ICR Treatment Study Summary Report

Evaluation of Membrane Technology Using a Pilot-Scale Study for Compliance with the Information Collection Rule

Prepared for

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June 1999

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Submitted to

New Jersey-American Water Company

June 1999

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SECTION 1

Conclusions and Recommendations

The New Jersey American Water Company (NJAWC) owns and operates the 20-million-gallon-per-day (mgd) Canoe Brook Station in Millburn, New Jersey. The NJAWC retained CH2M HILL to perform a pilot study of membrane treatment to comply with the U.S. Environmental Protection Agency's (EPA) Information Collection Rule (ICR). A pilot study was conducted from November 1997 through April 1998 with a goal of achieving 3,300 operational hours, per the requirements agreed upon by the NJAWC and the EPA.

Microfiltration followed by nanofiltration was chosen as the advanced treatment process for pilot testing. Microfiltration followed by nanofiltration as a dual membrane system has distinct advantages for the control of contaminants that may contribute to acute and chronic health concerns in drinking water. Microfiltration provides a physical barrier to particles in the micron-size range (including parasitic protozoa), and nanofiltration provides a barrier to natural organic matter, a precursor of trihalomethanes (THMs), haloacetic acids (HAAs), and other disinfection by-products (DBPs) that have been identified as a potential chronic health risk, and also to protozoan passage. However, the higher cost for a dual membrane treatment system is a major constraint in its use in conventional treatment processes for drinking water supplies, particularly surface water.

The findings of the study can be summarized based on the following categories:

- **Water quality issues** related to the forthcoming Disinfection / Disinfection By-Products Rule and the Enhanced Surface Water Treatment Rule, and to finished water stability.
- **Operational issues** concerning the use of microfiltration and nanofiltration on surface waters.
- **Process design issues** concerning full-scale implementation of microfiltration and nanofiltration.

Water Quality Issues

Nanofiltration was very effective at removing total organic carbon (TOC) and DBP precursors in microfiltration filtrate, to the extent that after exposure of the nanofiltration permeate to free chorine under simulated distribution system (SDS) conditions, no DBPs (THM4, HAA6, or total organic halides (TOX)) were detected in the nanofiltration permeate over the course of the 6-month study. TOC removal was greater than 97 percent, and permeate turbidity levels were generally below 0.05 NTU, although most of the turbidity removal is achieved by the microfiltration.

Operational Issues

Despite the use of microfiltration for raw water treatment, some fouling of the nanofiltration membranes was evident during most of the study. The most probable mechanisms of fouling during this study were (1) post-microfiltration oxidation of manganese or iron, which caused rapid but reversible fouling, and (2) bacterial growth, which occurred more gradually but was less reversible with chemical cleanings. After receiving approval from the EPA, bacterial growth was effectively controlled by the use of chloramines, which was implemented during the latter part of the study.

Process Design Issues

The results can be applied directly to development of design criteria including flux rates, backwash intervals, cleaning requirements and chemical needs, and feedwater disinfection requirements. Establishment of proper values for these criteria is crucial to achieving cost-effective operation of the facility.

As a dual treatment process, microfiltration and nanofiltration provides the ability to treat raw water at the Canoe Brook Station to a quality that surpasses even the most stringent anticipated regulations with regard to DBPs and microbiological inactivation. The cost of the dual membrane system needs to be compared to other integrated processes that could be used to meet anticipated regulations.

SECTION 2

Background Information

Goals and Objectives of Study

The goals and objectives of this study were to:

- Meet ICR requirements by conducting pilot-scale testing of the nanofiltration process
- Determine if nanofiltration at the Canoe Brook Station would meet anticipated DBP regulations
- Assess the operational issues and cost implications of using a dual membrane system on a surface water supply

Regulatory Overview

The ICR was a result of a negotiated rulemaking process used to reach agreement on a regulatory course of action for control of microbial contaminants and DBPs. The committee that negotiated the rule-making strategy decided that it is necessary to obtain information on the potential effect of future requirements to reduce the level of DBP precursors (i.e., natural organic material measured as TOC) on the cost of drinking water treatment in the U.S. To accomplish that objective, a requirement to conduct treatment studies is included in the ICR. The committee also felt that the treatment study requirement would accelerate local acquisition of information to assess the feasibility of advanced treatment to reduce levels of DBP precursors.

The rulemaking committee used a volunteer group of technical experts to develop a tentative strategy for precursor removal testing in the ICR proposal. The outcome was that either bench- or pilot-scale testing of either granular activated carbon (GAC) or membranes, specifically either reverse osmosis or nanofiltration, would be allowed. For membrane pilot studies, evaluation of only one membrane type under one set of operation conditions is required. Other requirements include:

- The pilot study must run continuously over a period of 1 year with allowances for downtime due to membrane cleaning, maintenance, or other reasons.
- The run time may be no less than 6,600 hours.
- The pilot system must use at least two stages, with at least two vessels in the first stage and one vessel in the second stage, and must contain at least three elements per vessel.
- Spiral wound elements are recommended and must be at least 2.5 inches in diameter by 40 inches long.

NJAWC was required to perform a bench-scale ICR study, but it was suggested that a pilot study would provide more useful design information on membranes specific to the Canoe

Brook Station. In negotiations with the EPA, NJAWC agreed to perform a membrane pilot study for a period of 6 months, with an operational run-time requirement of 3,300 hours. A copy of the agreement is contained in Appendix A.

Treatment Plant Description

The NJAWC serves communities in the Short Hills District, a service area comprising all or part of 25 communities in northern New Jersey. It also furnishes water wholesale to four communities and two water purveyors. The population served directly at the end of 1995 was 192,665, and the average day demand for the Short Hills District was 35.17 mgd.

NJAWC owns and operates the 20-million-gallon-per-day (mgd) Canoe Brook Station in Millburn, which serves the Short Hills District. The station provides complete chemical treatment and filtration of surface water pumped from the Passaic River and the Canoe Brook into three interconnected raw water reservoirs. Supplementing the surface supply are 10 wells that provide water directly to clearwater storage and 15 wells throughout the service area. Additional supply is provided to the Short Hills District with interconnections from local water purveyors.

The Canoe Brook Station comprises two separate filtration plants, each rated at 10-mgd capacity. Figure 1 is a schematic of the station. The raw water supply to station is drawn from Reservoir No. 1. A tap off the intake line of the low service pumps in Filter Plant No. 1 delivered raw water to the pilot trailers used in the study.

Treatment Plant Design Information

Table 1 presents the design information for the Canoe Brook Station. Tables 2 and 3 present raw water and finished water quality data, respectively, at the station from 1994 to 1996.

Treatment Alternatives

If NJAWC decides to upgrade the existing treatment facilities at Canoe Brook Station, the NJAWC would probably consider the following alternatives:

- Conventional treatment (dissolved air flotation (DAF) followed by ozone and deep-bed granular activated carbon (GAC) filters)
- Membrane treatment (microfiltration, ultrafiltration, Zeeweed)

As part of a process selection study, NJAWC offered to perform a modified ICR study using membranes to provide EPA with valuable cost information on membrane treatment of surface waters while obtaining pilot data on a process selection alternative.

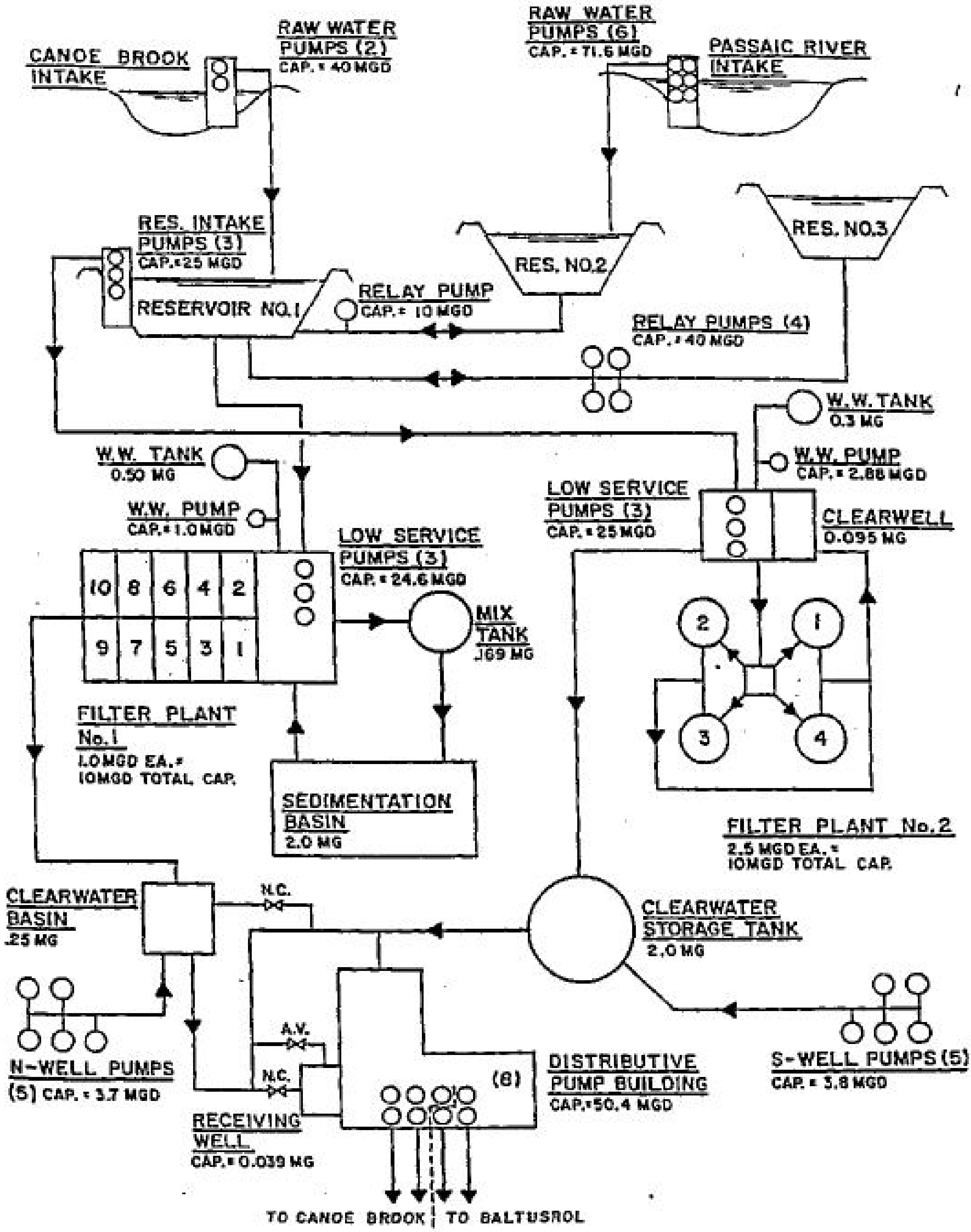


Figure 1
NJ American Water Company
Canoe Brook ICR Pilot
Process Schematic

TABLE 1
Design Criteria

	Process Description	
Unit Process	**Plant No. 1**	**Plant No. 2**
Raw water intake	Takes suction from reservoir with low service pumps in the filter building.	Pumping at intake to control building
Chemical addition	Alum, gas chlorination, polymer, and carbon as required. Prechlorination at dose rate of 8 mg/L	Alum, gas chlorination, polymer, and carbon as required. Prechlorination at dose rate of 8 mg/L
Rapid mixing	169,000 gallon mixing tank; Estimated T_{10} = 1 min	Static mixer
Flocculation/Sedimentation	2 mgal rectangular basin at 10 ft depth	Clarification and Filtration are achieved in four outdoor steel purification units.
Filtration	10 conventional sand filters with surface wash systems; all with rate of flow controllers, loss of head and rate-of-flow gauges. Surface area = 3,494 ft^2. Target filter run time = 17 hours	Each unit is 74 ft diameter by 18 ft high, open round steel tank; concentric circular shell for sedimentation, wash water gullet, and filter with surface wash; all with rate of flow controllers, loss of head and rate-of-flow gauges. Solids contact clarifier surface area = 13,684 ft^2. Filtration unit surface area = 1,368 ft^2.
Disinfection	Gas chlorination at dose rate of 1 mg/L	Gas chlorination at dose rate of 1 mg/L
Corrosion Control	Zinc orthophosphate	Zinc orthophosphate
Clearwell	250,000 gallons	2,000,000 gallons

TABLE 2
Raw Water Quality, 1994–96

Parameter	Average	Range
Temperature (°C)	16	5–26
pH	7.7	6.9–9.3
Turbidity (NTU)	9.5	1.6–28.3
Alkalinity (mg/L as $CaCO_3$)	44	33–60
Total Hardness (mg/L as $CaCO_3$)	77	57–151
TOC (mg/L)[a]	5.9	4.1–11.2
Algae count (#/mL)[b]	133	0.025–1033
Iron (mg/L)	0.14	< 0.1–0.27
Manganese (mg/L)	0.10	< 0.05–0.63
Color (cu)	38	18–75

[a]TOC values shown are from 1995–96.
[b]Algae data shown are from May 97–April 98.

TABLE 3
Finished Water Quality, 1997–98

Parameter	Average	Range
Temperature (°C)	15	5.9–26.1
pH	7.0	7.0–7.4
Turbidity (NTU)	0.07	0.02–0.13
Alkalinity (mg/L as $CaCO_3$)	70	45–105
Total Hardness (mg/L as $CaCO_3$)	125	98–160
TOC (mg/L)	4.26	3.60–5.06
Iron (mg/L)	< 0.01	
Manganese (mg/L)	< 0.05	
Color (cu)	2	2–3

Note: Based on 1997 and 1998 ICR data

SECTION 3

Materials and Methods

Pretreatment Processes to the Advanced Treatment Process

Raw water was first treated with microfiltration to remove suspended solids. Water from Reservoir No. 1 was pumped to a Memcor Model No. 60M10C microfiltration, supplied by Memtec America Corporation. The raw water entered a 100-gallon break tank on the microfiltration unit, was pressurized with an on-board pump, and directed to six modules, each containing 15 square meters of polypropylene, hollow fiber membranes having a nominal pore size of 0.2 microns. Pressurized feedwater flowed through the membrane fibers from the outside of the fiber to the inside. All feedwater entering the modules was converted to filtrate (direct filtration). Filtrate flowed to a 500-gallon polyethylene storage tank. Part of the filtrate (roughly 20 gpm) was pumped to the nanofiltration unit, and the unused microfiltration filtrate overflowed to a gravity drain connected to the filter backwash lift station. Drain flow was recycled to the reservoir. Figure 2 is a process flow diagram for the microfiltration treatment system.

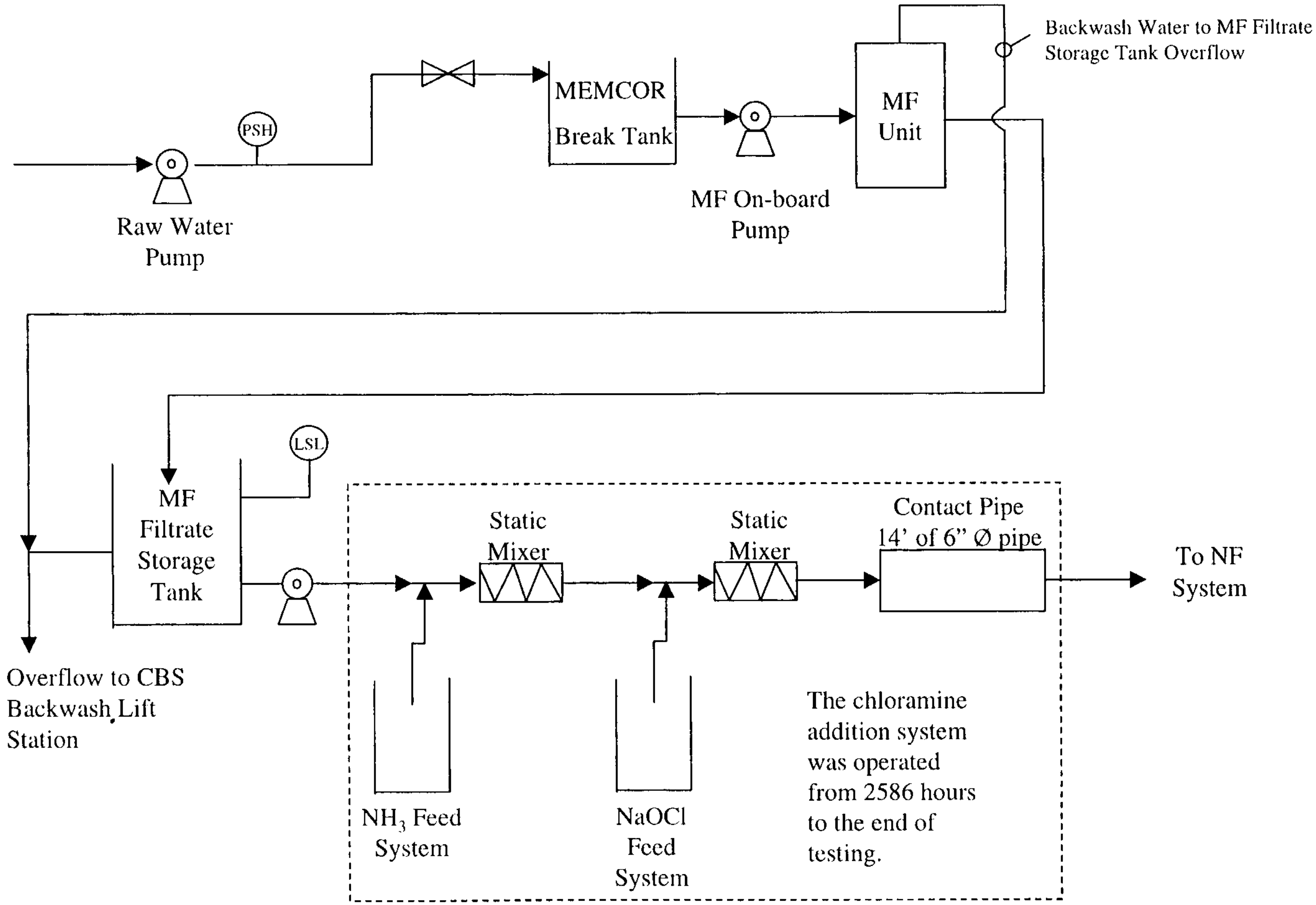
Every 22 minutes, the microfiltration modules were automatically removed from service and backwashed using compressed air to remove accumulated solids. The displaced solids were swept from the module with feedwater at high velocity.

Before the microfiltration filtrate entered the nanofiltration unit, a threshold inhibitor chemical (antiscalant) was added to prevent precipitation of the soluble salts calcium carbonate and barium sulfate. (Nanofiltration concentrates these salts to concentrations that exceed their theoretical saturation level at the system recovery used in this study.) A premixed antiscalant manufactured by King Lee Technologies (PreTreat Plus) was added at 3 mg/L. This particular brand was chosen because its very low organic carbon content (<10 percent neat) minimized the addition of TOC to the nanofiltration feedwater, as desired by the EPA. During the first 600 hours of operation, the microfiltration filtrate was filtered through 5-micron nominally rated polypropylene cartridge filters to remove debris in the nanofiltration feed piping from pilot plant construction. Cartridge filtration was not employed during the rest of the study because of its potential to provide a site for bacterial growth that could promote biological fouling of the nanofiltration membranes.

The following parameters were monitored in the microfiltration feed (sampling point (SP)#0) and filtrate (the nanofiltration feed, SP#3) during the test period:

Parameters	Frequency
Turbidity, UVA_{254}, pH	Once per day
Iron, manganese, apparent color	Weekly
TOC, calcium hardness, total hardness, alkalinity	Biweekly
Particle counts (not taken until 1600 hours of runtime)	On-line

Samples of microfiltration feed were taken at the same time as the biweekly samples required by the ICR.



Legend:
LSL - Low level switch
PSH - High pressure switch

Figure 2
NJ American Water Company
Canoe Brook ICR Pilot
Pretreatment System Process Schematic

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NJO/Water/Canoebrk/142770a.ppt

Advanced Treatment Process Information

The nanofiltration system consisted of two stages of pressure vessels, arranged in a 2-1 array. The first stage consisted of two pressure vessels with 6 elements in each vessel. The second stage consisted of one pressure vessel with 6 elements in the vessel. Each element was a 4-inch-diameter by 40-inch-long spiral wound nanofiltration element. The system was operated at a feedwater recovery of 90 percent and a membrane flux of 12 gallons per day per square foot of membrane area (gfd). Part of the stage 2 concentrate flow was recycled to the suction of the nanofiltration feed pump to increase feed flows as required by the ICR testing protocol.

The membrane element used was an Osmonics / Desal, Model HL4040F1674. The element uses a proprietary thin-film membrane that has identical performance characteristics to the Model DS-5 / DL membrane selected during bench-scale testing. Figure 3 is a process flow diagram of the nanofiltration system as operated during the pilot study.

Instrumentation was provided to monitor and record flow rate continuously for nanofiltration feed, stage 1 permeate (SP#12), system permeate (SP#15), and system concentrate (SP#14) streams. Pressure, temperature, conductivity, and pH at selected points in the nanofiltration process train were taken manually once per day. Samples for TOC, chlorine demand, simulated distribution system (SDS) results, and other ICR required analyses were collected biweekly and analyzed by CH2M HILL's Applied Sciences Laboratory in Corvalis, Oregon. Daily monitoring of system pressures, pH, and conductivities was consistently recorded after 500 hours of system runtime.[1]

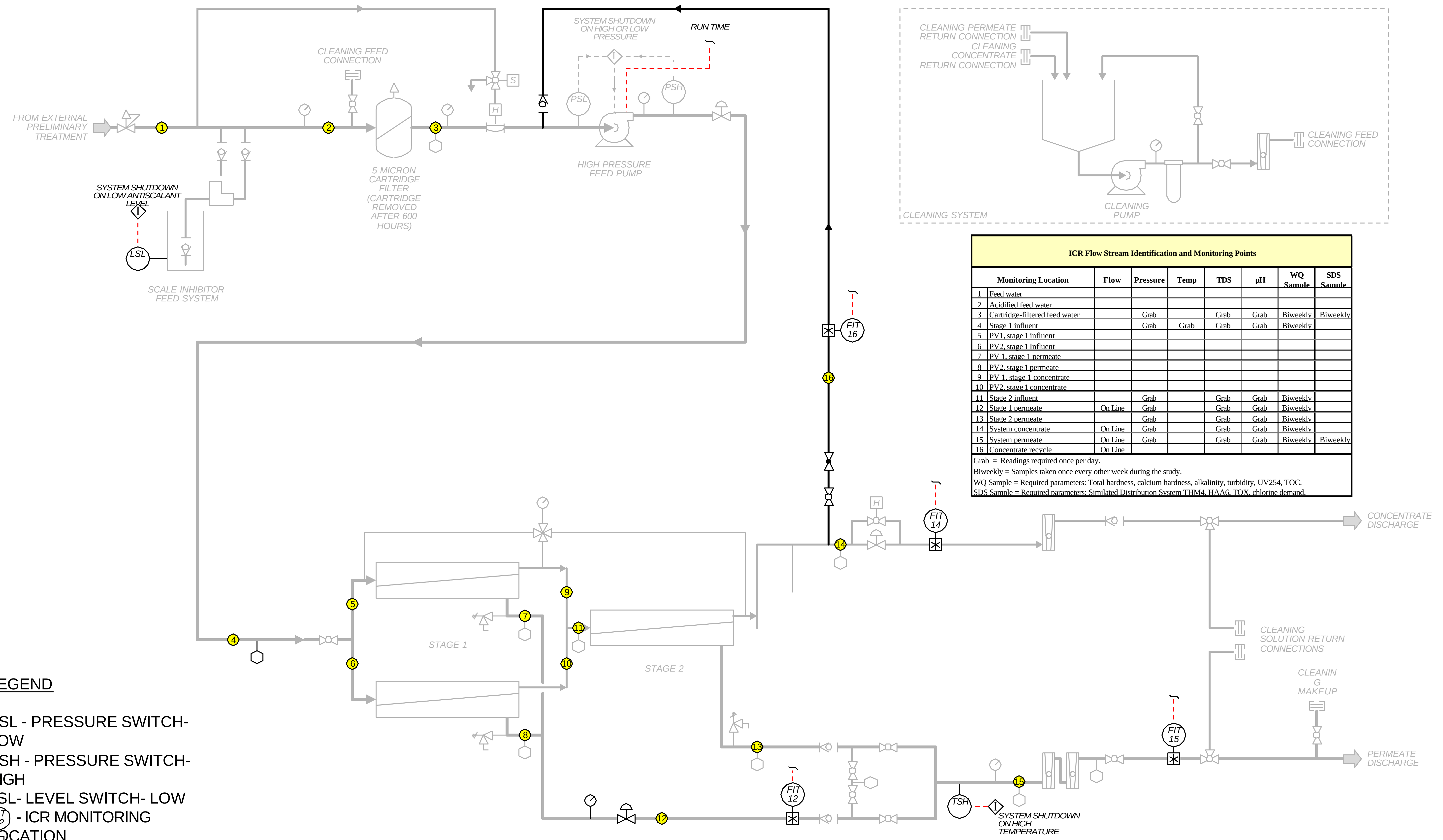
The following parameters were monitored at the nanofiltration feed, stage 1 influent (SP#4), stage 1 permeate, stage 2 influent (SP#11), stage 2 permeate (SP#13), system permeate and system concentrate during the test period:

Parameter	Frequency
Pressure, conductivity (all)	Once per day
Turbidity (nanofiltration feed, system permeate, system concentrate)	
UVA_{254} (nanofiltration feed, system permeate)	
pH (nanofiltration feed, stage 1 influent, stage 2 influent, system concentrate, system permeate)	
Iron, manganese, apparent color (nanofiltration feed, system permeate, system concentrate)	Weekly
Silt density index[2] (nanofiltration feed)	
TOC, Calcium hardness, Total hardness, Alkalinity (All)	Biweekly

[1]Inaccurate data (pressure, conductivity, and pH) were recorded during the first 500 hr of operation due to a problem with the on-line monitoring system. EPA was contacted, and normal/grab sample monitoring of parameters once per day was approved.

[2]Silt density index is a measure of the colloidal fouling potential of a water supply. It measures reduction in flow rate through a 0.45-µm filter pad over a fixed time interval at a fixed pressure in a direct filtration mode and is intended to simulate colloidal fouling that occurs with a spiral wound membrane element operated in a cross-flow mode. Values typically range from 2 to 4 for a surface water with effective pretreatment.

Parameter	Frequency
SDS (THM4 and HAA6), TOX, Chlorine demand (nanofiltration feed and system permeate)	
Flow (stage 1 permeate, system permeate, system concentrate, and concentrate recycle)	On-line



	ICR Flow Stream Identification and Monitoring Points							
	Monitoring Location	Flow	Pressure	Temp	TDS	pH	WQ Sample	SDS Sample
1	Feed water							
2	Acidified feed water							
3	Cartridge-filtered feed water		Grab		Grab	Grab	Biweekly	Biweekly
4	Stage 1 influent		Grab	Grab	Grab	Grab	Biweekly	
5	PV1, stage 1 influent							
6	PV2, stage 1 Influent							
7	PV 1, stage 1 permeate							
8	PV2, stage 1 permeate							
9	PV 1, stage 1 concentrate							
10	PV2, stage 1 concentrate							
11	Stage 2 influent		Grab		Grab	Grab	Biweekly	
12	Stage 1 permeate	On Line	Grab		Grab	Grab	Biweekly	
13	Stage 2 permeate		Grab		Grab	Grab	Biweekly	
14	System concentrate	On Line	Grab		Grab	Grab	Biweekly	
15	System permeate	On Line	Grab		Grab	Grab	Biweekly	Biweekly
16	Concentrate recycle	On Line						

Grab = Readings required once per day.
Biweekly = Samples taken once every other week during the study.
WQ Sample = Required parameters: Total hardness, calcium hardness, alkalinity, turbidity, UV254, TOC.
SDS Sample = Required parameters: Similated Distribution System THM4, HAA6, TOX, chlorine demand.

LEGEND

PSL - PRESSURE SWITCH-LOW
PSH - PRESSURE SWITCH-HIGH
LSL- LEVEL SWITCH- LOW
4 - ICR MONITORING LOCATION
FIT 12 - FLOW METER

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DSGN	P MUELLER
DR	P MUELLER
CHK	
APVD	

NO.	DATE	REVISION	BY	APVD

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BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

ICR
MEMBRANE PRECURSOR REMOVAL STUDIES

PROCESS SCHEMATIC
FIGURE 3
MEMBRANE PILOT TRAILER MODIFICATIONS FOR ICR STUDIES

SHEET	1
DWG NO.	
DATE	JULY 1997
PROJ NO.	

JUL 16, 1998

Procedures Specific to the Treatment Study

Cleaning Procedures

Chemical cleanings were performed as needed to remove materials accumulated on the microfiltration and nanofiltration membranes and to restore losses in productivity.

Microfiltration Unit

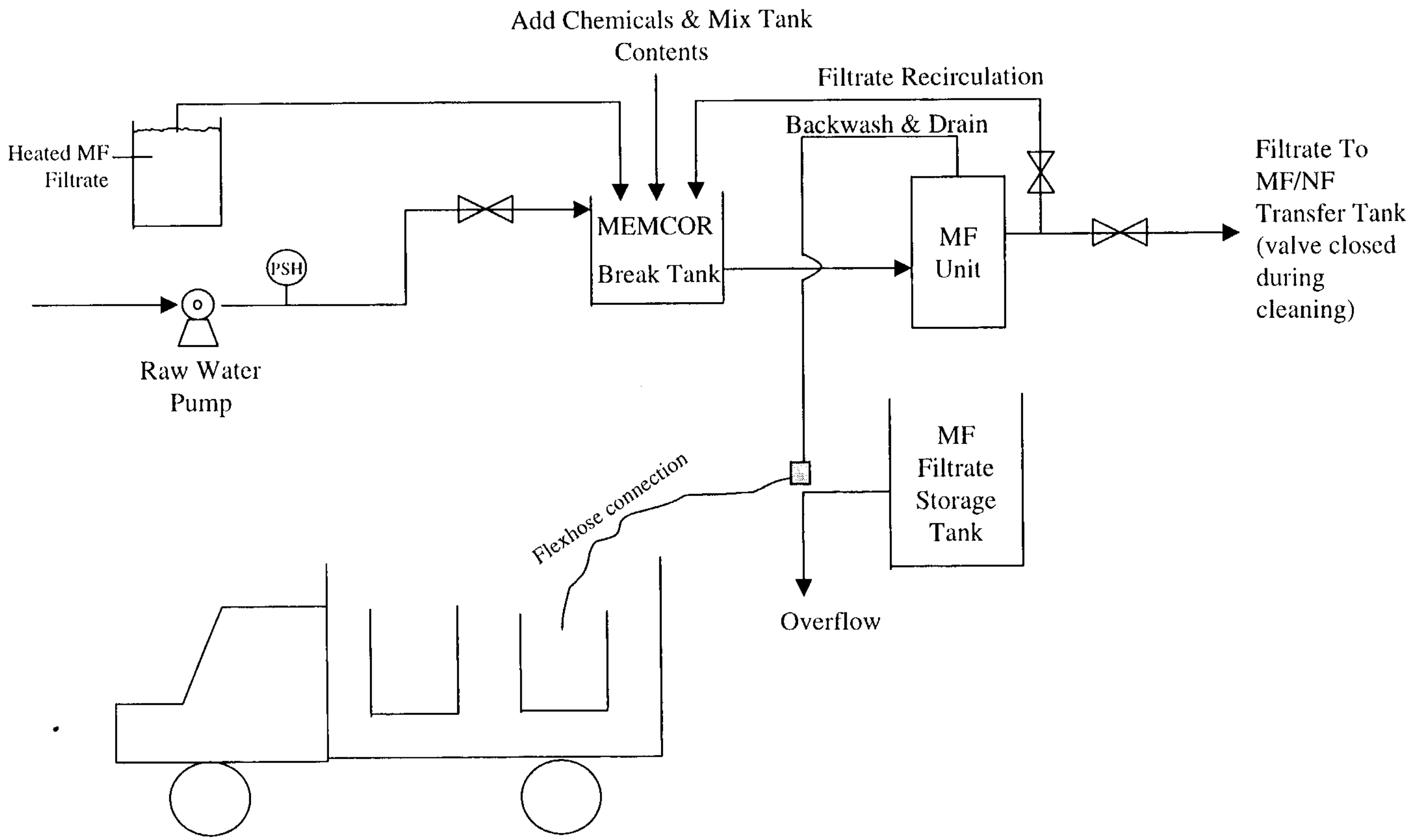
Backwashing is not completely effective in removing solids from the surface of the hollow fibers and with time, the residual solids accumulate and cause an increase in transmembrane pressure[3] (TMP). When TMP rises to a predetermined value, the microfiltration modules must be cleaned chemically using a clean-in-place (CIP) procedure. Chemical cleanings were performed when the TMP reached 22 psi in accordance with Memtec America recommended cleaning procedures.

Cleaning was performed by preparing a cleaning solution in the influent break tank and recirculating the solution through the modules and back to the tank with the on-board feed pump. Microfiltration filtrate was used for all cleanings. The filtrate was first heated to about 35°C in a 55-gallon drum with a drum heater, and then transferred to the break tank with a sump pump. Cleaning chemicals were added and mixed, and the temperature and pH of the cleaning water were measured before the CIP process was initiated. The cleaning chemicals used were a 1 percent citric acid solution followed by a proprietary high pH cleaning solution (Memclean EXA), in two separate cleaning cycles. The CIP procedure consisted of 30 minutes of solution recirculation, followed by a 30-minute soak period and a second recirculation for 60 minutes. A series of backwashes was then performed to rinse the cleaning chemicals from the microfiltration unit before putting the system back into service. To avoid discharging the waste cleaning solution to the gravity drain (and ultimately to Reservoir No. 1), the combination spent cleaning solution and backwash water (roughly 700 to 800 gallons per cleaning cycle) were captured and pumped to tanks on a box trailer, which were discharged to the sanitary sewer after pH adjustment.

A chemical cleaning cycle normally generates about 400 gallons of spent cleaning solution and backwash water. However, NJAWC required that all water discharged to the drain (to Reservoir No. 1) be within a pH range of 6 to 9. As a result, after each CIP cycle was completed the unit was started with the filtrate recycled back to the break tank. The filtrate pH was measured, and if the pH was not within NJAWC's criteria, the break tank was drained and/or a backwash was manually initiated to further rinse the residual cleaning solution from the microfiltration unit. This process was repeated until the pH met the NJAWC criteria. Two to three additional backwashes for each cleaning cycle were required to bring the pH in the microfiltration unit to within NJAWC's acceptable range. This resulted in the increase of spent cleaning solution and backwash water from the original 400 gallons to approximately 800 gallons. Figure 4 is a schematic diagram of the microfiltration cleaning system.

[3] Transmembrane pressure is the feed pressure minus the filtrate pressure.

The cleaning procedure was cumbersome and time consuming at the pilot scale. However, on a full-scale operation, the cleaning procedure can be automated thereby reducing the amount of human exposure to the cleaning chemicals and minimize the downtime of the unit being cleaned.



Waste cleaning solution is diverted to tanks on a box truck, which were discharged to the plant's sanitary sewer after pH adjustment.

Figure 4
NJ American Water Company
Canoe Brook ICR Pilot
MF Unit Cleaning Schematic

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Nanofiltration Unit

The nanofiltration membranes were chemically cleaned when the water mass transfer coefficient (MTC_w) declined by 20 percent from the value measured during initial operation or immediately after a cleaning. The nanofiltration cleaning system consisted of a 45-gallon batch tank and a transfer/recirculation pump as well as appropriate piping and valves. Nanofiltration permeate was used for cleaning; it was heated to between 40 and 45° C in a 55-gallon drum with a drum heater and transferred to the batch tank with a sump pump.

Cleaning chemicals used during the testing period were 2 percent citric acid, and a proprietary high pH cleaner provided by American Fluid Technologies and approved by the nanofiltration membrane manufacturer. The citric acid cleaner was used first. After the acid cleaning cycle was completed, the high pH cleaner was utilized. Both the acid and high pH cleaning chemicals mixed externally in a heated drum. For each cleaning cycle, once the recirculation pump was operating, the first flush of water from the system piping and voids in the membranes (about 30 gallons) was directed to waste to avoid diluting the cleaning solution.

After the waste step, the cleaning solution was recirculated between the batch tank and the vessels at about 8 gpm for 30 minutes. The recirculation pump was then shut off and the system soaked for roughly 1 hour. A second batch of cleaning solution was prepared and recirculated (after draining the first cleaning solution) for an additional 30 minutes. The system was finally flushed with feed water before putting the system back in service. The waste cleaning solution (about 150 gallons) was disposed of in the same manner as the microfiltration cleaning solution. Figure 3 is a schematic diagram of the nanofiltration cleaning system.

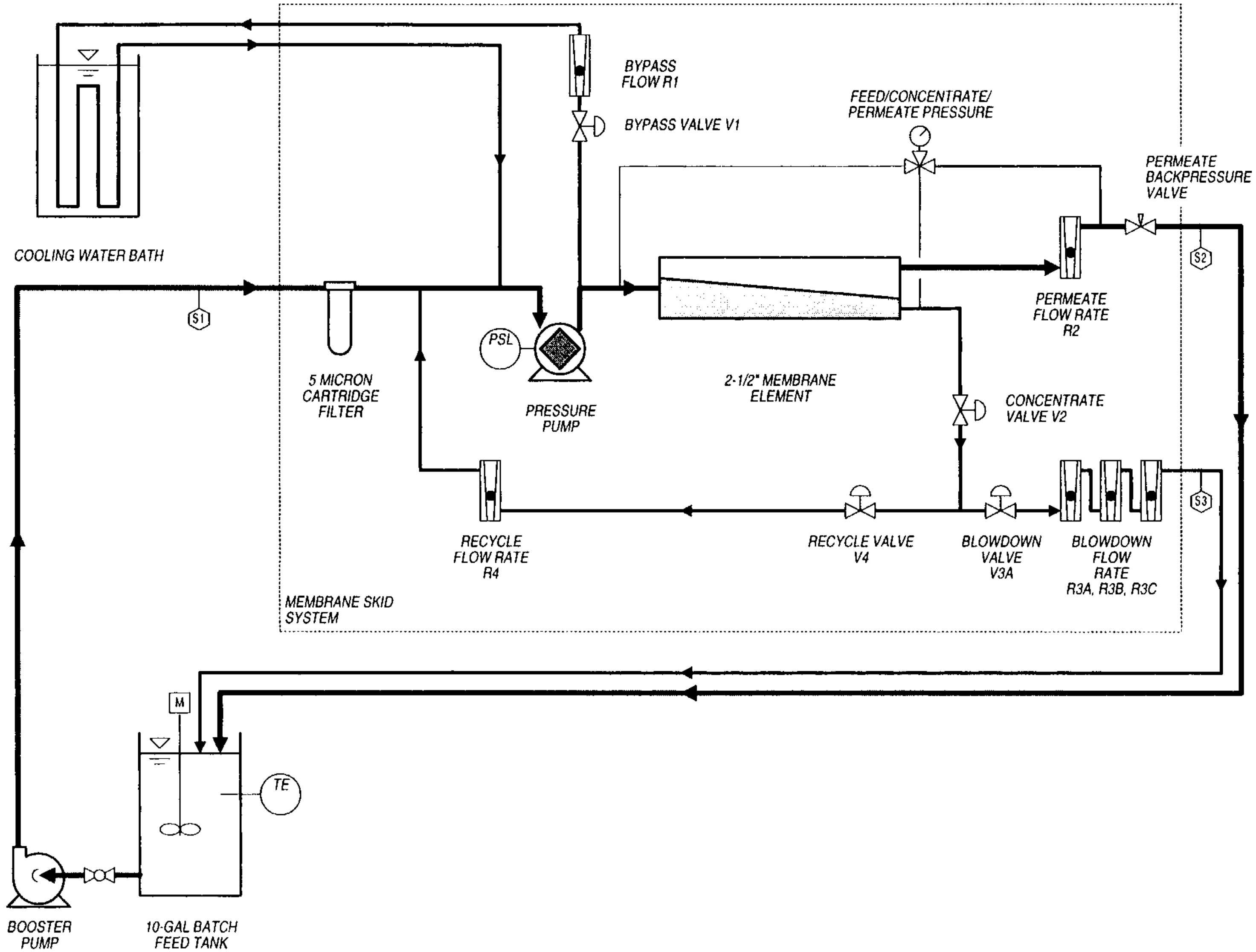
Experimental Design

Bench-scale testing was performed in August 1997 to choose the optimal nanofiltration membrane for pilot testing. The pilot study was conducted during the period November 1997 through April 1998 with a goal of achieving a minimum of 3,300 operational hours. Design parameters for the system are presented in the ICR Treatment Studies Data Collection Spreadsheet (EPA spreadsheet) in Appendix B. Hard copies of the information included in the EPA spreadsheet are contained in Appendix C.

Nanofiltration Bench-Scale Testing

CH2M HILL's Applied Sciences Laboratory performed bench-scale evaluations of four membranes to select the optimal nanofiltration membrane for pilot testing. The screening was performed using a single element bench test unit, equipped with concentrate recycle to permit testing at feedwater recoveries representative of full-scale operation. The purpose of the study was to characterize the DBP precursor, alkalinity, and hardness rejection of each membrane and to select the membrane that could provide the greatest rejection of the former and the least rejection of the latter two. Low alkalinity and hardness rejection was desirable to minimize chemical treatment associated with stabilization of the membrane product water.

Figure 5 is a schematic diagram of the bench-scale test apparatus. The bench-scale testing results are presented in Table 4.



CH2M HILL	DSGN P MUELLER DR P MUELLER CHK APVD	NJAWC NANOFILTRATION SCREENING TESTS	PROCESS SCHEMATIC **FIGURE 5** **2-1/2 INCH BENCH-SCALE NF SYSTEM**	SHEET 1 DWG NO. PD-1 DATE SEPT 1997 PROJ NO. 140181.B1

JUN 30, 1998

TABLE 4
Membrane Selection: Summary of Test Results

Parameter	FilmTec Nanofiltration70	TriSep TS40	Desal DS-5/DL	Hydranautics TTV7450
Product Recovery (%)	65.2	66.1	65.1	66.7
UVA_{254} Rejection (%)	95.7	85.3	97.3	80.4
TOC Rejection (%)	> 97.9	87.1	90.9	80.0
Alkalinity Rejection (%)	90.7	35.7	26.9	13.1
Calcium Hardness Rejection (%)	92.6	40.7	45.8	18.5

Note: Flux for all tests was 12 gfd. Test results are for high recovery test.

Ultraviolet light absorbance at 254 nanometers (UVA_{254}) was used as a real-time surrogate for DBP precursor content during the study. TOC was also analyzed and used as a decision tool for selection of the membrane for the pilot-scale testing. The Hydraunatics membrane provided the best water quality for the required treatment goals—sufficient UVA_{254} and TOC rejection and very low alkalinity and hardness rejection. However, the membrane was not chosen for the pilot-scale test because the lead time for delivery of the membranes was too long to accommodate the ICR testing schedule. The selected nanofiltration membrane (Desal DS-5 / DL) provided very high ultraviolet absorbance rejection and relatively low alkalinity and hardness rejection, and it could be delivered to the site in a reasonable time.

Experimental Summary

For ICR membrane pilot studies, evaluation of only one membrane type under one set of operating conditions is required. However, it was necessary to employ different feedwater pretreatment conditions during the testing as a result of changes in source water quality and biological fouling. Table 5 presents the experimental summary, which indicates the timeframe for the different pretreatment conditions.

Primary Variables Investigated

As stated above, the study was conducted under one set of operation conditions for the nanofiltration unit, 90 percent recovery, using a constant water flux through the nanofiltration membrane. The critical operating parameter was the water mass transfer coefficient (MTC_w), a measure of the rate of water flow through the semipermeable membrane barrier layer and any material (foulant) that accumulates at the membrane surface or within the membrane barrier layer. At the initial system startup, the MTC_W reflects the resistance of water permeate through the membrane barrier layer and as the membrane fouls, the MTC_W decreases as the foulant material imparts additional resistance to the water permeate. In accordance with the ICR Manual, chemical cleanings due to membrane fouling were required when there was a 20 percent decrease in the MTC_w. The MTC_w is the major factor in evaluating the productivity of the membrane. Cleaning frequency is the major factor in determining the effect of microfiltration and other nanofiltration feedwater pretreatment in controlling membrane fouling.

