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REPORT

OF THE

HON. WM. J. McALPINE,

CIVIL ENGINEER,

TO THE

Water Commissioners

OF THE

CITY OF SCHENECTADY.

A. D. 1867.

SCHENECTADY:
DAILY UNION POWER BOOK AND JOB PRINTING HOUSE, 199 STATE STREET.
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LETTER TO THE COMMISSIONERS.

STOCKBRIDGE, MASS., February 1, 1868.

To Messrs. ANDREW MCMULLEN, WM. VAN VRANKEN, WM. J. HORNE, JOHN C. ELLIS and GEORGE MAXON, *Water Commissioners of the City of Schenectady:*

GENTLEMEN — I herewith submit a report and estimates for supplying water to your city.

I have prefaced the report with a statement of the usual objections to, and arguments in favor of a public water supply, and an essay on the general subject of the sources of water and the contaminations to which it is subject.

This information was familiar to us in our earlier days, but as it is rarely called for in ordinary life, it is forgotten by many. A reconsideration of these general principles will enable the citizens to discuss the merits of the several plans which have been suggested, and the extent of the necessity for a public water supply.

I have been greatly indebted to Mr. WM. HENRY, the City Surveyor, for the field work and valuable aid in the preparation of the plans and estimates. Mr. CHARLES Z. MCALPINE has made the calculations to determine the size of the pumping engines, distribution pipes, etc.

Respectfully yours,

WM. J. MCALPINE.

REPORT.

OBJECTIONS TO A PUBLIC WATER SUPPLY.

The usual objections which are urged against a new project for a public distribution of water in a city, are:

FIRST. Doubts as to the quantity or quality of the water from the proposed new source, or that it may be injured by storage, or in the iron and lead distribution pipes;

SECOND. Fears that the cost of the proposed works will greatly exceed the estimates, and that the revenue will fall so far short of the expenses of their maintenance, and of the interest on the cost, as to impose a heavy burden of taxation on property, and thus deter settlers and business from the city;

THIRD. Apprehension, that the money to be provided may be injudiciously expended;

FOURTH. Contentment with the present supply from wells and cisterns, arising from ignorance of their impure condition and from disregarding their first cost and subsequent maintenance; the liability of failure in supply during dry times, and the daily tax on labor which they involve in drawing and distributing the water.

The most important of these objections are discussed elsewhere in the report, and it may be replied in general terms, that the present examination demonstrates beyond all reasonable doubt, that an ample supply of pure and wholesome water can be procured and distributed to every building for domestic and manufacturing purposes for the present and future requirements of the city, at a reasonable outlay, and that the revenue will repay the cost of maintenance and the interest on the cost of construction, and therefore will not impose any tax on the property of the citizens; and that instead of keeping away settlers and business, the introduction of water upon this plan will bring

new citizens and encourage additional manufactories, and thereby add to the wealth, and lessen other taxes on the present property.

The objections, which are not discussed elsewhere, will now be considered more in detail.

In answer to the first of these objections it may be said that the character of the collecting grounds of the water shed of Sand creek is identical with that of the Hunger Kill and Patroon's creek, which, by analysis, are known to be as pure as any water furnished to any other city, and of a very superior quality.

The sanitary powers of the Water Commissioners will be sufficient to prevent any defilement of this water by manufactories or otherwise, along the stream, and hence the citizens can be assured that it will be served to them with great purity.

No inconvenience has been experienced in other cities from the oxydation of the iron and lead pipes, when proper care has been taken in the arangement of the distributing pipes, and in emptying the water which has stood long in the lead pipes.

By connecting the pipes so as to produce a complete circulation, and by frequently blowing off the water at the lowest places, the pipes will be kept so clean that the quantity of oxydized iron, taken up by one or two millions of gallons of water, which will daily pass through them, will be so small as to be insensible to even the most delicate tests, and in no way injurious.

