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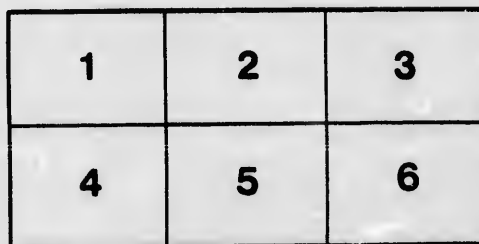
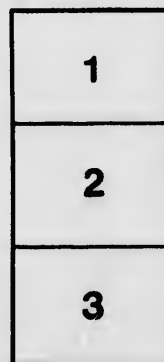
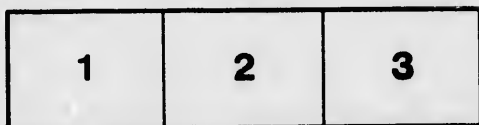
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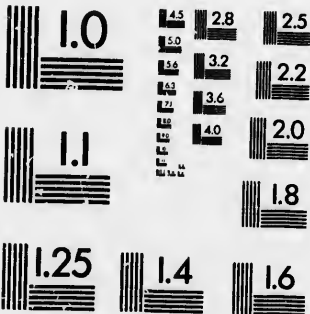
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# REPORT

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OF

MESSRS. J. B. JERVIS, AND ALFRED W. CRAVEN, ESQ'S.,

CIVIL ENGINEERS, NEW YORK,

ON

## A SUPPLY OF WATER

FOR THE

CITY OF HAMILTON.

---

BOARD OF WATER COMMISSIONERS FOR 1857:

CHAS. MAGILL, CHAIRMAN.  
ADAM BROWN.  
DAVID GALBREATH.  
M. W. BROWNE.  
PETER BALFOUR.

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HAMILTON:

PRINTED AT THE "MORNING BANNER" JOB PRINTING OFFICE,

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NEW YORK, 24th Dec., 1856.

To CHARLES MAGILL, Esq., Chairman of the Board  
of Water Commissioners, of the City of Hamilton, C. W.

SIR,—The undersigned, called by your Board as Consulting Engineers, in reference to the supply of Water for the City of Hamilton, beg leave to submit the following

### R E P O R T :

The preliminary surveys of THOS. C. KEEFER, Civil Engineer, made under your direction, and his able report thereon, develop three several plans, all of which he considered practicable, and discussed their respective merits. MR. KEEFER also reported his reconnaissance on sources which he discarded as inferior to any of the others.

The undersigned made reconnaissance of the several plans proposed by MR. KEEFER, as well as of those which he deemed too unfavorable to be taken into consideration. This reconnaissance with the Report and explanations of MR. KEEFER (who accompanied the undersigned) have led to the conclusion that the three plans presented by him afford the best means of procuring the desired supply. As the reasons given by MR. KEEFER for discarding certain sources are stated fully in his Report, and appear to be satisfactory, no extended remarks are deemed necessary on this branch of the subject. The Waterdown and Flamboro' sources are clearly more unfavorable than the Ancaster streams; and the Hess Spring is quite inadequate for any further purpose than (as suggested by MR. KEEFER, in one of his Reports)



to supply some few residences that are elevated on a level higher than it will be expedient to reach by the general supply.

There seems to be no doubt that the Ancaster is the proper source from which to obtain a supply by gravitation. MR. KEEFER has discussed this source in its general character very fully; and has shewn it to be adequate to the required supply. His surveys have exhibited this result very well; but, it is obviously necessary to have more detailed surveys to ascertain the full basis of cost. His reservoirs for storage appear, in the aggregate, quite sufficient in capacity, while their number complicates the system, and they are inadequate in depth for such a purpose. The topography of the country indicates the convenience and economy of such a system as he has proposed, and it may not be practicable to abandon it entirely. A reservoir for storage, to supply a town, should have as little shallow water as practicable. It should leave, when the water is drawn off, the least amount of surface exposed on its sides and bottom—especially if that be vegetable matter; and, ordinarily, it should be of such depth as will prevent the growth of aquatic plants.—The district, at the points desirable to concentrate the drainage, is not favorable for large and deep bodies of water; and it would not, probably, be expedient to undertake the accomplishment of the whole storage in one, or even in two Reservoirs. The plan of combining Cold Spring stream with the Ancaster renders at least two Reservoirs necessary. The most favorable site for one on the Ancaster is between the Red and Burnt Mills, and will involve some encroachment on the water power of the latter. At this place MR. KEEFER proposes a Reservoir of about thirty (30) acres. This

