Report of the Canal board in relation to Honeoye, Conesus and other lakes

New York (State) Canal board

REPORT

OF THE

(State) N.Y. - CANAL BOARD

IN RELATION TO

HONEOYE, CONESUS AND OTHER LAKES.

Made to the Legislature, January 28, 1850.

ALBANY:
WEED, PARSONS & Co., PUBLIC PRINTERS.
1850.

That in pursuance of the said resolution, Mr. Tracy proceeded, under the direction of the Canal Commissioner in charge of the Western Division of canals, to make such surveys and estimates, and on the 17th day of December last, submitted a report to this Board, which report is herewith transmitted to the Senate.

CHRISTOPHER MORGAN,
Secretary of State.
WASHINGTON HUNT,
Comptroller.
ALVAH HUNT,
Treasurer.
CHARLES COOK,
JACOB HINDS,
Canal Commissioners.

REPORT

On the cost and policy of constructing Reservoirs of Conesus, Hemlock, Honeoye and Canadice Lakes.

By HENRY TRACY, *Civil Engineer.*

To the Honorable, the Canal Board of the State of New-York:

In pursuance of the following resolution, viz:

"STATE OF NEW-YORK,
"CANAL DEPARTMENT,
"*Albany, June* 16, 1849.

"At a meeting of the Canal Board,

"*Resolved,* That Henry Tracy, Engineer, be employed to make the requisite surveys and estimates in regard to the usefulness and policy of bringing Conesus, Honeoye, Canadice and Hemlock lakes into use as reservoirs, pursuant to the provisions of the act, chapter 222 of 1849, and that he report to this board as soon as practicable."

The following is a copy of the act referred to, viz: chapter 222, Laws of 1849.

"§ 1. The Canal Commissioners are hereby authorized and required, whenever the Canal Board shall deem it expedient to construct the works necessary for bringing into use the Conesus, Honeoye, Canadice and Hemlock lakes, or either of them, as reservoirs to supply the Genesee Valley and Erie canals with water, and the expense thereof shall be defrayed out of the monies to be appropriated for the enlargement of the Western Division of the Erie canal."

"§ 2. All acts or parts of acts inconsistent with this act are hereby repealed."

"§ 3. This act shall take effect immediately."

I have the honor to submit the following

REPORT :

That part of the Erie canal between Buffalo and Lock Pit, near Seneca river, a distance of about 153 miles, is supplied with water from Lake Erie, the Tonawanda creek, the Oak Orchard feeder, and the Genesee river.*

In the spring, when the streams are high, the canal is filled between Buffalo and Tonawanda creek from lake Erie, between Pendleton and Rochester from the Tonawanda creek and the Oak Orchard feeder, and between Rochester and Pit Lock from the Genesee river.

As the streams dry up in the months of June and July, Tonawanda creek and Oak Orchard feeder afford but a small quantity of water. The canal then receives its supply from Lake Erie.

The Genesee Valley canal is but partially completed, the finished portion (52½ miles in length, extending from Rochester to Dansville) is supplied with water from the Genesee river and its tributaries. Either next year or the year after, that part of the unfinished canal between the Shaker settlement near Mount Morris and Rounsevells in the town of Caneadea, (36½ miles in length,) will be completed, which is also to be supplied with water from the same sources. The remainder of this canal is to be supplied from reservoirs and streams which empty into the Allegany river.

The flouring mills and other manufactories in the city of Rochester depending on the Genesee river for their motive power, need more than the whole water of this river, during the dry season of the year, to drive their machinery. So that diverting for the canals a portion of its water reduces the value of all the mills and manufactories depending upon it.

The owners of these mills have brought large claims against the State for damages on account of this diversion of the water.

None of these claims have been settled, and it is uncertain what amount of damages the State may have to pay.

* See annexed map and profile No. 1.

Hence to ascertain the "usefulness and policy of bringing Conesus, Honeoye, Canadice and Hemlock lakes into use as reservoirs,"* it is necessary to determine,

First. The amount of water required for feeding the enlarged Erie canal between Buffalo and the Montezuma level.

Second. The sources from which it has been proposed heretofore to furnish said supply of water and the sources from which it should be obtained.

Third. The amount of water diverted from the Genesee river for the use of the Erie and Genesee Valley canals.

Fourth. The amount of water that may be obtained by converting the four lakes above named into reservoirs, their plans and cost.

FIRST.

THE AMOUNT OF WATER REQUIRED FOR FEEDING THE ENLARGED CANAL BETWEEN BUFFALO AND THE MONTEZUMA LEVEL.

I. *From Montezuma to Pendleton*, 120 *miles in length.*

This part of the canal traverses a country nearly level, having but slight undulations in its surface, though in some places cut up by ravines running at right angles to the line of the canal. The soil is generally favorable for constructing tight embankments, but there are some portions where it is porous and leaky.

1. *Filtration, Leakage, Waste and Evaporation.*

As a sufficient number of experiments have not been made to determine with accuracy the leakage, filtration and waste on a canal of the size of the enlargement, it has been deemed proper to furnish the investigation at length,† by which the quantity required is given as follows, viz:

Evaporation, ...	6 cubic feet	a mile	a minute.
Leakage, filtration and waste,......	194	"	"	"
Total,........	200	"	"	"

* The four lakes mentioned in the resolution are in the valley of the Genesee river.

† See Note A.

2. *Lockage water.*

As the day is not far distant when the canal will be crowded to the extent of its capacity, it is perhaps well to know the greatest number of lockages that may be made in a day on the enlarged Erie canal.*

At the best enlarged locks on the canal there is required about one and a half minutes for a boat to enter the lock, snub and shut the lock gates; one minute is required to open the paddles and empty the lock; 1½ minutes are required to open the gates and get the boat out of the lock, making in all a total of 4 minutes. At this rate 360 boats can pass a single lock in a day.

The greatest number that has ever been passed through a single lock in six hours is 82 or at the rate of 328 in a day, and this was only done by extraordinary exertions on the part of the lock tenders. At this last rate 656 boats a day may be passed through the double locks.†

The trade of the canal fluctuates considerably, sometimes there being twice as many boats passing one day as the next, and as on the old canal, boats have often been detained, for want of water, waiting in some instances hours for their turn to be locked, it is important that a sufficient supply should be furnished, so as to avoid these detentions on the enlargement.‡

Therefore, for an average trade of 200 lockages a day it is deemed proper to allow that at times during the busy season there will be twice this, or 400 lockages a day.||

In the ordinary trade of a canal with double locks, as a general rule every two locks full of water will pass three boats, viz: two in

* In this calculation there has been no allowance for improvements that may be made in the plans of the locks, but simply an examination of enlarged locks now in use, which are believed to be the best locks in this or any country.

† In the ordinary business of a canal from 6 to 10 minutes is used up in passing a boat.

‡ Thus, at the first lock east of Rochester, in 1848, the average daily number of lockages during the season of navigation was 70, while the average daily number of lockages in one month was 108, and in one day 192

|| By instructions from the Hon. N. J. Beach, I was directed to make my calculations for an average trade of 200 lockages a day.

one direction and one in the other. At this rate 300 locks full of water will be enongh for 450 lockages, but for safety say 400 lockages.

We therefore conclude that 300 locks full of water daily is sufficient for a trade averaging 200 lockages a day. This gives 2959 cubic feet of water a minute for lockage water.*

Add to this 25 per cent, or 740 cubic feet a minute for swelling or flushing the descending boats out of the locks, making a total of 3699 cubic feet a minute.

3. *Leakage through the last lock.*

The leakage through the last lock is quite an important item in the supply of water, for, on the Erie canal the leakage of some of the old locks amounts to more than the lockage water. This leakage through the lock is principally at the foot of the gates, about the mitre sill, and at the paddle gates. It is not entirely uniform, depending to some extent upon the business and the care used by the lock-tenders.

From experiments made the past summer † it was found that enlarged lock No. 61, of 8 feet lift, which appeared to be in good order, leaked at the rate of rather more than 1200 cubic feet a minute.

Hence it seems no more than safe to allow 1200 cubic feet a minute for leakage of the last lock, (which is about the same lift as lock No. 61,) or 2400 cubic feet a minute for the pair of double locks.

Collecting and arranging these results we have for that part of the canal between Pendleton and Montezuma level,

Leakage and evaporation on 120 miles, at 200 cubic feet,................. ...	24,000	cu. ft a minute,
Lockage water 2,959, flushing boats 740,=	3,699	"
Leakage of last lock,.................	2,400	"
Total,..................... ..	30,099	"

Say 31,000 cubic feet a minute.

* The maximum number of lockages that can be made in a day at a set of double locks is above given at 656. Before the trade of the canal is sufficiently great to require this number of lockages, its embankments will have become so much tighter than when first constructed, that probably the saving in filtration will be sufficient to supply the increased lockage water.

† See note B.

II. *From Pendleton to Buffalo, a distance of 24 miles.*

This part of the canal is differently situated in many respects from the other portion. It has consequently been thought best to make a separate calculation of the water required on it, and for the purpose of making the description plain, it commences at Buffalo.

1. Between Buffalo and Black Rock guard lock, a distance of four miles the surface of the canal is to be of the same, or nearly the same level as that of Lake Erie and Black Rock Harbor, along the shore of which it is to be built, consequently it can lose nothing by leakage or filtration. The canal on this part is to be wide and will lose more by evaporation than ordinary canal. The loss by evaporation is however but small, amounting on this part to but 12 cubic a mile a minute or 48 cubic feet a minute on the four miles.

2. From Black Rock guard lock to Tonawanda creek, a distance of 8 miles, the canal is to be constructed along the bank of the Niagara river, the surface of which is about 5 feet below that of the canal. This part of the canal will lose water by filtration on only one side of the tow-path, the land on the berm side being generally elevated some feetabove the surface water of the canal. The soil is good for making tight embankments Hence it is probable that this loss will not be half as much as on ordinary canal, but for safety we assume it to lose by evaporation, filtration and leakage 100 cubic feet a mile a minute, or 800 cubic feet a minute on the whole distance.