If pipes lined with cement are used for all except the pump main, no inconvenience will be experienced from the corrosion of the metal.

Care must be taken not to use water which has been left in the lead pipes a long time; but with the precaution of drawing it off no danger need be apprehended from this source.

The gauges of Sand Creek, made by the late Professor Gillespie, and also very careful ones made by myself, show that there is enough water in that stream to supply a population of fifty thousand.

In reply to the second objection, it may be remarked that the annual revenue from water in New York, Philadelphia, Boston, Brooklyn, Cincinnati and Chicago, gives a mean of about forty cents per lineal foot of pipe, or two thousand dollars per mile of pipe laid; when the use of water in the city has become general, as in other water supplied cities, and when it has produced its legitimate effect in the establishment of new manufactories and increased

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density of population, the works will yield a NET REVENUE beyond all expenses of maintenance, and interest on their cost. The new investments which the water would introduce would afford an increased amount of property subject to taxation, and thus lessen the rate of taxation for the ordinary purposes below what it would be without the water.

It has been suggested that after the water has been introduced, the citizens would not generally abandon their present supply from wells and cisterns and resort to the new supply. This, like almost every other objection made to a public water supply, is best answered by referring to the experience of other cities, where precisely the same objections were made before water was introduced, but where it has been found that eventually all of the private wells have been abandoned and the new water has been universally used.

In my opinion there will not be a dozen houses where the new supply is not taken within two years after the comple tion of the works. With the water from the present and new source, side by side, the contrast between the purity, quantity, cost and convenience of the one over the other, will be so great as to leave no doubt as to the result.

The excessive impurity of well water, and the bad charter of cistern water, even when filtered, will be discussed in another part of the report.

ADVANTAGES OF A PUBLIC WATER SUPPLY.

An abundant supply of pure and wholesome water is necessary to the health comfort and prosperity of a city, and the superior economy, quality and convenience of a public water supply are now so generally appreciated, that there are few of our North American cities, or even villages, that are not supplied in this manner.

The advantages of a public water supply are:

FIRST. That it furnishes a better quality of water than can be obtained by any except a few of the most wealthy citizens, and then only in peculiar and unusual cases.

SECOND. That the quantity supplied is so much greater and so readily accessible, that it encourages the free use of water among the poor as well as the rich, and consequently diminishes one large class of diseases, and in this aspect alone, saves the community a sum frequently equal to the interest on the whole cost of the works.

THIRD. It furnishes an abundant supply of water at all times, so convenient and accessible, that in most cases, the household can put out the small beginnings of a fire, which

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in a short time would defy the efforts of the whole fire department.

Almost all of our American cities have been visited by extensive conflagrations at distant intervals, occurring when the weather and winds operate in conjunction, spreading devastation over large districts, and destroying millions of property. Although the introduction of water has not always prevented these large conflagrations, it is evident that the damage therefrom has been much diminished where an ample supply of water under pressure was at hand, applicable to instant use. A careful examination of the cases where they have been prevented, as well as those other numerous cases which attract but little attention, will show in a series of years, the saving from damage by fires is more than equal to the cost of the water works.

It is earnestly hoped that no such extensive conflagrations as have devastated this and other cities will ever again occur here, but if one should ever commence under certain conditions of the wind and weather, and with the present insufficient supply of water, it is fearful to contemplate the damage that might occur before it could be checked. A plan of water works like that proposed, would either wholly prevent such a disaster, or would certainly check its progress and lessen the damage therefrom to an extent that would go far toward paying the cost of the works.

From these considerations, and the experience of other cities where water has been introduced, it is evident that the rates of insurance on property against losses by fire will be materially lessened, and thus indirectly, contribute largely toward the repayment of the cost of the work.