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should be made larger and deeper, which will further encroach on the power of the Burnt Mill. The Reservoir on the Cold Spring stream, below Egglestone's Factory, should be raised so as to make it the main storage on this branch; but this raising would destroy the power for the factory. It appears that two Reservoirs would be necessary to store the water of the two branches of the Hermitage Creek, and it may not be practicable to do this at a warrantable expense. To carry out this view of storage the expense of Reservoirs would be materially increased. If Reservoirs could be obtained at a reasonable expense, sufficiently large and deep to retain the whole drainage, the water which would be collected from the surface would be much softer than that from the natural flow of the streams. The latter, in low stages of water, being mostly from springs, through a limestone soil, partakes of the character of wells in a similar district. In this view, also, a liberal storage is important. The analysis shews that the water of Aueaster is harder than that of Lake Ontario; but a liberal storage of surface water would, no doubt, produce an average of superior softness.

From the preceding remarks the opinion will be inferred that Reservoirs of greater expense will be necessary to make this source perfectly available. In order to estimate the excess, detailed surveys should be made with this view of the plan. All that can be said at this time is, that the excess will probably be very material.

In his estimate, Mr. KEEFER leaves out the cost of Mill and Water rights. He puts down the total amount of power below the point of occupation as equal to 74 horse-power. This portion, being mostly unoccupied,

cannot be of great value. Above the point of occupation, Eggleston's Factory, on Cold Spring, should be taken, and a portion of the fall of the Burnt Mill, at Ancaster. Some other water rights will probably be affected by the Reservoirs. A system of compensation, as suggested by MR. KEEFER, may be practicable as a means of adjusting these rights for the most part, (except where an existing improvement must be taken up.) To determine this more extended guagings will be necessary. This plan of compensation will, at best, be complicated in design, and will require attentive supervision in maintenance—both of which it is desirable to avoid. With present information, it is not possible to say what this water and mill question may amount to. Experience shews that the litigation on such points between corporations and individuals has not been favorable to the former. This has probably deterred MR. KEEFER from making an estimate. In this case the item is supposed to bear a greater ratio of importance to the general question than is usual in such enterprises, and, therefore, the uncertainty is embarrassing. In other respects, MR. KEEFER's estimate appears satisfactory; and, in relation to the points above discussed, he may dispose of one of them on more full surveys; while the other must remain subject to the best conjectural estimate that may be made, after investigation of Water and Mill rights.

Two plans for obtaining water by pumping have been presented by MR. KEEFER—one from Burlington Bay—the other from Lake Ontario. In providing for his *larger* supply, the cost of the plan by Lake Ontario, he makes,—Forty-two Thousand Five Hundred Pounds (£42,500) greater than that by Burlington Bay; and, for the *smaller* supply.—Twenty-one Thousand Pounds

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(£21,000) greater. The quality of the water is the great question involved in these two plans. The arguments adduced in Mr. KEEFER'S Report against the water in Burlington Bay, seem to be entitled to much consideration. It cannot be doubted that, the marshes on its borders, and those of the streams emptying into it, must be prolific of vegetable impurities, liable at certain seasons of the year, to affect the water unfavorably. To what extent this deterioration may reach the want of practical tests, by the general use of the water for any long continued period, prevents the undersigned from forming a reliable opinion. But the main argument against pumping from the Bay is the natural and well grounded repugnance that most of the inhabitants would have to drinking water which must be more or less mixed up with the sewage and other filth, constantly flowing into it from the City. If this be a reasonable objection *now*, it must become stronger; as the population increases, the accumulation of impurities in the streets and around the wharves becomes greater, and sewers (the consequence of a copious supply of water) become multiplied. These objections would not be so decided in a city watered by a stream, whose current set *past* its wharves, constantly in *one direction*. The draught could then be made *above* the wharves and the flow of the street washings. But Burlington Bay has no such advantage: no current passes through its waters; and a careful examination of the Reports laid before us, and of the localities themselves, convince us that the objections to its use are well founded now, and must become more decided every year. It cannot be recommended for your purposes to take water of inferior quality, when pure water may be had. Analysis shews that the water of the Bay contains less solid

matter, and, probably, is softer than that of the Lake. This may be, and the water still be more objectionable for drinking and for culinary purposes. MR. KEEFER has very well discussed the influence upon consumers, of water taken from sources of doubtful purity, even though the mind might not be able to satisfy itself fully that the influence is, in reality, very material. Under the circumstances, it does not appear advisable to adopt the Bay as a source of supply. This conclusion is more readily reached from a conviction that some modifications will reduce considerably the excess of cost by the Lake plan. MR. KEEFER seems to have had very little time to examine the details of either plan of pumping, and will, no doubt, be able to improve those suggested, and reduce the cost even on the scale he has contemplated.