3. At Tonawanda the canal enters Tonawanda creek. At the mouth of this creek there is a dam which raises the water of the creek about 5 feet. There will always be some leakage and waste at this point. It is believed safe to allow 1500 cubic feet a minute loss from these causes.

4. There is also a lock entering the Tonawanda harbor at this point. The lift is about 5 feet and its leakage will be about 900 cubic feet a minute.

5. The lockage water of this lock (assuming 75 lockages a day,) will be 461 cubic feet a minute. The amount required for flushing boats out of the lock, will be about 25 per cent on this or 115 cubic feet a minute.

6. From Tonawanda to Pendleton, (a distance of about 12 miles,) the bed of Tonawanda creek is used for the canal. This is accomplished by a dam at its mouth, which turns the water that enters from the canal, (in time of low water of the creek,) so as to flow up the old channel of the creek to Pendleton where it again enters the canal. On this portion the width of water surface is about 3 times as great as on ordinary canal; and the evaporation will be about 20 feet a mile a minute. This on 12 miles amounts to 240 cubic feet a minute. It is believed that there will be no loss on this part from leakage or filtration.

Collecting and arranging these results, we have the amount of water required as follows, viz:

		Cubic ft. a minute.
* Amount required east of Pendleton,.		31,000
Evaporation on 12 miles of Tonawanda creek at 20 cubic ft., ...		240
Leakage of Tonawanda lock,................		900
Lockage, ...	461 c. ft.	
Flushing boats, ...	115 "	
		576
Leakage and waste at Tonawanda creek dam, ...		1,500
Evaporation, leakage, &c., on 8 miles of canal Black Rock, to Tonawanda.		800
Evaporation on 4 miles, from Black Rock to Buffalo at 20 cubic feet, ...		80
Total, ...		35,096

Say 35,100 cubic feet a minute.

The amount required to pass the different points will be as follows, viz:

To pass	Black Rock,..............	35,020	c. ft. a minute.
do	Tonawanda, up the creek,...	31,240	do
do	Pendleton, ...	31,000	do
do	Middleport,..............	27,200	do
do	Albion, ...	24,000	do
do	Brockport, ...	21,000	do
do	Rochester, ...	17,000	do
do	Last lock at Clyde,........	6,100	do

* See page seven.

Although these amounts may at the first glance appear extravagant, yet it must be remembered that the trade of the canal has been limited by the number of lockages that could be made without drawing down the canal to an unnavigable condition at the ends of the long levels, and not by the number of lockages which could have been made with an abundant supply of water.

The small amount of water that will be afforded by the Oak Orchard feeder and the Genesee Valley canal is not taken into account. It is thought best to leave these items, amounting in all to about 1,300 cubic feet a minute, as an additional allowance for contingencies.

SECOND.

THE SOURCES FROM WHICH IT HAS BEEN PROPOSED HERETOFORE TO FURNISH THE SUPPLY OF WATER, AND THE BEST SOURCES FROM WHICH IT SHOULD BE OBTAINED.

1. Before the western division of the Erie canal was commenced, the Canal Commissioners had two routes examined between Buffalo and Rochester, viz:

The route upon which the canal is constructed, and another to the south of it, which was several miles shorter and was estimated to cost the least.

But on the southern route it was necessary to rise by locks 75 feet above Lake Erie. This was deemed objectionable, and the Canal Commissioners speaking of the other route (afterwards adopted) say: * "Pursuing this route the canal never rises above lake Erie level. It would therefore derive its waters until it descends to the Genesee level, and as much further as may be necessary from that never-failing reservoir."

The Commissioners, in 1821, reported that they had adopted the present route, arranging for it such a descent towards the east from the locks at the mountain ridge (now Lockport) to Rochester as † "to induce a current of so much water from lake Erie towards the east as will leave but little to be required from the Genesee river, and

* See report of DeWitt Clinton, S. Van Rensselaer, S. Young, and M. Holley, dated February 15th, 1817. Canal Laws, vol. 1, p. 201.

† See report of DeWitt Clinton, S. Van Rensselaer, S. Young, M. Holley, and Henry Seymour, dated March 12th, 1821. Canal Laws, vol. 2, p. 12.

this may be still reduced if it shall ever become expedient, by a feeder from the Irondequoit creek." This feeder it was proposed to take into the canal at Pittsford.

The Commissioners also add: "From this level (the Pittsford level) eastwards, there might be obtained a sufficient supply of water from Canandaigua lake, Mud creek, and several other sources for all the demands of the canal if the Genesee river were annihilated."

2. Before the canal was completed between Lockport and Buffalo, a feeder (known as the Oak Orchard feeder,) was constructed from the Tonawanda creek (near Batavia) to the Erie canal, at Medina, and the State erected dams at the outlets of Conesus, Hemlock, Honeoye, and Canadice lakes, converting them into reservoirs to assist the Genesee river, which was used to feed the Erie canal, until the cut through the mountain ridge was completed. The dam at Honeoye lake was destroyed the following year by a storm; and the other three were torn down in 1829 by the inhabitants, who found that raising the water in these lakes rendered the adjacent country unhealthy.*

3. The Canal Commissioners, in their annual report of 1839, speaking of the enlargement, say:† "In the original construction of the Erie canal, the design was to take the water from Lake Erie to supply the canal from thence to the Seneca river, a distance of about 159 miles. This was successfully accomplished for a few years, while the canal was new and the channel unobstructed. The first formidable impediment was in the canal through the mountain ridge, where annually, the channel became obstructed by sand washed in from the sides, and by a heavy growth of grass. The same difficulty has extended to other parts of the canal; and for several years past, a resort to the Genesee river became necessary during extreme drought.

"Since the construction of the Erie canal, the hydraulic establishments at Rochester have been vastly extended. The uninterrupted enjoyment of the water power at that place is identified with the prosperity of a large section of country. The Commissioners are of opinion that such arrangements should be made, and such capacity

* See Assembly Documents, No. 172, for 1848.

† See report of S. Van Rensselaer, Wm. C. Bouck, Jonas Earll, junr., J. Bowman, and Wm. Baker. Assembly Documents for 1839, No. 86.

given to the canal, as will render a resort to the Genesee river unnecessary. This is deemed practicable; and the engineers have been instructed to make the necessary calculations, and present a proper plan."

Again in 1841, the Canal Commissioners, in their annual report, say that surveys have been made the past season, (1840,) and the levels tested between Lockport and Rochester. *"The result of the examination shows that the present canal has a declivity of half an inch to the mile from Lockport to Brockport, but that from the latter place to Rochester, a distance of about 20 miles, the bottom is level; and this circumstance will account, in part, for the difficulties that have occurred in supplying the canal with water, east of Brockport. To divert the water of the Genesee river, to any considerable extent, would be manifestly unjust, occasioning irreparable injury to the citizens of Rochester, and, to some extent, to the business and revenues of the canal."

"As it is intended to feed the enlarged canal from Buffalo to Montezuma exclusively with water from Lake Erie, and as the present supply is barely sufficient, it will be manifest that the division from Buffalo to Rochester should be completed prior to the enlargement of the prism from Rochester to Montezuma."

4. After the suspension of the public works by the stop law of 1842, the Genesee river dam (which was about 1½ miles above Rochester, and raised the water in the river so as to be available for feeding the Erie canal,) was destroyed, as a nuisance, by the sheriff of Monroe county. And then, for the first time, the Commissioners (in their annual report of 1843) say: †"It is believed that it will be necessary to maintain a dam at this point, of sufficient height to afford the requisite supply of water for the canal."

It is proper to remark that the Legislature took no action in the premises, and that the Canal Commissioners never have attempted to carry out this plan, and no such dam has been built to furnish a sufficient supply for the canal during the time of low water. But the

* See report of Samuel B. Ruggles, H. Hamilton, A. Whitney, S. N. Dexter, D. Hudson, and G. H. Boughton, dated January 25th. Assembly Document, No. 72, for 1841, p. 43.

† See report of Jonas Earll, junr., D. P. Bissell, B. Enos, G. H. Little, J. Hooker, and S. Clark. Assembly Document, No. 25, for 1843, p. 79.

canal has been gradually improved by raising its banks west of Brockport, so that this year the surface of the water has been raised and maintained during the dry season about two feet higher at Lockport that it was when the canal was first constructed. Also about three miles of the eastern portion of this level has also been deepened through the city of Rochester to the first lock. So that season there was a fall of about 4½ feet in the surface of the canal between Lockport and the first lock east of Rochester. By means of this inclination of the surface the current was so increased that the Erie canal during the month of August and September of this year, the time of extreme low water, has actually been fed from Lake Erie as far east as Seneca river, with the exception of a small amount (about 800 cubic feet a minute, as gaged by D. Hurd, esq., resident engineer at Lockport,) from the Oak Orchard feeder.

5. As these reports from which extracts have been taken, were all made to, and printed by order of the Legislature, and as numerous appropriations have been made in pursuance of recommendations contained in said reports, (with the exception of that which stated the necessity of feeding the canal from the Genesee river,) and as no instructions have ever been given by the Legislature to the Canal Commissioners to alter this plan, it may be considered as settled that the Legislature has repeatedly approved and virtually recommended the plan of feeding the Western Division of the enlarged Erie canal from Buffalo to the Montezuma level, with the water of Lake Erie.

In view of the preceding it appears,

1st. That the present route through the mountain ridge was adopted for the purpose of obtaining an abundant supply of water from Lake Erie, to feed the canal as far east as the Seneca river.

2nd. That for many years the State has made use of a part of the water of the Genesee river for the purpose of feeding the Erie canal.

3d. That this year during the dry season, in the months of August and September, the Erie canal has been fed from Lake Erie, aided by the Oak Orchard feeder.

4th. That the plan, for supplying the Erie canal enlargement with water from Lake Erie without taking the water from the Genesee river has been repeatedly reported to and approved of by the Legislature.

