thereof, with rare exceptions, has made such a course prohibitive. To purchase the sixteen thousand (16,000) acres on the watershed above the proposed Charlton reservoir would cost a large sum. Instead of acquiring the watershed, it is customary to enforce stringent sanitary inspection and regulation upon such watersheds, which is not expensive. Statute law makes ample provision therefor through the State Department of Health, and otherwise.

Among the more important gravity supplies similar in nature to the proposed Charlton works, are New York, Troy, Amsterdam, Little Falls, Utica, Syracuse and Rochester.

The Hemlock Lake supply for Rochester has been remarkably satisfactory. The water is clear and so pure that it is used without filtration and no detrimental features to the public health have appeared during the many years of its use. Hemlock Lake is but an immense storage reservoir supplied with water from a large agricultural district quite similar to that about Charlton. The storage is so large that probably the greatest beneficial results derived from such storage in purifying the water are attained. Explanatory of these beneficial results, the following quotation is made from United States Geological Survey Water Supply Paper No. 315, entitled "The Purification of Public Water Supplies":

"Impounded Supplies.

"Utility of Impounding Reservoirs.— Where the most suitable source of water supply is one or more comparatively small streams, it is frequently necessary to build impounding reservoirs in which to store the heavy spring and fall flow for use during the low periods of summer and winter. In this way use may be made of streams whose normal flow frequently falls below that necessary to supply the demand during certain seasons. Storage is also beneficial in other ways. It greatly minimizes the danger from such pathogenic pollution as the water may be subjected to before it reaches the reservoir, and it effects a substantial improvement in the physical quality of the water.

"It is a well established fact that sewage bacteria, and particularly the pathogenic organisms, die off rapidly in

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"It is a well established fact that sewage bacteria, and particularly the pathogenic organisms, die off rapidly in

water. The pathogens die for numerous reasons, most important among them being unfavorable and unnatural surroundings, osmosis, an insufficient or unsuitable food supply, and the antagonistic influences of other bacteria and of some forms of animal life. Furthermore, bacteria do not persistently multiply in water, at least not under the climatic conditions of this country. It is a fact that although for a brief period there may be positive indications of bacterial propagation in standing water, this condition rapidly disappears and the bacteria show a rapid and steady diminution and in a few days or weeks may almost entirely disappear. The data already published on this point are abundant. For example, at Lawrence, Mass., the bacterial removal effected in the city reservoir, where the period of storage is about two weeks, amounts to over 93 per cent. At Washington, D. C., where the maximum period of storage is five or six days, the bacterial removal is the same as at Lawrence. In the Boonton Reservoir, where the water supply of Jersey City is impounded, there is storage capacity for over 200 days' supply, and it has been found that during the time the water remains in the reservoir the average bacterial purification effected is 99 per cent.

"The physical improvement in water resulting from storage consists of the subsidence of the fine suspended particles that give the water a turbid appearance and the reduction of color due to substances held in solution. The latter effect is produced in the main by the bleaching effect of the sun.

"The foregoing comments are made in order to show the salutary effect of storage upon the quality of water. There are further important questions to be considered, however, such as the care which should be given to catchment areas above lakes and impounding reservoirs used for domestic purposes, and stagnation of lakes and impounded water, which produces disagreeable tastes and odors in water.

A sample of water was taken from the Alplaus Kill near the site of the proposed reservoir by a representative of the State

Department of Health on April 4th, 1914. The chemical analysis made from this sample shows the water to be very satisfactory for domestic purposes. A complete report of this analysis is given in "Appendix D" hereof.

Filtration.

The water supplies of Troy, Utica, Syracuse, Rochester, and some other gravity supplies with large storage reservoirs, are used without filtration. As these supplies are much of the same nature as the proposed Charlton supply, it is possible that the Alplaus Kill water, after storage, would be suitable, safe and satisfactory without filtration.

However, the Conservation Law requires that supplies to Union Water Districts shall be by gravity and be filtered. The cost of filtering clear water is small compared to filtering roily water such as is now obtained by Cohoes and Watervliet from the Mohawk river. The cost of chemical treatment of water that is pure, or very nearly so, is much less than in treating such water as that of the Mohawk river. These features of the Charlton supply are very favorable both as to the quality of the water and the cost of filtering. The proposed filtering plant for the Charlton supply is fully set forth hereinafter.

General Description of the Design.

