as nearly as possible, with that which the canal should occupy, so that the preliminary estimates which are founded on these surveys may be the more correct, was kept steadily in view, and fulfilled as nearly as the time and the peculiar circumstances of the case would admit. The choice is limited to the valleys of the streams.

The discharge of Dead river pond at its outlet was

16.07 C.Ft.per sec.

Of Ammonusuck pond	00.27	"	"	"
South Branch of Ammonusuck	82.13	"	"	"
North Branch near and above the south	16.56	"	"	"
Mill Brook	10.09	"	"	"
Nashes Creek	8.32	"	"	"

But it should be remarked that all these streams excent the 1st & 2nd, were considered at the periods of measuring the same, as yielding more than a minimum, and that by making a deduction conformably to the best information which could be collected of their least volume of discharge, the results will be as follows::

1st----------16.07
2nd----------00.27
3rd----------50.00
4th----------10.00
5th----------6.00
6th----------5.00

But the Androscoggin furnishes an ample supply, and will render unnecessary any resort to other sources. No convenient place could be obtained for the measurement of its discharge. Reasoning however from its width probable depth and apparent velocity, the minimum quantity which this river will furnish, may be stated at five hundred cubic feet per second.

The very arduus duties of executing this survey were performed by Lieuts. Bennett and Mackay.

As the surveys and plans for the improvement of the Connecticut made by an incorporated company do not extend to a point above the falls at Barnet, that all the facts bearing upon this route may be known, it is proper that the survey should be extended from those falls up to the junction of the Connecticut and Ammonusuck.

It is, perhaps, proper that I should remark, that all of these surveys, except the levelling, were done by the compass.

We have no other instrument for detail operations, and the errors to which this is liable, cannot fail to effect the results collected by it.

The errors are so well known and have been so frequently exposed by men of scientific acquirements, that it is unnecessary for me to make any comments upon them. They are inseparable from the use of the instrument, and may be said to form a part of its very theory.

In surveys of Harbours & rivers where a system of triangles, determined by the theodolite, regulates the work, & where the points of these triangles are seldom more than a mile apart, the compass may be used, as its run is so frequently corrected by the triangle points, and any accumulation of error is by that means prevented. But in a long line for a canal or other purpose, and through a country so abounding in iron as ours, the errors from the use of the compass cannot fail to be serious.

The plane table is the only instrument which can be substituted for the compass, and it is well adapted for the collection of the details required from our labours. Its theory is perfect, if I may so express myself. Its results must be without error, or error can be a consequence only of inexcusable carelessness in its use. It has some inconveniences and when the ground is such as to render frequent stations necessary, may

occasion some delay, but these are more than compensated for by its accuracy. And when we consider that the result from the plane table is a map which needs only to be copied, I am inclined to doubt if the loss of time in its use in comparison with the compass, will prove as great as is generally supposed.

Having used a plane table on one occasion, I speak with the advantage of some experience. But even if there were a saving of time in favor of the compass, what can this weigh in the scale against the unequivocally superior accuracy of the Plane Table.

Our labours should, at least, be exempt from those errors resulting from the imperfect nature of the instruments used. Under these impressions, I must request of the Department permission to have two plane tables made and to introduce their use in the operations of my party. The cost of a plane table will not exceed that of a good compass.

It is also proper to state that the measurements of the streams, to ascertain the quantity of water discharged, were made during the period of the survey. And altho these measurements were made at a season when the streams are generally at a minimum, it is yet rather at variance with the practice of more experienced nations to be governed by less than the average result of the observations of many months. With ourselves I should doubt the propriety of constructing a canal, until at least after the average daily observations during the dry

season. If the result is then a sufficient quantity, there can be no cause of fear on this subject.

In the surveys and examination made in New Hampshire, I was aided and accompanied by Colonel P. Carrigan, as commisioner on the part of that state. This gentleman is well known as the compiler of a very excellent map of that state, and as an active promoter of all the subjects connected with its prosperity and improvement. His intelligence and urbanity of manner made the association highly valuable and agreeable, and his zeal induced him after my duties called me elsewhere to remain with the surveying parties in the field in order to assist them by his knowledge of the country, and to facilitate their accomodation by his universal acquaintance with the inhabitants.

He was authorized on the part of the state, to go into the actual location of the routes, and to aid in making the estimates. But as your orders to me were silent on these subjects, and as I knew from the arrangements of your Department to divide the labour of these duties, that the business of making the estimates was reserved for another branch, and as also what was particularly ordered required all my time to accomplish, I was obliged to decline his proposition in relation to these objects.

I was also urged on the same subject elsewhere, and for the same reasons had to refuse, which, it appeared to me rather lessened the gratification which our labours generally gave.

But there was no remedy. My orders were the only guide which I could follow, and were the more obligatory when an attention to the subjects of locating the canal routes and estimating their probable cost would have occasioned delays of surveys elsewhere, and where the anxiety of the inhabitants was equally great, to have the surveys made.

For the same reasons also which governed me in declining to locate any of the canals or make the estimates, I have not attempted to delineate upon the maps or profiles the plan of any canal, or to assign places for the locks, leaving this also to the office to which the Department has assigned that duty.

The report of each survey contains the names of the officers by whom it was made, and each sheet of drawings has also upon it, the name of the officer by whom this duty was done. No better evidence than that which these facts expose can, it appears to me, be adduced to prove how ably and industriously my efforts have been seconded by my several assistants. It is due to them, however, that I should add that during several of the surveys herein reported, severe indisposition prevented my personal superintendance of the work, the effect of which on them was to infuse into their exertions a degree of intelligence, care and minuteness of observation, which has left nothing more to be desired, and has also proved how well they merit the confidence reposed in them by the government, in assigning

them to these duties. In the drawings I have also again had the aid of my old and highly valued assistant Lieut. G. W. Wheelber.

It is also proper that I should bring to your notice the services of Mr. C. E. Anderson. This gentleman finely educated and possessing excellent business and moral habits, joined my parties in Vermont, and rendered important aid to our operations there. During several weeks he filled the part and did the duty of an Officer, in the place of one who from continued exposure to the wet, was confined by a rheumatic ~~affection~~ infection.

His services had been so essential and were so necessary in forwarding our results, that he has been continued in employ since our return from the field, and by his neatness accuracy and industry, has rendered great assistance in completing the drawings. I have only to regret that the discretion vested in me did not admit of an adequate recompense.

It will no doubt be observed that in the course these reports I have made but few remarks upon the nature of the various soils encountered, and the extent to which each kind would influence parts of the several canal lines.

The reason is that these facts are so minutely noted on the profiles, that remarks upon them in the reports appeared unnecessary; and my object was to make these reports as short as

possible, consistent with a clear understanding of the principal features of each route, without too laborious an investigation of the drawings.

Respectfully submitted,

J. J. Abert,

Major & T. E.

The following is a list of the drawings which accompany this report.

* * * * *

Ammonoosuck Canal 3 sheets	exhibiting plan & profile of the route surveyed.

* * * * *

George Town Feb. 29 1828

Sir

I have the honor to transmit a report of the several surveys made in pursuance of your orders, in the States of Maine New Hampshire & Vermont.

Most respectfully

I remain Sir

Your obt. servant,

J. J. Abert,

Major & T. E.

Major General Macomb
Chief Engineer
Comdg. U. S. Eng. Dept.

OLIVERIAN CANAL.

The object of this Canal route is to join by inland navigation the waters of the Connecticut near Haverhill with those of the Pennegewasset or Merrimack near Plymouth. But as it terminated at a point on the latter river not navigable for some miles below, and as previous examinations had connected this line with Lake Winnipissogee by the Squam ponds the officer was directed to extend his survey to that lake, which would determine the practicability, by the aid of the Winnipissogee Canal and the Piscataqua, of connecting the Connecticut with the seaport of Portsmouth. Having previously examined the ground and determined upon the course to be surveyed, and employed Mr. McDuff, an old and sound surveyor of that county and well acquainted with it to pilot the party, the survey was commenced.

The Connecticut on the day of the survey was about 23 feet below its high water mark.

The rise to the water in the mill dam at Haverhill, rather more than 6/8 of a mile from the Connecticut is 109.32 feet, with the greater part of this fall in a short distance, and near the dam. From thence the rise is regular, but very rapid to a point 3 m. & 5/8 from the Connecticut and 347.85 feet above the same.

The hill at the 4th mile is not to be avoided, and is rocky and very steep. Immediately after passing this hill, bottom land occurs, its first point 378.95 feet above the Connecticut. The bottom land continues to the 9th mile and 7/8, with a more gradual slope, as this latter point is but 531.76 feet above the Connecticut. A rapid rise again occurs, attaining to 606.63 in 1/4 of a mile farther. The summit ridge is 11-1/2 miles from the Connecticut and its height 683.45 feet above the same. By some singular misunderstanding, the officer her departed from the valley of berys brook, and passed over the enormous ridge at the 14th mile, which leaves an hiatus in the line from the summit to where Berys brook is again encountered at a point nearly 15 m. & 3/8 from the Connecticut and 199.45 below the summit (199.45). From thence the ground falls regularly to a point 33-2/8 of a mile from the Connecticut, and continues so to the Pennegewasset 39 & 6/8 of a mile from the Connecticut & 549.45 feet below the summit ridge (549.45 feet).

To effect only a connection with the Pennegewasset, the high ground from beyond the 33 mile to the same is to be avoided. This is also much the better course for the connexion with the Winnipissogee, but it seems to have been misunderstood and the line maintained entirely too high.

The banks of the Pennegewasset are 33.5 feet above the

surface of the water where the line was crossed, and 200 feet from each other. The canal should be crossed here on an aqueduct and the level after crossing maintained until opposite Blairs mills, the mill pond of which is 46 feet above the banks before named. These were the directions to the officer charged with this survey but appear to have been misunderstood, as he previously gained the second bank of the Pennegewasset and then kept that level up to the mills. On conversing with him on this subject he states that the instructions were not delivered to him until long after he had passed the points which these would have influenced, but that he would still have carried them into effect if his funds had not been exhausted and the season nearly at its close.

Much of this survey will therefore have to be made over, and at the same time it will be proper to have a survey from the crossing place of the Pennegewasset above Plymouth in the valley of that river to Concord, up to which point the navigation of the Merrimack has been improved.. From Blairs mill to little Squam pond the stream can be advantageously used. This pond was 12.86 above the mill pond when the survey was made and about 2 miles and 1/8 from the same. Then using the little Squam.. The distance between this and big Squam is 1011 feet and the latter 00.95 of a foot above the same. They connect

by a small winding stream; but the better plan to effect the junction is by a through cut, which exclusive of its depth as a canal would involve in no place a deeper digging than 9-1/2 feet. The big Squam will then have to be used. It approaches within 1-1/4 miles of long pond and is 50.87 feet above the latter. The profile shows the cutting necessary to effect the junction with Long pond. This last is 7.45 feet above the Winnipissogee and 1/2 mile distant from the same. A short canal of about 3/8 of a mile will be requisite here, involving no deep cutting, as the intervening ground, does not rise at any point more than 5-1/2 feet above Long pond, and then a lock to communicate with the Winnipissogee. No advantage would here be derived from a thorough cut as the lock would in that case have to be placed in the communication between Big Squam and Long pond.