Before proceeding further, in regard to either plan, the question of quantity should be examined. It seems MR. KEEFER was instructed to provide for a population of 50,000. For this he estimated 50 imperial gallons per day for each inhabitant, as the average for the year; and a maximum for the warm summer season of about 75 gallons per day. Authorities may be quoted which sustain this estimate. But it is believed to be high for such a city as Hamilton. A seaport town consumes a large quantity of water in supplying vessels and steamboats, which would not be demanded in Hamilton.—Such towns as New York, Boston and Philadelphia, use large quantities of water in manufacturing establishments, and probably a much larger ratio than would be consumed in your city. A supply for domestic use and the extinguishment of fires, are the primary and indispensable objects. Next to these come the supply of manufactories, railway stations; watering sidewalks and

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streets ; watering gardens and lawns ; supplying public baths ; and, when not too expensive, public and private fountains. Private baths and water closets are regarded as necessary for domestic use.

When water is used in a city, under pressure, it is easily obtained in profusion, for all purposes, by merely turning a cock ; consequently, the consumption will always be greater than when supplied by measure, in tanks, at certain periods, as is practised in some European cities ; or than when raised by pumps, or transported some distance. Again, if service-pipes and cocks are of liberal size, to give the supply promptly, the consumption will be greater than if they were of smaller capacity, causing delay in obtaining what is required. It would be an inferior plan that contemplated any other method than a direct supply, under pressure ; though this plan involves considerable waste, which, as yet, no effectual means have been found to prevent. In large establishments much has been done by water-metres to check this evil, and obtain more fully, compensation for the water used ; but, for domestic use, metres have not yet been adopted, nor does there seem to be much confidence that this method can be beneficially applied in such cases. Something would be gained by the use of smaller service-pipes, at the loss of corresponding convenience to the consumer ; and rates could be adjusted on different sized pipes. No doubt more water is consumed in cases where the flow is by gravitation, and looked upon as abundant, as in the cities of New York and Boston. A similar influence is experienced in Philadelphia where water is obtained at less cost than in either of the two cities just named.

Without going into detail, it may be stated, that up to

1845, the supply in Philadelphia seldom exceeded 30 gallons, as the average, and 40 gallons as the greatest daily amount for each inhabitant. By a statement in Mr. McELROY's proposition to your city, it appears that the average for 1853 was 40 gallons, and the maximum 50 gallons. Thus, it seems that Philadelphia had gradually increased its consumption up to the year 1853, and that in 1854 its maximum was 54 gallons.— In that city, though water is obtained by pumping, it is cheaper than in New York or Boston. The works were erected at small expense, and the pumping is done by water power. The statement in Mr. McELROY's paper, that 90 gallons is the maximum in New York, is believed to be an error. Take the last season, when the city contained (say) 600,000 people, at 90 gallons, the consumption would have been 54,000,000 gallons. The maximum flow of the aqueduct has, at no time, been over 35,000,000, or say, 60 gallons for each inhabitant per day. Of this quantity it is believed that full one-third is wasted. Probably no measures could prevent a large portion of this waste, if the water be used under pressure. In New York the consumption by shipping and steamboats is large, and this is an item that is not needed by towns situated on fresh water.— Very extensive manufacturing is carried on in both New York and Philadelphia, and in the former, from its situation on salt water, the Croton water is used for most of its steam engines, as well as for the general purposes of manufacturing. For the purposes of substantial usefulness it cannot be necessary for the City of Hamilton to provide as high a ratio as for either of those cities. It may happen after water is freely introduced into your city that there may be found a taste to use it for ornamental purposes, and thus equal

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the ratio of the large cities named above; but it cannot be necessary to set out your plan on so large a scale in the beginning, especially if you may look to adequate sources to enlarge your supply when it shall appear to be the interest of your city to do so. Your citizens, no doubt, desire a liberal supply, and certainly an abundance of good water, under pressure, is a great blessing to all; especially to those residing in large and densely populated towns. In plans and calculations of this sort much depends on the facility and cheapness at which the supply can be had, and the undersigned regard your facilities as reasonably favorable; but do not think they warrant your entering on the project without cautious consideration of financial responsibility.— They therefore have arrived at the conclusion to recommend that the plan be based on an average supply of 35 gallons, and a maximum of 50 gallons per day; at the same time to keep in view such enlargement as your city may desire, when this quantity shall be deemed inadequate to its wants. If you regard this view as too cautious, you may at least rely on its being adequate to every substantial want. You will see, by reference to Mr. KEEFER's communication of June, 1856, that his views of quantity required had undergone a modification, and he suggested that material reduction in the scale of the works could be made, consistent with adequate provision for the present wants of the city. In this discussion the imperial gallon is intended. *This* is the rule in New York. Boston has adopted the wine gallon, and Philadelphia the ale gallon.