TABLE 5
Experimental Summary

Nanofiltration System Testing Period	Nanofiltration Feedwater Pretreatment	Microfiltration Flux (gfd)	Nanofiltration Flux (gfd)	Notes
Weeks 1–12	Microfiltration and antiscalant (3 ppm)	59	12	
Weeks 13–15	Microfiltration and antiscalant (3 ppm)	53	12	Reduced flux on microfiltration unit by 10% (reduced flow rate from 40 gpm to 36 gpm) to reduce cleaning frequency.
Week 16	Microfiltration, antiscalant (3 ppm) and chloramines (1 ppm)	53	12	Disinfection of nanofiltration membrane required due to biological fouling.
Weeks 17–20	Microfiltration, antiscalant (3.5 ppm) and chloramines (1 ppm)	53	12	Increased antiscalant dosage in response to increase in feedwater pH (due to addition of aqueous ammonia).

The critical operating parameters for the microfiltration unit are the flux rate and the TMP, which determine the membrane cleaning frequency. During the test, rapid TMP increases due to a change in source water quality prompted the decrease in the flux rate to reduce the cleaning frequency, as discussed later in the text.

Analytical Methods

Sample analysis was performed in the field and by the CH2M HILL Applied Sciences Laboratory in Corvallis, Oregon. Table 6 lists the equipment used to perform the field tests along with the analytical method employed. Table 7 summarizes the analytical methods used by the laboratory.

TABLE 6
Field Equipment and Testing Procedures

Parameter	Equipment Used	Method Used	Detection Limit
Flow	Signet 8512 on-line flow sensor	Paddlewheel	0.01 gpm
Pressure	Standard pressure gauges	Bourden Tube	0.25 psi
Conductivity	Portable conductivity meter (Hach)	SM 2510 B.	1 µS/cm
.pH	Portable pH meter (Cole-Palmer)	SM 4500-H^+	0.1 pH units
UVA_{254}	UV Spectrophotometer @ 254 nm (Milton Roy)	SM 5910 B	0.001 cm^{-1}
Turbidity	Turbidimeter (Hach Ratio XR)	SM 2130 B.	0.01 NTU
Temperature	Digital thermometer	SM 2550 B.	0.1°C
Alkalinity	Digital Titrator (Hach)	Hach method 8203	1 mg/L
Calcium hardness	Digital Titrator (Hach)	Hach method 8222	1 mg/L
Total hardness	Digital Titrator (Hach)	Hach method 8213	1 mg/L
SDI	Auto SDI meter, Purification Products, Model PPC-1000K	ASTM D4189	0.1 unit
Color	Hach Colorimeter @ 450 nm	SM 2120 C.	1 CU
Iron	Hach Colorimeter @ 500 nm	FerroVer method	0.01 mg/L
Manganese	Hach Colorimeter @ 550 nm	Low Range PAN method	0.001 mg/L
Free Chlorine	Hach Colorimeter @ 525 nm	DPD method	0.1 mg/L
Total Chlorine	Hach Colorimeter @ 525 nm	DPD method	0.1 mg/L

TABLE 7
Analytical Methods Used

Analyte	Method	Minimum Reporting Level
Alkalinity	EPA 310.1	0.5 mg/L
Bromide	EPA 300	20 µg/L
Calcium Hardness	EPA 200.7	0.1 mg/L
Chlorine Residual	SM 5710.D	0.05 mg/L
Haloacetic Acids (HAA5, HAA6)	SM 6251.B	1.0 µg/L
Iron	EPA 200.7	0.0200 mg/L
Manganese	EPA 200.7	0.0008 mg/L
Total Dissolved Solids	EPA 160.1	1 mg/L
Trihalomethanes (THM4)	EPA 502.2	1.0 µg/L
Total Hardness	SM 2340.B	0.2 mg/L
Total Organic Carbon	SM 5310.D	See note[a]
Total Organic Halides	SM 5320.B	25 µg/L

[a] Detection limits for TOC analysis are as follows:
nanofiltration permeate samples (Stage 1, Stage 2, and System) 0.1 mg/L
microfiltration feed, nanofiltration feed 0.5 mg/L
nanofiltration concentrate sample (Stage 1, Stage 2, and System) 2.5 mg/L

SECTION 4

Results and Discussion

Problems Encountered

System Downtime

The microfiltration and nanofiltration units performed as expected. Most of the operational problems encountered during the testing period involved equipment malfunctions with the microfiltration pretreatment unit, primarily due to various electrical problems with the on-board pump's variable frequency drive. Other major contributors to system downtime were chemical cleanings for both the microfiltration and nanofiltration units, installation of the chloramine system, and equipment maintenance and replacement. Table 8 summarizes all causes of system shutdown and the total runtime for the testing period. As shown, the percentage of total downtime experienced (13 percent) and downtime due directly to ICR-related issues (9 percent) was less than the EPA's 25 percent allowance.

Environmental Factors

The Canoe Brook Station is susceptible to flooding of the Canoe Brook during periods of intense rainfall. Flooding has occurred at all times of the year. Provisions were made to anchor the pilot trailers, and a plan was developed to shut down the system in the event of a flood. In addition, freezing weather during the testing period required heat tracing of piping to transfer water from the microfiltration unit to the nanofiltration unit.

Study Observations

Table 9 presents general observations during the course of testing that require further explanation to interpret the raw data on the EPA spreadsheets. Below is a discussion of observations of data elements specific to membrane testing.

Membrane Productivity

The microfiltration unit initially was operated at 40 gpm, or a flux of 59 gfd. The criteria for membrane cleaning was a TMP of 22 psi. The unit was installed and operated intermittently in early September and late October before the nanofiltration membranes were loaded into the vessels. Beginning with week 13, the flux was decreased by 10 percent to reduce the cleaning frequency. Figure 6 presents changes in TMP over time for the unit during the testing period. The cleaning frequency is discussed in the next section, Membrane Fouling.

The nanofiltration unit was operated at a constant flux of 12 gallons per foot per day (gfd) (average for the system), and feed pressure increased to maintain flux as membrane fouling occurred. The criteria for membrane cleaning was a 20 percent decrease in the water mass transfer coefficient (MTC_w) for either Stage 1 or Stage 2. This criterion was met, except for a rapid fouling event that decreased the MTC_w to 50 percent of the initial MTC_w in a short period, as described in Table 9.

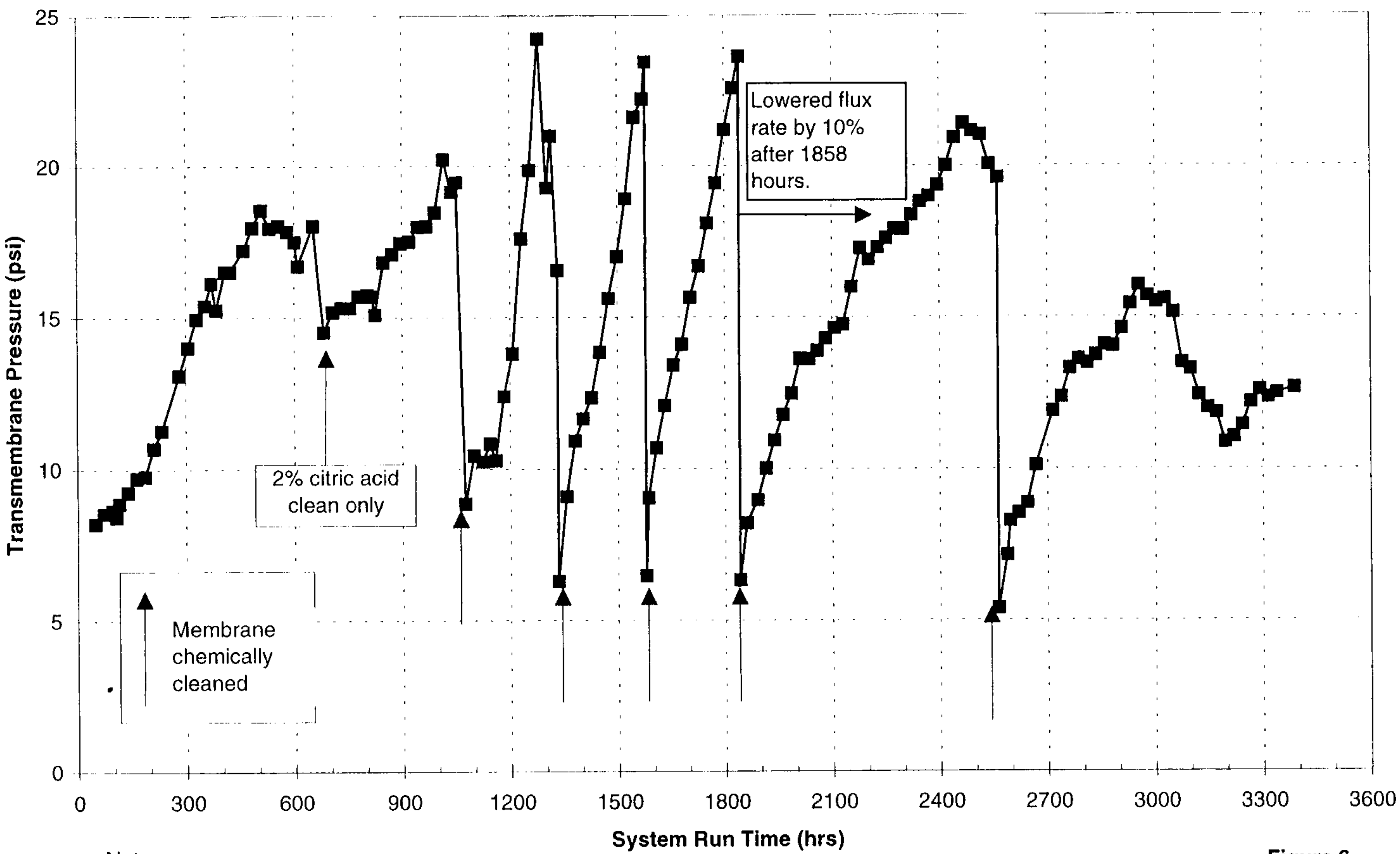
Table 8
Canoe Brook Station ICR Pilot
System Runtime

Start	Stop	Reason for Shutdown	Shutdown for more than 48 hrs?	Cumulative Runtime (hrs)	Event Downtime (hrs)	Event Downtime directly related to ICR[1] (hrs)
10/24/97 11:00	10/27/97 20:00	Raw water pump clogged	YES			
10/31/97 13:30	11/3/97 0:00	No shutdown; start test				
Official Start of ICR Testing						
11/3/97 0:00	11/7/97 10:30	Memcor unit - "Low filtrate flow"		107	29.5	
11/8/97 16:00	11/13/97 19:30	Install check valves on DAS		230	1.5	1.5
11/13/97 21:00	11/19/97 17:45	NJ American shutoff power for maintenance		371	17.0	
11/20/97 10:45	11/22/97 13:30	Memcor unit - "Low filtrate flow"		422	20.5	
11/23/97 10:00	11/30/97 20:40	Memcor unit - "Sweep feed flow low - BW11"		600	17.8	
12/1/97 14:30	12/3/97 19:00	Memcor unit - "Sweep feed flow low - BW11" Performed chemical clean on MEMCOR unit (Citric Acid)		653	47.5	47.5
12/5/97 18:30	12/12/97 0:00	Memcor unit - VFD alarm "OC2" - Overcurrent trip during pump deceleration		802	10.6	
12/12/97 10:35	12/13/97 1:00	Memcor unit - VFD alarm "OP" - Overvoltage trip		817	18.3	
12/13/97 19:15	12/15/97 9:30	NJ American shutoff power for maintenance		855	0.3	
12/15/97 9:50	12/22/97 3:15	Memcor unit - "Low filtrate flow" (no VFD alarm)		1016	1.6	
12/22/97 4:50	12/23/97 10:00	Chemical Clean Memcor unit		1045	10.8	10.8
12/23/97 20:50	12/27/97 20:10	Memcor unit - "CIP requested"		1141	3.7	
12/27/97 23:50	12/28/97 2:45	Memcor unit - "CIP requested"		1144	1.3	
12/28/97 4:05	12/28/97 5:50	Memcor unit - "CIP requested"		1145	31.3	
12/29/97 13:10	1/4/98 1:10	Chemical Clean NF unit (Citric Acid)	YES	1277	70.3	70.3
1/6/98 23:30	1/8/98 11:15	Chemical Clean Memcor unit (Citric Acid)		1313	5.8	5.8
1/8/98 17:00	1/9/98 9:15	Chemical Clean Memcor unit (Memclean)		1329	5.3	5.3
1/9/98 14:30	1/12/98 15:45	Install isolation valves on NF trailer		1403	1.3	1.3
1/12/98 17:05	1/13/98 0:45	MF Feed tank drained (recirc pulled out of tank)		1410	0.8	
1/13/98 1:30	1/14/98 12:50	Install tap for particle counter on NF feed		1446	0.3	0.3
1/14/98 13:05	1/20/98 8:00	Chemical Clean Memcor unit (Citric Acid/Memclean)		1585	32.9	32.9
1/21/98 16:55	1/22/98 13:50	Memcor unit (change valve actuator on PV3)		1606	1.7	1.7
1/22/98 15:30	2/1/98 10:40	Chemical Clean Memcor unit (Citric Acid/Memclean)		1841	7.1	7.1
2/1/98 17:45	2/2/98 10:55	Chemical Clean NF unit (High pH pre-mixed cleaner)		1858	4.4	4.4
2/2/98 15:20	3/3/98 12:00	Chemical Clean Memcor unit (Citric Acid/Memclean)		2551	6.5	6.5
3/3/98 18:30	3/4/98 11:00	Chemical Clean NF unit (High pH pre-mixed cleaner) and implement chloramination of NF feed		2567	100.2	100.2
3/8/98 15:10	4/10/98 9:30	Power outage		3353	1.0	1.0
4/10/98 10:30	4/10/98 13:00	End test		3356		
			Totals[2]	**3356**	**449**	**297**
			Percent of downtime		**13%**	**9%**

Notes:
[1] Includes downtime directly related to the NF unit (including expected downtime for pretreatment)
[2] Cumulative testing period was 3356 + 449 = 3805 hours.

TABLE 9
Operational Observations Unique to Canoe Brook Study

Nanofiltration System Operating Time (hr)	Description
0–484	Inaccurate data (pressure, conductivity, and pH) were recorded due to a problem with the on-line monitoring system. EPA was contacted, and grab sample monitoring of daily parameters once per day was approved. Pressure gauge readings and portable pH and conductivity meters were used for monitoring during the remainder of the test. In-line flow meters were not affected.
1277	**Rapid fouling event**. A rapid drop in the system water mass transfer coefficient (MTC_w) over a 4-day period in December 1997 required the nanofiltration unit to be cleaned. A rapid increase of the microfiltration unit TMP was also observed. Directly preceding and during this period, heavy rains and low reservoir levels forced plant operators to begin withdrawing water from the Canoe Brook, which is not usually the direct primary source of supply. The specific foulant was not identified, although it was believed to be colloidal manganese. An acid clean restored the MTC_w to pre-pumping values.
1585	**Rapid fouling event**. A second rapid drop in the system MTC_w occurred over a 5-day period in January 1998. An acid clean returned the MTC_w back to conditions prior to the event. Daily monitoring of iron and manganese was initiated after this fouling event.
1858	**Increase in TDS passage.** Passage of TDS through the nanofiltration membranes increased significantly in response to a high pH clean to the nanofiltration unit. A decrease in passage was not observed during the previous run cycle. The step increase in TDS passage without the gradual decrease during the previous run cycle may have indicated that the cleaning event did not reverse a decrease in passage caused by fouling but may have changed the characteristics of the membrane. However, UVA_{254} passage did not change following cleaning, which would have been an indication of degradation.
2567	**Biological fouling**. A steady decline in water MTC_w coupled with a more rapid rate of increase in the temperature normalized differential pressure (k factor) for Stage 1 indicated that biological fouling was occurring. This conclusion was corroborated by the identification of several bacterial strains in films recovered from the inside Stage 1 vessel end caps. Chloramination of nanofiltration feed was implemented to control bacterial growth in the membrane elements.
2567	UVA_{254} results for the system permeate increased substantially when chloramines were added to nanofiltration feedwater. To determine the cause of the increase, subsequent UVA_{254} samples were collected with the chloramine system off-line. These samples showed UVA_{254} values to be consistent with results obtained prior to chloramine use. Therefore, it was concluded that there was no real change in UVA_{254} rejection by the nanofiltration membranes and that the increased results were an artifact of the presence of chloramines in the nanofiltration permeate. Studies conducted by the University of Colorado show that chloramines absorb light in the 254-nm range and represented a positive interference to the measurement of UVA_{254} in the nanofiltration permeate.



Notes:
System Run Time is same as NF unit.

Figure 6
CANOE BROOK ICR PILOT
MICROFILTRATION PRETREATMENT
TRANSMEMBRANE PRESSURE

Figure 7 depicts the system MTC_w over time for the testing period. Problems with the automated sampling system during the first part of the testing period prevented the direct calculation of the initial MTC_w. The initial MTC_w of 0.2142 gfd / psi was extrapolated from a regression line developed using a representative number of operating points before the first cleaning event. This estimate was confirmed with the high pH clean on February 2, 1998, which restored the MTC_w to 0.2046 gfd / psi, a difference of less than 5 percent from the estimated initial value. The MTC_w calculation includes normalization to a temperature of 16°C, the average raw water temperature for the Canoe Brook Station. The temperature correction factor in the EPA spreadsheet is a generalized equation and does not take into account specific manufacturer's data for the Desal HL4040F1674 membrane. The system MTC_w using the manufacturer's temperature correction factor is presented in Figure 7.

Membrane Fouling

Membrane fouling increases the resistance to water flow through the membrane rejecting layer, thereby increasing power consumption to maintain a given permeate flow (productivity). There are several contaminants present in surface water supplies like that used for this study, including:

1. Particulate matter
2. Microorganisms, most typically bacteria and algae
3. Oxidizable metals (iron, manganese, and aluminum)
4. Large molecular weight, hydrophobic dissolved organic compounds
5. Precipitates of sparingly soluble salts (where they become concentrated to supersaturated levels in the nanofiltration system)

Microfiltration is very effective at removing foulant categories 1 and 2, and can provide effective removal of category 3 if the metals are in an oxidized state. Microfiltration is not effective at controlling categories 4 and 5.

Three types of fouling were evident during the testing:

- Inorganic fouling caused by precipitation of manganese or iron
- Biological fouling caused by microbial growth on the membrane and the element feed spacer
- Organic fouling caused by buildup of natural organic matter on the membrane

Cleaning Events

Tables 10 and 11 present notes on the cleaning events required for the microfiltration and nanofiltration units during the testing period.

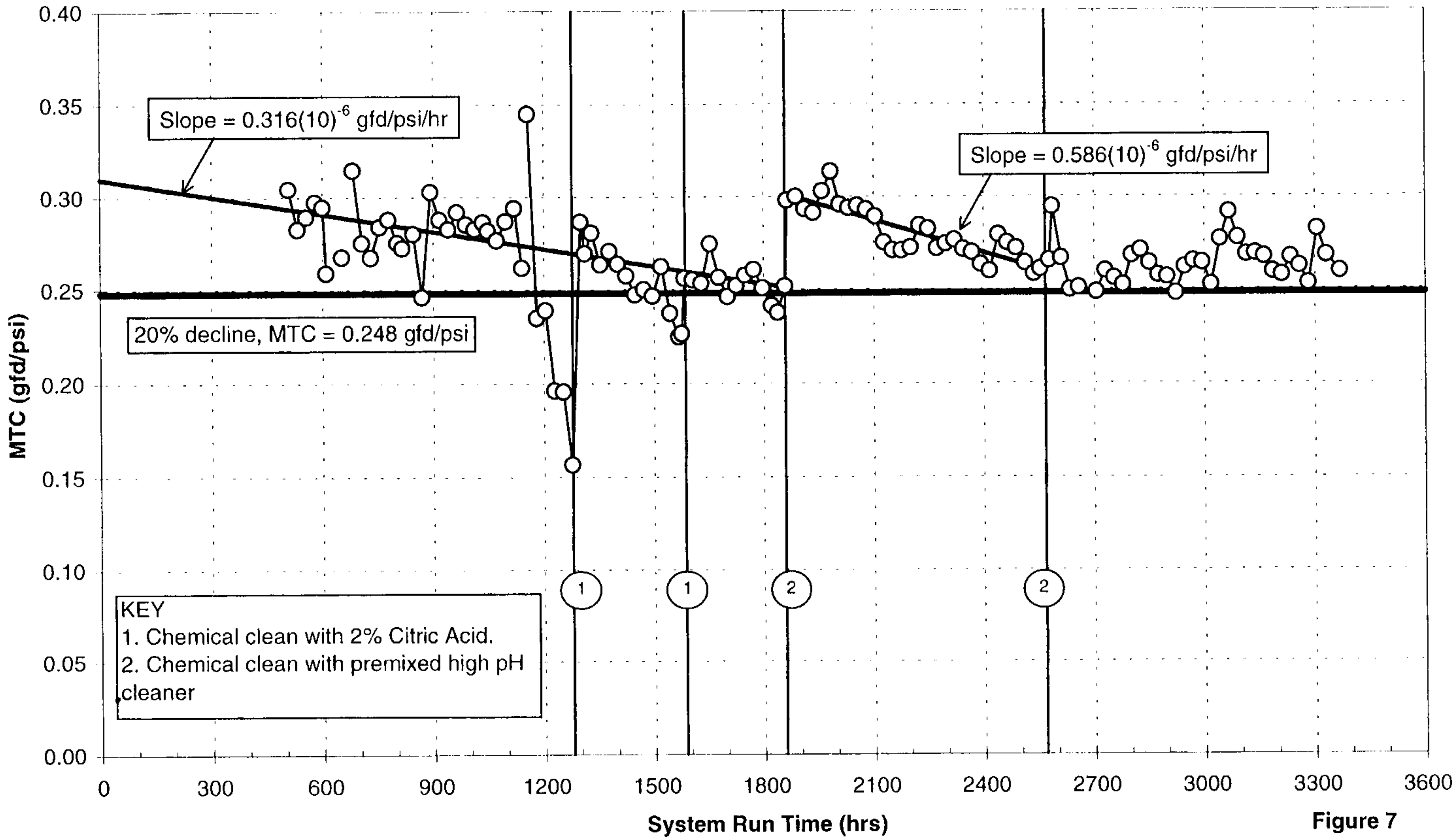


Figure 7
CANOE BROOK ICR PILOT
NANOFILTRATION UNIT
MASS TRANSFER COEFFICIENT
NORMALIZED WITH MANUFACTURER'S
TEMPERERATURE CORRECTION FACTOR

4_10sum.xls[MTC wO-D Tc]

TABLE 10
Microfiltration Cleaning Events

Date	Nanofiltration System Operating Time (hr)	Operating Interval between Cleanings (hr)	Chemicals Used	Notes
12/4/98	653	—	2% Citric Acid	Chemical clean was initiated to alleviate operational problems with microfiltration unit. It was found that a pump's variable frequency drive caused the problem. Thus, clean was unnecessary.
12/23/97	1045	1045	2% Citric Acid followed by 2% Memclean	
1/8/98	1313	268		
1/20/98	1585	272		
2/1/98	1841	256		Reduced flux by 10% (reduced flow rate from 40 gpm to 36 gpm)
3/3/98	2551	710		

Note: Operating interval between the cleaning on 3/3/98 and the completion of testing was 805 hours.

TABLE 11
Nanofiltration Cleaning Events

Date	Nanofiltration System Operating Time (hr)	Operating Interval between Cleanings (hr)	Chemicals Used	Notes
1/4/98	1277	1277	2% Citric Acid	Cleaning required due to sudden, rapid decrease of MTC_w believed to be caused by colloidal manganese. Acid cleaning restored MTC_w to level prior to fouling event.
1/21/98	1585	307	2% Citric Acid	Cleaning required due to sudden, rapid decrease of MTC_w believed to be caused by colloidal manganese. Acid cleaning restored MTC_w to level prior to fouling event.
2/2/98	1858	273	1% AFT Filterpure TF	Cleaning required due to 20% decrease in MTC_w from estimated initial condition. Cleaning restored MTC to estimated initial condition.
3/4/98	2567	709	1% AFT Filterpure TF	Cleaning performed to increase MTC_w before addition of chloramines. Cleaning did not improve the MTC_w.

Note: Operating interval between the cleaning on 3/3/98 and the completion of testing was 789 hours.

Based on the cleaning frequencies and chemical used, the following was observed:

- The microfiltration unit initially operated for roughly 1,000 hours before requiring chemical cleaning due to a high TMP condition.
- During the first 1277 hours of testing, no chemical cleaning of the nanofiltration membrane was required. MTC_w for the nanofiltration unit declined very gradually, most likely caused by dissolved organic compounds accumulating at the membrane surface. This rate of fouling would necessitate chemical cleaning every 70 to 80 days.
- After the change in raw water quality in December 1997, rapid fouling occurred with both membrane units during the period from 1,200 to 1,800 hours. Cleaning frequency for both units increased to less than 300 hours.
- There was a noticeable change in the color of the cleaning solution during the high pH cleaning at 1,858 hours. A dark brown color was observed, which is an indication that the fouling was caused by buildup of natural organic matter on the membrane.
- The cleaning frequency for the microfiltration unit after the first rapid fouling event was consistent through three consecutive filter cycles at just over 250 hours. The flux was subsequently decreased from 59 gfd to 53 gfd (10 percent), increasing the time between cleanings to every 700 to 800 hours.
- The cleaning frequency for nanofiltration after 1,600 hours returned to a rate similar to that observed prior to December 1997. Following the implementation of chloramines, membrane fouling appeared to be completely arrested. In this case, a very long cleaning frequency would be predicted on the order of 6 months to a year.

Rapid Fouling Event

The first rapid fouling event described in Table 9 was a result of a change in the raw water pumping scenario at the Canoe Brook Station. Operators needed to withdraw water from the Passaic River and the Canoe Brook because the reservoirs were below capacity (about 40 percent) and significant rain brought potential floodwaters down the Canoe Brook. Water withdrawn from the Passaic River is discharged into Reservoir No. 2, and water withdrawn from the Canoe Brook is discharged to Reservoir No. 1, where the intake to the Canoe Brook Station is located. The most apparent indicator of the change in water quality was UVA_{254} results. The effect of pumping from the Canoe Brook on UVA_{254} results is shown in Figure 8. The reservoir is shallow (about 10 feet), and it was suggested that a possible cause for the rapid fouling of the membrane was reservoir turnover due to the continued pumping from Canoe Brook (operators pumped from the Canoe Brook whenever there was available flow for the remainder of the test).

The cause of rapid fouling of the nanofiltration system was not determined, but it was deduced that organic fouling was not the cause. Although UVA_{254} is used as a surrogate indicator for organics, organic compounds did not cause the rapid fouling because a citric acid cleaning restored the MTC_w value to the level prior to the fouling event. Citric acid is used to remove metal oxides and acid soluble scales. Fouling caused by oxidized metals (such as manganese or iron) would be removed by citric acid, but fouling caused by organics or biofouling would not be affected. Therefore, it may be possible that the increase in UVA_{254} is due to an inorganic compound or compounds that absorb UV light at 254 nm (ammonia is an example).

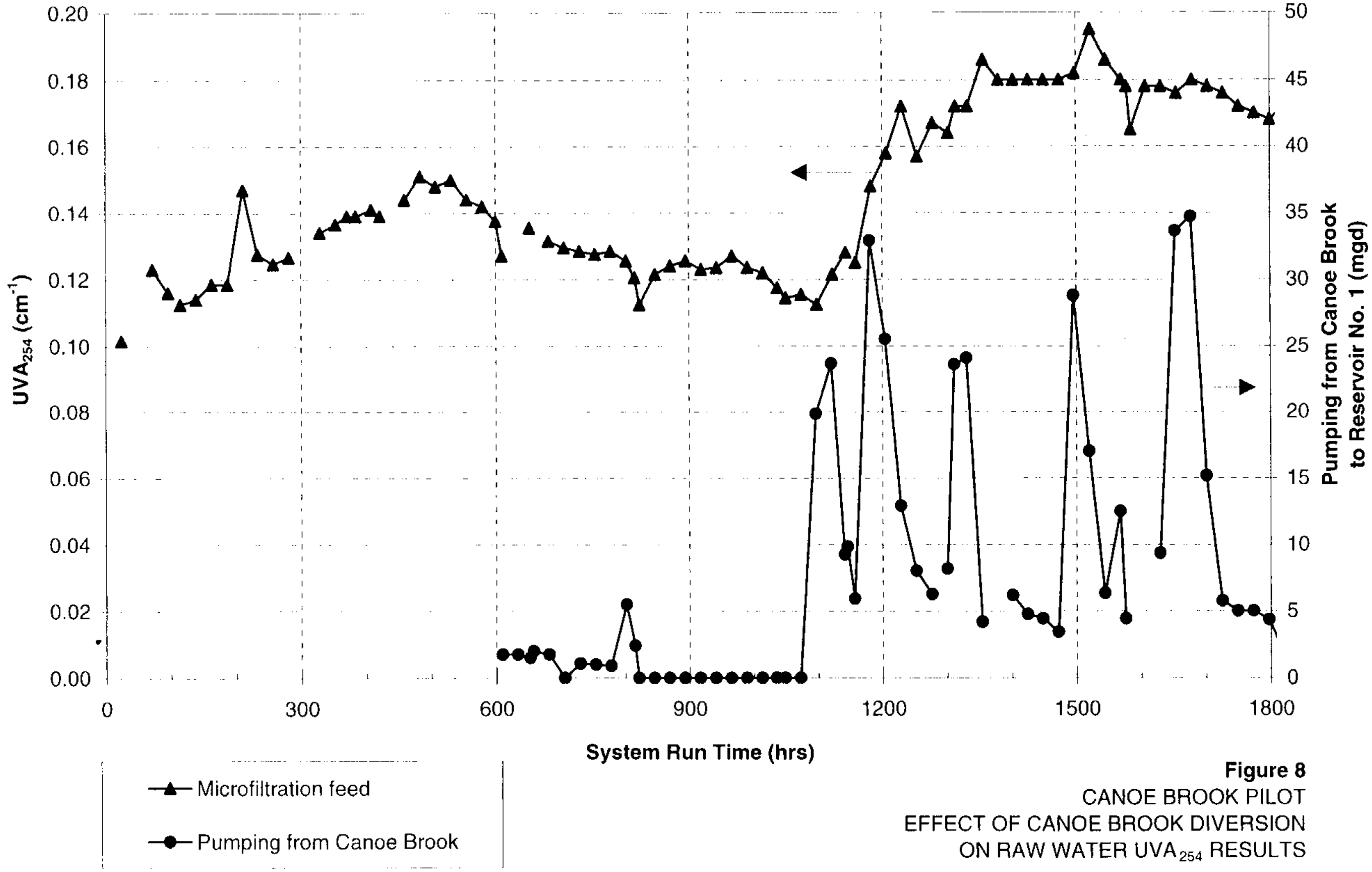


Figure 8
CANOE BROOK PILOT
EFFECT OF CANOE BROOK DIVERSION
ON RAW WATER UVA_{254} RESULTS

Further, a possible cause was the introduction into the microfiltration feedwater of dissolved manganese caused by reservoir turnover. It is hypothesized that manganese was present in its reduced form in the lower part of Reservoir No. 1 during the rapid fouling event in December 1997, and that pumping from the Canoe Brook into the reservoir hydraulically mixed water containing the reduced (soluble manganese) with well oxygenated river water. The mixture was then pumped to the microfiltration unit. Because of the slow rate of manganese oxidation by dissolved oxygen, soluble manganese could have passed through microfiltration membranes. The detention time in the microfiltration filtrate tank then allowed the manganese to oxidize to a colloidal form, which then fouled the nanofiltration membranes.

Manganese and iron were not monitored before or during the rapid fouling event to support the theory. After the fouling events, daily monitoring of iron and manganese was initiated to assess the potential for elevated levels of iron and manganese in the nanofiltration feedwater to impact membrane performance. Daily samples were taken for microfiltration feed, nanofiltration feed, system permeate, and system concentrate. Iron and manganese levels during the monitoring period after the rapid fouling events remained relatively low and constant and were not considered to contribute significantly to membrane fouling potential (see Figure 9).

Microbial Fouling and Chloramine Addition

Increases in differential pressure (or k factor) indicate a buildup of particulate matter in the nanofiltration element feed spacer. Microfiltration removed virtually all particles in the raw water; therefore the increased k factor was attributed to the growth of periphytic bacteria and their attendant exopolymeric substances. Selective increase in Stage 1 differential pressure is characteristic of biological fouling.

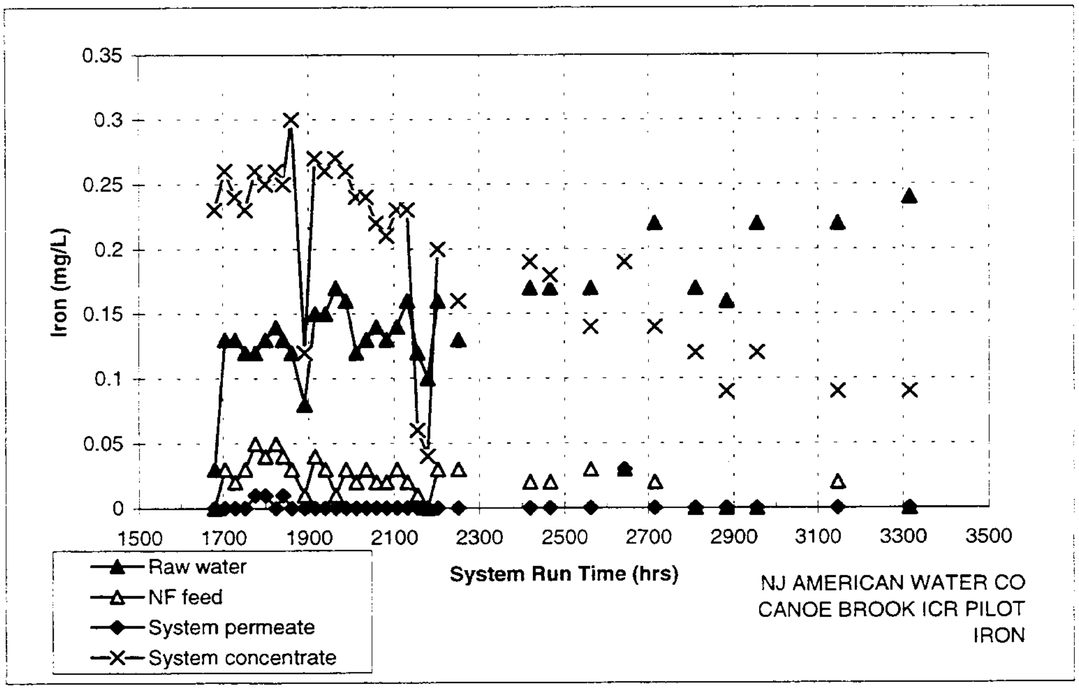
Figures 10 and 11 depict the flow normalized differential pressure (k factor) across each stage of the nanofiltration unit. The k factor consistently increased in Stage 1 after about 1,500 hours of operation, whereas the Stage 2 k factor remained relatively constant. This phenomenon was observed during tests for other surface waters where a microfiltration / nanofiltration system was employed. Based on other operational experiences, 1,500 hours is sufficient time for biological growth to develop and begin to foul the membrane. After a substantial increase in the k factor for Stage 1, it was decided that nanofiltration feedwater disinfection was required to control biological fouling.

Chloramines were selected as the method for controlling bacterial growth in the nanofiltration system because they:

- Have demonstrated the ability to control biofilm formation in distribution system
- Are suitable for use with drinking water systems
- Have successfully controlled biofouling on nanofiltration membranes at other sites
- Have been demonstrated safe for use with membranes at several locations operating at periods up to 5 years, although not readily approved for use with thin film membranes
- Are relatively easy to implement on a pilot scale

- Result in lower DBP formation than other disinfectants such as free chlorine
- Can maintain a combined residual through the nanofiltration system with adversely impacting the integrity of the membrane

The nanofiltration system was cleaned in preparation for feedwater chloramination. Before the system was cleaned, swab samples were taken on the inside wall of the lead end of the Stage 1 vessel and the tail end of the Stage 2 vessel and sent to NJAWC's Delaware River



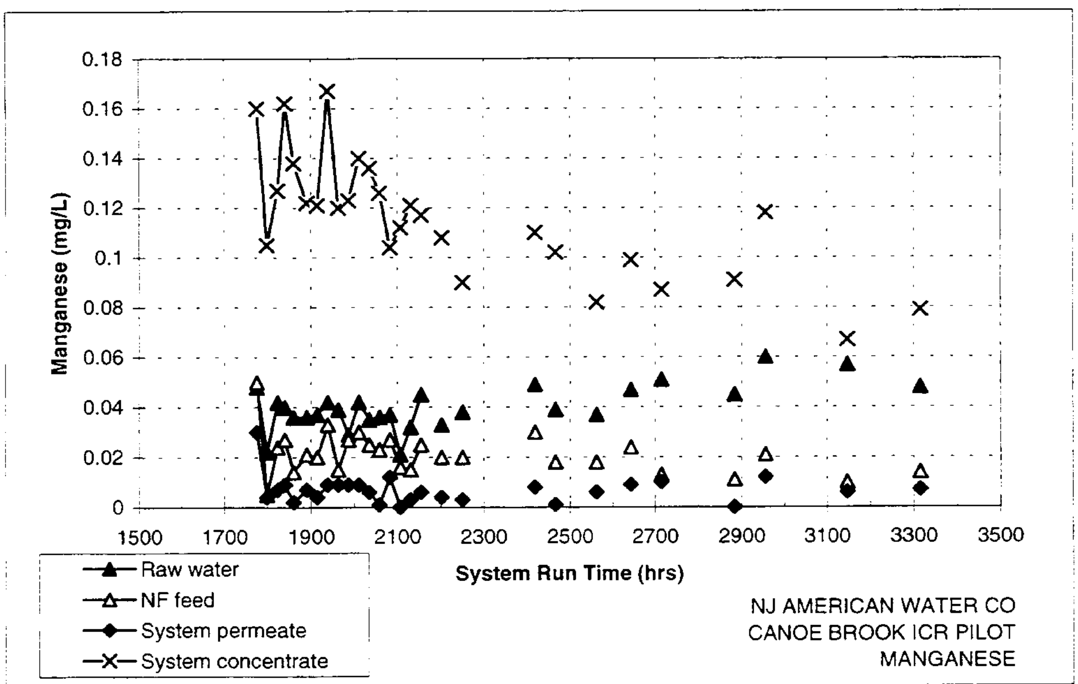


Figure 9
CANOE BROOK ICR PILOT
IRON AND MANGANESE RESULTS

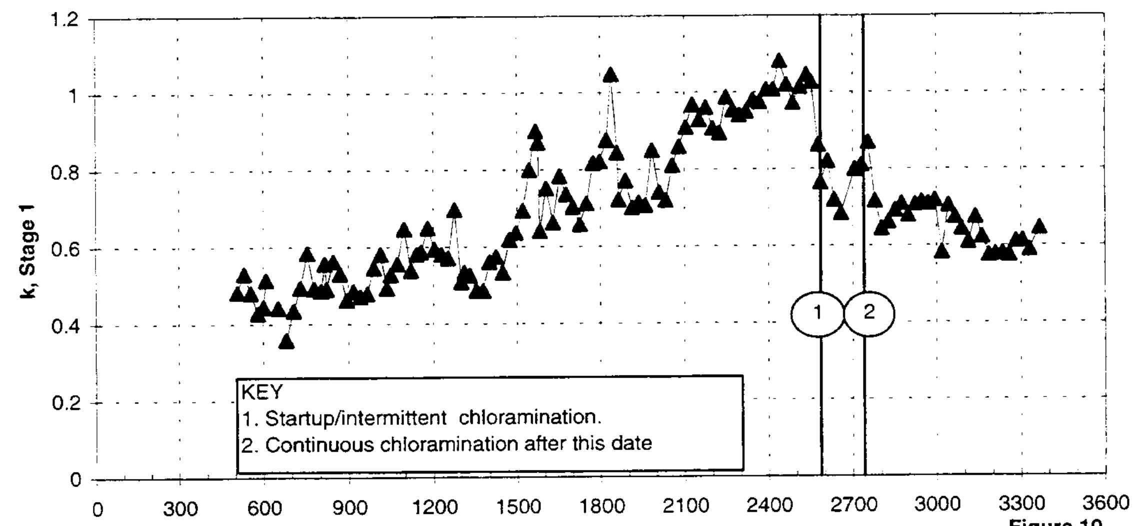


Figure 10
CANOE BROOK ICR PILOT
PRESSURE DROP COEFFICIENT
STAGE 1

Note: $k = (\Delta P)/(Q^{1.5})$
where Q is average of feed and concentrate flow of Stage 1

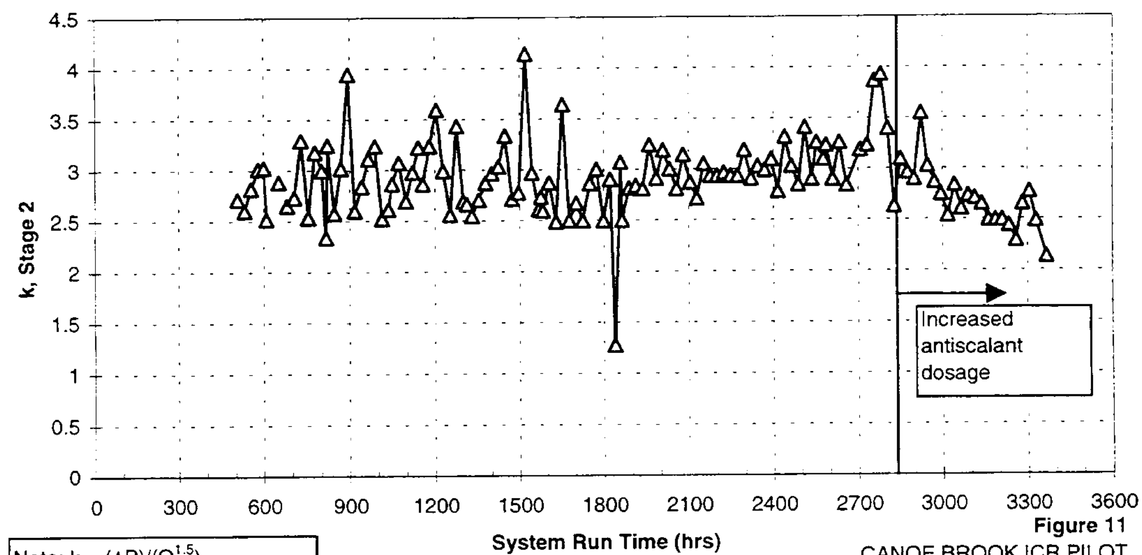


Figure 11
CANOE BROOK ICR PILOT
PRESSURE DROP COEFFICIENT
STAGE 2

Note: $k = (\Delta P)/(Q^{1.5})$
where Q is average of feed and concentrate flow of Stage 2

Regional Laboratory for bacterial speciation and enumeration. The object of the analysis was to identify the presence of bacterial strains responsible for fouling. Different species were found to predominate in each vessel. Results are presented in Appendix D.

Aqueous ammonia and sodium hypochlorite chemical feed systems were installed, and piping modifications were made to allow an additional 1 to 2 minutes of contact time before entering the nanofiltration unit. A 4:1 weight ratio of chlorine to ammonia was targeted to provide for optimal formation of monochloramine. Daily samples of free chlorine residual and total chlorine residual were taken to monitor the combined chlorine, and to ensure that free chlorine did not contact the membrane.

