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September 27 2013

Karen Fell
Assistant Director
New Jersey Department of Environmental Protection
Water Supply Operations Element
Bureau of Safe Drinking Water
401 East State Street
P O Box 420
Trenton New Jersey 08625

Re City of New Brunswick Comprehensive Performance Evaluation Final Report

Dear Karen

In accordance with your letter of June 20 2013 the City of New Brunswick – Water Utility has completed a Comprehensive Performance Evaluation (CPE) of its water treatment facility. The CPE was performed August 27 – 30 2013 by Process Applications Inc. Attached is the final report.

In addition the City has retained the services of Howard J Woods Jr & Associates L L C for six months to complete the Comprehensive Technical Assistance (CTA) which began immediately following the conclusion of the CPE. The above mentioned should satisfy the requirements set forth in your letter of June 20 2013.

Sincerely,

A handwritten signature in black ink, appearing to read "Frank J. Marascia".

Frank J Marascia
City of New Brunswick
Director of Water Utility

Cc Tom Loughlin 3rd – City Administrator

**Results of the
Comprehensive Performance Evaluation
for the
New Brunswick Water Treatment Plant
New Brunswick, New Jersey**

August 27 – 30, 2013

Prepared By

**Process Applications, Inc.
2627 Redwing Road, Suite 340
Fort Collins, Colorado 80526**

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Site Visit Information

Site and Mailing Address

New Brunswick Water Treatment Plant
1 Comstock Street
New Brunswick, NJ 08901
732-745 5060

Date of Site Visit

August 27 – 30 2013

New Brunswick Water Treatment Plant Personnel Participating

Frank Marascia	Utility Director
Ed O Rourke	Chief Water Treatment Plant Operator
Jack Belchaff	Water Treatment Plant Maintenance Supervisor
Sean Faust	Assistant Supervisor for Maintenance
Eric Murvay	Senior Water Treatment Plant Operator
Robert Bereheiko	Water Treatment Plant Operator
Kenneth Carter	Water Treatment Plant Operator
Michael Jenkins	Water Treatment Plant Operator
Andres Sanchez	Water Treatment Plant Operator
Scott Tarnoski	Water Treatment Plant Operator
Ed Devine	Assistant Water Treatment Plant Operator
James Murguly	Assistant Water Treatment Plant Operator
Kevin McGorvin	Water Treatment Plant Repairer
James Waldron	Water Treatment Plant Repairer
Michael Hockaday	Water Treatment Plant Repairer
Scott Irwin	Senior Maintenance Repairer
Kevin Kovacs	Laborer
JoVonn Quinones	Laborer
Hector Rodriguez	Laborer
Robert Robertson	Building Maintenance Worker

CPE Team

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INTRODUCTION

The Composite Correction Program (CCP)¹ is an approach developed by the U S Environmental Protection Agency (USEPA) and Process Applications Inc (PAI) to improve surface water treatment plant performance and to achieve compliance with the Surface Water Treatment Rule (SWTR) Its development was initiated by PAI and the State of Montana² which identified the need for a program to manage performance problems at its surface water treatment plants The approach consists of two components the Comprehensive Performance Evaluation (CPE) and the Comprehensive Technical Assistance (CTA)

A CPE is a thorough evaluation of an existing treatment plant resulting in a comprehensive assessment of the unit process capabilities and the impact of the operation maintenance and administrative practices on performance of the plant The results of the evaluation establish the plant capacity and list a set of prioritized factors limiting performance A CTA is used to improve performance of an existing plant by systematically addressing the factors limiting performance identified during the CPE

The implementation of the Interim Enhanced Surface Water Treatment Rule (IESWTR) promulgated in December 1998 required plants that serve greater than 10 000 customers to achieve less than 0.3 NTU (nephelometric turbidity units) turbidity in 95 percent of the monthly combined filter effluent samples and to monitor individual filter performance The requirement went into effect for all surface water treatment plants in 2005 Research results and field experience have shown that just meeting the requirements of the IESWTR does not guaranty adequate protection against some pathogenic microorganisms as evidenced by some waterborne disease outbreaks

Producing a finished water with a turbidity of less than or equal to 0.10 NTU provides much greater protection against pathogens like *Cryptosporidium* This microorganism that passed through the public water supply was responsible for a large outbreak of *Cryptosporidiosis* in

1 Hegg B.A., L.D. DeMers, J.H. Bender, E.M. Bissonette, and R.J. Lieberman Handbook: Optimizing Water Treatment Plant Performance Using the Composite Correction Program, EPA 625/6-91/027 USEPA, Washington, DC (August 1998)

2 Renner, R.C., B.A. Hegg, and D.F. Fraser Demonstration of the Comprehensive Performance Evaluation Technique to Assess Montana Surface Water Treatment Plants, Association of State Drinking Water Administration Conference, Tucson, AZ (February 1989)

Milwaukee Wisconsin in April 1993 where 400 000 people became ill and nearly 100 deaths occurred *Cryptosporidium* cysts are extremely resistant to chlorine disinfection, necessitating optimization of physical removal of particles

This CPE was triggered due to Individual Filter Effluent (IFE) turbidity readings in May and June 2013 that exceeded 2 NTU in two consecutive 15-minute readings The CPE arrangements were required to be made within 30 days of the CPE trigger (as required by 40 CFR §141.175) and a report must be produced within 90 days The city of New Brunswick contracted with PAI to conduct the mandatory CPE and also to participate in a conference call with the New Jersey Department of Environmental Protection to ensure that the resulting CPE and CPE report would meet the needs of the primacy agency The city of New Brunswick has also contracted with Howard J Woods Jr & Assoc L L C to facilitate a voluntary CTA follow up project, using the findings of this CPE report to focus training and transfer problem-solving skills to the New Brunswick Water Treatment Plant (WTP) personnel

The CPE team would like to thank the plant staff for taking the time to assist the team in completing the CPE at their facility During the evaluation, plant staff members acted in a professional manner were forthcoming with information, and demonstrated a genuine interest in learning about methods to improve plant performance This attitude represents a strong foundation for future plant optimization activities This report documents the findings of the CPE conducted at the New Brunswick WTP on August 27 – 30 2013

DESCRIPTION OF WATER TREATMENT PLANT

Overview

The New Brunswick Water Utility WTP is the main source of potable water for the city of New Brunswick The New Brunswick Water Utility also has interconnections with North Brunswick, East Brunswick, and New Jersey American Water Company to purchase potable water as needed, to supplement the water produced Potable water is delivered to approximately 50 000 consumers and to the neighboring communities of Milltown and Franklin. The New Brunswick Water Utility Department operates and maintains the system

and has a mission to provide all customers with a reliable uninterrupted supply of high quality drinking water at a reasonable cost

The source water is supplied to the plant from the Delaware and Raritan Canal and is supplemented as necessary with water from Westons Mill Pond. Each source has its own intake and pump station that transport the raw water to the water treatment plant. Historically the plant has had the ability to feed chemicals at the intake pump stations but no chemical was being added during the time of this CPE. The chemical feed equipment would have to be repaired and, in some cases replaced to begin feeding chemicals.

Water Treatment Processes

The New Brunswick WTP utilizes conventional surface water treatment processes including coagulation, flocculation, sedimentation, filtration, and disinfection processes. Filtration in the plant is achieved through conventional gravity filters for some of the flow (up to about 16.13 MGD but normally operated at 8 MGD or lower) and through membrane filters for part of the flow (up to about 10.68 MGD but normally operated at 9 MGD). The reported plant capacity is 20 MGD. Treated water is pumped to the distribution system from two clearwells tied together by a 30" line that feeds the finished water pump station. The clearwells hold 390,000 gallons and 540,000 gallons. A process flow schematic for the treatment plant, which was developed by the CPE team, is shown in Figure 1.

Raw water is pumped from the Delaware and Raritan (D & R) Canal pump station at all times and it is supplemented as necessary with raw water from the Weston Mills Pond pump station. The water quality of the Weston Mills Pond source tends towards higher turbidities and more taste and odor challenges. The chemical feed facilities at each of the raw water pump stations were once used for potassium permanganate chemical feed, but they are now inoperable. The most recent 2013 budget for the plant includes a line item to repair and restore the potassium permanganate feed systems at both pump stations.

REDACTED

FIGURE 1 Schematic of the New Brunswick Water Treatment Plant

The water from each pump station travels to the plant in separate raw water transmission lines that join on the water treatment plant property. A raw water sample station is located just downstream of the raw water line junction, which is fed to the continuous raw water surface scatter turbidimeter and is used for other raw water analyses (e.g. pH, alkalinity, temperature). Downstream from the raw water sample location, there are chemical injection points for lime, acid, and potassium permanganate. None of these chemicals were being fed during the CPE. A recent change in plant process control includes the feeding of raw lime based on the raw water alkalinity concentration and coagulated water pH.