At the site near Charlton it is proposed to build a reservoir dam on the Alplaus Kill with a maximum height of approximately seventy-seven (77) feet. Plate III shows a map of the reservoir site, the dam, spillway, overflow channel, highways and lands to be taken. A short distance below the proposed site there is an outcropping of rock in the bottom of the creek, and rock also appears in the side hills some little distance above the proposed dam. It is, therefore, intended that the core wall of the dam shall join the ledge rock. It is proposed to build an earth dam with a reinforced concrete core wall (see Plate IV). This core wall will extend from the rock foundation, or other suitable impervious stratum, to above the flow line of the reservoir. The gate-house (see Plate V) is to be of mass concrete with a duplicate set of gates so that one set can be inspected and repaired without inter-

rupting the service. There are also to be two intakes — one 20 feet above the bottom and one 45 feet above the bottom, making it possible to take the water from the level which gives the better quality at any particular time. It is designed to put an automatic water stage register in the gate-house so that a constant record of the fluctuations of the water surface can be kept.

To take care of the flood waters during construction, a reinforced concrete culvert 11 feet in diameter is designed through the dam (see Plates IV and V). This is to carry internal pressure as well as the vertical loading, and would be capable of discharging 500 cubic feet of water per second, which is equal to 200 second feet per square mile, which is believed to be greater than any flood that will ever occur in this watershed.

When the dam is completed the supply main will be laid through the culvert. It is also proposed to install a Venturi meter in the culvert. By comparing the records of this meter with those to be placed at the lower ends of the line to each of the municipalities in the district, it will be possible to determine the amount of leakage, if any, along the line, and promptly stop it.

The spillway is to be placed at the extreme westerly end of the dam, and is designed to carry any flood that can occur without allowing the water to attain a depth greater than two feet on the crest (see Plate IV).

It will be necessary to excavate an approach channel to the weir and a waste water channel from the weir following the natural contour of the country leading back into the Alplaus Kill, about 3,000 feet below the dam. The material excavated from these channels would be used as a part of the material for the embankment of the dam.

It would be necessary to relocate and construct two sections of highway, as is shown on Plate III.

The supply main from the Charlton reservoir to the present Cohoes reservoir is to be of 36-inch diameter cast-iron pipe, approximately 19 miles long (for location and profile see Plate VI).

The route selected is on the northerly side of the Alplaus Kill, crossing the Schenectady railroad at High Mills road, thence continuing in a southeasterly direction, passing near Grooms Corners,

and across the Mohawk river about one mile above Dunsbach Ferry. After crossing the river, the route follows a ravine due south for nearly one mile, and then takes a northeasterly direction to the Cohoes reservoir.

The supply main is to be carried across the Erie canal on a bridge (or without a bridge if the canal is abandoned before the construction of the pipe line), and is to be carried under the Mohawk river in a tunnel located some 50 feet below the river bed (see Plate VII). The tunnel is so designed that it will be possible to unwater it at any time and allow an inspection of the pipe line through it, and also to permit of repairs if any should be necessary. Six (6) valves are designed to be placed in the line between Charlton and Cohoes, which will permit the water to be drawn off in comparatively small sections to facilitate repairs when necessary. Blow-off valves are to be placed in the depressions and air valves on the summits.

It is designed to acquire the Cohoes Filter Plant and Reservoir No. 3, and operate them as a part of the proposed Conservation Water Works. It is designed to use Cohoes reservoir No. 3 as a regulating reservoir from which the water would, as at present, be supplied to the filter plant, at which plant water would be filtered to the entire district, that is, for Cohoes, Waterford, Green Island and Watervliet. It is believed that the present filter plant, which is filtering about seven million (7,000,000) gallons per day of Mohawk river water, will be capable of filtering fifteen million (15,000,000) gallons of the clear, comparatively pure, water from the Charlton reservoir.

It is proposed to aerate the water as it passes from the 36-inch supply main from the Charlton reservoir into the Cohoes reservoir No. 3. The aeration process replaces the oxygen which might be lost by long storage, and largely frees the water from objectionable tastes and odors due to minute vegetable or other organisms which sometimes occur in stored water. The aeration will be accomplished by discharging the water into the air through a large number of small nozzles after the manner of fountains.

Cohoes Reservoir No. 3 has a capacity of 60 million gallons, which on the basis of fifteen million (15,000,000) gallons per day (the estimated quantity 20 years hence) would last four

days, and afford ample time to make repairs in case of any interruption in the supply pipe from the Charlton Reservoir to said Reservoir No. 3.

After being filtered at the Cohoes plant, water will be supplied to Cohoes as at present. Filtered water will be carried by a 12 inch pipe line to the stand-pipe of the Waterford works. A 30 inch main is designed to deliver the combined supply of filtered water from the Cohoes plant to Watervliet and Green Island at the sites of stand-pipes or small covered reservoirs to be constructed and owned by those municipalities, which stand-pipes or reservoirs may have a water surface elevation of 263 feet above tide, thus affording ample head and pressure in the distribution systems. Some statute law enactment may be necessary to authorize the transfer by the City of Cohoes of its Reservoir No. 3 and filter plant, to the Conservation Commission. If there is any serious objection to the proposed use of Reservoir No. 3 and the filter plant, some substitute design can be made, as there is no physical difficulty in constructing a regulating reservoir in lieu of using Cohoes Reservoir No. 3 or another filter plant. The cost of a new regulating reservoir and filter plant would not be more than the estimated value of Cohoes Reservoir No. 3 and filter plant, viz., one hundred and ninety-two thousand dollars ($192,000.00).