All these ponds were represented as being at their lowest state, when the survey was made.

The important question with this as well as every other canal route is the supply of water at the summit level.

All the resources for this object which we could ascertain consist in the discharge from Bakers river, from the Tarlton ponds, and the supply which may be derived from the latter as reservoires.

The surveys to these were merely to determine their position in relation to the summit and do not indicate the traces of the feeders.

The discharge from Bakers river was, 52.89 cubic feet per second.

The discharge from the Tarlton ponds was 13.22 cubic feet per second.

The two largest of these now communicate with each other and the smallest could be made to do so but by a cut tho not exceeding 1/4 of a mile in length yet so deep as may be seen from the profile X, that considering the smallness of this pond and that it does not discharge any water in dry seasons, it may not be thought worth the expense.

These ponds are not more than 3-1/2 miles in a direct line from the summit but the ground between is high and mountainous, and thickly wooded, and the least distance which our examinations exposed for the length of the feeder would be about 9-1/2 miles. By this route the water would be taken from the northern end of the ponds, crossed over to the valley of the Oliverian in the trace of the survey and there conducted on the side of the mountain bordering that valley up to the summit.

In the future surveys recommended for this route, a line should be examined from the southern end of the great pond, to

ascertain if the water from the same might be conducted to the summit in a less distance by winding around the mountain in that direction.

The area of the two large ponds is 698500 square yards.

The discharge of the Oliverian 9 miles & 78 from the Connecticut and 16.7 feet below the summit was 10.52 cubic feet per second. There does not appear to have been any other measurement of this stream elsewhere.

The discharges of the other streams measured on this route were as follows::

Berry's brook (2 miles from the summit),	10.22 C.F.per sec.
Middle branch (at its junction with Bakers river,)	16.02 " " " "
Pemigawasset above Plymouth,	367.20 " " " "
Squam stream (at Blair's mills),	28.14 " " " "

From the incomplete state of this survey it will be seen that no plan of the canal can yet be proposed. This must be the result of future labour.

The survey was made by Lieuts. Macomb and Andrews.

It is, perhaps, proper that I should remark, that all of these surveys, except the levelling, were done by the compass.

We have no other instrument for detail operations, and the errors to which this is liable, cannot fail to effect the results collected by it.

The errors are so well known and have been so frequently exposed by men of scientific acquirements, that it is unnecessary for me to make any comments upon them. They are inseparable from the use of the instrument, and may be said to form a part of its very theory.

In surveys of Harbours & rivers where a system of triangles, determined by the theodolite, regulates the work, & where the points of these triangles are seldom more than a mile apart, the compass may be used, as its run is so frequently corrected by the triangle points, and any accumulation of error is by that means prevented. But in a long line for a canal or other purpose, and through a country so abounding in iron as ours, the errors from the use of the compass cannot fail to be serious.

The plane table is the only instrument which can be substituted for the compass, and it is well adapted for the collection of the details required from our labours. Its theory is perfect, if I may so express myself. Its results must be without error, or error can be a consequence only of inexcusable carelessness in its use. It has some inconveniences and when the ground is such as to render frequent stations necessary, may

occasion some delay, but these are more than compensated for by its accuracy. And when we consider that the result from the plane table is a map which needs only to be copied, I am inclined to doubt if the loss of time in its use in comparison with the compass, will prove as great as is generally supposed.

Having used a plane table on one occasion, I speak with the advantage of some experience. But even if there were a saving of time in favor of the compass, what can this weigh in the scale against the unequivocally superior accuracy of the Plane Table.

Our labours should, at least, be exempt from those errors resulting from the imperfect nature of the instruments used. Under these impressions, I must request of the Department permission to have two plane tables made and to introduce their use in the operations of my party. The cost of a plane table will not exceed that of a good compass.

It is also proper to state that the measurements of the streams, to ascertain the quantity of water discharged, were made during the period of the survey. And altho these measurements were made at a season when the streams are generally at a minimum, it is yet rather at variance with the practice of more experienced nations to be governed by less than the average result of the observations of many months. With ourselves I should doubt the propriety of constructing a canal, until at least after the average daily observations during the dry

season. If the result is then a sufficient quantity, there can be no cause of fear on this subject.

In the surveys and examination made in New Hampshire, I was aided and accompanied by Colonel P. Currigan, as commisioner on the part of that state. This gentleman is well known as the compiler of a very excellent map of that state, and as an active promoter of all the subjects connected with its prosperity and improvement. His intelligence and urbanity of manner made the association highly valuable and agreeable, and his zeal induced him after my duties called me elsewhere to remain with the surveying parties in the field in order to assist them by his knowledge of the country, and to facilitate their accomodation by his universal acquaintance with the inhabitants.

He was authorized on the part of the state, to go into the actual location of the routes, and to aid in making the estimates. But as your orders to me were silent on these subjects, and as I knew from the arrangements of your Department to divide the labour of these duties, that the business of making the estimates was reserved for another branch, and as also what was particularly ordered required all my time to accomplish, I was obliged to decline his proposition in relation to these objects.

I was also urged on the same subject elsewhere, and for the same reasons had to refuse, which, it appeared to me rather lessened the gratification which our labours generally gave.

But there was no remedy. My orders were the only guide which I could follow, and were the more obligatory when an attention to the subjects of locating the canal routes and estimating their probable cost would have occasioned delays of surveys elsewhere, and where the anxiety of the inhabitants was equally great, to have the surveys made.

For the same reasons also which governed me in declining to locate any of the canals or make the estimates, I have not attempted to delineate upon the maps or profiles the plan of any canal, or to assign places for the locks, leaving this also to the office to which the Department has assigned that duty.

The report of each survey contains the names of the officers by whom it was made, and each sheet of drawings has also upon it, the name of the officer by whom this duty was done. No better evidence than that which these facts expose can, it appears to me, be adduced to prove how ably and industriously my efforts have been seconded by my several assistants. It is due to them, however, that I should add that during several of the surveys herein reported, severe indisposition prevented my personal superintendance of the work, the effect of which on them was to infuse into their exertions a degree of intelligence, care and minuteness of observation, which has left nothing more to be desired, and has also proved how well they merit the confidence reposed in them by the government, in assigning

them to these duties. In the drawings I have also again had the aid of my old and highly valued assistant Lieut. C. W. Wheelber.

It is also proper that I should bring to your notice the services of Mr. C. M. Anderson. This gentleman finely educated and possessing excellent business and moral habits, joined my parties in Vermont, and rendered important aid to our operations there. During several weeks he filled the part and did the duty of an Officer, in the place of one who from continued exposure to the wet, was confined by a rheumatic affection.

His services had been so essential and were so necessary in forwarding our results, that he has been continued in employ since our return from the field, and by his neatness accuracy and industry, has rendered great assistance in completing the drawings. I have only to regret that the discretion vested in me did not admit of an adequate recompense.

It will no doubt be observed that in the course these reports I have made but few remarks upon the nature of the various soils encountered, and the extent to which each kind would influence parts of the several canal lines.

The reason is that these facts are so minutely noted on the profiles, that remarks upon them in the reports appeared unnecessary; and my object was to make these reports as short as

possible, consistent with a clear understanding of the principal features of each route, without too laborious an investigation of the drawings.

Respectfully submitted,

J. J. Abert,

Major & T. M.

The following is a list of the drawings which accompany this report.

* * * * *

Oliverian Canal 7 sheets	exhibiting plan & profile of the route surveyed

* * * * *

George Town Feb. 29 1828

Sir

I have the honor to transmit a report of the several surveys made in pursuance of your orders, in the States of Maine New Hampshire & Vermont.

Most respectfully

I remain Sir

Your obt. servant,

J. J. Abert,

Major & T. E.

Major General Macomb
Chief Engineer
Comdg. U. S. Eng. Dept.

SUNAPEE CANAL.

The object of this canal is to connect the Connecticut by the valley of Sugar river and the Sunapee Lake, and the valleys of the Blackwater and the Contoocook with the Merrymack near Concord.

The summit level is the Sunapee Lake, which is so immense a reservoire that no doubt about the supply of water can be entertained. Its outlet is the Sugar river, by which it empties into the Connecticut below Clairmont.

The distance from the Connecticut by the valley of Sugar river, to the bridge at Clairmont is nearly five miles and a quarter, and the rise from the surface of the Connecticut to the surface of the water above the dam at Clairmont bridge was, on the day of the survey, 229.54 feet. The water line of the profiles shows how irregularly this difference of level is disposed of. The water at the bridge was three feet below high water mark, and that of the Connecticut twenty five and a half. The location of this section will require the exercise of some judgement on the part of the Engineer, that proper advantage may be taken of the table land on the north side of the river. And this section should originate in my opinion from the pond above the bridge, in order that this pond could be used advantageously as a harbour for the trade of Clairmont and its vicinity. The

dam at the bridge should be reconstructed and made tight.

The ground from thence up is favourable. The hills between the 8th & 9th mile (from the Connecticut) with the side slopes noted in the profile are not to be avoided. From thence to 10 miles and 7 eighths there is a small piece of interval land coinciding with the profile and varying from 50 to 150 feet in width. For the next 2/8 the hill is close in upon the river, but from thence to the 13th mile, the interval or bottom is about the same never less than 40 and occasionally 150 feet wide. But the hill next adjacent and indicated in the profile with its side slope, is not to be avoided without crossing the river. The bottom land again occurs and similar in character, with an occasional spur from the hill for a short distance, and continues to the 15th mile and a half, where another spur is encountered of the heighth and length indicated. The bottom land now increases in width, its least being about 100 feet. The small spur at the 17th mile and a quarter is about 50 feet high. This character of an occasional small spur and then bottom land continues to about 1/8 beyond the 19th mile. The breadth of these spurs and their side slopes are noted on the profiles.

On the plan of using the pond at Clairmont for a harbour, it would be advisable to use the stream as far as its depth &

back water from the dam at that place will admit. This point does not appear to have been determined in the survey. From thence to the point near the 19th mile previously mentioned, the bottom immediately adjacent to the river on its southern side is generally wider and less broken by spurs than that on the northern. The hill between the 19th and 20th mile might be avoided by keeping on the opposite side of the river. The bottom after passing this hill is again about 100 feet wide. From thence a bottom varying from 40 to 100 feet in width, with the exceptions of the spurs of the hills noted on the profile with their side slopes, occurrs to 3/8 beyond the 25th mile, from Whence the ground rises very rapidly to the Lake, 25 miles and 7/8 from the Connecticut, according to the path of the survey, and 786.09 feet above the same; near the Lake this rise is 81 feet in half a mile.

A review of the line will show that the greatest difficulties from Clairmont to the Sunnapee, will be found in the last seven miles, and these consist only in the necessity of locating the locks together in several places.

The valley of the river cannot at any place be abandoned, nor is it desirable except in the last rapid rise near the Lake. The ground should here be carefully examined before the canal is located, to see if this pass, narrow rocky and of a great

fall in a short distance, could not be avoided. I am inclined to think it can be advantageously, and the valley of the river soon recovered again, in which throughout the most favourable ground is to be obtained.