The raw water transmission line terminates at the rapid mix basins where the water is mixed by three parallel mechanical mixers. During the CPE visit, one of the mixers was not functioning due to the loss of a variable frequency drive. Alum is added to the raw water in the

rapid mix basin After the rapid mix basin, the coagulated water travels through a transmission line to a junction box A streaming current monitor is located about 10 feet downstream of the rapid mix basin on the transmission line and is used to adjust the alum dosage The junction box is currently used as a grab sample location for coagulated water prior to its entry into the flocculation process

There are two parallel flocculation basins with single stage walking beam mixers Flocculated water passes through a baffle from the flocculation process into the two parallel sedimentation basins The sedimentation basins have been modified since their original construction however non functional structures remain in the basins and small perimeter areas of the basins appear to have stagnant flow conditions The outlet ports on the sedimentation basin are located about four feet below the water surface The outlet channel of the sedimentation basins collects the settled water from both basins where a lime feed system adds lime prior to the water entering a transmission line

A flow control valve on the settled water transmission line and a float system are used to maintain the water level in the downstream chlorine contact tanks Sodium hypochlorite is injected into the settled water transmission line after the flow control valve prior to the settled water entering either of two parallel chlorine contact basins The chlorine contact basins contain serpentine baffling to provide near plug flow characteristics for the purposes of producing consistent contact time for the water as it moves toward the filters At the outlet of the chlorine contact basin the water is combined again and then split to either the gravity or the membrane filters

The water that is directed toward the membrane filters is sampled by a continuous turbidimeter prior to entering the membrane cells It is then pumped into the membrane cells where it is drawn via suction through the membranes and pumped again through a transmission line to the gravity clearwell The membranes are arranged in racks of nine modules that are hung into the cells There are four cells in the plant, three of which would be in service at any one time On the effluent line of each of the cells is a continuous laser turbidimeter and the combined flow from the membranes is monitored with another laser turbidimeter

The water that proceeds from the chlorine contact basins to the gravity filters is monitored for pH and chlorine residual and then distributed to the eight gravity anthracite-sand filters. The membrane filters are operated at a relatively constant flow rate and the gravity filters are operated to meet the plant flow demands. This is accomplished by the operators by controlling the number of filters in service and by making adjustments to the individual filter flow rates. Gravity filters are kept off line if they are not needed to meet demand, and usually only three or four filters are used at any one time. Each filter effluent is monitored with a continuous turbidimeter, all of which were recently added (May 2013). The filters discharge directly into the gravity clearwell separately, so there is no location for a true combined filter effluent (CFE) sample. Currently, the CFE continuous turbidimeter receives a sample stream from the gravity clearwell near a location closest to Filters 1 and 2, where most of the filter flow would pass through the clearwell.

Flow from the gravity clearwell travels to either another buried clearwell or the high service pump station. There is an additional sample stream located after the high service pumps, and it is currently used to measure pH and chlorine residual of the pumped water.

PERFORMANCE ASSESSMENT

Historical Performance Assessment

To achieve optimized performance, a water treatment plant must demonstrate that it can take a raw water source of variable quality and produce a consistent, high quality finished water. Further, the performance of each unit process must demonstrate its capability to act as a barrier to the passage of particles at all times.

This Comprehensive Performance Evaluation uses turbidity data collected from instrument data loggers and operator log sheets to assess the effectiveness of the flocculation/ sedimentation and the filtration barriers. It also uses an inactivation ratio calculation, based on operator log sheet records, to assess the performance of the disinfection barrier.

The turbidity log sheets for the gravity filters provided to the CPE team contained data since May 1 2013 when the new continuous IFE turbidimeters were installed. Continuous IFE turbidity data prior to that date were not reviewed because the existing meters at that time were deemed to be inaccurate. The log sheets also contained raw water data and settled water data recorded hourly. The log sheets were used to analyze the raw and settled water turbidity also because the operators reported that they found discrepancies between their log sheets and the historical SCADA records and found the SCADA system was in error. They had their SCADA expert visit the week before the CPE visit to correct the historical data storage problems but all historical data in the SCADA system were of suspect quality. Also the historical IFE data in the SCADA system collected data for all eight gravity filters at all times even when the filter was resting backwashing or filtering to waste so interpretation of the data was too difficult. The data used from the log sheets came from transcribed readings from the continuous IFE turbidimeter controllers the raw water continuous turbidimeter controller, and hourly grab samples taken from the end of each settling basin.

See Table 1 for a discussion of the data used in the CPE performance analysis. The membrane filter data were taken from the SC100 data loggers and were only available after June 2013 due to limitations in capturing the data.

TABLE 1 CPE Turbidity Performance Analysis Data Acquisition Description

Performance Parameter	Data Used in the CPE Performance Analysis
Raw water turbidity	The data from the continuous raw water turbidimeter are stored in the SCADA system but there are questions about the accuracy of the historical SCADA data prior to the CPE site visit. On an hourly basis, operators record the reading from the raw water continuous turbidimeter controller signal display onto an hourly log sheet. The CPE team used the hourly log sheets for the CPE performance analysis.
Settled water turbidity (Each Basin)	Operators sample settled water hourly at the midpoint of the settling basins and at the end of the settling basins, and they record the data on the hourly log sheets. The CPE team used the hourly log sheets to compile the data.
IFE turbidity (Gravity Filters)	The data from the continuous IFE turbidimeters are stored in the SCADA system, but there are questions about the accuracy of the historical SCADA data prior to the CPE site visit. Also, the historical IFE data would not differentiate between times that filters were on line producing filtered water and off line. On an hourly basis, operators record the reading from the IFE continuous turbidimeter controller signal display (of the active filters) onto an hourly log sheet. The CPE team used the hourly log sheets for the CPE performance analysis.
IFE turbidity (Membrane Filters)	The data were downloaded from the IFE continuous turbidity controller and provided to the CPE team. All 15 minute readings were included in the data-set, including times when the turbidimeter may have been off-line for cleaning, calibrating, or sample line maintenance. Also, the data would include readings when a cell was off line for cleaning or backwashing.
CFE turbidity	The data were downloaded from the CFE continuous turbidity controller and provided to the CPE team. All 15 minute readings were included in the data set, including times when the turbidimeter may have been off line for cleaning, calibrating, or sample line maintenance.

For the disinfection analysis the CPE team used the following data included in Table 2

TABLE 2 CPE Disinfection Performance Analysis Data Acquisition Description

Disinfection Performance Parameter	Data Used in the CPE Performance Analysis
Water temperature	A continuous temperature instrument is located between the chlorine contact basin and the membrane filters. Readings are manually compiled from the signal monitor on an hourly basis and recorded on a log sheet.
pH	A continuous pH meter records pH of the water discharged from the chlorine contact basin. Hourly operators record the reading from the signal monitor located at the continuous pH analyzer controller. The results are recorded in the hourly log sheets.
Chlorine residual	A continuous chlorine analyzer records pH of the water discharged from the chlorine contact basin. Hourly operators record the reading from the signal monitor located at the continuous chlorine analyzer controller. The results are recorded in the hourly log sheets.

Raw water, settled water, IFE and CFE turbidity data were entered into an Optimization Assessment Spreadsheet (OAS) and analyzed through the spreadsheet calculations and charts. Figure 2 shows the OAS summary information for the gravity filter part of the plant.

The Turbidity Profile in the upper left section of Figure 2 shows the maximum daily values of raw, settled, IFE and CFE turbidity for each day during the May 1 to August 26, 2013 time period. For optimization purposes, the maximum daily turbidity readings are used to show the daily worst case performance by each of the barriers. If the plant can perform within the optimization goals even at the time of its worst daily performance, then the plant staff can be assured that it is also meeting the goals during the rest of the day. The annual data table in the lower left quadrant of Figure 2 shows that the daily maximum raw water turbidity values average for the New Brunswick WTP is 5.4 NTU. For raw water conditions such as this where the average maximum daily raw water turbidity is below 10 NTU, the optimization goal for settled water turbidity is 1 NTU.