It is proper to remark that the supply of water required for the Erie canal enlargement east of Rochester, is 17,000 cubic feet a minute,* while the Genesee river in time of extreme low water does not afford more than 19,000 cubic feet a minute. To feed this portion of the enlargement from the river, would consequently destroy all the permanent water in the city of Rochester.†

With the exception of Rochester, the country in the vicinity, and for thirty miles south of the canal, between Buffalo and the Seneca river is but poorly supplied with water power, and it seems unjust to injure it by diverting water from any of the streams in its vicinity.

Therefore in view of all the circumstances, it seems evident that Lake Erie is the best source from which to obtain a supply of water for that part of the enlargement of the Erie canal between Buffalo and the Montezuma level.

But since without resort to the Genesee river in case of a break in the canal at any point west of Rochester, the canal might for a few days be rendered useless from that point to Clyde: and as much time may be saved in filling the canal in the spring when there is an abundance of water in the river. There should be a feeder constructed from the Genesee river to enter the canal below the first lock east of Rochester. This feeder only to be used for filling the canal in the spring, and as contingent insurance against accidents.‡ Then in case of a break west of Rochester, the canal could, during the time required for repairing, be supplied with water from this feeder and the Genesee Valley canal.

* See page 9.

† See guage of Genesee river in 1839, at Rochester, (Ass. Documents of 1840, p. 30.) The guage of the river is given at,.............................. 16,154
Add leakage of dam, ... 2,500
18,654

‡ Such a feeder can be made by lowering the bed of the present feeder so as to take out the water of the river without a dam.

THIRD.

THE AMOUNT OF WATER DIVERTED FROM THE GENESEE RIVER FOR THE USE OF THE ERIE AND GENESEE VALLEY CANAL.S

During the past season an examination has been made of the finished portion ($52\frac{1}{2}$ miles from Rochester to Dansville,) of the G. V. canal, and it was ascertained that the total amount of water taken from Genesee river and its tributaries for feeding the canal in the dry season (in the month of August,) was 6,256 cubic feet a minute.

Of this 184 cubic feet was lost by evaporation; 2,627 cubic feet escaped by filtration and leakage; 545 cubic feet (being the leakage and lockage of mud lock,) entered the Erie canal at Rochester.*

And the balance, or 2,900 cubic feet was restored to the river by waste at the weirs and aqueducts.

Next year or the year after there will be brought into use $36\frac{1}{2}$ miles more of this canal, extending from the Shaker settlement near Mount Morris to Rounsevells, in the town of Caneadea.

It will be necessary to take from the Genesee river and its tributaries water for the supply of this part of the canal. Its lockage water and the leakage of the last lock will be restored to the Genesee river at Mount Morris.

The waste and leakage at mechanical structures will be restored to the river, so that the water diverted for this part of the canal will be simply the filtration and evaporation on $36\frac{1}{2}$ miles.

From an examination of many experiments made on the Chenango, Erie, and the finished part of the Genesee Valley canals, it is believed that 70 cubic feet a mile a minute will be a sufficient allowance for this, viz: $3\frac{1}{2}$ cubic feet a mile a minute for evaporation, and $66\frac{1}{2}$ cubic feet a mile a minute for filtration and leakage.

This gives the total evaporation at 128 cubic feet, and the filtration at 2427 cubic feet a minute.

* Mud lock is in the city of Rochester, is the last lock on the canal, and is but 2 1-2 feet lift.

Collecting and arranging the results we have

Loss by evaporation.	*Cubic ft. a minute.*	
On the part of the canal in use, $52\frac{1}{2}$ miles,........	184	
do do to be completed, $36\frac{1}{4}$ miles,.........	128	
		312
Loss by filtration.		
On the part of the canal in use, $52\frac{1}{2}$ miles,.........	2,627	
do do to be completed, $36\frac{1}{2}$ miles,........	2,427	
		5,054
Enters the Erie canal through Mud Lock at Rochester,.....		545
Total,.....		5,911

Of the water that escapes by filtration a part will be brought to the surface of the ground by capillary attraction or other causes, and evaporate; but from a careful examination of the route of the canal, it is thought that less than one-half of the filtration will be lost in this manner.

The remainder by underground passages and small streams will find its way back into the river. In order to be safe it is assumed that but one-third of the loss by filtration or 1684 cubic feet a minute will in this way be restored to the river.

Deducting this from 5,911 (the amount above given) we have 4,227; add to this 10 per cent for contingencies, and we have 4,650 cubic feet a minute as the total diversion of the water of the Genesee river during the dry season for the use of the Genesee Valley canal, including the lockage and leakage of Mud lock, which enters the Erie canal.

According to the plan proposed in this report the Erie canal during the dry season will be supplied with water from Lake Erie, but as it is proposed to construct a feeder from the Genesee river for the purpose of filling the canal in the spring, there will always be some leakage into the canal through the lock at the head of the feeder. This leakage, however, will not be equal to the water restored to the river by the leakage and loss at the weigh lock in the city of Rochester.

The water required for filling the canal in the spring will be taken at a season when the river is high and consequently do no injury to the water power.

FOURTH.

Supply of water that may be obtained by converting Conesus, Hemlock, Canadice and Honeoye Lakes into Reservoirs.

The object of making reservoirs of these lakes, is to restore an equivalent for the water taken from the Genesee river for the use of the canals. They should therefore be able to do this in the driest year.

1. The rain and snow, which falls upon the ground, is in part taken up by evaporation from the surface, and the remainder runs off in streams. By some it has been supposed that the annual evaporation from the surface of the ground is the same each year, and consequently the amount of water which runs off is equal to the differrence between the fall of rain and the evaporation. But experiments made with great care,* give the results contained in the following

TABLE,

Of the fall of rain, the amount of water ran off, the amount of evaporation from the surface of the ground, and the ratio of the drainage, or the quotient of the total quantity of rain that fell in the valleys, divided by the total quantity of water that ran off in streams.

Year.	Name of valley.	Fall of rain & snow in the valley.	Water that ran off.	Evaporation from surface of ground.	Ratio of drainage.
1835,	Madison Brook,	35.26 in.	15.83 in.	19.43 in.	0.449
1837,	Long Pond,	26.65 "	11.70 "	14.95 "	0.439
1838,	" "	38.11 "	16.62 "	21.49 "	0.436

† From which it appears that the evaporation from the surface of the ground in the valley of Long Pond, was about 44 per cent. more in 1838 than it was in 1837, while the ratio of the drainage differed less than one per cent. the same years.

These experiments were made in valleys similar to those of Hemlock, Conesus and Honeoye lakes.

* The experiments in the Madison Brook Valley, were made by J. B. Jervis, Esq Chief Engineer of the Chenango Canal; those in the Valley of Long Pond, by order of the Commissioners of the Boston Water Works.

† The drainage basin of Madison brook valley contains 6,000 acres, of Long Pond valley, 11,400 acres.

Other experiments have been made in valleys favorable for a higher ratio of drainage, which give it at rather over 0.500.

Canadice lake valley, from the limited extent and the steep inclinations of its slopes appears favorable for this higher ratio. Hence it is considered proper to assume $\frac{4}{10}$ as the ratio of drainage in the valleys of Conesus, Hemlock and Honeoye lakes, and $\frac{5}{10}$ for Canadice lake.

2. In the reports of the Regents of the University, we have given the fall of rain and snow as measured at various academies in this State for a series of years.

These measurements are generally correct, yet it is well known, that some of the observers were men unaccustomed to the taking of careful observations, and that the minimum fall of rain may have in some cases been given too small.

From these reports has been compiled the following

TABLE

Of the annual fall of rain, as observed at the academies in various places in the State of New-York, showing the maximum, minimum and average in the whole State, also the fall at Rochester.

	Maximum.		*Minimum.*			
Year.	Name of Place.	Inches.	Name of Place.	Inches.	Average fall in whole State.	Rochester.
1830.	Erasmus Hall,	53.47	Delaware,	22.55	38.84	34.94
1831.	Dutchess,	49.63	Fairfield,	23.73	38.83	.....
1832.	Kinderhook,	53.46	Lewiston,	21.45	37.22	.....
1833.	Cambridge,	47.51	Lewiston,	20.73	37.03	.....
1834.	Oyster Bay,	42.29	Palmyra,	17.30	30.75	17.84
1835.	Governeur,	46.16	Oneida Institute,	25.00	34.12	28.60
1836.	Schenectady,	47.47	St. Lawrence,	18.54	34.45	27.95
1837.	Delaware,	54.95	Ithaca,	28.25	35.15	30.61
1838.	Johnstown,	49.63	Pompey,	23.21	32.38	25.46
1839.	Clinton,	46.39	Lewiston,	17.73	32.10	30.09
1840.	Oneida Institute,	49.11	Mexico,	19.07	35.38	29.34
1841.	Erasmus Hall,	52.12	Lewiston,	19.00	32.57	30.53
1842.	Fairfield,	51.56	Lewiston,	18.58	37.04	33.19
1843.	Ithaca,	50.19	Granville,	25.91	36.75	30.21
1844.	Johnstown,	49.77	Mt. Pleasant,	23.31	32.44	26.17
1845.	Hartwick,	41.75	Middlebury,	25.19	33.62	34.44
1846.	New-York Institute,	55.28	Lewiston,	21.40	34.69	37.19
1847.	Fredonia,	49.24	Newbury,	29.82	38.92	38.99
	Average,	49.44		22.26	35.13	30.37

From which it appears that the average annual fall of rain in this State is about 35 inches, ranging from 30 to 39 inches in different years; that the greatest fall was $55\frac{1}{4}$ inches, at the New-York Institute in 1846; that the least fall was $17\frac{1}{3}$ inches at Palmyra in 1834; and that the average minimum fall is $22\frac{1}{4}$ inches a year.

No rain gage has been kept in the vicinity of these lakes. They are elevated several hundred feet above Rochester, their vallies are bounded by hills, in some places reaching from 1,000 to 1,500 feet above tide, and the places in which the least fall of rain has been observed are generally in low and level country.

Hence it is believed safe to assume 22 inches as the minimum annual fall of rain in the vallies of these lakes.