The Sunnapee Lake will not only have to be the summit resevoire but also the summit pass of the canal. The trade must cross it, and the least distance on the opposite side, from Sugar river, at which the water can be most advantageously drawn from the Lake for descending towards the merrymack, is 3 miles and a quarter.

It may readily be supposed that so deep a Lake & of so extensive an area, suffers but little variation in its level, which was represented to me as not exceeding three feet. It was also stated to be at its lowest state when the survey was made, but to be sure on so interesting a subject as that of having the canal allways navigable, I would not recommend a line less than five feet below the surface, to be assumed for the bottom of the canal.

Drawing a line on this supposition, it will not cut the profile of the surface of the ground towards the merrimack in less than three miles and 5/8 from the Lake, and at a point 32 miles and 6/8 from the Connecticut, near to Harveys mill dam. Involving a deep cutting throughout, which will not be

found to average less than twenty six feet. The soil is so minutely noted in the profile, that remarks upon the same appear unnecessary.

From Harveys mill the fall in the ground is rapid, descending to 447.55 feet below the surface of the Lake in five miles. The low grounds immediately adjacent to this last point are liable to be overflowed from 4 to 6 feet, this is also the case at other points below, which are indicated by the high water line. The general slope of the ground now becomes more gradual. The survey is made to cross the Blackwater at 3/8 beyond the 62 mile from the Connecticut, a much better crossing place will be found at 3/8 beyond the 59th mile. The fall to this latter distance from the point previously noticed near Harveys mill is 266.91, and distant from the same 21 miles 5 eighths. From thence to the merrimack a distance of 12 miles and 2 eighths, the fall to the water of the same on the day of the survey was found to be 144.58.

These three points are noted in the report as they form three distinct divisions of the line between the lake and the merrimack, essentially varying in the character of their slope.

In the first five miles from the point to where the water of the lake may be conducted on a level by the deep cutting stated, the average fall is 89.51 feet per mile. In the next

21 miles & 5 eighths the average fall per mile is 12.22 feet, and in the next 12 miles and two eighths, the average fall per mile is 11.80 feet. The fall is tollerably regular in these three divisions - its varieties are well exhibited in the profiles. The topography is also well expressed in the plans and ~~as~~ the nature of the soil, side slopes and their angles are minutely stated in the profiles, ~~any remarks on these subjects appear unnecessary~~.

The entire distance by the survey from the Connect to the merrimack is 71 miles and 5/8. Of this 3-1/4 miles is contained in the crossing of Cunnanee Lake leaving 25 miles and 7/8 of canal line from the Lake to the Connecticut with a difference in level of 786.09 feet, and a length of canal line of 42 miles and 5 eighths from the Lake to the merrimack, with a difference in level of 859.04 feet, making a total line of canal of 68 miles & 3 eights and a total rise and fall of 1645.13 feet.

The profile of a section across the head of Sugar river shows the elements of a dam there, in order to maintain the Lake at a level not less than that existing when the survey was made.

The discharge of Sugar River near the Lake was 60.79 cubic feet per second, and at Newport after receiving the south branch

the discharge was 182.05 cubic feet per second.

In the direction towards the Merrimac, the discharge from Pleasant pond was 20.04 cubic feet per second.

The discharge of the Blackwater near Thompson's was 52.25 cubic feet per second.

Of Long bridge brook----------10.18 C.F.per sec.
Of the Boscoriver ----------49.27 do. do.

This survey was made by Lieutenants Wheelwright & Wilson. Col. Carrigan who had previously ridden over this route with me, joined the surveying party at the Lake, and point out the ground thence to the Merrimack.

It is, perhaps, proper that I should remark, that all of these surveys, except the levelling, were done by the compass.

We have no other instrument for detail operations, and the errors to which this is liable, cannot fail to effect the results collected by it.

The errors are so well known and have been so frequently exposed by men of scientific acquirements, that it is unnecessary for me to make any comments upon them. They are inseparable from the use of the instrument, and may be said to form a part of its very theory.

In surveys of Harbours & rivers where a system of triangles, determined by the theodolite, regulates the work, & where the points of these triangles are seldom more than a mile anart, the compass may be used, as its run is so frequently corrected by the triangle points, and any accumulation of error is by that means prevented. But in a long line for a canal or other purpose, and through a country so abounding in iron as ours, the errors from the use of the compass cannot fail to be serious.

The plane table is the only instrument which can be substituted for the compass, and it is well adapted for the collection of the details required from our labours. Its theory is perfect, if I may so express myself. Its results must be without error, or error can be a consequence only of inexcusable carelessness in its use. It has some inconveniences and when the ground is such as to render frequent stations necessary, may

occasion some delay, but these are more than compensated for by its accuracy. And when we consider that the result from the plane table is a map which needs only to be copied, I am inclined to doubt if the loss of time in its use in comparison with the compass, will prove as great as is generally supposed.

Having used a plane table on one occasion, I speak with the advantage of some experience. But even if there were a saving of time in favor of the compass, what can this weigh in the scale against the unequivocally superior accuracy of the Plane Table.

Our labours should, at least, be exempt from those errors resulting from the imperfect nature of the instruments used. Under these impressions, I must request of the Department permission to have two plane tables made and to introduce their use in the operations of my party. The cost of a plane table will not exceed that of a good compass.

It is also proper to state that the measurements of the streams, to ascertain the quantity of water discharged, were made during the period of the survey. And altho these measurements were made at a season when the streams are generally at a minimum, it is yet rather at variance with the practice of more experienced nations to be governed by less than the average result of the observations of many months. With ourselves I should doubt the propriety of constructing a canal, until at least after the average daily observations during the dry

season. If the result is then a sufficient quantity, there can be no cause of fear on this subject.

In the surveys and examination made in New Hampshire, I was aided and accompanied by Colonel P. Carrigan, as commisioner on the part of that state. This gentleman is well known as the compiler of a very excellent map of that state, and as an active promoter of all the subjects connected with its prosperity and improvement. His intelligence and urbanity of manner made the association highly valuable and agreeable, and his zeal induced him after my duties called me elsewhere to remain with the surveying parties in the field in order to assist them by his knowledge of the country, and to facilitate their accomodation by his universal acquaintance with the inhabitants.

He was authorized on the part of the state, to go into the actual location of the routes, and to aid in making the estimates. But as your orders to me were silent on these subjects, and as I knew from the arrangements of your Department to divide the labour of these duties, that the business of making the estimates was reserved for another branch, and as also what was particularly ordered required all my time to accomplish, I was obliged to decline his proposition in relation to these objects.

I was also urged on the same subject elsewhere, and for the same reasons had to refuse, which, it appeared to me rather lessened the gratification which our labours generally gave.

But there was no remedy. My orders were the only guide which I could follow, and were the more obligatory when an attention to the subjects of locating the canal routes and estimating their probable cost would have occasioned delays of surveys elsewhere, and where the anxiety of the inhabitants was equally great, to have the surveys made.

For the same reasons also which governed me in declining to locate any of the canals or make the estimates, I have not attempted to delineate upon the maps or profiles the plan of any canal, or to assign places for the locks, leaving this also to the office to which the Department has assigned that duty.

The report of each survey contains the names of the officers by whom it was made, and each sheet of drawings has also upon it, the name of the officer by whom this duty was done. No better evidence than that which these facts expose can, it appears to me, be adduced to prove how ably and industriously my efforts have been seconded by my several assistants. It is due to them, however, that I should add that during several of the surveys herein reported, severe indisposition prevented my personal superintendance of the work, the effect of which on them was to infuse into their exertions a degree of intelligence, care and minuteness of observation, which has left nothing more to be desired, and has also proved how well they merit the

confidence reposed in them by the government, in assigning them to these duties. In the drawings I have also again had the aid of my old and highly valued assistant Lieut. G. W. Wheelber.

It is also proper that I should bring to your notice the services of Mr. C. E. Anderson. This gentleman finely educated and possessing excellent business and moral habits, joined my parties in Vermont, and rendered important aid to our operations there. During several weeks he filled the part and did the duty of an Officer, in the place of one who from continued exposure to the wet, was confined by a rheumatic affection.

His services had been so essential and were so necessary in forwarding our results, that he has been continued in employ since our return from the field, and by his neatness accuracy and industry, has rendered great assistance in completing the drawings. I have only to regret that the discretion vested in me did not admit of an adequate recompense.

It will no doubt be observed that in the course these reports I have made but few remarks upon the nature of the various soils encountered, and the extent to which each kind would influence parts of the several canal lines.

The reason is that these facts are so minutely noted on the profiles, that remarks upon them in the reports appeared unnecessary; and my object was to make these reports as short as

possible, consistent with a clear understanding of the principal features of each route, without too laborious an investigation of the drawings.

Respectfully submitted,

J. J. Abert,

Major & T. E.

The following is a list of the drawings which accompany this report.

* * * * *

Sunapee Canal 8 sheets	exhibiting plan & profile of the route surveyed.

* * * * *

George Town Feb. 29 1828

Sir

I have the honor to transmit a report of the several surveys made in pursuance of your orders, in the States of Maine New Hampshire & Vermont.

Most respectfully

I remain Sir

Your obt. servant,

J. J. Abert,

Major & T. E.

Major General Macomb
Chief Engineer
Comdg. U. S. Eng: Dept..

WINNIPISSOGEE CANAL.

The object of this canal is to unite the Winnipissogee Lake, with the navigable waters of the Cocheco at Dover and from thence, by the Piscataqua to effect a connexion with the harbour of Portsmouth.

It also forms a part of a great line of communication between Lake Champlain and Portsmouth, by means of the Cliverian and Montpelier Canal routes.

Commencing at the station on the Cocheco at Dover, it will be seen by the profile of the survey, that in two miles from the first station, the ground rises regularly to a height of 184.45 feet. The soil in this extent is clay. From thence to the 9th mile from the starting point, ground more favourable for a canal, can hardly offer itself, the soil being of easy excavation, of the kinds noticed on the profiles, and the rise very gradual. At the 9th mile this rise is 206.63 feet above the zero or starting point, being a rise in a distance of seven miles of 21.18 feet. Near to the line, between the 4 & 5th mile, there is a ledge of remarkably fine granite stone.

Two streams are crossed soon after passing the 9th mile, over which aqueducts will have to be constructed, of the dimensions exhibited in the profiles.

After crossing these streams, as the ground admitted of two routes, one passing on the East side and the other on the West side of the Cocheco, both were surveyed and are exhibited in plan and profile.

By the examination of these it will be seen that no serious difficulties present themselves in either route. The Eastern is however in my opinion to be preferred, as it avoids the double crossing of the Cocheco, requiring an aqueduct at each. The soil of either route is easy of excavation, but more favourable in the Eastern, as this latter entirely avoids the parts noted as rocky in the Western, and the eastern has also fewer inequalities of surface. But by the survey it is also about three quarters of a mile longer than the western route. A judicious location however, would I think reduce them to an equality in this respect.

These two join at a point 18-1/2 miles from the commencement, and which is at an elevation of 308.34 feet above the zero at Dover.

Waldrons brook, which occurs soon after passing the 19th mile, will have to be passed by an aqueduct. Its ravine is about 200 feet wide and 15 deep. At the time of the survey, the stream did not occupy more than 35 feet of the ravine and never fills it entirely.