Use of aqueous ammonia at 2,567 hours to form chloramines in the microfiltration filtrate increased the pH of the nanofiltration feedwater. The pH increase likewise increased the potential for calcium carbonate to precipitate in the nanofiltration system (as measured by the Langelier Saturation Index of the nanofiltration concentrate stream). To provide adequate inhibition of $CaCO_3$ precipitation, the dosage of the antiscalant was increased to 4 ppm beginning at 2,835 hours.

Water Quality Data

Table 12 summarizes critical water quality parameters monitored during the test. Summary tables and figures including daily and biweekly sampling results are contained in Appendix D. As anticipated, microfiltration treatment was very effective at removing turbidity and particles from the raw water, but provided very limited removal of dissolved organic and inorganic substances. Nanofiltration treatment provided very effective removal of target organic compounds, included TOC and DBP precursors. Below is further discussion on water quality issues observed during the testing period.

Comparison of Bench-Scale Test with Pilot-Scale Test

Table 13 presents a comparison of the bench-scale and pilot-scale results. The pilot-scale system performed much better than expected with respect to UVA_{254} and TOC rejection. However, the alkalinity and calcium hardness rejections were also higher than expected. Higher rejections of alkalinity and calcium hardness may require additional costs associated with the stabilization of finished water and could impact concentrate disposal.

TOC and Disinfection By-products

Figures 12 and 13 present the biweekly sampling results for TOC and the daily results of UVA_{254}, respectively. TOC removal was greater than 97 percent, and UVA_{254} removal was greater than 99 percent, with all removal achieved by nanofiltration. TOC in the raw water increased slightly between week 6 and week 8, but the daily UVA_{254} increased substantially, corresponding to the first rapid fouling event. The raw water UVA_{254} remained at the higher level for the remainder of the test, suggesting that the event caused a step change in water quality that would need to be accounted for in the process design. As the raw water TOC and UVA_{254} varied due to the change in the raw water quality, the removal efficiency of the microfiltration unit remained constant at about 13 percent. The microfiltration filtrate TOC and UVA_{254} results were a function of the raw water, whereas nanofiltration removals of TOC and UVA_{254} were independent of feed levels.

TABLE 12
MF Unit
Summary of Water Quality Results

Parameter	MF Feed			MF Filtrate (NF Feed)			NF Permeate			NF Concentrate		
	Average	Range	Standard Deviation	Average	Range	Standard Deviation	Average	Range	Standard Deviation	Average	Range	Standard Deviation
TOC (mg/L)	5.1	4.5 - 6.0	0.4	4.4	3.8 - 5	0.3	All reported results below detection limits.			39.3	32.1 - 44.6	4.4
Trihalomethanes[a]												
Chloroform				56.4	33.9 - 69.2	12.5	All reported results below detection limits.					
Bromodichloromethane				7.4	6.0 - 10.3	1.3	All reported results below detection limits.					
Dibromochloromethane				1.2	0.8 - 1.6	0.3	All reported results below detection limits.					
Bromoform				< 1.0			All reported results below detection limits.					
Total THM_4 (μg/L)				64.4	45.8 - 76.5	11.1	---					
Haloacetic Acids[a]												
Monochloroacetic acid				1.6	1.3 - 1.9	0.2	All reported results below detection limits.					
Dichloroacetic acid				25.2	13.5 - 32.7	6.6	All reported results below detection limits.					
Trichloroacetic acid				30.8	20.5 - 37.8	6.5	All reported results below detection limits.					
Monobromoacetic acid				< 1.0			All reported results below detection limits.					
Dibromoacetic acid				< 1.0			All reported results below detection limits.					
Bromochloroacetic acid				3.0	2.6 - 3.7	0.3	All reported results below detection limits.					
Total HAA_5 (μg/L)				56.6	35.7 - 69.0	12.9	---					
Total HAA_6 (μg/L)				59.6	38.6 - 72.2	13.1	---					
Total Organic Halides (μg/L)				377	275 - 446	60	All reported results below detection limits.					
Bromide (μg/L)				37.9	32 - 42	3.5	36.8	32 41.5	2.7			
UVA_{254} (cm^{-1})	0.14[b]	0.085 - 0.17	0.016	0.12	0.08 - 0.15	0.02	0.0005	< 0.0001 - 0.0059	0.0008	1.17	0.678 - 1.52	0.3
Turbidity (ntu)	4.4	2.1 - 8.6	1.4	0.045	< 0.001 - 0.11	0.019	0.03	< 0.01 - 0.1	0.015	0.19	0.051 - 1.11	0.11
Silt Density Index	Not Analyzed			2.2	1.3 - 2.7	0.42	Not Analyzed			Not Analyzed		
Particle counts (#/100mL)	7,989	3,605 - 10,100	1,118	8.2	0.74 - 25	6.2	Not Analyzed			Not Analyzed		
Apparent Color (CU)	69	24 - 124	21	21	< 1 - 44	9.4		< 1 -	---	201	148 - 251	30
Iron (mg/L)	0.15	0.03 - 0.24	0.04	0.024	< 0.001 - 0.03	0.013	< 0.01	< 0.01 - 0.03	---	0.195	0.04 - 0.3	0.07
Manganese (mg/L)	0.04	0.021 - 0.06	0.009	0.021	0.005 - 0.050	0.009	0.007	< 0.001 - 0.03	0.006	0.12	0.067 - 0.17	0.02
Algae (#/100mL)	590	75 - 3102	596	0	---		Not Analyzed			Not Analyzed		
Total hardness (mg/L)	67.6	46.6 - 75.8	9.5	67.7	53.8 - 75	7.7	26.3	20 - 38.3	6.1	384	[#] - 536	[#]
Calcium hardness (mg/L)	43.3	29.7 - 49	6.4	43.7	33.7 - 51	5.4	19.5	15.4 - 28.2	4	228	[#] - 315	[#]
Alkalinity (mg/L)	36.3	34 - 40	1.7	35.8	34 - 38	1.3	18.7	16 - 23	2	180	154 - 214	23

Notes:
[a] DBP samples were analyzed after a 6 hour holding time, as simulated distribution system samples.
[b] UVA254 results for MF feed are for samples filtered with a 0.45 μ filter before analysis.

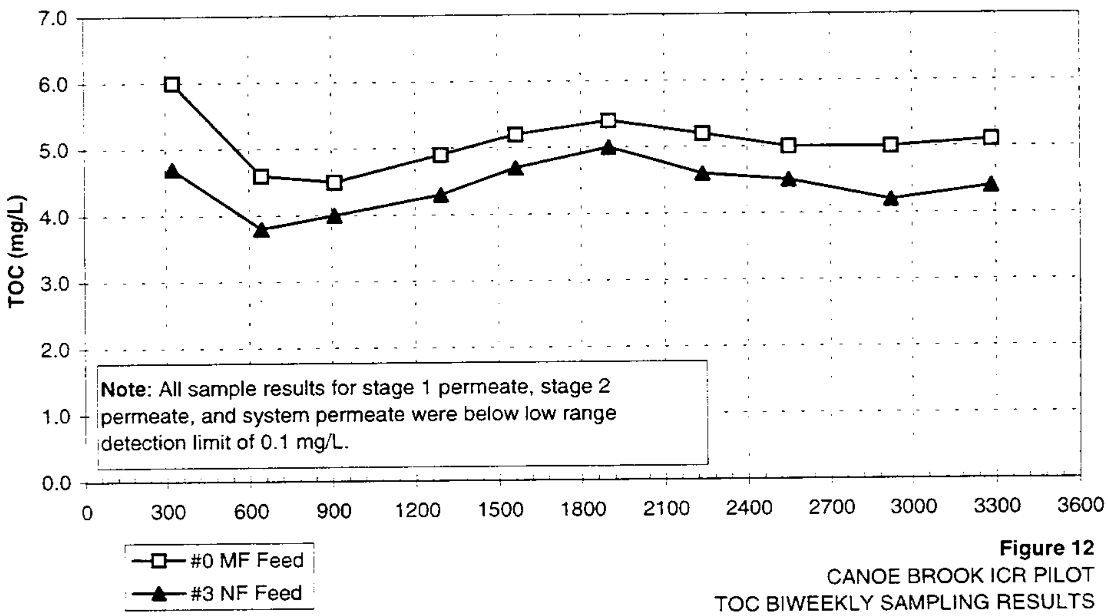


Figure 12
CANOE BROOK ICR PILOT
TOC BIWEEKLY SAMPLING RESULTS

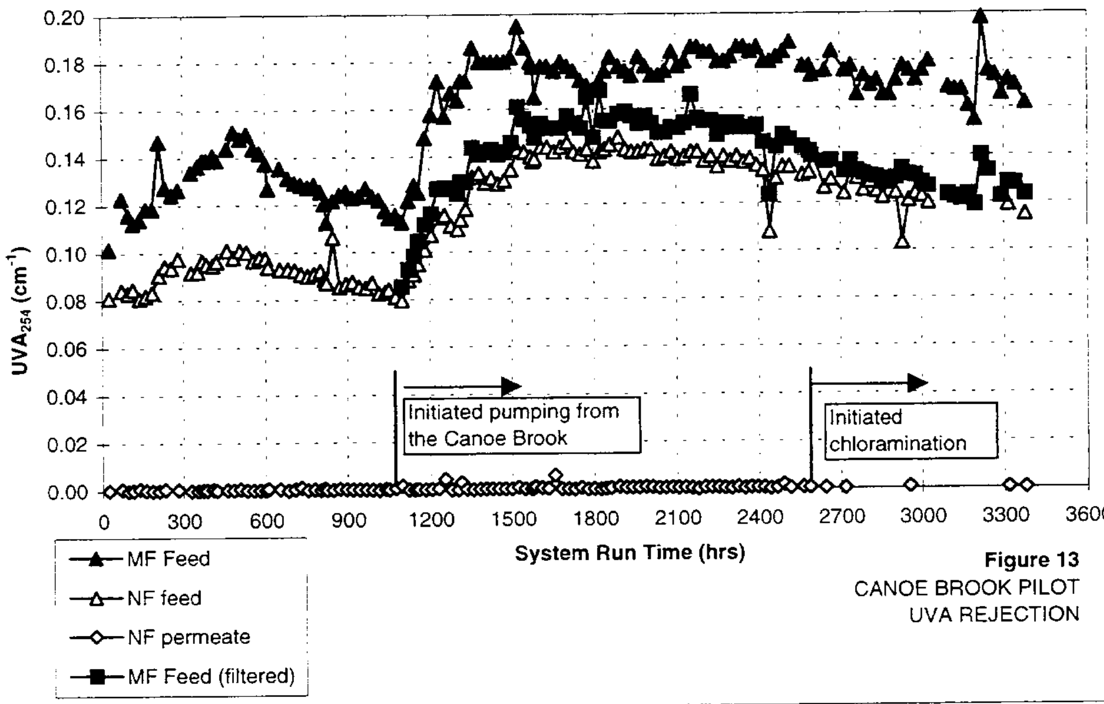


Figure 13
CANOE BROOK PILOT
UVA REJECTION

Notes:
1. NF feed results after 2,587 hours include an interference due to chloramine addition.
2. System permeate results shown after 2,587 hours were sampled without chloramine addition.

TABLE 13
Comparison of Bench- and Pilot-Scale Results

Parameter	Bench-Scale Results	Pilot-Scale Results[a]	% Difference from Pilot-scale Results
Product Recovery (%)	65.1	90.3	28
UVA_{254} Rejection (%)	97.3	99.6	2
TOC Rejection (%)	90.9	97.7	7
Alkalinity Rejection (%)	26.9	47.7	44
Ca Hardness Rejection (%)	45.8	55.0	17

[a]Pilot-scale results are average results.

As discussed in Table 9, UVA_{254} results for the system permeate increased substantially when chloramines were added to nanofiltration feedwater; the increased results were considered an artifact of the presence of chloramines in the nanofiltration permeate. Study results from the University of Colorado showing that chloramines absorb light in the 254-nm range are included in Appendix E. Because the nanofiltration permeate results (< 0.001 cm^{-1}) were so low, the interference due to chloramines had a much greater effect on the nanofiltration permeate results than on the nanofiltration feed results. Therefore, daily UVA_{254} results were discontinued and weekly TOC samples were taken. However, during the required biweekly sampling, the chloramine system was shut down the previous day and therefore allowed the UVA_{254} to be taken. This data are presented in Figure 13.

The test conditions for the SDS analyses were a target contact time of 6 hours and a chlorine dosage of between 2.5 and 2.8 mg/L for the nanofiltration feed and a chlorine dosage of 1.0 mg/L for system permeate. At the end of the testing period, residual chlorine was recorded to determine the chlorine demand for each sample, and the samples were analyzed for THM, HAA, and TOX. Four THM species and six HAA species were analyzed, and the results recorded are total amounts (hence THM4 and HAA6). Figures 14 and 15 present the biweekly sampling results for chlorine demand and simulated distribution sample (SDS) DBP results.

As expected, chlorine demand and DBP results for the nanofiltration feed increased when raw water TOC and UVA_{254} increased, as the microfiltration unit is not capable of removing dissolved organic materials. Chlorine demand in the nanofiltration permeate also increased, indicating increased passage of oxidizable matter not likely to be organic in nature (i.e., ammonia, sulfite, etc.) that can pass more readily than organics through a nanofiltration membrane. The results may also provide indirect evidence of manganese fouling during the rapid fouling event in December 1997(1277 hours of operation).The nanofiltration feed results for THM4 were below the Stage 1 MCL of 80 µg/L during the entire testing period, and the HAA6 results were below the Stage 1 MCL of 60 µg/L until the rapid fouling event that caused the change in water quality. The nanofiltration removed individual THM4 and HAA6 compounds to less than the detection limit of 1.0 µg/L (except for chloroacetic acid, with a detection limit of 2.0 µg/L), and removed TOX to less than detection limit of 25 µg/L during the entire testing period.

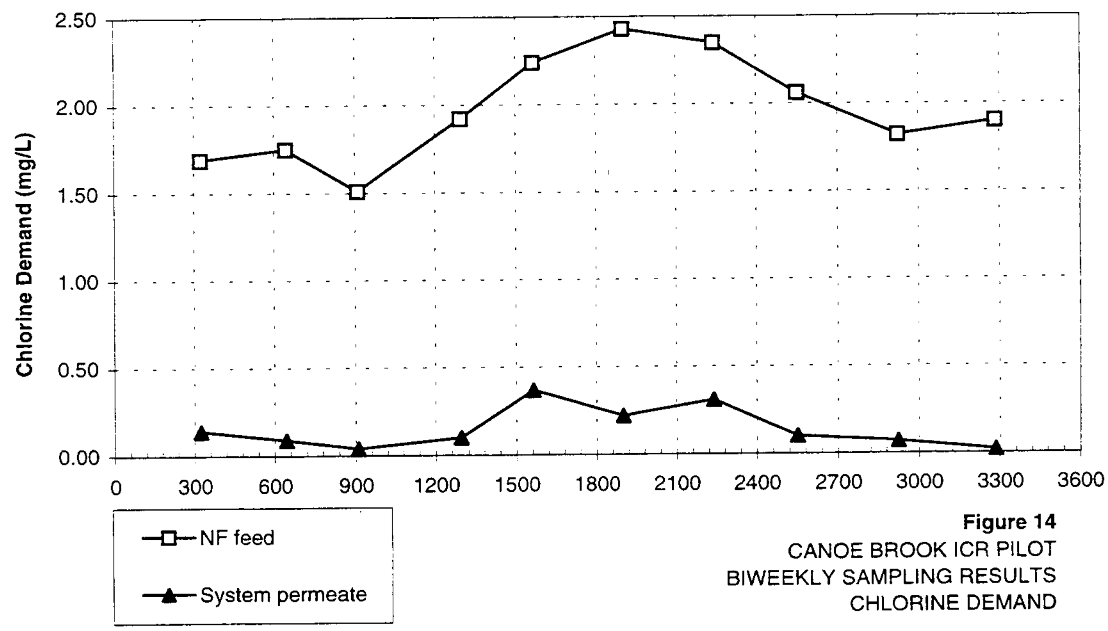


Figure 14
CANOE BROOK ICR PILOT
BIWEEKLY SAMPLING RESULTS
CHLORINE DEMAND

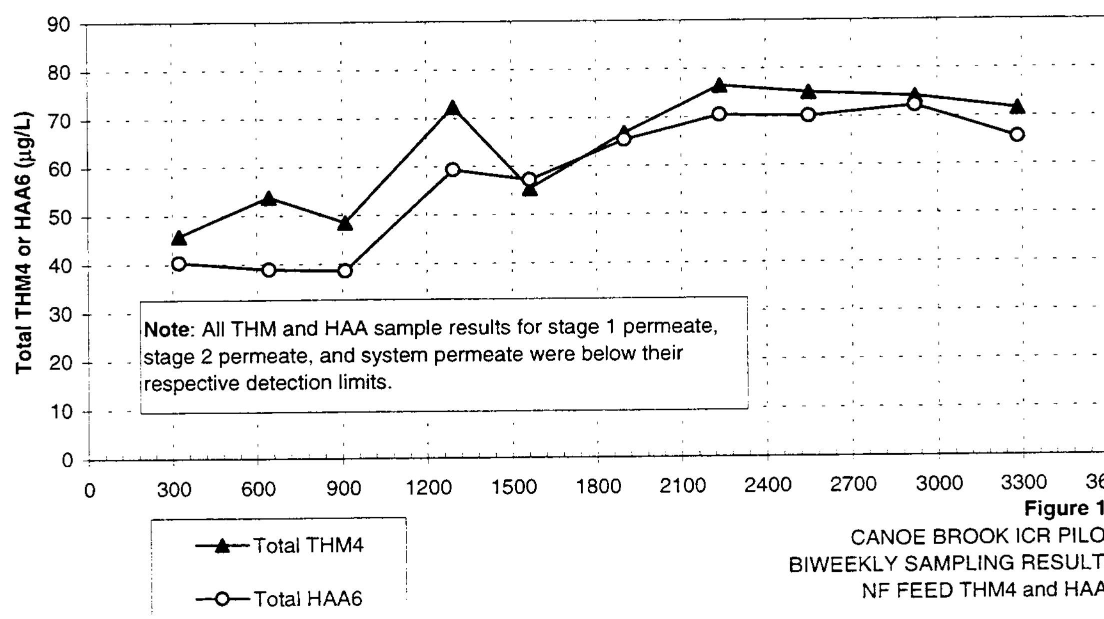


Figure 15
CANOE BROOK ICR PILOT
BIWEEKLY SAMPLING RESULTS
NF FEED THM4 and HAA6

Bromide

The nanofiltration membrane provided no removal of bromide. However, the presence of bromide in the nanofiltration permeate was not a concern in this study because of the absence of organic precursors with which it could react to form bromanated DBPs. This may be of a concern in future studies with membranes that do pass some organic DBP precursors because the ratio of bromide to precursors would be substantially increased, in turn increasing the percentage of bromanated DBPs formed.

Solute Passage

UVA_{254} passage[4] was routinely monitored across the nanofiltration system as a surrogate method to assess changes in the passage of DBP precursors through the nanofiltration membrane with time. TDS passage (as estimated through the measurement of conductivity) is a standard means for tracking changes in salt passage through the membrane with time. Figure 16 presents the percent passage of calcium hardness and alkalinity, and Figure 17 presents the percent passage of TDS for the nanofiltration system. Except for a few outliers, passage of UVA_{254} was extremely low, typically less than 1 percent, and less than observed during bench testing (Table 4). TDS passage was generally between 60 and 80 percent. Although not measured during bench-scale testing, the range of TDS passage was within the range observed for calcium hardness and alkalinity during bench testing.

UVA_{254} passage was constant throughout the test, but TDS passage varied somewhat with operating time and with chemical cleaning. TDS passage increased gradually from 60 to 70 percent between 900 and 1300 hours of operation. The cause of this increase is not known.

Directly following the high pH clean at 1,858 hours, TDS passage increased to 80 percent. The cause of the step increase in TDS passage following cleaning is not known. The increased passage is not attributable to an o-ring leak, as such a leak would also have caused an increase in UVA_{254} passage. The same type of clean was performed at 2,567 hours with an opposite effect: TDS passage decreased (although not directly after the cleaning). Overall, increases in TDS passage are not considered problematic, as TDS removal is not a goal of treatment. In fact, increases in TDS passage increase the levels of alkalinity and calcium in the permeate, a desirable condition.

Iron and Manganese

Figure 9 presents the iron and manganese sampling results during the testing period. The microfiltration unit provided an average of 80 percent removal of iron and 50 percent removal of manganese during the study. The nanofiltration unit further removed iron to approximately less than 0.03 mg/L and manganese to approximately 0.02 mg/L. Raw water levels remained consistent, however iron and manganese were not monitored during the first half of the testing period.

[4]Passage of UVA_{254} (or TDS) is defined as the UVA_{254} (or TDS) level in the permeate divided by the UVA_{254} (or TDS) level in the feed recorded as a percentage. Passage = 1 – Rejection.

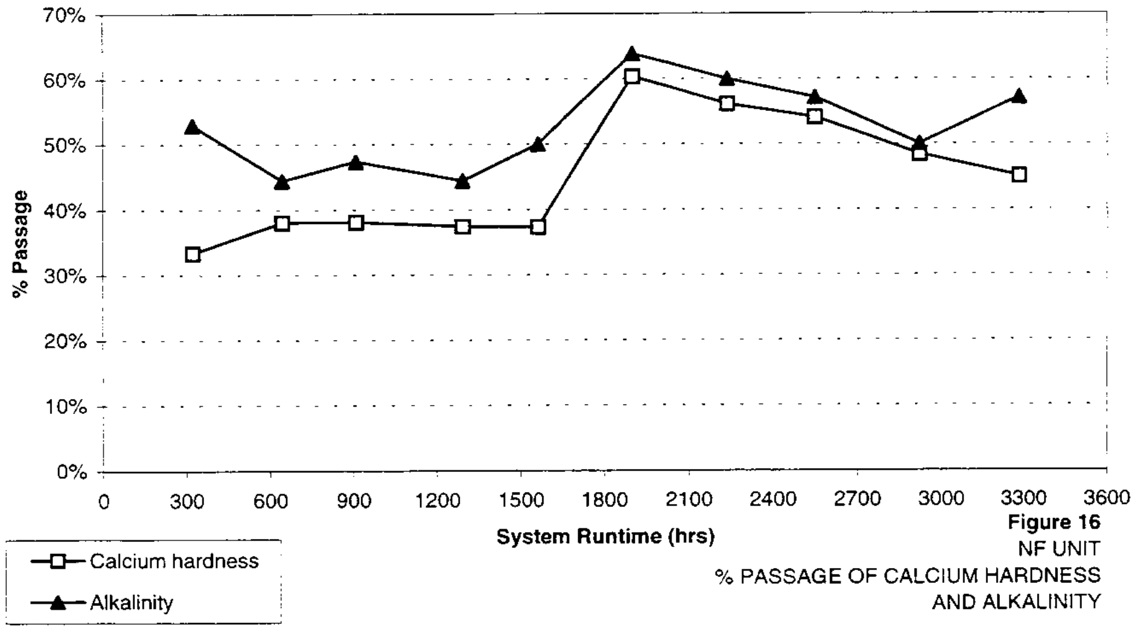


Figure 16
NF UNIT
% PASSAGE OF CALCIUM HARDNESS
AND ALKALINITY

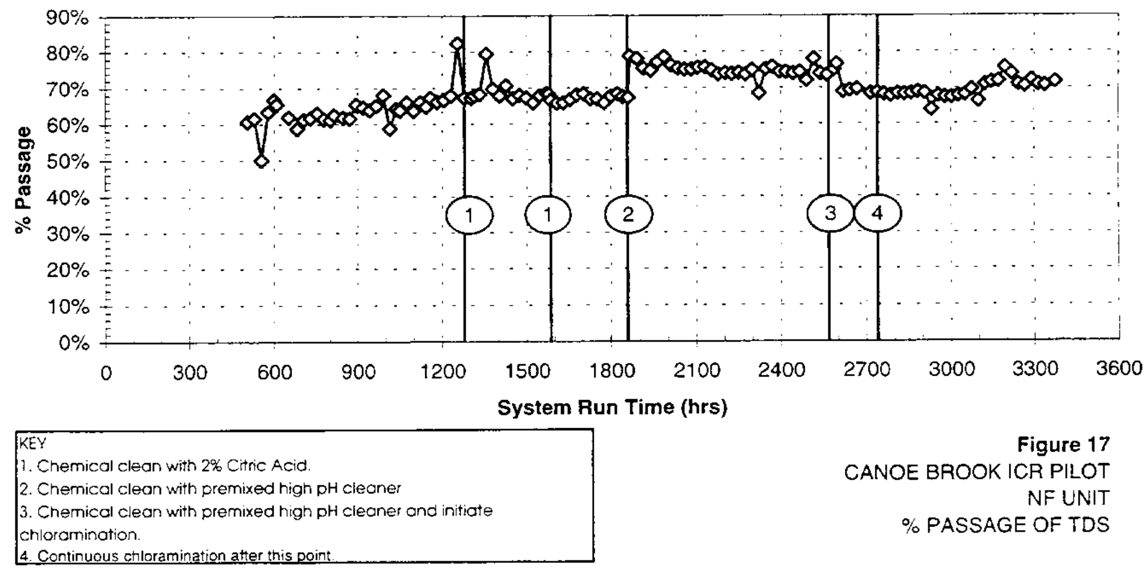


Figure 17
CANOE BROOK ICR PILOT
NF UNIT
% PASSAGE OF TDS

Impact of Seasonal Variability

The NJAWC and EPA agreed upon a 6-month testing period. Therefore, seasonal variability could not fully be determined. However, the effect of pumping from the Canoe Brook during periods of low reservoir levels or high flows in the Canoe Brook was observed and considered to be seasonal. It is not known if this effect is repeatable and consistent, or if it reflects primarily differences in water quality between the Canoe Brook and that of the reservoirs, stratification within the reservoirs, or a combination of the two. It is suggested that NJAWC continue to regularly monitor UVA_{254} and manganese to determine their variability.

Cost Information and Analysis

Many alternative blending scenarios at the Canoe Brook Station are possible, due to the flexibility of two parallel treatment plants and wells. Additionally, due to multiple site constraints and the various blending scenarios between surface and groundwater suppliers, it is very difficult to develop a budget level cost estimate, within the scope of this project, that could truly reflect the requirements for designing a membrane system. Therefore, cost curves were used to provide a standard basis and to assess the order of magnitude of the various membrane facilities.

Microfiltration

A budgetary equipment cost for a microfiltration unit was developed by the supplier of the pretreatment unit for the study (Memtec) based on the operating flux of 53 gfd. The estimated equipment cost is $4.8 million, based on an average daily flow of 8.2 mgd, with a peak daily flow of 10 mgd. It is estimated that capital cost of a microfiltration system designed for use as a pretreatment system for nanofiltration would be $10,000,000 and annual O&M cost would be $600,000.[5] The capital cost include mobilization, bonds, insurance, engineering and contractor overhead and profit.

Nanofiltration

The high rejection (low percent passage) capabilities of the nanofiltration membranes used in the Canoe Brook ICR pilot study produces a water quality that exceeds the regulatory treatment objectives for DBPs. For a full-scale process, feed water could be blended with permeate water, reducing the membrane area or energy requirements for the plant, thus lowering the cost of the membrane facility. The EPA spreadsheet contains calculations determining the permeate to total flow ratio (i.e., the blend ratio) to achieve the Stage 1 and proposed Stage 2 DBP MCLs with a 10 percent factor of safety. Table 14 presents the results.

During the first 6 weeks of testing, the SDS results for the nanofiltration feed were below the Stage 1 limits for both THMs and HAAs. Therefore, no blending with membrane treated

[5]Cost Estimates based on “Characteristics and Costs of MF and UF Plants,” Samer Adham, Joseph Jacangelo, and Jean-Michel Laine, *Journal American Water Works Association,* May 1996.

water would be required under those conditions. During the remainder of testing, the HAA5 blend ratios were higher for both the Stage 1 and Stage 2 limits, with only two

TABLE 14
Summary of Blend Ratios to Achieve Stage 1 and Stage 2 DBP Regulations

	Stage 1			Stage 2		
Control	Average	Range	SD	Average	Range	SD
THM4 (μg/L)	3.3	< 0–5.9	2.3	41.8	25.8–52.9	11.9
HAA6 (μg/L)	13.2	< 0–21.7	8.6	47.4	24.4–60.9	15.2

Note:
Values are the percentage of finished water requiring membrane treatment in order to meet DBP limits.
Averages do not include results where the influent was below the Stage 1 DBP limits.

exceptions (THM4 blend ratios were higher for Stage 2 limits during Week 4 and Week 6). The higher blend ratio requires a larger plant capacity, and thus is the controlling treatment objective.

It is estimated that the capital cost of a 10 mgd nanofiltration system would be roughly $20,000,000 and annual O&M costs would be $1,500,000.[6] The capital cost include mobilization, bonds, insurance, engineering and contractor overhead and profit.

Summary of Significant Results

Microfiltration followed by nanofiltration as a dual membrane system has distinct advantages for the control of both acute and chronic health concerns in drinking water. Microfiltration provides a physical barrier to particles in the micron-size range (including parasitic protozoa and other causes of waterborne disease with the exception of viruses), and nanofiltration provides a barrier to remove natural organic matter, a precursor of THMs, HAAs, and other DBPs that have been identified as a potential chronic health risk, removal of viruses, as well as a second barrier to protozoan passage. However, the higher cost for a dual membrane treatment system is a major constraint in its use relative to conventional treatment processes for drinking water supplies, particularly surface water.

Nanofiltration treatment is very effective at removing TOC and DBP precursors present in microfiltration filtrate, to the extent that after exposure of the nanofiltration permeate to free chorine under SDS conditions, no DBPs (THM4, HAA6, or TOX) were detected in the nanofiltration permeate over the course of the 6-month study. TOC removal was greater than 97 percent and permeate turbidity levels were generally below 0.05 NTU, although most of the turbidity removal is achieved by the microfiltration.

Despite the use of microfiltration for raw water treatment, some fouling of the nanofiltration membranes was evident during most of the study. The most probable

[6]Cost were developed based on “Cost of Membrane Softening in Florida” by Robert Bergman, *Journal American Water Works Association,* May 1996.

mechanisms of fouling were post-microfiltration oxidation of manganese or iron, which caused rapid but reversible fouling, and bacterial growth, which occurred more gradually but was less reversible with chemical cleanings. The bacterial growth was effectively controlled by the continuous use of chloramines.

SECTION 5

QA / QC Summary

Calibration: Calibration for the DBPs (HAA, THM) was performed by generating a calibration curve based upon a minimum of five standards. Analyte concentration is determined by quantitation relative to an internal standard. Standards are made up from materials distributed by the U.S. EPA.

Calibration for bromide and TOX was performed by generating a calibration curve based upon at least three standards. Analyte concentration is determined by direct quantitation relative to the calibration curve.

Calibration Verification: Calibration verification standards were analyzed at a frequency set by the ICR (generally 1 in 10). Calibration verification concentrations cover the entire calibration range and also set by the ICR. Acceptable analyte recoveries were set by the ICR, and sample results were not considered valid unless the limits were met.

Method Blanks: Before analysis of any samples or standards, a method blank was analyzed to ensure the instrument was free of contamination. Acceptable analyte concentrations in the method blank were set by the ICR, and sample results were not considered valid unless the limits were met.

Duplicates: TOX and TOC samples were all analyzed in duplicate. For the other analyses, duplicates were analyzed at a frequency set by the ICR (generally 1 in 20).

Matrix Spikes: No acceptance criteria for matrix spike recoveries were set by the ICR. However, matrix spike samples were analyzed at a frequency set by the ICR (generally 1 in 20). Acceptable matrix spiking concentrations were set by the ICR.

Laboratory Control Samples: The Applied Sciences Laboratory and the ICR required QC analyses of a laboratory control sample. A laboratory control sample is a standard from a secondary source used to verify quantitation. There were no acceptance limits set by the ICR for the control sample, but acceptance criteria are set by the manufacturer of the standard.

CH2M HILL Applied Sciences Laboratory
2300 NW Walnut Boulevard
Corvallis, OR 97330
Contact: Kathy McKinley
Phone 541-752-4271
Fax 541-752-0276

References

American Water Works Association Research Foundation. *Water Treatment Membrane Processes.* 1996.

U.S. EPA. *ICR Manual for Bench- and Pilot –Scale Treatment Studies.* April 1996.

U.S. EPA. *ICR Treatment Studies Data Collection Spreadsheets User's Guide.* April 1997.

Appendix A

Copy of ICR Study Agreement between NJAWC and EPA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

Office of Ground Water and Drinking Water
Technical Support Center

February 13, 1997

Mr. Kevin Dixon
New Jersey-American Water Company
500 Grove Street
Haddon Heights, NJ 08035

Re: Approval of ICR Treatment Study Plan for PWSID# NJ0712001, Plant ICR# 466

Dear Mr. Dixon:

Your receipt of this letter acknowledges EPA's approval of your Study Concept Form and Study Plan dated February 11, 1997. Although your proposed pilot study has significant deviations from the requirements in the *ICR Manual for Bench- and Pilot-Scale Treatment Studies (EPA 814-B-96-003, April 1996)*, EPA is approving this study on the basis that it will provide more useful information than the bench-scale study that the Canoe Brook Station would be required to conduct under the ICR. The deadline to begin the study is April 14, 1998; however, you may begin the ICR treatment study for the Canoe Brook Station upon receipt of this letter. EPA requests that you submit three bi-monthly progress reports, as identified in Table 5-12 of the *ICR Manual for Bench- and Pilot-Scale Treatment Studies,* to assist in tracking the progress of the treatment studies.

The deadline to submit the Final Treatment Study Report to EPA is July 14, 1999. In a few months you will be receiving a copy of the *ICR Treatment Study Data Collection Spreadsheets* on diskette, along with documentation explaining the use of these spreadsheets. These spreadsheets are consistent with the data collection requirements as detailed in Parts 2 and 3 of the *ICR Manual for Bench- and Pilot-Scale Treatment Studies*. They are designed to assist utilities in reporting the results from the treatment studies in a standard format that will facilitate comparison of results from different studies.

If you have any questions regarding this letter, please call the Safe Drinking Water Hotline at 800 426-4791 or the ICR Treatment Studies Coordinator at 513 569-7131.

Sincerely yours,

James J Westrick

James J. Westrick
Chief

Appendix B

3.5^2 Diskette with EPA Spreadsheet

Appendix C

Tables from EPA Spreadsheet

QA/QC Data - Sheet 1

Analyte Identification	Units	Laboratory Identification	Start Service Date	End Service Date	Method	MRL		Count	Average	Std Dev	Percentiles 25th	50th	75th
pH	unit	ICROR001	Nov-97	May-98	SM4500H								
Temperature	C	ICROR001	Nov-97	May-98	SM2550B								
Alkalinity	mg/L as $CaCO_3$	ICROR001	Nov-97	May-98	EPA310.1	0.5							
Ammonia	mg NH_3-N/L												
Calcium Hardness	mg/L as $CaCO_3$	ICROR001	Nov-97	May-98	EPA200.7	0.1							
SDS-Cl_2 Residual	mg/L	ICROR001	Nov-97	May-98	SM5710D	0.05							
Total Hardness	mg/L as $CaCO_3$	ICROR001	Nov-97	May-98	SM2340B	0.2							
Turbidity	ntu	ICROR0001	Nov-97	May-98	SM2130B	0.01							
Bromide	µg/L	ICROR0001	Nov-97	May-98	EPA300	20	RPE of Analytical Duplicates:	11	96.55	180.26	20	20	69
							% Recovery for Lab Fortified Matrix:	11	104.37	11.24	103	108	111.5
							% Recovery for PE Samples:	10	103.7	6.04	101	102	107.25
UV_{254}	1/cm	ICROR001	Nov-97	May-98		0.001	RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
TOC	mg/L	ICROR001	Nov-97	May-98	SM5310D	0.1	RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:	11	99.36	7.83	95	100	106
							% Recovery for PE Samples:	11	99.55	6.25	98.5	100	101.5
SDS-TOX	µg Cl-/L	ICROR001	Nov-97	May-98	SM5320B	25	RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:	11	114.64	20.31	102.5	112	126
							% Recovery for PE Samples:						
SDS-$CHCl_3$	µg/L	ICROR001	Nov-97	May-98	EPA502.2	1	RPE of Analytical Duplicates:	11	32.04	30.81	1.3	38.9	63.8
							% Recovery for Lab Fortified Matrix:	11	100.82	19.27	99	110	111
							% Recovery for PE Samples:	11	99.09	7.27	94	98	106
SDS-BDCM	µg/L	ICROR001	Nov-97	May-98	EPA502.2	1	RPE of Analytical Duplicates:	11	4.81	3.3	1.5	6.6	7.4
							% Recovery for Lab Fortified Matrix:	11	109.64	26.09	97.5	105	115
							% Recovery for PE Samples:	11	94.82	20.98	99	100	102
SDS-DBCM	µg/L	ICROR001	Nov-97	May-98	EPA502.2	1	RPE of Analytical Duplicates:	11	2.51	1.86	1	1.4	4.8
							% Recovery for Lab Fortified Matrix:	11	102.27	6.07	98	100	108
							% Recovery for PE Samples:	11	99.09	13.02	97	102	106
SDS-$CHBr_3$	µg/L	ICROR001	Nov-97	May-98	EPA502.2	1	RPE of Analytical Duplicates:	11	3.11	3.03	1	1	6.1

QA/QC Data - Sheet 1

Analyte Identification	Units	Laboratory Identification	Start Service Date	End Service Date	Method	MRL		Count	Average	Std Dev	Percentiles 25th	50th	75th
							% Recovery for Lab Fortified Matrix:	11	112.27	22.31	105	106	116
							% Recovery for PE Samples:	11	101.45	12.21	97.5	100	110.5
THM4	µg/L	ICROR001	Nov-97	May-98	EPA502.2		**Avg** RPE of Indiv Anal Dupl:	11	10.6175	9.75	1.2	11.975	20.525
							Avg % Recov for Indiv Lab Fort Matrix:	11	106.25	18.435	99.875	105.25	112.5
							Avg % Recov for Indiv PE Samples:	11	98.6125	13.37	96.875	100	106.125
SDS-MCAA	µg/L	ICROR001	Nov-97	May-98	SM6251B	1	RPE of Analytical Duplicates:	11	2	0	2	2	2
							% Recovery for Lab Fortified Matrix:	11	101.91	11.84	96	101	104
							% Recovery for PE Samples:	11	96.36	23.09	91.5	100	107
SDS-DCAA	µg/L	ICROR001	Nov-97	May-98	SM6251B	1	RPE of Analytical Duplicates:	11	7.38	6.17	1.6	4.2	13.5
							% Recovery for Lab Fortified Matrix:	11	110	40.51	90.5	97	111
							% Recovery for PE Samples:	11	93.27	12.25	87.5	91	96.5
SDS-TCAA	µg/L	ICROR001	Nov-97	May-98	SM6251B	1	RPE of Analytical Duplicates:	11	10.12	9.87	1.1	7.5	20.65
							% Recovery for Lab Fortified Matrix:	11	104.91	37.41	91.5	99	102.5
							% Recovery for PE Samples:	11	92	13.42	84	90	97
SDS-MBAA	µg/L	ICROR001	Nov-97	May-98	SM6251B	1	RPE of Analytical Duplicates:	11	1	0	1	1	1
							% Recovery for Lab Fortified Matrix:	11	100.73	8.37	94.5	102	105
							% Recovery for PE Samples:	11	97.64	13.18	89	94	103
SDS-DBAA	µg/L	ICROR001	Nov-97	May-98	SM6251B	1	RPE of Analytical Duplicates:	11	1.28	0.63	1	1	1
							% Recovery for Lab Fortified Matrix:	11	97.55	8.84	93.5	95	99.5
							% Recovery for PE Samples:	11	96.18	8.65	92.5	96	103
SDS-BCAA	µg/L	ICROR001	Nov-97	May-98	SM6251B	1	RPE of Analytical Duplicates:	11	1.86	0.92	1	1.9	2.7
							% Recovery for Lab Fortified Matrix:	11	101.64	24	89	95	104.5
							% Recovery for PE Samples:	11	90.82	10.82	86.5	89	94.5
SDS-TBAA	µg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
SDS-CDBAA	µg/L	ICROR001	Nov-97	May-98	SM6251B	1	RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
SDS-DCBAA	µg/L	ICROR001	Nov-97	May-98	SM6251B	1	RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
HAA5	µg/L	ICROR001	Nov-97	May-98	SM6215B		**Avg** RPE of Indiv Anal Dupl:						
							Avg % Recov for Indiv Lab Fort Matrix:						
							Avg % Recov for Indiv PE Samples:						
HAA6	µg/L	ICROR001	Nov-97	May-98	SM6215B		**Avg** RPE of Indiv Anal Dupl:	11	3.94	2.931667	1.283333	2.933333	6.808333
							Avg % Recov for Indiv Lab Fort Matrix:	11	102.79	21.82833	92.5	98.16667	104.4167
HAA9	µg/L						**Avg** RPE of Indiv Anal Dupl:						
							Avg % Recov for Indiv Lab Fort Matrix:						

Miscellaneous Information

PWSID	NJ0712001
Plant ICR #	466

Full-Scale Plant Information

Item	Result
Primary Disinfectant	Free Cl2
Residual Disinfectant	Free Cl2
Source Type	River/Stream
Source Name	Canoe Brook

Laboratory Information

Item	ICR ID or Abbrev	Lab Name	Lab Type	Lab City	Lab State
Lab #1	ICROR001	CH2M HILL Analytical Services	Consultant	Corvallis	OR
Lab #2					
Lab #3					
Lab #4					

Batch Sampling Dates for Quarterly Bench-Scale Testing

Item	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Sample Collection Date				

1998 Flow and Population Information

Source	Flow (mgd)	Population Served
Total Population Served		246332
Surface Water	6	1
Ground Water	15	5
Purchased Finished Water	21	11
Total	43	

Full-Scale Water Quality Data

Full-Scale Influent Water Quality Data

Item	Units	Average	Std Dev	Min	Max	Count
Temperature	C	15	6.5	7	25	365
pH	Unit	7.6	0.4	7	8	365
Turbidity	ntu	11.3	10.1	2.9	37	365
Alkalinity	mg/L as $CaCO_3$	47	5.3	44	60	365
Total Hardness	mg/L as $CaCO_3$	82	13.6	63	108	365
Calcium Hardness	mg/L as $CaCO_3$					
TOC	mg/L	5	0.9	3.8	6	12
UV_{254}	1/cm	0.15	0.03	0.091	0.206	12
Bromide	µg/L	0.04	0.05	0.02	0.08	12
TSUVA*	L/(mg*m)	3	3	2.4	3.4	12

*TSUVA = [UV_{254} (1/m)] / [TOC (mg/L)]. Summary information for TSUVA should only be calculated from TSUVA values with paired TOC and UV_{254} measurements

Full-Scale Finished Water Quality Data

Item	Units	Average	Std Dev	Min	Max	Count
Temperature	C	15	6.5	7	25	365
pH	unit	7.5	0.5	6.7	7.8	365
Turbidity	ntu	0.1	0.02	0.08	0.12	365
TOC	mg/L	1.8	0.5	1.1	2.7	12
UV_{254}	1/cm	0.022	0.007	0.007	0.033	12
DS-THM4	µg/L	36		17	56	4
DS-HAA5	µg/L	40		15	64	4
DS-HAA6	µg/L					

Field 1-1: PWS And Treatment Plant Data

PWS Name	New Jersey American Water Company
Public Water System Identification Number	NJ0712001
Water Industry Data Base Number (*optional*)	
Official ICR Contact Person	Kevin Dixon
Mailing Address	500 Grove Street Haddon Heights, NJ 08035
Phone Number	(609) 764-4902
FAX Number	(609) 764-3547
E-Mail Address (*optional*)	76632,313 (Compuserve)
Technical ICR Contact Person	Kevin Dixon
Mailing Address	500 Grove Street Haddon Heights, NJ 08035
Phone Number	(609) 764-4902
FAX Number	(609) 764-3547
E-Mail Address (*optional*)	76632,313 (Compuserve)
Plant Name	Canoe Brook Station
Treatment Plant Category	Conventional
Process Train Name	Plant No. 1 - Conventional Filtration
ICR Treatment Plant Identification Number	466
PWSID Number of Plant (*if assigned*)	NJ0712001
Historical Minimum Water Temperature (°C)	4
Historical Average Water Temperature (°C)	26
State Approved Plant Capacity (MGD)	20

Field 1-2: Manufacturer Reported Membrane Characteristics[1]

General Information

Membrane manufacturer	Desal Systems
Membrane trade name	DS-5/DL grade
Membrane element model number	HL4040FF
Molecular weight cutoff (Daltons)	**150-300**
Membrane material (e.g., PVD, polyamide, etc.)	Polyamide
Membrane construction (e.g., thin-film composite)	Thin film composite spiral wound
Membrane hydrophobicity	Hydrophilic
Membrane charge (e.g., negative, highly negative, neutral, etc.)	Negative

Design Parameters

Element size (e.g., 2.5" x 40", 4" x 40", etc.)	4" x 40"
Active membrane area of membrane element used, A (ft^2)	90.0
Design flux, F_W (gfd)	12.0
Net driving pressure at the design flux, NDP (psi)	38.7
Water mass transfer coefficient, MTC_W (gfd/psi)	0.310
Temperature at which the MTC_W was determined, T°C (°C)	25.0
Maximum flow rate to the element, $Q_{I,max}$ (gpm)	18.0
Minimum flow rate to the element, $Q_{I,min}$ (gpm)	4.0
Total width of all membrane envelopes in the element, w (ft)	16.0
Feed spacer thickness, T (ft)	0.0023
Active membrane area of an equivalent 8" x 40" element (ft^2)	350.0
Purchase price for an equivalent 8" x 40 " element ($)	

Additional Information

Design cross-flow velocity (fps)	0.050
Required influent flow to permeate flow rate ratio, Q_I:Q_p	6.6
Maximum element recovery (%)	15
Variability of design flux (%)	15
Rejection of reference solute and conditions of test (e.g., solute type and concentration)	Minimum 96% 2000 mg/L MgSO4 at 100 psi NDP
Variability of rejection of reference solute (%)	
Standard testing recovery (%)	10
Standard testing pH	Neutral
Acceptable range of operating pressures	< 500 psi
Acceptable range of operating pH values	3 - 10
Maximum permissible SDI	5
Maximum permissible turbidity (ntu)	1
Chlorine/oxidant tolerance (e.g., < 0.1 mg/L for extended use, etc.)	< 0.1 mg/L

1: All of the information requested in this field may not be available, but values for all of the ***Design Parameters*** must be entered in cells E15:E26, since these parameters are used in calculations.