3. There are numerous water privileges in use on the outlets of and which are supplied in part from these lakes; hence it is necessary that the plans should be arranged and managed so that when the reservoirs are constructed they will not injure but rather benefit this water power. For, if thus constructed and managed, it will be for the interest of the inhabitants of the vicinity and the owners of the mills and manufactories to maintain the reservoirs; but if otherwise they will probably meet with the same fate that attended the old dams at their outlets.

4. The dry season, when the streams are low, generally commences in July and ends in October, amounting to three months, but occasionally commences in June and extends four months.

It is therefore deemed prudent to assume it at 120 days per annum. After the reservoirs are completed, the supply of water from them will be abundant for these months, but for the remaining portion of the year it is believed proper to allow an average flow from them, sufficiently large to prevent any damage to the water power on the outlets.

During the present season full and careful surveys have been made of the four lakes and their drainage basins.

The accompanying maps and profiles give, it is believed, all the information that is required as to their size, depth, &c.

PLAN OF THE WORK.

In making the estimates it has been deemed proper to calculate for constructing the work in a permanent and durable manner. The dams and bulkheads at the outlets are to be of substantial hydraulic masonry, neatly hammer dressed to a half inch joint, and covered with a coping cut to a quarter of an inch joint.

This masonry will be rather expensive, as it must be built either of limestone brought from quarries seven or eight miles distant from the work, or from hard granite, gneis and trap boulders which are to be found in the immediate vicinity.

It will be necessary to extend piers into the lake to prevent the outlets from becoming filled with sand. These piers it is proposed to construct of earth 10 feet wide on the top, having side slopes of 3 horizontal to 1 vertical, covered with slope and rip-rap wall to prevent injury from the washing of the waves.

Some trouble will be caused to the contractors by the water of the lake during the progress of the work. This will render the excavation expensive.

Pits have been dug and the soil found to consist of loam, soft blue clay, quicksand and gravel.

The quantities and prices in the estimate are believed sufficient to do the work.

That it can be put under contract for less than the estimate is certain; but that it will cost, when completed, very nearly the amount estimated is also believed.

A description of each of the proposed reservoirs in detail, with the amount of water it will furnish, and the estimated cost, is given in note C, from which has been compiled the following,

TABULAR STATEMENT,

Showing the Dimensions, Capacity and Cost of the Reservoirs.

NAME OF RESERVOIR.	Area of drainage, basin in acres.	Area of reservoir, in acres.	Available depth, in feet.	Cubic feet of water per minute, for 120 days.	Cost of reservoir.	Cost of water per cubic foot, per minute.
Conesus,..	39,980	3,184	8	3,700	$57,000 00	$15,41
Hemlock,....................	31,069	1,828	10	3,057	72,500 00	23,72
Canadice,..........	8,883	648	8	661	19,300 00	29,20
Honeoye,......................	36,100	1,679	5	1,694	32,000 00	18,89
Total,.........	116,032	7,339		9,112	$180,800 00	$19,83

Exclusive of land damages.

The land damages probably amount

to not more than,	$13,000 00 for	Conesus lake,	Nor in all to less than $20,000.
	4,500 00	Hemlock "	
	2,500 00	Canadice "	
	10,000 00	Honeoye "	
	$30,000 00	Total.	

GENERAL SUMMARY.

From the preceding investigations it appears that Lake Erie is the best source, for supplying the water required for the use of that part of the Erie canal enlargement, between Buffalo and the Montezuma level.

That during the dry season of the year, about 4650 cubic feet of water a minute will be diverted from the Genesee river and its tributaries, for the purpose of supplying the Genesee Valley canal with water.

That by converting either two of the three Lakes Conesus, Hemlock and Honeoye into reservoirs, a sufficient supply of water may be retained in them to restore, during the dry season, an equivalent for the water diverted from the Genesee river.

But, as the vicinity of both Hemlock and Honeoye lakes is infested with fever and ague, caused in part by swamps which in time of high water are overflowed by these lakes: And as the vicinity of Conesus lake, is comparatively free from the fever and ague: It is believed that Honeoye and Hemlock lakes are the most suitable to make into reservoirs, and that, if made on the plan proposed in this report, after their construction the adjacent country will be rendered healthy.

The cost of making reservoirs of these lakes, and the amount of water they will furnish, will be as follows, viz:

	Cost.	Cubic feet of water a minute for 120 days.
Honeoye lake,	$32,000	1,694
Hemlock lake,	72,500	3,057
Total,	$104,500	4,751

The land damages will not exceed $14,500, making a total of $119,000, or say $120,000.

In conclusion, if we reflect, that, though the flourishing city of Rochester is in one of the best wheat growing districts in the world, yet its prosperity depends either directly or indirectly upon its water power; and that whether its manufacturers themselves make or lose money, every turn of their water wheels contributes not only to the growth and wealth of the city and adjacent country, but also to the trade of the canals. It seems evident, that the State, which has diverted a part of the water from the Genesee river, by its right of eminent domain,—a right which it can only exercise under the plea of necessity,—should, if it is practicable for a reasonable expense by means of reservoirs; restore to the river an equivalent, not merely as a matter of common honesty, but also of good policy.

Therefore, it is believed "expedient to construct the works necessary for bringing into use Honeoye and Hemlock laks, as reservoirs."

If, after these reservoirs are constructed, it shall be found that their vicinity becomes healthy, it will be good policy to convert Conesus lake into a reservoir, so as to insure a supply of water for feeding the canal eastward, for a few days, whenever a break occurs in the canal west of Rochester.

It may also be a good plan, eventually, to convert Canandaigua lake into a reservoir, so as to have at command a supply of water, for the canal east of Palmyra, in case there should be a break between that place and Rochester.

The great and increasing trade of the canal will justify any expense necessary to provide against accidents, which (though generally caused by carlessness,) will sometimes occur under the most prudent management.

All of which is

Respectfully submitted,

HENRY TRACY, *Civil Engineer.*

Albany, December 17th 1849.

NOTE A.

Investigation to determine the amount of water required for evaporation, leakage and waste on the Erie canal enlargement between Tonawanda creek at Pendleton and the last lock, near Clyde.

In 1839 a set of guages were made on the Chenango canal, and it was found, that on that part of the canal between the summit level and Utica, which was in good order, and at that time the best constructed piece of canal in this state that,

The leakage and evaporation amounted to $65\frac{1}{2}$ cubic feet a mile a minute.

The leakage at waste weirs and aqueducts averaged 10 cubic feet a mile a minute.

The waste, by running over at waste weirs and other mechanical structures, averaged $9\frac{1}{3}$ cubic feet a mile a minute.

Making a total of $84\frac{5}{6}$, say 85 cubic feet a mile a minute actually used.

The leakage through the last lock was 479 cubic feet a minute; but this lock was then new, had been used but little and was in very good order.*

In 1840 the engineers on the western division of the Erie Canal made a series of guages to determine the amount of water used on 122 miles, between Lockport and Lockpit. The result of these guages was that 67 cubic feet a mile a minute was used up in filtration, leakage and evaporation. It is, however, stated that during a portion of the time in which these experiments were made, the supply of water was insufficient.†

* See Report of Wm. H. Talcott, Resident Engineer Assem. Doc. for 1840.

† See Report of O. W. Childs, State Engineer, Assem. Doc. No. 16th, p. 146, for 1848.

Experiments have been made since that time on various portions of the Erie canal and other canals in this State, which show that when a canal is maintained in good order it gradually becomes tighter for many years after its construction, and that time and the action of water are required to consolidate the banks of a canal.

If we assume that the sides and bottom of the old and enlarged canals will be equally permeable to water,

1. *Leakage through the sides.*

Then let h=the depth of water in a canal,

q=the leakage through one bank,

a=a constant number to be determined by experiment:

And by the laws of Hydrodynamics, we have:

$$dq = ah^{\frac{1}{2}}dh;$$

$$\therefore \int dq = \int ah^{\frac{1}{2}}dh, \text{ or}$$

$$q = \tfrac{2}{3}ah\sqrt{h} + C.$$

If $q=0$, evidently $h=0$, and the constant $C=0$.

Hence the equation becomes:

$q = \frac{2}{3}ah\sqrt{h}$=leakage through one bank.

2. *Leakage through the bottom.*

Then let q'=the leakage through the bottom of the canal,

w=the width of the canal,

h=the depth of water in the canal as above,

b=a constant to be determined by experiment, and we have by the laws of Hydrodynamics:

$$q' = bw\sqrt{h}.$$

Hence the total leakage, which we will call K, is:

$$K = \tfrac{4}{3}ah\sqrt{h} + bw\sqrt{h}.$$

No experiments have been made to determine the relative leakage of the bottom and sides of a canal. But owing to the washing at the sides, and the deposit of sediment at the bottom of a canal, there is a greater relative amount of leakage through the sides than through the bottom.

We will solve equation 3d for such values of a and b as will give us the limits, and also for two other values of a and b, which will probably approximate to actual practice.

4. If there is no leakage through the bottom, and consequently all the filtration is through the sides,

Then $b=0$, and equation 3d becomes:

$$K = \tfrac{4}{3}ah\sqrt{h}.$$

Substituting for h its values on the old and on the enlarged canal, we have:

$h'=4$ on the old canal,

$h''=7$ on the enlarged canal.

Therefore $K'=\frac{4}{3}\times a\times 4\sqrt{4}$, on old canal, or

$K'=\frac{32}{3}\ a.$

$K''=\frac{4}{3}\ a\times 7\sqrt{7}$, on the enlarged canal, or

$K''=\frac{741}{30}\ a.$

Hence $K' : K''$ :: 320 : 741 :: 1 : 2·32.

5. If there is no leakage through the sides, and consequently all the leakage is through the bottom,

Then $a=0$, and equation 3d becomes:

$K=bw\sqrt{h}.$

Substituting for h its values on the old and enlarged canals, viz:

$w'=28$ on old canal,

$w''=525$ on enlarged canal.