The eminence at the 19th mile can be avoided, by including the line to the left of the trace and a profile similar to the dotted line be obtained. At 5/8 beyond the 19th mile, which is at an elevation of 351 feet above the zero at Dover, an activity commences which in two miles attains to a height of 521.42 feet above that zero, making in these two miles a rise of 171.42 feet. The angles of the side slope of this rise are noted on the profile. The soil is clay and granite rock. The latter does not appear in strata, but lies in loose and small masses on the surface.

The ground still rises after attaining this eminence, to the table land between the 24th and 25th mile, which is the highest land between the Cocheco at Dover and Willeys river, and is about 546 feet above the starting point or zero.

The highest land between Willeys river, in the route surveyed, and the Winnipissogee, is at the 28th mile, which is 564 feet above the zero.

Alton bay is 29-3/4 miles from the Cocheco at Dover, and the water of the bay, on the day of the survey, was found to be 508.86 feet, above the assumed zero at Dover. It may be well to remark that this zero was on the Cap of Smiths wharf. That the high tide mark of the Cocheco was 2.30 feet lower, and the low tide mark 8.35 feet, which would leave this last

to be added to any point of the profile, in order to obtain the difference between that point and a low tide of the Cocheco on the day of the survey. This addition would make a difference between a low tide and the Lake Winnipissoggee, 517.21 feet.

When examining this ground, I was informed that the favourite plan for the canal, and one which had been recommended to the company, was to consider the Winnipissogee Lake as the summit, and to draw the supply of water from the same, by depressing the level of the canal and cutting through the extensive summit range of land.

This Lake is an immense reservoire thirty miles long, several wide in places and very deep, and the plan of using it to feed the canal is without doubt a practicable one. But it appeared to me also as one involving great expenses, and which expenses might be avoided by obtaining the supply of water from a different source, and by taking advantage of other facilities which nature had offered in the route. The officer charged with this survey was therefore directed, after he had completed the work upon the plan already approved, to return to Willeys river, and to collect the facts which might support the views which suggested themselves to me on examining the ground, and which were communicated to him in detail to guide

his operations. By this the facts necessary to determine a choice of either plan were collected, and are now submitted to your better judgment.

Altho the condition of the water of the Lake was represented as low at the time of the survey, I should not think it adviseable, on the plan of drawing the water from the Lake, to assume less than five feet below the surface of the lake at that time, for the bottom of the canal. Drawing a line on this supposition parallel to that surface, it does not cut the surface of the soil, until at a distance of eight miles and three eighths from the Lake.

For the first mile of this distance the cutting would not be great, and would be at the base of a side hill, in order to avoid the very soft and deep marsh between that and the river. But after that distance a less cutting than the one exhibited by the profile, is not to be obtained, averaging about 33 feet deep. At one place the ground rises to 61 feet above the line, at another 46.5. The line also on this supposition passes 21 feet below the surface of Willeys river, which would make it necessary to conduct this river over the canal by an aqueduct. It also passes thirty one feet below Rain brook. From which it is evident that the plan of drawing the water from the Lake would make this section very expensive, and that no inconsiderable

object would be gained, if this plan could be avoided, which it proposed to do in the following manner.

The water of Willeys river is backed up by Barkers mill dam to about the point at which this river is crossed in the drawings. The river from thence to that dam, being sufficiently deep, and its depth uniform, the river narrow and its banks low, a tow path can be conveniently constructed and the river used as a canal down to Barkers mill. The fall from the mill pond to the navigable waters of the river below is nearly eleven feet, and the ground favourable, requiring no cutting much deeper than may be necessary for the depth of the canal. And from thence the river should be again used to the lake.

There is a bridge across the junction of Willeys river with the lake, and the water of the river at the bridge was four feet deep when the survey was made. It was then however a somewhat swollen by late rains.

I would recommend that a dam should be constructed at this bridge, to raise the water of the river not exceeding two feet above its state when the survey was made, which would always ensure navigation up to lock near Barkers mills.

Willeys river joins the Lake at the head of a narrow bay, called Alton bay, liable to be choaked with sands, and generally shoal in dry seasons. On these accounts, the communicating lock

should not be placed at the dam, but a short canal from the same to be made, about 600 feet long, to where it would let into the Lake in 20 feet water, and the communicating lock be by that means, exempt from impediment to its use by any sand or gravel from the bottom.

The Lake is very uniform in its level, being but little influenced by rains which seldom occasion a variation of more than three feet.

The shores of Willeys river from the proposed lock near Barkers mills to the Lake, are marshy as before stated and would render the construction of the tow path costly. Abundance of excellent soil is however near at hand, but timber is also so abundant and so cheap in that country, that I am disposed to recommend the construction of a narrow bridge tow path, over this short and marshy distance.

The piles to sustain it could be drove extremely cheap, by taking advantage of the winter when the river & surface of the marsh is frozen.

For the same reasons which governed me in assuming five feet below the Lake, for the bottom line of the canal on the first plan, I have also draw a line parallel to the same and five feet below the surface of Willeys river. And from that river to a point where this line would cut the surface of the

ground, in the direction towards the Cocheco is three miles and three eighths. On this supposition the mile of deep cutting previously spoken of and immediately adjacent to the river, would be reduced to 28 feet, and after this mile to the termination of the three miles and three eighths before mentioned the cutting would not average more than ten feet. Cow rain brook would on this plan be 15 feet above the bottom of the canal.

But if desirable even the deep cutting of the mile before mentioned could be avoided, by considering this part as the summit level, and by leading the water there and locking down into Willeys river. Altho however by this method, the deep cutting of this section would be avoided, yet as it involves the construction of a feeder, and the double lockage of this height, I do not consider it as having any advantages, and when it would also loose the facilities of the summit reservoire formed by Willeys river and the cut from thence to the termination of the three miles and three eighths, it may rather be viewed as objectionable.

As the waters of the Winnipissogee to supply the canal are abandoned on the latter plan, it is now necessary to shew from what other source this necessary supply is to be obtained.

The examination of the country plainly pointed out the Merrymeeting pond from which Willeys river derives its origine, and the officer who made the survey was directed to determine the height of the pond. It was found to be 125.5 feet above the proposed bottom of the canal upon the second plan. It is also a very large pond, long narrow and deep, and embracing an area of not less than 3,400,000 square yards. The outlet is narrow & with high and steep banks, so that a dam to raise its waters ten feet above their level when the survey was made, would not exceed 230 feet in length. Its discharge is not less than 50 cubic feet of water per second, by estimation. The measurement appears not to have been made.

But if the construction of the dam were so planned as to admit of the water being drawn off six feet below the surface when the survey was made, it would yield independent of its running discharge a supply of 6,800,000 cubic yards of water for dry seasons. These last do not continue in that country more than two months on the most unfavourable supposition, and this supply would leave, on a supposition a day of ten working hours, 84 cubic feet of water per second. Adding to this the running discharge of 50 cubic feet, the total supply for the canal and one mill which lies below the crossing place of Willeys river (Barkers mill) would be 134 cubic feet per second.

But if we take into consideration that the dam in raising the pond ten feet, would leave on the most extravagant allowance for losses by filtration and evaporation, an additional supply of 42 cubic feet, we shall have 176 cubic feet of water per second during the dryest seasons.

Should however any doubt remain on this subject, as the total elevation of the pond above the bottom of the proposed canal is 125 feet and its distance from the line about three miles, it will be seen that the dam may be so constructed, that with a moderate excavation, the water may be drawn off six feet below the lowest level proposed, yielding by this arrangement an addition of 84 cubic feet, and making a total supply of water, equal to 260 cubic feet per second. There need be no fear, that the rains of the fall & spring will not fill the pond again, and to make sure, on so interesting a point as the supply of water I would recommend that the dam be constructed in the first instance, so as to admit of the drawing off of the greatest quantity proposed..

But little labour or expense will be necessary for the feeder, as the natural bed of the stream can be used.

To prevent conflicts and controversies about the use of the water, as there are mills above as well as below the summit, it might be the better course for the company to purchase all the

water rights, and if this could be done at a fair price, the investment would be profitable, and could not be considered as enhancing the cost of this section.

At about the point where the bottom line of the canal, upon the supposition of drawing the supply of water from merrymeeting pond, intersects the profile of the surface of the soil, the rapid fall previously spoken of as commencing 5/8 beyond the 19th mile from the zero at Dover is encountered. This point is 526.35 feet above the low tide of the Cocheco.

Upon the supposition of drawing the water from the lake, this point would be reduced 16 feet, and the distance from thence to Dover lessened 1/4 of a mile.

This terminates the exposition of the principal facts which should influence a choice between the two plans the one for taking the water from the lake, and the other for taking the water from merrymeeting pond, and which facts, do in my opinion, justify me in recommending that plan which takes the water for the canal from the pond.

Within two miles from the point of intersection of the line drawn 5 feet below Willeys river, and the profile, the locks to overcome the great fall in that distance will have to be located. And altho a profile similar to the dotted line may be obtained, in the half mile, next succeeding to these two

miles, yet the canal should be kept up in order to pass Waldrons brook advantageously. This should be done by an aqueduct and the brook on no account let into the canal, nor any other stream in the continuation of the route.

These streams are all tributaries to the Cocheco, which supplies the water power to the valuable cotton factories at Dover. The great amount of capital invested in these establishments, the high spirit of enterprize which they exhibit, and the great skill for which they are famed, place them as objects worthy of national exultation, and I may even add, of national protection. At least so far as to prevent any divertion of the smallest quantity of water now so valuable employed, from its present use. On these accounts no reasoning from convenience or economy to the construction of the canal, should admit into it, a particle of the water of the Cocheco or its tributaries - moreover these waters are not necessary to the canal as the supply from the merrymeeting pond, is unquestionably sufficient.

After passing this stream the plan and profiles of the survey exhibit so plain a piece of work down to the 2nd mile from the zero at Dover, and the peculiarities of the soil, are exhibited so much in detail on the same, that additional remarks to those of the first view of the line, are considered

unnecessary.

The 2nd mile from Dover is at the head of the rapid rise previously spoken of, from which point to the tide of the Cocheco, locks to overcome a fall of 193.80 feet will have to be located, to communicate with a low tide.

The level of the canal above these locks should be pursued for some distance, to form a reservoire for their supply, and the ground is very favourably situated for that object. A waste weir should be placed at head of this fall, to discharge the surplus water, on the western side, so that it might fall into the Cocheco above the factories at Dover, and instead of being lost, be by that arrangement most valuably employed.

The communicating lock at the Cocheco, will of course have to be sufficiently depressed below the low water mark, to admit of a free passage at all times of tide.

The survey of this canal route was made by Lieuts. Findlay and Worth.

It is, perhaps, proper that I should remark, that all of these surveys, except the levelling, were done by the compass.

We have no other instrument for detail operations, and the errors to which this is liable, cannot fail to effect the results collected by it.

The errors are so well known and have been so frequently exposed by men of scientific acquirements, that it is unnecessary for me to make any comments upon them. They are inseparable from the use of the instrument, and may be said to form a part of its very theory.