Fourth. The charges for the use of the water are less than the aggregate cost of the same quantity obtained by individuals from wells and cisterns. There can be no question, therefore, but that a public supply is the most economical method of furnishing water to a compactly located population. A tariff of charges for the use of the water supplied by the proposed works, sufficent to pay the expense of maintenance and the interest on their cost, would not prove an oppressive burden on the people. A few of our Northern cities have been supplied with water by joint stock companies, the investment in which has generally proved remunerative. The more common plan, however, has been to furnish the supply at the expense of the city, and for policy the water charges have been made lower. In consequence of this and the more expensive management, the revenue sometimes fails to pay the interest on the cost, besides which, the works are often constructed with a greater

view to adornment than would be necessary for the simple purpose of revenue. Constructed and managed even under such circumstances a public water supply will always result in benefits greater than its cost, if the outlay is not too large and the management is tolerably frugal.

Fifth. The introduction of water into cities has always brought in its train various manufactories, which could not be maintained where there was not an abundant supply of water. This class of smaller manufactories, in the aggregate, become essential to the growth and prosperity of a city, and adds considerably to its means of paying, not only the expenses for water, but also those of the government of the city.

An ample supply of pure water encourages settlements and investments, and is indispensable for certain kinds of manufactories, while the absence of such a supply, will probably divert more business from the city than the cost of the works.

With an abundant supply of pure water distributed throughout the city, easily accessible at all times, cleanly habits are encouraged and supported among all classes, but especially among the poor; disease is diminished, and in consequence more labor is given to increase the substantial wealth of the place. With pure water always at hand the craving for ardent spirits is lessened, and with it the diminution of the crimes and follies, which follow in the train of dissipation. The universal experience of other places has been that when a feasible project for introducing a water supply has been carried out and the benefits practically demonstrated, it has answered all of the previous objections, and secured for it universal approbation.

THE QUALITY OF THE WATER.

In the varied population of a city, there are always prejudices and fallacies in regard to this branch of the subject, which it is advisable to remove by a statement of the received opinions of the sources of the water, and the changes which it undergoes before it is used.

In a preliminary report which I submitted to you in August last, I included an essay on this branch of the subject, an abstract of which, at your request, I now make.

The parent source of all the fresh water on the earth, is the ocean; and the atmosphere is the vehicle by which it is conveyed over and precipitated upon the land, in the form of rain, snow and dew. This water either flows off through the visible water courses on the surface, or sinking beneath,

flows through the soil and emerging, forms springs and rivulets. Wells derive their supply by their interception of these subterranean veins.

Water is never found in nature in a perfectly pure condition. In its vapory form it is an absorbent of all the noxious gasses of the atmosphere, and in its liquid form it is a solvent of earthy salts, and effete animal and vegetable matter.

Rain water, although tolerably pure elsewhere, becomes contaminated when falling through the atmosphere over a city, and by absorbing deleterious matter from decaying wood and oxydizing metal roofs. The analysis of rain water thus collected in cisterns shows it to be very impure, although much softer than other waters. That such water is very impure is evident from the rapid production of animalculæ in it, which shows the presence of the food necessary to maintain that minute, but vast quantity of animal life.

An examination of the sources of supply to wells in cities, shows that the water from them must be a most disgusting solution, and modern investigations have shown it to be a prolific source of the most fatal diseases.

Besides becoming charged with the dissolving gases in the atmosphere, it also absorbs the decaying animal and vegetable matter on the surface of the ground, and then mingles with the drainage which has entered the soil from stables and privies.

The progress and fatality of cholera both in this country and in Europe, has been traced in a vast number of cases, directly to the use of impure water from certain wells, and their analysis and that of other wells compared with other supplies a water in the same cities, show that this frightful disease is promoted and rendered more fatal wherever well water is used.

The annexed analysis of water in Schenectady will fully bear out the assertion that such water is totally unfit for drinking.

Contrasting such water with that proposed to be supplied by the proposed plan, cannot fail to convince the citizens of the necessity of such a supply as the latter will afford.