$K'=28\ b\sqrt{4}=56\ b.$

$K''=52{\cdot}5\ b\sqrt{7}=138{\cdot}91.$

Hence $K' : K''$ :: 56· : 138·91 :: 1 : 2·48.

6. If the leakage through the bottom be relatively the same as it is through the sides,

Then we have $a=b$, and equation 3d becomes:

$K=\frac{4}{3}\ ah\sqrt{h}+aw\sqrt{h}$, or

$K'=(\frac{4}{3}4\sqrt{4}+28\sqrt{4})\ a=66{\cdot}7\ a$ on old canal,

$K''=(\frac{4}{3}7\sqrt{7}+52{\cdot}5\sqrt{7})\ a=163.6\ a.$

Hence $K' : K''$ :: 66·7 : 163·6 :: 1 : 2·45.

7. If the leakage through the bottom be relatively half what it is through the sides,

Then we have $b=\frac{1}{2}a$, or $a=2\ b$, and equation 3d becomes:

$K'=\frac{4}{3}\ 2bh\sqrt{h}+bw\sqrt{h}=(\frac{8}{3}\ h+w)\ b\sqrt{h}$, or

$K'=(\frac{8}{3}\ 4+28)\ b\sqrt{4}=77{\cdot}3\ b$, on old canal,

$K''=(\frac{8}{3}\ 7+52{\cdot}5)\ b\sqrt{7}=188{\cdot}3\ b.$

$\therefore K' : K''$ :: 73·3 : 188·3 :: 1 : 2·44.

From the preceding, it appears that it will be safe to assume the leakage through the banks of the enlarged canal, at 2·45 times the leakage through the old canal.

Taking the experiments made in 1840, as the basis of our calculations, we have the leakage and evaporation at 67 cubic feet a mile a minute.

The loss from the surface by evaporation, ranges from $\frac{1}{5}$ to $\frac{1}{8}$ of an inch a day, in the months of the dry season. This, on the old canal, amounts to about $3\frac{1}{2}$ feet a minute, (and on the enlarged canal will amount to 6·1 cubic feet a mile a minute); leaving the leakage at 63·5 cubic feet a mile a minute for leakage.

To this should be added the waste at mechanical structures, which will be nearly in proportion to the cross section of water in the canal, and in the Chenango canal amounted to about 9 cubic feet a mile a minute.

Hence $(42 + 26)\frac{4}{2} : (70 + 52{\cdot}5)\frac{7}{2} :: 1 : 3{\cdot}15$.

$3{\cdot}15 \times 9 = 28{\cdot}35$, as the waste per mile per minute.

Collecting and arranging the results, we have:

1. Leakage, $63{\cdot}5 \times 2{\cdot}45 =$	155·6 cubic feet a mile a minute.
2. Evaporation,	6·1
3. Waste,	28·3
Add for contingencies,	10·0
Total,	200·0

NOTE B.

Leakage of locks.

The enlarged lock No. 60, (in the vicinity of Lyons) built in 1840, of 10 feet lift, was found to leak 1,344 cubic feet a minute, though apparently in good order.

Enlarged lock No. 61, of 8 feet lift, at the same time was found to leak 1,220 cubic feet a minute.

Other enlarged locks were found to leak at different rates, ranging from 450 to 1,100 cubic feet a minute.

The leakage of one of the Brighton (old) locks, was found to be more than 200 locks full of water a day; while the average number of lockages at that lock during the season of navigation last year, was but 70 a day.

The last lock at Clyde, is to be of about the same lift as lock No. 61.

In the calculation of leakage and lockage through the last lock, it has been thought proper to allow its lift the same as that of the first lock west of it.

NOTE C.

Hemlock Lake.

A survey of the drainage of Hemlock lake made the present season, shows its area to be 27,554 acres.

To this may be added 3,515 acres, the drainage basin of the outlet of Canadice lake, which it is proposed to turn into Hemlock lake, making in all 31,069 acres as the total drainage into the lake.

The area of Hemlock lake has been accurately measured for several different heights of water, the results of which are as follows:

		Difference.
Covered at low water	1828 acres.	
5 ft. below "	1544 "	284
10 " "	1405 "	139

Deducting from 31,069 acres, the area of the valley of Hemlock lake 1,544 acres, the averaged area of the proposed reservoir, we have 29,525 acres as the true area of drainage. Hence the amount of water that will run into the lake in a year of last fall amounts to

$$\frac{{}^*29.525\times43{,}560\times22\times0.4}{12}= \quad 943{,}146{,}600 \text{ cubic feet.}$$

From which deduct the excess of evaporation† more than the fall of rain on the lake

$$\frac{(49-22)\ 1{,}544\times43{,}560}{12}= \quad 151{,}327{,}440 \text{ "}$$

Gives 791,819,160 cubic feet

as the amount available in the year of least fall of rain.

* 43,560 is the number of square feet in an acre.

† The evaporation from careful experiments has been found to be about 49 inches per annum in this State.

During the past season, which has been unusually dry, the Hemlock lake has afforded during the drought about 300 cubic feet of water a minute.

It is believed that it will be necessary after the reservoir is constructed to furnish at least twice this amount as a regular supply for that part of the year when the water is not needed for restoring the water of the Genesee river. Hence we have the water available as above, ... 791,819,160 cubic feet.

From which deduct 245 days at 600 feet a minute, equal $245 \times 1,440 \times 600$ for the use of mills on the outlet, ... 211,680,000

Balance, ... 580,139 160

amounting to 3,357 cubic feet a minute for 120 days. From this should be deducted the present minimum flow from the lake, or 300 cubic feet a minute during the dry season, leaving 3,057 cubic feet a minute as the saving to be effected by the reservoir.

Hemlock lake is about $6\frac{7}{10}$ miles long and $\frac{6}{10}$ of a mile wide.

The water is generally deep, ranging from 45 to 86 feet in the centre.

The shores are bold and the beach is covered with gravel, except a few chains in length in the vicinity of the inlet.

At the head of this lake is a swamp of 118 acres, partially covered at high water, and so much injured thereby as to render it unfit for agricultural purposes. During the time of low water in the lake this swamp is nearly dry.

To avoid producing miasmas, by occasionally in wet seasons having the water cover this swamp in the months of July and August, it is believed best to have the top water line of the reservoir on a level with the present low water mark.

This plan will leave the adjacent country less exposed to fever and ague than at present.

The areas of the lake at low water mark and when drawn down different depths, also the water it will contain, are given in the following table:

	Area of lake.	Contents in cubic feet.
At low water mark.........	1,828 acres.	
5 ft. below "	1,544 "	367,210,800
10 ft. " "	1,405 "	321,146,100
Total,....................		688,356,900 cubic ft.

as the contents of the reservoir, if constructed so as to draw down the lake surface ten feet deep from the low water mark.

If now we take the amount of water available during the dry season in the year of least fall (as previously computed) at 580,139,160 cubic feet, and add to it the excess of evaporation more than the fall of rain for the months July, August, September and October, equal to about $\frac{2}{3}$ the annual loss as previously given,

viz: 151,327,440,........................ 100,884,960

We have,............... . 681,024,060 cubic ft.

as the necessary cubical contents of a reservoir to hold the amount of water required for the supply, on the supposition that no water runs into the reservoir during the dry season, and that the dry season commences when the reservoir is full.

But as occasionally the dry season may commence on the river when the reservoir is not quite full, it is believed proper to make the Hemlock lake reservoir so as to be able to draw down the water ten feet below the present low water mark. And to construct a dam and bulk head at the outlet, so as to be able to maintain the high water mark of the reservoir at the present low water mark of the lake.

The cutting down of the outlet would destroy the water power at Hemlock Lake village. As this would cause great injury to the village, in addition to the value of the mills, &c., it has been thought best to calculate for cutting a tail race from near the site of the mills so as (if a suitable arrangement can be made with the proprietors) to restore a water power as good as that which it may be necessary to destroy.

Estimate of the cost of Hemlock Lake Reservoir.

Grubbing and cleaning,			$1,000	$1,000
Excavation,	170,000	cubic yards at	20c	34,000
do	9,000	do	12c	1,080
Embankment,	12,000	do	16c	1,920
Slope wall,	4,600	do	$1.00	4,600
Rip rap wall,	5,000	do	50c	2,500
Road bridges,	2	do	200	400

Dam.

(Excavation and embankment included above.)

Bailing and draining, $300	$300	
Hemlock timber, 800 cubic feet at 15c	120	
Pine, 250 cubic feet at 18c	45	
Piles, 5,600 linear feet at 20c	1,120	
Pine plank, 14 M. at $15.00	210	
Masonry, 420 cubic yards at $9.00	3,780	
Wrought iron, spikes and nails, 1,000 lbs. at 12c	120	
Puddle, 1,000 cubic yards at 30c	300	
		$5,995

Bulk head.

Bailing and draining, $500	$500	
Hemlock timber, 600 cubic feet at 15c	90	
Pine, 300 do 18c	54	
Piles, 2,400 linear feet at 20c	480	
Pine plank, 7 M. at $15.00	105	
Masonry, 220 cubic yards at $9.00	1,980	
Wrought iron, spikes and nails, 500 lbs. at 12c	60	
Puddle, 500 cubic yards at 30c	150	
Hildreth's patent Gates, 4 at $225,	900	
Painting, $5,	5	
		$4,324
		55,819
Add about 10 per cent for contingencies,		5,581
If a tail race be dug for the water power at Hemlock Lake village, there will be in addition to the above required excavation, 56,000 cubic yards at 18c,	10,080	
Add about 10 per cent,	1,020	
		11,100
Total,		$72,500

Canadice Lake.

A survey of the drainage of this lake shows its area to be 8,883 acres, including the lake. The lake has been accurately surveyed for several depths and the results are as follows, viz:

Area at low water mark,........	648 acres.
" " 5 ft. below water mark,.............	588 "
" " 10 ft. " " "	567 "

Deducting from the area of the valley of Canadice lake 600 acres, the average area of the proposed reservoir, we have 8,283 acres as the true area of drainage.