Field 1-3: 2-Stage Membrane Pilot System Design Parameters

Calculate Temperature Normalized MTC_W

Average yearly temperature of feed water, Tavg°C (°C)	16.0
Temperature normalized MTC_W (gfd/psi)	0.238

Calculate System Permeate, Feed and Waste Flow Rates

Design system recovery, R (decimal)	0.90
Design average system flux, F_W (gfd)	12.0
Number of elements per pressure vessel, N_e	6
Number of parallel pressure vessels in stage 1, $N_{v\text{-}s(1)}$	2
Number of parallel pressure vessels in stage 2, $N_{v\text{-}s(2)}$	1
Permeate flow rate per element, $Q_{p\text{-}e}$ (gpm)	0.75
Permeate flow rate per pressure vessel, $Q_{p\text{-}v}$ (gpm)	4.50
Permeate flow rate from stage 1, $Q_{p\text{-}s(1)}$ (gpm)	9.00
Permeate flow rate from stage 2, $Q_{p\text{-}s(2)}$ (gpm)	4.50
Permeate flow rate from system, $Q_{p\text{-}sys}$ (gpm)	13.50
Feed flow rate to system, $Q_{F\text{-}sys}$ (gpm)	14.98
Concentrate-waste flow rate from system, $Q_{W\text{-}sys}$ (gpm)	1.48

Calculate the Feed Flow Rates at the End of Each Stage

Feed flow rate at the end of stage 1, $(Q_{F\text{-}s(1)})_{end}$ (gpm)	7.48
Feed flow rate at the end of stage 2, $(Q_{F\text{-}s(2)})_{end}$ (gpm)	2.23

Calculate the Minimum Recycle Flow Rates for Each Stage[1]

Minimum recycle flow rate for stage 1, $(Q_{R\text{-}s(1)})_{min}$ (gpm)	0.52
Minimum recycle flow rate for stage 2, $(Q_{R\text{-}s(2)})_{min}$ (gpm)	1.77

1: A negative minimum recycle flow rate indicates that recycle is not required to meet the manufacturer's minimum flow requirement.

Calculate the Maximum Recycle Flow Rates for Each Stage

Maximum recycle flow rate for stage 1, $(Q_{R\text{-}s(1)})_{max}$ (gpm)	21.02
Maximum recycle flow rate for stage 2, $(Q_{R\text{-}s(2)})_{max}$ (gpm)	12.02

Select the Design System Recycle Flow Rate[2]

Minimum system recycle flow rate, $(Q_{R\text{-}sys})_{min}$ (gpm)	1.77
Maximum system recycle flow rate, $(Q_{R\text{-}sys})_{max}$ (gpm)	12.02
Design system recycle flow rate, $Q_{R\text{-}sys}$ (gpm)	2.90
Recycle ratio, r	0.19

2: The **design system recycle flow rate** must fall between the **minimum** and **maximum** system recycle flow rates.

Summary of the Stage and System Flow Rates

Influent flow rate to stage 1, $Q_{I\text{-}s(1)}$ (gpm)	17.10
Permeate flow rate from stage 1, $Q_{p\text{-}s(1)}$ (gpm)	9.00
Concentrate flow rate from stage 1, $Q_{C\text{-}s(1)}$ (gpm)	8.10
Influent flow rate to stage 2, $Q_{I\text{-}s(2)}$ (gpm)	8.10
Permeate flow rate from stage 2, $Q_{p\text{-}s(2)}$ (gpm)	4.50
Concentrate flow rate from stage 2, $Q_{C\text{-}s(2)}$ (gpm)	3.60
System concentrate recycle flow rate, $Q_{R\text{-}sys}$ (gpm)	2.90
System concentrate waste flow rate, $Q_{W\text{-}sys}$ (gpm)	0.70
System permeate flow rate, $Q_{p\text{-}sys}$ (gpm)	13.50
System feed flow rate, $Q_{F\text{-}sys}$ (gpm)	14.20

Calculate the Required System Influent Pressure

Osmotic pressure for stage 1[3], $\Delta\pi_1$ (psi)	5.0
Osmotic pressure for stage 2[3], $\Delta\pi_2$ (psi)	5.7
Pressure losses due to stage hardware, ΔP_s (psi)	
Pressure losses in a single element, ΔP_e (psi)	
Design permeate pressure, P_p (psi)	
Mechanical pressure losses per stage, L_s (psi)	0.0
Net driving pressure required for permeation, NDP (psi)	50.5
Flow weighted system pressure losses, L_{sys} (psi)	5.2
Required influent pressure to the system, P_I (psi)	55.7

3: The osmotic pressure can be estimated from Table 6-5 in Part 3 of the "ICR Manual for Bench- and Pilot-Scale Treatment Studies."

Field 1-4: Foulants And Fouling Indices[1]

Parameters Evaluated Prior to Pretreatment

Alkalinity (mg/L as $CaCO_3$)	40
Calcium Hardness (mg/L as $CaCO_3$)	45
LSI	
Dissolved iron (mg/L)	
Total iron (mg/L)	0.2
Dissolved aluminum (mg/L)	
Total aluminum (mg/L)	
Fluoride (mg/L)	0.4
Phosphate (mg/L)	
Sulfate (mg/L)	24
Calcium (mg/L)	20
Barium (mg/L)	0.1
Strontium (mg/L)	0.2
Reactive silica (mg/L as SiO_2)	7
Turbidity (ntu)	4
SDI	
MFI	
MPFI	

1: Only those foulants and fouling indices relevant to the water being tested need to be evaluated. Additional foulants and indices can be listed in the blank rows.

Field 1-5: Pretreatment Used Prior To Membranes[1]

Process	Description	Scale
Microfiltration	0.2 μm hollow fiber membrane	Pilot-scale
Antiscalant addition	3 mg/L PreTreat Plus (King Lee)	Pilot-scale

1: Design information, similar to that shown in Tables 6c and 6d of the ICR rule, must be included in the hard-copy *Treatment Study Summary Report* (see Section 10.0). The purpose of this table is to list the pretreatment processes used in this particular pilot-scale run.

Field 1-6: Membrane Performance Data During Operation With The Test Water

System Operating Parameters

Field 1-6: Membrane Performance Data During Operation With The Test Water (continued)

Date	Time	Operation		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		
		time	Influent	PI	PC	PP	QR	Qp	QW	Cleaning Event	QF	QI	Recovery	Recycle	FW (ToC)	FW (TavgoC)	Dp	NDP	MTCW (TavgoC)	pH		TDS (mg/L)								
MM/DD/YY	hh:mm	hh.hh	Temp. (oC)	(psi)	(psi)	(psi)	(gpm)	(gpm)	(gpm)	Indicate with "X"	(gpm)	(gpm)	(decimal)	ratio	(gfd)	(gfd)	(psi)	(psi)	(gfd/psi)	pHF (before acid)	pHF (after acid)	TDSp	TDSF (before acid)	TDSF (after acid)	TDSC	TDSC(calc	ErrorMB (%)	RF (%)	TDSB	RB (%
			#4	#4	#14	#15	FIT-16	FIT-15	FIT-14											#3	#3	#15	#3	#3	#14					
																						0.41	0.52	0.52	0.65					
11/3/97		24.00	12.65				2.85	12.94	1.43		14.37	17.22	0.90	0.20	11.51	12.70														
11/4/97		48.00	12.75				2.85	12.97	1.43		14.40	17.25	0.90	0.20	11.53	12.69														
11/5/97		72.00	12.19				2.86	12.82	1.43		14.25	17.12	0.90	0.20	11.40	12.76														
11/6/97		96.00	12.11				2.87	12.76	1.43		14.19	17.05	0.90	0.20	11.34	12.72														
11/7/97		106.50	12.11				2.88	12.70	1.42		14.12	17.00	0.90	0.20	11.29	12.67														
11/8/97		114.50	11.45				2.63	12.49	1.63		14.12	16.75	0.88	0.19	11.10	12.70														
11/9/97		138.50	11.40				2.94	12.81	1.25		14.06	17.01	0.91	0.21	11.39	13.04														
11/10/97		162.50	11.25				3.03	13.04	1.05		14.09	17.12	0.93	0.21	11.59	13.34														
11/11/97		186.50	11.10				2.98	13.04	1.03		14.07	17.05	0.93	0.21	11.59	13.40														
11/12/97		210.50	10.35				2.93	12.84	1.51		14.35	17.28	0.89	0.20	11.41	13.49														
11/13/97		233.00	9.48				2.95	12.85	1.26		14.11	17.06	0.91	0.21	11.42	13.85														
11/14/97		257.00	8.52	111.17	69.79		2.90	12.93	1.33		14.25	17.15	0.91	0.20	11.49	14.33														
11/15/97		281.00	7.80	111.23	69.00		2.88	12.67	1.61		14.29	17.17	0.89	0.20	11.27	14.35														
11/16/97		305.00	7.69	111.73	69.36		2.91	12.64	1.61		14.25	17.16	0.89	0.20	11.24	14.36														
11/17/97		329.00	7.08	112.00	70.27		2.83	12.51	1.51		14.02	16.85	0.89	0.20	11.12	14.47														
11/18/97		353.00	6.78	115.53	73.07		2.70	12.64	1.29		13.93	16.62	0.91	0.19	11.23	14.76														
11/19/97		370.75	6.62	117.15	73.35		2.77	12.69	1.57		14.26	17.04	0.89	0.19	11.28	14.89														
11/20/97		384.00	7.22	114.15	72.30		2.98	12.69	1.18		13.87	16.85	0.91	0.21	11.28	14.62														
11/21/97		408.00	7.05	114.48	72.30		3.01	12.63	1.28		13.91	16.92	0.91	0.22	11.23	14.63														
11/22/97		421.50	7.62	108.00	69.00		2.96	12.74	1.44		14.19	17.15	0.90	0.21	11.33	14.51														
11/23/97		435.50	8.02				2.90	12.36	1.03		13.39	16.29	0.92	0.22	10.99	13.91														
11/24/97		459.50	7.27	102.00	66.00	11.00	2.97	12.46	1.19		13.65	16.62	0.91	0.22	11.07	14.33														
11/25/97		483.50	5.71	114.00	72.00	11.00	3.09	12.82	1.54		14.36	17.45	0.89	0.21	11.40	15.45														
11/26/97		507.50	5.71	110.00	70.00	11.00	3.13	12.96	1.55		14.51	17.64	0.89	0.22	11.52	15.61	4.90	74.10	0.21			77.54	160.32	160.32	605.15	851.72	-40.75	51.63	567.36	86.33
11/27/97		531.50	6.59	116.00	74.00	13.00	3.08	12.94	1.53		14.47	17.55	0.89	0.21	11.50	15.19	4.86	77.14	0.20			78.37	159.79	159.79	625.95	847.97	-35.47	50.96	564.19	86.11
11/28/97		555.50	6.34	112.00	72.00	11.50	2.97	12.75	1.52		14.27	17.24	0.89	0.21	11.33	15.08	5.55	74.95	0.20			62.20	156.15	156.15	637.00	943.37	-48.10	60.17	617.54	89.93
11/29/97		579.50	6.34	110.00	70.00	11.50	2.97	12.93	1.55		14.48	17.45	0.89	0.21	11.49	15.29	4.55	73.95	0.21			78.78	156.15	156.15	643.50	801.50	-24.55	49.55	533.72	85.24
11/30/97		600.00	6.34	113.00	72.00	12.50	2.99	13.10	1.54		14.64	17.63	0.89	0.20	11.65	15.49	4.38	75.62	0.20			82.93	156.15	156.15	702.00	780.06	-11.12	46.89	520.97	84.08
12/1/97		609.50	7.92	112.00	76.00	11.00	2.31	12.53	1.19		13.72	16.03	0.91	0.17	11.14	14.14	5.41	77.59	0.18			84.17	161.36	161.36	735.80	972.06	-32.11	47.84	625.12	86.54
12/2/97		633.50	5.79				1.94	12.14	1.15		13.29	15.23	0.91	0.15	10.79	14.59														
12/3/97		652.50	5.54	124.00	86.00	13.50	2.77	13.07	1.23		14.30	17.07	0.91	0.19	11.62	15.83	5.93	85.57	0.18			80.44	162.92	162.92	689.65	1040.72	-50.91	50.63	673.00	88.05
12/5/97		658.00	6.32				2.69	12.81	1.17		13.98	16.67	0.92	0.19	11.39	15.16														
12/6/97		682.00	5.65	103.00	71.00	11.00	2.85	12.81	1.22		14.02	16.87	0.91	0.20	11.38	15.46	6.73	69.27	0.22			82.93	176.97	176.97	630.50	1166.83	-85.06	53.14	755.44	89.02
12/7/97		706.00	4.98	116.00	78.00	11.00	2.95	12.74	1.47		14.21	17.15	0.90	0.21	11.32	15.68	5.19	80.81	0.19			81.27	166.56	166.56	706.55	906.76	-28.34	51.21	600.27	86.46
12/8/97		730.00	5.05	122.00	79.00	12.00	2.89	12.48	1.50		13.98	16.87	0.89	0.21	11.10	15.34	4.93	83.57	0.18	7.66	7.66	80.85	164.48	164.48	638.30	862.66	-35.15	50.84	573.36	85.90
12/9/97		754.00	4.80	118.00	74.00	11.00	2.97	12.70	1.43		14.13	17.10	0.90	0.21	11.29	15.72	5.15	79.85	0.20	7.85	7.85	83.34	166.04	166.04	701.35	903.04	-28.76	49.81	598.51	86.08
12/10/97		778.00	5.60	116.00	74.00	11.00	2.91	12.58	1.41		13.99	16.90	0.90	0.21	11.18	15.21	5.28	78.72	0.19	7.67	7.67	81.27	166.04	166.04	674.70	923.00	-36.80	51.06	609.68	86.67
12/11/97		802.00	5.50	120.00	76.00	11.00	2.98	12.88	1.46		14.34	17.32	0.90	0.21	11.44	15.61	5.25	81.75	0.19	7.43	7.43	80.85	166.04	166.04	646.10	917.12	-41.95	51.31	606.28	86.66
12/12/97		815.50	5.60	120.00	78.00	12.25	3.00	12.73	1.58		14.31	17.31	0.89	0.21	11.31	15.38	4.79	81.96	0.19			82.93	166.56	166.56	712.40	840.26	-17.95	50.21	561.82	85.24
12/13/97		821.25	6.60	113.00	74.00	11.50	2.87	12.46	1.19		13.65	16.52	0.91	0.21	11.08	14.62														
12/14/97		845.25	5.30	112.00	74.00	11.00	2.86	12.50	1.10		13.60	16.46	0.92	0.21	11.11	15.24	6.87	75.13	0.20	7.40	7.40	87.07	176.97	176.97	669.50	1194.74	-78.45	50.80	774.30	88.75
12/15/97		868.92	4.40	129.00	88.00	13.00	2.80	12.51	1.35		13.85	16.65	0.90	0.20	11.12	15.66	5.54	89.96	0.17	7.62	7.62	82.93	169.16	169.16	698.10	970.27	-38.99	50.98	636.99	86.98
12/16/97		892.92	4.80	116.00	69.00	11.00	2.87	12.70	1.49		14.19	17.06	0.89	0.20	11.28	15.71	4.81	76.69	0.20	7.70	7.70	87.90	168.64	168.64	763.75	854.84	-11.93	47.88	569.40	84.56
12/17/97		916.92	5.40	115.00	76.00	11.00	2.86	12.73	1.49		14.22	17.08	0.90	0.20	11.32	15.48	4.79	79.71	0.19	7.52	7.52	85.00	165.00	165.00	728.00	848.53	-16.56	48.48	563.94	84.93
12/18/97		940.92	4.80	115.00	77.00	11.00	2.89	12.75	1.28		14.03	16.92	0.91	0.21	11.33	15.78	5.55	79.45	0.20	7.53	7.53	84.17	165.52	165.52	728.65	974.16	-33.69	49.15	638.88	86.83
12/19/97		964.92	5.30	116.00	78.00	11.25	2.91	12.85	1.07		13.92	16.83	0.92	0.21	11.42	15.67	6.41	79.34	0.20	7.63	7.63	85.83	165.52	165.52	777.40	1122.85	-44.44	48.15	726.97	88.19
12/20/97		988.92	5.40	118.00	76.00	11.50	2.89	12.88	1.11		13.98	16.88	0.92	0.21	11.45	15.66	5.66	79.84	0.20	7.48	7.48	85.41	157.71	157.71	778.05	1000.27	-28.56	45.84	651.18	86.88
12/21/97		1012.92	4.80	117.00	76.00	10.50	2.94	12.76	1.28		14.03	16.98	0.91	0.21	11.34	15.79	6.46	79.54	0.20	7.49	7.49	82.93	176.97	176.97	747.50	1117.43	-49.49	53.14	728.71	88.62
12/22/97		1035.33	4.90	117.00	78.00	11.50	2.65	12.88	1.46		14.34	17.00	0.90	0.19	11.45	15.89	4.97	81.03	0.20	7.49	7.49	85.41	167.08	167.08	746.85	886.23	-18.66	48.88	582.79	85.34
12/23/97		1048.50	5.20	118.00	77.00	11.00	2.58	12.79	1.40		14.18	16.76	0.90	0.18	11.36	15.64	5.02	81.48	0.19	7.41	7.41	82.51	162.40	162.40	740.35	893.41	-20.67	49.19	584.08	85.87
12/24/97		1072.50	5.10	119.00	78.00	11.25	2.34	12.76	1.25		14.01	16.34	0.91	0.17	11.34	15.65	5.33	81.92	0.19	7.49	7.49	86.24	163.96	163.96	768.95	959.95	-24.84	47.40	618.88	86.06
12/25/97		1096.50	4.60	119.00	74.00	11.20	2.47	12.87	1.40		14.27	16.74	0.90	0.17	11.44	16.03	5.32	79.98	0.20	7.42	7.42	87.07	171.77	171.77	689.00	951.51	-38.10	49.31	619.10	85.94
12/26/97		1120.50	6.60	117.00	75.00	11.00	2.80	12.88	1.31		14.19	16.99	0.91	0.20	11.45	15.12	5.44	79.56	0.19	7.51	7.51	89.56	170.21	170.21	756.60	965.60	-27.62	47.38	633.44	85.86
12/27/97		1140.83	5.90	120.00	77.00	11.00	2.81	12.64	1.18		13.82	16.63	0.91	0.20	11.24	15.15	6.15	81.35	0.19	7.62	7.62	89.98	174.37	174.37	768.30	1082.09	-40.84	48.40	704.95	87.24
12/28/97		1145.33																												
12/29/97		1156.17	6.60	118.00	74.00	11.50	2.80	12.63	1.45		14.08	16.88	0.90	0.20	11.22	14.82	5.15	79.35	0.19	7.29	7.29	97.85	182.70	182.70	791.05	920.53	-16.37	46.44	612.84	84.03
12/30/97		1180.17	5.10	128.00	81.00	11.00	2.89	12.29	1.46		13.75	16.64	0.89	0.21	10.92	15.08	5.28	88.22	0.17	7.56	7.56	98.68	187.38	187.38	802.75	935.34	-16.52	47.34	626.40	84.25
12/31/97		1204.17	4.60	129.00	86.00	11.00	3.11	12.12	1.28		13.40	16.51	0.90	0.23	10.77	15.08	6.05	90.45	0.17	7.58	7.58	103.24	194.67	194.67	767.65	1058.42	-37.88	46.96	707.92	85.42
1/1/98		1228.17	3.50	151.00	110.00	11.50	3.12	12.22	1.35		13.56	16.68	0.90	0.23	10.86	15.71	5.98	113.02	0.14	7.64	7.64	110.29	204.04	204.04	810.55	1054.43	-30.09	45.94	708.68	84.44
1/2/98		1252.17	3.50	156.00	116.00	11.00	2.92	12.52	1.38		13.90	16.82	0.90	0.21	11.13	16.10	3.85	121.15	0.13	7.45	7.45	116.10	176.97	176.97	692.25	728.68	-5.26	34.40	500.65	76.81
1/3/98		1276.17	4.40	190.00	141.00	11.00	2.99	12.29	1.37	X	13.66	16.65	0.90	0.22	10.92	15.39	5.91	148.59	0.10	7.96	7.96	108.22	201.96	201.96	845.00	1044.49	-23.61	46.41	698.98	84.52
1/7/98		1300.17	6.50	119.00	80.00	11.75	3.05	12.71	1.29		14.00	17.05	0.91	0.22	11.30	14.96	6.58	81.17	0.18	8.00	8.00	111.54	208.20	208.20	885.30	1160.81	-31.12	46.43	769.74	85.51
1/8/98		1311.42	6.40	120.00	78.00	12.00	3.09	12.91	1.42		14.33	17.42	0.90	0.22	11.48	15.24	5.99	81.01	0.19	7.80	7.80	111.12	205.60	205.60	867.75	1062.82	-22.48	45.95	710.14	84.35
1/9/98		1330.17	7.50	114.00	77.00	12.00	2.40	12.77	1.28		14.05	16.45	0.91	0.17	11.35	14.59	6.28	77.22	0.19	7.60	7.60	111.54	205.08	205.08	846.30	1138.31	-34.50	45.61	739.77	84.92
1/10/98		1354.17	6.90	115.00	76.00	11.50	2.85	12.90	1.41		14.31	17.16	0.90	0.20	11.47	15.01	4.24	79.76	0.19	8.10	8.10	115.27	182.18	182.18	760.50	794.32	-4.45	36.73	539.08	78.62
1/11/98		1378.17	7.20	116.00	76.00	11.50	2.90	12.80	1.40		14.20	17.10	0.90	0.20	11.38	14.76	5.73	78.77	0.19	7.80	7.80	112.78	203.00	203.00	817.05	1027.83	-25.80	44.44	685.36	83.54
1/12/98		1400.92	7.70	121.00	76.00	12.25	3.00	12.90	1.50		14.40	17.40	0.90	0.21	11.47	14.66	5.71	80.54	0.18	7.40	7.40	111.12	205.60	205.60	826.80	1018.11	-23.14	45.95	681.90	83.70
1/13/98		1424.17	8.10	120.00	75.00	11.50	2.90	12.80	1.40		14.20	17.10	0.90	0.20	11.38	14.37	5.61	80.39	0.18	7.60	7.60	113.61	201.96	201.96	852.80	1009.69	-18.40	43.75	674.32	83.15
1/14/98		1447.92	6.30	122.00	78.00	12.00	3.00	12.70	1.40		14.10	17.10	0.90	0.21	11.29	15.04	6.11	81.89	0.18	7.40	7.40	110.71	207.16	207.16	835.25	1082.13	-29.56	46.56	721.40	84.65
1/15/98		1471.92	6.20	128.00	83.00	12.50	2.90	12.80	1.50		14.30	17.20	0.90	0.20	11.38	15.20	5.71	87.29	0.17	7.60	7.60	112.37	207.68	207.68	852.80	1021.04	-19.73	45.90	682.93	83.55
1/16/98		1495.92	5.90	130.00	84.00	12.50	3.00	12.80	1.50		14.30	17.30	0.90	0.21	11.38	15.34	5.67	88.83	0.17	7.50	7.50	108.63	203.00	203.00	839.15	1008.23	-20.15	46.48	675.43	83.92
1/17/98		1519.92	4.80	130.00	75.00	12.50	3.01	12.79	1.63		14.42	17.43	0.89	0.21	11.37	15.83	5.68	84.32	0.19	7.70	7.70	111.95	213.41	213.41	767.00	1009.49	-31.62	47.54	680.19	83.54
1/18/98		1543.92	6.00	136.00	90.00	10.50	2.90	12.60	1.20		13.80	16.70	0.91	0.21	11.20	15.05	6.71	95.79	0.16	7.60	7.60	110.29	204.04	204.04	794.30	1188.36	-49.61	45.94	781.67	85.89
1/19/98		1567.92	5.10	142.00	92.00	12.50	3.00	12.80	1.30		14.10	17.10	0.91	0.21	11.38	15.70	6.31	98.19	0.16	7.40	7.40	111.54	204.56	204.56	856.70	1120.47	-30.79	45.47	742.85	84.99
1/20/98		1575.92	5.80	142.00	94.00	12.50	3.00	12.60	1.30	X	13.90	16.90	0.91	0.22	11.20	15.14	6.27	99.23	0.15	7.50	7.50	111.54	205.08	205.08	851.50	1111.72	-30.56	45.61	738.87	84.90
1/21/98		1582.92	5.50	126.00	85.00	12.50	2.60	12.80	1.40		14.20	16.80	0.90	0.18	11.38	15.52	6.19	86.81	0.18	7.30	7.30	111.12	209.76	209.76	921.70	1111.63	-20.61	47.03	730.48	84.79
1/22/98		1605.42	5.10	130.00	84.00	12.75	2.70	12.80	1.40		14.20	16.90	0.90	0.19	11.38	15.70	6.16	88.09	0.18	7.50	7.50	107.39	205.08	205.08	924.30	1098.23	-18.82	47.63	723.00	85.15
1/23/98		1629.42	4.80	130.00	87.00	12.50	3.10	12.80	1.50		14.30	17.40	0.90	0.22	11.38	15.84	5.89	90.11	0.18	7.60	7.60	107.80	205.60	205.60	897.00	1040.11	-15.95	47.57	697.19	84.54
1/24/98		1653.42	4.60	128.00	74.00	12.50	3.04	12.64	1.55		14.19	17.23	0.89	0.21	11.24	15.74	5.52	82.98	0.19	7.80	7.80	107.80	203.00	203.00	877.50	979.27	-11.60	46.89	659.62	83.66
1/25/98		1677.42	5.60	130.00	86.00	11.50	2.90	12.80	1.40		14.20	17.10	0.90	0.20	11.38	15.47	5.82	90.68	0.17	7.60	7.60	108.22	199.87	199.87	889.20	1037.86	-16.72	45.86	689.92	84.31

Date	Time	Operation		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM		SYSTEM			SYSTEM			SYSTEM		SYSTEM	
		time	Influent	P_I	P_C	P_P	Q_R	Q_P	Q_W	Cleaning Event	Q_F	Q_I	Recovery	Recycle	F_W (T°C)	F_W (Tavg°C)	$\Delta\pi$	NDP	MTC_W (Tavg°C)	pH		TDS (mg/L)								
MM/DD/YY	hh:mm	hh.hh	Temp. (°C)	(psi)	(psi)	(psi)	(gpm)	(gpm)	(gpm)	Indicate with " X"	(gpm)	(gpm)	(decimal)	ratio	(gfd)	(gfd)	(psi)	(psi)	(gfd/psi)	pH_F (before acid)	pH_F (after acid)	TDS_p	TDS_F (before acid)	TDS_F (after acid)	TDS_C	$TDS_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	TDS_B	R_B (%)
1/26/98		24.00	5.3	130.0	88.0	12.5	2.90	12.70	1.30		14.00	16.90	0.91	0.21	9.88	8.45	6.2	90.3	0.172	7.60	7.60	109.9	202.0	202.0	883.4	1101.5	-24.69	45.6	728.9	84.9
1/27/98		48.00	4.9	129.0	88.0	12.5	2.90	12.80	1.40		14.20	17.10	0.90	0.20	9.96	8.61	6.1	89.9	0.176	7.40	7.40	109.9	206.1	206.1	872.3	1086.0	-24.50	46.7	720.7	84.8
1/28/98		72.00	4.8	129.0	87.0	12.5	3.00	12.70	1.20		13.90	16.90	0.91	0.22	9.88	8.57	7.0	88.5	0.178	7.40	7.40	109.9	206.1	206.1	880.1	1224.7	-39.15	46.7	805.8	86.4
1/29/98		96.00	5.4	130.0	85.0	12.5	2.90	12.60	1.10		13.70	16.60	0.92	0.21	9.80	8.35	7.8	87.2	0.176	7.60	7.60	112.0	213.4	213.4	898.3	1375.5	-53.13	47.5	896.0	87.5
1/30/98		120.00	5.8	132.0	85.0	12.5	2.80	12.80	1.40		14.20	17.00	0.90	0.20	9.96	8.39	6.0	90.0	0.171	7.40	7.40	111.1	206.1	206.1	887.3	1074.7	-21.12	46.1	711.9	84.4
1/31/98		144.00	6.0	134.0	85.0	12.5	2.90	12.60	1.30		13.90	16.80	0.91	0.21	9.80	8.21	6.3	90.7	0.166	7.60	7.60	112.8	207.2	207.2	898.3	1121.9	-24.89	45.6	743.5	84.8
2/1/98		161.00	5.3	133.0	86.0	12.0	2.90	12.60	1.40		14.00	16.90	0.90	0.21	9.80	8.38	6.0	91.5	0.168	7.60	7.60	112.4	208.7	208.7	890.5	1075.9	-20.82	46.2	716.7	84.3
2/2/98		180.75	5.9	133.0	84.0	12.8	2.90	12.70	1.30		14.00	16.90	0.91	0.21	9.88	8.30	6.5	89.3	0.170	7.50	7.50	111.1	207.2	207.2	878.8	1145.4	-30.34	46.4	756.8	85.3
2/2/98		186.75	6.2	113.0	72.0	13.0	2.40	12.80	1.30		14.10	16.50	0.91	0.17	9.96	8.29	5.2	74.3	0.205		0.00	132.7	211.3	211.3	750.8	985.6	-31.29	37.2	654.8	79.7
2/3/98		210.75	6.6	114.0	72.0	13.0	2.40	12.90	1.00		13.90	16.30	0.93	0.17	10.03	8.26	6.5	73.5	0.206	7.40	7.40	127.3	204.6	204.6	765.1	1201.3	-57.02	37.8	776.3	83.6
2/4/98		234.75	6.1	114.0	68.0	12.5	2.90	12.80	1.50		14.30	17.20	0.90	0.20	9.96	8.31	5.0	73.5	0.207	7.40	7.40	124.8	207.7	207.7	709.2	914.9	-29.01	39.9	620.9	79.9
2/5/98		258.75	5.3	114.0	69.0	12.3	3.00	12.60	1.50		14.10	17.10	0.89	0.21	9.80	8.38	5.0	74.2	0.207	7.50	7.50	124.0	208.2	208.2	722.8	915.7	-26.69	40.5	624.0	80.1
2/6/98		282.75	4.8	114.0	69.0	12.0	3.00	12.60	1.30		13.90	16.90	0.91	0.22	9.80	8.50	5.9	73.6	0.212	7.50	7.50	141.0	229.5	229.5	772.2	1088.0	-40.89	38.6	734.9	80.8
2/7/98		306.75	4.9	115.0	68.0	12.3	3.07	12.70	1.14		13.84	16.91	0.92	0.22	9.88	8.55	6.2	73.0	0.215	7.50	7.50	136.8	218.6	218.6	776.8	1129.7	-45.44	37.4	756.9	81.9
2/8/98		330.75	5.3	120.0	72.0	13.0	2.90	12.80	1.40		14.20	17.10	0.90	0.20	9.96	8.51	5.3	77.7	0.201	7.70	7.70	129.4	212.9	212.9	765.7	976.5	-27.53	39.2	659.4	80.4
2/9/98		354.75	5.1	119.0	74.0	13.0	2.90	12.90	1.30		14.20	17.10	0.91	0.20	10.03	8.63	5.9	77.6	0.204	7.60	7.60	129.8	216.0	216.0	770.9	1071.7	-39.01	39.9	716.4	81.9
2/10/98		378.75	5.9	120.0	71.0	13.0	3.00	12.80	1.50		14.30	17.30	0.90	0.21	9.96	8.36	5.2	77.3	0.198	7.60	7.60	128.5	215.0	215.0	757.3	952.5	-25.79	40.2	647.7	80.2
2/11/98		402.75	6.4	121.0	71.0	13.0	2.90	13.00	1.20		14.20	17.10	0.92	0.20	10.11	8.37	6.3	76.7	0.200	7.60	7.60	127.7	213.4	213.4	770.3	1141.8	-48.24	40.2	756.3	83.1
2/12/98		426.75	7.2	122.0	69.0	13.3	2.90	13.10	1.40		14.50	17.40	0.90	0.20	10.19	8.24	5.4	76.9	0.196	7.60	7.60	126.5	209.8	209.8	758.6	989.2	-30.41	39.7	664.4	81.0
2/13/98		450.75	6.9	124.0	70.0	13.3	2.80	13.10	1.40		14.50	17.30	0.90	0.19	10.19	8.31	5.3	78.4	0.194	7.60	7.60	125.2	207.7	207.7	753.4	979.3	-29.99	39.7	655.9	80.9
2/14/98		474.75	6.1	126.0	70.0	13.0	2.90	13.00	1.50		14.50	17.40	0.90	0.20	10.11	8.44	5.1	79.9	0.194	7.70	7.70	124.4	208.2	208.2	757.3	934.6	-23.42	40.3	631.9	80.3
2/15/98		498.75	5.7	126.0	72.0	12.5	2.90	12.80	1.40		14.20	17.10	0.90	0.20	9.96	8.41	5.3	81.2	0.190	7.60	7.60	119.8	204.0	204.0	727.4	973.9	-33.90	41.3	654.3	81.7
2/16/98		522.75	5.3	126.0	74.0	12.8	2.90	12.80	1.40		14.20	17.10	0.90	0.20	9.96	8.51	5.4	81.9	0.191	7.70	7.70	121.9	206.6	206.6	760.5	981.4	-29.05	41.0	659.7	81.5
2/17/98		546.75	5.8	124.0	71.0	12.8	2.90	12.80	1.50		14.30	17.20	0.90	0.20	9.96	8.39	5.1	79.6	0.193	7.80	7.80	121.9	207.2	207.2	750.1	934.7	-24.61	41.2	632.3	80.7
2/18/98		570.75	7.0	125.0	70.0	13.0	2.80	12.90	1.40		14.30	17.10	0.90	0.20	10.03	8.16	5.2	79.3	0.189	7.60	7.60	119.0	201.4	201.4	733.9	961.0	-30.96	40.9	643.4	81.5
2/19/98		594.75	6.4	124.0	70.0	13.0	2.90	12.90	1.40		14.30	17.20	0.90	0.20	10.03	8.30	5.3	78.7	0.193	7.60	7.60	116.9	199.4	199.4	705.3	958.9	-35.96	41.3	643.1	81.8
2/20/98		618.75	7.1	126.0	70.0	12.5	2.90	13.00	1.40		14.40	17.30	0.90	0.20	10.11	8.20	5.1	80.4	0.187	7.80	7.80	117.8	197.3	197.3	724.1	935.6	-29.21	40.3	628.3	81.3
2/21/98		642.75	6.4	125.0	69.0	13.0	2.87	13.10	1.45		14.55	17.42	0.90	0.20	10.19	8.43	5.6	78.4	0.197	7.80	7.80	107.8	197.8	197.8	728.0	1010.8	-38.84	45.5	671.3	83.9
2/22/98		666.75	7.2	126.0	70.0	13.0	2.90	12.80	1.40		14.20	17.10	0.90	0.20	9.96	8.05	5.0	80.0	0.184	7.80	7.80	116.5	194.7	194.7	735.8	909.2	-23.57	40.1	612.5	81.0
2/23/98		690.75	7.7	126.0	68.0	13.0	2.90	13.00	1.50		14.50	17.40	0.90	0.20	10.11	8.05	4.6	79.4	0.186	7.80	7.80	115.7	191.5	191.5	715.0	849.0	-18.74	39.6	575.1	79.9
2/24/98		714.75	6.8	126.0	69.0	13.0	2.90	12.90	1.30		14.20	17.10	0.91	0.20	10.03	8.21	5.3	79.2	0.190	7.60	7.60	113.6	191.5	191.5	710.5	964.9	-35.82	40.7	643.8	82.4
2/25/98		738.75	6.6	125.0	68.0	12.8	2.90	12.40	1.80		14.20	17.10	0.87	0.20	9.64	7.94	3.9	79.8	0.182	7.50	7.50	113.2	191.0	191.0	706.6	727.2	-2.92	40.7	504.6	77.6
2/26/98		762.75	6.8	126.0	67.0	13.0	2.90	12.90	1.20		14.10	17.00	0.91	0.21	10.03	8.21	5.7	77.8	0.193	7.40	7.40	112.0	190.0	190.0	704.6	1028.8	-46.02	41.1	681.0	83.6
2/27/98		786.75	7.9	126.0	68.0	13.0	2.90	13.00	1.40		14.40	17.30	0.90	0.20	10.11	8.01	5.0	79.0	0.186	7.60	7.60	112.4	189.5	189.5	704.6	905.4	-28.49	40.7	607.4	81.5
2/28/98		810.75	7.3	124.0	67.0	13.0	2.85	13.10	1.45		14.55	17.40	0.90	0.20	10.19	8.21	5.2	77.3	0.195	7.80	7.80	112.0	195.2	195.2	702.0	947.2	-34.93	42.6	632.8	82.3
3/1/98		834.75	8.4	126.0	68.0	12.8	3.10	12.80	1.30		14.10	17.20	0.91	0.22	9.96	7.77	4.6	79.6	0.179	8.00	8.00	112.0	180.1	180.1	692.3	851.0	-22.94	37.8	576.0	80.6
3/2/98		858.75	8.9	125.0	66.0	12.8	2.90	12.80	1.50		14.30	17.20	0.90	0.20	9.96	7.65	4.6	78.1	0.180	8.00	8.00	110.7	187.9	187.9	689.0	846.6	-22.88	41.1	572.8	80.7
3/3/98		876.25	8.6	124.0	65.0	13.0	3.00	12.90	1.40		14.30	17.30	0.90	0.21	10.03	7.78	5.0	76.5	0.186	8.10	8.10	109.5	186.9	186.9	674.7	900.0	-33.40	41.4	605.3	81.9
3/4/98		900.25	8.6	119.0	67.0	12.5	3.20	12.80	1.30		14.10	17.30	0.91	0.23	9.96	7.72	5.1	75.4	0.188	8.60	8.60	111.1	185.8	185.8	692.3	921.3	-33.09	40.2	621.6	82.1
3/8/98		909.08	8.6	110.0	64.0	13.0	2.95	12.82	1.08		13.90	16.85	0.92	0.21	9.97	7.73	5.9	68.1	0.208	8.80	8.80	115.3	188.9	188.9	685.8	1063.5	-55.08	39.0	702.8	83.6
3/9/98		933.08	10.4	118.0	68.0	13.0	2.70	12.80	1.50		14.30	17.00	0.90	0.19	9.96	7.32	4.9	75.1	0.179	8.00	8.00	100.8	183.7	183.7	728.0	891.9	-22.51	45.2	594.0	83.0
3/10/98		957.08	8.7	116.0	69.0	12.8	3.00	12.70	1.40		14.10	17.10	0.90	0.21	9.88	7.64	5.2	74.6	0.188	7.90	7.90	101.2	183.2	183.2	755.3	927.5	-22.80	44.8	620.6	83.7
3/11/98		981.08	7.2	118.0	73.0	12.3	2.90	12.60	1.50		14.10	17.00	0.89	0.21	9.80	7.92	4.9	78.3	0.185	8.80	8.80	103.7	186.9	186.9	759.9	885.8	-16.57	44.5	595.9	82.6
3/13/98		1029.08	6.1	128.0	78.0	12.8	2.80	12.80	1.40		14.20	17.00	0.90	0.20	9.96	8.31	5.3	84.9	0.179	8.00	8.00	100.8	184.8	184.8	778.7	953.0	-22.38	45.5	632.1	84.1
3/14/98		1053.08	6.3	129.0	77.0	13.0	2.90	12.82	1.42		14.24	17.14	0.90	0.20	9.97	8.28	5.3	84.7	0.179	8.90	8.90	102.0	186.3	186.3	791.7	947.8	-19.71	45.3	631.5	83.8
3/15/98		1077.08	6.2	128.0	78.0	12.8	2.66	12.55	1.07		13.62	16.28	0.92	0.20	9.76	8.13	6.6	83.6	0.178	8.90	8.90	100.8	185.3	185.3	800.8	1176.9	-46.97	45.6	762.1	86.8
3/16/98		1101.08	5.5	128.0	80.0	12.3	3.00	12.60	1.20		13.80	16.80	0.91	0.22	9.80	8.33	6.3	85.5	0.179	8.70	8.70	102.4	189.5	189.5	834.0	1103.5	-32.32	45.9	728.1	85.9
3/17/98		1125.08	5.9	124.0	81.0	12.5	3.30	12.70	1.10		13.80	17.10	0.92	0.24	9.88	8.30	6.8	83.2	0.183	8.90	8.90	103.2	189.5	189.5	835.9	1184.9	-41.75	45.5	783.2	86.8
3/18/98		1149.08	6.8	122.0	78.0	12.5	3.00	12.90	1.50		14.40	17.40	0.90	0.21	10.03	8.21	5.2	82.3	0.183	8.20	8.20	101.6	186.9	186.9	817.7	920.2	-12.54	45.6	616.8	83.5
3/19/98		1173.08	7.2	122.0	77.0	12.8	2.90	12.80	1.30		14.10	17.00	0.91	0.21	9.96	8.05	5.7	81.1	0.182	8.40	8.40	100.8	184.8	184.8	821.0	1012.1	-23.28	45.5	669.0	84.9
3/20/98		1197.08	7.4	123.0	77.0	13.0	2.90	12.80	1.50		14.30	17.20	0.90	0.20	9.96	8.00	5.0	82.0	0.179	8.40	8.40	101.6	185.3	185.3	789.1	899.7	-14.01	45.2	602.7	83.1
3/21/98		1221.08	7.2	122.0	77.0	13.0	2.90	12.80	1.50		14.30	17.20	0.90	0.20	9.96	8.05	4.9	81.6	0.181	8.80	8.80	97.4	178.5	178.5	772.2	870.5	-12.73	45.4	582.9	83.3
3/22/98		1245.08	5.4	126.0	79.0	12.8	2.95	12.59	1.36		13.95	16.90	0.90	0.21	9.79	8.35	5.9	83.8	0.183	8.20	8.20	95.4	187.4	187.4	806.0	1039.2	-28.93	49.1	687.6	86.1
3/23/98		1269.08	6.2	128.0	82.0	13.0	2.80	12.90	1.40		14.30	17.10	0.90	0.20	10.03	8.35	5.2	86.8	0.176	7.80	7.80	95.0	175.9	175.9	786.5	922.1	-17.24	46.0	610.1	84.4
3/24/98		1293.08	7.3	125.0	80.0	13.3	2.80	13.00	1.40		14.40	17.20	0.90	0.19	10.11	8.15	5.3	83.9	0.178	8.60	8.60	97.0	180.6	180.6	800.2	956.8	-19.58	46.3	631.9	84.6
3/25/98		1317.08	8.8	120.0	75.0	13.0	2.60	12.80	1.50		14.30	16.90	0.90	0.18	9.96	7.68	4.9	79.6	0.177	8.80	8.80	96.6	180.1	180.1	776.1	892.5	-15.00	46.4	591.1	83.7
3/26/98		1341.08	7.4	116.0	77.0	12.8	2.60	12.80	1.50		14.30	16.90	0.90	0.18	9.96	8.00	4.9	78.8	0.186	8.60	8.60	97.9	181.1	181.1	778.1	891.8	-14.62	46.0	591.1	83.4
3/27/98		1365.08	10.1	118.0	72.0	13.3	2.60	13.00	1.50		14.50	17.10	0.90	0.18	10.11	7.50	4.9	76.8	0.179	8.40	8.40	97.4	179.6	179.6	765.7	891.4	-16.42	45.7	589.6	83.5
3/28/98		1389.08	12.5	104.0	63.0	12.5	2.60	12.90	1.30		14.20	16.80	0.91	0.18	10.03	6.93	5.4	65.6	0.194	8.60	8.60	100.3	181.1	181.1	741.0	982.9	-32.64	44.6	644.0	84.4
3/29/98		1413.08	12.8	104.0	64.0	13.0	2.68	13.12	1.16		14.28	16.96	0.92	0.19	10.20	6.99	6.8	64.2	0.200	9.00	9.00	100.3	190.0	190.0	722.8	1203.9	-66.56	47.2	777.0	87.1
3/30/98		1437.08	13.4	102.0	62.0	13.0	2.90	12.80	1.40		14.20	17.10	0.90	0.20	9.96	6.70	4.9	64.1	0.192	8.60	8.60	101.2	179.1	179.1	710.5	891.1	-25.43	43.5	595.5	83.0
3/31/98		1461.08	13.9	103.0	60.0	13.0	2.90	13.00	1.40		14.40	17.30	0.90	0.20	10.11	6.70	4.9	63.6	0.193	8.20	8.20	102.0	179.1	179.1	710.5	894.6	-25.91	43.0	596.8	82.9
4/1/98		1485.08	14.8	101.0	61.0	13.3	2.90	13.00	1.40		14.40	17.30	0.90	0.20	10.11	6.53	4.9	62.8	0.191	8.20	8.20	102.4	179.1	179.1	707.9	890.7	-25.83	42.8	594.5	82.8
4/2/98		1509.08	15.8	97.0	59.0	13.0	2.80	13.00	1.40		14.40	17.20	0.90	0.19	10.11	6.34	2.2	62.8	0.185	8.30	8.30	52.7	87.4	87.4	343.2	410.5	-19.60	39.8	275.2	80.9
4/3/98		1533.08	14.9	97.0	59.0	13.0	2.80	12.90	1.40		14.30	17.10	0.90	0.20	10.03	6.46	4.4	60.6	0.196	8.20	8.20	99.5	169.2	169.2	652.0	811.0	-24.39	41.2	542.6	81.7
4/4/98		1557.08	14.5	96.0	58.0	12.8	2.75	12.80	1.50		14.30	17.05	0.90	0.19	9.96	6.49	4.5	59.8	0.199	8.20	8.20	97.0	171.8	171.8	650.7	809.6	-24.42	43.5	542.1	82.1
4/5/98		1581.08	13.2	96.0	58.0	12.0	2.80	12.60	1.60		14.20	17.00	0.89	0.20	9.80	6.63	4.2	60.8	0.200	8.40	8.40	96.6	172.3	172.3	652.6	768.2	-17.72	43.9	519.3	81.4
4/6/98		1605.08	12.1	106.0	65.0	13.3	3.30	12.90	1.45		14.35	17.65	0.90	0.23	10.03	7.02	4.6	67.6	0.190	8.30	8.30	99.9	173.8	173.8	687.7	831.5	-20.91	42.5	564.2	82.3
4/7/98		1629.08	13.4	100.0	60.0	12.5	2.90	12.80	1.30		14.10	17.00	0.91	0.21	9.96	6.70	5.0	62.5	0.197	7.60	7.60	95.8	169.7	169.7	658.5	897.4	-36.28	43.6	595.6	83.9
4/8/98		1653.08	13.5	100.0	60.0	12.8	3.00	12.80	1.55		14.35	17.35	0.89	0.21	9.96	6.68	4.4	62.8	0.195	8.30	8.30	97.4	173.3	173.3	667.6	800.0	-19.84	43.8	540.9	82.0
4/10/98		1690.08	12.3	102.0	63.0	12.8	3.00	12.90	1.40		14.30	17.30	0.90	0.21	10.03	6.98	4.6	65.2	0.196	7.60	7.60	95.0	166.6	166.6	681.9	826.4	-21.20	43.0	553.7	82.9