The average supply for a population of 30,000, on the basis above presented, would be 1,050,000 gallons per day, and 1,500,000 gallons for the maximum sup-



ply. This is equal to an average of 117 cubic feet, and a maximum of 166 cubic feet per minute. To pass this quantity through an 18 inch pipe would require a velocity, for the average supply, of  $1\frac{1}{10}$  feet per second; and for the maximum supply, of  $1\frac{8}{10}$  feet per second; and if the velocity be carried to 2 feet per second, it would be sufficient for the maximum supply of about 40,000 people. This last velocity is rather more than is desirable for the pumping main, but not materially objectionable. It is therefore proposed to put down 18 inch main pipes, which is ample for the present population, and will answer the purpose until the population approaches to 40,000, when a second main may be laid, either 18 or 20 inches, as may appear desirable after the experience of the works shall demonstrate what may be necessary. One 18 inch main, together with one 20 inch main, will discharge the same quantity, under equal head, as a 24 inch main. The cost of the latter will be about One Dollar and Eighty (1.80) Cents per foot less than the two former. The first cost of the 18 inch pipe will be over Two Dollars per foot less than the 24 inch main. The 18 inch main will be sufficient for probably twelve years or more, and the saving of interest on this difference will more than compensate for the difference in first cost. When it shall become necessary to have the second main this plan will be useful in other respects. In case of repairs on one of the lines of pipes the other will secure the supply in the meantime, and an important advantage will be thereby gained, at no increase, as has been shewn, in the ultimate cost.

To do the work proposed an engine of 100 horsepower will be sufficient: it will perform the duty for

the average supply in 12 hours, and for the maximum supply in 1. hours per day.

It is advisable to have a Reservoir as near the pumps as circumstances will permit. This should be at such height as will carry the water into the city at a proper elevation. Ground is not favorable for this; and a Reservoir of moderate dimensions will have to be submitted to. MR. KEEFER is of the opinion that a site may be had more favorable than the one which he selected, and at the same time shorten the main about half a mile, all of which he pointed out in the reconnaissance made by the undersigned, and the plan appeared quite feasible. The distance from the pumps to the Reservoir will, probably, not vary much from three miles. The growth of the City will be towards this Reservoir, and it may be quite convenient to have two distributing mains leading from it, which will be in accordance with the plan above suggested; that is, to lay an 18 inch pipe in the first place, and, as the city grows, lay a second main from the Reservoir for distribution in the new part of the city, of such size as may be indicated by experience.

A second Reservoir will be desirable to increase the storage, and to render the distribution more effective; but this is not indispensable, and may be deferred with propriety until the water is let in, and experience demonstrates its usefulness.

The height, 180 feet above the Lake, at which MR. KEEFER proposes to put the water, will accommodate very well, nearly all the dwellings. The small number that may be too high for this may, if found expedient, obtain water from Hess' Spring, as suggested by Mr. KEEFER; or a small engine may be erected to raise the

quantity required, if found more economical, or if the Lake water be preferred for use to this Spring.

This height will give a very good pressure for fire purposes to nearly the whole city, and *decidedly effective* for a large portion of it.

The plan of taking the Lake water by excavating a basin in the Beach, appears to be well calculated to afford filtered water, and is believed to be quite practicable at moderate expense.

It is proposed to put up in the first place one double acting condensing engine of 100 horse-power, as proposed by Mr. KEEFER. This will easily furnish the average supply on 12 hours work per day—increasing the hours to meet the larger supply. Such an engine, well put up, will work for a long time, with little necessity for repairs; but accidents may happen, and it would be imprudent to construct the works without provision for such contingency. Eventually, therefore, two such engines will be needed, but not for some years to come; and to provide in the meantime against accidents, a plunger high-pressure engine, as recommended to the undersigned by Mr. KEEFER, appears well adapted to the purpose. The high-pressure engine will be more expensive for fuel; but as it will be used only in cases of emergency, that consideration is not so important as the saving in outlay, and it will be superseded when a second engine is needed for supply. In the plan for pumping from Lake Ontario, it will be seen that the suggestions of Mr. KEEFER, in his communication of June, 1856, have been regarded as indicating a prudent view, adapted to present wants with provision for expansion as the city may grow—is believed to be the most judicious policy, and therefore is recommended.

