# REPORT

OF

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CIVIL ENGINEER,

ON PROPOSED

# WATER SUPPLY

FOR

## DARTMOUTH, N. S.



HALIFAX, N. S.
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OTTAWA, 7TH MARCH, 1876.

*G. J. TROOP, Esq.*,

*Warden*,

*Dartmouth, N. S.*

DEAR SIR,—I have received from Mr. Murphy, C. E., the results of the surveys which I recommended to you in my letter of 18th August last.

It may be proper to repeat that having examined the vicinity of Dartmouth last summer, I was fully convinced that the only adequate sources of supply within financial reach of your town were the three lakes on the Preston road, known as "Lamont," "Topsail," and "Loon" Lakes, which are over 220 feet above tide,—within 3 feet of same level, and divided from each other by low ground, through which a connection of their waters may be easily made.

Apparently there was abundance of water in this quarter, there being a Mill on the outlet of Lamont Lake;—and it may be accepted as a rule that any source of water supply for a town is at least a doubtful one if it is not a "mill stream." The fact that a Mill was in operation there was to me the strongest reason for believing in the sufficiency of the supply; but I was unable to pronounce upon this important point until the acreage drained into these Lakes was ascertained.

The extent of water surface is not always a guide to the value of these Lakes. If on a summit level they may have a mere rim of drainage area around them, furnishing annually little more than will supply the avaporation, and when once drawn down, it would require a series of years to fill them up again.

Subterranean sources of supply are sometimes ascribed to such Lakes, but the simple experiment of drawing one of them down will explode this theory. This rather expensive test was made by the City of London, Ontario, two or three years ago.

It requires but little reflection to be convinced that all our sources of fresh water supply are derived from the clouds, and that the annual quantity of water which any stream wil. afford depends upon the annual amount of rain and snow fall, which is precipitated upon the drainage area due to that stream. A portion of this water is evaporated, that from the land being the smaller portion (varying very much with the character of the soil on which it falls:) that from the water surface being the greater portion if not the whole.

Evaporation goes on at all temperatures, and for our latitudes is a tolerably constant quantity; but rain-fall varies nearly one hundred per cent between the great Lakes in Ontario and the neighbourhood of Halifax. While here evaporation disposes of one-half of the rain-fall, with you it would seldom exceed one-third, and your remainder would be about double that of ours; that is the available annual yield of water from an acre in the neighbourhood of Dartmouth will be about double that from an acre near Hamilton, Ont. Evaporation is greatest from rock and clay surfaces, especially if cleared, and least from gravel, sand and forest land, which immediately absorb and protect the rain-fall from the sun and heated air. In this respect you are fortunate about Dartmouth, and will suffer less loss than usual from this action of the sun, who will always be your greatest competitor for a share in the water-shed of your Lakes.

The second point in importance to be determined by the surveys recommended, was the *depth* of the Lakes which it was proposed to make your Reservoir's. For purposes of town supply, storage is as important as drainage area. Many streams furnish abundant annual supplies, which are useless for town purposes, unless the surplus in freshets can be stored up for a season of drought. Your Lakes are magnificient natural reservoir's, but assuming a prolonged drought, during which they would receive no supply at all from the clouds, while all the while they would be losing the highest amount from evaporation: it becomes necessary to know to what extent they may be drawn upon. A common practice is to raise the level by damming the outlet, and where the Lakes are shallow this is necessary. The supply pipe should have its mouth from 5 to 10 feet below the Lake surface, in order to draw off that quantity if necessary; and the raising of the natural surface facilitates and cheapens the work of leading out this pipe

On the other hand, unless the banks are bold, raising the level is objectionable, as it increases the surface exposed to evaporation, and floods more land, producing more shallow water and subaqueous vegetation, which, when exposed in a time of drought, decays and taints the whole body of the water.

As Lamont and Topsail Lakes have much low border, it was evident from inspection that it would be desirable to avoid raising their surfaces. If this had been necessary there would have been, in addition to the value of the land so drowned, a much greater expenditure to be provided for in order to remove all vegetable matter from the flooded border.