Field 1-6: Membrane Performance Data During Operation With The Test Water (continued)

Stage 1 Operating Parameters

Date	Time	Operation	STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1	
		time	PI	PC	PP	Qp	Qc	QF	Ql	vc	Recovery	FW (ToC)	FW (TavgoC)	Dp	NDP	MTCW (TavgoC	pH		TDS (mg/L)							
MM/DD/YY	hh:mm	hh.hh	(psi)	(psi)	(psi)	(gpm)	(gpm)	(gpm)	(gpm)	(fps)	(decimal)	(gfd)	(gfd)	(psi)	(psi)	(gfd/psi)	pHI	pHC	TDSp	TDSI	TDSC	TDSC(calc	ErrorMB (%)	RF (%)	CB	RB (%
			#4	#11	#12	FIT-12	calc										#4	#11	#12	#4	#11					
																			0.49	0.55	0.59					
11/3/97		24.00				8.88	8.34	14.37	17.22	0.38	0.62	11.84	13.07													
11/4/97		48.00				8.90	8.35	14.40	17.25	0.38	0.62	11.87	13.07													
11/5/97		72.00				8.80	8.31	14.25	17.12	0.38	0.62	11.74	13.14													
11/6/97		96.00				8.78	8.27	14.19	17.05	0.38	0.62	11.71	13.14													
11/7/97		106.50				8.77	8.24	14.12	17.00	0.38	0.62	11.69	13.12													
11/8/97		114.50				8.51	8.24	14.12	16.75	0.37	0.60	11.34	12.98													
11/9/97		138.50				8.74	8.26	14.06	17.01	0.38	0.62	11.66	13.36													
11/10/97		162.50				8.99	8.12	14.09	17.12	0.38	0.64	11.99	13.80													
11/11/97		186.50				9.06	7.99	14.07	17.05	0.37	0.64	12.08	13.96													
11/12/97		210.50				8.93	8.36	14.35	17.28	0.38	0.62	11.90	14.06													
11/13/97		233.00				8.81	8.25	14.11	17.06	0.38	0.62	11.74	14.24													
11/14/97		257.00				8.71	8.44	14.25	17.15	0.38	0.61	11.61	14.48													
11/15/97		281.00				8.55	8.62	14.29	17.17	0.39	0.60	11.40	14.52													
11/16/97		305.00				8.53	8.63	14.25	17.16	0.39	0.60	11.37	14.54													
11/17/97		329.00				8.47	8.38	14.02	16.85	0.38	0.60	11.29	14.70													
11/18/97		353.00				8.56	8.06	13.93	16.62	0.37	0.61	11.41	14.99													
11/19/97		370.75	109.00	86.00	17.50	8.62	8.42	14.26	17.04	0.38	0.60	11.49	15.16													
11/20/97		384.00	108.00	88.00	15.00	8.66	8.19	13.87	16.85	0.37	0.62	11.54	14.97													
11/21/97		408.00	106.00	87.00	16.50	8.63	8.30	13.91	16.92	0.38	0.62	11.50	14.99													
11/22/97		421.50	108.00	88.00	17.50	8.87	8.28	14.19	17.15	0.38	0.63	11.83	15.15													
11/23/97		435.50				8.53	7.76	13.39	16.29	0.36	0.64	11.37	14.40													
11/24/97		459.50	102.00	71.00	16.00	8.65	7.97	13.65	16.62	0.37	0.63	11.54	14.94													
11/25/97		483.50	114.00	94.00	16.00	8.94	8.52	14.36	17.45	0.39	0.62	11.92	16.15													
11/26/97		507.50	118.00	95.00	18.00	9.00	8.64	14.51	17.64	0.39	0.62	12.00	16.26	2.55	85.95	0.19			84.06	251.91	443.34	426.75	3.74	47.57	339.33	75.23
11/27/97		531.50	116.00	91.00	18.00	9.02	8.53	14.47	17.55	0.39	0.62	12.02	15.88	1.79	83.71	0.19			73.85	190.84	253.50	314.45	-24.04	53.78	252.64	70.77
11/28/97		555.50	112.00	90.00	16.50	8.91	8.33	14.27	17.24	0.38	0.62	11.89	15.81	2.39	82.11	0.19			68.02	223.56	400.89	390.03	2.71	56.44	306.79	77.83
11/29/97		579.50	110.00	90.00	16.50	8.97	8.48	14.48	17.45	0.39	0.62	11.96	15.90	2.31	81.19	0.20			77.74	229.01	389.10	388.87	0.06	50.21	308.94	74.84
11/30/97		600.00	113.00	92.00	17.50	9.13	8.50	14.64	17.63	0.39	0.62	12.17	16.20	2.50	82.50	0.20			82.60	245.37	448.05	420.26	6.20	47.10	332.81	75.18
12/1/97		609.50	112.00	91.00	18.00	8.34	7.69	13.72	16.03	0.35	0.61	11.13	14.13	2.33	81.17	0.17			86.00	237.19	436.26	401.28	8.02	46.70	319.23	73.06
12/2/97		633.50				8.12	7.11	13.29	15.23	0.33	0.61	10.83	14.64													
12/3/97		652.50	124.00	104.00	21.00	8.75	8.32	14.30	17.07	0.38	0.61	11.67	15.89	2.50	90.50	0.18			83.57	247.55	445.69	420.02	5.76	48.70	333.79	74.96
12/5/97		658.00						-2.69	0.00	0.00	0.00	0.00	0.00													
12/6/97		682.00	103.00	87.00	18.50	8.61	8.26	14.02	16.87	0.38	0.61	11.48	15.59	1.96	74.54	0.21			116.61	245.37	418.58	379.56	9.32	34.11	312.46	62.68
12/7/97		706.00	116.00	96.00	17.50	8.64	8.51	14.21	17.15	0.38	0.61	11.52	15.96	2.54	85.96	0.19			87.46	256.27	459.84	427.61	7.01	47.49	341.94	74.42
12/8/97		730.00	122.00	100.00	20.00	8.60	8.27	13.98	16.87	0.38	0.62	11.46	15.85	2.31	88.69	0.18	7.66	7.87	83.08	235.01	410.91	392.98	4.36	49.49	313.99	73.54
12/9/97		754.00	118.00	91.00	18.50	8.44	8.66	14.13	17.10	0.38	0.60	11.25	15.67	2.60	83.40	0.19	7.85	8.05	85.51	260.09	462.20	430.25	6.91	48.50	345.17	75.23
12/10/97		778.00	116.00	94.00	18.00	8.58	8.32	13.99	16.90	0.38	0.61	11.44	15.55	2.33	84.67	0.18	7.87		86.49	240.46	448.05	399.25	10.89	47.91	319.86	72.96
12/11/97		802.00	120.00	97.00	18.00	8.47	8.85	14.34	17.32	0.39	0.59	11.29	15.41	2.34	88.16	0.17	7.88		83.57	242.09	422.11	393.86	6.69	49.67	317.98	73.72
12/12/97		815.50	120.00	94.00	19.50	8.68	8.63	14.31	17.31	0.39	0.61	11.57	15.73	2.60	84.90	0.19			88.43	261.18	440.98	434.82	1.40	46.91	348.00	74.59
12/13/97		821.25	113.00	92.00	17.00	8.58	7.94	13.65	16.52	0.37	0.63	11.44	15.11													
12/14/97		845.25	112.00	88.00	16.00	8.52	7.94	13.60	16.46	0.36	0.63	11.35	15.58	2.26	81.74	0.19	7.60		87.46	234.46	400.89	392.04	2.21	50.58	313.25	72.08
12/15/97		868.92	129.00	106.00	19.50	8.62	8.03	13.85	16.65	0.37	0.62	11.50	16.20	2.47	95.53	0.17	7.75		85.03	245.91	445.10	418.80	5.91	49.74	332.36	74.42
12/16/97		892.92	116.00	95.00	16.50	8.65	8.40	14.19	17.06	0.38	0.61	11.54	16.06	2.53	86.47	0.19	7.90		87.94	254.64	462.79	426.30	7.88	47.85	340.47	74.17
12/17/97		916.92	115.00	93.00	16.50	8.72	8.36	14.22	17.08	0.38	0.61	11.62	15.90	2.54	84.96	0.19	7.65	7.77	86.00	253.00	451.00	427.02	5.32	47.88	340.01	74.71
12/18/97		940.92	115.00	94.00	16.00	8.72	8.20	14.03	16.92	0.38	0.62	11.62	16.18	2.49	86.01	0.19	7.78		86.00	248.64	452.18	421.44	6.80	48.04	335.04	74.33
12/19/97		964.92	116.00	95.00	16.50	8.78	8.05	13.92	16.83	0.37	0.63	11.71	16.07	2.59	86.41	0.19	7.77	7.93	87.46	255.18	469.28	438.27	6.61	47.16	346.73	74.78
12/20/97		988.92	118.00	94.00	17.00	8.81	8.06	13.98	16.88	0.37	0.63	11.75	16.08	2.39	86.61	0.19	7.60		88.43	243.19	472.22	412.37	12.68	43.93	327.78	73.02
12/21/97		1012.92	117.00	91.00	16.00	8.74	8.23	14.03	16.98	0.38	0.62	11.66	16.23	2.60	85.40	0.19	7.65	7.84	97.18	267.18	453.95	447.71	1.37	45.09	357.44	72.81
12/22/97		1035.33	117.00	95.00	16.75	8.84	8.16	14.34	17.00	0.38	0.62	11.78	16.36	2.69	86.56	0.19	7.63	7.86	86.00	260.63	462.20	449.73	2.70	48.53	355.18	75.79
12/23/97		1048.50	118.00	95.00	16.50	8.77	7.99	14.18	16.76	0.37	0.62	11.70	16.10	2.59	87.41	0.18	7.65	7.83	85.03	251.91	454.54	435.22	4.25	47.64	343.57	75.25
12/24/97		1072.50	119.00	96.00	16.50	8.75	7.59	14.01	16.34	0.36	0.63	11.67	16.11	2.73	88.27	0.18	7.65	7.91	86.00	259.00	468.69	458.57	2.16	47.55	358.78	76.03
12/25/97		1096.50	119.00	91.00	16.75	8.84	7.90	14.27	16.74	0.37	0.62	11.79	16.51	2.56	85.69	0.19	7.60	7.51	92.32	256.27	442.16	439.80	0.53	46.25	348.03	73.47
12/26/97		1120.50	117.00	93.00	16.00	8.86	8.13	14.19	16.99	0.38	0.62	11.82	15.60	2.53	86.47	0.18	7.80	7.89	91.83	255.73	474.58	434.43	8.46	46.05	345.08	73.39
12/27/97		1140.83	120.00	95.00	16.50	8.69	7.93	13.82	16.63	0.37	0.63	11.59	15.63	2.77	88.23	0.18	7.80	7.95	91.83	270.45	486.96	466.23	4.26	47.34	368.34	75.07
12/28/97		1145.33																								
12/29/97		1156.17	118.00	92.00	17.00	8.72	8.16	14.08	16.88	0.37	0.62	11.62	15.35	2.63	85.37	0.18	7.43	7.64	97.66	268.81	486.37	451.57	7.15	46.54	360.19	72.89
12/30/97		1180.17	128.00	100.00	16.75	8.69	7.95	13.75	16.64	0.37	0.63	11.59	16.00	2.88	94.37	0.17	7.82	7.97	101.55	287.90	517.62	491.74	5.00	45.81	389.82	73.95
12/31/97		1204.17	129.00	104.00	16.50	8.83	7.68	13.40	16.51	0.36	0.66	11.77	16.48	2.97	97.03	0.17	7.77	7.95	104.95	293.35	521.16	509.77	2.19	46.09	401.56	73.86
1/1/98		1228.17	151.00	126.00	22.00	8.79	7.89	13.56	16.68	0.37	0.65	11.72	16.96	3.32	113.18	0.15	7.85	7.98	112.24	325.52	573.04	563.24	1.71	44.99	444.38	74.74
1/2/98		1252.17	156.00	131.00	21.50	8.78	8.03	13.90	16.82	0.37	0.63	11.71	16.95	2.54	119.46	0.14	7.60	7.84	97.18	261.72	489.32	441.62	9.75	45.09	351.67	72.37
1/3/98		1276.17	190.00	160.00	29.00	8.76	7.89	13.66	16.65	0.37	0.64	11.68	16.46	2.94	143.06	0.12	8.10	8.21	106.89	296.08	596.62	506.21	15.15	47.07	401.14	73.35
1/7/98		1300.17	119.00	96.00	15.25	8.72	8.33	14.00	17.05	0.38	0.62	11.63	15.40	2.97	89.28	0.17	8.20	8.20	110.29	305.34	551.22	509.70	7.53	47.03	407.52	72.94
1/8/98		1311.42	120.00	95.00	15.00	8.87	8.55	14.33	17.42	0.39	0.62	11.83	15.71	2.91	89.59	0.18	8.00	8.20	111.27	302.62	538.25	501.32	6.86	45.88	401.97	72.32
1/9/98		1330.17	114.00	92.00	15.00	8.81	7.64	14.05	16.45	0.36	0.63	11.75	15.10	2.72	85.28	0.18	7.80	8.00	114.18	286.81	521.16	485.87	6.77	44.32	386.34	70.45
1/10/98		1354.17	115.00	93.00	15.00	8.91	8.25	14.31	17.16	0.38	0.62	11.88	15.55	2.70	86.30	0.18	8.00	7.80	116.61	291.71	515.85	480.82	6.79	35.99	386.27	69.81
1/11/98		1378.17	116.00	94.00	14.50	8.80	8.30	14.20	17.10	0.38	0.62	11.73	15.22	2.68	87.82	0.17	7.90	8.00	121.47	296.62	530.59	482.32	9.10	40.16	389.47	68.81
1/12/98		1400.92	121.00	95.00	15.25	9.00	8.40	14.40	17.40	0.39	0.63	12.00	15.34	2.91	89.84	0.17	7.70	8.00	115.64	305.34	551.22	508.60	7.73	43.76	406.97	71.59
1/13/98		1424.17	120.00	94.00	15.00	8.80	8.30	14.20	17.10	0.38	0.62	11.73	14.82	2.90	89.10	0.17	7.80	8.00	121.95	311.34	559.48	512.14	8.46	39.61	411.74	70.38
1/14/98		1447.92	122.00	98.00	14.75	8.90	8.20	14.10	17.10	0.38	0.63	11.87	15.81	3.15	92.10	0.17	7.70	7.90	116.12	320.61	555.35	542.56	2.30	43.94	431.58	73.09
1/15/98		1471.92	128.00	100.00	15.00	9.00	8.20	14.30	17.20	0.38	0.63	12.00	16.03	2.99	96.01	0.17	7.80	7.90	115.64	308.62	555.94	520.42	6.39	44.32	414.52	72.10
1/16/98		1495.92	130.00	101.00	15.00	9.10	8.20	14.30	17.30	0.38	0.64	12.13	16.35	2.94	97.56	0.17	7.70	7.90	113.69	302.62	551.81	512.28	7.16	43.99	407.45	72.10
1/17/98		1519.92	130.00	103.00	15.00	8.90	8.53	14.42	17.43	0.39	0.62	11.87	16.52	2.92	98.58	0.17	7.80	7.80	121.47	313.52	548.27	513.91	6.27	43.08	413.72	70.64
1/18/98		1543.92	136.00	107.00	18.00	8.60	8.10	13.80	16.70	0.37	0.62	11.47	15.41	2.89	100.61	0.15	7.70	7.80	115.64	304.25	545.92	504.51	7.58	43.33	404.38	71.40
1/19/98		1567.92	142.00	108.00	20.50	8.70	8.40	14.10	17.10	0.38	0.62	11.60	16.01	2.88	101.62	0.16	7.70	7.90	115.64	305.34	552.99	501.83	9.25	43.47	403.59	71.35
1/20/98		1575.92	142.00	110.00	20.50	8.70	8.20	13.90	16.90	0.38	0.63	11.60	15.68	2.93	102.57	0.15	7.70	7.90	116.12	307.53	552.40	510.60	7.57	43.38	409.06	71.61
1/21/98		1582.92	126.00	102.00	17.00	8.60	8.20	14.20	16.80	0.37	0.61	11.47	15.64	2.65	94.35	0.17	7.20	7.60	130.21	304.25	561.24	486.78	13.27	37.92	395.52	67.08
1/22/98		1605.42	130.00	102.00	17.50	8.80	8.10	14.20	16.90	0.37	0.62	11.73	16.19	3.24	95.26	0.17	7.70	7.90	109.32	318.98	560.65	546.75	2.48	46.69	432.86	74.74
1/23/98		1629.42	130.00	104.00	17.00	8.60	8.80	14.30	17.40	0.39	0.60	11.47	15.97	2.99	97.01	0.16	7.80	8.00	109.32	310.25	552.40	506.62	8.29	46.83	408.43	73.23
1/24/98		1653.42	128.00	98.00	17.00	8.71	8.52	14.19	17.23	0.38	0.61	11.61	16.27	2.88	93.12	0.17	7.80	8.00	109.32	299.89	548.27	494.71	9.77	46.15	397.30	72.48
1/25/98		1677.42	130.00	102.00	17.00	8.70	8.40	14.20	17.10	0.38	0.61	11.60	15.77	2.78	96.22	0.16	7.50	7.90	111.27	294.44	535.30	484.16	9.56	44.33	389.30	71.42

Field 2-6: Membrane Performance Data During Operation With The Test Water (continued)

Stage 1 Operating Parameters

Sheet2. Weeks 11-20

STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1		STAGE 1	
P_i	P_C	P_P	Q_p	Qc	Q_F	Q_i	v_c	Recovery	F_W (T°C)	F_W (Tavg°C)	$\Delta\pi$	NDP	MTC_W (Tavg°C)	pH		TDS (mg/L)							
(psi)	(psi)	(psi)	(gpm)	(gpm)	(gpm)	(gpm)	(fps)	(decimal)	(gfd)	(gfd)	(psi)	(psi)	(gfd/psi)	pH_i	pH_C	TDS_p	TDS_i	TDS_C	$TDS_{C(calc)}$	$Error_{M.B}$ (%)	R_F (%)	C_B	R_B (%)
130.0	104.0	17.0	8.70	8.20	14.00	16.90	0.000	0.62	13.53	11.57	2.8	97.2	0.119	7.50	7.90	114.2	295.5	549.5	487.9	11.20	43.5	391.7	70.9
129.0	104.0	17.0	8.70	8.40	14.20	17.10	0.000	0.61	13.53	11.71	2.8	96.7	0.121	7.60	7.80	113.2	299.3	546.5	492.1	9.95	45.1	395.7	71.4
129.0	103.0	17.0	8.80	8.10	13.90	16.90	0.000	0.63	13.69	11.88	2.9	96.1	0.124	7.70	7.90	112.2	298.3	545.3	500.4	8.25	45.5	399.3	71.9
130.0	101.0	17.0	8.70	7.90	13.70	16.60	0.000	0.64	13.53	11.54	2.9	95.6	0.121	7.40	7.80	114.2	303.7	554.8	512.4	7.63	46.5	408.1	72.0
132.0	101.0	17.0	8.70	8.30	14.20	17.00	0.000	0.61	13.53	11.40	2.9	96.6	0.118	7.70	7.90	111.8	303.2	548.9	503.8	8.21	45.8	403.5	72.3
134.0	102.0	16.5	8.70	8.10	13.90	16.80	0.000	0.63	13.53	11.33	2.9	98.6	0.115	7.60	7.80	116.6	302.1	553.6	501.3	9.45	43.7	401.7	71.0
133.0	94.0	16.5	8.60	8.30	14.00	16.90	0.000	0.61	13.38	11.44	2.8	94.2	0.121	7.60	7.80	115.2	299.9	547.1	491.3	10.20	44.8	395.6	70.9
133.0	102.0	16.8	8.80	8.10	14.00	16.90	0.000	0.63	13.69	11.50	2.8	97.9	0.117	7.70	7.80	115.2	298.8	543.0	498.3	8.22	44.4	398.6	71.1
113.0	87.0	17.8	8.80	7.70	14.10	16.50	0.000	0.62	13.69	11.40	2.4	79.9	0.143			138.5	291.2	469.3	465.7	0.77	34.5	378.4	63.4
114.0	87.0	17.0	8.80	7.50	13.90	16.30	0.000	0.63	13.69	11.26	2.2	81.3	0.139	7.60	7.80	132.2	271.0	466.9	433.9	7.07	35.4	352.4	62.5
114.0	87.0	17.0	8.70	8.50	14.30	17.20	0.000	0.61	13.53	11.30	2.3	81.2	0.139	7.60	7.80	132.2	283.5	475.8	438.5	7.84	36.4	361.0	63.4
114.0	87.0	16.8	8.70	8.40	14.10	17.10	0.000	0.62	13.53	11.57	2.3	81.4	0.142	7.70	7.80	132.2	286.3	482.2	445.9	7.54	36.5	366.1	63.9
114.0	88.0	16.5	8.70	8.20	13.90	16.90	0.000	0.63	13.53	11.74	2.5	82.0	0.143	7.70	7.80	149.6	312.4	517.0	485.1	6.17	34.8	398.8	62.5
115.0	84.0	17.0	8.75	8.16	13.84	16.91	0.000	0.63	13.61	11.78	2.1	80.4	0.146	7.70	7.90	143.3	278.1	507.0	422.6	16.65	34.4	350.3	59.1
120.0	92.0	17.5	8.80	8.30	14.20	17.10	0.000	0.62	13.69	11.70	2.4	86.1	0.136	7.70	7.80	138.5	292.3	502.9	455.3	9.46	35.0	373.8	63.0
119.0	92.0	17.5	8.90	8.20	14.20	17.10	0.000	0.63	13.84	11.91	2.5	85.5	0.139	7.80	7.90	137.0	299.9	507.6	476.7	6.09	36.6	388.3	64.7
120.0	89.0	17.8	8.90	8.40	14.30	17.30	0.000	0.62	13.84	11.63	2.5	84.3	0.138	7.80	7.90	137.0	300.4	507.6	473.6	6.70	36.3	387.0	64.6
121.0	89.0	18.0	9.00	8.10	14.20	17.10	0.000	0.63	14.00	11.59	2.5	84.5	0.137	7.80	8.00	134.1	294.4	502.9	472.6	6.02	37.2	383.5	65.0
122.0	87.0	18.3	9.10	8.30	14.50	17.40	0.000	0.63	14.16	11.44	2.5	83.8	0.137	7.80	8.00	134.6	293.3	493.4	467.4	5.28	35.8	380.4	64.6
124.0	87.0	18.3	9.10	8.20	14.50	17.30	0.000	0.63	14.16	11.54	2.4	84.9	0.136	7.80	7.90	132.2	286.3	489.3	457.3	6.55	36.4	371.8	64.5
126.0	90.0	18.0	9.00	8.40	14.50	17.40	0.000	0.62	14.00	11.69	2.4	87.6	0.133	7.80	7.80	132.2	286.8	495.8	452.5	8.73	36.5	369.7	64.2
126.0	90.0	17.0	8.90	8.20	14.20	17.10	0.000	0.63	13.84	11.70	2.9	88.1	0.133	7.80	7.90	128.8	315.7	489.9	518.6	-5.86	36.9	417.2	69.1
126.0	92.0	17.5	8.90	8.20	14.20	17.10	0.000	0.63	13.84	11.84	2.5	89.0	0.133	8.00	8.10	129.2	291.7	497.0	468.1	5.82	37.5	379.9	66.0
124.0	90.0	17.5	8.90	8.30	14.30	17.20	0.000	0.62	13.84	11.66	2.5	87.0	0.134	8.00	8.10	128.8	289.0	493.4	460.8	6.62	37.8	374.9	65.7
125.0	88.0	17.8	9.00	8.10	14.30	17.10	0.000	0.63	14.00	11.38	2.4	86.4	0.132	7.80	8.00	124.4	278.1	474.0	448.9	5.30	38.3	363.5	65.8
124.0	88.0	17.8	9.00	8.20	14.30	17.20	0.000	0.63	14.00	11.59	2.4	85.9	0.135	7.80	8.00	124.9	278.6	472.2	447.4	5.26	37.4	363.0	65.6
126.0	90.0	18.0	9.00	8.30	14.40	17.30	0.000	0.63	14.00	11.35	2.3	87.7	0.129	7.90	8.00	126.3	273.7	478.1	433.5	9.32	36.0	353.6	64.3
125.0	88.0	18.0	9.01	8.41	14.55	17.42	0.000	0.62	14.02	11.60	2.3	86.2	0.135	7.90	8.00	121.5	269.9	465.7	428.9	7.90	38.6	349.4	65.2
126.0	89.0	18.0	8.80	8.30	14.20	17.10	0.000	0.62	13.69	11.07	2.1	87.4	0.127	7.80	8.00	122.9	260.6	461.6	406.6	11.91	36.9	333.6	63.2
126.0	88.0	19.0	8.90	8.50	14.50	17.40	0.000	0.61	13.84	11.03	2.2	85.8	0.129	7.90	7.90	122.9	266.6	468.7	417.1	11.01	35.8	341.9	64.0
126.0	88.0	19.0	8.80	8.30	14.20	17.10	0.000	0.62	13.69	11.20	2.3	85.7	0.131	7.90	8.00	119.5	267.2	460.4	423.7	7.97	37.6	345.4	65.4
125.0	87.0	18.5	8.80	8.30	14.20	17.10	0.000	0.62	13.69	11.26	2.3	85.2	0.132	7.80	7.90	120.0	273.2	458.1	435.6	4.91	37.2	354.4	66.1
126.0	86.0	19.0	8.90	8.10	14.10	17.00	0.000	0.63	13.84	11.32	2.3	84.7	0.134	7.60	7.70	118.1	268.8	462.2	434.4	6.01	37.9	351.6	66.4
126.0	87.0	19.0	9.00	8.30	14.40	17.30	0.000	0.63	14.00	11.08	2.2	85.3	0.130	7.70	7.90	118.6	264.5	459.8	422.7	8.09	37.4	343.6	65.5
124.0	86.0	19.5	8.91	8.49	14.55	17.40	0.000	0.61	13.86	11.17	2.2	83.3	0.134	7.90	8.00	121.5	267.2	451.0	420.1	6.85	37.8	343.6	64.7
126.0	88.0	18.5	8.90	8.30	14.10	17.20	0.000	0.63	13.84	10.80	2.2	86.3	0.125	8.00	8.10	119.5	261.2	459.8	413.1	10.17	33.6	337.1	64.5
125.0	85.0	18.8	8.80	8.40	14.30	17.20	0.000	0.62	13.69	10.52	2.3	84.0	0.125	8.20	8.30	114.7	265.0	456.9	422.5	7.53	39.0	343.7	66.6
124.0	85.0	19.0	9.00	8.30	14.30	17.30	0.000	0.63	14.00	10.86	2.2	83.3	0.130	8.20	8.20	115.6	261.2	450.4	419.0	6.98	38.1	340.1	66.0
119.0	86.0	18.3	8.70	8.60	14.10	17.30	0.000	0.62	13.53	10.50	2.3	82.0	0.128	8.30	8.30	118.1	267.7	463.4	419.1	9.55	36.5	343.4	65.6
110.0	82.0	17.0	8.70	8.15	13.90	16.85	0.000	0.63	13.53	10.50	2.2	76.8	0.137			119.5	263.4	458.7	416.9	9.11	36.7	340.1	64.9
118.0	87.0	16.5	8.80	8.20	14.30	17.00	0.000	0.62	13.69	10.07	2.3	83.7	0.120	8.10	8.20	97.2	248.1	458.1	410.1	10.48	47.1	329.1	70.5
116.0	89.0	16.3	8.80	8.30	14.10	17.10	0.000	0.62	13.69	10.59	2.7	83.5	0.127	8.10	8.20	100.6	278.6	486.4	467.4	3.90	45.1	373.0	73.0
118.0	92.0	15.5	8.50	8.50	14.10	17.00	0.000	0.60	13.22	10.69	2.7	86.8	0.123	8.90	8.90	105.4	285.2	508.8	464.9	8.62	43.6	375.0	71.9
128.0	98.0	16.0	8.80	8.20	14.20	17.00	0.000	0.62	13.69	11.43	3.0	94.0	0.122	8.20	8.20	98.6	290.6	510.5	496.7	2.72	46.6	393.6	74.9
129.0	98.0	16.0	8.70	8.44	14.24	17.14	0.000	0.61	13.53	11.23	2.9	94.6	0.119	8.80	8.70	96.7	287.4	505.2	483.9	4.23	48.1	385.6	74.9
128.0	98.0	16.0	8.71	7.57	13.62	16.28	0.000	0.64	13.55	11.28	3.0	94.0	0.120	8.90	8.80	101.5	290.1	527.1	507.0	3.80	45.2	398.5	74.5
128.0	102.0	14.5	8.70	8.10	13.80	16.80	0.000	0.63	13.53	11.50	3.1	97.4	0.118	8.80	8.70	99.1	303.2	545.3	522.3	4.22	47.7	412.7	76.0
124.0	100.0	15.0	8.60	8.50	13.80	17.10	0.000	0.62	13.38	11.24	3.0	94.0	0.119	8.90	8.90	100.1	296.6	538.8	495.5	8.05	47.2	396.0	74.7
122.0	96.0	15.0	8.70	8.70	14.40	17.40	0.000	0.60	13.53	11.07	2.5	91.5	0.121	8.40	8.40	119.0	283.5	528.2	448.0	15.18	36.3	365.8	67.5
122.0	96.0	15.0	8.70	8.30	14.10	17.00	0.000	0.62	13.53	10.94	2.9	91.1	0.120	8.50	8.50	97.7	285.2	524.7	481.7	8.19	47.1	383.4	74.5
123.0	96.0	15.5	8.90	8.30	14.30	17.20	0.000	0.62	13.84	11.12	2.8	91.2	0.122	8.50	8.50	98.1	282.4	514.7	480.1	6.72	47.0	381.3	74.3
122.0	96.0	15.5	8.80	8.40	14.30	17.20	0.000	0.62	13.69	11.07	2.6	90.9	0.122	8.80	8.60	96.2	265.0	501.7	441.8	11.93	46.1	353.4	72.8
126.0	100.0	15.0	8.77	8.13	13.95	16.90	0.000	0.63	13.64	11.63	2.7	95.3	0.122	8.20	8.20	97.2	272.6	510.0	461.9	9.42	48.1	367.3	73.5
128.0	101.0	15.8	8.90	8.20	14.30	17.10	0.000	0.62	13.84	11.53	2.9	95.8	0.120	8.00	8.10	89.4	277.5	500.5	481.7	3.75	49.2	379.6	76.5
125.0	98.0	16.0	9.00	8.20	14.40	17.20	0.000	0.63	14.00	11.28	2.8	92.7	0.122	8.60	8.60	94.3	273.2	514.7	469.5	8.77	47.8	371.4	74.6
120.0	93.0	15.5	8.80	8.10	14.30	16.90	0.000	0.62	13.69	10.55	2.6	88.4	0.119	8.80	8.70	94.3	265.0	490.5	450.5	8.16	47.7	357.7	73.7
116.0	94.0	15.3	8.70	8.20	14.30	16.90	0.000	0.61	13.53	10.87	2.7	87.1	0.125	8.60	8.60	95.7	270.4	495.2	455.8	7.95	47.2	363.1	73.6
118.0	91.0	16.0	8.90	8.20	14.50	17.10	0.000	0.61	13.84	10.27	2.6	85.9	0.120	8.40	8.40	96.2	267.7	491.7	453.9	7.69	46.4	360.8	73.3
104.0	79.0	15.0	8.80	8.00	14.20	16.80	0.000	0.62	13.69	9.46	2.4	74.1	0.128	8.90	8.80	99.1	256.3	471.0	429.1	8.90	45.3	342.7	71.1
104.0	80.0	16.0	8.95	8.01	14.28	16.96	0.000	0.63	13.92	9.54	2.4	73.6	0.130	8.90	8.90	101.1	253.0	459.8	422.8	8.06	46.8	337.9	70.1
102.0	79.0	15.5	8.80	8.30	14.20	17.10	0.000	0.62	13.69	9.21	2.4	72.6	0.127	8.70	8.70	100.1	254.6	460.4	418.5	9.11	44.1	336.6	70.3
103.0	77.0	16.0	8.90	8.40	14.40	17.30	0.000	0.62	13.84	9.18	2.3	71.7	0.128	8.30	8.30	101.1	250.8	459.8	409.5	10.95	43.6	330.2	69.4
101.0	77.0	16.3	8.90	8.40	14.40	17.30	0.000	0.62	13.84	8.94	2.3	70.5	0.127	8.20	8.20	101.5	250.8	459.8	409.0	11.06	43.3	329.9	69.2
97.0	75.0	16.0	8.90	8.30	14.40	17.20	0.000	0.62	13.84	8.68	0.9	69.1	0.126	8.40	8.30	68.5	124.9	221.1	185.3	16.19	21.7	155.1	55.8
97.0	75.0	15.5	8.80	8.30	14.30	17.10	0.000	0.62	13.69	8.81	2.1	68.4	0.129	8.20	8.20	96.2	233.9	422.7	379.9	10.12	43.1	306.9	68.7
96.0	74.0	15.3	8.80	8.25	14.30	17.05	0.000	0.62	13.69	8.92	2.2	67.6	0.132	8.40	8.40	97.7	240.5	428.6	392.8	8.36	43.1	316.6	69.2
96.0	74.0	14.5	8.50	8.50	14.20	17.00	0.000	0.60	13.22	8.95	2.1	68.4	0.131	8.30	8.40	97.2	239.4	432.7	381.6	11.82	43.6	310.5	68.7
106.0	82.0	16.0	8.90	8.75	14.35	17.65	0.000	0.62	13.84	9.68	2.4	75.6	0.128	8.40	8.40	96.7	256.3	457.5	418.6	8.50	44.4	337.4	71.3
100.0	77.0	15.0	8.70	8.30	14.10	17.00	0.000	0.62	13.53	9.11	2.3	71.2	0.128	7.80	8.00	93.8	243.2	431.0	399.8	7.23	44.7	321.5	70.8
100.0	77.0	15.3	8.70	8.65	14.35	17.35	0.000	0.61	13.53	9.08	2.2	71.0	0.128	8.40	8.40	97.7	245.4	441.6	393.9	10.79	43.7	319.6	69.4
102.0	77.0	15.0	8.70	8.60	14.30	17.30	0.000	0.61	13.53	9.41	2.2	72.3	0.130	7.80	8.00	94.3	242.1	446.9	391.6	12.36	43.4	316.9	70.3

Field 1-6: Membrane Performance Data During Operation With The Test Water (continued)