In surveys of Harbours & rivers where a system of triangles, determined by the theodolite, regulates the work, & where the points of these triangles are seldom more than a mile apart, the compass may be used, as its run is so frequently corrected by the triangle points, and any accumulation of error is by that means prevented. But in a long line for a canal or other purpose, and through a country so abounding in iron as ours, the errors from the use of the compass cannot fail to be serious.

The plane table is the only instrument which can be substituted for the compass, and it is well adapted for the collection of the details required from our labours. Its theory is perfect, if I may so express myself. Its results must be without error, or error can be a consequence only of inexcusable carelessness in its use. It has some inconveniences and when the ground is such as to render frequent stations necessary, may

occasion some delay, but these are more than compensated for by its accuracy. And when we consider that the result from the plane table is a map which needs only to be copied, I am inclined to doubt if the loss of them in its use in comparison with the compass, will prove as great as is generally supposed.

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season. If the result is then a sufficient quantity, there can be no cause of fear on this subject.

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I was also urged on the same subject elsewhere, and for the same reasons had to refuse, which, it appeared to me rather lessened the gratification which our labours generally gave.

But there was no remedy. My orders were the only guide which I could follow, and were the more obligatory when an attention to the subjects of locating the canal routes and estimating their probable cost would have occasioned delays of surveys elsewhere, and where the anxiety of the inhabitants was equally great, to have the surveys made.

For the same reasons also which governed me in declining to locate any of the canals or make the estimates, I have not attempted to delineate upon the maps or profiles the plan of any canal, or to assign places for the locks, leaving this also to the office to which the Department has assigned that duty.

The report of each survey contains the names of the officers by whom it was made, and each sheet of drawings has also upon it, the name of the officer by whom this duty was done. No better evidence than that which these facts expose can, it appears to me, be adduced to prove how ably and industriously my efforts have been seconded by my several assistants. It is due to them, however, that I should add that during several of the surveys herein reported, severe indisposition prevented my personal superintendence of the work, the effect of which on them was to infuse into their exertions a degree of intelligence, care and minuteness of observation, which has left nothing more to be desired, and has also proved how well they merit the

confidence reposed in them by the government, in assigning them to these duties. In the drawings I have also again had the aid of my old and highly valued assistant Lieut. C. W. Wheelber.

It is also proper that I should bring to your notice the services of Mr. C. E. Anderson. This gentleman finely educated and possessing excellent business and moral habits, joined my parties in Vermont, and rendered important aid to our operations there. During several weeks he filled the part and did the duty of an Officer, in the place of one who from continued exposure to the wet, was confined by a rheumatic affection.

His services had been so essential and were so necessary in forwarding our results, that he has been continued in employ since our return from the field, and by his neatness accuracy and industry, has rendered great assistance in completing the drawings. I have only to regret that the discretion vested in me did not admit of an adequate recompense.

It will no doubt be observed that in the course these reports I have made but few remarks upon the nature of the various soils encountered, and the extent to which each kind would influence parts of the several canal lines.

The reason is that these facts are so minutely noted on the profiles, that remarks upon them in the reports appeared unnecessary; and my object was to make these reports as short as

possible, consistent with a clear understanding of the principal features of each route, without too laborious an investigation of the drawings.

Respectfully submitted,

J. J. Abert,

Major & T. E.

The following is a list of the drawings which accompany this report.

* * * * *

Winnipissogee Canal 6 sheets	exhibiting plans & profile of the route surveyed.

* * * * *

George Town Feb. 29 1828

Sir

I have the honor to transmit a report of the several surveys made in pursuance of your orders, in the States of Maine New Hampshire & Vermont.

Most respectfully

I remain Sir

Your obt. servant,

J. J. Abert,

Major & T. E.

Major General Macomb
Chief Engineer
Comdg. U. S. Eng. Dept.

PASUMPSICK CANAL.

The object of this canal is to unite the waters of the Connecticut with those of Memphramagog Lake, by the valleys of Pasumpsick and Barton rivers.

The surface of a small piece of Savannah ground nearly on the summit, commonly called Savannah pond, as it is generally wet, is 803 feet above the Connecticut, and distant 33-1/4 miles from the same.

The fall from Savannah pond, to where Barton river can be used to the Lake is 572.69 feet, and the distance to the same point is 13-3/4 miles, constituting a total rise and fall of 1375.69 feet, and a total distance of forty seven miles.

In an examination of the adjacent country, we could not find any water conveniently situated and sufficient for the summit section, and if the supply could not be derived from Willoughby Lake, the canal in this direction was impracticable. The Officer was therefore directed to determine, in the course of his survey, the relative level between the summit and the Lake, which he did, but unfortunately the Lake proved to be 58.88 feet below the Savannah pond.

This canal is, in consequence, impracticable without an extensive deep cutting at the summit. The deepest cutting would for a short distance be 67.46 feet (as the ground rises north of Savannah pond) exclusive of the canal depth, which

it may be thought necessary to give to this section.

Willoughby Lake lies in so very deep a valley, that its water is difficult to command. It discharges itself from its northern extremity by Willoughby river into Barton river, and its southern end is a low sandy beach, where the inclosing ground is of a less height, than at any other place, except at the natural outlet of the Lake.

How the water might be conducted to the summit from this outlet has yet to be ascertained, but in taking it from its southern end, any better ground than that of the plan and profile, to an extent of one mile and a quarter from the Lake, is not to be obtained there. After this distance, the feeder, which would have to be several miles long, may be wound around the hill to the summit.

The rise in this distance of one mile and a quarter, is such as to make a tunnel necessary, or an extensive deep cutting. Its greatest elevation is 118.33 feet above the surface of the Lake.

From these circumstances, it will be seen that the summit section of this canal will probably involve a great expense. On which account, I think, that any determination on the same should be suspended, until after it shall be know how the water from the lake may be led from the natural outlet.

There are also other routes, which may offer greater

facilities, but which have not yet been surveyed. Your orders were to survey all the routes by which the communication between the Connecticut and Lake Memphramagog could be affected, but the time and means at my disposal admitted only of the survey now reported.

Additional surveys in relation to this communication, being therefore ordered and requisite, any further remarks upon the subject, until after the facts involved in all the various routes are collected, appear to me unnecessary.

The survey in question was made by Lieuts. Findlay and Worth.

It is, perhaps, proper that I should remark, that all of these surveys, except the levelling, were done by the compass.

We have no other instrument for detail operations, and the errors to which this is liable, cannot fail to effect the results collected by it.

The errors are so well known and have been so frequently exposed by men of scientific acquirements, that it is unnecessary for me to make any comments upon them. They are inseparable from the use of the instrument, and may be said to form a part of its very theory.

In surveys of Harbours & rivers where a system of triangles, determined by the theodolite, regulates the work, & where the points of these triangles are seldom more than a mile apart, the compass may be used, as its run is so frequently corrected by the triangle points, and any accumulation of error is by that means prevented. But in a long line for a canal or other purpose, and through a country so abounding in iron as ours, the errors from the use of the compass cannot fail to be serious.

The plane table is the only instrument which can be substituted for the compass, and it is well adapted for the collection of the details required from our labours. Its theory is perfect, if I may so express myself. Its results must be without error, or error can be a consequence only of inexcusable carelessness in its use. It has some inconveniences and when the ground is such as to render frequent stations necessary, may

occasion some delay, but these are more than compensated for by its accuracy. And when we consider that the result from the plane table is a map which needs only to be copied, I am inclined to doubt if the loss of time in its use in comparison with the compass, will prove as great as is generally supposed.

Having used a plane table on one occasion, I speak with the advantage of some experience. But even if there were a saving of time in favor of the compass, what can this weigh in the scale against the unequivocally superior accuracy of the Plane Table.

Our labours should, at least, be exempt from those errors resulting from the imperfect nature of the instruments used. Under these impressions, I must request of the Department permission to have two plane tables made and to introduce their use in the operations of my party. The cost of a plane table will not exceed that of a good compass.

It is also proper to state that the measurements of the streams, to ascertain the quantity of water discharged, were made during the period of the survey. And altho these measurements were made at a season when the streams are generally at a minimum, it is yet rather at variance with the practice of more experienced nations to be governed by less than the average result of the observations of many months. With ourselves I should doubt the propriety of constructing a canal, until at least after the average daily observations during the dry

season. If the result is then a sufficient quantity, there can be no cause of fear on this subject.

In the surveys and examination made in New Hampshire, I was aided and accompanied by Colonel P. Carrigan, as commissioner on the part of that state. This gentleman is well known as the compiler of a very excellent map of that state, and as an active promoter of all the subjects connected with its propperity and improvement. His intelligence and urbanity of manner made the association highly valuable and agreeable, and his zeal induced him after my duties called me elsewhere to remain with the surveying parties in the field in order to assist them by his knowledge of the country, and to facilitate their accomodation by his universal acquaintance with the inhabitants.

He was authorized on the part of the state, to go into the actual location of the routes, and to aid in making the estimates. But as your orders to me were silent on these subjects, and as I knew from the arrangements of your Department to divide the labour of these duties, that the business of making the estimates was reserved for another branch, and as also what was particularly ordered required all my time to accomplish, I was obliged to decline his proposition in relation to these objects.

I was also urged on the same subject elsewhere, and for the same reasons had to refuse, which, it appeared to me rather lessened the gratification which our labours generally gave.

But there was no remedy. My orders were the only guide which I could follow, and were the more obligatory when an attention to the subjects of locating the canal routes and estimating their probable cost would have occasioned delays of surveys elsewhere, and where the anxiety of the inhabitants was equally great, to have the surveys made.

For the same reasons also which governed me in declining to locate any of the canals or make the estimates, I have not attempted to delineate upon the maps or profiles the plan of any canal, or to assign places for the locks, leaving this also to the office to which the Department has assigned that duty.

The report of each survey contains the names of the officers by whom it was made, and each sheet of drawings has also upon it, the name of the officer by whom this duty was done. No better evidence than that which these facts expose can, it appears to me, be adduced to prove how ably and industriously my efforts have been seconded by my several assistants. It is due to them, however, that I should add that during several of the surveys herein reported, severe indisposition prevented my personal superintendance of the work, the effect of which on them was to infuse into their exertions a degree of intelligence, care and minuteness of observation, which has left nothing more to be desired, and has also proved how well they merit the confidence reposed in them by the government, in assigning

them to these duties, In the drawings I have also again had the aid of my old and highly valued assistant Lieut. C. V. Wheelber.

It is also proper that I should bring to your notice the services of Mr. C. E. Anderson. This gentleman finely educated and possessing excellent business and moral habits, joined my parties in Vermont, and rendered important aid to our operations there. During several weeks he filled the part and did the duty of an Officer, in the place of one who from continued exposure to the wet, was confined by a rheumatic affection.

His services had been so essential and were so necessary in forwarding our results, that he has been continued in employ since our return from the field, and by his neatness accuracy and industry, has rendered great assistance in completing the drawings. I have only to regret that the discretion vested in me did not admit of an adequate recompense.

It will no doubt be observed that in the course these reports I have made but few remarks upon the nature of the various soils encountered, and the extent to which each kind would influence parts of the several canal lines.

The reason is that these facts are so minutely noted on the profiles, that remarks upon them in the reports appeared unnecessary; and my object was to make these reports as short as

possible, consistent with a clear understanding of the principal features of each route, without too laborious an investigation of the drawings.