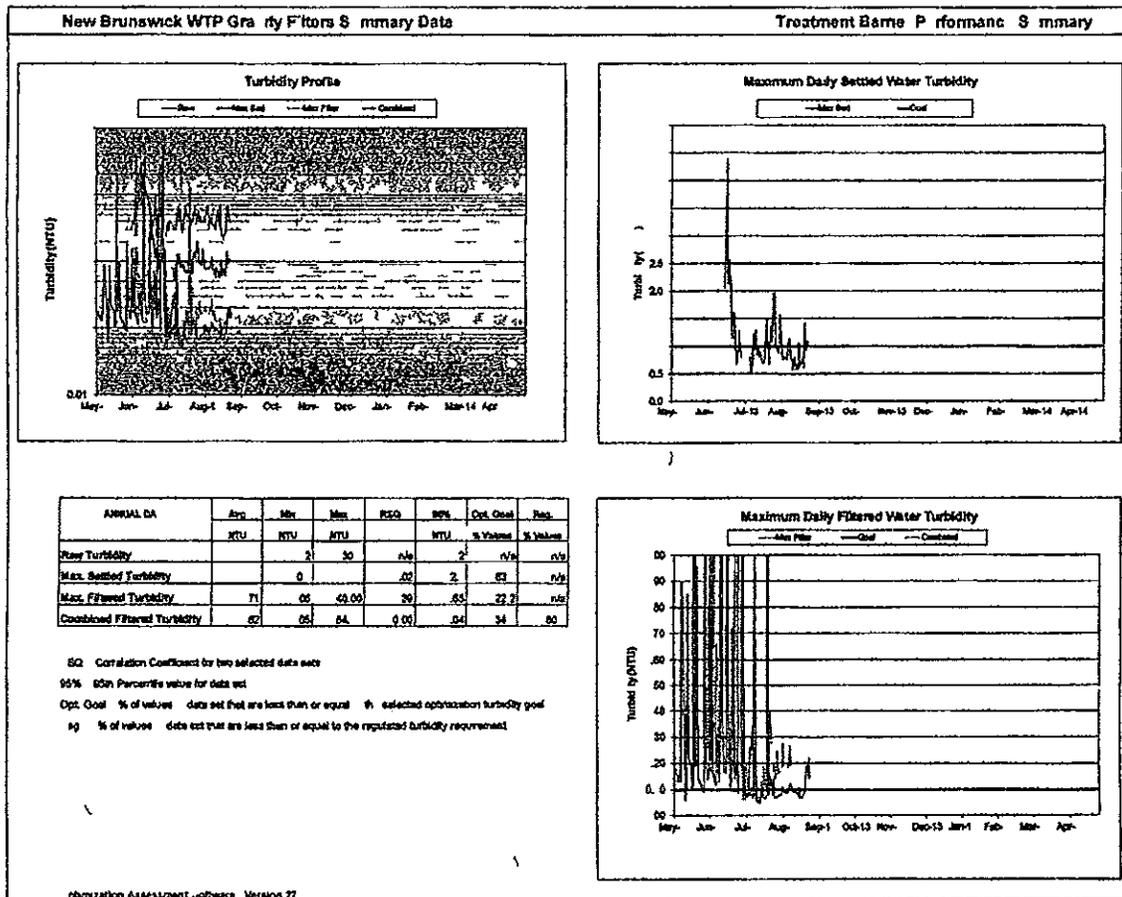


FIGURE 2 OAS Summary Sheet – gravity filters

The graph in the upper right quadrant of Figure 2 shows a red horizontal line at the optimization goal of 1 NTU. The settled water turbidity trend line is a plot of the maximum daily value of settled water turbidity from whichever of the sedimentation basins yielded the highest value each day. The plant should strive to meet the goal 95 percent of the days during the year. The settled water turbidities are highly variable with their highest readings near the beginning of the time period for which data were available. The steady lowering of the settled water turbidities over the time period and steady lessening of the magnitude of the data variability indicate improvement in performance and process control over time. This is an encouraging trend. The table at the lower left quadrant of Figure 2 shows that the 95th percentile of the settled water daily maximums was 2.1 NTU, which is above the goal of 1 NTU. During

the period the settled water turbidity goal was achieved 63.6 percent of the time. The filtered water data trend is in the chart in the lower right quadrant of Figure 2. The red line on the trend line shows the optimization goal 0.10 NTU based on daily maximum values. The solid blue line represents the maximum daily CFE data for the gravity filters and the dashed blue line represents the maximum daily IFE data point from the highest of the eight gravity filters. The data show some large spikes above 1 NTU at times for the filtered water CFE and IFE data. The statistics in Figure 2 show the 95th percentile of the IFE maximum daily data is 0.65 NTU. The 95th percentile of the CFE maximum daily data is 3.04 NTU. Further, the IFE maximum daily turbidity data only met the optimization goal of 0.10 NTU 22 percent of the days in the evaluation period, while the CFE maximum daily turbidity data only met the optimization goal 34.8 percent of the days in the period. To further illustrate the performance issues with the gravity filters, the historical trend in the upper left quadrant of Figure 2 shows that the IFE and CFE maximum daily turbidity is higher than the maximum raw water turbidity on the same day.

Figure 3 shows a summary of the individual sedimentation basin and filter performance for the gravity filter side of the New Brunswick plant. The basin or filter with the highest 95th percentile reading for the month is highlighted in red. The sedimentation basin data indicate that Basin 2 has performance that is slightly worse than performance at Basin 1. The individual filter data show different filters representing the highest filter for each month reported, suggesting that no specific filter is consistently performing worse than the others. June was the worst overall month for IFE performance, with Filter 6 having the highest 95th percentile value of 2.57 NTU. Overall filter performance has improved since June, however, no filter has met the optimization goal of 0.10 NTU since June.

Optimization Trend Report

New Brunswick WTP Gravity Filters Summary Data

	8th Water Turbidity												Filtered Water Turbidity											
	95th Perc nbl Values (NTU)				% Y 1 as Meeting Goal				95th Percentile Values (NTU)												% Values Meeting Goal			
	Bed 1	Bed 2	Bed 3	Bed 4	3 NTU	2 NTU	1 NTU	0 NTU	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6	Filter 7	Filter 8	Filter 9	Filter 10	Filter 11	Filter 12	Combined	0.3	0.2	0.1
May 13					#N/A	#N/A	#N/A	#N/A		0.12	0.05	0.10	0.05	0.08	0.16	0.26					1.53	75.86	68.97	10.3
Jun 13	2.22	3.21			93.33	66.67	33.3		0.24	0.47	0.38	0.44	0.48	2.57	0.31	0.42					33.00	58.67	48.07	
Jul 13	1.39	1.78			100.00	100.00	69.2		0.22	0.20	0.31	0.22	0.18	0.25	0.25	0.18					0.81	90.32	83.87	84.5
Aug 13	1.11	1.35			100.00	100.00	78.0		0.37	0.35	0.21	0.21	0.22	0.23	0.38	0.38					0.18	100.00	100.00	88.0
Sep 13					#N/A	#N/A	#N/A	#N/A														#N/A	#N/A	#N/A
Oct 13					#N/A	#N/A	#N/A	#N/A														#N/A	#N/A	#N/A
Nov 13					#N/A	#N/A	#N/A	#N/A														#N/A	#N/A	#N/A
Dec 13					#N/A	#N/A	#N/A	#N/A														#N/A	#N/A	#N/A
Jan 14					#N/A	#N/A	#N/A	#N/A														#N/A	#N/A	#N/A
Feb 14					#N/A	#N/A	#N/A	#N/A														#N/A	#N/A	#N/A
Mar 14					#N/A	#N/A	#N/A	#N/A														#N/A	#N/A	#N/A
Apr 14					#N/A	#N/A	#N/A	#N/A														#N/A	#N/A	#N/A
Yr 80%	1.02	2.04			1.26	0.39	0.30	0.34	0.24	0.33	0.30	0.34	0.24	0.33	0.34	0.38					3.04			
Yr G 1	74.2%	71.2%			51.8%	40.0%	41.8%	35.1%	43.2%	43.0%	41.8%	35.1%	43.2%	38.1%	23.1%	37.3%					34.6%			

FIGURE 3 OA's Individual Unit Performance Data - gravity filters

Figures 4 and 5 show the same summary data for the membrane side of the plant. The raw and settled water data in Figures 4 and 5 are identical to similar data shown in Figures 2 and 3 because the same raw water facilities and sedimentation basins serve the membrane filtration side of the plant. The filtration data show the 95th percentile of the individual cell maximum daily turbidities to be 0.21 NTU. The membrane filter cells met the optimization goal of 0.10 NTU 84.5 percent of the days in the three month analysis period. The CFE data met the optimization goals with a 95th percentile of 0.04 NTU and 100 percent of the days meeting the goal during the evaluation period.