Stage 2 Operating Parameters

Date	Time	Operation	STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2
		time	PI	PC	PP	Qp	Qc	QF	QI	vc	Recovery	FW (ToC)	FW (TavgoC)	Dp	NDP	MTCW (TavgoC	pH		TDS (mg/L)						
MM/DD/YY	hh:mm	hh.hh	(psi)	(psi)	(psi)	(gpm)	(gpm)	(gpm)	(gpm)	(fps)	(decimal)	(gfd)	(gfd)	(psi)	(psi)	(gfd/psi)	pHI	pHC	TDSp	TDSI	TDSC	TDSC(calc)	ErrorMB (%	RF (%)	CB
			#11	#14	#13	calc	FIT-14										#11	#14	#13	#11	#14				
																			0.39	0.59	0.65				
11/3/97		24.00				4.06	1.43	2.65	5.49	0.21	1.54	10.84	11.97												
11/4/97		48.00				4.07	1.43	2.65	5.50	0.21	1.54	10.85	11.94												
11/5/97		72.00				4.02	1.43	2.59	5.45	0.21	1.55	10.72	12.00												
11/6/97		96.00				3.97	1.43	2.54	5.40	0.20	1.57	10.60	11.89												
11/7/97		106.50				3.93	1.42	2.47	5.35	0.20	1.60	10.49	11.77												
11/8/97		114.50				3.98	1.63	2.98	5.61	0.22	1.34	10.62	12.15												
11/9/97		138.50				4.07	1.25	2.37	5.32	0.20	1.71	10.84	12.42												
11/10/97		162.50				4.04	1.05	2.07	5.10	0.18	1.96	10.79	12.41												
11/11/97		186.50				3.98	1.03	2.04	5.02	0.18	1.95	10.62	12.27												
11/12/97		210.50				3.91	1.51	2.49	5.42	0.21	1.57	10.44	12.33												
11/13/97		233.00				4.05	1.26	2.36	5.31	0.20	1.71	10.79	13.09												
11/14/97		257.00				4.22	1.33	2.65	5.55	0.21	1.59	11.26	14.04												
11/15/97		281.00				4.13	1.61	2.86	5.74	0.22	1.44	11.00	14.02												
11/16/97		305.00				4.11	1.61	2.82	5.72	0.22	1.46	10.97	14.02												
11/17/97		329.00				4.04	1.51	2.72	5.55	0.21	1.49	10.76	14.01												
11/18/97		353.00				4.08	1.29	2.67	5.36	0.20	1.53	10.87	14.28												
11/19/97		370.75				4.07	1.57	2.87	5.64	0.22	1.42	10.86	14.33												
11/20/97		384.00				4.03	1.18	2.24	5.21	0.19	1.80	10.75	13.94												
11/21/97		408.00				4.01	1.28	2.27	5.28	0.20	1.76	10.68	13.92												
11/22/97		421.50				3.87	1.44	2.36	5.32	0.20	1.64	10.33	13.24												
11/23/97		435.50				3.83	1.03	1.96	4.86	0.18	1.96	10.22	12.94												
11/24/97		459.50				3.80	1.19	2.02	4.99	0.18	1.88	10.14	13.12												
11/25/97		483.50				3.89	1.54	2.34	5.43	0.21	1.66	10.37	14.05												
11/26/97		507.50	88.00	70.00	11.00	3.96	1.55	2.38	5.51	0.21	1.66	10.55	14.31	3.82	64.18	0.22			104.45	272.37	605.15	700.84	-15.81	34.85	486.60
11/27/97		531.50	91.00	74.00	13.00	3.93	1.53	2.38	5.46	0.21	1.65	10.47	13.83	7.22	62.28	0.22			99.01	415.63	625.95	1227.36	-96.08	38.04	821.50
11/28/97		555.50	90.00	72.00	11.50	3.84	1.52	2.39	5.36	0.21	1.61	10.23	13.61	6.96	62.54	0.22			93.19	400.89	637.00	1176.68	-84.72	40.32	788.78
11/29/97		579.50	90.00	70.00	11.50	3.97	1.55	2.55	5.52	0.21	1.56	10.57	14.07	6.65	61.85	0.23			97.07	389.10	643.50	1135.94	-76.53	37.84	762.52
11/30/97		600.00	92.00	72.00	12.50	3.97	1.54	2.52	5.51	0.21	1.57	10.59	14.09	7.95	61.55	0.23			100.95	448.05	702.00	1344.65	-91.55	35.35	896.35
12/1/97		609.50	91.00	76.00	11.00	4.18	1.19	3.07	5.38	0.20	1.36	11.16	14.17	9.05	63.45	0.22			107.55	436.26	735.80	1589.40	-116.01	33.34	1012.83
12/2/97		633.50				4.02	1.15	3.23	5.17	0.19	1.24	10.72	14.49												
12/3/97		652.50	104.00	86.00	13.50	4.32	1.23	2.78	5.55	0.20	1.55	11.53	15.70	9.45	72.05	0.22			103.28	445.69	689.65	1650.65	-139.35	36.60	1048.17
12/5/97		658.00				12.81	1.17	11.29	13.98	0.45	1.14	34.17	45.49												
12/6/97		682.00	87.00	71.00	11.00	4.20	1.22	2.57	5.41	0.20	1.64	11.19	15.20	8.34	59.66	0.25			112.60	418.58	630.50	1473.91	-133.77	36.37	946.24
12/7/97		706.00	96.00	78.00	11.00	4.10	1.47	2.62	5.57	0.21	1.57	10.93	15.13	8.51	67.49	0.22			104.84	459.84	706.55	1450.87	-105.35	37.06	955.36
12/8/97		730.00	100.00	79.00	12.00	3.89	1.50	2.49	5.38	0.21	1.56	10.36	14.32	7.17	70.33	0.20	7.87	8.01	99.01	410.91	638.30	1221.34	-91.34	39.80	816.13
12/9/97		754.00	91.00	74.00	11.00	4.26	1.43	2.72	5.69	0.21	1.57	11.37	15.83	8.91	62.59	0.25	8.05	8.08	105.22	462.20	699.40	1530.16	-118.78	36.63	996.18
12/10/97		778.00	94.00	74.00	11.00	4.00	1.41	2.50	5.41	0.20	1.60	10.67	14.51	8.29	64.71	0.22		8.13	105.61	448.05	674.70	1420.52	-110.54	36.39	934.28
12/11/97		802.00	97.00	76.00	11.00	4.40	1.46	2.88	5.86	0.22	1.53	11.74	16.02	8.07	67.43	0.24		8.13	100.18	422.11	646.10	1393.02	-115.60	39.67	907.57
12/12/97		815.50	94.00	78.00	12.25	4.05	1.58	2.63	5.63	0.22	1.54	10.80	14.69	7.68	66.07	0.22			104.45	440.98	712.40	1303.74	-83.01	37.29	872.36
12/13/97		821.25	92.00	74.00	11.50	3.88	1.19	2.21	5.07	0.19	1.76	10.35	13.66												
12/14/97		845.25	88.00	74.00	11.00	3.98	1.10	2.22	5.08	0.18	1.79	10.61	14.56	8.41	61.59	0.24			100.95	400.89	669.50	1482.41	-121.42	42.96	941.65
12/15/97		868.92	106.00	88.00	13.00	3.88	1.35	2.43	5.23	0.20	1.60	10.35	14.59	8.29	75.71	0.19		8.07	105.61	445.10	698.10	1424.14	-104.00	37.57	934.62
12/16/97		892.92	95.00	69.00	11.00	4.04	1.49	2.67	5.54	0.21	1.51	10.78	15.01	8.37	62.63	0.24		8.13	107.16	462.79	763.75	1425.15	-86.60	36.45	943.97
12/17/97		916.92	93.00	76.00	11.00	4.02	1.49	2.65	5.51	0.21	1.52	10.71	14.65	8.10	65.40	0.22	7.77	7.89	106.00	451.00	728.00	1380.87	-89.68	35.76	915.94
12/18/97		940.92	94.00	77.00	11.00	4.03	1.28	2.43	5.31	0.20	1.66	10.75	14.97	8.94	65.56	0.23		7.98	104.45	452.18	728.65	1545.43	-112.09	36.90	998.80
12/19/97		964.92	95.00	78.00	11.25	4.07	1.07	2.22	5.14	0.19	1.83	10.84	14.88	10.45	64.80	0.23	7.93	7.97	109.11	469.28	777.40	1838.34	-136.47	34.08	1153.81
12/20/97		988.92	94.00	76.00	11.50	4.07	1.11	2.28	5.17	0.19	1.78	10.84	14.83	10.39	63.11	0.23	7.93	7.97	106.39	472.22	778.05	1817.95	-133.65	32.54	1145.09
12/21/97		1012.92	91.00	76.00	10.50	4.01	1.28	2.35	5.29	0.20	1.71	10.71	14.91	8.18	64.82	0.23	7.84	7.78	135.90	453.95	747.50	1454.81	-94.62	23.21	954.38
12/22/97		1035.33	95.00	78.00	11.50	4.04	1.46	2.85	5.51	0.21	1.42	10.78	14.97	8.47	66.53	0.23	7.86	7.95	106.78	462.20	746.85	1444.88	-93.46	36.09	953.54
12/23/97		1048.50	95.00	77.00	11.00	4.01	1.40	2.84	5.41	0.20	1.42	10.70	14.73	8.51	66.49	0.22	7.83	7.92	105.22	454.54	740.35	1457.90	-96.92	35.21	956.22
12/24/97		1072.50	96.00	78.00	11.25	4.01	1.25	2.91	5.25	0.19	1.37	10.68	14.74	9.40	66.35	0.22	7.91	7.97	108.33	468.69	768.95	1627.29	-111.62	33.93	1047.99
12/25/97		1096.50	91.00	74.00	11.20	4.03	1.40	2.96	5.43	0.20	1.36	10.75	15.06	7.86	63.44	0.24	7.51	7.47	120.37	442.16	689.00	1370.23	-98.87	29.92	906.19
12/26/97		1120.50	93.00	75.00	11.00	4.02	1.31	2.53	5.33	0.20	1.59	10.72	14.16	9.19	63.81	0.22	7.89	7.95	112.60	474.58	756.60	1589.04	-110.02	33.84	1031.81
12/27/97		1140.83	95.00	77.00	11.00	3.95	1.18	2.31	5.12	0.19	1.71	10.52	14.19	10.01	64.99	0.22	7.95	8.01	113.38	486.96	768.30	1741.47	-126.67	34.98	1114.21
12/28/97		1145.33																							
12/29/97		1156.17	92.00	74.00	11.50	3.91	1.45	2.56	5.36	0.20	1.53	10.43	13.77	8.54	62.96	0.22	7.64	7.73	122.31	486.37	791.05	1466.72	-85.41	33.05	976.54
12/30/97		1180.17	100.00	81.00	11.00	3.60	1.46	2.16	5.05	0.19	1.67	9.59	13.24	8.73	70.77	0.19	7.97	8.04	126.97	517.62	802.75	1481.50	-84.55	32.24	999.56
12/31/97		1204.17	104.00	86.00	11.00	3.29	1.28	1.46	4.57	0.17	2.25	8.77	12.29	8.84	75.16	0.16	7.95	8.02	133.96	521.16	767.65	1514.54	-97.30	31.19	1017.85
1/1/98		1228.17	126.00	110.00	11.50	3.43	1.35	1.66	4.77	0.18	2.07	9.13	13.22	9.68	96.82	0.14	7.98	8.02	146.77	573.04	810.55	1657.06	-104.44	28.07	1115.05
1/2/98		1252.17	131.00	116.00	11.00	3.74	1.38	2.20	5.12	0.19	1.70	9.97	14.42	8.41	104.09	0.14	7.84	7.83	132.01	489.32	692.25	1455.82	-110.30	25.40	972.57
1/3/98		1276.17	160.00	141.00	11.00	3.53	1.37	1.90	4.89	0.19	1.86	9.40	13.25	9.97	129.53	0.10	8.21	8.24	161.14	596.62	845.00	1719.96	-103.55	20.21	1158.29
1/7/98		1300.17	96.00	80.00	11.75	3.99	1.29	2.22	5.28	0.20	1.79	10.63	14.08	10.34	65.91	0.21	8.20	8.20	144.83	551.22	885.30	1807.15	-104.13	30.44	1179.19
1/8/98		1311.42	95.00	78.00	12.00	4.04	1.42	2.37	5.46	0.21	1.70	10.76	14.30	9.63	64.87	0.22	8.20	8.20	140.17	538.25	867.75	1667.52	-92.17	31.82	1102.89
1/9/98		1330.17	92.00	77.00	12.00	3.96	1.28	2.84	5.24	0.19	1.39	10.56	13.58	9.69	62.81	0.22	8.00	8.10	140.56	521.16	846.30	1698.63	-100.71	31.46	1109.89
1/10/98		1354.17	93.00	76.00	11.50	3.99	1.41	2.55	5.40	0.20	1.56	10.64	13.92	9.13	63.87	0.22	7.80	8.00	137.84	515.85	760.50	1585.54	-108.49	24.34	1050.69
1/11/98		1378.17	94.00	76.00	11.50	4.00	1.40	2.50	5.40	0.20	1.60	10.67	13.84	9.55	63.95	0.22	8.00	8.10	137.45	530.59	817.05	1653.84	-102.42	32.29	1092.21
1/12/98		1400.92	95.00	76.00	12.25	3.90	1.50	2.40	5.40	0.21	1.63	10.40	13.29	9.50	63.75	0.21	8.00	8.00	138.23	551.22	826.80	1625.01	-96.54	32.77	1088.12
1/13/98		1424.17	94.00	75.00	11.50	4.00	1.40	2.50	5.40	0.20	1.60	10.67	13.47	10.19	62.81	0.21	8.00	8.00	139.78	559.48	852.80	1758.61	-106.22	30.79	1159.04
1/14/98		1447.92	98.00	78.00	12.00	3.80	1.40	2.20	5.20	0.20	1.73	10.13	13.50	9.81	66.19	0.20	7.90	8.00	139.00	555.35	835.25	1685.43	-101.79	32.90	1120.39
1/15/98		1471.92	100.00	83.00	12.50	3.80	1.50	2.40	5.30	0.20	1.58	10.13	13.54	9.43	69.57	0.19	7.90	8.00	139.78	555.94	852.80	1610.21	-88.81	32.69	1083.07
1/16/98		1495.92	101.00	84.00	12.50	3.70	1.50	2.20	5.20	0.20	1.68	9.87	13.30	9.29	70.71	0.19	7.90	8.00	135.90	551.81	839.15	1577.73	-88.02	33.05	1064.77
1/17/98		1519.92	103.00	75.00	12.50	3.89	1.63	2.51	5.52	0.21	1.55	10.37	14.44	9.04	67.46	0.21	7.80	7.80	135.90	548.27	767.00	1532.41	-99.79	36.32	1040.34
1/18/98		1543.92	107.00	90.00	10.50	4.00	1.20	2.30	5.20	0.19	1.74	10.67	14.34	11.03	76.97	0.19	7.80	7.90	132.40	545.92	794.30	1924.29	-142.26	35.11	1235.11
1/19/98		1567.92	108.00	92.00	12.50	4.10	1.30	2.40	5.40	0.20	1.71	10.93	15.09	10.70	76.80	0.20	7.90	8.00	137.84	552.99	856.70	1862.32	-117.38	32.62	1207.65
1/20/98		1575.92	110.00	94.00	12.50	3.90	1.30	2.20	5.20	0.19	1.77	10.40	14.06	10.35	79.15	0.18	7.90	8.00	138.23	552.40	851.50	1794.92	-110.80	32.60	1173.66
1/21/98		1582.92	102.00	85.00	12.50	4.20	1.40	3.00	5.60	0.21	1.40	11.20	15.28	10.59	70.41	0.22	7.60	7.80	137.45	561.24	921.70	1832.63	-98.83	34.47	1196.94
1/22/98		1605.42	102.00	84.00	12.75	4.00	1.40	2.70	5.40	0.20	1.48	10.67	14.72	10.37	69.88	0.21	7.90	8.00	133.57	560.65	924.30	1780.90	-92.68	34.87	1170.78
1/23/98		1629.42	104.00	87.00	12.50	4.20	1.50	2.60	5.70	0.22	1.62	11.20	15.60	10.02	72.98	0.21	8.00	8.00	134.73	552.40	897.00	1721.87	-91.96	34.47	1137.14
1/24/98		1653.42	98.00	74.00	12.50	3.93	1.55	2.44	5.48	0.21	1.61	10.48	14.68	9.44	64.06	0.23	8.00	8.00	132.01	548.27	877.50	1603.69	-82.76	34.97	1075.98
1/25/98		1677.42	102.00	86.00	11.50	4.10	1.40	2.60	5.50	0.21	1.58	10.93	14.87	9.95	72.55	0.20	7.90	8.00	131.63	535.30	889.20	1717.51	-93.15	34.15	1126.40

Field 2-6: Membrane Performance Data During Operation With The Test Water (continued)

Stage 2 Operating Parameters

Sheet2. Weeks 11-20

STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2		STAGE 2	
P_I	P_C	P_P	Q_p	Qc	Q_F	Q_I	v_c	Recovery	F_W (T°C)	F_W (Tavg°C)	Δπ	NDP	MTC_W (Tavg°C)	pH		TDS (mg/L)							
(psi)	(psi)	(psi)	(gpm)	(gpm)	(gpm)	(gpm)	(fps)	(decimal)	(gfd)	(gfd)	(psi)	(psi)	(gfd/psi)	pH_I	pH_C	TDS_p	TDS_I	TDS_C	$TDS_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
104.0	88.0	12.5	4.00	1.30	2.40	5.30	0.000	1.67	6.22	5.32	10.5	73.0	0.073	7.90	8.00	135.1	549.5	883.4	1824.3	-106.52	33.1	1186.9	88.6
104.0	88.0	12.5	4.10	1.40	2.60	5.50	0.000	1.58	6.38	5.52	10.1	73.4	0.075	7.80	7.90	136.3	546.5	872.3	1747.9	-100.37	33.9	1147.2	88.1
103.0	87.0	12.5	3.90	1.20	2.10	5.10	0.000	1.86	6.07	5.26	10.7	71.8	0.073	7.90	8.00	135.9	545.3	880.1	1876.0	-113.15	34.1	1210.6	88.8
101.0	85.0	12.5	3.90	1.10	2.10	5.00	0.000	1.86	6.07	5.17	11.6	68.9	0.075	7.80	7.90	135.1	554.8	898.3	2042.6	-127.38	36.7	1298.7	89.6
101.0	85.0	12.5	4.10	1.40	2.70	5.50	0.000	1.52	6.38	5.37	10.1	70.4	0.076	7.90	8.00	137.8	548.9	887.3	1752.6	-97.53	33.1	1150.7	88.0
102.0	85.0	12.5	3.90	1.30	2.30	5.20	0.000	1.70	6.07	5.08	10.4	70.6	0.072	7.80	7.90	138.6	553.6	898.3	1798.5	-100.21	33.1	1176.0	88.2
94.0	86.0	12.0	4.00	1.40	2.50	5.40	0.000	1.60	6.22	5.32	10.0	68.0	0.078	7.80	7.90	136.7	547.1	890.5	1719.7	-93.12	34.5	1133.4	87.9
102.0	84.0	12.8	3.90	1.30	2.30	5.20	0.000	1.70	6.07	5.10	10.1	70.1	0.073	7.80	8.00	138.2	543.0	878.8	1757.2	-99.95	33.3	1150.1	88.0
87.0	72.0	13.0	4.00	1.30	2.90	5.30	0.000	1.38	6.22	5.18	8.0	58.5	0.088	0.00		155.7	469.3	750.8	1434.1	-91.03	26.3	951.7	83.6
87.0	72.0	13.0	4.10	1.00	2.70	5.10	0.000	1.52	6.38	5.25	9.7	56.8	0.092	7.80	7.80	147.9	466.9	765.1	1774.8	-131.98	27.7	1120.8	86.8
87.0	68.0	12.5	4.10	1.50	2.70	5.60	0.000	1.52	6.38	5.33	7.8	57.2	0.093	7.80	7.90	146.0	475.8	709.2	1377.1	-94.19	29.7	926.4	84.2
87.0	69.0	12.3	3.90	1.50	2.40	5.40	0.000	1.63	6.07	5.19	7.7	58.0	0.089	7.80	7.90	146.4	482.2	722.8	1355.5	-87.53	29.7	918.9	84.1
88.0	69.0	12.0	3.90	1.30	2.20	5.20	0.000	1.77	6.07	5.26	8.8	57.7	0.091	7.80	7.90	165.8	517.0	772.2	1570.7	-103.41	27.8	1043.9	84.1
84.0	68.0	12.3	3.95	1.14	2.02	5.09	0.000	1.96	6.14	5.32	9.6	54.1	0.098	7.90	8.00	155.3	507.0	776.8	1725.6	-122.16	29.0	1116.3	86.1
92.0	72.0	13.0	4.00	1.40	2.50	5.40	0.000	1.60	6.22	5.32	8.5	60.5	0.088	7.80	8.00	153.0	502.9	765.7	1502.6	-96.24	28.1	1002.7	84.7
92.0	74.0	13.0	4.00	1.30	2.40	5.30	0.000	1.67	6.22	5.35	9.0	61.0	0.088	7.90	8.00	153.4	507.6	770.9	1597.5	-107.23	29.0	1052.6	85.4
89.0	71.0	13.0	3.90	1.50	2.40	5.40	0.000	1.63	6.07	5.10	8.2	58.8	0.087	7.90	8.00	152.6	507.6	757.3	1430.6	-88.92	29.0	969.1	84.3
89.0	71.0	13.0	4.00	1.20	2.30	5.20	0.000	1.74	6.22	5.15	9.4	57.6	0.089	8.00	8.00	151.4	502.9	770.3	1674.4	-117.38	29.0	1088.6	86.1
87.0	69.0	13.3	4.00	1.40	2.50	5.40	0.000	1.60	6.22	5.03	8.3	56.4	0.089	8.00	8.00	151.0	493.4	758.6	1471.8	-94.02	28.0	982.6	84.6
87.0	70.0	13.3	4.00	1.40	2.60	5.40	0.000	1.54	6.22	5.07	8.3	56.9	0.089	7.90	8.00	147.5	489.3	753.4	1465.8	-94.57	29.0	977.6	84.9
90.0	70.0	13.0	4.00	1.50	2.60	5.50	0.000	1.54	6.22	5.20	8.2	58.8	0.088	7.80	8.00	145.6	495.8	757.3	1429.7	-88.80	30.1	962.7	84.9
90.0	72.0	12.5	3.90	1.40	2.40	5.30	0.000	1.63	6.07	5.13	8.3	60.2	0.085	7.90	8.00	143.7	489.9	727.4	1454.5	-99.97	29.6	972.2	85.2
92.0	74.0	12.8	3.90	1.40	2.40	5.30	0.000	1.63	6.07	5.19	8.4	61.9	0.084	8.10	8.10	146.4	497.0	760.5	1473.7	-93.78	29.2	985.3	85.1
90.0	71.0	12.8	3.90	1.50	2.50	5.40	0.000	1.56	6.07	5.11	8.0	59.8	0.086	8.10	8.20	146.0	493.4	750.1	1396.8	-86.22	29.5	945.1	84.6
88.0	70.0	13.0	3.90	1.40	2.50	5.30	0.000	1.56	6.07	4.93	8.0	58.0	0.085	8.00	8.00	141.7	474.0	733.9	1399.6	-90.72	29.6	936.8	84.9
88.0	70.0	13.0	3.90	1.40	2.40	5.30	0.000	1.63	6.07	5.02	7.9	58.1	0.086	8.00	8.00	140.6	472.2	705.3	1396.2	-97.97	29.5	934.2	85.0
90.0	70.0	12.5	4.00	1.40	2.50	5.40	0.000	1.60	6.22	5.04	8.2	59.3	0.085	8.00	8.00	140.6	478.1	724.1	1442.6	-99.22	28.7	960.4	85.4
88.0	69.0	13.0	4.09	1.45	2.67	5.54	0.000	1.53	6.36	5.27	7.9	57.6	0.091	8.00	8.10	139.8	465.7	728.0	1385.2	-90.27	29.3	925.5	84.9
89.0	70.0	13.0	4.00	1.40	2.50	5.40	0.000	1.60	6.22	5.03	7.8	58.7	0.086	8.00	8.10	139.8	461.6	735.8	1381.1	-87.70	28.2	921.4	84.8
88.0	68.0	13.0	4.10	1.50	2.70	5.60	0.000	1.52	6.38	5.08	7.9	57.1	0.089	7.90	8.10	135.5	468.7	715.0	1379.4	-92.92	29.3	924.0	85.3
88.0	69.0	13.0	4.10	1.30	2.50	5.40	0.000	1.64	6.38	5.22	8.4	57.1	0.091	8.00	8.00	134.7	460.4	710.5	1487.6	-109.39	29.7	974.0	86.2
87.0	68.0	12.8	3.60	1.80	2.50	5.40	0.000	1.44	5.60	4.61	6.5	58.3	0.079	7.90	8.00	135.1	458.1	706.6	1104.0	-56.25	29.3	781.0	82.7
86.0	67.0	13.0	4.00	1.20	2.30	5.20	0.000	1.74	6.22	5.09	8.8	54.7	0.093	7.70	7.80	132.4	462.2	704.6	1561.5	-121.62	30.3	1011.9	86.9
87.0	68.0	13.0	4.00	1.40	2.50	5.40	0.000	1.60	6.22	4.93	7.9	56.6	0.087	7.90	8.00	134.0	459.8	704.6	1390.9	-97.41	29.3	925.4	85.5
86.0	67.0	13.0	4.19	1.45	2.79	5.64	0.000	1.50	6.52	5.25	7.8	55.7	0.094	8.00		132.0	451.0	702.0	1372.8	-95.55	32.4	911.9	85.5
88.0	68.0	12.8	3.90	1.30	2.10	5.20	0.000	1.86	6.07	4.73	8.2	57.0	0.083	8.10	8.20	133.6	459.8	692.3	1438.7	-107.83	25.8	949.3	85.9
85.0	66.0	12.8	4.00	1.50	2.60	5.50	0.000	1.54	6.22	4.78	7.5	55.2	0.087	8.30	8.30	133.6	456.9	689.0	1319.1	-91.45	28.9	888.0	85.0
85.0	65.0	13.0	3.90	1.40	2.30	5.30	0.000	1.70	6.07	4.71	7.6	54.4	0.087	8.20	8.40	132.4	450.4	674.7	1336.3	-98.06	29.1	893.3	85.2
86.0	67.0	12.5	4.10	1.30	2.20	5.40	0.000	1.86	6.38	4.95	8.4	55.6	0.089	8.30	8.40	135.5	463.4	692.3	1497.4	-116.31	27.1	980.4	86.2
82.0	64.0	13.0	4.12	1.08	2.25	5.20	0.000	1.83	6.41	4.97	9.2	50.8	0.098			140.6	458.7	685.8	1672.2	-143.85	25.6	1065.4	86.8
87.0	68.0	13.0	4.00	1.50	2.80	5.50	0.000	1.43	6.22	4.58	7.4	57.1	0.080	8.20	8.30	139.0	458.1	728.0	1308.9	-79.80	24.3	883.5	84.3
89.0	69.0	12.8	3.90	1.40	2.30	5.30	0.000	1.70	6.07	4.69	8.3	57.9	0.081	8.20	8.20	137.8	486.4	755.3	1457.3	-92.94	24.8	971.8	85.8
92.0	73.0	12.3	4.10	1.50	2.70	5.60	0.000	1.52	6.38	5.16	8.8	61.5	0.084	8.90	8.80	138.6	508.8	759.9	1520.5	-100.11	25.8	1014.7	86.3
98.0	78.0	12.8	4.00	1.40	2.60	5.40	0.000	1.54	6.22	5.20	9.0	66.2	0.078	8.20	8.30	138.2	510.5	778.7	1574.3	-102.17	25.2	1042.4	86.7
98.0	77.0	13.0	4.12	1.42	2.64	5.54	0.000	1.56	6.41	5.32	9.1	65.4	0.081	8.70	8.70	132.0	505.2	791.7	1588.1	-100.60	29.2	1046.7	87.4
98.0	78.0	12.8	3.84	1.07	2.25	4.91	0.000	1.71	5.97	4.97	10.9	64.3	0.077	8.80	8.70	137.5	527.1	800.8	1925.2	-140.41	25.8	1226.1	88.8
102.0	80.0	12.3	3.90	1.20	2.10	5.10	0.000	1.86	6.07	5.16	10.6	68.1	0.076	8.70	8.60	140.2	545.3	834.0	1862.1	-123.29	26.0	1203.7	88.4
100.0	81.0	12.5	4.10	1.10	1.90	5.20	0.000	2.16	6.38	5.36	11.4	66.6	0.080	8.90	8.80	140.2	538.8	835.9	2024.8	-142.23	26.0	1281.8	89.1
96.0	78.0	12.5	4.20	1.50	2.70	5.70	0.000	1.56	6.53	5.34	9.4	65.1	0.082	8.40	8.40	138.2	528.2	817.7	1620.2	-98.15	26.0	1074.2	87.1
96.0	77.0	12.8	4.10	1.30	2.50	5.40	0.000	1.64	6.38	5.16	10.0	63.8	0.081	8.50	8.40	137.1	524.7	821.0	1747.2	-112.83	25.8	1136.0	87.9
96.0	77.0	13.0	3.90	1.50	2.50	5.40	0.000	1.56	6.07	4.87	8.7	64.8	0.075	8.50	8.50	135.9	514.7	789.1	1499.5	-90.02	26.7	1007.1	86.5
96.0	77.0	13.0	4.00	1.50	2.60	5.50	0.000	1.54	6.22	5.03	8.8	64.7	0.078	8.60	8.60	123.1	501.7	772.2	1511.3	-95.72	31.1	1006.5	87.8
100.0	79.0	12.8	3.82	1.36	2.23	5.18	0.000	1.71	5.94	5.07	9.1	67.6	0.075	8.20	8.20	130.1	510.0	806.0	1577.0	-95.65	30.6	1043.5	87.5
101.0	82.0	13.0	4.00	1.40	2.60	5.40	0.000	1.54	6.22	5.18	9.1	69.4	0.075	8.10	8.10	127.7	500.5	786.5	1565.6	-99.06	27.4	1033.1	87.6
98.0	80.0	13.3	4.00	1.40	2.60	5.40	0.000	1.54	6.22	5.01	9.3	66.5	0.075	8.60	8.60	133.2	514.7	800.2	1604.6	-100.54	26.3	1059.7	87.4
93.0	75.0	13.0	4.00	1.50	2.90	5.50	0.000	1.38	6.22	4.80	8.4	62.6	0.077	8.70	8.70	131.6	490.5	776.1	1447.5	-86.51	26.9	969.0	86.4
94.0	77.0	12.8	4.10	1.50	3.00	5.60	0.000	1.37	6.38	5.12	8.6	64.2	0.080	8.60	8.60	132.4	495.2	778.1	1486.9	-91.11	26.9	991.1	86.6
91.0	72.0	13.3	4.10	1.50	3.00	5.60	0.000	1.37	6.38	4.73	8.5	59.8	0.079	8.40	8.40	132.8	491.7	765.7	1472.6	-92.33	26.1	982.2	86.5
79.0	63.0	12.5	4.10	1.30	2.80	5.40	0.000	1.46	6.38	4.41	8.6	49.9	0.088	8.80	8.80	135.5	471.0	741.0	1529.3	-106.38	25.2	1000.2	86.5
80.0	64.0	13.0	4.17	1.16	2.65	5.33	0.000	1.57	6.49	4.44	9.1	49.9	0.089	8.90	8.80	134.0	459.8	722.8	1631.4	-125.70	29.5	1045.6	87.2
79.0	62.0	13.0	4.00	1.40	2.50	5.40	0.000	1.60	6.22	4.19	7.9	49.6	0.084	8.70	8.70	134.3	460.4	710.5	1392.1	-95.95	25.0	926.3	85.5
77.0	60.0	13.0	4.10	1.40	2.60	5.50	0.000	1.58	6.38	4.23	8.0	47.5	0.089	8.30	8.30	135.5	459.8	710.5	1409.7	-98.42	24.3	934.8	85.5
77.0	61.0	13.3	4.10	1.40	2.60	5.50	0.000	1.58	6.38	4.12	8.0	47.8	0.086	8.20	8.20	135.9	459.8	707.9	1408.5	-98.99	24.1	934.2	85.5
75.0	59.0	13.0	4.10	1.40	2.70	5.50	0.000	1.52	6.38	4.00	3.8	50.2	0.080	8.30	8.30	67.6	221.1	343.2	670.7	-95.42	22.7	445.9	84.8
75.0	59.0	13.0	4.10	1.40	2.70	5.50	0.000	1.52	6.38	4.11	7.2	46.8	0.088	8.20	8.20	128.5	422.7	652.0	1284.2	-96.98	24.0	853.5	84.9
74.0	58.0	12.8	4.00	1.50	2.75	5.50	0.000	1.45	6.22	4.05	7.0	46.3	0.088	8.40	8.40	129.3	428.6	650.7	1226.7	-88.54	24.7	827.7	84.4
74.0	58.0	12.0	4.10	1.60	2.90	5.70	0.000	1.41	6.38	4.32	7.0	47.0	0.092	8.40	8.20	127.7	432.7	652.6	1214.2	-86.06	25.9	823.5	84.5
82.0	65.0	13.3	4.00	1.45	2.15	5.45	0.000	1.86	6.22	4.35	7.8	52.5	0.083	8.40	8.40	130.5	457.5	687.7	1359.6	-97.71	25.0	908.6	85.6
77.0	60.0	12.5	4.10	1.30	2.50	5.40	0.000	1.64	6.38	4.29	7.9	48.1	0.089	8.00	8.00	125.4	431.0	658.5	1394.6	-111.80	26.1	912.8	86.3
77.0	60.0	12.8	4.10	1.55	2.65	5.65	0.000	1.55	6.38	4.28	7.2	48.5	0.088	8.40	8.40	130.1	441.6	667.6	1265.5	-89.58	25.0	853.5	84.8
77.0	63.0	12.8	4.20	1.40	2.60	5.60	0.000	1.62	6.53	4.54	8.0	49.2	0.092	8.00	8.00	126.2	446.9	681.9	1408.9	-106.63	24.2	927.9	86.4

Field 1-7: System And Stage Water Quality For Week 2

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.89
System feed flow rate during sample collection (gpm)	14.20
System influent flow rate during sample collection (gpm)	17.20

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-2	$C_{F\text{-}sys}$-2	$C_{C\text{-}sys}$-2	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	11/13/97	11/13/97	11/13/97	---	---	---	---	---
Sampling time	hh:mm	12:45	12:45	12:45	---	---	---	---	---
Operation time	hh.hh	323.75	323.75	323.75	---	---	---	---	---
pH	---	NR	NR	NR	---	---	---	---	---
Temperature	°C	9.2	9.4	NR	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	18.0	34.0	148.0	169.5	-14.50	47.1	113.5	84.1
Total dissolved solids	mg/L	83.4	162.0	600.6	827.6	-37.80	48.5	552.9	84.9
Total hardness	mg/L as $CaCO_3$	20.0	65.0	322.0	446.0	-38.51	69.2	288.7	93.1
Calcium hardness	mg/L as $CaCO_3$	17.0	51.0	216.0	338.9	-56.88	66.7	220.0	92.3
Turbidity	ntu	0.02	0.02	0.08	0.04	43.74	10.9	0.04	42.1
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.70	32.10	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0006	0.094	0.678	0.887	-30.88	99.4	0.560	99.9
SUVA	L/(mg*m)	#VALUE!	2.00	2.11	---	---	---	---	---
Bromide	µg/L	41.5	41.5	---	41.5	---	0.0	41.5	0.0
SDS-Cl_2 dose	mg/L	2.80	2.80	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	2.66	1.11	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.14	1.69	---	14.81	---	91.7	9.40	98.5
SDS-Chlorination temp.	°C	9.0	9.0	---	---	---	---	---	---
SDS-Chlorination pH	---	7.10	7.10	---	---	---	---	---	---
SDS-Incubation time	hours	6.0	6.0	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	300.00	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	33.90	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	10.30	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	1.60	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	45.80	---	433.57	---	100.0	273.50	100.0
SDS-*MCAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	13.50	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	24.20		#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	2.60	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	37.70	---	356.89	---	100.0	225.13	100.0
SDS-HAA6	µg/L	0.00	40.30	---	381.51	---	100.0	240.66	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	-57.2	21.4
SDS-$THM4_b$, µg/L	NA	36.00
SDS-$HAA5_b$, µg/L	NA	29.63
SDS-TOX_b, µg Cl^-/L	NA	#VALUE!
SDS-CD_b, mg/L	NA	1.36
TOC_b, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.074
$Bromide_b$, µg/L	NA	41.5
Alk_b, mg/L $CaCO_3$	NA	30.6
T-Hd_b, mg/L $CaCO_3$	NA	55.4
Ca-Hd_b, mg/L $CaCO_3$	NA	43.7

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	-43.2	28.4
SDS-$THM4_b$, µg/L	NA	32.80
SDS-$HAA5_b$, µg/L	NA	27.00
SDS-TOX_b, µg Cl^-/L	NA	#VALUE!
SDS-CD_b, mg/L	NA	1.25
TOC_b, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.068
$Bromide_b$, µg/L	NA	41.5
Alk_b, mg/L $CaCO_3$	NA	29.5
T-Hd_b, mg/L $CaCO_3$	NA	52.2
Ca-Hd_b, mg/L $CaCO_3$	NA	41.4

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs. i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 1-7: System And Stage Water Quality For Week 2 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.64
Stage 1 permeate flow rate during sample collection (gpm)	9.10
Stage 1 influent flow rate during sample collection (gpm)	17.20

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	$C_{p\text{-}s1}$-2	$C_{i\text{-}s1}$-2	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	11/13/97	11/13/97	---	---	---	---
Sampling time	hh:mm	12:45	12:45	---	---	---	---
Operation time	hh.hh	323.75	323.75	---	---	---	---
pH	---	NR	NR	---	---	---	---
Temperature	°C	NR	NR	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	12.0	58.0	109.7	64.7	83.8	85.7
Total dissolved solids	mg/L	86.0	231.1	394.0	46.9	312.6	72.5
Total hardness	mg/L as $CaCO_3$	18.0	108.0	209.1	72.3	158.6	88.6
Calcium hardness	mg/L as $CaCO_3$	14.0	75.0	143.5	72.5	109.3	87.2
Turbidity	ntu	0.02	0.13	0.25	17.4	0.19	89.8
Total organic carbon	mg/L	BMRL	9.80	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0005	0.190	0.403	99.5	0.296	99.8
SUVA	L/(mg*m)	#VALUE!	1.94	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.71
Stage 2 permeate flow rate during sample collection (gpm)	3.60
Stage 2 influent flow rate during sample collection (gpm)	8.10

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	$C_{p\text{-}s2}$-2	$C_{i\text{-}s2}$-2	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	11/13/97	11/13/97	---	---	---	---
Sampling time	hh:mm	12:45	12:45	---	---	---	---
Operation time	hh.hh	323.75	323.75	---	---	---	---
pH	---	NR	NR	---	---	---	---
Temperature	°C	NR	NR	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	26.0	92.0	144.8	23.5	118.4	78.0
Total dissolved solids	mg/L	102.0	388.2	617.2	37.0	502.7	79.7
Calcium hardness	mg/L as $CaCO_3$	26.0	122.0	198.8	49.0	160.4	83.8
Turbidity	ntu	0.01	0.08	0.15	76.1	0.11	95.2
Total organic carbon	mg/L	BMRL	20.10	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0009	0.400	0.719	99.0	0.560	99.8
SUVA	L/(mg*m)	#VALUE!	1.99	---	---	---	---

Field 1-8: System And Stage Water Quality For Week 4

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.92
System feed flow rate during sample collection (gpm)	13.98
System influent flow rate during sample collection (gpm)	16.69

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-4	$C_{F\text{-}sys}$-4	$C_{C\text{-}sys}$-4	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	12/3/97	12/3/97	12/3/97	---	---	---	---	---
Sampling time	hh:mm	10:15	10:15	10:15	---	---	---	---	---
Operation time	hh.hh	643.75	643.75	643.75	---	---	---	---	---
pH	---	NR	NR	NR	---	---	---	---	---
Temperature	°C	NR	NR	NR	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	16.0	36.0	188.0	261.8	-39.23	55.6	167.2	90.4
Total dissolved solids	mg/L	59.8	163.1	689.7	1329.3	-92.74	63.4	840.9	92.9
Total hardness	mg/L as $CaCO_3$	20.0	67.0	414.0	597.5	-44.33	70.1	375.4	94.7
Calcium hardness	mg/L as $CaCO_3$	16.0	42.0	270.0	335.5	-24.25	61.9	212.6	92.5
Turbidity	ntu	0.04	0.08	0.14	0.53	-279.65	50.0	0.34	88.3
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	3.80	32.80	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.001	0.092	0.755	1.121	-48.51	99.3	0.690	99.9
SUVA	L/(mg*m)	#VALUE!	2.42	2.30	---	---	---	---	---
Bromide	µg/L	37.9	39.3	---	55.1	---	3.6	48.5	21.8
SDS-Cl_2 dose	mg/L	1.00	2.80	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.91	1.05	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.09	1.75	---	20.49	---	94.9	12.64	99.3
SDS-Chlorination temp.	°C	9.0	9.0	---	---	---	---	---	---
SDS-Chlorination pH	---	7.10	7.10	---	---	---	---	---	---
SDS-Incubation time	hours	6.0	6.0	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	282.00	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	43.60	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	8.80	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	1.40	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	53.80	---	661.09	---	100.0	406.79	100.0
SDS-*MCAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	14.90	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	21.20	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	2.80	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	36.10	---	443.59	---	100.0	272.96	100.0
SDS-HAA6	µg/L	0.00	38.90	---	478.00	---	100.0	294.13	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	-33.8	33.1
SDS-$THM4_b$, µg/L	NA	36.00
SDS-$HAA5_b$, µg/L	NA	24.16
SDS-TOX_b, µg Cl^-/L	NA	#VALUE!
SDS-CD_b, mg/L	NA	1.20
TOC_b, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.062
$Bromide_b$, µg/L	NA	38.8
Alk_b, mg/L $CaCO_3$	NA	29.4
T-Hd_b, mg/L $CaCO_3$	NA	51.4
Ca-Hd_b, mg/L $CaCO_3$	NA	33.4

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	-49.6	25.2
SDS-$THM4_b$, µg/L	NA	40.24
SDS-$HAA5_b$, µg/L	NA	27.00
SDS-TOX_b, µg Cl^-/L	NA	#VALUE!
SDS-CD_b, mg/L	NA	1.33
TOC_b, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.069
$Bromide_b$, µg/L	NA	38.9
Alk_b, mg/L $CaCO_3$	NA	31.0
T-Hd_b, mg/L $CaCO_3$	NA	55.2
Ca-Hd_b, mg/L $CaCO_3$	NA	35.4

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs, i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 1-8: System And Stage Water Quality For Week 4 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.64
Stage 1 permeate flow rate during sample collection (gpm)	8.75
Stage 1 influent flow rate during sample collection (gpm)	16.69

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s1}-4	C_{i-s1}-4	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	12/3/97	12/3/97	---	---	---	---
Sampling time	hh:mm	10:15	10:15	---	—	---	---
Operation time	hh.hh	643.75	643.75	---	---	---	---
pH	---	NR	NR	---	---	---	---
Temperature	°C	NR	NR	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	15.0	60.0	109.5	58.3	84.8	82.3
Total dissolved solids	mg/L	83.6	247.4	427.8	48.7	337.6	75.2
Total hardness	mg/L as $CaCO_3$	17.0	126.0	246.0	74.6	186.0	90.9
Calcium hardness	mg/L as $CaCO_3$	13.0	82.0	157.9	69.0	120.0	89.2
Turbidity	ntu	0.07	0.08	0.09	12.5	0.09	18.1
Total organic carbon	mg/L	BMRL	7.00	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.001	0.049	0.102	99.5	0.076	99.3
SUVA	L/(mg*m)	#VALUE!	0.70	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.83
Stage 2 permeate flow rate during sample collection (gpm)	4.10
Stage 2 influent flow rate during sample collection (gpm)	7.95

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s2}-4	C_{i-s2}-4	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	12/3/97	12/3/97	---	---	---	---
Sampling time	hh:mm	10:15	10:15	---	---	—	---
Operation time	hh.hh	643.75	643.75	---	---	---	---
pH	---	NA	NA	---	---	---	---
Temperature	°C	NA	NA	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	29.0	121.0	218.9	19.4	169.9	82.9
Total dissolved solids	mg/L	103.2	446.0	810.7	36.7	628.4	83.6
Calcium hardness	mg/L as $CaCO_3$	26.0	160.0	302.5	38.1	231.3	88.8
Turbidity	ntu	0.10	0.20	0.31	-25.0	0.25	60.5
Total organic carbon	mg/L	BMRL	16.30	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0003	0.094	0.193	99.7	0.144	99.8
SUVA	L/(mg*m)	#VALUE!	0.58	---	---	---	---

Field 1-9: System And Stage Water Quality For Week 6

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.90
System feed flow rate during sample collection (gpm)	14.20
System influent flow rate during sample collection (gpm)	17.10

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-6	$C_{F\text{-}sys}$-6	$C_{C\text{-}sys}$-6	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	12/17/98	12/17/98	12/17/98	---	---	---	---	---
Sampling time	hh:mm	14:00	14:00	14:00	---	---	---	---	---
Operation time	hh.hh	910.00	910.00	910.00	---	---	---	---	---
pH	---	7.32	7.52	7.89	---	---	---	---	---
Temperature	°C	NA	NA	NA	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	18.0	38.0	198.0	220.9	-11.54	52.6	144.9	87.6
Total dissolved solids	mg/L	85.0	165.0	728.0	896.4	-23.14	48.5	592.7	85.7
Total hardness	mg/L as $CaCO_3$	24.2	75.0	472.0	539.5	-14.29	67.7	346.6	93.0
Calcium hardness	mg/L as $CaCO_3$	18.2	47.7	267.0	317.4	-18.88	61.8	205.4	91.1
Turbidity	ntu	0.04	0.06	0.12	0.16	-37.26	21.8	0.12	63.9
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.00	34.60	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0002	0.088	0.800	0.887	-10.84	99.8	0.555	100.0
SUVA	L/(mg*m)	#VALUE!	2.19	2.31	---	---	---	---	---
Bromide	µg/L	38.6	41.1	---	64.0	---	6.1	54.5	29.1
SDS-Cl_2 dose	mg/L	1.00	2.80	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.96	1.29	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.04	1.51	---	14.95	---	97.4	9.37	99.6
SDS-Chlorination temp.	°C	9.0	9.0	---	---	---	---	---	---
SDS-Chlorination pH	---	7.20	7.20	---	---	---	---	---	---
SDS-Incubation time	hours	6.0	6.0	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	275.00	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	38.70	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	8.30	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	1.50	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	48.50	---	491.93	---	100.0	307.81	100.0
SDS-*MCAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	15.20	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	20.50	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	2.90	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	35.70	---	362.10	---	100.0	226.58	100.0
SDS-HAA6	µg/L	0.00	38.60	---	391.51	---	100.0	244.98	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	-48.5	25.8
SDS-THM4$_b$, µg/L	NA	36.00
SDS-HAA5$_b$, µg/L	NA	26.50
SDS-TOX$_b$, µg Cl^-/L	NA	#VALUE!
SDS-CD$_b$, mg/L	NA	1.13
TOC$_b$, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.065
Bromide$_b$, µg/L	NA	40.5
Alk$_b$, mg/L $CaCO_3$	NA	32.8
T-Hd$_b$, mg/L $CaCO_3$	NA	61.9
Ca-Hd$_b$, mg/L $CaCO_3$	NA	40.1