Hence the amount of water that will run into the lake in a year of least fall amounts to

$$\frac{8{,}283 \times 43{,}560 \times 22 \times 0.5}{12} = \quad 330{,}740{,}190$$

From which deduct the excess of evaporation more than the fall of rain on the lake $\frac{(49-22)}{12} \times 600 \times 43{,}560 =$ 58,806,000

Gives balance,..............................271,934,190

As the amount available in the year of least fall of rain.

There is now a saw-mill and dam at the outlet of this lake which to some extent controls the flow of water from it.

During the past year the flow from Canadice lake has averaged 300 cubic feet a minute during the dry season. It is believed in a year of least fall of rain the flow will not be more than two-thirds of this amount or 200 cubic feet a minute during a part of the dry season.

Hence we have the water available as above,......... 271,934,190

From which deduct 300 feet a minute for 245 days=

$300 \times 245 \times 1{,}440 =$............ 105,840,000

Balance,........................ 166,094,190

Amounting to 961 cubic feet a minute for 120 days.

From this should be deducted the present average minimum flow during the dry season, which may be taken at 300 cubic feet a minute, leaving 661 cubic feet a minute as the saving to be effected by the reservoir.

Canadice lake is about $3\frac{1}{10}$ miles long and $\frac{1}{3}$ of a mile wide. The water is generally deep, ranging from 50 to 86 feet in the centre, and averaging of a greater depth than Hemlock lake.

The shores are bold, and the beach is generally covered with gravel.

Its surface is about two hundred feet above the level of Hemlock lake.

At the head of this lake there is a swamp of about 45 acres.

For reasons similar to those given in relation to Hemlock lake, it is deemed proper, if this lake be made into a reservoir, to have the top water line of the reservoir on a level with the present low water mark.

The area of the lake at low water mark, and when drawn down different depths, and the water it will contain, are given in the following table:

	Area of lake.	Contents in cubic feet.
At low water mark,................	648 acres,	
At 5 feet below low water mark,. ..	588 "	134,600,400
At 8 " "	574 "	75,925,080
Total, ...		210,525,480

as the contents of this reservoir, if constructed so as to draw down the lake surface 8 feet during the dry season.

If we now take the amount of water available in the year of least fall, as before given,...............	166,094,190
And add the evaporation during the months of July, August, September, and October, inclusive, equal to $\frac{2}{3}$ the annual loss, as before given at 58,806,000,.. ...	39,204,000
We have,..............................	205,298,190

cubic feet as the contents of a reservoir necessary to hold the amount required.

And for similar reasons to those given in relation to Hemlock lake reservoir, it is deemed proper to construct Canadice lake so that it can be drawn down 8 feet, and the high water mark maintained at the present low water mark of the lake.

There is a saw mill at the outlet of this lake, which would be destroyed if this reservoir be constructed.

Estimate of the cost of constructing Canadice lake reservoir.

Outlet.		
Grubbing and clearing,		$150 00
49,000 cubic yards' excavation, at 18c.,		8,820 00
6,000 " embankment, at 16c.,		960 00
3,500 " slope wall, at $1.00,		3,500 00
2 road bridges, at $125.00,		250 00
Bulk head and dam.		
(Excavation and embankment included above.)		
Bailing and draining,	$500 00	
220 cubic yards masonry, at $9.00,	1,980 00	
600 " feet hemlock timber, at 15c.,	90 00	
300 " " pine " 18c.,	54 00	
2,400 linear " piles, at 20c.,	480 00	
7 M. pine plank, at $15.00,	105 00	
500 lbs. wrought iron spikes & nails, 12c.,	60 00	
500 cubic yards puddle, at 30c.,	150 00	
2 Hildreth's patent gates, at $225.00,	450 00	
Painting, 5.00,	5 00	
		$3,874 00
		17,554 00
Add about 10 per cent. for contingencies,		1,746 00
Total,		$19,300 00

Honeoye Lake.

The drainage basin of this lake contains 27,850 acres. To this may be added 8,250 acres, the area of Mill Brook valley, the drainage of which it is proposed to turn into the lake, making a total of 36,100 acres. From this should be deducted 1,640 acres, the area of the lake when drawn down four feet below the present low-water mark, gives 34,460 acres as the true area of drainage.

Hence the amount of that will run into the lake in a year of least fall of rain is equal to

$$\frac{34{,}460 \times 43{,}560 \times 0.4 \times 22}{12} = \qquad 1{,}100{,}790{,}240 \text{ c. feet.}$$

From which deduct the excess of evaporation more than the fall of rain on the lake $= \frac{27 \times 1{,}640 \times 43{,}560}{12} =$ 160,736,400 c. feet.

Gives, 940,053,840 c. feet,

as the amount available in a year of least fall of rain.

During the last season Honeoye lake has afforded about 350 cubic feet of water a minute during the drought.

It is believed that it will be necessary to furnish twice this amount as a regular supply for that part of the year when the water is not needed for restoring the water of the Genesee river.

Hence from the amount of water available as above given, ...	940,053,840 c. feet,
deduct 245 days at 700 cubic feet a minute, $= 245 \times 700 \times 1.440 =$	246,960,000 "
Balance,	693,093,840 "

amounting to 4,010 cubic feet a minute.

From this should be deducted the present minimum flow, or 350 cubic feet a minute during the dry season, leaving 3,660 cubic feet a minute as the saving which might be effected by the reservoir, if made of sufficient size to contain the drainage.

But it is not deemed proper to cut down the outlet of this lake enough to obtain this amount of water.

Honeoye lake is about 4½ miles long and ⅝ of a mile wide. The water is generally shallow, varying from 15 to 25 feet deep in the centre.

The shores of the lake are not so bold as either of the other lakes, but the beach is generally covered with gravel, except a few chains at the inlet.

At the head of this lake there is a swamp of 715 acres partially covered at high water.

For similar reasons to those given in relation to Hemlock lake, it is deemed proper, if this lake be converted into a reservoir, to make the high water line of the reservoir one foot below the present low water mark of the lake.

The area of the lake at low water mark is........			1,727	acres.
"	"	" 1 ft. below low water mark is	1,679	"
"	"	" 6 ft. " " "	1,564	"

making the cubical contents of the reservoir for a depth of 5 feet, equal to 353,162,700 cubic feet.

From observations made on the lake the present season, it is believed that the flow of water into the lake during the dry season will at least be equal to the evaporation from its surface, and that it will be safe to calculate on having this reservoir full at the commencement of the dry season. Therefore the lake may be depended upon to furnish

$$\frac{353,162,700}{120 \times 1,440} = 2,044 \text{ cubic feet a minute for 120 days.}$$

From this should be deducted the present minimum flow of the lake, or 350 cubic feet a minute, leaving 1.694 cubic feet a minute, as the saving to be effected by converting this lake into a reservoir.

This lake might, by cutting down the outlet to a greater depth, be made to furnish a larger supply of water.

But it is not deemed prudent so to do, because the lake is shallow, and by drawing it down to any considerable depth there will be a large quantity of decomposing vegetable matter exposed to the influence of the weather, which will probably increase the tendency to fever and ague in the vicinity; while, by the plan proposed, it is believed that the swamp at the head of the lake will be reclaimed and made valuable land, and the adjacent country rendered healthy.

There is a saw-mill, flouring-mill and small factory in the village of Honeoye Flats, on the outlet of this lake. The construction of a reservoir would destroy these.

The flouring-mill in the dry season of the past summer had barely sufficient water for one run of stone about 10 hours a day. The factory is driven by water-power when the lake is high, and has a small steam engine which it uses when the lake is low. Probably an arrangement can be made with the proprietors of this and the saw-mill, so as to enable them to use steam power exclusively.

Estimate of the cost of Honeoye Lake Reservoir.

Grubbing and clearing, ...			$150.00		$ 150
Excavation, ...	82,000 cubic yds. at		18		14,760
" Mill Brook chnl,	13,000	"	14		1,820
Embankment, ...	4,500	"	16		720
Slope wall, ...	2,500	"	1 00		2,500
Rip rap, ...	3,000	"	50		1,500
Road bridges, ...	2	"	150 00		300
		Dam.			
Bailing and draining, ...			$200 00	$200	
Hemlock timber, ...	700 cubic ft. at		15	105	
Pine "	250	"	18	45	
Piles, ...	5,000 linear "		20	1,000	
Pine plank, ...	14 M.	"	15 00	210	
Masonry, ...	200 cubic yds. at		9 00	1,800	
Wrought iron, &c., .	800 lbs.	"	12	96	
Puddle, ...	800 cubic yds.	"	30	240	
				——	$3,696
		Bulkhead.			
Bailing and drawing, ...			$500 00	$500	
Hemlock timber, ...	500 cubic ft. at		15	75	
Pine "	250	"	18	45	
Piles, ...	2,000 linear "		20	400	
Masonry, ...	170 cubic yds. "		9 00	1,530	
Wrot. iron, spikes &c,	500 lbs.	at	12	60	
Puddle, ...	450 cubic yds. at		30	135	
Painting, ...			5 00	5	
Hildreth's pat. gates,	4		225 00	900	
				——	$3,650
Total, ...					... $29,096
Add about 10 per cent for contingencies, ...					2,904
Total, ...					$32,000

Conesus Lake,

Is about $7\frac{4}{5}$ miles long and $\frac{5}{8}$ mile broad.

The water is generally deep, ranging from 35 to 70 feet in the centre. The shores are not as bold as those of Hemlock lake, but rather steeper than those of Honeoye. The beach is covered with gravel, except a small distance near the inlet.

At its head is a swamp of 616 acres, now of little value, which may be reclaimed and rendered valuable by making this lake into a reservoir and fixing its high water mark at the present low water mark of the lake.

The area of the lake at low water mark and when drawn down different depths, also the water it will contain, are given in the following

TABLE

	Area of lake.	Contents in cubic feet.
At low water mark,........ ..	3,184 Acres	
" 5 ft. below low water mark,.	2,884 "	660,805,200
" 8 ft. " " " " .	2,797 "	371,196,540
Total,....................		1,032,001,740

The drainage of this lake contains 39,980 acres, from which should be deducted 3,080 acres, (the area when drawn down $2\frac{1}{2}$ feet) gives 36,900 acres as the true area of drainage.

