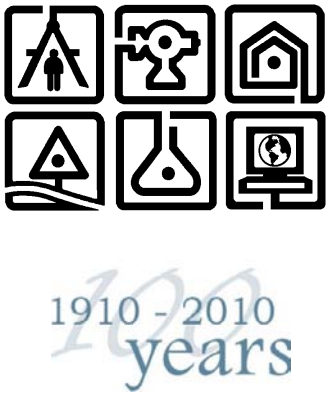
DRAFT

July 26, 2010



Engineer's Report
Water Softening Alternatives for Boyack Road Water Treatment Plant

Town of Clifton Park, New York

Prepared for:

CLIFTON PARK WATER AUTHORITY
661 Clifton Park Center Road
Clifton Park, New York 12065

Prepared by:

C.T. MALE ASSOCIATES, P.C.
50 Century Hill Drive
Latham, New York 12110
(518) 786-7400
FAX (518) 786-7299

C.T. Male Project No: 10.1227

ENGINEER'S REPORT
WATER SOFTENING ALTERNATIVES FOR
BOYACK ROAD WATER TREATMENT PLANT
CLIFTON PARK WATER AUTHORITY

TABLE OF CONTENTS

TABLES

FIGURES

1.0 INTRODUCTION

C.T. Male Associates, P.C. (C.T. Male) has prepared this Engineer's Report for the Clifton Park Water Authority (CPWA) to assess the various water softening alternatives for the Boyack Road water treatment plant (WTP). The water from the Boyack Road plant currently has a high level of hardness.

Depending upon the costs, it may be desirable to install a water softening system. While not eliminating the hardness, it may be reasonable to lower the hardness to a level at which water users would not have to soften their water individually, or would at a minimum require less softening. It is anticipated that many of the water users currently have individual water softening systems.

The costs associated with a water softening system will include initial construction and start-up costs, as well as annual operating costs. Issues which also must be considered include the desired finished water hardness, as well as the acceptable level of sodium within the finished water. This Engineer's Report addresses the significant aspects of these issues and will assist in determining which alternative is the most viable for this facility.

2.0 WATER SOFTENING ALTERNATIVES

The primary goal of this report is to evaluate different softening alternatives in order to determine which is the most efficient and cost effective option for the Boyack Road water treatment plant. Depending on the alternative selected, the installation of softening equipment at the plant would either reduce the hardness of the treated water to zero, which would require that the softened water be blended with non-softened water, or reduce the hardness to a desirable level.

Either a portion of the flow will be treated or all of it will be treated. If a portion is treated, all of the hardness will be removed and this softened water will be blended with non-softened water in order to achieve the desired level of hardness. If all the water is treated, the hardness will be lowered to a desirable level; therefore, blending would not be necessary. The five alternatives are ion exchange softening, lime-soda ash softening, nanofiltration, weak acid cation exchange softening and purchasing additional water from the Saratoga County Water Authority. The alternatives analyzed are described in this section of the report.

2.1 Alternative 1: Ion Exchange Softening

This softening approach was based on using two 12-foot diameter ion exchange units. As evaluated, the system would include two units installed in parallel, each unit capable of softening approximately 670 gpm. The softening will effectively reduce the hardness of the treated water to near zero.

As the hard water is passed through the exchangers, positive sodium or potassium ions are exchanged for the positive ions within the water that are responsible for the hardness. Periodically, the system must be regenerated with a brine solution, which drives the ion exchange in the other direction and results in new sodium or potassium ions being attached to the resin, and the positive ions associated with the hardness being concentrated in a waste solution. This regeneration is generally required every 8-12 hours of operation. In addition, the system must periodically be backwashed with clean water. The regeneration and backwash activities result in a wastewater discharge stream. The regeneration and backwash processes are generally automated to reduce

operator requirements. Refer to Figure 1 for a schematic of the ion exchange softening system.

- *Pros – Relatively economical, effective, equipment doesn't take up too much space, consistent.*

- *Cons – Increases sodium content in drinking water (if potassium chloride is not substituted for sodium chloride), sodium/postassium chloride costs can be expensive. Management of bulk chemical deliveries in residential areas surrounding plant could be an issue. The ability of the Saratoga County Sewer District #1 (SCSD #1) and Crescent Waste disposal system to accept backwash waste would need to be verified.*

2.2 Alternative 2: Lime – Soda Ash Softening

This softening option involves the addition of lime-soda ash to the water which allows the calcium and magnesium to form nearly insoluble precipitates which will then settle out. The lime is used to remove chemicals that cause carbonate hardness, whereas the soda ash is used to remove chemicals that cause non-carbonate hardness. A byproduct of this process is lime sludge which must be dewatered and properly disposed of. Refer to Figure 2 for a schematic of the lime – soda ash softening system.