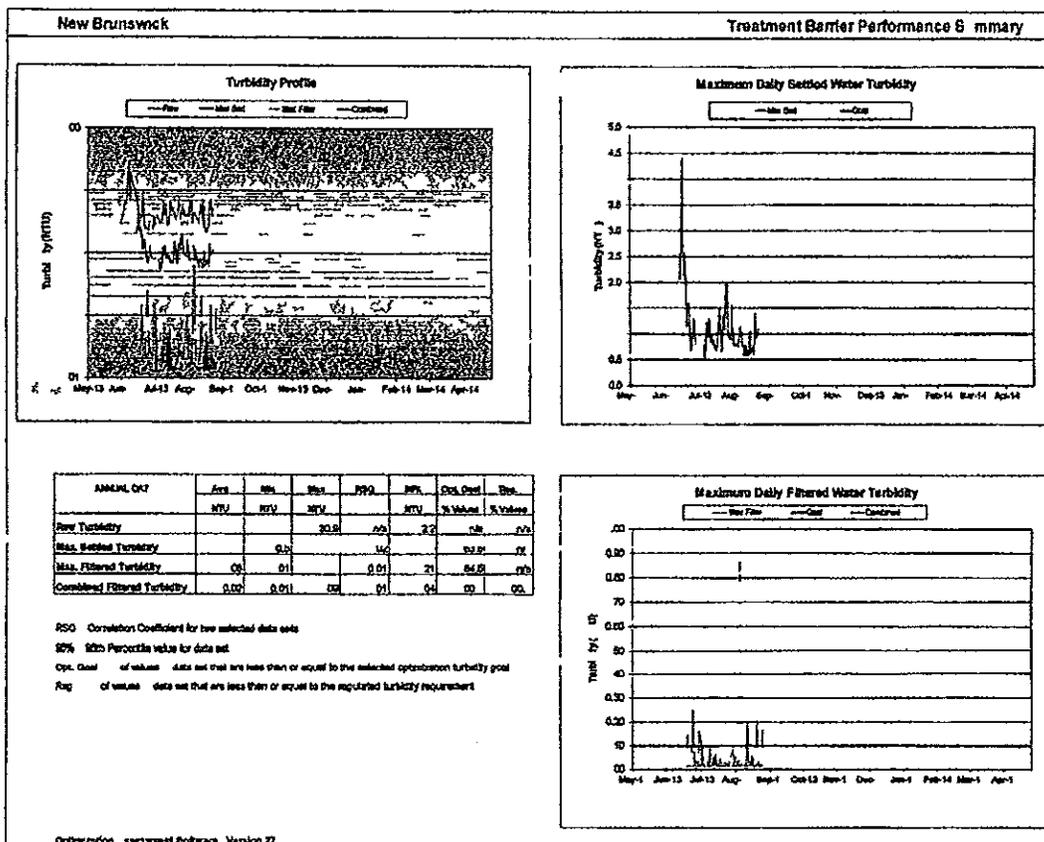


FIGURE 4 OAS Summary Sheet – membrane filters

Optimization Trend Report

New Brunswick WTP Membrane Filters Summary Data

	Settle d V to T clarity												Filtered W to T clarity											
	85th Percentile Values (NTU)						% V to 8 Mechl g Goal						85th Percentile V lues (NTU)						% Value Meeting Goal					
	Bed 1	Bed 2	Bed 3	Bed 4	3 NTU	2 NTU	1 NTU	NTU	Fiber 1	Fiber 2	Fiber 3	Fiber 4	Fiber 5	Fiber 6	Fiber 7	Fiber 8	Fiber 9	Fiber 10	Fiber 11	Fiber 12	Combined	0.3	0.2	0.1
May 13																								
J. n-13	2.22	3.21						0.02	0.08		0.17										0.02	100.00	100.00	100.00
J. 1-13	1.36	1.78						0.02	0.08		0.08										0.06	100.00	100.00	100.00
Aug 13	1.11	1.35						0.08	0.02		0.21										0.02	100.00	100.00	100.00
Sep 13																								
Oct 13																								
N 13																								
Dec 13																								
Jan 14																								
F. b 14																								
Mar 14																								
Apr-14																								
Yr 85%	1.92	2.04						0.03	0.02		0.10										0.04			
Y G of	74.5%	71.2%						97.2%	97.2%		88.7%										100.0%			

FIGURE 5 OAS Individual Unit Performance Data – membrane filters

Handwritten notes and scribbles in the bottom right corner of the page.

Figure 5 shows the same summary of the individual sedimentation units as Figure 3 along with the filtration units at the membrane filter side of the New Brunswick plant. Cell 2 achieved the optimization goal of 0.10 NTU 95 percent of the days during the period, but Cells 1 and 4 exceeded the goal during some of the months. It should be noted that the staff was only able to download the IFE turbidity data from the membrane cells during the CPE week, so limited quality control of the dataset was completed.

A review of the Log Removal Values (LRV) of the membranes showed the data to be relatively consistent based on the pressure decay testing and LRV values were consistently greater than 3.25 log. Table 3 below summarizes log removal values based on reviews of pressure decay testing hard copy records kept at the plant.

TABLE 3 Log Removal Values for Membrane Filters Based on Pressure Decay Testing

Date	Cell 1	Cell 2	Cell 3	Cell 4
5/1/2013	3.42	3.32	3.28	3.28
6/1/2013	3.36	3.33		3.27
6/17/2013	3.41	3.26		3.3
7/1/2013	3.54	3.45		4.01
7/15/2013	3.51	3.25		4.01
8/1/2013	3.48	3.48		3.99
8/12/2013	3.45	3.42		3.94
8/28/2013	3.43	3.43		4.04

The LRV data show good performance by the membrane filters and could be an indicator that the turbidity spikes that occur occasionally are due to instrumentation issues (e.g. maintenance recording data during backwash). The membrane filters are capable of achieving LRVs of > 4 log; however, due to delayed maintenance on the individual modules (i.e. pinning) performance has degraded slightly through this process. Staff acknowledged that the membranes are required to achieve at least 2.5 log removal to meet the disinfection

requirements for the plant, and they thought that the current level of performance provided a sufficient safety factor

The disinfection treatment process is an important barrier to microorganisms in any surface water treatment plant. In the case of the New Brunswick plant, the gravity filter side of the plant is considered to remove 2.5 log (approximately 99.7 percent) of the target pathogen *Giardia* cysts. Disinfection is required to inactivate another 0.5 log of the cysts to bring the total reduction of viable *Giardia* cysts to 3 log, or 99.9 percent. The filter performance on the gravity side was so poor during the time period analyzed (although it was improving over the three month period) that the disinfection process is even more critical.

To evaluate the disinfection process, the CPE team reviewed data submitted by the plant on Monthly Operation Reports and determined inactivation ratios. The inactivation ratio is the log removal achieved at the plant on a particular day divided by the required log removal (in this case 0.5 log). The red line in Figure 6 is the minimum requirement of 1.0 for the inactivation ratio. The black line represents the trend line for the inactivation ratio based on using the data submitted with the monthly operating reports. The black line only dips below the red line during two days on the graph. The blue line in Figure 6 represents the inactivation ratio trend line based on the assessment of the disinfection process by the CPE team. The difference between the CPE team disinfection assessment and the Monthly Operating Report assessment is that the CPE team only counted the inactivation in disinfection Zone 1, the chlorine contact basins. The Monthly Operating Report assessment included both Zone 1 as well as Zone 2, the gravity clearwell.

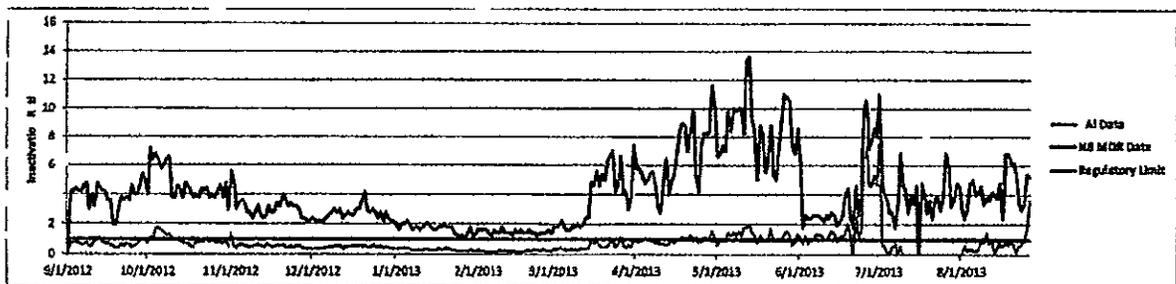


FIGURE 6 Inactivation Ratio for *Giardia* cysts at the New Brunswick WTP

Figure 7 shows the flow pattern of water through the gravity clearwell based on the review of the clearwell drawings and visual observations by the CPE team. Access to the clearwell is very limited so confirmation of this information could not be verified by the team. Based on this limited review the CPE team assumes that the water enters the clearwell from the membranes at the left of the graphic and from the eight discharge lines from the gravity filters at the top of the graphic. Sodium hypochlorite (chlorine) is added at two locations noted by yellow circles on the graphic: one near Filter 2 and one between the membrane filtered water and the gravity filtered water discharges. The sodium hypochlorite is fed into the top of the water in the clearwell through penetrations in the clearwell roof. The method of chlorination, feeding into the clearwell near the center of the basin, does not allow complete mixing of the chlorine prior to entering the clearwell and does not allow the chlorine that is added to be in contact with the water for the entire volume of the clearwell. There will likely be a higher concentration of chlorine near the top of the clearwell where the chlorine enters and it is likely that there will be less chlorine upstream of the locations of the chlorine addition.

REDACTED

FIGURE 7 Gravity clearwell flow pattern

The Monthly Operating Report disinfection assessment used a baffling factor of 0.5 for the clearwell meaning it is moderately baffled throughout the entire clearwell. Based on the assumed configuration of the clearwell, the CPE team thinks that this baffling factor is too high. However, on a more fundamental level of water disinfection, the CPE team thinks that the clearwell should not be used for disinfection credit because there is no way to measure the lowest chlorine concentration in the clearwell. As a result of the CPE team decision to not use the clearwell volume in the disinfection assessment, the disinfection goal was attained only 78 days out of 336 (23.2 percent) for which data are available.

The disinfection trend line in Figure 6 shows one time period in July 2013 when the blue line was well above the goal. This occurred immediately after the operators learned that the poor filter performance in June and May had triggered a mandatory CPE. As a result of this finding, the chlorine dosage was increased at the chlorine contact basin. This action indicates that the plant could meet the disinfection requirements simply by adding more chlorine at Zone 1 (the chlorine contact basin) and disallowing the use of Zone 2 (the gravity clearwell). The operators could continue to add chlorine at the gravity clearwell to make sure that the chlorine residual leaving the plant is in the range they are targeting (about 1.5 mg/L during the CPE) to achieve their distribution system residual goals.

Performance Summary

The performance observations described above are summarized in Table 4 on the following page.

TABLE 4 New Brunswick WTP Performance Summary

Barrier	Optimization Goal	Performance
Sedimentation	Settled water turbidity 1 NTU or less 95% of the time based on daily maximum values	Not meeting the goals based on 95 th percentile of 2.1 NTU and 64% of days meeting 1 NTU over 3 month period. Performance trends have improved recently but the data set is limited.
Gravity Filtration	IFE and CFE turbidities 0.10 NTU or less 95% of the time based on daily maximum values	<p>Not meeting the goal for IFE or CFE filtration. This area needs focus and improvement.</p> <p>The IFE 95th percentile is 0.65 NTU and the IFE performance is meeting the optimization goal only 22% of the time (based on a recent 3 month sample set).</p> <p>The CFE 95th percentile is 3.04 NTU and the CFE performance is meeting the optimization goal only 34% of the time (based on a recent 3 month sample set).</p>
Membrane Filtration	IFE and CFE turbidities 0.10 NTU or less 95% of the time based on daily maximum values	<p>The CFE data indicate that the goal is being met. The 95th percentile is 0.04 NTU and the CFE performance is meeting the optimization goals 100% of the days in the recent 3 month sample period.</p> <p>The membrane IFE data are not meeting the goals. The IFE 95th percentile is 0.21 NTU and the IFE performance is meeting the optimization goal about 85% of the days in the recent 3 month period that was used for the analysis. Reasonably good LRV data suggest that high turbidity values may be related to instrumentation issues.</p>
Disinfection	Inactivation ratio above 1 every day that the plant is in operation	Because the CPE team did not include disinfection Zone 2 (the gravity clearwell) for this assessment, the goal was attained only 23% of the days for which data were available in the last year. Limited performance data and design assessment indicate that the disinfection goal can be achieved using only the chlorine contact basins in the future.