The results of the surveys are most satisfactory. The water-shed of Lamont and Topsail Lakes, exclusive of their water surfaces, is 540 acres, and that of Loon Lake 630 acres, or a total of 1170 acres.

The area of water surfaces of the Lakes is as follows:—

| | | | |
|---|---|---|---|
| Lamont, | acres, | 24. | 2.29. |
| Topsail, | " | 144. | 2.12. |
| Loon, | " | 193. | 0.18. |
| | | 362. | 0.19. |
| Add land drained, | | 1170. | 0.0. |
| Total, | | 1532 acres. | |

The average rain-fall at Dartmouth is probably not less than 50 inches. but as there is one year (1860) in which 39 inches only has been recorded, I think the rain-fall of that year may safely be taken as the minimum, and it is with that we have to do at present.

Allowing 24 inches of available water, from 1100 acres land, drained by these three Lakes, this would give 60 gallons per diem each, to a population of 27,000. As the storage is so large, a higher per centage of the rain-fall than that due to the minimum year can be utilized, because the Lakes, if drawn down only five feet, would supply over one million gallons daily for a whole year without any incoming water. When it becomes necessary to use Loon Lake the surplus storage will be ample to make up the deficiency of an exceptionally dry year. It is therefore evident that the first great desideratum, ample quantity of water, not only for the present but for the future, can be obtained from this quarter. I believe that with the addition of Loon Lake a population as large as Halifax can be supplied in the future. For the wants of Dartmouth for many years to come, Lamont and Topsail Lakes will afford an ample supply; and the soundings taken shew that it will not be necessary to raise their level. This will avoid much expense and secure the best quality of water.

The depth of the Topsail and Lamont Lakes, ranges between 15 and 20 feet, and this makes them natural Reservoir's, to be drawn upon in dry weather. Loon Lake, however, being 3 feet lower than Topsail, must be raised before it can be used; but that necessity will not arise with the present generation. Topsail Lake alone will provide an ample supply for many years, and its value is greatly enhanced by the fact that the supply from it can be more than doubled in the future, by the addition of Loon Lake to the system. When the population of Dartmouth becomes so large that more water will be wanted than Topsail Lake can supply, if the full sized pipe is now adopted, nothing further is required than to dam the Loon Lake outlet, and cut a ditch between it and Topsail Lake.

In order fully to draw down the surface of Topsail Lake it will be necessary to deepen the channel which connects it with

Lamont Lake. This may be postponed until the necessity arises, as it can be done to better advantage when the water is low, and it may be some years before it will be necessary.

The mouth of the supply pipe for the town should be placed about ten feet (or not less than eight feet) below the level of Topsail Lake. This will not only enable you to draw the largest amount from Topsail Lake, but when Loon Lake is brought in, its great contents may then be drawn upon to the extent of at least five feet from its raised surface

The headworks, gate house, screens, &c., can be put in below the present dam, near the Mill, on dry ground, and a new dam built below them, after which the old one may be cut through and the Topsail Lake level brought down to the Mill.

The pipe track should follow the highway where it is direct and in favorable excavation ; but if to shorten the length or to avoid rock or deep excavations, it will be better to go through private property. The route should be selected with care, on as good grades as the ground will afford, avoiding all intermediate summits as far as possible, especially any which rise above the line of a continuous uniform gradient from the mouth of the pipe to Dartmouth. Where rock excavation occurs it will be better and cheaper to arrange the pipe levels as far as possible to keep above the rock, and to embank over the pipe and enter on private property for this purpose ; if the highway is rock, or to get around a high point, wherever this course may be followed.

The size of your pipe should be as large as can be afforded at present. It is usual to provide a pipe capable of passing a supply for say double the present population. Sixty gallons per head, per diem, is considered a liberal supply ; and although there are some places using more, the greater number are under this. Dartmouth, however, being upon the salt water, and an eligible situation for manufacturing establishments, should (with an unlimited gravitation supply under high pressure) anticipate the highest rate of consumption per head. In large places the estimate for domestic use, as above, is always in excess of that required for another most important purpose, the extinguishment of fires, but in smaller towns this is reversed. For efficiency in this direction, a certain provision is necessary without reference to population ; and, in the case of Dartmouth, I think this is the consideration which ought to determine the size of pipe to be used. For the domestic wants of Dartmouth (with a population of 6000) a six inch pipe would afford an ample supply from Topsail Lake ; but for fire and manufacturing purposes the size should be twelve inches. With such a pipe you can dispense with fire engines of all kinds, in all parts of the town, not more than 125 feet above tide. Moreover, with ample capacity of pipe, the water may be freely used for small occasional powers, where steam could not be afforded, such as warehouse hoists, printing presses, sewing machines, church organs, &c., &c.