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	-51.3	24.4
SDS-THM4$_b$, µg/L	NA	36.68
SDS-HAA5$_b$, µg/L	NA	27.00
SDS-TOX$_b$, µg Cl^-/L	NA	#VALUE!
SDS-CD$_b$, mg/L	NA	1.15
TOC$_b$, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.066
Bromide$_b$, µg/L	NA	40.5
Alk$_b$, mg/L $CaCO_3$	NA	33.1
T-Hd$_b$, mg/L $CaCO_3$	NA	62.6
Ca-Hd$_b$, mg/L $CaCO_3$	NA	40.5

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs, i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 1-9: System And Stage Water Quality For Week 6 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.61
Stage 1 permeate flow rate during sample collection (gpm)	8.70
Stage 1 influent flow rate during sample collection (gpm)	17.10

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s1}-6	C_{i-s1}-6	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	12/17/98	12/17/98	---	---	---	---
Sampling time	hh:mm	14:00	14:00	---	---	---	---
Operation time	hh.hh	910.00	910.00	---	---	---	---
pH	---	6.87	7.65	---	---	---	---
Temperature	°C	NA	NA	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	14.0	58.0	103.6	63.2	80.8	82.7
Total dissolved solids	mg/L	86.0	253.0	426.0	47.9	339.5	74.7
Total hardness	mg/L as $CaCO_3$	19.7	135.0	254.4	73.7	194.7	89.9
Calcium hardness	mg/L as $CaCO_3$	15.0	80.4	148.1	68.6	114.3	86.9
Turbidity	ntu	0.01	0.07	0.12	74.5	0.09	84.7
Total organic carbon	mg/L	BMRL	9.00	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0001	0.204	0.415	99.9	0.310	100.0
SUVA	L/(mg*m)	#VALUE!	2.27	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.75
Stage 2 permeate flow rate during sample collection (gpm)	4.10
Stage 2 influent flow rate during sample collection (gpm)	8.40

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s2}-6	C_{i-s2}-6	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	12/17/98	12/17/98	---	---	---	---
Sampling time	hh:mm	14:00	14:00	---	---	---	---
Operation time	hh.hh	910.00	910.00	---	---	---	---
pH	---	7.37	7.77	---	---	---	---
Temperature	°C	NA	NA	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	31.0	123.0	210.7	18.4	166.9	81.4
Total dissolved solids	mg/L	106.0	451.0	780.0	35.8	615.5	82.8
Calcium hardness	mg/L as $CaCO_3$	27.5	153.0	272.7	42.3	212.8	87.1
Turbidity	ntu	0.02	0.07	0.12	72.7	0.09	83.9
Total organic carbon	mg/L	BMRL	18.50	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0007	0.444	0.867	99.2	0.655	99.9
SUVA	L/(mg*m)	#VALUE!	2.40	---	---	---	---

Field 1-10: System And Stage Water Quality For Week 8

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.90
System feed flow rate during sample collection (gpm)	14.40
System influent flow rate during sample collection (gpm)	17.50

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-8	$C_{F\text{-}sys}$-8	$C_{C\text{-}sys}$-8	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	1/7/98	1/7/98	1/7/98	---	---	---	---	---
Sampling time	hh:mm	15:05	15:05	15:05	---	---	---	---	---
Operation time	hh.hh	1293.00	1293.00	1293.00	---	---	---	---	---
pH	---	7.20	7.50	8.30	---	---	---	---	---
Temperature	°C	NA	NA	NA	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	16.0	36.0	214.0	208.0	2.80	55.6	137.2	88.3
Total dissolved solids	mg/L	110.4	206.3	876.9	1031.3	-17.61	46.5	691.9	84.0
Total hardness	mg/L as $CaCO_3$	22.4	73.9	513.0	516.8	-0.74	69.7	334.6	93.3
Calcium hardness	mg/L as $CaCO_3$	17.2	45.9	295.0	292.7	0.77	62.5	191.2	91.0
Turbidity	ntu	0.02	0.036	0.19	0.17	10.52	44.4	0.12	82.9
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.30	40.60	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.001	0.111	0.950	1.060	-11.63	99.5	0.670	99.9
SUVA	L/(mg*m)	#VALUE!	2.58	2.34	---	---	---	---	---
Bromide	µg/L	40.4	41.9	---	54.8	---	3.6	49.5	18.4
SDS-Cl_2 dose	mg/L	1.00	2.50	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.90	0.58	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.10	1.92	---	17.57	---	94.8	11.13	99.1
SDS-Chlorination temp.	°C	9.0	9.0	---	---	---	---	---	---
SDS-Chlorination pH	---	7.00	7.00	---	---	---	---	---	---
SDS-Incubation time	hours	6.0	6.0	---	---	---	---	---	---
SDS-TOX	µg Cl^- /L	BMRL	392.00	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	66.10	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	6.20	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	72.30	---	694.08	---	100.0	438.26	100.0
SDS-*MCAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	28.40	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	27.30	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	3.60	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	55.70	---	534.72	---	100.0	337.64	100.0
SDS-HAA6	µg/L	0.00	59.30	---	569.28	---	100.0	359.46	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	0.4	50.2
SDS-$THM4_b$, µg/L	72.00	36.00
SDS-$HAA5_b$, µg/L	55.47	27.73
SDS-TOX_b, µg Cl^- /L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.91	1.01
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.111	0.056
$Bromide_b$, µg/L	41.9	41.1
Alk_b, mg/L $CaCO_3$	35.9	26.0
T-Hd_b, mg/L $CaCO_3$	73.7	48.0
Ca-Hd_b, mg/L $CaCO_3$	45.8	31.5

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	3.1	51.5
SDS-$THM4_b$, µg/L	70.09	35.05
SDS-$HAA5_b$, µg/L	54.00	27.00
SDS-TOX_b, µg Cl^- /L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.86	0.98
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.108	0.054
$Bromide_b$, µg/L	41.9	41.1
Alk_b, mg/L $CaCO_3$	35.4	25.7
T-Hd_b, mg/L $CaCO_3$	72.3	47.4
Ca-Hd_b, mg/L $CaCO_3$	45.0	31.1

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs. i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 1-10: System And Stage Water Quality For Week 8 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.60
Stage 1 permeate flow rate during sample collection (gpm)	8.80
Stage 1 influent flow rate during sample collection (gpm)	17.50

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	$C_{p\text{-}s1}$-8	$C_{f\text{-}s1}$-8	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	1/7/98	1/7/98	---	---	---	---
Sampling time	hh:mm	15:05	15:05	---	---	---	---
Operation time	hh.hh	1293.00	1293.00	---	---	---	---
pH	---	6.70	8.10	---	---	---	---
Temperature	°C	NA	NA	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	18.0	63.0	108.5	50.0	85.8	79.0
Total dissolved solids	mg/L	109.8	304.7	501.7	46.8	403.2	72.8
Total hardness	mg/L as $CaCO_3$	19.0	141.0	264.4	74.3	202.7	90.6
Calcium hardness	mg/L as $CaCO_3$	14.3	83.4	153.3	68.8	118.3	87.9
Turbidity	ntu	0.025	0.065	0.11	30.6	0.09	70.7
Total organic carbon	mg/L	BMRL	9.90	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0003	0.265	0.533	99.7	0.399	99.9
SUVA	L/(mg*m)	#VALUE!	2.68	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.73
Stage 2 permeate flow rate during sample collection (gpm)	4.10
Stage 2 influent flow rate during sample collection (gpm)	8.70

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	$C_{p\text{-}s2}$-8	$C_{f\text{-}s2}$-8	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	1/7/98	1/7/98	---	---	---	---
Sampling time	hh:mm	15:05	15:05	---	---	---	---
Operation time	hh.hh	1293.00	1293.00	---	---	---	---
pH	---	7.20	8.20	---	---	---	---
Temperature	°C	NA	NA	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	26.0	126.0	215.1	27.8	170.6	84.8
Total dissolved solids	mg/L	140.8	542.8	901.1	31.7	721.9	80.5
Calcium hardness	mg/L as $CaCO_3$	25.7	168.0	294.8	44.0	231.4	88.9
Turbidity	ntu	0.02	0.08	0.14	44.4	0.11	82.2
Total organic carbon	mg/L	BMRL	23.50	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0013	0.543	1.026	98.8	0.784	99.8
SUVA	L/(mg*m)	#VALUE!	2.31	---	---	---	---

Field 1-11: System And Stage Water Quality For Week 10

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.91
System feed flow rate during sample collection (gpm)	14.10
System influent flow rate during sample collection (gpm)	17.10

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-sys}}$-10	$C_{F\text{-sys}}$-10	$C_{c\text{-sys}}$-10	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	1/19/98	1/19/98	1/19/98	---	---	---	---	---
Sampling time	hh:mm	11:15	11:15	11:15	---	---	---	---	---
Operation time	hh.hh	1563.83	1563.83	1563.83	---	---	---	---	---
pH	---	7.10	7.40	8.00	---	---	---	---	---
Temperature	°C	6.9	5.0	7.1	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	18.0	36.0	200.0	213.2	-6.62	50.0	140.2	87.2
Total dissolved solids	mg/L	111.6	204.8	856.7	1121.6	-30.92	45.5	743.6	85.0
Total hardness	mg/L as $CaCO_3$	22.8	74.5	536.0	583.5	-8.87	69.4	373.7	93.9
Calcium hardness	mg/L as $CaCO_3$	17.9	47.9	315.0	343.3	-8.98	62.6	221.5	91.9
Turbidity	ntu	0.037	0.034	0.11	0.00	95.94	-8.8	0.02	-122.4
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.70	44.10	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0005	0.140	1.355	1.514	-11.70	99.6	0.947	99.9
SUVA	L/(mg*m)	#VALUE!	2.98	3.07	---	---	---	---	---
Bromide	µg/L	35.0	38.0	---	67.5	---	7.9	55.4	36.8
SDS-Cl_2 dose	mg/L	1.00	2.50	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.63	0.26	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.37	2.24	---	20.65	---	83.5	13.06	97.2
SDS-Chlorination temp.	°C	9.0	9.0	---	---	---	---	---	---
SDS-Chlorination pH	---	7.10	7.10	---	---	---	---	---	---
SDS-Incubation time	hours	6.0	6.0	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	387.00	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	48.40	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	6.00	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	1.00	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	55.40	---	600.88	---	100.0	375.99	100.0
SDS-*MCAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	27.50	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	26.50	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	3.20	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	54.00	---	585.69	---	100.0	366.49	100.0
SDS-HAA6	µg/L	0.00	57.20	---	620.40	---	100.0	388.20	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	-30.0	35.0
SDS-THM4$_b$, µg/L	NA	36.00
SDS-HAA5$_b$, µg/L	NA	35.09
SDS-TOX$_b$, µg Cl^-/L	NA	#VALUE!
SDS-CD$_b$, mg/L	NA	1.59
TOC$_b$, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.091
Bromide$_b$, µg/L	NA	36.9
Alk$_b$, mg/L $CaCO_3$	NA	29.7
T-Hd$_b$, mg/L $CaCO_3$	NA	56.4
Ca-Hd$_b$, mg/L $CaCO_3$	NA	37.4

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	0.0	50.0
SDS-THM4$_b$, µg/L	NA	27.70
SDS-HAA5$_b$, µg/L	NA	27.00
SDS-TOX$_b$, µg Cl^-/L	NA	#VALUE!
SDS-CD$_b$, mg/L	NA	1.31
TOC$_b$, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.070
Bromide$_b$, µg/L	NA	36.5
Alk$_b$, mg/L $CaCO_3$	NA	27.0
T-Hd$_b$, mg/L $CaCO_3$	NA	48.7
Ca-Hd$_b$, mg/L $CaCO_3$	NA	32.9

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs. i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 1-11: System And Stage Water Quality For Week 10 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.62
Stage 1 permeate flow rate during sample collection (gpm)	8.70
Stage 1 influent flow rate during sample collection (gpm)	17.10

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	$C_{p\text{-}s1}$-10	$C_{i\text{-}s1}$-10	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	1/19/98	1/19/98	---	---	---	---
Sampling time	hh:mm	11:15	11:15	---	---	---	---
Operation time	hh.hh	1563.83	1563.83	---	---	---	---
pH	---	6.90	7.70	---	---	---	---
Temperature	°C	6.7	5.1	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	12.0	62.0	113.8	66.7	87.9	86.3
Total dissolved solids	mg/L	115.7	305.2	501.5	43.5	403.4	71.3
Total hardness	mg/L as $CaCO_3$	17.9	155.0	297.0	76.0	226.0	92.1
Calcium hardness	mg/L as $CaCO_3$	13.9	94.6	178.2	71.0	136.4	89.8
Turbidity	ntu	0.026	0.08	0.14	23.5	0.11	75.9
Total organic carbon	mg/L	BMRL	11.30	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0002	0.343	0.698	99.9	0.521	100.0
SUVA	L/(mg*m)	#VALUE!	3.04	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.76
Stage 2 permeate flow rate during sample collection (gpm)	4.10
Stage 2 influent flow rate during sample collection (gpm)	8.40

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	$C_{p\text{-}s2}$-10	$C_{i\text{-}s2}$-10	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	1/19/98	1/19/98	---	---	---	---
Sampling time	hh:mm	11:15	11:15	---	---	---	---
Operation time	hh.hh	1563.83	1563.83	---	---	---	---
pH	---	7.30	7.90	---	---	---	---
Temperature	°C	6.4	6.9	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	30.0	124.0	213.6	16.7	168.8	82.2
Total dissolved solids	mg/L	137.7	553.4	949.8	32.7	751.6	81.7
Calcium hardness	mg/L as $CaCO_3$	26.5	183.0	332.2	44.7	257.6	89.7
Turbidity	ntu	0.03	0.11	0.19	11.8	0.15	79.7
Total organic carbon	mg/L	BMRL	24.90	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0002	0.810	1.582	99.9	1.196	100.0
SUVA	L/(mg*m)	#VALUE!	3.25	---	---	---	---

Field 1-12: Duplicate Analysis Of System And Stage Water Quality For Week 10

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.91
System feed flow rate during sample collection (gpm)	14.10
System influent flow rate during sample collection (gpm)	17.10

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-10 (dup)	$C_{F\text{-}sys}$-10 (dup)	$C_{C\text{-}sys}$-10 (dup)	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	1/19/98	1/19/98	1/19/98	---	---	---	---	---
Sampling time	hh:mm	11:15	11:15	11:15	---	---	---	---	---
Operation time	hh.hh	1563.83	1563.83	1563.83	---	---	---	---	---
pH	---	7.10	7.40	8.00	---	---	---	---	---
Temperature	°C	7.0	5.4	6.9	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	18.0	38.0	203.0	234.9	-15.73	52.6	153.7	88.3
Total dissolved solids	mg/L	111.2	204.8	854.8	1125.7	-31.70	45.7	746.0	85.1
Total hardness	mg/L as $CaCO_3$	21.5	71.7	508.0	566.0	-11.41	70.0	362.2	94.1
Calcium hardness	mg/L as $CaCO_3$	16.9	46.2	300.0	334.7	-11.56	63.4	215.8	92.2
Turbidity	ntu	0.021	0.035	0.18	0.17	3.97	40.0	0.12	81.9
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.70	44.60	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0007	0.139	1.460	1.501	-2.79	99.5	0.939	99.9
SUVA	L/(mg*m)	#VALUE!	2.96	3.27	---	---	---	---	---
Bromide	µg/L	35.0	37.0	---	56.7	---	5.4	48.6	27.9
SDS-Cl_2 dose	mg/L	1.00	2.50	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.71	0.50	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.29	2.00	---	18.84	---	85.5	11.90	97.6
SDS-Chlorination temp.	°C	9.0	9.0	---	---	---	---	---	---
SDS-Chlorination pH	---	7.00	7.00	---	---	---	---	---	---
SDS-Incubation time	hours	6.0	6.0	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	373.00	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	52.40	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	6.60	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	1.00	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	60.00	---	650.77	---	100.0	407.21	100.0
SDS-*MCAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	32.70	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	33.50	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	3.70	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	66.20	---	718.02	---	100.0	449.28	100.0
SDS-HAA6	µg/L	0.00	69.90	---	758.15	---	100.0	474.40	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	-20.0	40.0
SDS-$THM4_b$, µg/L	NA	36.00
SDS-$HAA5_b$, µg/L	NA	39.72
SDS-TOX_b, µg Cl^-/L	NA	#VALUE!
SDS-CD_b, mg/L	NA	1.32
TOC_b, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.084
$Bromide_b$, µg/L	NA	36.2
Alk_b, mg/L $CaCO_3$	NA	30.0
T-Hd_b, mg/L $CaCO_3$	NA	51.6
Ca-Hd_b, mg/L $CaCO_3$	NA	34.5

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	18.4	59.2
SDS-$THM4_b$, µg/L	48.94	24.47
SDS-$HAA5_b$, µg/L	54.00	27.00
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.68	0.99
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.114	0.057
$Bromide_b$, µg/L	36.6	35.8
Alk_b, mg/L $CaCO_3$	34.3	26.2
T-Hd_b, mg/L $CaCO_3$	62.4	42.0
Ca-Hd_b, mg/L $CaCO_3$	40.8	28.9

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs, i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 1-12: Duplicate Analysis Of System And Stage Water Quality For Week 10 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.62
Stage 1 permeate flow rate during sample collection (gpm)	8.70
Stage 1 influent flow rate during sample collection (gpm)	17.10

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s1}-10 (dup)	C_{i-s1}-10 (dup)	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	1/19/98	1/19/98	---	---	---	---
Sampling time	hh:mm	11:15	11:15	---	---	---	---
Operation time	hh.hh	1563.83	1563.83	---	---	---	---
pH	---	7.00	7.70	---	---	---	---
Temperature	°C	6.1	5.5	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	14.0	64.0	115.8	63.2	89.9	84.4
Total dissolved solids	mg/L	114.2	306.3	505.2	44.2	405.8	71.9
Total hardness	mg/L as $CaCO_3$	17.1	150.0	287.6	76.2	218.8	92.2
Calcium hardness	mg/L as $CaCO_3$	13.3	91.6	172.7	71.2	132.1	89.9
Turbidity	ntu	0.019	0.11	0.20	45.7	0.16	87.9
Total organic carbon	mg/L	BMRL	11.80	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0004	0.353	0.718	99.7	0.536	99.9
SUVA	L/(mg*m)	#VALUE!	2.99	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.76
Stage 2 permeate flow rate during sample collection (gpm)	4.10
Stage 2 influent flow rate during sample collection (gpm)	8.40

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s2}-10 (dup)	C_{i-s2}-10 (dup)	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	1/19/98	1/19/98	---	---	---	---
Sampling time	hh:mm	11:15	11:15	---	---	---	---
Operation time	hh.hh	1563.83	1563.83	---	---	---	---
pH	---	7.30	7.90	---	---	---	---
Temperature	°C	6.5	6.9	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	30.0	126.0	217.5	21.1	171.8	82.5
Total dissolved solids	mg/L	137.0	552.2	948.2	33.1	750.2	81.7
Calcium hardness	mg/L as $CaCO_3$	25.7	171.0	309.5	44.4	240.3	89.3
Turbidity	ntu	0.02	0.10	0.18	48.6	0.14	87.1
Total organic carbon	mg/L	BMRL	25.60	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0008	0.780	1.523	99.4	1.151	99.9
SUVA	L/(mg*m)	#VALUE!	3.05	---	---	---	---

Field 2-7: System And Stage Water Quality For Week 12

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.90
System feed flow rate during sample collection (gpm)	14.30
System influent flow rate during sample collection (gpm)	17.20

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-sys}}$-12	$C_{F\text{-sys}}$-12	$C_{C\text{-sys}}$-12	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	2/4/98	2/4/98	2/4/98	---	---	---	---	---
Sampling time	hh:mm	9:45	9:45	9:45	---	---	---	---	---
Operation time	hh.hh	1900.00	1900.00	1900.00	---	---	---	---	---
pH	---	7.20	7.40	7.90	---	---	---	---	---
Temperature	°C	6.6	5.3	6.7	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	23.0	36.0	154	146.9	4.59	36.1	100.8	77.2
Total dissolved solids	mg/L	125	208	709	914.9	-29.01	39.9	620.9	79.9
Total hardness	mg/L as $CaCO_3$	38.3	74.0	78.0	378.6	-385.44	48.2	252.0	84.8
Calcium hardness	mg/L as $CaCO_3$	28.2	46.7	49.4	204.6	-314.10	39.6	138.9	79.7
Turbidity	ntu	0.02	0.03	0.13	0.12	11.28	33.3	0.08	75.0
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	5.0	43.8	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0007	0.1430	1.520	1.357	10.70	99.5	0.853	99.9
SUVA	L/(mg*m)	#VALUE!	2.86	3.47	---	---	---	---	---
Bromide	µg/L	38.0	42.0	---	76.1	---	9.5	61.9	38.7
SDS-Cl_2 dose	mg/L	1.00	2.70	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.78	0.27	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.22	2.43	---	21.29	---	90.9	13.45	98.4
SDS-Chlorination temp.	°C	9	9	---	---	---	---	---	---
SDS-Chlorination pH	---	7.1	7.0	---	---	---	---	---	---
SDS-Incubation time	hours	6.82	6.93	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	446	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	60.8	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	6.0	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	66.80	---	636.83	---	100.0	399.87	100.0
SDS-*MCAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	29.6	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	32.8	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	3.0	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	62.40	---	594.88	---	100.0	373.53	100.0
SDS-HAA6	µg/L	0.00	65.40	---	623.48	---	100.0	391.49	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	-7.8	46.1
SDS-$THM4_b$, µg/L	NA	36.00
SDS-$HAA5_b$, µg/L	NA	33.63
SDS-TOX_b, µg Cl^-/L	NA	#VALUE!
SDS-CD_b, mg/L	NA	1.41
TOC_b, mg/L	NA	#VALUE!
$UV_{254\ b}$, cm^{-1}	NA	0.077
$Bromide_b$, µg/L	NA	40.2
Alk_b, mg/L $CaCO_3$	NA	30.0
T-Hd_b, mg/L $CaCO_3$	NA	57.5
Ca-Hd_b, mg/L $CaCO_3$	NA	38.2

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	13.5	56.7
SDS-$THM4_b$, µg/L	57.81	28.90
SDS-$HAA5_b$, µg/L	54.00	27.00
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	2.13	1.18
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\ b}$, cm^{-1}	0.124	0.062
$Bromide_b$, µg/L	41.5	39.7
Alk_b, mg/L $CaCO_3$	34.3	28.6
T-Hd_b, mg/L $CaCO_3$	69.2	53.7
Ca-Hd_b, mg/L $CaCO_3$	44.2	36.2

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs. i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 2-7: System And Stage Water Quality For Week 12 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.61
Stage 1 permeate flow rate during sample collection (gpm)	8.70
Stage 1 influent flow rate during sample collection (gpm)	17.20

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s1}-12	C_{i-s1}-12	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	2/4/98	2/4/98	---	---	---	---
Sampling time	hh:mm	9:45	9:45	---	---	---	---
Operation time	hh.hh	1900.00	1900.00	---	---	---	---
pH	---	7.00	7.60	---	---	---	---
Temperature	°C	6.3	6.1	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	17.0	56.0	95.9	52.8	76.0	77.6
Total dissolved solids	mg/L	132.2	283.5	438.5	36.4	361.0	63.4
Total hardness	mg/L as $CaCO_3$	31.5	132.0	234.9	57.4	183.4	82.8
Calcium hardness	mg/L as $CaCO_3$	22.6	79.9	138.5	51.6	109.2	79.3
Turbidity	ntu	0.016	0.05	0.08	46.7	0.07	76.3
Total organic carbon	mg/L	BMRL	11.2	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0004	0.366	0.740	99.7	0.553	99.9
SUVA	L/(mg*m)	#VALUE!	3.27	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.73
Stage 2 permeate flow rate during sample collection (gpm)	4.10
Stage 2 influent flow rate during sample collection (gpm)	8.50

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s2}-12	C_{i-s2}-12	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	2/4/98	2/4/98	---	---	---	---
Sampling time	hh:mm	9:45	9:45	---	---	---	---
Operation time	hh.hh	1900.00	1900.00	---	---	---	---
pH	---	7.30	7.80	---	---	---	---
Temperature	°C	6.4	6.7	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	34.0	101	163.4	5.6	132.2	74.3
Total dissolved solids	mg/L	146.0	475.8	783.0	29.7	629.4	76.8
Total hardness	mg/L as $CaCO_3$	50.4	235	407.0	31.9	321.0	84.3
Calcium hardness	mg/L as $CaCO_3$	36.7	134	224.7	21.4	179.3	79.5
Turbidity	ntu	0.018	0.10	0.18	40.0	0.14	87.0
Total organic carbon	mg/L	BMRL	24.6	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0011	0.795	1.535	99.2	1.165	99.9
SUVA	L/(mg*m)	#VALUE!	3.23	---	---	---	---

Field 2-8: System And Stage Water Quality For Week 14

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.90
System feed flow rate during sample collection (gpm)	14.30
System influent flow rate during sample collection (gpm)	17.10

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-14	$C_{F\text{-}sys}$-14	$C_{C\text{-}sys}$-14	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	2/18/98	2/18/98	2/18/98	---	---	---	---	---
Sampling time	hh:mm	11:30	11:30	11:30	---	---	---	---	---
Operation time	hh.hh	2238.00	2238.00	2238.00	---	---	---	---	---
pH	---	7.40	7.00	8.00	---	---	---	---	---
Temperature	°C	7.7	7.6	7.8	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	21	35	168	164.0	2.38	40.0	110.1	80.9
Total dissolved solids	mg/L	119.0	201.4	733.9	961.0	-30.96	40.9	643.4	81.5
Total hardness	mg/L as $CaCO_3$	35.6	74.1	447	428.9	4.06	52.0	280.5	87.3
Calcium hardness	mg/L as $CaCO_3$	26.2	46.7	255	235.6	7.61	43.9	156.6	83.3
Turbidity	ntu	0.020	0.030	0.16	0.12	23.66	33.3	0.08	76.1
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.6	42.7	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0007	0.1355	1.380	1.378	0.17	99.5	0.858	99.9
SUVA	L/(mg*m)	#VALUE!	2.95	3.23	---	---	---	---	---
Bromide	µg/L	37	39	---	57.4	---	5.1	49.7	25.6
SDS-Cl_2 dose	mg/L	1.00	2.80	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.69	0.45	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.31	2.35	---	21.15	---	86.8	13.29	97.7
SDS-Chlorination temp.	°C	11	11	---	---	---	---	---	---
SDS-Chlorination pH	---	7.1	7.0	---	---	---	---	---	---
SDS-Incubation time	hours	6.42	6.58	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	440	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	69.2	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	7.3	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	76.50	---	781.39	---	100.0	486.66	100.0
SDS-*MCAA**	µg/L	BMRL	1.3	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	28.3	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	37.8	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	3.0	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	67.40	---	688.44	---	100.0	428.77	100.0
SDS-HAA6	µg/L	0.00	70.40	---	719.09	---	100.0	447.85	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	5.9	52.9
SDS-$THM4_b$, µg/L	72.00	36.00
SDS-$HAA5_b$, µg/L	63.44	31.72
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	2.23	1.27
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.128	0.064
$Bromide_b$, µg/L	38.9	37.9
Alk_b, mg/L $CaCO_3$	34.2	27.6
T-Hd_b, mg/L $CaCO_3$	71.8	53.7
Ca-Hd_b, mg/L $CaCO_3$	45.5	35.8

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	19.9	59.9
SDS-$THM4_b$, µg/L	61.29	30.65
SDS-$HAA5_b$, µg/L	54.00	27.00
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.94	1.13
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.109	0.055
$Bromide_b$, µg/L	38.6	37.8
Alk_b, mg/L $CaCO_3$	32.2	26.6
T-Hd_b, mg/L $CaCO_3$	66.4	51.0
Ca-Hd_b, mg/L $CaCO_3$	42.6	34.4

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs. i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 2-8: System And Stage Water Quality For Week 14 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.63
Stage 1 permeate flow rate during sample collection (gpm)	9.00
Stage 1 influent flow rate during sample collection (gpm)	17.10

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s1}-14	C_{i-s1}-14	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	2/18/98	2/18/98	---	---	---	---
Sampling time	hh:mm	11:30	11:30	---	---	---	---
Operation time	hh.hh	2238.00	2238.00	---	---	---	---
pH	---	7.30	7.80	---	---	---	---
Temperature	°C	7.1	7.0	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	16	58	104.7	54.3	81.3	80.3
Total dissolved solids	mg/L	124.4	278.1	448.9	38.3	363.5	65.8
Total hardness	mg/L as $CaCO_3$	28.1	132.0	247.4	62.1	189.7	85.2
Calcium hardness	mg/L as $CaCO_3$	20.5	77.7	141.3	56.1	109.5	81.3
Turbidity	ntu	0.016	0.075	0.14	46.7	0.11	85.2
Total organic carbon	mg/L	BMRL	10.7	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0007	0.353	0.744	99.5	0.549	99.9
SUVA	L/(mg*m)	#VALUE!	3.30	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.74
Stage 2 permeate flow rate during sample collection (gpm)	3.90
Stage 2 influent flow rate during sample collection (gpm)	8.10

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s2}-14	C_{i-s2}-14	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	2/18/98	2/18/98	---	---	---	---
Sampling time	hh:mm	11:30	11:30	---	---	---	---
Operation time	hh.hh	2238.00	2238.00	---	---	---	---
pH	---	7.50	8.00	---	---	---	---
Temperature	°C	7.2	7.2	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	33	105	171.9	5.7	138.4	76.2
Total dissolved solids	mg/L	141.7	474.0	782.5	29.6	628.3	77.4
Total hardness	mg/L as $CaCO_3$	46.9	250	438.6	36.7	344.3	86.4
Calcium hardness	mg/L as $CaCO_3$	34.2	144	246.0	26.8	195.0	82.5
Turbidity	ntu	0.02	0.10	0.17	33.3	0.14	85.4
Total organic carbon	mg/L	BMRL	22.6	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0012	0.790	1.522	99.1	1.156	99.9
SUVA	L/(mg*m)	#VALUE!	3.50	---	---	---	---

Field 2-9: System And Stage Water Quality For Week 16

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.90
System feed flow rate during sample collection (gpm)	14.30
System influent flow rate during sample collection (gpm)	17.30

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-16	$C_{F\text{-}sys}$-16	$C_{C\text{-}sys}$-16	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	3/3/98	3/3/98	3/3/98	---	---	---	---	---
Sampling time	hh:mm	11:10	11:10	11:10	---	---	---	---	---
Operation time	hh.hh	2550.00	2550.00	2550.00	---	---	---	---	---
pH	---	7.80	8.00	8.40	---	---	—	---	---
Temperature	°C	9.4	8.1	9.8	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	20	35	154	173.2	-12.48	42.9	116.1	82.8
Total dissolved solids	mg/L	109.5	186.9	674.7	900.0	-33.40	41.4	605.3	81.9
Total hardness	mg/L as $CaCO_3$	30.5	63.5	359	367.6	-2.39	52.0	241.9	87.4
Calcium hardness	mg/L as $CaCO_3$	22.0	40.7	201	213.0	-5.97	45.9	141.8	84.5
Turbidity	ntu	0.027	0.034	0.142	0.10	30.63	20.6	0.07	62.4
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.5	40.6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0005	0.132	1.430	1.344	6.04	99.6	0.843	99.9
SUVA	L/(mg*m)	#VALUE!	2.93	3.52	---	---	—	---	—
Bromide	µg/L	35	36	---	45.2	---	2.8	41.4	15.5
SDS-Cl_2 dose	mg/L	1.00	2.80	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.90	0.74	—	---	---	---	---	—
SDS-Cl_2 demand	mg/L	0.10	2.06	---	20.12	---	95.1	12.66	99.2
SDS-Chlorination temp.	°C	11	11	---	---	---	—	—	—
SDS-Chlorination pH	---	7.2	7.0	---	---	---	---	---	---
SDS-Incubation time	hours	6.15	6.23	---	—	---	---	—	—
SDS-TOX	µg Cl^-/L	BMRL	435	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	68.1	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	6.9	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	75.00	---	766.07	---	100.0	480.46	100.0
SDS-*MCAA**	µg/L	BMRL	1.50	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	28.4	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	37.6	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	2.6	---	#VALUE!	—	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	67.50	---	689.46	---	100.0	432.41	100.0
SDS-HAA6	µg/L	0.00	70.10	---	716.02	---	100.0	449.07	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	4.0	52.0
SDS-$THM4_b$, µg/L	72.00	36.00
SDS-$HAA5_b$, µg/L	64.80	32.40
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.98	1.04
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.127	0.064
$Bromide_b$, µg/L	36.0	35.5
Alk_b, mg/L $CaCO_3$	34.4	27.2
T-Hd_b, mg/L $CaCO_3$	62.2	46.3
Ca-Hd_b, mg/L $CaCO_3$	40.0	31.0

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	20.0	60.0
SDS-$THM4_b$, µg/L	60.00	30.00
SDS-$HAA5_b$, µg/L	54.00	27.00
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.67	0.88
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.106	0.053
$Bromide_b$, µg/L	35.8	35.4
Alk_b, mg/L $CaCO_3$	32.0	26.0
T-Hd_b, mg/L $CaCO_3$	56.9	43.7
Ca-Hd_b, mg/L $CaCO_3$	37.0	29.5

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs. i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 2-9: System And Stage Water Quality For Week 16 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.63
Stage 1 permeate flow rate during sample collection (gpm)	9.00
Stage 1 influent flow rate during sample collection (gpm)	17.30

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s1}-16	C_{i-s1}-16	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	3/3/98	3/3/98	---	---	---	---
Sampling time	hh:mm	11:10	11:10	---	---	---	---
Operation time	hh.hh	2550.00	2550.00	---	---	---	---
pH	---	7.60	8.20	---	---	---	---
Temperature	°C	9.4	8.6	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	15	55	98.4	57.1	76.7	80.4
Total dissolved solids	mg/L	116	261	419.0	38.1	340.1	66.0
Total hardness	mg/L as $CaCO_3$	25.5	114	210.0	59.8	162.0	84.3
Calcium hardness	mg/L as $CaCO_3$	18.7	67.9	121.2	54.1	94.6	80.2
Turbidity	ntu	0.034	0.078	0.13	0.0	0.10	66.6
Total organic carbon	mg/L	BMRL	11.1	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0004	0.328	0.683	99.7	0.506	99.9
SUVA	L/(mg*m)	#VALUE!	2.95	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.74
Stage 2 permeate flow rate during sample collection (gpm)	3.90
Stage 2 influent flow rate during sample collection (gpm)	8.30

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s2}-16	C_{i-s2}-16	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	3/3/98	3/3/98	---	---	---	---
Sampling time	hh:mm	11:10	11:10	---	---	---	---
Operation time	hh.hh	2550.00	2550.00	---	---	---	---
pH	---	7.80	8.20	---	---	---	---
Temperature	°C	9.5	9.8	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	31	104	168.7	11.4	136.4	77.3
Total dissolved solids	mg/L	132	450	732.3	29.1	591.3	77.6
Total hardness	mg/L as $CaCO_3$	42.6	215	367.8	32.9	291.4	85.4
Calcium hardness	mg/L as $CaCO_3$	30.7	124	206.7	24.6	165.3	81.4
Turbidity	ntu	0.026	0.092	0.15	23.5	0.12	78.6
Total organic carbon	mg/L	BMRL	22.9	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0008	0.775	1.461	99.4	1.118	99.9
SUVA	L/(mg*m)	#VALUE!	3.38	---	---	---	---

Field 2-10: System And Stage Water Quality For Week 18

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.90
System feed flow rate during sample collection (gpm)	14.30
System influent flow rate during sample collection (gpm)	17.10

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-18	$C_{F\text{-}sys}$-18	$C_{C\text{-}sys}$-18	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	3/23/98	3/23/98	3/23/98	---	---	---	---	---
Sampling time	hh:mm	11:30	11:30	11:30	---	---	---	---	---
Operation time	hh.hh	2923.00	2923.00	2923.00	---	---	---	---	---
pH	---	7.40	7.80	8.10	---	---	---	---	---
Temperature	°C	7.2	6.3	7.4	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	18	36	200	201.9	-0.93	50.0	132.5	86.4
Total dissolved solids	mg/L	95.0	175.9	786.5	922.1	-17.24	46.0	610.1	84.4
Total hardness	mg/L as $CaCO_3$	29.7	66.4	403	404.6	-0.39	55.3	263.2	88.7
Calcium hardness	mg/L as $CaCO_3$	20.2	41.7	238	239.8	-0.76	51.6	157.0	87.1
Turbidity	ntu	0.035	0.04	0.12	0.09	28.27	12.5	0.07	47.6
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.2	40.6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0007	0.121	1.305	1.229	5.79	99.4	0.766	99.9
SUVA	L/(mg*m)	#VALUE!	2.88	3.21	---	---	---	---	---
Bromide	µg/L	32	33	---	42.2	---	3.0	38.4	16.6
SDS-Cl_2 dose	mg/L	1.00	2.80	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.93	0.98	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.07	1.82	---	17.95	---	96.2	11.20	99.4
SDS-Chlorination temp.	°C	10	10	---	---	---	---	---	---
SDS-Chlorination pH	---	7.1	7.1	---	---	---	---	---	---
SDS-Incubation time	hours	5.6	5.7	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	409	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	66.5	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	6.8	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	0.8	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	74.10	---	756.88	---	100.0	471.39	100.0
SDS-*MCAA**	µg/L	BMRL	1.9	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	30.1	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	37.0	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	3.2	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	69.00	---	704.79	---	100.0	438.95	100.0
SDS-HAA6	µg/L	0.00	72.20	---	737.47	---	100.0	459.30	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	2.8	51.4
SDS-$THM4_b$, µg/L	72.00	36.00
SDS-$HAA5_b$, µg/L	67.04	33.52
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.77	0.92
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.118	0.059
$Bromide_b$, µg/L	33.0	32.5
Alk_b, mg/L $CaCO_3$	35.5	26.7
T-Hd_b, mg/L $CaCO_3$	65.4	47.5
Ca-Hd_b, mg/L $CaCO_3$	41.1	30.6

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	21.7	60.9
SDS-$THM4_b$, µg/L	57.99	29.00
SDS-$HAA5_b$, µg/L	54.00	27.00
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.44	0.75
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.095	0.048
$Bromide_b$, µg/L	32.8	32.4
Alk_b, mg/L $CaCO_3$	32.1	25.0
T-Hd_b, mg/L $CaCO_3$	58.4	44.1
Ca-Hd_b, mg/L $CaCO_3$	37.0	28.6

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs, i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 2-10: System And Stage Water Quality For Week 18 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.62
Stage 1 permeate flow rate during sample collection (gpm)	8.90
Stage 1 influent flow rate during sample collection (gpm)	17.10

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s1}-18	C_{i-s1}-18	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	3/23/98	3/23/98	---	---	---	---
Sampling time	hh:mm	11:30	11:30	---	---	---	---
Operation time	hh.hh	2923.00	2923.00	---	---	---	---
pH	---	7.20	8.00	---	---	---	---
Temperature	°C	6.8	6.2	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	12	66	124.6	66.7	95.3	87.4
Total dissolved solids	mg/L	89.4	277.5	481.7	49.2	379.6	76.5
Total hardness	mg/L as $CaCO_3$	21.2	130	248.1	68.1	189.0	88.8
Calcium hardness	mg/L as $CaCO_3$	14.2	79.2	149.7	65.9	114.5	87.6
Turbidity	ntu	0.014	0.05	0.09	65.0	0.07	79.9
Total organic carbon	mg/L	BMRL	11.5	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0003	0.339	0.707	99.8	0.523	99.9
SUVA	L/(mg*m)	#VALUE!	2.95	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.74
Stage 2 permeate flow rate during sample collection (gpm)	4.00
Stage 2 influent flow rate during sample collection (gpm)	8.20

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s2}-18	C_{i-s2}-18	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	3/23/98	3/23/98	---	---	---	---
Sampling time	hh:mm	11:30	11:30	---	---	---	---
Operation time	hh.hh	2923.00	2923.00	---	---	---	---
pH	---	7.60	8.10	---	---	---	---
Temperature	°C	7.0	7.1	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	29	127	220.3	19.4	173.7	83.3
Total dissolved solids	mg/L	127.7	500.5	855.5	27.4	678.0	81.2
Total hardness	mg/L as $CaCO_3$	44.5	242	430.1	33.0	336.0	86.8
Calcium hardness	mg/L as $CaCO_3$	31.0	146	255.5	25.7	200.8	84.6
Turbidity	ntu	0.039	0.075	0.11	2.5	0.09	57.7
Total organic carbon	mg/L	BMRL	22.6	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0011	0.710	1.385	99.1	1.048	99.9
SUVA	L/(mg*m)	#VALUE!	3.14	---	---	---	---

Field 2-11: System And Stage Water Quality For Week 20

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.91
System feed flow rate during sample collection (gpm)	14.10
System influent flow rate during sample collection (gpm)	17.00

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-20	$C_{F\text{-}sys}$-20	$C_{C\text{-}sys}$-20	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	4/7/98	4/7/98	4/7/98	---	---	---	---	---
Sampling time	hh:mm	12:20	12:20	12:20	---	---	---	---	---
Operation time	hh.hh	3284.00	3284.00	3284.00	---	---	---	---	---
pH	---	7.40	7.60	8.00	---	---	---	---	---
Temperature	°C	14.6	13.4	14.7	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	20	35	165	182.7	-10.72	42.9	121.4	83.5
Total dissolved solids	mg/L	95.8	170	658	897.4	-36.28	43.6	595.6	83.9
Total hardness	mg/L as $CaCO_3$	23.2	53.9	277	356.2	-28.58	57.0	230.8	89.9
Calcium hardness	mg/L as $CaCO_3$	15.4	34.2	167	219.3	-31.32	55.0	142.5	89.2
Turbidity	ntu	0.022	0.038	0.14	0.20	-39.67	42.1	0.13	83.1
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.4	36.9	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0002	0.1190	1.200	1.289	-7.39	99.8	0.804	100.0
SUVA	L/(mg*m)	#VALUE!	2.70	3.25	---	---	---	---	---
Bromide	µg/L	37	32	---	-17.2	---	-15.6	3.2	-1061.5
SDS-Cl_2 dose	mg/L	1.00	2.80	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.98	0.90	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.02	1.90	---	20.41	---	98.9	12.73	99.8
SDS-Chlorination temp.	°C	10.0	10.0	---	---	---	---	---	---
SDS-Chlorination pH	---	7.3	7.2	---	---	---	---	---	---
SDS-Incubation time	hours	6.53	6.68	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	385	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	63.9	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	7.6	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	71.50	---	775.50	---	100.0	483.55	100.0
SDS-*MCAA**	µg/L	BMRL	1.5	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	26.4	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	34.9	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	2.8	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	62.80	---	681.14	---	100.0	424.71	100.0
SDS-HAA6	µg/L	0.00	65.60	---	711.51	---	100.0	443.65	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	-0.7	49.7
SDS-$THM4_b$, µg/L	NA	36.00
SDS-$HAA5_b$, µg/L	NA	31.62
SDS-TOX_b, µg Cl^-/L	NA	#VALUE!
SDS-CD_b, mg/L	NA	0.97
TOC_b, mg/L	NA	#VALUE!
$UV_{254\,b}$, cm^{-1}	NA	0.060
$Bromide_b$, µg/L	NA	34.5
Alk_b, mg/L $CaCO_3$	NA	27.6
T-Hd_b, mg/L $CaCO_3$	NA	38.7
Ca-Hd_b, mg/L $CaCO_3$	NA	24.9

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	14.0	57.0
SDS-$THM4_b$, µg/L	61.48	30.74
SDS-$HAA5_b$, µg/L	54.00	27.00
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.64	0.83
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.102	0.051
$Bromide_b$, µg/L	32.7	34.9
Alk_b, mg/L $CaCO_3$	32.9	26.4
T-Hd_b, mg/L $CaCO_3$	49.6	36.4
Ca-Hd_b, mg/L $CaCO_3$	31.6	23.5

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs, i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 2-11: System And Stage Water Quality For Week 20 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.62
Stage 1 permeate flow rate during sample collection (gpm)	8.70
Stage 1 influent flow rate during sample collection (gpm)	17.00