Special Studies

During the CPE several special studies were conducted for use in assessing plant performance and process control. These studies included 1) a gravity filter investigation consisting of filter media examination, filter cleaning using spent backwash water turbidity readings and post backwash turbidity recovery 2) a comparison of bench top and continuous turbidimeter data integrity using both the plant bench top and a portable turbidimeter provided by the CPE team 3) a comparison of the data integrity related to turbidimeter values versus SCADA values and 4) an alum feed draw down test.

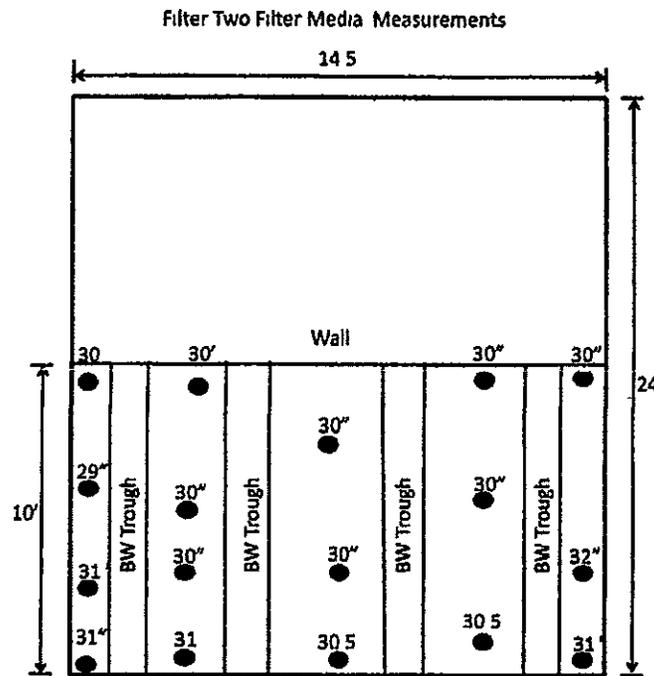
Special Study 1 Filter Media Assessment and Backwash Procedures and Recovery–

Filter 2 was the subject of these special studies because it was scheduled for backwashing while the CPE team was onsite. It was drained by a plant operator at the request of the CPE team, enabling a member of the evaluation team and plant staff to probe and inspect the filter media. The total media depth from the support deck to the top of media was measured by manually probing the filter with a metal rod until the rod contacted mediate support deck. The media depth of Filter 2 was generally level across the surface of the filter and was found to be approximately 30 inches deep. The media depth was measured at seventeen locations across the filter (see Figure 8) and varied from 29 to 32 inches. The back area of the filter was only visually inspected due to the lower roof elevation allowing limited access to this area. A visual inspection of the media did not reveal the presence of mud balls and the sand and anthracite appeared to be clean. A filter excavation indicated that the media was well stratified anthracite for about 18 inches and then sand for about 12 inches. It is important to note that these findings only represent the inspection of one of the eight gravity filters.

Once the filter media assessment was completed Filter 2 was backwashed by a plant operator. The flow across both sides of the filter appeared to be even (no dead spots were noted). During the high-rate portion of the backwash, the average media rise was measured to be approximately two inches, which equates to a 7 percent expansion of the filter bed. This is not within the suggested minimum 20 to 25 percent expansion that should be achieved during a backwash, however the filter media was in good shape and the combination of the backwash along with the air scour process that is part of the backwash appears to be adequately

cleaning the filter media. When the backwash was complete Filter 2 was returned to service in rewash (filter to waste) mode for fifteen minutes and then returned to filter to clearwell mode

During the Filter 2 backwash, turbidity grab samples were pulled from the waste trough and analyzed with a Hach 2100Q portable turbidimeter. The results of the grab samples and analyses are shown in the turbidity trend line in Figure 9. The trend line shows that the turbidity approached its lowest level after about seven minutes. Further special studies could be conducted to determine if the backwash time could be shortened without affecting post backwash recovery. Also, additional studies could be pursued to determine if setting a spent backwash turbidity target (i.e. allowing some solids to remain in the filter) could be an effective strategy for shortening the filter ripening time.



Media expansion during backwash was 2" at the peak backwash rate. Media excavation showed 18" of anthracite and 14" of sand.

FIGURE 8 Filter 2 – media depth testing

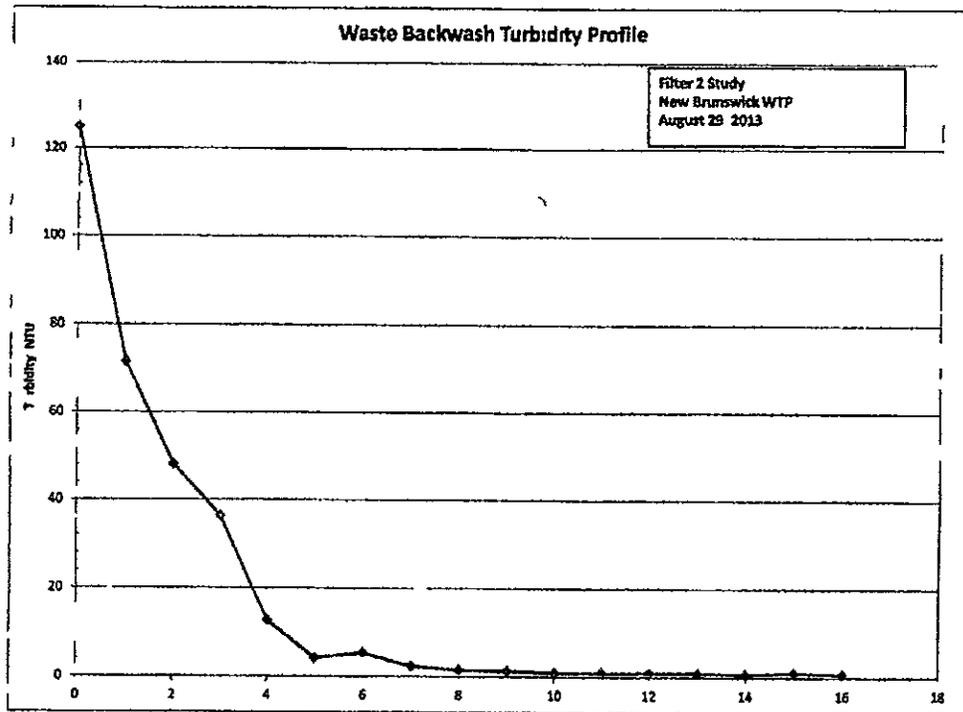


FIGURE 9 Filter 2 turbidity of spent backwash.

The post backwash recovery curve was recorded from the turbidimeter SC200 Controller that receives the Filter 2 data signal for about 40 minutes. The data collected during the filter rewash are suspect to some degree because the turbidimeter sample line is in a location that could contain stagnant water when the filter rewash valve is open and the clearwell valve is closed. Figure 10 shows the filter piping arrangement and the sample line. The blue area could represent stagnant water during the filter rewash period.

The post backwash recovery curve for Filter 2 is shown in Figure 11. After 40 minutes the filter had recovered to about 0.12 NTU after reaching a maximum post backwash turbidity of about 0.13 NTU. The post backwash recovery goal of ≤ 0.10 NTU at the time of returning the filter to service was not achieved during this study. Although no significant turbidity spike was observed during the filter backwash recovery, achieving the 0.10 NTU performance goal was requiring more time than expected from a clean filter.

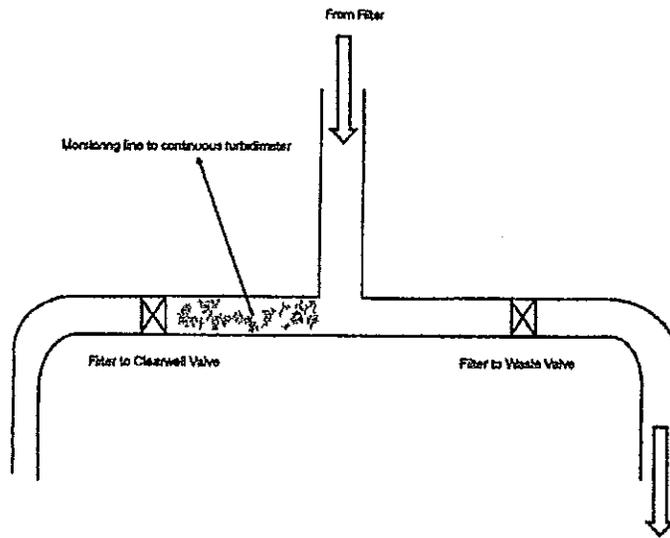


FIGURE 10 Filter 2 discharge piping.