Respectfully submitted,

J. J. Abert,

Major & T. E.

The following is a list of the drawings which accompany this report.

* * * * *

Pasumpsick Canal 7 sheets	exhibiting plan & profile of the route surveyed.

* * * * *

George Town Feb. 29 1828

Sir

I have the honor to transmit a report of the several surveys made in pursuance of your orders, in the States of Maine New Hampshire & Vermont.

Most respectfully

I remain Sir

Your obt. servant,

J. J. Abert,

Major & T. E.

Major General Macomb
Chief Engineer
Comdg. U. S. Eng. Dept.

MONTPELIER CANAL.

The object of this canal is to connect the waters of Lake Champlain with those of the Connecticut, by the valleys of Onion and White rivers, passing in its course by Montpelier the Capitol of Vermont.

The lowest place at which the high lands between these waters, in this direction can be passed is at the hogs back, and through Cutters pond. Assuming the center of this pond as a zero for the distances and levels, and pursuing a course towards Lake Champlain, it will be seen that the variation of level is not great in a distance of 2 miles and six eights, at which the stream from Cutters pond descends 58.94 feet. There is then a rapid descent of 76.12 feet in about one quarter of a mile, the slope of the ground then continues even and gradual to the 6th mile, which is 185.90 feet below the zero. The water from the mill dam of Days Factory is backed up to this point. This Factory is 6/8 of a mile farther and the high ground in that distance, varying from 15 to 23 feet above the surface at the 6th mile is not to be avoided. The water of this dam on the day of the survey was 196.11 below the summit. The entire fall of the stream here was 67.50 feet in 1/4 of a mile. It breaks through a ledge of rocks, of slate and lime stone in alternate strata. They rise some feet above the upper pond and nearly perpendicular from

its surface, so that a dam of 75 feet would raise an additional head of from 10 to 12 feet of water, if required. The fall is divided by two dams. The upper one feeds a grist and saw mill, the lower a wollen factory. The stream below these mills is about 50 feet wide, running through banks nearly 150 feet high and with a slope of twenty degres. At the 7th mile & 4/8 another fall is encountered of 34.5 feet in a distance of 850. It here also passes over a bed of argillite and granular lime stone, with a superincumbent strata of gravel and sand, 30 feet high, through which the stream has cut its way. This channel appears to be of recent formation, as a bend of the stream at right angles still carries a part of the water off in its old bed. A short distance below this fall jail branch comes in, about the size of Stepens's branch, and carrying in its appearance evidence of being at times and overwelming torrent. This branch enters Stephens's at a point 7 m. & 6/8 from the center of Cutters pond, and 302.14 feet below the same. The soil now assumes a more gradual slope, but the line still continues in the valley of Stevens brance to a point 300 feet more than 12-5/8 miles from the summit, where it first enters the valley of Onion river. The surface of the soil is here 371.75 below the summit and the water of Onion river on the day of the survey was 11.39 lower. The general slope towards the lake continues as gradual as heretofore, the trace of the line being on the side slope of the valley of the river.

A short distance above the Berlin pond outlet, there was a projecting ridge of clay, furnishing bricks of a good quality. A brick yard is established there.

Montpelier is 14 miles and 7/8 from the summit, and the water of the river above the dam at that place 392.79 below the same. The high water nearly attains the surface of the soil at the dam.The freshets are from 4 to 5 feet. The argillite which prevails throughout this line to this point, here assumes a more valuable character and can be wrought into slate for roofing.

The water from this dam supplies a saw mill grist mill wollen factory and paper mill. 1 mile & 3/8 below Montpelier, a small stream called Dog river crosses the line. Its ravine is 75 feet wide, and its water was 14.14 below the line.

The slope continues gradual to the middlesex falls, 21 miles from the summit, and 410.44 below the same. The water at the head of the falls was 14.76 lower.

Much of the bottom land is liable to be overflowed, as indicated by the high water line, and as the freshets are very violent, the canal should be located farther from the river than the line of the survey. This would avoid their effect, and have a favourable soil.

The chasm of these falls is an argillite with veins of

quartz and the bank so steep that no foot hold could be maintained along them, and the instrument had to be conducted over the ridge. In locating the canal from Montpelier, it should be maintained sufficiently high to command the greater part of this ridge, and reduce the cutting only to the peake at 3/8 beyond the 21 mile, and this from appearances could easily be done, as the part of the ridge to be commanded is only 21 feet above, the immediately preceeding bottom land which is so much overflowed occasionally, and would only require the level of the ground immediately after crossing dog river to be maintained.

A saw, grist and fulling mill are supplied with water from these falls.

Throughout these falls, the river is confined to a narrow bed of from 15 to 20 feet. The strata of the rock inclined nearly perpendicular to the horizon and about the same in their direction to the current.

The banks were so steep, that an offsett could not be made to the immediate foot of the falls. These however extended through 6/8 of a mile, with a fall in that distance of 57.50 feet.

A short distance below the 22nd mile Mad river crossed the line, in its course to Onion river. This stream has its origin in the green Mountain range and is subject to sudden and violent

freshets. Apparently the best crossing place was that chosen in the survey, where a small Island would aid in furnishing a position for a pier of the Aqueduct. It is the longest which will be required in the route, and must be constructed with great care to withstand the efforts of the river. The bed of the river is an argillite, its banks clay, the small Island an alluvial Deposit. The river was crossed in the survey obliquely to its course, if crossed more directly it would much lessen the length of the Aqueduct, but it would then encounter a steep, high & rocky shore. Before the exact position and dimensions of this aqueduct can be determined, this part of the line should be more minutely surveyed, sections taken in various directions and the whole represented on a large scale.

Antil the general character of a survey admits of the practicability of an object, within a reasonable limit of expense, those preliminary operations which involve much delay are usually omitted.

After passing mad river, the slope continues uniformly descending to where a spur of the Green Fountain range is first encountered at Bolton falls, 2/8ths beyond the 30th mile. The river here breaks through this range. Its banks a mass of Argillite nearly perpendicular but with a less angle on the opposite side. The line was over the ridge a short distance from

the river, at its lowest accessable point. An excavation for a road exhibited a clay soil about 20 feet below the summit of the ridge. The line passed through this excavation. How much lower the clay prevailed was not ascertained. The descent below the summit, just before ascending the ridge, was 503.81 feet - the point where the ridge was passed was 70.99 feet higher. The entire fall of the river at this place was 45.55 feet in 3/8 of a mile.

After passing these falls the gradual slope heretofore noticed continues.

Spurs from the Adjacent hills occasionally cross the line, as indicated in the profiles, with the side slopes therein noted, which is the character of the ground to a point 3/8 beyond the 50th mile and 631.14 below the summit, where there is a dam across the river, and a saw mill at each end of it. The river has now a more rapid descent to the head of Hubbles falls 1/8 from the 53 mile. The surface of the soil at these falls was 657.73 feet below the summit, and the water at their head 8.32 feet lower, and the total fall from the dam above 26.08 feet.

These falls pass over an argillite rock with a superincumbent strata of gravel and sand. The fall is divided as shown in the water lines of the profile, and the total descent in about 5/8 of a mile is 41.97 feet. After this better ground

than that of the profile is not to be obtained, nor the sandy ridge 1/8 beyond the 54th mile to be avoided.

The favourable bottom which has hitherto prevailed, is interrupted 1/8 beyond the 55th mile. The interruption is from two ridges of lime stone. The descent previous to passing these ridges is 702.16 feet. The level passed over their summits, by which their height may be known and it is protracted in the profile. The angle of their side slopes is also noted at various points. The opposite shore is similar.

This stone is of excellent quality for making lime and is used for that purpose. It appears to rest upon compact sand stone.

The falls below at 3/8 beyond the 59th mile also pass through lime stone rock. The water of these falls is profitably employed in supplying various mills.

It now became necessary to cross the river, that the canal might debouch as nearto Burlington as possible, and in good water, and also to avoid the long and circuitous course of the valley of the river before it connected itself with the Lake. By crossing from the head of the falls the profile of the line from o to n was obtained. But by continuing the line until below thes falls before the crossing is effected the separate profile o.n. passing over better ground and of less

distance, is the one which would have to be followed, giving also a shorter aqueduct. The sand hill encountered 6/8 beyond the 61 mile, is not to be avoided. It winds along the river to near its junction with the Lake, where it terminates in a rocky point.

It may be most economical to pass this obstacle with a Tunnel.

The Lake immediately occurrs after passing this elevated sandy plain, and is 59 miles 7/8 + 200 feet from the center of Cutters pond at the summit, and the surface of the water of Lake Champlain, was on the day of the survey 818.58 feet below that of the pond.

Returning back to the summit to proceed with a similar exposition of the line from thence to the Connecticut.

On the ridge immediately adjacent to Cutters pond, there is a small stream, which originates about 1/4 of a mile eastward of the line, and which discharges itself in both directions. This ridge is therefore, properly speaking the summit of the route. It was crossed at a point, 10.80 feet above Cutters pond. The ground is more irregular than the opposite direction from the summit and the fall in 1 m. & 6/8 is 116.88 feet. It continues then of a gradual slope to 1/8 beyond the 2d mile, at which point there is another rapid descent of

41.70 feet in rather less than 1/8th. The last mile of this length is called the Gulph. The passage is very narrow, bounded by high and steep hills, and affording in many places, but room sufficient for the road & stream.

From this point the slope is again gradual to Fowle's dam, nearly 9 miles and 1/8 from the summit. The surface of the soil at this dam is 238.15 below the level of Cutters pond and the water of the dam, 14.71 feet lower.

The dam is 6 feet high, but may be easily raised ten feet more. The fall is then rapid to 4/8 beyond the 12 mile between these two last points there are five mill dams. At the first there is a saw mill, a grist mill and a distillery belonging to Mr. Fowle. At the second a mill for cleaning clover seed. At the third a carding machine and at the fourth, which is at the village of Randolph, there is a grist mill, a saw mill, a fulling mill, an oil mill and a trip-hammer shop for own work. At the fifth, which is below the village there is a saw mill. The fall to the water of this last dam is 327.28 feet. A more gradual slope again follows and continues to Bethel village, 17 miles and 6/8 from the summit.

The ridge of high land near the 14th mile may be avoided, but only by a circuit of great length. The bottom land of the profile at the 15th mile is about 40 feet wide, bounded on one

side by the stream and on the other by a ledge of argillite rocks.

The water above the dam at Bethel village is 374.71 feet below Cutters pond, and supplies the power to a grist mill saw mill and carding machine.

At marshalls dam, 5/8 beyond the 19th mile there is also a saw and grist mill.

The survey which had been conducted in the valley of the second branch, crosses the same, near the 22 mile and from thence continued down the valley of White river.

The gradual slope in the general aspect of the soil, previously noticed continued to 4/8 beyond the 29th mile, at which point the surface was 457.39 feet below Cutters pond.

The rise of ground immediately following at the 30th mile, is not to be avoided. Its height & its side slope, will be found on the profiles.

The dam at the termination of this ridge supplies water to two saw mills two grist mills, a fulling mill and a carding mill.