Lastly, with such a pipe it would not be necessary to buy a second one when the growth of Dartmouth would call for the addition of Loon Lake to your system.

## COST OF THE WORKS.

The cost of bringing in the water will depend upon the size of pipe adopted, and I have prepared a table shewing the relative cost and efficiency of different sizes between 6 and 12 inch. From this it will be seen that a twelve inch pipe will be more efficient than five six inch pipes, while it will only cost twice as much. For fire purposes the smallest size which could be entertained would be 9 inches, and this would not be efficient on the higher levels. The fact that Dartmouth extends so high above tide, and that these elevations are the most helpless in case of fire, renders it doubly important that the delivery should be as efficient as possible on the high levels; moreover these high levels comprise a large portion of the taxable area, and if efficiently supplied their taxable value will be doubled, and the rate will be cheerfully borne because, with efficient water supply for house and garden purposes and for fire protection, they will become the most eligible building sites.

The difference in cost between a 9 inch and a 12 inch pipe will not exceed $10,000; and the Dartmouth Water Works, with a twelve inch pipe, will be worth at least double what they will be with a nine inch one. The difference, in your favor, in the annual cost of Fire Insurance, with the larger pipe, will in a few years pay for the extra cost.

The cost of the distribution will depend upon the extent to which it is carried, and the amount of rock excavation which may be encountered.

Exclusive of land and water rights, the necessary present expenditure to bring in a 12 inch pipe, with the headworks and pipe track expenditure, will range between $40 000 and $50,000, and the cost of distributing the same will be $6000 per mile, in earth excavation, and nearly double this amount wherever there is an average of 4 feet of rock. This includes hydrants, valves and special castings and all the work of laying and setting complete.

The want of correct maps, shewing the position of the roads and Lakes, makes it impossible to form any opinion as to how direct a route the Preston Road gives between Dartmouth and Topsail Lake. If the route can be shortened, or the pipe kept on a higher level until it approaches Dartmouth, a route through private property may be preferable. It is not necessary to purchase a right of way, or create a "severance,"—a "servitude" only is required. The ground over the pipe can, except in cuttings and embankments, be cultivated as usual.

In conclusion I must say that I know of no town more favorably situated for an abundant, efficient and economical suppiy of the best quality of water than Dartmouth. I would also say that I know of no town which has regretted water works expenditure; or which has *not* regretted that that expenditure was, in the first place, too small. Everywhere the complaint is,—want of sufficient foresight and confidence in the future,—want of pluck to carry out, on a liberal scale, works upon which so much of the future success of the municipality depends. With such facilities as you possess I am satisfied no better investment can be made; nothing which, for the same outlay and in the same time, will add so much and so rapidly to the population and wealth of Dartmouth, as the bringing of an abundant supply of pure water from so high an elevation as Topsail Lake.

I have the honor to be,
Sir,
Your obedient servant,

THOS. C. KEEFER.

# DARTMOUTH WATER WORKS.

*TABLE shewing Discharge, at fifty feet above tide. Cost, &c. for 12 in., 10 in., 8 in., and 6 in. pipes, feeding from Topsail Lake, 225 feet above tide, and distant from Dartmouth 3.22 miles.*