Hence the amount of water that will run into the lake in a year of least fall of rain is equal to

$$\frac{36{,}900 \times 43{,}560 \times 0.4 \times 22}{12} = \quad 1{,}178{,}733{,}600$$

From which deduct the excess of evaporation more than the fall of rain on the lake $= \frac{27 \times 3{,}080 \times 43{,}560}{12} =$ 301,870,800

Gives......... 876,862,800

cubic feet as the amount available in the year of least fall of rain.

This year the lake during the drought furnished but 150 cubic feet a minute.

It is however believed that if the Lake should be converted into a reservoir, it would be necessary to arrange it so as on an average to furnish during that part of the year when not needed for the Genesee river at least 600 cubic feet a minute. Hence from the water available as above given,............ ... 876,862,800

deduct 245 days at 1000 cubic feet a minute $= 600 \times 245 \times 1440 =$ 211,680,000

Balance,. . ... 665,182,800 cubic feet,

equal to 3850 cubic feet a min. for 120 dys.

From this should be deducted the present minimum flow, or 150 cubic feet a minute, gives 3,700 cubic feet a minute as the saving to be effected by the reservoir.

If now we take the amount of water available during the dry season in the year of least fall as before given, 665,182,800 cubic feet, and add to it the loss by evaporation for the months of July, August, September and October, equal to about ⅔ the annual loss as previously given, at 301,870,800, we have } =201,247,200

866,430,000 cubic feet as the necessary contents of a reservoir to hold the amount of water required for the supply on the supposition that the reservoir is full when the dry season commences and that no water runs into it during the drought. But it is believed best, if this Lake be made into a reservoir, to construct it large enough to contain rather more than this amount or to make it so that it can be drawn down eight feet in depth. The construction of this reservoir will destroy Olmstead's water power on the outlet.

Estimate of the cost of Conesus lake reservoir.

Grubbing and clearing,		$1,200 00	$1,200
Excavation....	147,000 cubic yards at	20c	29,400
Embankment........	24,000 "	16	3,840
Slope wall,.........	2,600 "	1 00	2,600
Rip-rap,.	11,500 "	50	5,750
Road bridges, ...	2	150 00	300

Dam.

Bailing and draining	$300 00	$300	
Hemlock and timber, 800 cubic feet at	15	120	
Pine, 250 cubic feet at.............	18	45	
Piles, 5,600 linear feet at..	20	1,120	
Pine plank, 14 M. at...............	15 00	210	
Masonry, 260 cubic yards	9 00	2,340	
Wrought iron, spikes, &c., 1,000 lbs..	12	120	
Puddle, 1,000 cubic yards at........	30	300	
			4,555

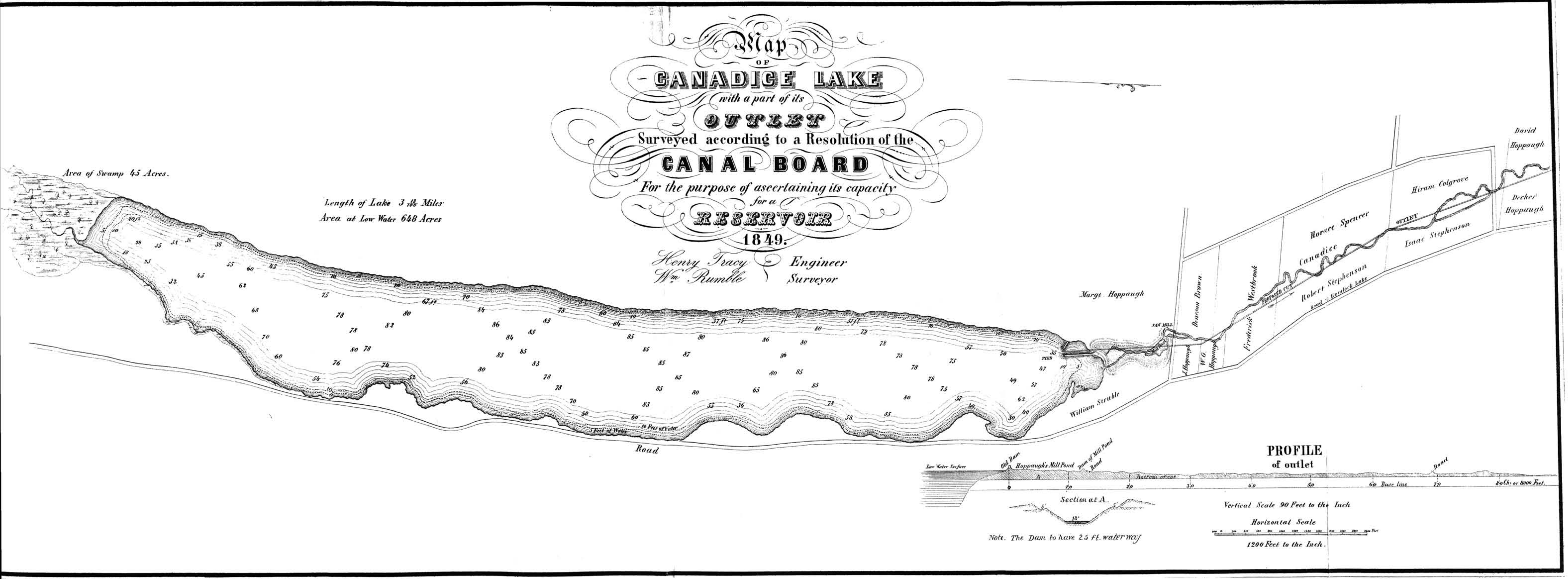
Bulk-head.

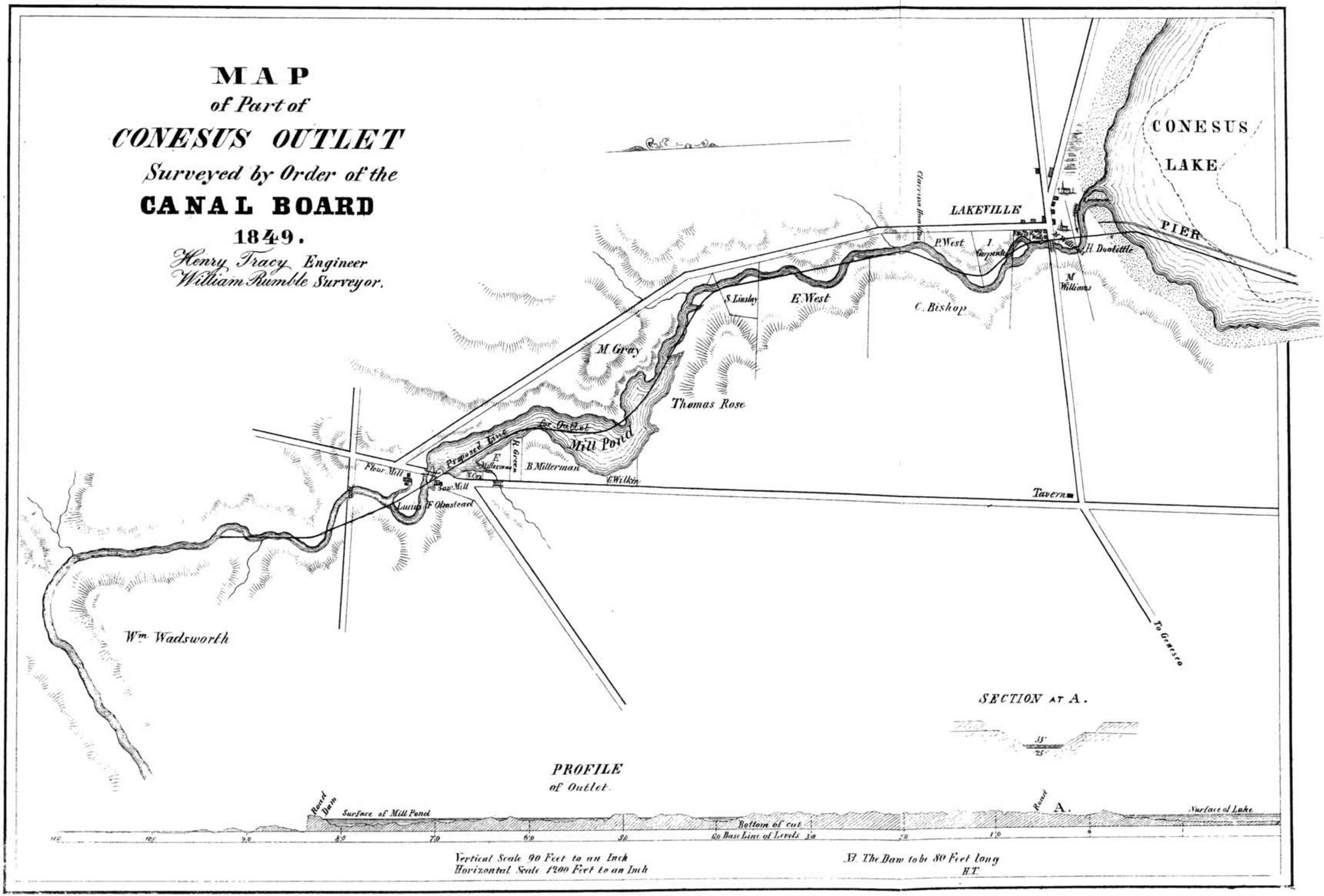
Bailing and draining, ...	500 00	500	
Hemlock timber, 600 cubic feet at....	15	90	
Pine, 300 cubic feet at.............	18	54	
Piles, 2,400 linear feet at.....	20	480	
Pine plank, 7 M., at	15 00	105	
Masonry, 190 cubic yards at	9 00	1,710	
Wrought iron, spikes, &c., 500 lbs. at	12	60	
Puddle, 450 cubic yards, at.........	30	135	
Hildreth's patent gates, 4 at........	225 00	900	
Painting,.........................	5 00	5	
			$4,039
			51,684
Add about 10 per cent for contingencies,............			5,316
Total............			$57,000