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The surveys for the pumping plan have evidently been very limited; however, except for Reservoirs, there is not much needed—the main expense being made up of pipes and machinery. That for pipe-track, pumping-basin, and foundations, may very well be judged of, from the general character of the country, and the estimate appears to be adequate. The estimate for distribution for 25,000 inhabitants appears fair and is regarded as sufficient for this branch of the expenditure in the outset of the works. This item will depend on the liberality of the scale that may be adopted for the distribution, and, of course, must increase as the city extends. The estimate of Mr. KEEFER for the smaller supply from Lake Ontario, including the capitalization of annual expenses, is - - £187,537. By reducing the size and shortening the mains and leaving out one large engine, this may be diminished - - - - - 27,537

Leaving first cost - - - - - £160,000.

As will be inferred, from what has been stated, the choice is between the Ancaster gravitation plan, and pumping from Lake Ontario. MR. KEEFER'S estimate for Ancaster, is about £35,000 less, for the small supply, than that from the Lake; but he does not take into the estimate the item of damage to water-power and Mills. To provide in the first instance, for the "small" supply from Ancaster, it would not be necessary to include the Cold Spring Stream. It would be expedient, however, to extinguish all the water and mill rights in the first instance, so as to meet ultimate wants, in order to guard against further improvements, that would be likely to swell the future cost materially. The estimate of the Ancaster plan, is based on a large number of

Reservoirs, small in area, and shallow in depth. This feature, as before observed, is objectionable. The large number complicates the plan by increasing the points to be attended to in the maintenance of the works. If good situations could be had for two, or even for three Reservoirs, of suitable depth and capacity for ample storage, this would be the best source from which to obtain the supply; especially if, on investigation, the water rights and mill damages could be settled on reasonable terms. It is believed sufficient Reservoirs might be made; but the expense would materially exceed the estimate; and, with the cost of water rights and mills, render this source, in all probability, more expensive than the Lake plan. This source has been more dwelt upon, for the reason, that any simple plan of gravitation is better adapted to the object than pumping; and moreover, from the belief that a liberal storage of surface water would furnish an article, softer, and better adapted to the general purposes of a City, than that of the Lake. But while there is an embarrassing uncertainty, and, most probably, an excess of cost in the Ancaster, over the Lake plan, the latter is easily understood in all its essential features.—Although the Lake water is not as soft as rain water, it appears so be softer than the low water flow of the Ancaster; and by filtration, will be rendered highly favorable for drinking and most culinary purposes. It will be essentially of the same quality as that now used from the Niagara River to supply the City of Buffalo, while it will be superior in purity from the filtration proposed.

In view of all the circumstances, which it is believed have been sufficiently discussed,—*the plan of pumping a supply from Lake Ontario*, as recommended by Mr.

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KEEFER, is regarded as the most simple—the most free from unfavorable contingencies—likely to be attended with the least ultimate cost, and capable of expansion as the wants of the City may require ; it is therefore proposed by the undersigned for your adoption.

There appears no good reason to doubt, that, the sum stated above (£160,000) will be sufficient, with prudent and intelligent management, to complete the works on the scale proposed. Excepting as the growth of the City will require further outlay for distribution, the works may be regarded as sufficient for your wants, until your population exceeds 35,000.

The expense of distribution must go on with the growth of your City ; and to provide for 35,000 people, an addition should be made to the estimate of £15,000. It may therefore be considered that, for a population of 35,000, your works will cost £175,000, or \$700,000, or an annual cost of \$1.25 cts. per inhabitant. This would provide an ample supply, under pressure, for domestic use, and is well worth the cost. The economy in domestic service, (aside from the convenience and comfort of being able to command water in all parts of the domicile) cannot be appreciated until it has been enjoyed. The saving on insurance, and the blessing of better protection from fire, which spares neither life nor property, is of itself a consideration, worth a large portion of the whole expenditure. The tendency, moreover, of a full supply of water, to increase manufacturing operations, is calculated to promote the prosperity of your City to a very material extent. These and other desirable results, which your Citizens will find to flow in upon you, along with an abundant supply of good water, will doubly repay the expense that will be incurred in its introduction.

It has not appeared necessary to discuss, specifically, questions of location. The surveys, in fact, have not been sufficient to do this satisfactorily. There are several other matters that would require further discussion in a general Report, had they not been anticipated in Reports already before you. All matters of detail, in location and construction, it is believed, may, with great safety, be left in the hands of Mr. KEEFER, who, by his Reports and in his verbal discussions has evinced a capacity on this subject that inspires great confidence in his ability to construct the works in a satisfactory manner.

This Report, Gentlemen,

Is very respectfully submitted by

Your obedient servants,

JOHN B. JERVIS, *C. E.*

ALFRED W. CRAVEN, *C. E.*

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