| Diam. of Pipe. in. | Head in feet. | Length of Pipe. feet. | Discharge. | | Weight per foot. lbs. | Cost of Pipes. | | Cost of Excavation and re-filling. | | Pipe Laying, Head, &c. | Total Cost. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Galls. per min. | Galls. per 24 hours. | | Per foot. | 17,000 feet. | Per foot. | 17,000 feet. | per foot. | Per foot. | 17,000 feet. |
| 12 | 175 | 17000 | 1370 | 1,972,800 | 77 | $1.64 | $27,880 | 42 c. | $7,140 | 12½ c. | $2.18½ | $37,145 |
| 10 | 175 | 17000 | 860 | 1,238,400 | 62 | 1.32 | 22,440 | 42 c. | 7,140 | 11 c. | 1.85 | 31,450 |
| 8 | 175 | 17000 | 495 | 712,800 | 44 | .94 | 15,980 | 40 c. | 6,800 | 8 c. | 1.42 | 24,140 |
| 6 | 175 | 17000 | 240 | 345,600 | 30 | .64 | 10,880 | 40 c. | 6,800 | 6½ c. | 1.10½ | 18,785 |

The discharge in above Table is in open air. Two nozzles 1 in. diam. each, under 100 feet head, will discharge about 160 gallons each per minute. Allow for supply for Town at same time as hydraut is being used, 240 gallons per minute, = 560 gallons per minute, or 806,400 gallons per 24 hours.

Head required to overcome friction in 12 in. pipe, 17,000 ft. long, discharging 560 gallons per minute = 29 feet,-leaving effective pressure of 146 feet, at 50 feet above tide. Head required for 10 in. pipe discharging 560 gallons pe. minute = 73 feet., leaving 102 feet for pressure. Head required for 8 in. pipe discharging 560 gallons per minute = 224 feet, full capacity at tide level. An 8 in. pipe will be too small for fire purposes. A 12 in. pipe would delive: the same quantity with the same efficiency nearly 100 feet higher above tide than a 9 inch one would do.

# DARTMOUTH WATER WORKS.

*TOTAL PRECIPITATION at HALIFAX, N. S., 1867 to 1875 inclusive.*

| | 1867 | 1868 | 1869 | 1870 | 1871 | 1872 | 1873 | 1874 | 1875 |
|---|---|---|---|---|---|---|---|---|---|
| January........ ........ | 4.03 | 3.30 | 4.53 | 7.11 | 3.73 | 3.88 | 7.83 | 5.42 | 3.74 |
| February.... .......... | 2.55 | 3.39 | 4.38 | 10.34 | 5.88 | 4.49 | 1.61 | 5.31 | 5.83 |
| March......... ... .. . | 3.75 | 1.77 | 7.95 | 3.02 | 6.16 | 5.37 | 4.09 | 3.98 | 2.13 |
| April.................. | 5.08 | 3.86 | 2.57 | 3.9[illegible] | 4.88 | 2.85 | 2.86 | 4.55 | 3.38 |
| May ... ............. | 5.37 | 6.38 | 5.57 | [illegible].19 | 2.59 | 4.44 | 2.34 | 4.77 | 3.98 |
| June....... ....... .. | 2.01 | 5.18 | 3.92 | 1.69 | 2.96 | 4.23 | 2.96 | 7.92 | 4 07 |
| July .......... ...... | 3.08 | 1.02 | 2.92 | 3.21 | 3.38 | 2.88 | 3.90 | 2.29 | 5.61 |
| August................ | 4.22 | 3.60 | 2.58 | 2.20 | 3.69 | 6.82 | 4.45 | 3.37 | 3.55 |
| September......... ... | 4.66 | 5.55 | 1.57 | 3.33 | 4.81 | 1.41 | 4.48 | 5.04 | 2 06 |
| October ... ........... | 7.02 | 5.89 | 7.2[illegible] | 6.85 | 4.49 | 4.88 | 8.63 | 2.46 | 9.98 |
| November.............. | 6.67 | 6.45 | 5.47 | 6.28 | 4.18 | 6.65 | 7.98 | 3.58 | 5.54 |
| December .......... . | 7.07 | 3.58 | 5.77 | 6.06 | 4.39 | 6.16 | 4.31 | 5.49 | 1.61 |
| Annual Total ....... ... | 55.51 | 49.97 | 54.53 | 57.19 | 51.14 | 54.06 | 55.44 | 54.18 | 51.48 |

(Signed) F. ALLISON,
*Met. Chf. Agt. and Tel. Supt.*