Another rise of ground or ridge, through which the river passes, crosses the line, a short distance below this dam, as exhibited in the profile. Its character is similar to the preceeding ridge.

After passing these two ridges the ground has a regular and gradual slope to the Connecticut river, which is 43 miles 3/8 + 380 feet from the center of Cutters pond and 579.34 feet below the surface of that pond..

Valuable mills are situated near all the several dams shown in the profile between the ridges last noticed and the Connecticut. At the 1st there is a saw and grist mill. At the second a saw mill, grist mill, wollen factory and clover mill, and at the third, a saw mill, grist mill, oil mill and carding mill.

The total length of this line is 103 m. 2/8 & 580 feet, and the total rise and fall 1397.92 feet..

Altho the passing of the summit land in this this route is at a place much below the surrounding country, yet the necessary supply of water is doubtful.

The water from Clarks, Colts, Pierce's, and Roods ponds can be conducted to the summit, and with some embankments, the water of lime pond may be sufficiently raised to be conducted there also.

These ponds are all too small to be depended upon as reservoires, and no advantage can be taken, for purposes of that kind, of the valleys through which they discharge as these latter have, all of them, a very rapid descent.

The measurements of the discharge from these ponds, were made near the maine line, which is some distance from the ponds, and at a time when they were all supposed to be reduced to their mimimum by the droughth of the summer.

Clarks pond empties into Colts pond, and the discharge of the latter was 9.20 cubic feet per second. But this water could not be conducted to the summit at Cutters pond by a feeder, less in length than 7 miles.

The discharge from Pierce's pond was, 155 cubic feet per second, and the length of the feeder necessary to conduct this to the summit is four miles.

The bed of Rood pond was dry near the line.

Cutters pond discharged 123 cubic feet per second, and lime pond 0.62.

From these facts, unless additional resources for water shall hereafter be ascertained, I deem myself justified in stating it as my opinion that a canal to pass by the summit of Cutters pond is impracticable. The surrounding country was dilligently searched, and the supplies of water reported were all that could be found.

The discharges, of the streams through the valleys of which the line passes from the summit, were at 1 mile and 3/8 from the summit in the direction towards the Connecticut 1.78 cubic feet

per second, and in two miles and 6/8 from the summit in the direction towards Lake Champlain 10 cubic. But this latter includes the discharge from Cutters pond, as the stream measured has its origine in that pond.

Making therefore a deduction of the discharge previously stated from Cutters pond, these last two discharges so reduced, are all the additional supplies which can be brought to feed the canal, on the supposition of a depression of the summit to the level where the last measurement of water stated was made and which is 58.94 feet below Cutters pond.

But as from the profile, it will be seen how many locks would have to be located together at each end of this depressed level, it is doubtful if even this additional supply would be sufficient for the canal.

Stevens Branch does not much increase in size until after it receives the Jail Branch, eight miles from the summit, nor does the second branch of White river through the valley of which the line passes towards the Connecticut until after some distance from the summit.

At a point, 5 miles and a half from the summit, and after the discharge from Clarks ponds was received, this 2nd branch previously alluded to, yielded no more than 9.42 cubic feet per

second.

On the supposition of a Tunnel, which could not be longer than to avoid the rapid descent immediately adjacent to the profile all the running water which could be brought to feed the tunnel would be, the

Discharge from Clarks ponds	=	9.20
The discharge from Pierces pond	=	1.55
Second Branch	=	1.78
Stevens Branch	=	10.00

with no great diminution in the length of the feeders previously stated, from the two first sources of supply just enumerated.

This would leave a total supply for the Tunnel summit, not however exclusive of loss in the feeders, of 22.73 cubic feet of water per second, and with a length of tunnel not less than four miles. If therefore this supply of water, under all its circumstances should be considered sufficient, the canal might be made with the aid of a Tunnel.

But in my opinion the adequacy of the supply of water is too doubtful, for the construction of so expensive a canal as this would be, on any of the suppositions of passing the summit by Cutters pond, by a depressed level and deep cutting, or by the aid of a Tunnel.

The instructions given to the officers who made this survey were minutely attended to and intelligently executed, and their field books are filled with valuable notes.

The survey was made by Lieuts.Bennett and Mackay, aided by

Mr. C. E. Anderson.

This canal route forms so important a feature, in the improvement by inland navigation in the eastern States, that I felt no small degre of regret, on ascertaining that the results of our labour were so unfavourable to its practicability.

By the aid of this, the Oliverian and the Winnipissogee, an inland navigation would be opened between Lake Champlain and the Atlantic at Portsmouth New Hampshire. It would not therefore be advisable to abandon so important a line without further investigation. Additional supplies of water may yet be ascertained, or the summit may be passed by a railroad.

On this last supposition the railroad could occupy the Tunnel, or pass the rapid elevations of the summit by the aid of stationary engines.

It is, perhaps, proper that I should remark, that all of these surveys, except the levelling, were done by the compass.

We have no other instrument for detail operations, and the errors to which this is liable, cannot fail to effect the results collected by it.

The errors are so well known and have been so frequently exposed by men of scientific acquirements, that it is unnecessary for me to make any comments upon them. They are inseparable from the use of the instrument, and may be said to form a part of its very theory.

In surveys of Harbours & rivers where a system of triangles, determined by the theodolite, regulates the work, & where the points of these triangles are seldom more than a mile apart, the compass may be used, as its run is so frequently corrected by the triangle points, and any accumulation of error is by that means prevented. But in a long line for a canal or other purpose, and through a country so abounding in iron as ours, the errors from the use of the compass cannot fail to be serious.

The plane table is the only instrument which can be substituted for the compass, and it is well adapted for the collection of the details required from our labours. Its theory is perfect, if I may so express myself. Its results must be without error, or error can be a consequence only of inexcusable carelessness in its use. It has some inconveniences and when the ground is such as to render frequent stations necessary, may

occasion some delay, but these are more than compensated for by its accuracy. And when we consider that the result from the plane table is a map which needs only to be copied, I am inclined to doubt if the loss of time in its use in comparison with the compass, will prove as great as is generally supposed.

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But there was no remedy. My orders were the only guide which I could follow, and were the more obligatory when an attention to the subjects of locating the canal routes and estimating their probable cost would have occasioned delays of surveys elsewhere, and where the anxiety of the inhabitants was equally great, to have the surveys made.

For the same reasons also which governed me in declining to locate any of the canals or make the estimates, I have not attempted to delineate upon the maps or profiles the plan of any canal, or to assign places for the locks, leaving this also to the office to which the Department has assigned that duty.

The report of each survey contains the names of the officers by whom it was made, and each sheet of drawings has also upon it, the name of the officer by whom this duty was done. No better evidence than that which these facts expose can, it appears to me, be adduced to prove how ably and industriously my efforts have been seconded by my several assistants. It is due to them, however, that I should add that during several of the surveys herein reported, severe indisposition prevented my personal superintendance of the work, the effect of which on them was to infuse into their exertions a degree of intelligence, care and minuteness of observation, which has left nothing more to be desired, and has also proved how well they merit the confidence reposed in them by the government, in assigning

them to these duties. In the drawings I have also again had the aid of my old and highly valued assistant Lieut. G. W. Wheelber.

It is also proper that I should bring to your notice the services of Mr. C. E. Anderson. This gentleman finely educated and possessing excellent business and moral habits, joined my parties in Vermont, and rendered important aid to our operations there. During several weeks he filled the post and did the duty of an officer, in the place of one who from continued exposure to the wet, was confined by a rheumatic affection.

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possible, consistent with a clear understanding of the principal features of each route, without too laborious an investigation of the drawings.

Respectfully submitted,

J. J. Abert,

Major A. T. C.

The following is a list of the drawings which accompany this report.

* * * * *

Montpelier Canal 14 sheets	exhibiting plan & profile of the route surveyed.

* * * * *

George Town Feb. 29 1828

Sir

I have the honor to transmit a report of the several surveys made in pursuance of your orders, in the States of Maine New Hampshire & Vermont.

Most respectfully

I remain Sir

Your obt. servant,

J. J. Abert,

Major T. E.

Major General Macomb
Chief Engineer
Comdg. U. S. Eng. Dept..

RUTLAND CANAL.

The object of this canal is to connect by a water communication, the town of Rutland Vt. with the northern canal at White Hall and to open an easy access to a good market for the products of the State brought to Rutland and those raised in the fine valley of the upper part of Otter Creek.

As this creek passes some distance from Rutland, and it was necessary to obtain a nearer position to form a basin for the trade of that place, the position marked B, in the plan was adopted for the basin. This is already a natural inclosure on all sides but one, embracing an area of about ten thousand square yards, and requiring an embankment on one side only, not exceeding four hundred feet in length. By taking the earth for the formation of this embankment from the basin, and thereby lowering its present bottom, it would much reduce the expense of this construction. There is a small knoll in the center of the basin which could not be better disposed of. By this means the waters of East Creek, could be commanded for the purpose of feeding the basin within about half a mile. At this distance the bottom of that Creek was found to be about five feet above the bottom of the basin and the banks of the creek to which its waters might be conveniently raised by a dam, are four feet feet

higher. The width of the creek at the surface of the water, is forty five feet, and at the top of its banks about twenty feet more. The course of the feeder from the creek to the basion, would require neither deep cutting or embankment, and passes through a soil easy of excavation.

From the basin, at a, to otter creek, the distance exceeds half a mile by about fifty yards, and the waters of Otter Creek, on the day of the survey, which I was informed was their lowest state, were eleven feet below the basin. The soil is an alluvial meadow land, sloping gradually. There is a small elevation near the Creek indicated in the profile.

As Otter Creek will have to be used as a feeder, the canal should here be let into the creek, and also for the additional purpose of conveniently commanding its trade. The creek is navigable for many miles above, passing through a well cultivated country. A more particular description of it is however necessarily postoned, until the same shall be surveyed, which will probably be during the ensuing season.

The width of the creek at the crossing point in the survey, was found to be one hundred and ten feet, and a good position for a dam offers itself at a short distance below. This dam should not be constructed to raise the water, above the

condition in which it was found when surveyed, or as I was informed, it would prove seriously injurious to valuable lands above. This is not however a cause of any difficulty, as the height of the water when passed was sufficient, to feed conveniently the line below.

After passing the creek, the line continues to Yorks mills at the base of a side hill, composed of sand, clay & loose stones and the hill has a very moderate side slope. The rock shows itself at the mill in a ledge which crosses the creek and occasions the fall at that place. Two ravines with small streams passing through them indicated in the profiles, would have to be passed in this distance.

The side hill, after passing the second ravine, has a slope of about 15° and continues very regularly at that. There is a small place, shown in the plan, in which a bluff of rocks is encountered.

Between Otter Creek and Castleton there is a summit or dividing elevation at the point C soon after passing West Creek. As the valley of this latter creek, between C and Otter Creek, is below this summit, the canal must either be kept on the edge of the side hill, delineated in the plan, or maintained by an embankment if kept on the meadow. The extent of

this embankment, may be ascertained from the plan and its height from the profile at D, which passed over it for this purpose. The ground sinks rapidly as it approaches Otter Creek from D.