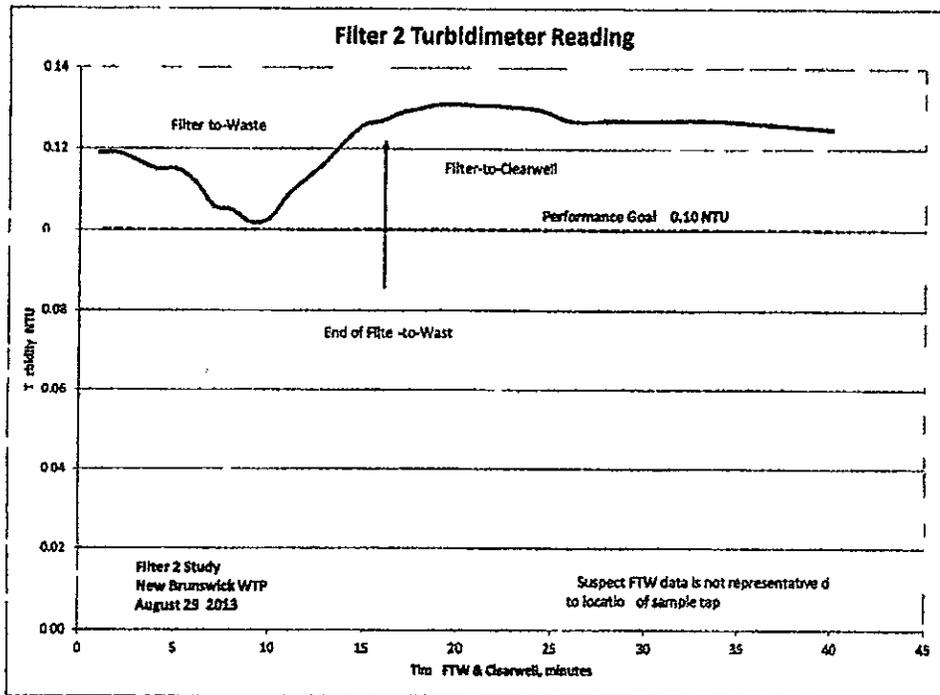


FIGURE 11 Filter 2 backwash recovery curve

Special Study 2 Filtered Water Turbidity Data Integrity--

A special study was conducted to investigate the data integrity of the gravity filter continuous turbidimeters. Plant staff indicated there had been data integrity issues with the data being transmitted from the membrane IFE and CFE turbidimeters to SCADA, and they had just recently corrected the situation about a week before the CPE. The special study was conducted with the help of an operator who went into the filter gallery. He read the turbidimeter value from the SC200 monitors for the eight gravity filters at the same time that a CPE team member viewed the display of the SCADA monitor in the control room. The data are shown in Figure 12. In general, the data show close correlation, with the exception of Filters 7 and 8. The values of these filters should be investigated further to confirm that the signals are not mis-wired or experiencing some type of signal interference.

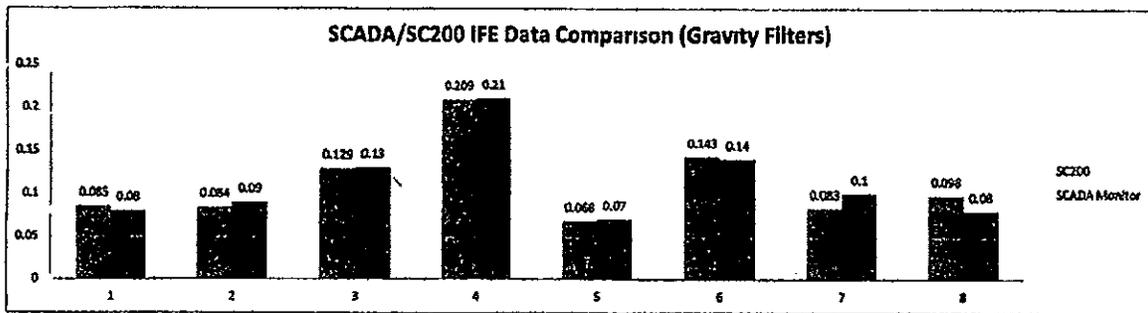


FIGURE 12 SCADA/SC200 data integrity comparison

Special Study 3 Alum Feed Draw-Down Study --

The plant operators do not use conventional methods such as jar testing to set the alum dose. They have recently begun using their streaming current monitor (SCM) and adjusting the alum feed up or down until they get the charge reading they want to maintain on the SCM. The alum feed system has a rotometer and a chart posted on the wall next to it that interprets how many gallons per day are added based on the rotometer reading. This special study used a newly installed draw down cylinder on the alum feed pump to measure the actual flow rate of the alum. On the day of the test, the plant was operating between 12 and 13 MGD depending on the desired water level in the gravity filter clearwell. The operators did not change the chemical feed settings as they alternated between 12 and 13 MGD so the dosage varied with the flow rate. The rotometer setting at the feed rate used read 0.59 gpm. The readout on the chemical feed pump was reading 12,808 lb/day.

Using the draw down cylinder the feed rate was found to be 3.4 gallons in 10 minutes or 0.34 gpm. The dosage can be derived from the feed rate as follows:

$$\text{The dosage in gallons per day} = 0.34 \text{ gpm} \times 1,440 \text{ min/day} = 489.6 \text{ gpd}$$

$$\text{The feed rate in lb/day} = 489.6 \text{ gpd} \times 0.48 \times 1.35 \times 8.34 \text{ lb/gal} = 2,646 \text{ lb/day}$$

(This calculation uses a specific gravity of alum of 1.35 and the percent solution of the liquid alum of 48 percent)

$$\begin{aligned} \text{The dosage in ppm} &= 2,646 \text{ lb/day} - (13 \text{ MGD} \times 8.34 \text{ lb/gal}) = \underline{24.4 \text{ ppm}} \text{ at the} \\ &13 \text{ MGD flow rate. At the 12 MGD flow rate the dosage would be } 24.4 \times 13/12 = \\ &\underline{26.4 \text{ ppm}} \end{aligned}$$

$$\text{The dosage indicated by the rotometer at 0.59 gpm would translate to } (0.59 \times 1,440 \times 0.48 \times 1.35 \times 8.34) - (13 \times 8.34) = \underline{42.3 \text{ ppm}} \text{ at 13 MGD}$$

$$\text{The dosage indicated by the alum feed pump display would translate to } 12,808 \text{ lb/day} - (13 \text{ MGD} \times 8.34 \text{ lb/gal}) = 118 \text{ ppm at 13 MGD}$$

The feed rate calculations from the draw-down study show the dosage is about half of what the rotometer and its corresponding chart would indicate. The new draw down cylinder should make process control of the alum feed more exact.

Special Study 4 Continuous and Bench Top Turbidimeter Comparison Study--

Operators at the New Brunswick WTP routinely compare the continuous turbidimeter readings from the gravity filter CFE turbidimeter to the bench top turbidimeter at the plant. A sample is drawn from the online CFE turbidimeter discharge tubing and taken to the control room where the sample is run on the bench top turbidimeter in the control room. Figure 13 shows an image of the log sheet used by the operators to document the comparisons. The column marked *analyzer* is the data recorded from the CFE controller display and the column marked *grab* is the data from the bench top analyses.

A review of the log sheet shows considerable variation between the two columns. The bench top results are always higher than the online readings, by as much as a factor of five. These data show that either the bench top or the continuous turbidimeter are out of calibration (or both) or the operators are not performing the bench top analysis correctly. There is one data point where the continuous monitor is reading 0.08 NTU and the bench top data shows 0.17 NTU struck out and replaced with 0.10 NTU. A senior staff member reported that he explained to the operator running the bench top test that his glassware was not clean. He demonstrated how to clean the sample cell and reran the test on the same sample getting the 0.10 NTU result. The senior staff member believes the high bench top readings are due to the bench top procedures used by the other operators. Operators do not normally respond to the discrepancies to determine the cause. The operators performed this special study but did not determine follow-up action steps.

Gravity Filter Cl Turbidity (FTU)	
At	Grab
0.07	0.3
0.2	0.11
8	0.10
7	0.15
0.07	0.14
0.08	0.13
0.09	0.18
0.11	0.31
0.10	0.27
0.10	0.29
0.07	0.15
0.08	0.43
0.08	0.46
0.07	0.18
0.08	0.10
0.08	0.12
0.08	0.14
0.08	0.15
0.08	0.16
0.08	0.17
0.08	0.18
0.08	0.19
0.08	0.20
0.08	0.21
0.08	0.22
0.08	0.23
0.08	0.24
0.08	0.25
0.08	0.26
0.08	0.27
0.08	0.28
0.08	0.29
0.08	0.30
0.08	0.31
0.08	0.32
0.08	0.33
0.08	0.34
0.08	0.35
0.08	0.36
0.08	0.37
0.08	0.38
0.08	0.39
0.08	0.40
0.08	0.41
0.08	0.42
0.08	0.43
0.08	0.44
0.08	0.45
0.08	0.46
0.08	0.47
0.08	0.48
0.08	0.49
0.08	0.50
0.08	0.51
0.08	0.52
0.08	0.53
0.08	0.54
0.08	0.55
0.08	0.56
0.08	0.57
0.08	0.58
0.08	0.59
0.08	0.60
0.08	0.61
0.08	0.62
0.08	0.63
0.08	0.64
0.08	0.65
0.08	0.66
0.08	0.67
0.08	0.68
0.08	0.69
0.08	0.70
0.08	0.71
0.08	0.72
0.08	0.73
0.08	0.74
0.08	0.75
0.08	0.76
0.08	0.77
0.08	0.78
0.08	0.79
0.08	0.80
0.08	0.81
0.08	0.82
0.08	0.83
0.08	0.84
0.08	0.85
0.08	0.86
0.08	0.87
0.08	0.88
0.08	0.89
0.08	0.90
0.08	0.91
0.08	0.92
0.08	0.93
0.08	0.94
0.08	0.95
0.08	0.96
0.08	0.97
0.08	0.98
0.08	0.99
0.08	1.00

FIGURE 13 Bench top and online CFE turbidimeter comparison records

MAJOR UNIT PROCESS EVALUATION

Major unit processes were assessed with respect to their capability to meet the optimized settled and filtered water goals as well as the disinfection requirements of the SWTR. The capability of each individual unit process was also assessed to ensure that it could provide consistent performance. This level of plant performance is considered necessary to help ensure removal or inactivation of potential pathogens. Calculation of plant disinfection capability was based on CT values (i.e. chlorine concentration multiplied by time) outlined in the USEPA Guidance Manual³ for meeting both filtration and disinfection requirements.