The water in sand Creek has descended through a pure atmosphere, and entered a soil almost free from vegetable and solvent matter, and in its flow through the creek and pipes may be protected from all contaminations, and will therefore be served of the purest quality possible. The capacity of the reservoir will be sufficient to always serve out clean water, even although the water in the creek is turbid, and the pumping is temporarily stopped.

The great depth and volume of the water in the reservoir, and the depth of the pipes below the surface of the ground, will keep the water cooler in Summer and warmer in Winter, than it is in the creek, and nearly at the same agreeable temperature at which it is found in deep wells.

Stored water is sometimes defiled for a few days by the rapid generation and decay of vegetation and animalculæ. This requires the conjunction of a high temperature and quiet atmosphere, and perhaps a certain electric condition of the latter. These conditions only occur in conjunction, after long intervals of time. The plan proposed would enable the supply to be obtained directly from the stream, which would never be thus affected at the same time that water stored in the reservoir might be thus contaminated.

THE QUANTITY OF WATER TO BE SUPPLIED.

The actual consumption of water, for domestic uses, would be liberally supplied by allowing twenty gallons per day for each inhabitant. The experience of other American cities shows that there is as much wasted as used, and to allow for this waste, and also for the use of various mechanical and other works, it is now customary to provide a quantity equal to sixty gallons per day for each person.

The population of Schenectady is supposed to be about ten thousand, and in the plans herein submitted, it is proposed to provide for a daily supply of one million of gallons, which it is estimated will be ample for a population of fifteen thousand, besides for the quantity estimated for the railroads, and additional number of manufactories, which will probably be started after the water is introduced.

This quantity may be doubled by running the engines twenty four instead of twelve hours, and even that quantity may be still further increased, on an emergency, by running the engine at greater speed.*

The plans have also been arranged to pump directly into the distribution mains when the reservoir is out of order, or when an unusual quantity of water is required, under great head during conflagrations.

When the pumping and distributing mains are connect-

* It is not supposed that the ordinary necessities of the city will require, for many years, this large amount of water, but if, unfortunately, an extensive conflagration should occur when the reservoir is not full, the immense value of such a flood of water, under such great pressure as could be given to it, would be incalculable, and would almost repay the entire cost of the works, in the saving of property, which it would effect.

ed, however, this head may be increased up to the capacity of the power of the engines and the strength of the pipes. To prevent subjecting the machinery and pipes to too great a strain, a safety valve will be put on the air chamber of the pumps.

Professor Gillespie's gauges of Sand Creek, near the Brandywine mills in the lowest water was two and a half millions of gallons per day. The least quantity of water which has ever flowed past Veeder's mill in the driest time, is nearly four millions of gallons, and this quantity can be confidently relied upon at all times.

THE PLANS PROPOSED.

Three differant sources of supply and incidentally a fourth one have been examined, namely from the Brandywine or Sand Creek; from Saunder's Lake, and from the Binne Kill. Also three methods of introducing the water of the Sand Creek.

First. By pumping the water by steam power from the creek below Veeder's Dam.

Second. By pumping it by water and power steam power from Veeder's mill pond; and

Third. By raising the dam at Crane's mill and conducting the water by gravity through a large pipe to Crescent Park.

Incidentally the last plan has been modified by estimating for water and steam works to elevate the water to the same level as in the other plans.

The following general description of the plan which has been adopted will now be given.

A small dam will be built across Sand Creek just below Veeder's mill, and the water conveyed by a brick pipe of two feet diameter along the highway and to a pump well placed near Center street, and from thence it will be pumped by a steam engine through a cast iron pipe of one foot diameter, five hundred feet long, into a reservoir situated on Paige's hill, and from there distributed by cast iron or cement lined pipes to all parts of the city.