- *Pros – Does not increase the sodium content in water, relatively low start-up and O&M costs, effective.*

- *Cons – Creates a large amount of sludge which needs to be dewatered in lagoons and then disposed of, equipment takes up a lot of space. Management of bulk chemical deliveries (lime, CO_2) in residential areas could be an issue. The treatment process requires significant operator attention to work consistently.*

2.3 Alternative 3: Nanofiltration

This process involves applying a high-pressure stream to a thin-film membrane that is permeable to water but only semi-permeable to dissolved ions such as calcium and magnesium. Nanofiltration systems are effective at removing both positively and negatively charged ions, including organics. They have the capability to remove a large number of contaminants in a single process step.

- *Pros – Can remove a large number of contaminants, does not increase the sodium content in water, economical from an O&M perspective, relatively small footprint.*

- *Cons – Expensive equipment, daily operational cost is relatively high, a high percentage of water is lost to backwash. The ability of the wastewater receiving systems (SCSD #1 & Crescent Waste) to handle the backwash flows would need to be evaluated.*

2.4 Alternative 4: Weak Acid Cation Exchange

This softening process reduces hardness in water without the addition of sodium. It involves weak acid cation (WAC) exchangers, which convert hardness associated with alkalinity to carbon dioxide and water. Since carbon dioxide (CO_2) is formed as a result of this process, a forced draft decarbonator uses air to remove the CO_2 generated. Hydrochloric acid is added to regenerate the resin in the exchangers. A small amount of caustic is used to increase the pH to the desired level. Softened water will be pumped from the clear well to the storage tank and wastewater will enter a waste neutralization tank before being conveyed to the sanitary sewer system. Refer to Figure 3 for a schematic of the weak acid cation exchange softening system.

- *Pros – Does not involve the addition of sodium, efficient, no sludge to dispose of.*

- *Cons – Equipment cost is fairly high, takes up a lot of space and has many components, making it more complicated to operate.*

2.5 Alternative 5: Purchasing Additional Water from Saratoga County

There are currently two on-site wells (Boyack wells) and two off-site wells (preserve wells) which are capable of producing 700± gpm and 1,300± gpm, respectively. The Boyack wells have a hardness of approximately 500 mg/L and the preserve wells have a hardness of approximately 200 mg/L. Since the hardness of the Boyack wells is relatively high, taking them off-line would greatly reduce the hardness; however, the available flow rate would only be 1,300 gpm. In order to provide the desired flow rate (2,000 gpm), additional water would need to be purchased from Saratoga County.

- *Pros – Softening equipment not required; therefore, there are no start-up/O&M costs.*

- *Cons – Could potentially be more costly than installing certain types of softening equipment.*

3.0 WATER QUALITY DATA

3.1 Raw Water Quality Data

Samples of the raw water and finished water at the Boyack Water Treatment Plant were collected on April 30, 2010 and analyzed by CNA Environmental, Inc.. The only parameters analyzed from these samples were calcium, magnesium and alkalinity. Additional raw water data was provided to C.T. Male by the Town of Clifton Park. Table 1 shows the results of the raw water analysis.

Table 1
Raw Water Quality

Parameter	Unit of Measurement	Result
Calcium	mg/L as $CaCO_3$	272
Magnesium	mg/L as $CaCO_3$	69
Sodium	mg/L as $CaCO_3$	25.2 – 75.6
Alkalinity (raw)	mg/L as $CaCO_3$	257
Alkalinity (finished)	mg/L as $CaCO_3$	253
Sulfate	mg/L as $CaCO_3$	0 – 79.4
Chloride	mg/L as $CaCO_3$	28.1 – 147
Total Hardness	mg/L as $CaCO_3$	341
Free Carbon Dioxide	mg/L as $CaCO_3$	Not provided for raw water
Iron (Total)	mg/L as Fe	0.01 – 1.13
Manganese (Total)	mg/L as Mn	0.3 – 2.9
pH	Standard Units	Not provided for raw water

3.2 Finished Water Quality

3.2.1 Hardness

A finished water hardness of 100-150 mg/L or less is desirable. Table 2 shows the finished water hardness(es) which could be obtained for the alternatives analyzed.