³ Guidance Manual for Compliance With the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources USEPA, Office of Drinking Water, Washington, D.C. (1989) revised 1991

Since the treatment processes of the plant must provide multiple effective barriers at all times a peak instantaneous operating flow was also determined. The peak instantaneous operating flow represents conditions when the treatment processes are the most vulnerable to the passage of parasitic cysts and microorganisms. If the treatment processes are adequate at the peak instantaneous flow then the major unit processes should be capable of providing the necessary effective barriers at lower flow rates.

A peak instantaneous operating flow rate of 17 MGD was used to assess the capabilities of the major unit processes. The peak instantaneous flow was determined from interviews with operators regarding operational policies at the plant as well as the review of plant operating logs. There are multiple raw water pumps at both pumping stations and the pumps can be operated in different combinations and at different flow rates through the use of variable frequency drives.

Unit process capability was assessed using a performance potential graph, where the projected treatment capability of each major unit process was compared against the peak instantaneous operating flow rate (and the average daily flow and plant design flow for comparison). The Major Unit Process Evaluation graph developed for the New Brunswick WTP is shown in Figure 14. The unit processes evaluated during the CPE are shown along the vertical axis. The horizontal bars on the graph represent the projected peak capability of each unit process that would support achievement of optimized process performance. These capabilities were projected based on several factors including the combination of treatment processes at the plant, the CPE team's experience with other similar processes, raw water quality, industry guidelines, the New Brunswick WTP design, and regulatory standards.

REDACTED

FIGURE 14 Major Unit Process Evaluation graph

Each unit process can fall into one of three categories

- Type 1 Where the bar for the unit process exceeds the peak instantaneous flow (>100 percent of peak flow) the plant should be expected to achieve the performance goals
- Type 2 If the bar for the unit process falls short but close to the peak instantaneous flow (80 to 100 percent of peak flow) then operational adjustments may still allow the plant to achieve the performance goals
- Type 3 If the bar for a particular unit process falls far short of the peak instantaneous flow (<80 percent of peak flow) then it may not be possible to achieve the performance goals with the existing unit process

The shortest bar represents the unit process that may most limit plant capability relative to achieving optimized plant performance. The major unit processes evaluated included flocculation, sedimentation, filtration (both gravity and membrane filtration) and disinfection.

Flocculation is accomplished through two single-stage rectangular flocculation basins. Based upon the flocculation unit designs (single stage with lowest water temperature < 5° C) a hydraulic detention time (HDT) of 30 minutes was used to rate the process. The result was that the flocculation process was rated at 28 MGD, a flow rate greater than the reported plant instantaneous flow rate and the reported design rate.

Sedimentation is accomplished using two semi-rectangular basins. Basins 1 and 2 have a combined surface area of 33,799 ft². The side wall depth of the basins is controlled by a manual process through observation of the water level and controlling the effluent valve, but the side wall depth is usually kept at 12 to 14 feet. Based on this information and a surface overflow rate of 0.5 gpm/ft² based on conventional sedimentation and manual sludge removal, the total rated capability for the water treatment plant's sedimentation unit process was 24 MGD. The sedimentation basin process rating is also greater than the reported plant peak instantaneous flow rate and design rate.

Gravity filtration is performed using eight dual-media filters with a total surface area of 2 780 ft². The gravity filtration process was rated at 16 MGD using the total surface area of the filters and a maximum hydraulic loading rate of 4.0 gpm/ft². This loading rate was based on dual media filters acceptable backwash capability and no reported air binding problems. The filtration process rating is below the peak instantaneous flow and below the plant design flow but the gravity filters are normally loaded at about 6 MGD or less well below the 16 MGD rated flow rate.

The membrane filters treat up to about 9 MGD and consist of four cells, with a total of 360 modules per cell containing hollow tube membrane fibers. One cell is normally out of service at all times for backwashing, cleaning or maintenance. With one cell out of service the 9 MGD flow rate translates to flux rating of 28 gal/ft²/day. The reviews of pressure decay and LRV results for the membrane filters show that they are capable of achieving ≥ 4 log removal when operating at the 9 MGD rate. When combined, the gravity filters and membrane filters have a rated capability of 25 MGD (i.e. 16 MGD + 9 MGD) well above the peak instantaneous flow and the design flow for the plant.

The disinfection process was assessed based on the USEPA Surface Water Treatment Rule (SWTR) requirements for inactivation/removal of 3 log (99.9 percent) of *Giardia* cysts and 4 log (99.99 percent) of viruses. The *Giardia* inactivation requirement is typically more stringent than that of viruses. Consequently it was used as the basis for the disinfection evaluation. A well operated, conventional gravity filtration plant can be credited for 2.5 log (99.7 percent) removal of *Giardia* cysts through the plant's physical treatment processes. The membrane filters consistently achieve at least 3 log *Giardia* removal. The remaining 0.5 log of *Giardia* must be inactivated through disinfection on the gravity filtration side of the plant. Likewise although the membrane filters are already achieving greater than 3 log *Giardia* removal the State of New Jersey requires an additional 0.5 log *Giardia* inactivation through disinfection. This can be achieved by meeting the specified CT required for disinfection with chlorine, the disinfectant used at the New Brunswick WTP. CT is the disinfectant concentration (C) in mg/L multiplied by the time (T) in minutes that the water is in contact with the disinfectant.

The required CT value of 47 mg/L-min was obtained from the USEPA Guidance Manual³ using a minimum chlorine residual of 1 mg/L a maximum pH of 8 and a worst case temperature of 2 °C for disinfection. These data were obtained from reviewing the previous year of operating data. The total volume used for the chlorine contact basins was 696 240 gallons and the well baffled basin was assigned a baffling factor of 0.9. Based on the review of the disinfection performance described earlier in this report, the CPE team decided to not include the gravity clearwell volume during the disinfection capability assessment. Under this scenario the disinfection process should be capable of treating 19 MGD a flow above the peak instantaneous flow but below the design flow rate. If the plant staff were to increase the chlorine residual through the tank above 1.0 mg/L the rated flow rate would increase.

The unit process performance potential for each of the processes is summarized in Figure 14. The graph shows all unit processes are capable of treating the peak instantaneous flow rate of 17 MGD through the facility thus they were rated as Type 1 unit processes. In Figure 14 the filtration processes are evaluated separately (bars 3A and 3B) and together as one filtration process (Bar 3). Figure 14 also shows a performance potential bar for the plant of 19 MGD for the chlorine contact basin and the disinfection process (Bar 4A) and a bar at 27 MGD (Bar 4B) should the chlorine contact basin be operated at 1.5 mg/L.

Overall the major unit process evaluation shows that the plant has the capability of meeting the optimized performance goals for turbidity and disinfection with existing infrastructure.

PERFORMANCE LIMITING FACTORS

The areas of design, operation, maintenance and administration were evaluated in order to identify factors that limit performance. These evaluations were based on information obtained from the plant tour, interviews, performance and design assessments, special studies and the judgment of the CPE team. Each of the factors was assessed for a possible classification as A, B, or C according to the following guidelines:

- A Major effect on a long term repetitive basis
- B Moderate effect on a routine basis or major effect on a periodic basis
- C Minor effect

The performance limiting factors identified were prioritized as to their relative impact on performance and they are summarized below. While developing the list of factors limiting performance, over 50 potential factors were reviewed and their impact on the performance of the New Brunswick WTP was assessed. There were three *A* factors identified and five *B* factors. The CPE team observed that significant progress has been made by the plant management and staff in starting to address these performance limiting factors. Sustained effort directed at these prioritized areas should result in improved performance from the plant.

Administration Policies – Administration (A)

The management team at the New Brunswick water utility has not set in place policies to adopt performance goals for the plant that go beyond just meeting compliance requirements. There is a Mission Statement for the utility that has been in place for about six months that states in part, *maintain compliance with all applicable drinking water and environmental regulations*, but an operating goal to maintain compliance will lead to compliance lapses whenever the goal is not met. A goal that seeks to produce water of a quality more stringent than the regulatory requirements would lead to safer water with less opportunity for microbiological contamination surviving the treatment plant. Such a goal would provide a safety factor for compliance should the goal be missed by a moderate margin.