The pump well will be of stone masonry, thirty-two feet by forty-four feet, and eighteen feet high. Upon the outer extremity of the walls will be erected an engine house of brick, and adjacent thereto a boiler house and chimney, also of brick. The floor of the engine room will be placed at a level of two feet above the highest floods. The steam engine will be a vertical, condensing beam engine of a nominal power of sixty-five horse, with a steam cylinder of

twenty-seven inches diameter and six feet stroke, and driving two single acting water pumps of eighteen inches diameter and three feet eleven inches stroke, capable of elevating two million of gallons of water into the reservoir daily.

The reservoir with its enclosing banks will cover an area of five acres, and with fifteen feet depth of water will contain fifteen millions of gallons. The surface of the water, when full will be at a level of one hundred and twenty-five feet above the railroad crossing at State street. The banks and bottom will be lined with heavy clay puddle, the inside of the banks, exposed to the water, will be lined with a slope wall and cement mortar facing, and the top and exterior of the banks will be seeded down with grass seed.

The reservoir grounds will be enclosed with a picket fence. The inlet and outlet chamber will be of stone masonry, provided with iron gates for regulating the flow of the water into the distribution pipes. The force and delivery pipes extending through the reservoir bank will be of cast iron, eighteen inches in diameter, provided with a cross pipe connecting them together on the outside of the reservoir and with water gates, by means of which the water may be forced from the pumps directly into the distributing pipes without entering the reservoir.

This arrangement will enable the reservoir to be cleaned or repaired, without interrupting the supply of water to the city, and will also enable a great head to be put on the pipes in case of a great conflagration, requiring a large quantity of water to be used under a great pressure.

The distributing main from the reservoir to a point in Veeder avenue, north of Hamilton street will be of cast iron, and in all other places it, as well as the other distributing pipes, may be of either cast iron, or of wrought iron lined and covered with cement.

The main will be carried over the canal at Liberty street, with a wrought iron pipe, supported by strong trusses, and enclosed in a wooden box of six feet square, filled with charcoal to prevent freezing. There will be nine miles of distributing mains and pipes, from twelve to three inches in diameter, and laid in the streets stated in the schedule accompanying the specifications.

I would have preferred to have avoided the use of any pipes of less than four inches, but many of the streets are so near together, and some of them have so few houses that it was not considered warranted to incur the additional expense of larger pipes.

A sufficient number of large pipes are distributed among

the smaller ones to feed them with an ample supply of water, and thus remove the objection to their small size.

The city is divided into five water districts by lines of water gates, so that repairs or additions may be made in either one of these divisions without interrupting the supply to any of the others.

A sufficient number of hydrants (viz. sixty) have been provided, which will be found useful.

The distributing pipes in many of the smaller cities have been made of sheet iron lined and covered with hydraulic cement mortar, instead of the pipes of cast iron in use in the larger cities. In some places the use of this description of pipes has been found objectionable. In other places objections have been raised against the use of cast iron pipes. This arises from a faulty method of laying the former, and the use of an improper quality of metal in the latter.

The cement lined pipes are non-elastic, and must be laid upon a foundation which will give everywhere the same support. With this provision they are generally no more liable to break and leak than pipes of cast iron.

In the specifications, it will be seen that this provision has been made, and that wherever any unequal settlement is apprehended, and also for all of the pump mains which are subject to concussions, and the branches at the intersections of the streets, cast iron pipes are required to be used.

The merit of the cement lined pipes is that they can be furnished from ten to twenty per cent cheaper, and the water standing in them is not liable to be discolored by the oxydation of the metal. Experiments extending over a long time has shown that the wrought iron in these pipes covered with cement is not liable to oxydation, and, therefore, that they approximate in duration to cast iron pipes. The corrosion of cast iron pipes has been a subject of careful examination. The metal is subject to alterations of moisture and dryness and to the corrosive effects of the gaseous emanations from sewers, gas pipes, etc., and certain descriptions of metal, in these situations, are found to corrode rapidly. Some of these metals will also corrode internally when only subject to the action of pure water. If a proper description of iron is used, the corrosion on the inside will not occur to any appreciable extent, and even on the outside it will be so slow as to remove the objection to their use.