From C the route can hardly be said to possess a difficulty, until arriving at Davis's mill dam, Fair Haven. The distance to this dam from the basin near Rutland, is 16-1/2 miles and the fall of the surface of the ground at the dam, below the point a of the basin, was found to be 165.5 feet. The water of the dam, on the day of the survey, was 6.5 feet lower. Near the dam is a ledge of rocks, which the line will have to encounter, indicated in the plan and profile, but from thence there are no rocks, to the termination of the line.

The crossing at the 8th mile was to avoid a low and deep marsh on the south side of the river. The stream is narrow and the aqueducts need not be costly. The crossings indicated in the survey a short distance above & below the town of Castleton, can be avoided and the line of the Canal be more advantageously located on the south side of the river and out of the influence of its freshets. These crossings at the 12th mile being the same just alluded to below the town, were to avoid a ledge of rocks on the south side of the river indicated in the plan.

From the junction of the stream discharged by Bombazine lake with Castleton river and for a distance of about one mile, the bottom on the south side of the river was covered with so thick a growth of timber, that the instrument was here crossed to avoid this impediment to its course, and returned again to the south side of the river below. But these crossings would be unnecessary in locating the canal, as the bottom on the south is nearly equally as favourable as that on the north side of the river, offering no impediments equivalent to the cost of two aqueducts.

As it might be desirable to have a feeder, between Otter Creek and Davis's mill dam, a line for that purpose was surveyed, which is also exhibited in plan and profile. The feeder would take its origin from the discharge of Bombazine lake.

The ravines below and near to Davis's mill dam, cannot well be turned, but will have to be crossed as indicated. The soil between these and Poultney river is a sandy loam, easy of excavation.

The fall from the Rutland basin at a, to the east bank immediately at Poultney river, which river is the dividing line between the states of Vermont and New York, is one hundred and eighty four feet in a distance of nearly eighteen miles and

three eighths, and from thence to the northern canal at c, in a distance of 7 miles and one eighth, the fall is 220.98 feet. This latter distance lies in the state of New York. The whole makes an entire lockage of 404.98 feet.

The profile also shows a difference in the height of the two banks of Poultney river equal to 17 feet, but the eastern may be considered as a first bank, as in a distance of 1/4 of a mile back, eastwardly, there is a second bank where the surface of the soil is equal in height to that on the New York side.

A short distance below Poultney river there are several ravines, of the dimensions exhibited in the profile, which cannot be avoided, without much increasing the length of the Canal. At 20 miles and 1/8 from the point a of the basin near Rutland, the gradual slope which had hitherto characterized the surface of the soil, becomes suddenly more rapid, occasioning in a distance of about one mile a fall of one hundred & thirty five feet. This short distance also embraces several ravines, which cannot well be avoided.

From the termination of this rapid descent, to the junction of the survey with the northern Canal at White Hall, the surface of the soil again assumes its gradual and favourable slope, and may be considered in this distance as without difficulty or without requiring any unusual expense, except in

the aqueduct necessary for the passage of Wood creek.

When within half a mile of the northern canal, two routes were surveyed to complete the junction with the same. The more northern at the solicitation of several gentlemen of that vicinity. It appeared to me not so well chosen, as it passed through a well settled part of White Hall lying on that side of Wood Creek, where the ground is of course very valuable, and as the termination of the aqueduct would have in this route to be at the junction with the Canal, the enlargement requisite to enable a boat to pass with facility from one to the other, would necessarily have to form a part of its construction. This enlargement could not be in the northern Canal, as the point of junction is in a thickly built part of the Town. Its only advantage over the route which appeared to me preferable, is that the junction of the two canals would be about 1700 feet nearer the outlet of the northern Canal into Lake Champlain.

The second route, also exhibited in plan & profile, is shorter passes over less valuable ground, and unites with the northern Canal, where there is already an enlargement in the opposite side of the same, sufficient to admit of boats turning & passing from one to the other with facility. It will be seen by the profile that a slight embankment will be necessary in

order to sustain the Rutland Canal, between Wood Creek & the Northern Canal at the level of the last named. This embankment would operate as a dam over the meadow lands of Wood Creek in times of freshets, but I was informed that those lands were rarely overflowed at any depth, and a paving of the slope of the embankment would defend it from all injuries arising from this cause.

The great fall in this route may with justice be considered as its principal difficulty, and as a cause of occasioning an unusual expense in comparison with the length of the Canal. Any means therefore, by which servicable and cheap locks can be made, are certainly deserving of serious consideration. While in that neighborhood and conversing with many gentlemen of excellent practical knowledge, the subject of constructing locks of wood was frequently canvassed.

The great difference in the first cost in comparison with those of stone, the facility of making and of repairing them, and their durability when well made, so much exceeding the general opinion entertained in relation to them, place them in an attitude deserving more of the attention of the Engineer than they have hitherto received, and may be considered in all lines of secondary communication as giving to them a prefference. The few facts which have come under my personal observation are

much in their favour. And when it is considered how many parts of our Country are well adapted by nature for canal navigation, but which are now deprived of its advantages, in consequence of the cost of such works exceeding the capacity of the locality which would be immediately benefited by them and which would have from this cause to meet the greater part of the cost, and that if locks of wood were employed, they would place all the great advantages of canals within the reach of moderate means and extend them to every part of the nation, the subject appears in a truely interesting light, and might be considered of sufficient importance to justify the orders of the Department to all its officers, to report to it the detailed history methods of construction, durability cost &c., of locks of this kind, (of which there are many spread over the country), which may exist within the limit of their operations. This course could not fail to collect in time a mass of highly valuable information, from which the most beneficial results might be derived.

The difficulty in procuring suitable timber and its very high price there, may be the reasons why locks of wood have received so little attention in England, the great school of practical canal architecture.

The following is the result of the gauging of the various

streams during the period of the survey.

East Creek, 32.65 c.ft. per second
Otter Creek 264.00 near the crossing place.
West Creek 16.9
Bombazine 26.22

The survey of this route was made by Lieuts. Bennett and Mackay.

It is, perhaps, proper that I should remark, that all of these surveys, except the levelling, were done by the compass.

We have no other instrument for detail operations, and the errors to which this is liable, cannot fail to effect the results collected by it.

The errors are so well known and have been so frequently exposed by men of scientific acquirements, that it is unnecessary for me to make any comments upon them. They are inseparable from the use of the instrument, and may be said to form a part of its very theory.

In surveys of Harbours & rivers where a system of triangles, determined by the theodolite, regulates the work, & where the points of these triangles are seldom more than a mile apart, the compass may be used, as its run is so frequently corrected by the triangle points, and any accumulation of error is by that means prevented. But in a long line for a canal or other purpose, and through a country so abounding in iron as ours, the errors from the use of the compass cannot fail to be serious.

The plane table is the only instrument which can be substituted for the compass, and it is well adapted for the collection of the details required from our labours. Its theory is perfect, if I may so express myself. Its results must be without error, or error can be a consequence only of inexcusable carelessness in its use. It has some inconveniences and when the ground is such as to render frequent stations necessary, may

occasion some delay, but these are more than compensated for by its accuracy. And when we consider that the result from the plane table is a map which needs only to be copied, I am inclined to doubt if the loss of time in its use in comparison with the compass, will prove as great as is generally supposed.

Having used a plane table on one occasion, I speak with the advantage of some experience. But even if there were a saving of time in favor of the compass, what can this weigh in the scale against the unequivocally superior accuracy of the Plane Table.

Our labours should, at least; be exempt from those errors resulting from the imperfect nature of the instruments used. Under these impressions, I must request of the Department permission to have two plane tables made and to introduce their use in the operations of my party. The cost of a plane table will not exceed that of a good compass.

It is also proper to state that the measurements of the streams, to ascertain the quantity of water discharged, were made during the period of the survey. And altho these measurements were made at a season when the streams are generally at a minimum, it is yet rather at variance with the practice of more experienced nations to be governed by less than the average result of the observations of many months. With ourselves I should doubt the propriety of constructing a canal, until at least after the average daily observations during the dry

season. If the result is then a sufficient quantity, there can be no cause of fear on this subject.

In the surveys and examination made in New Hampshire, I was aided and accompanied by Colonel P. Carrigan, as commisioner on the part of that state. This gentleman is well known as the compiler of a very excellent map of that state, and as an active promoter of all the subjects connected with its prosperity and improvement. His intelligence and urbanity of manner made the association highly valuable and agreeable, and his zeal induced him after my duties called me elsewhere to remain with the surveying parties in the field in order to assist them by his knowledge of the country, and to facilitate their accomodation by his universal acquaintance with the inhabitants.

He was authorized on the part of the state, to go into the actual location of the routes, and to aid in making the estimates. But as your orders to me were silent on these subjects, and as I knew from the arrangements of your Department to divide the labour of these duties, that the business of making the estimates was reserved for another branch, and as also what was particularly ordered required all my time to accomplish, I was obliged to decline his proposition in relation to these objects.

I was also urged on the same subject elsewhere, and for the same reasons had to refuse, which, it appeared to me rather lessened the gratification which our labours generally gave.

But there was no remedy. My orders were the only guide which I could follow, and were the more obligatory when an attention to the subjects of locating the canal routes and estimating their probable cost would have occasioned delays of surveys elsewhere, and where the anxiety of the inhabitants was equally great, to have the surveys made.

For the same reasons also which governed me in declining to locate any of the canals or make the estimates, I have not attempted to delineate upon the maps or profiles the plan of any canal, or to assign places for the locks, leaving this also to the office to which the Department has assigned that duty.

The report of each survey contains the names of the officers by whom it was made, and each sheet of drawings has also upon it, the name of the officer by whom this duty was done. No better evidence than that which these facts expose can, it appears to me, be adduced to prove how ably and industriously my efforts have been seconded by my several assistants. It is due to them, however, that I should add that during several of the surveys herein reported, severe indisposition prevented my personal superintendance of the work, the effect of which on them was to infuse into their exertions a degree of intelligence, care and minuteness of observation, which has left nothing more to be desired, and has also proved how well they merit the

confidence reposed in them by the government, in assigning them to these duties. In the drawings I have also again had the aid of my old and highly valued assistant Lieut. G. W. Wheelber.

It is also proper that I should bring to your notice the services of Mr. C. E. Anderson. This gentleman finely educated and possessing excellent business and moral habits, joined my parties in Vermont, and rendered important aid to our operations there. During several weeks he filled the part and did the duty of an Officer, in the place of one who from continued exposure to the wet, was confined by a rheumatic affection.

His services had been so essential and were so necessary in forwarding our results, that he has been continued in employ since our return from the field, and by his neatness accuracy and industry, has rendered great assistance in completing the drawings. I have only to regret that the discretion vested in me did not admit of an adequate recompense.

It will no doubt be observed that in the course these reports I have made but few remarks upon the nature of the various soils encountered, and the extent to which each kind would influence parts of the several canal lines.

The reason is that these facts are so minutely noted on the profiles, that remarks upon them in the reports appeared unnecessary; and my object was to make these reports as short as

possible, consistent with a clear understanding of the principal features of each route, without too laborious an investigation of the drawings.

Respectfully submitted,

J. J. Abert,

Major & T. E.

The following is a list of the drawings which accompany this report.

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Rutland Canal 3 sheets	exhibiting plan & profile of the route surveyed.