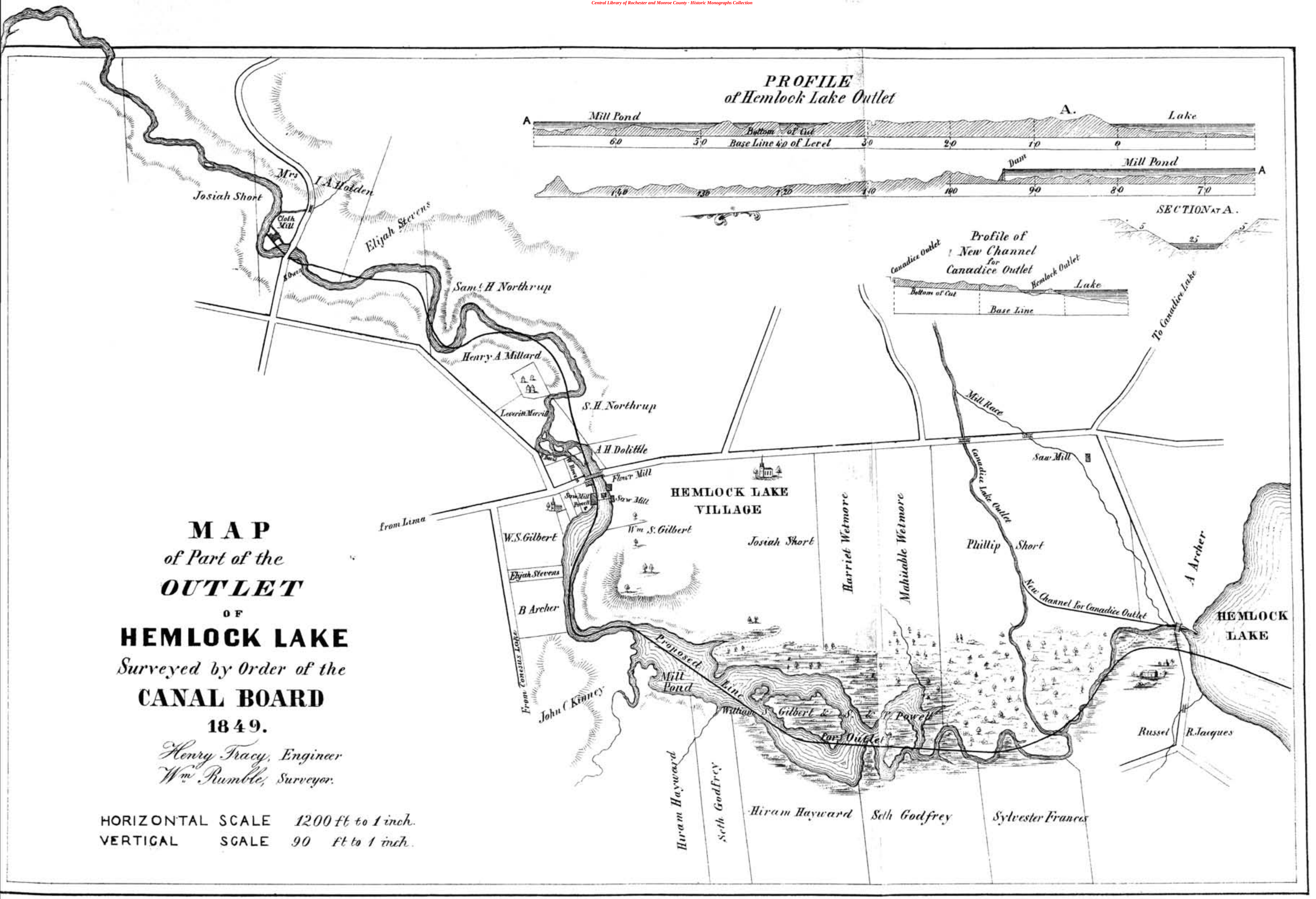
MAP
OF
HEMLOCK LAKE
Surveyed according to a Resolution
of the
CANAL BOARD
For the purpose of ascertaining its capacity
FOR
A RESERVOIR
1849.
Henry Tracy ____ Engineer.
H. F. Hart & Wm Rumble __ Surveyors.
D. VAUGHAN DEL.
R. H. Pease, Lith. Albany.
Length of Lake ___ 6. 61/100 Miles.
Area at Low Water __ 1.828 Acres.
Town of Livonia
Town of Canadice
Town of Conesus
Road
Road
Canadice Outlet
Area of Swamp 118 Acres
SWAMP
Inlet
Scale 1200 Feet per Inch.


MAP
OF
CONESUS LAKE
Surveyed according to a Resolution
of the
CANAL BOARD
For the purpose of ascertaining its capacity
FOR A
RESERVOIR
1849
Henry Tracy Engineer
Chas. Oscar Benedict Asst. Engr. & Surveyor
D. VAUGHAN DEL
R. H. Pease, Lith. Albany
L i v o n i a
C o n e s u s
Lakeville
PIER
Town of Livonia
Town Line
Geneseo
Town Line
WADSWORTHS LANDING
Road
Scale 1200 Feet per Inch
Geneseo
Town Line
Groveland
Town Line
Length of Lake 7 8/10 Miles
Area at Low Water 3184 Acres.


MAP
OF
HONEOYE LAKE
Surveyed according to a Resolution
of the
CANAL BOARD
For the purpose of ascertaining its capacity
for
A RESERVOIR
1849.
Henry Tracy — Engineer.
William Rumble
William Hall
Surveyors.
D. VAUGHAN DELINEAVIT.
R. H. Pease, Lith. Albany.
Length of Lake — 4 18 Milles.
Area at Low Water — 1, 727 Acres.
Area of Swamp 745 Acres
S W A M P
Profile of New Channel for Mill-Brook
Lake
Section at B
PROPOSED CHANNEL FOR MILL BROOK
Road
Mill Brook
J. Pennel
D. Pennel
Barn
Barn
G. W. Pitt
Hiram D.P.Pitt
Outlet
Proposed Cut
Cloth Works
Honeoye
Saw Mill
Flouring Mill
Hiram Pitt's
Wm. Short
John Allen
Jed Briggs
David Pierpont
Andemas Briggs
PIER
PROFILE OF PROPOSED OUTLET
Low Water Surface
Bottom of Cut
Base Line of Level
60 50 40 30 20 10 0 0
Section at A
Line of 5 feet
5 feet
Town of Richmond
Town of Canadice
Swamp
Scale 1200 Feet per Inch.


Map
of
CANADICE LAKE
with a part of its
OUTLET
Surveyed according to a Resolution of the
CANAL BOARD
For the purpose of ascertaining its capacity
for a
RESERVOIR
1849.
Henry Tracy Engineer
Wm. Rumble Surveyor
Area of Swamp 45 Acres.
Length of Lake 3 48/100 Miles
Area at Low Water 648 Acres
Road
Margt Hoppaugh
William Struble
Saw Mill
Pier
Deacon Brown
Westbrook
Fredrick
Horace Spencer
Robert Stephenson
Road to Hemlock Lake
Canadice
Outlet
Isaac Stephenson
Hiram Colgrove
David Hoppaugh
Decker Hoppaugh
PROFILE
of outlet
Low Water Surface
Old Dam
Hoppaugh's Mill Pond
Dam of Mill Pond
Road
Bottom of cut
Base line
80 Ch. or 8000 Feet.
Section at A.
Note. The Dam to have 25 ft. water way
Vertical Scale 90 Feet to the Inch
Horizontal Scale
1200 Feet to the Inch.


MAP
of Part of
CONESUS OUTLET
Surveyed by Order of the
CANAL BOARD
1849.
Henry Tracy Engineer
William Rumble Surveyor.
CONESUS
LAKE
PIER
LAKEVILLE
P. West
J. Carpenter
H. Doolittle
M. Williams
S. Linsley
E. West
C. Bishop
M. Gray
Thomas Rose
Mill Pond
Proposed Line for Outlet
K. Green
B. Millerman
E. Millerman
G. Wilkin
Flour Mill
Saw Mill
Lucius F. Olmstead
Tavern
To Geneseo
Wm. Wadsworth
SECTION AT A.
33'
25'
PROFILE
of Outlet.
Road
Dam
Surface of Mill Pond
Bottom of cut
Base Line of Levels
Road
A.
Surface of Lake
Vertical Scale 90 Feet to an Inch
Horizontal Scale 1200 Feet to an Inch
N.B. The Dam to be 80 Feet long
H.T.


MAP
of Part of the
OUTLET
OF
HEMLOCK LAKE
Surveyed by Order of the
CANAL BOARD
1849.
Henry Tracy, Engineer
Wm. Rumble, Surveyor.
HORIZONTAL SCALE 1200 ft to 1 inch.
VERTICAL SCALE 90 ft to 1 inch.
PROFILE
of Hemlock Lake Outlet
Mill Pond
Lake
Bottom of Cut
Base Line of Level
Dam
SECTION AT A.
Profile of
New Channel
for
Canadice Outlet
Canadice Outlet
Hemlock Outlet
Base Line
HEMLOCK LAKE VILLAGE
HEMLOCK LAKE
Josiah Short
Mrs. I. A. Holden
Cloth Mill
Elijah Stevens
Saml. H Northrup
Henry A Millard
Leverett Merrill
S. H. Northrup
A H. Dolittle
Flour Mill
Saw Mill
from Lima
W. S. Gilbert
Wm. S. Gilbert
Elijah Stevens
B Archer
From Conesus Lake
John C Kinney
Mill Pond
Proposed Line
William S. Gilbert & S. & T. Powell
Fort Outlet
Hiram Hayward
Seth Godfrey
Sylvester Frances
Harriet Wetmore
Mahitable Wetmore
Phillip Short
Mill Race
Canadice Lake Outlet
New Channel for Canadice Outlet
To Canadice Lake
A Archer
Russel
R. Jacques