Detailed specifications of all of the different kinds of work have been prepared and have been directed to be printed, which will save the necessity of any further description. According to which propositions have been received from

responsible persons to execute the work for one hundred and fifty-six thousand dollars, ($156,000.).

REVENUE AND EXPENSES.

The gross revenue of the works at the average rates charged in other cities when they are owned and managed by the city, at two thousand dollars per mile, for nine miles proposed to be put down, would amount to eighteen thousand dollars per annum. The quantity of distributing pipe, independent of force main and supply pipe, being $9\frac{97}{5280}$ miles. Of this amount the proportion which would be paid by the citizens who would probably use the water, would be equal to an average of one dollar per head ; the balance would be paid by manufactories, breweries, etc.

Whenever the demand requires an extension of the pipes, it will be done at an average outlay of five thousand dollars per mile of pipe, and the annual revenue from such extensions will average at least fifteen hundred dollars per mile. The current expenses of running the engine and superintending and maintaining the works will be, say, from seven thousand to eight thousand dollars per annum ; which deducted from the average gross receipts for the first five years will leave sufficient to pay the interest on the cost of the works. It would therefore appear that the works will be entirely self-sustaining, provided the charges for water are arranged at the usual rates in other places.

The surface of water in Reservoir, when full will be one hundred and twenty-five feet above State street at the railroad crossing ; eighty-one feet above Veeder avenue, at Crescent Park ; twenty-three feet above the road at county house, and ninety feet above Nott Terrace, at South College.

The following analysis, made by and under Professors CHANDLER and PERKINS, of Union College, shows the character of the water in different parts of the city and vicinity, by which it will appear that Sand Creek, the proposed source of supply, is the purest :

	ORGANIC.	INORGANIC.	TOTAL.
East Union,	7.41	22.23	29.64
West street,	7.47	31.09	38.56
Binne Kill,	5.87	6.90	12.77
Sand Kill,	.29	5.55	5.84
Rain water, (filtered,)	2.97		2.97
West Union,	12.53	62.66	75.19
East State,	7.77	42.17	49.94
Railroad,	5.22	51.14	56.36
Spring on Troy R. R. 2 1-2 miles from Schenectady	1.14	3.40	4.54

	ORGANIC.	INORGANIC.	TOTAL.
Spring at the entrance of Vale,.....	1.64	8.43	10.06
Spring in woods back of North College,..	1.16	11.73	12.90
Van Guysling's spring,.....	6.20	23.46	29.66
Well at No. 94 Liberty street, ...	7.31	34.38	41.99
Well No. 36 Washington ave., at foot of Union street,.....	2.52	43.09	45.61
Well No. 179 State street by the railroad,	11.30	37.60	48.90
Well at head of State street,.....	2.33	46.88	49.21
Well at North College,.....	10.90	38.40	49.30
Well at No. 15 Wash. av., cor. Front st...	5 21	62.31	67.52
Well at No. 92 Liberty street, ...	12.22	63.46	75.69

These impurities consist of the following substances; the order of representing, approximately, the relative proportion; the preponderating substances heading the list:

INORGANIC.		ORGANIC.
Carbonic Acid,	Magnesium or Magnesia.	Crenic Acid.
Lime,	Alumina,	Apocrenic Acid.
Chlorine,	Oxyde of Iron,	Ammonia.
Sulphuric Acid,	Phosphoric Acid,	Substances of uncertain composition.
Sodium or Soda,	Nitric Acid,	
Potassium or Potassia.		

Professor PALMER of Cleveland, says:

"Cholera was more fatal in that city in those districts where well water was used, although the most high and apparently the most healthy. The lower districts containing such quantities of surface water and filth, as entirely to preclude the use of well water, were supplied with water from the lake by carts, and were comparatively free from this disease."