Distribution Systems.

As under Article 9-A, Section 531, of the Conservation Law, "Union Water Districts," each municipality in the district is to provide stand-pipes or distributing reservoirs at which the Conservation Water Works is to deliver water to each municipality, and as each municipality is also to provide the entire distribution system, and control and sell the water therefrom, designs and estimates of such stand-pipes and reservoirs and distributing systems cannot properly be included in this report, and for that reason are omitted.

Estimated Cost of Proposed Water Works.

Land to be acquired (1,250 acres)	$62,500
Clearing and grubbing (112 acres)	8,000
Stripping dam site (21,300 cubic yards)	8,500

Rock excavation (150 cubic yards)	300
Earth excavation (1,700 cubic yards)	700
Highway relocated (2.4 miles)	20,400
Earth embankment (396,000 cubic yards)	257,400
Paving (12,100 cubic yards)	24,200
Concrete — Class A (2,820 cubic yards)	39,500
Concrete — Class B (4,000 cubic yards)	32,000
Reinforcing steel (89,690 lbs.)	3,600
Gate-house appurtenances (lump sum)	4,500
36-inch cast-iron pipe (101,000 lin. feet)	720,000
30-inch cast-iron pipe (16,000 lin. feet)	80,000
12-inch cast-iron pipe (11,600 lin. feet)	21,000
Erie canal crossing (lump sum)	2,400
Mohawk river crossing (lump sum)	113,200
Railroad crossings (lump sum)	1,300
Cohoes filter plant (lump sum)	133,000
Cohoes reservoir (lump sum)	59,000
Aeration plant (lump sum)	1,000
	$1,592,500
Add for engineering and contingencies	237,500
Total	$1,830,000

Operating Expenses, Sinking Fund, and Cost per Million Gallons.

Operating expenses per annum, including filtration	$20,000
Taxes per annum	18,300
Interest on $1,830,000 of bonds at 4½% per annum	82,350
Annual contribution to sinking fund which at 4½% interest would retire bonds in forty years	17,092
	$137,742

$$\frac{\$137,742.00}{15 \text{ mil. gal. x } 365 \text{ days}} = \$25.16 \text{ per mil. gal.}$$

Rock excavation (150 cubic yards)	300
Earth excavation (1,700 cubic yards)	700
Highway relocated (2.4 miles)	20,400
Earth embankment (396,000 cubic yards)	257,400
Paving (12,100 cubic yards)	24,200
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The cost per million gallons would, of course, be more, while less than fifteen million (15,000,000) gallons were used. After the expiration of the forty year bond period, the annual cost would be reduced to only $38,500 per annum, or to only $2.56 per million gallons.

Conclusion.

While much in the way of argument in favor of this scheme would, under ordinary conditions, be proper in an engineer's report of this general nature, the provisions of section 531 of Article 9 of the Conservation Law — "Union Water Districts" — make it inadvisable at this time.

The law requires that after the Conservation Commission has made its report to the trustees of the Union Water District, based on the results of its engineering and scientific investigations, surveys, maps, plans, estimate of cost, etc., the Conservation Commission, after due public notice, shall hold a public hearing upon the petition and report, and hear allegations for and against the scheme, and reach a determination as required by said law.

Therefore, to avoid anything in the nature of prejudgment, your Chief Engineer will not go further than to say that he believes the Alplaus Kill as a source of supply and a Conservation Water Works for the Charlton Union Water District, under the general plan submitted herewith, would be the best and most economical supply obtainable for Cohoes, Watervliet, Green Island and Waterford combined in a Union Water District.

Respectfully submitted,

R. W. SHERMAN,
Chief Engineer.

The surveys, investigations, design and estimate of cost of the proposed works as set forth in the foregoing report of the Chief Engineer have been carefully made at considerable expense, and this Commission believes them to be reliable. A careful study of them is urged upon the trustees of the Charlton Union Water District and by the governments and people of Cohoes, Waterford, Green Island and Watervliet.

Article 9-A, Conservation Law, "Union Water Districts," which is included herewith as "Appendix A" for convenience, should also be carefully read and studied in this connection.

A public hearing on this very important subject will be called for an early date by the Conservation Commission as required by Article 9-A of the Conservation Law.

The Conservation Commission will take further action after the close of the hearing.

CONSERVATION COMMISSION,
GEORGE E. VAN KENNEN,
Chairman.
JAMES W. FLEMING,
JOHN D. MOORE,
Commissioners.