Although there is currently no lack of funding for water treatment plant O&M and modest upgrades, the water treatment plant budget has not historically included these types of items. Progress has been made in addressing this factor in recent months, leading to improvements in plant instrumentation and controls and hiring of certified operators. However, the poor performance at the plant has been in part due to the historical policies that did not budget for key O&M needs. Examples that have affected performance are:

- Outdated or inadequate continuous monitoring equipment, including SCADA upgrades that resulted in data integrity issues and inaccurate performance data.
- Reduced staffing overtime and positions (maintenance) resulting in delayed maintenance like membrane pinning affecting the membrane performance.

- Lack of safety equipment (Personal Protection Equipment) and plant deteriorations such as the walkway between the sedimentation basins which has led to an unsafe work environment, which in turn has affected staff morale
- Delayed repairs on the raw water screening mechanisms This has resulted in maintenance resources being directed away from the plant on a seasonal basis

Supervision – Administration (A)

Observations during the CPE led to the identification of several areas of supervision that must be addressed to improve staff morale establish high expectations and achieve optimized performance from the plant Some of the supervision challenges at the plant have been addressed during the past year by hiring a competent manager and by moving capable people to new positions of leadership in the plant However several of the internal staffing changes have been done informally and a more permanent plan needs to be implemented to continue progress on this factor The following examples of supervision affecting plant performance were noted by the CPE team

- There is no one person at the plant who is clearly providing supervision to all plant staff This has led to communication issues and misunderstandings regarding plant operation and maintenance procedures
- Management styles have allowed limited opportunities for staff development and input many operators told the CPE team during interviews that they suggested operational changes that would have improved performance but were told *That s not the way we have always done it* or *I ve tried that and it doesn t work* Supervisors have not, in many cases, given operators the latitude to make changes and learn through experimentation
- A professional operator/maintenance worker attitude is not promoted at the staff level by management The plant staff did not give the impression during interviews that they think of themselves as part of a professional group They appear to have a complacent demeanor in many cases and they are not motivated by their jobs as employees responsible for providing safe drinking water to their customers This attitude has

led to operator errors in treatment that have led to losing control of one or more processes and has led to slow response times when the processes are not performing. The supervisor must endeavor to create a work environment that fosters professionalism.

- Inconsistent communication has affected plant performance in numerous instances when operators were not made aware of previous operational decisions and new needs. There are no operator meetings, minimal operating procedures (or guidelines), and no means of documenting procedures at the plant. To produce water that meets regulatory requirements and optimization goals, supervisors must recognize the need for documenting procedures, and they must find a method to foster communication and collaboration within the operations staff.
- Plant activities are not always prioritized in a manner that would improve performance. For example, operator training has not been a priority for the supervision team. The CPE team was made aware of numerous occasions during staff interviews when routine maintenance activities that do not affect plant performance (such as grass cutting and trimming, moving plant furniture) were conducted at the expense of on-the-job training opportunities. In addition, operations staff is not formally part of the priority setting process for scheduling plant activities.

Water Treatment Understanding -- Operations (A)

Because of limited external and internal training opportunities, the plant staff's ability to address performance issues and maintain key equipment has been negatively affected. There are few (3) licensed operators at the plant, and only a few of the non-licensed operators are planning to pursue certification and its associated training. Examples of water treatment understanding affecting performance on a continuous basis include the following:

- Special studies are not done to address problems at the plant. The plant staff is not familiar with the scientific method and how it can be applied to the plant through conducting scientific (i.e., data based) studies.
- Chemical feed pumps are not calibrated and dosages are not accurately determined. This factor has been partially addressed by the addition of the calibration cylinder on

the alum feed pump but most operators are not able to do the calculations to determine dosages even with the calibration cylinder. The alum draw down special study showed that the dosage was about half of what the operators thought they were adding. The same situation likely exists for lime and sodium hypochlorite feed as well.

- Jar testing is not practiced by the plant staff to support the streaming current monitor optimization and other process objectives such as total organic carbon removal and manganese oxidation. Plant staff members do not understand jar testing techniques. As a result, they do not have access to an important tool that could be used to optimize multiple processes in the plant.
- Performance data trending is not conducted by the plant staff to assess unit process performance goals and support problem solving and continuous improvement in the plant.

Data Integrity – Operations (B)

Unreliable process control data has made performance assessments difficult at the plant, and unreliable performance data have led to compliance issues. This factor had been the main focus of plant staff during the six month period before the CPE visit. It has improved but still is having a major effect on performance on a periodic basis. Examples of data integrity issues that are in place include:

- The continuous turbidimeters on the gravity filters continue to read turbidity even when the filter is not in service and they report the results to the SCADA system. As a result, it is difficult to go through any historical data in the SCADA system and understand real performance issues. The same situation occurs with the membrane system when a cell is taken off line.
- There is no consistent effort to review large turbidity spikes to assess the validity of the data. In many cases the CPE team found spikes that occurred in filters that were not online or in backwash mode or spikes that occurred during a turbidimeter calibra

tion or cleaning procedure. These data should be eliminated from the performance data record to give a true reading of plant performance.

- The bench top and continuous turbidimeter comparison records (see Figure 13) show a poor correlation between the two readings and they could indicate data quality issues with the continuous turbidimeters that are used for process control and for compliance.

Operating Guidelines – Operations (B)

There are few plant operating guidelines that have been developed by plant staff. During the CPE interviews, the CPE team learned that the administration at the New Brunswick WTP is planning to address this factor by having operators develop O&M guidelines on key plant activities. Examples of the lack of operating guidelines affecting performance can be found below.

- Individual operators have different filter backwash techniques. This has resulted in inconsistent backwashing and has led to multiple occurrences of turbidity spikes when operators did not backwash properly. Similar feedback was heard regarding operators being inconsistent with the membrane clean-in place activities.
- There are no guidelines explaining how to collect the data to complete the disinfection calculations for the MOR. This has led to instances in the past when the wrong data were used for the calculations.
- There are no guidelines for developing plant O&M reports for areas such as water production, monthly operating reports, and maintenance planning. This has led to multiple people developing their own version of the same information and duplication of effort on an ongoing basis. Multiple reports are created that are reporting the same information. This has had a detrimental effect on manpower at the plant and has led to incorrect performance data going forward to the NJ DEP and the New Brunswick administration.

Maintenance – Maintenance (B)

Maintenance activities at the New Brunswick plant have not kept up with plant needs historically. There has been an inconsistent preventive maintenance program and there are many facilities at the plant and the pump stations that need corrective maintenance. This has affected the work environment at the plant, has lowered the morale of the plant staff and has contributed to staff complacency. Examples of the maintenance areas that have affected the plant are listed below:

- Pinning of the membranes to remove ruptured membrane fibers has been delayed resulting in lower log removal values
- Documentation and posting of maintenance schedules (preventive maintenance) is not practiced
- There are numerous examples of safety issues at the plant such as wooden hatches on the clearwell that are deteriorating, dirty chemical feed rooms (e.g. lime), the sedimentation basin catwalk that presents a danger to staff and visitors walking on it, the lack of Personal Protection Equipment proper protection gear for handling the chemicals and lack of equipment for lifting membrane racks and other heavy loads

Representative Sampling – Operations (B)

While the New Brunswick plant has numerous sample locations to grab samples for the various processes, the location of some of the continuous instrumentation can lead to measurements that are not indicative of real performance of the unit processes. Plant management has improved this area in recent months by moving the streaming current monitor to a more responsive location, moving the plant effluent pH and chlorine analyzers to a more representative sample location, and by adding the IFE turbidimeters. However, there are still some remaining sample locations that can lead to incorrect monitoring results:

- The individual gravity filter sample taps for the continuous turbidimeters are not in good locations to measure the turbidity during the filter rewash period (following backwash). This monitoring is key to optimizing the filter performance.

- The sample location for chlorine has historically not been representative of the residuals leaving the plant. The monitoring point was moved during the CPE visit, and the new location instrument was still being set up. The new location will be representative as long as the high service pumps are running. Data collected when the pumps are not running should be eliminated from the data records.
- The gravity filter combined filter effluent sample location is not ideal, although it might be the best that is possible without a common header from which the combined effluent could be sampled.

Compensation – Administration (B)

The plant management staff reported to the CPE team in interviews that the hourly rates for operators and maintenance staff at the New Brunswick WTP is comparable to similar positions at other surface water treatment plants in the area. However, it was noted during staff interviews that several of the plant staff members are maintaining at least two jobs to *make ends meet* as they described their job situations. This situation can result in unsafe working conditions as well as poor decision making on the job due to employees working long hours during a day.

The current compensation package does not provide any incentive for plant staff to acquire certification and the associated training. Encouraging certification would promote the development of professionalism at the plant, would increase water treatment understanding and would provide networking opportunities with the professional operators in the area. Plant management has begun efforts to develop an operator training program through a local community college. These kinds of activities, tied with a compensation package, would help to address this factor.

EVALUATION FOLLOW-UP AND COMPREHENSIVE TECHNICAL ASSISTANCE

As a follow up to this CPE report, the city of New Brunswick has hired Howard J Woods Jr & Assoc L L C to conduct a comprehensive technical assistance (CTA) project with the New Brunswick plant staff and administration. The project shows a commitment by the New Brunswick administration to improve performance at the plant and to move towards being a success story in the state of New Jersey.

The New Brunswick WTP although in need of corrective maintenance in many areas has the capability to begin a CTA project immediately. The CTA facilitators are encouraged to address the operational and administrative factors prioritized in this report and to foster collaboration and communication among the plant staff and with the administration. Although the CTA cannot address all water treatment understanding improvements that are needed at the plant in the time period allocated for the project, it can transfer some technical knowledge and can work with the New Brunswick administration to put a more long term training strategy in place.