Table 2
Finished Water Hardness at 2000 gpm for Softening Alternatives

Softening Alternative	Softened Water Flow Rate (gpm)	Non-softened Water Flow Rate (gpm)	Non-softened Water Hardness	Softened Water Hardness	Finished Water Hardness
Ion Exchange – Sodium Chloride	1,335	665	305	0	100*
Ion Exchange – Potassium Chloride	1,335	665	305	0	100*
Lime – Soda Ash	2,000	-	305	100	100
Nanofiltration	1,400	600	305	0	100*
Weak Acid Cation	2,000	-	305	100	100 - 150
Saratoga County Water	700**	1,300***	200***	-	200

* The finished water is a blend of softened and non-softened water

** From SCWA

*** From Preserve Wells

3.2.2 Sodium

The sodium concentration in the finished water will be dependent upon the alternative selected. A finished water sodium content of 270 mg/L or less is considered to be desirable. This would be at or below the New York State Department of Health (NYSDOH) recommended sodium level for those on a "moderately restricted sodium diet" (note: the NYSDOH recommends a level of less than 20 mg/L for those on a severely restricted sodium diet). Table 3 shows the finished water sodium concentration for the softening alternatives analyzed.

Table 3
Finished Water Sodium Concentration at 2000 gpm for Softening Alternatives

Softening Alternative	Softened Water Flow Rate (gpm)	Non-softened Water Flow Rate (gpm)	Non-softened Water Sodium Average (mg/L)	Softened Water Sodium (mg/L)	Finished Water Sodium (mg/L)
Ion Exchange – Sodium Chloride	1,335	665	50	117.2-167.6	86.6-136.9
Ion Exchange – Potassium Chloride	1,335	665	50	25.2-75.6	25.2-75.6
Lime – Soda Ash	2,000	0	50	25.2-75.6	25.2-75.6
Nanofiltration	1,400	600	50	25.2-75.6	25.2-75.6
Weak Acid Cation	2,000	0	50	25.2-75.6	25.2-75.6
Saratoga County Water	700**	1,300***	50	-	14.6

* The finished water is a blend of softened and non-softened water

** From SCWA

*** From Preserve Wells

The softening alternative with the least amount of water lost to waste is lime-soda ash softening. Of the total 2,000 gpm being softened, 1,967 gpm would get to users in the system. This is comparable to purchasing 667 gpm from SCWA. The softening alternative with the greatest amount of water lost to waste is nanofiltration. Of the 1,400 gpm being softened in combination with the 600 gpm not being softened, 1,650 gpm would get to users in the system. This is comparable to purchasing 350 gpm from SCWA.

4.0 COST ESTIMATE

4.1 Estimated Cost

4.1.1 Operation

Factors affecting the annual operating costs of a water softening unit are dependent on the unit selected and may include salt consumption, waste disposal, labor, power, routine maintenance, and unexpected repairs. The following table provides an estimate

of the costs associated with the various alternatives analyzed. Capital costs were amortized over a 20 year period at an interest rate of 4.5%. O&M costs and waste disposal costs were assumed to increase 2% per year and water purchase costs to increase 1.5% per the terms of the CPWA contract with SCWA.

Table 4
Estimated Equipment/Operating Costs for Softening Alternatives

Softening Alternative	Total Construction Cost	Operating Cost (1st Year)	Waste Disposal Cost (1st Year)	Total Annual Cost (1st Year)	Total Annual Cost (20th Year)
Ion Exchange – Sodium Chloride	$ 1,819,800.00	$ 217,055.85	$ 100,694.00	$ 457,649.06	$ 602,800.74
Ion Exchange – Potassium Chloride	$ 1,819,800.00	$ 1,306,945.85	$ 100,694.00	$ 1,547,539.06	$ 2,190,564.67
Lime – Soda Ash	$ 5,162,400.00	$ 237,663.75	$ 135,049.00	$ 769,578.06	$ 939,837.51
Nanofiltration	$ 3,564,000.00	$ 381,962.00	$ 1,203,120.00	$ 1,859,068.58	$ 2,583,151.75
Weak Acid Cation	$ 3,275,100.00	$ 1,374,613.20	$ 187,672.00	$ 1,814,062.26	$ 2,527,731.59
Saratoga County Water	-	$ 754,236.00	-	$ 754,236.00	$ 1,000,834.02

UPDATE TABLE

5.0 RECOMMENDATIONS

_____
_____
_____
_____
_____

If you have any questions or require additional information please contact this office at (518) 786-7400.

Sincerely,

C.T. MALE ASSOCIATES, P.C.

Lauren J. Kohl, E.I.T.
Civil Engineer II

Reviewed and approved by,

Edwin L. Vopelak, Jr., P.E.
Managing Engineer

k:\projects\101227\admin\draft - r engineer's report.doc