Professor DOUGLAS says:

"I am fully of the opinion that the fearful ravages of cholera in that city (Sandusky) may be, in a great measure, attributed to the use of impure water;" (from wells.) * * * "A careful examination would probably show that, during the prevalence of cholera, (in Detroit,) that disease was more fatal, and prevailed to a greater extent among those using the water of wells, than among those in the habitual use of the river water.* Wells dug in large towns may be considered the most impure water in use. * * * Rain water, as ordinarily secured, is far more deleterious than any water in use. I do not hesitate to say that rain water collected in the ordinary mode, used as a habitual drink, must prove highly injurious to health."

* Doctor Terry says, that the use of the water from the Park well, (in Detroit,) in 1850, caused the death of seven persons and the serious sickness of several more; and that no sickness ensued in the neighborhood, after they changed to the use of river water.†

† "The brewery spring, Cincinnati," says Professor Locke, "produced fatal cholera in all persons who used it during the prevalence of the epidemic in that city. * * * It is admirably adapted to act as the aid of epidemic in its hostility to human life."

DISCUSSION OF THE PLANS.

The plan adopted by the Board, viz: From Sand Creek below Veeder's mill,* possesses advantages over all of the others which were examined. It will be less costly in construction and maintenance, and will afford water of greater purity than either the Binne Kill or Saunders Lake plans, and will be less liable to interruptions and damage from high water. The quantity of water which the Sand Creek will furnish, in its lowest stages, will be ample until the population of the city reaches fifty thousand, or there arises some extraordinary demand for water for manufacturing purposes, and then the quantity may be doubled by turning into the pump well, at a very small expense, the water from Schermerhorn's creek, below his mill. An unlimited additional supply can also be obtained, at a moderate cost, by extending a suction pipe from the pumps to the Binne Kill. I do not believe that there will ever be a demand for more water than Sand Creek will furnish, but I state the facts in regard to these additional sources, in deference to the wishes of the Board, to meet any exceptions which may be taken in regard to the supply derivable from Sand Creek.

The Binne Kill plan will require an engine of one-third more power than the plan adopted, and a force main of half a mile greater length. It will also require considerable expense to erect and protect the works from floods, and in providing the necessary filter beds; and even then the works will not be as secure, or the water as pure, as in the adopted plan.

In the Saunders Lake plan the pump main would be over a mile in length, and its extra cost, together with that of the foundations at the pump well, and of the engine, would bring its cost much above that of the Sand creek plan.

The maintenance of the pump main across the Mohawk, and that of the works on the west side of the river, would be attended with hazard and extra cost.

Your Board also examined two modifications of the Veeder plan. The first contemplated taking the water from above Veeder's mill and using his water power in part to elevate the water into the reservoir. It was found, however, that the charges for the water power, rendered this plan more expensive, and it was also less reliable than the one which was adopted. The other modification was to take the water from Sand Creek above the Brandywine mills, and either

* From this point the water was taken for analyzation, as exhibited in the foregoing analysis.

bring it into the city by gravity, or to elevate it by steam power into a reservoir. The elevation of the creek at that place is fifty feet less than the water would be in the reservoir on the Veeder plan, and would be too low to be of service in the city; and the diminished quantity of water, and the destruction of manufactories and water power, valuable not only to the owners but to the city, rendered the adoption of either of these plans inadmissable.

It has been suggested that water could be introduced from Hunger Kill, one of the tributaries of Norman's Kill. I examined that stream in 1850, and ascertained that it was but two hundred and thirty feet above the level of the Hudson river, and therefore too low to be brought into Schenectady by gravity. The cost of elevating the water and the mill damages which would have to be paid for the diversion, would render this a very costly plan, and has no superiority over the one adopted.

There are some streams on the hills, but they are either too small or at two low an elevation, or too distant to be available.

The plan which has been adopted will, therefore, afford an ample supply of water of the best quality, at the least expense, and with the least liability of derangement.

WM. J. McALPINE.