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s1}-20	C_{i-s1}-20	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	4/7/98	4/7/98	---	---	---	---
Sampling time	hh:mm	12:20	12:20	---	---	---	---
Operation time	hh.hh	3284.00	3284.00	---	---	---	---
pH	---	7.20	7.80	---	---	---	---
Temperature	°C	14.3	13.7	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	15	57	101.0	57.1	79.0	81.0
Total dissolved solids	mg/L	93.8	243	399.8	44.7	321.5	70.8
Total hardness	mg/L as $CaCO_3$	22.0	93.4	168.2	59.2	130.8	83.2
Calcium hardness	mg/L as $CaCO_3$	14.5	57.7	103.0	57.6	80.3	82.0
Turbidity	ntu	0.027	0.05	0.07	28.9	0.06	56.5
Total organic carbon	mg/L	BMRL	9.4	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0001	0.298	0.610	99.9	0.454	100.0
SUVA	L/(mg*m)	#VALUE!	3.17	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.76
Stage 2 permeate flow rate during sample collection (gpm)	4.10
Stage 2 influent flow rate during sample collection (gpm)	8.30

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	C_{p-s2}-20	C_{i-s2}-20	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	4/7/98	4/7/98	---	---	---	---
Sampling time	hh:mm	12:20	12:20	---	---	---	---
Operation time	hh.hh	3284.00	3284.00	---	---	---	---
pH	---	7.50	8.00	---	---	---	---
Temperature	°C	14.6	14.8	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	33	103	171.3	5.7	137.2	75.9
Total dissolved solids	mg/L	125	431	729.2	26.1	580.1	78.4
Total hardness	mg/L as $CaCO_3$	42.0	161	277.2	22.1	219.1	80.8
Calcium hardness	mg/L as $CaCO_3$	28.5	97.6	165.1	16.7	131.3	78.3
Turbidity	ntu	0.03	0.07	0.11	21.1	0.09	66.5
Total organic carbon	mg/L	BMRL	20.5	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0013	0.663	1.309	98.9	0.986	99.9
SUVA	L/(mg*m)	#VALUE!	3.23	---	---	---	---

Field 2-12: Duplicate Analysis Of System And Stage Water Quality For Week 20

System Operating Parameters During Sample Collection

System recovery during sample collection (decimal)	0.91
System feed flow rate during sample collection (gpm)	14.10
System influent flow rate during sample collection (gpm)	17.00

System Permeate, Feed and Concentrate-Waste Water Quality Parameters

Parameter	Units	$C_{p\text{-}sys}$-20 (dup)	$C_{F\text{-}sys}$-20 (dup)	$C_{C\text{-}sys}$-20 (dup)	$C_{C(calc)}$	$Error_{MB}$ (%)	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	4/7/98	4/7/98	4/7/98	---	---	---	---	---
Sampling time	hh:mm	12:20	12:20	12:20	---	---	---	---	---
Operation time	hh.hh	3284.00	3284.00	3284.00	---	---	---	---	---
pH	---	7.40	7.60	8.00	---	---	---	---	---
Temperature	°C	14.6	13.4	14.7	---	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	18	34	157	191.5	-22.00	47.1	126.2	85.7
Total dissolved solids	mg/L	95.8	170	658	897.4	-36.28	43.6	595.6	83.9
Total hardness	mg/L as $CaCO_3$	27.5	53.6	278	310.6	-11.72	48.7	204.0	86.5
Calcium hardness	mg/L as $CaCO_3$	18.5	33.7	166	183.4	-10.46	45.1	121.3	84.7
Turbidity	ntu	0.025	0.025	0.13	0.03	80.77	0.0	0.03	0.0
Ammonia	mg NH_3-N / L	NA	NA	NA	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Total organic carbon	mg/L	BMRL	4.2	37.6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0003	0.118	1.200	1.277	-6.41	99.7	0.796	100.0
SUVA	L/(mg*m)	#VALUE!	2.81	3.19	---	---	---	---	---
Bromide	µg/L	34	34	---	34.0	---	0.0	34.0	0.0
SDS-Cl_2 dose	mg/L	1.00	2.80	---	---	---	---	---	---
SDS-Free Cl_2 residual	mg/L	0.98	0.89	---	---	---	---	---	---
SDS-Cl_2 demand	mg/L	0.02	1.91	---	20.52	---	99.0	12.80	99.8
SDS-Chlorination temp.	°C	10	10	---	---	---	---	---	---
SDS-Chlorination pH	---	7.3	7.1	---	---	---	---	---	---
SDS-Incubation time	hours	6.27	6.37	---	---	---	---	---	---
SDS-TOX	µg Cl^-/L	BMRL	400	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHCl3*	µg/L	BMRL	65.4	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BDCM*	µg/L	BMRL	7.4	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBCM*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CHBr3*	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-THM4	µg/L	0.00	72.80	---	789.60	---	100.0	492.34	100.0
SDS-*MCAA**	µg/L	BMRL	1.6	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCAA**	µg/L	BMRL	27.2	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TCAA**	µg/L	BMRL	36.1	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*MBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DBAA**	µg/L	BMRL	BMRL	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*BCAA**	µg/L	BMRL	2.9	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*TBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*CDBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-*DCBAA*	µg/L	NA	NA	---	#VALUE!	---	#VALUE!	#VALUE!	#VALUE!
SDS-HAA5	µg/L	0.00	64.90	---	703.92	---	100.0	438.91	100.0
SDS-HAA6	µg/L	0.00	67.80	---	735.37	---	100.0	458.52	100.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Blending Calculations For D-DBP MCLs

THM4 Controls

	Stage 1	Stage 2
Q_p/Q_T (THM4), %	1.1	50.5
SDS-$THM4_b$, µg/L	72.00	36.00
SDS-$HAA5_b$, µg/L	64.19	32.09
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.89	0.95
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.117	0.059
$Bromide_b$, µg/L	34.0	34.0
Alk_b, mg/L $CaCO_3$	33.8	25.9
T-Hd_b, mg/L $CaCO_3$	53.3	40.4
Ca-Hd_b, mg/L $CaCO_3$	33.5	26.0

HAA5 Controls

	Stage 1	Stage 2
Q_p/Q_T (HAA5), %	16.8	58.4
SDS-$THM4_b$, µg/L	60.57	30.29
SDS-$HAA5_b$, µg/L	54.00	27.00
SDS-TOX_b, µg Cl^-/L	#VALUE!	#VALUE!
SDS-CD_b, mg/L	1.59	0.81
TOC_b, mg/L	#VALUE!	#VALUE!
$UV_{254\,b}$, cm^{-1}	0.098	0.049
$Bromide_b$, µg/L	34.0	34.0
Alk_b, mg/L $CaCO_3$	31.3	24.7
T-Hd_b, mg/L $CaCO_3$	49.2	38.4
Ca-Hd_b, mg/L $CaCO_3$	31.1	24.8

Notes:

This field uses the feed and permeate water quality parameters entered above to determine the percentage of total flow that must be treated by the membrane process to meet the Stage 1 and proposed Stage 2 DBP MCLs.

A 10% factor of safety has been applied all the MCLs. i.e., MCLs for Stage 1 are 72 / 54 µg/L and Stage 2 are 36 / 27 µg/L for THM4 and HAA5.

Since either THM4 or HAA5 can control the allowable blend ratio, the blend ratio is calculated for both parameters.

The maximum (Q_p/Q_T) ratio controls the design.

Q_p/Q_T (THM4) is the permeate to total flow ratio for the case where THM4 controls the blend ratio.

Q_p/Q_T (HAA5) is the permeate to total flow ratio for the case where HAA5 controls the blend ratio.

The subscript "b" refers to the blended water quality for a given blend ratio.

If the permeate quality does not meet the MCL prior to blending, then these calculations are meaningless for that MCL.

If the feed water quality meets the MCL, then a negative ratio will be calculated for that MCL.

Field 2-12: Duplicate Analysis Of System And Stage Water Quality For Week 20 (continued)

Stage 1 Operating Parameters During Sample Collection

Stage 1 recovery during sample collection (decimal)	0.62
Stage 1 permeate flow rate during sample collection (gpm)	8.70
Stage 1 influent flow rate during sample collection (gpm)	17.00

Stage 1 Permeate and Influent Water Quality Parameters

Parameter	Units	$C_{p\text{-}s1}$-20 (dup)	$C_{i\text{-}s1}$-20 (dup)	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	4/7/98	4/7/98	---	---	---	---
Sampling time	hh:mm	12:20	12:20	---	---	---	---
Operation time	hh.hh	3284.00	3284.00	---	---	---	---
pH	---	7.40	7.80	---	---	---	---
Temperature	°C	14.3	13.7	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	14	56	100.0	58.8	78.0	82.1
Total dissolved solids	mg/L	93.8	243.2	399.8	44.7	321.5	70.8
Total hardness	mg/L as $CaCO_3$	21.3	88.5	158.9	60.3	123.7	82.8
Calcium hardness	mg/L as $CaCO_3$	14.2	53.9	95.5	57.9	74.7	81.0
Turbidity	ntu	0.018	0.05	0.08	28.0	0.07	73.0
Total organic carbon	mg/L	BMRL	9.8	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0002	0.287	0.588	99.8	0.437	100.0
SUVA	L/(mg*m)	#VALUE!	2.93	---	---	---	---

Stage 2 Operating Parameters During Sample Collection

Stage 2 recovery during sample collection (decimal)	0.76
Stage 2 permeate flow rate during sample collection (gpm)	4.10
Stage 2 influent flow rate during sample collection (gpm)	8.30

Stage 2 Permeate and Influent Water Quality Parameters

Parameter	Units	$C_{p\text{-}s2}$-20 (dup)	$C_{i\text{-}s2}$-20 (dup)	$C_{C(calc)}$	R_F (%)	C_B	R_B (%)
Sampling date	MM/DD/YY	4/7/98	4/7/98	---	---	---	---
Sampling time	hh:mm	12:20	12:20	---	---	---	---
Operation time	hh.hh	3284.00	3284.00	---	---	---	---
pH	---	7.50	8.00	---	---	---	---
Temperature	°C	14.6	14.8	---	---	---	---
Alkalinity	mg/L as $CaCO_3$	31	104	175.3	8.8	139.6	77.8
Total dissolved solids	mg/L	125	431	729.2	26.1	580.1	78.4
Total hardness	mg/L as $CaCO_3$	41.6	165	285.5	22.4	225.2	81.5
Calcium hardness	mg/L as $CaCO_3$	28.5	100	169.8	15.4	134.9	78.9
Turbidity	ntu	0.035	0.10	0.16	-40.0	0.13	73.4
Total organic carbon	mg/L	BMRL	21.9	#VALUE!	#VALUE!	#VALUE!	#VALUE!
UV_{254}	cm^{-1}	0.0008	0.648	1.280	99.3	0.964	99.9
SUVA	L/(mg*m)	#VALUE!	2.96	---	---	---	---

Appendix D

Summary of Data Collected

QA\QC Summary

CH2M HILL Analytical Services
2300 N.W. Walnut Blvd
P.O. Box 428
Corvallis, OR 97339-0428
phone (541) 752-4271
fax (541) 752-0276

ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 2
Sampling Date: 11/13/97
Lab Batch ID: 6418

Duplicate Sample

Analysis	MRL (μg/L)	Replicate 1 (μg/L)	Replicate 2 (μg/L)	Average (μg/L)	RPD (%)
Bromide	20	37	37	37	0%
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	13.5	14.3	13.9	6%
TCAA	1.0	24.2	25.1	24.6	4%
BCAA	1.0	2.6	2.8	2.7	7%
DBAA	1.0	<	<	--	--
THMs					
CHCl3	1.0	2.2	1.2	1.7	56%
BDCM	1.0	1.2	1.2	1.2	3%
DBCM	1.0	4.8	5.3	5.0	10%
CHBr3	1.0	8.4	9.4	8.9	11%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 2
Sampling Date: 11/13/97
Lab Batch ID: 6418

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	30	68	35	108%
TOC (mg/L)	0.5	4.0	7.7	4.0	91%
TOX	50	<	58	50	116%
HAAs					
MCAA	2.0	<	17.8	20.0	89%
MBAA	1.0	<	18.1	20.0	91%
DCAA	1.0	<	19.2	20.0	96%
TCAA	1.0	<	19.3	20.0	96%
BCAA	1.0	<	19.0	20.0	95%
DBAA	1.0	<	19.0	20.0	95%
THMs					
CHCl3	1.0	7.9	8.9	1.0	97%
BDCM	1.0	10.2	12.0	1.0	180%
DBCM	1.0	20.9	22.1	1.0	113%
CHBr3	1.0	15.0	16.7	1.0	173%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 2
Sampling Date: 11/13/97
Lab Batch ID: 6418

Independent QC Check

Analysis	True Value (μg/L)	Conc. Found (μg/L)	Recovery (%)
Bromide	165	166	101%
TOC (mg/L)	47.4	53.3	112%
HAAs			
MCAA	30.2	30.1	100%
MBAA	35.5	33.5	94%
DCAA	38.2	32.5	85%
TCAA	42.3	34.2	81%
BCAA	25.1	20.6	82%
DBAA	33.9	30.1	89%
THMs			
CHCl3	23.0	20.3	88%
BDCM	9.9	3.2	32%
DBCM	25.9	16.0	62%
CHBr3	19.0	13.6	71%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 4
Sampling Date: 12/3/97
Lab Batch ID: 6488

Duplicate Sample

Analysis	MRL (µg/L)	Replicate 1 (µg/L)	Replicate 2 (µg/L)	Average (µg/L)	RPD (%)
Bromide	20	<	<	--	--
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	4.2	4.2	4.2	1%
TCAA	1.0	7.5	7.5	7.5	1%
BCAA	1.0	<	<	--	--
DBAA	1.0	<	<	--	--
THMs					
CHCl3	1.0	43.6	44.9	44.2	3%
BDCM	1.0	8.8	9.0	8.9	2%
DBCM	1.0	1.4	1.4	1.4	0%
CHBr3	1.0	<	<	--	--

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 4
Sampling Date: 12/3/97
Lab Batch ID: 6488

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	50	150	100	100%
TOC (mg/L)	0.5	4.6	8.4	4.0	95%
TOX	50	281	348	50	134%
HAAs					
MCAA	2.0	<	2.4	2.0	118%
MBAA	1.0	<	1.2	1.0	118%
DCAA	1.0	14.9	17.2	1.0	227%
TCAA	1.0	21.2	23.4	1.0	213%
BCAA	1.0	2.8	4.5	1.0	170%
DBAA	1.0	<	1.2	1.0	121%
THMs					
CHCl3	1.0	<	1.006	1.0	101%
BDCM	1.0	<	1.016	1.0	102%
DBCM	1.0	<	0.958	1.0	96%
CHBr3	1.0	<	1.159	1.0	116%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 4
Sampling Date: 12/3/97
Lab Batch ID: 6488

Independent QC Check

Analysis	True Value (μg/L)	Conc. Found (μg/L)	Recovery (%)
Bromide	165	153	93%
TOC (mg/L)	47.4	46.0	97%
HAAs			
MCAA	30.2	41.2	136%
MBAA	35.5	46.5	131%
DCAA	38.2	47.5	124%
TCAA	42.3	52.5	124%
BCAA	25.1	29.4	117%
DBAA	33.9	35.2	104%
THMs			
CHCl3	23.0	20.8	90%
BDCM	9.9	10.0	101%
DBCM	25.9	27.3	105%
CHBr3	19.0	21.6	113%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 6
Sampling Date: 12/17/97
Lab Batch ID: 6561

Duplicate Sample

Analysis	MRL (μg/L)	Replicate 1 (μg/L)	Replicate 2 (μg/L)	Average (μg/L)	RPD (%)
Bromide	20	139	140	140	1%
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	15.2	14.1	14.6	8%
TCAA	1.0	20.5	18.6	19.5	10%
BCAA	1.0	2.9	2.6	2.7	10%
DBAA	1.0	<	<	--	--
THMs					
CHCl3	1.0	38.7	39.2	38.9	1%
BDCM	1.0	8.3	8.4	8.3	2%
DBCM	1.0	1.5	1.5	1.5	1%
CHBr3	1.0	<	<	--	--

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 6
Sampling Date: 12/17/97
Lab Batch ID: 6561

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	31	46	20	75%
TOC (mg/L)	0.5	3.5	7.3	4.0	95%
TOX	50	270	324	50	108%
HAAs					
MCAA	2.0	<	20.3	20.0	101%
MBAA	1.0	<	20.5	20.0	103%
DCAA	1.0	<	19.4	20.0	97%
TCAA	1.0	<	19.7	20.0	99%
BCAA	1.0	<	19.2	20.0	96%
DBAA	1.0	<	19.7	20.0	98%
THMs					
CHCl3	1.0	<	1.1	1.0	114%
BDCM	1.0	<	0.9	1.0	90%
DBCM	1.0	<	1.0	1.0	102%
CHBr3	1.0	<	1.1	1.0	106%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 6
Sampling Date: 12/17/97
Lab Batch ID: 6561

Independent QC Check

Analysis	True Value (µg/L)	Conc. Found (µg/L)	Recovery (%)
Bromide	165	166	101%
TOC (mg/L)	47.4	48.0	101%
HAAs			
MCAA	30.2	26.3	87%
MBAA	35.5	29.3	83%
DCAA	38.2	29.3	77%
TCAA	42.3	32.2	76%
BCAA	25.1	18.3	73%
DBAA	33.9	26.6	78%
THMs			
CHCl3	23.0	23.9	104%
BDCM	9.9	10.3	104%
DBCM	25.9	28.0	108%
CHBr3	19.0	21.0	110%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 8
Sampling Date: 1/7/98
Lab Batch ID: 6637

Duplicate Sample

Analysis	MRL (µg/L)	Replicate 1 (µg/L)	Replicate 2 (µg/L)	Average (µg/L)	RPD (%)
Bromide	20	42	43	42	2%
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	2.2	2.3	2.2	5%
TCAA	1.0	1.2	1.2	1.2	2%
BCAA	1.0	2.9	3.1	3.0	7%
DBAA	1.0	2.5	2.6	2.5	6%
THMs					
CHCl3	1.0	<	<	--	--
BDCM	1.0	1.5	1.6	1.5	2%
DBCM	1.0	4.8	4.9	4.8	3%
CHBr3	1.0	6.0	6.1	6.1	2%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 8
Sampling Date: 1/7/98
Lab Batch ID: 6637

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	42	137	100	95%
TOC (mg/L)	0.5	2.3	6.5	4.0	106%
TOX	50	393	445	50	104%
HAAs					
MCAA	2.0	<	18.6	20.0	93%
MBAA	1.0	1.3	19.8	20.0	93%
DCAA	1.0	5.5	23.1	20.0	88%
TCAA	1.0	3.5	20.5	20.0	85%
BCAA	1.0	5.5	22.7	20.0	86%
DBAA	1.0	3.6	21.8	20.0	91%
THMs					
CHCl3	1.0	<	22.2	20.0	111%
BDCM	1.0	1.9	24.9	20.0	115%
DBCM	1.0	5.6	27.2	20.0	108%
CHBr3	1.0	6.4	27.4	20.0	105%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 8
Sampling Date: 1/7/98
Lab Batch ID: 6637

Independent QC Check

Analysis	True Value (µg/L)	Conc. Found (µg/L)	Recovery (%)
Bromide	59	59	100%
TOC (mg/L)	47.4	47.1	99%
HAAs			
MCAA	30.2	30.4	101%
MBAA	35.5	34.3	97%
DCAA	38.2	34.7	91%
TCAA	42.3	38.3	91%
BCAA	25.1	21.7	87%
DBAA	33.9	32.6	96%
THMs			
CHCl3	23.0	24.8	108%
BDCM	9.9	9.9	100%
DBCM	25.9	25.0	97%
CHBr3	19.0	19.0	100%

QA\QC Summary

CH2M HILL Analytical Services
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Corvallis, OR 97339-0428
phone (541) 752-4271
fax (541) 752-0276

ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 10
Sampling Date: 1/19/98
Lab Batch ID: 6692

Duplicate Sample

Analysis	MRL (µg/L)	Replicate 1 (µg/L)	Replicate 2 (µg/L)	Average (µg/L)	RPD (%)
Bromide	20	<	<	--	--
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	<	<	--	--
TCAA	1.0	<	<	--	--
BCAA	1.0	<	<	--	--
DBAA	1.0	<	<	--	--
THMs					
CHCl3	1.0	<	<	--	--
BDCM	1.0	1.5	1.6	1.5	2%
DBCM	1.0	4.8	4.9	4.8	3%
CHBr3	1.0	6.0	6.1	6.1	2%

QA\QC Summary

CH2M HILL Analytical Services
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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 10
Sampling Date: 1/19/98
Lab Batch ID: 6692

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	<	21	20	106%
TOC (mg/L)	0.5	3.5	7.7	4.0	106%
TOX	50	392	465	50	146%
HAAs					
MCAA	2.0	<	19.9	20.0	99%
MBAA	1.0	<	20.3	20.0	102%
DCAA	1.0	5.6	27.3	20.0	109%
TCAA	1.0	2.7	22.5	20.0	99%
BCAA	1.0	2.2	20.6	20.0	92%
DBAA	1.0	4.5	23.4	20.0	94%
THMs					
CHCl3	1.0	<	22.2	20.0	111%
BDCM	1.0	1.9	24.9	20.0	115%
DBCM	1.0	5.6	27.2	20.0	108%
CHBr3	1.0	6.4	27.4	20.0	105%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 10
Sampling Date: 1/19/98
Lab Batch ID: 6692

Independent QC Check

Analysis	True Value (μg/L)	Conc. Found (μg/L)	Recovery (%)
Bromide	165	169	102%
TOC (mg/L)	47.4	47.4	100%
HAAs			
MCAA	30.2	17.3	57%
MBAA	35.5	31.1	88%
DCAA	38.2	34.5	90%
TCAA	42.3	36.6	87%
BCAA	25.1	22.2	89%
DBAA	33.9	31.8	94%
THMs			
CHCl3	23.0	24.8	108%
BDCM	9.9	9.9	100%
DBCM	25.9	25.0	97%
CHBr3	19.0	19.0	100%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 10-DUP
Sampling Date: 1/19/98
Lab Batch ID: 6693

Duplicate Sample

Analysis	MRL (μg/L)	Replicate 1 (μg/L)	Replicate 2 (μg/L)	Average (μg/L)	RPD (%)
Bromide	20	<	<	--	--
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	<	<	--	--
TCAA	1.0	<	<	--	--
BCAA	1.0	<	<	--	--
DBAA	1.0	<	<	--	--
THMs					
CHCl3	1.0	<	<	--	--
BDCM	1.0	1.5	1.6	1.5	2%
DBCM	1.0	4.8	4.9	4.8	3%
CHBr3	1.0	6.0	6.1	6.1	2%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 10-DUP
Sampling Date: 1/19/98
Lab Batch ID: 6693

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	<	21	20	106%
TOC (mg/L)	0.5	3.5	7.7	4.0	106%
TOX	50	392	465	50	146%
HAAs					
MCAA	2.0	<	19.9	20.0	99%
MBAA	1.0	<	20.3	20.0	102%
DCAA	1.0	5.6	27.3	20.0	109%
TCAA	1.0	2.7	22.5	20.0	99%
BCAA	1.0	2.2	20.6	20.0	92%
DBAA	1.0	4.5	23.4	20.0	94%
THMs					
CHCl3	1.0	<	22.2	20.0	111%
BDCM	1.0	1.9	24.9	20.0	115%
DBCM	1.0	5.6	27.2	20.0	108%
CHBr3	1.0	6.4	27.4	20.0	105%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 10-DUP
Sampling Date: 1/19/98
Lab Batch ID: 6693

Independent QC Check

Analysis	True Value (µg/L)	Conc. Found (µg/L)	Recovery (%)
Bromide	165	169	102%
TOC (mg/L)	47.4	47.4	100%
HAAs			
MCAA	30.2	17.3	57%
MBAA	35.5	31.1	88%
DCAA	38.2	34.5	90%
TCAA	42.3	36.6	87%
BCAA	25.1	22.2	89%
DBAA	33.9	31.8	94%
THMs			
CHCl3	23.0	24.8	108%
BDCM	9.9	9.9	100%
DBCM	25.9	25.0	97%
CHBr3	19.0	19.0	100%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 12
Sampling Date: 2/4/98
Lab Batch ID: 6780

Duplicate Sample

Analysis	MRL (µg/L)	Replicate 1 (µg/L)	Replicate 2 (µg/L)	Average (µg/L)	RPD (%)
Bromide	20	<	<	--	--
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	13.9	14.0	14.0	1%
TCAA	1.0	10.0	10.0	10.0	0%
BCAA	1.0	<	<	--	--
DBAA	1.0	<	<	--	--
THMs					
CHCl3	1.0	1.6	1.6	1.6	1%
BDCM	1.0	1.4	1.4	1.4	2%
DBCM	1.0	1.3	1.3	1.3	5%
CHBr3	1.0	<	<	--	--

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 12
Sampling Date: 2/4/98
Lab Batch ID: 6780

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	<	112	100	112%
TOC (mg/L)	0.5	2.4	6.5	4.0	100%
TOX	50	449	651	200	101%
HAAs					
MCAA	2.0	<	25.1	20.0	126%
MBAA	1.0	<	21.0	20.0	105%
DCAA	1.0	14.8	33.1	20.0	92%
TCAA	1.0	11.5	30.1	20.0	93%
BCAA	1.0	<	20.5	20.0	102%
DBAA	1.0	<	19.6	20.0	98%
THMs					
CHCl3	1.0	<	1.0	1.0	103%
BDCM	1.0	<	1.1	1.0	108%
DBCM	1.0	<	0.9	1.0	94%
CHBr3	1.0	<	1.2	1.0	116%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 12
Sampling Date: 2/4/98
Lab Batch ID: 6780

Independent QC Check

Analysis	True Value (µg/L)	Conc. Found (µg/L)	Recovery (%)
Bromide			#DIV/0!
TOC (mg/L)	47.4	48.3	102%
HAAs			
MCAA	30.2	34.4	114%
MBAA	35.5	35.9	101%
DCAA	38.2	35.3	93%
TCAA	42.3	38.8	92%
BCAA	25.1	23.1	92%
DBAA	33.9	32.7	96%
THMs			
CHCl3	23.0	22.5	98%
BDCM	9.9	10.2	103%
DBCM	25.9	27.4	106%
CHBr3	19.0	21.4	113%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 14
Sampling Date: 2/18/98
Lab Batch ID: 6849

Duplicate Sample

Analysis	MRL (µg/L)	Replicate 1 (µg/L)	Replicate 2 (µg/L)	Average (µg/L)	RPD (%)
Bromide	20	31	161	96	135%
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	13.3	12.9	13.1	3%
TCAA	1.0	22.6	21.0	21.8	7%
BCAA	1.0	1.9	1.8	1.9	2%
DBAA	1.0	<	<	--	--
THMs					
CHCl3	1.0	69.2	66.2	67.7	4%
BDCM	1.0	7.3	7.2	7.2	1%
DBCM	1.0	<	<	--	--
CHBr3	1.0	<	<	--	--

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 14
Sampling Date: 2/18/98
Lab Batch ID: 6849

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	161	273	100	112%
TOC (mg/L)	0.5	3.2	7.6	4.0	109%
TOX	50	440	484	50	88%
HAAs					
MCAA	2.0	3.4	24.1	20.0	103%
MBAA	1.0	<	21.0	20.0	105%
DCAA	1.0	22.0	44.6	20.0	113%
TCAA	1.0	5.6	26.9	20.0	106%
BCAA	1.0	2.8	24.1	20.0	107%
DBAA	1.0	<	20.3	20.0	101%
THMs					
CHCl3	1.0	<	21.9	20.0	110%
BDCM	1.0	<	21.0	20.0	105%
DBCM	1.0	<	19.9	20.0	100%
CHBr3	1.0	<	18.0	20.0	90%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 14
Sampling Date: 2/18/98
Lab Batch ID: 6849

Independent QC Check

Analysis	True Value (µg/L)	Conc. Found (µg/L)	Recovery (%)
Bromide	165	188	114%
TOC (mg/L)	47.4	46.5	98%
HAAs			
MCAA	30.2	32.2	107%
MBAA	35.5	37.4	105%
DCAA	38.2	38.3	100%
TCAA	42.3	43.0	102%
BCAA	25.1	24.0	95%
DBAA	33.9	36.2	107%
THMs			
CHCl3	23.0	21.5	94%
BDCM	9.9	9.7	98%
DBCM	25.9	26.3	102%
CHBr3	19.0	18.0	95%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 16
Sampling Date: 3/3/98
Lab Batch ID: 6896

Duplicate Sample

Analysis	MRL (µg/L)	Replicate 1 (µg/L)	Replicate 2 (µg/L)	Average (µg/L)	RPD (%)
Bromide	20	<	<	--	--
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	13.3	12.9	13.1	3%
TCAA	1.0	22.6	21.0	21.8	7%
BCAA	1.0	1.9	1.8	1.9	2%
DBAA	1.0	<	<	--	--
THMs					
CHCl3	1.0	69.2	66.2	67.7	4%
BDCM	1.0	7.3	7.2	7.2	1%
DBCM	1.0	<	<	--	--
CHBr3	1.0	<	<	--	--

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 16
Sampling Date: 3/3/98
Lab Batch ID: 6896

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	<	109	100	109%
TOC (mg/L)	0.5	2.3	6.2	4.0	96%
TOX	50	440	484	50	88%
HAAs					
MCAA	2.0	3.4	24.1	20.0	103%
MBAA	1.0	<	21.0	20.0	105%
DCAA	1.0	22.0	44.6	20.0	113%
TCAA	1.0	5.6	26.9	20.0	106%
BCAA	1.0	2.8	24.1	20.0	107%
DBAA	1.0	<	20.3	20.0	101%
THMs					
CHCl3	1.0	<	21.9	20.0	110%
BDCM	1.0	<	21.0	20.0	105%
DBCM	1.0	<	19.9	20.0	100%
CHBr3	1.0	<	18.0	20.0	90%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 16
Sampling Date: 3/3/98
Lab Batch ID: 6896

Independent QC Check

Analysis	True Value (µg/L)	Conc. Found (µg/L)	Recovery (%)
Bromide	59	64	108%
TOC (mg/L)	47.4	48.2	102%
HAAs			
MCAA	30.2	32.2	107%
MBAA	35.5	37.4	105%
DCAA	38.2	38.3	100%
TCAA	42.3	43.0	102%
BCAA	25.1	24.0	95%
DBAA	33.9	36.2	107%
THMs			
CHCl3	23.0	21.5	94%
BDCM	9.9	9.7	98%
DBCM	25.9	26.3	102%
CHBr3	19.0	18.0	95%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 18
Sampling Date: 3/23/98
Lab Batch ID: 6995

Duplicate Sample

Analysis	MRL (µg/L)	Replicate 1 (µg/L)	Replicate 2 (µg/L)	Average (µg/L)	RPD (%)
Bromide	20	635	618	627	3%
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	<	<	--	--
TCAA	1.0	<	<	--	--
BCAA	1.0	<	<	--	--
DBAA	1.0	<	<	--	--
THMs					
CHCl3	1.0	66.5	60.7	63.6	9%
BDCM	1.0	6.8	6.5	6.6	4%
DBCM	1.0	<	<	--	--
CHBr3	1.0	<	<	--	--

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 18
Sampling Date: 3/23/98
Lab Batch ID: 6995

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	635	1190	500	111%
TOC (mg/L)	0.5	4.2	7.6	4.0	84%
TOX	50	401	460	50	118%
HAAs					
MCAA	2.0	<	20.9	20.0	105%
MBAA	1.0	<	19.3	20.0	96%
DCAA	1.0	30.1	45.6	20.0	77%
TCAA	1.0	37.0	50.6	20.0	68%
BCAA	1.0	3.2	20.4	20.0	86%
DBAA	1.0	<	18.7	20.0	93%
THMs					
CHCl3	1.0	9.0	9.5	1.0	46%
BDCM	1.0	8.1	8.9	1.0	78%
DBCM	1.0	3.6	4.6	1.0	98%
CHBr3	1.0	<	1.2	1.0	120%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 18
Sampling Date: 3/23/98
Lab Batch ID: 6995

Independent QC Check

Analysis	True Value (µg/L)	Conc. Found (µg/L)	Recovery (%)
Bromide	59	62	105%
TOC (mg/L)	47.4	40.3	85%
HAAs			
MCAA	30.2	29.6	98%
MBAA	35.5	32.7	92%
DCAA	38.2	35.6	93%
TCAA	42.3	38.0	90%
BCAA	25.1	23.7	94%
DBAA	33.9	34.7	102%
THMs			
CHCl3	23.0	22.2	97%
BDCM	9.9	10.0	101%
DBCM	25.9	27.6	106%
CHBr3	19.0	20.5	108%

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 20
Sampling Date: 4/7/98
Lab Batch ID: 7097

Duplicate Sample

Analysis	MRL (µg/L)	Replicate 1 (µg/L)	Replicate 2 (µg/L)	Average (µg/L)	RPD (%)
Bromide	20	<	<	--	--
HAAs					
MCAA	2.0	<	<	--	--
MBAA	1.0	<	<	--	--
DCAA	1.0	3.2	3.0	3.1	5%
TCAA	1.0	1.9	1.9	1.9	1%
BCAA	1.0	3.2	3.4	3.3	4%
DBAA	1.0	2.5	2.7	2.6	8%
THMs					
CHCl3	1.0	63.9	64.1	64.0	0%
BDCM	1.0	7.6	7.6	7.6	0%
DBCM	1.0	<	<	--	--
CHBr3	1.0	<	<	--	--

QA\QC Summary

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ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 20
Sampling Date: 4/7/98
Lab Batch ID: 7097

Fortified Matrix Sample

Analysis	MRL (µg/L)	Unfortified Conc. (µg/L)	Fortified Conc. (µg/L)	Fortifying Conc. (µg/L)	Recovery (%)
Bromide	20	<	114	100	114%
TOC (mg/L)	0.5	4.8	9.0	4.0	105%
TOX	50	383	439	50	112%
HAAs					
MCAA	2.0	<	17.0	20.0	85%
MBAA	1.0	<	17.5	20.0	88%
DCAA	1.0	<	17.8	20.0	89%
TCAA	1.0	<	18.1	20.0	90%
BCAA	1.0	<	17.1	20.0	85%
DBAA	1.0	<	17.4	20.0	87%
THMs					
CHCl3	1.0	<	1.0	1.0	95%
BDCM	1.0	<	0.9	1.0	93%
DBCM	1.0	<	1.0	1.0	98%
CHBr3	1.0	<	1.1	1.0	109%

QA\QC Summary

CH2M HILL Analytical Services
2300 N.W. Walnut Blvd
P.O. Box 428
Corvallis, OR 97339-0428
phone (541) 752-4271
fax (541) 752-0276

ICR Lab ID No.: ICROR001

Client: NJ American Canoe Brook Pilot
Week No.: 20
Sampling Date: 4/7/98
Lab Batch ID: 7097

Independent QC Check

Analysis	True Value (µg/L)	Conc. Found (µg/L)	Recovery (%)
Bromide	59	66	111%
TOC (mg/L)	47.4	46.8	99%
HAAs			
MCAA	30.2	29.0	96%
MBAA	35.5	31.8	90%
DCAA	38.2	31.8	83%
TCAA	42.3	34.0	80%
BCAA	25.1	21.6	86%
DBAA	33.9	30.9	91%
THMs			
CHCl3	23.0	23.2	101%
BDCM	9.9	10.5	106%
DBCM	25.9	28.1	108%
CHBr3	19.0	21.2	111%

Appendix E Summary of Data Collected

New Jersey-American Water Company

Delaware River Regional Water Treatment Plant Laboratory

MICROBIOLOGICAL IDENTIFICATION REPORT

Company: New Jersey-American Water Company
Haddon Heights Operating Center
213 Carriage Lane
Delran, NJ 08075

Report Date 3/19/98

Eva Ibrahim

Sample Number: 9800852

Sample Location: S1 FRONT   Sample Type: SP

Collection Date:	3/4/98	Collection Time:	13:10	Sampler:	KIERNAN
Received Date:	3/5/98	Received Time:	10:30	Received By:	GRIFFIN

Field Analysis

Analysis	Method	Result		Date	Analysis	Method	Result		Date
pH:	150.1			3/4/98	Free Chlorine Residual:	330.4		mg/L	3/4/98
Temperature:	170.1		C	3/4/98	Total Chlorine Residual:	330.4		mg/L	3/4/98

Sample was streaked for isolation on March 9, 1998.

Procedure	Date	Identification	Analyst
Gram Stain	3/10/98	Gram negative rod	EAC
API 24E	3/12/98	Klebsiella pneumoniae	EAC

REVIEWED BY: Eva Ibrahim   Date: 3/20/98

Eva Ibrahim, Ph.D., Laboratory Manager

New Jersey-American Water Company

Delaware River Regional Water Treatment Plant Laboratory

MICROBIOLOGICAL IDENTIFICATION REPORT

Company: New Jersey-American Water Company
Haddon Heights Operating Center
213 Carriage Lane
Delran, NJ 08075

Report Date 3/19/98

Eva Ibrahim

Sample Number: 9800853

Sample Location: S1 FRONT-D4P

Sample Type: SP

Collection Date:	3/4/98	Collection Time:	13:10	Sampler:	KIERNAN
Received Date:	3/5/98	Received Time:	10:30	Received By:	GRIFFIN

Field Analysis

Analysis	Method	Result		Date	Analysis	Method	Result		Date
pH:	150.1			3/4/98	Free Chlorine Residual:	330.4		mg/L	3/4/98
Temperature:	170.1		C	3/4/98	Total Chlorine Residual:	330.4		mg/L	3/4/98

Sample was streaked for isolation on March 9, 1998.

Procedure	Date	Identification	Analyst
Gram Stain	3/10/98	Gram negative rod	EAC
API 24E	3/12/98	Klebsiella pneumoniae	EAC

REVIEWED BY: Eva Ibrahim Date: 3/20/98

Eva Ibrahim, Ph.D., Laboratory Manager

New Jersey-American Water Company

Delaware River Regional Water Treatment Plant Laboratory

MICROBIOLOGICAL IDENTIFICATION REPORT

Company: New Jersey-American Water Company
Haddon Heights Operating Center
213 Carriage Lane
Delran, NJ 08075

Report Date 3/19/98

Eva Ibrahim

Sample Number: 9800855

Sample Location: S1 BACK

Sample Type: SP

Collection Date:	3/4/98	Collection Time:	13:10	Sampler:	KIERNAN
Received Date:	3/5/98	Received Time:	10:30	Received By:	GRIFFIN

Field Analysis

Analysis	Method	Result	Date	Analysis	Method	Result	Date
pH:	150.1		3/4/98	Free Chlorine Residual:	330.4	mg/L	3/4/98
Temperature:	170.1	C	3/4/98	Total Chlorine Residual:	330.4	mg/L	3/4/98

Sample was streaked for isolation on March 9, 1998.

Procedure	Date	Identification	Analyst
Gram Stain	3/10/98	Gram negative rod	EAC
API 24E	3/12/98	Chryseomonas luteola	EAC
		note: This organism was previously known as Pseudomonas luteola	

REVIEWED BY: Eva Ibrahim Date: 3/20/98

Eva Ibrahim, Ph.D., Laboratory Manager

New Jersey-American Water Company

Delaware River Regional Water Treatment Plant Laboratory

MICROBIOLOGICAL IDENTIFICATION REPORT

Company: New Jersey-American Water Company
Haddon Heights Operating Center
213 Carriage Lane
Delran, NJ 08075

Report Date 3/19/98

Eva Ibrahim

Sample Number: 9800854

Sample Location: S2

Sample Type: SP

Collection Date:	3/4/98	Collection Time:	13:10	Sampler:	KIERNAN
Received Date:	3/5/98	Received Time:	10:30	Received By:	GRIFFIN

Field Analysis

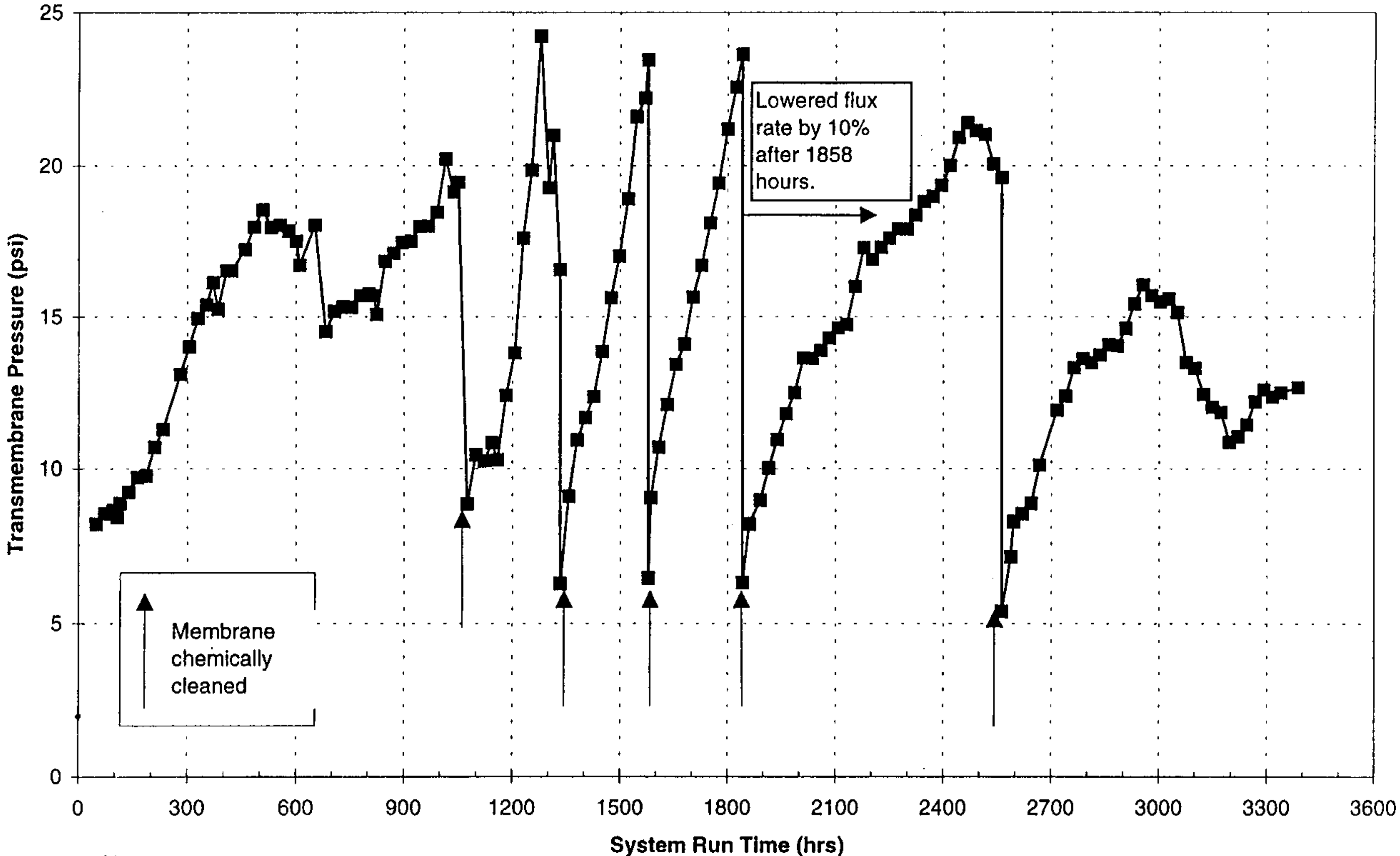
Analysis	Method	Result	Date	Analysis	Method	Result	Date
pH:	150.1		3/4/98	Free Chlorine Residual:	330.4	mg/L	3/4/98
Temperature:	170.1	C	3/4/98	Total Chlorine Residual:	330.4	mg/L	3/4/98

Sample was streaked for isolation on March 9, 1998.

Procedure	Date	Identification	Analyst
Gram Stain	3/10/98	Gram negative rod	EAC
API 24E	3/12/98	Pseudomonas aeruginosa	EAC

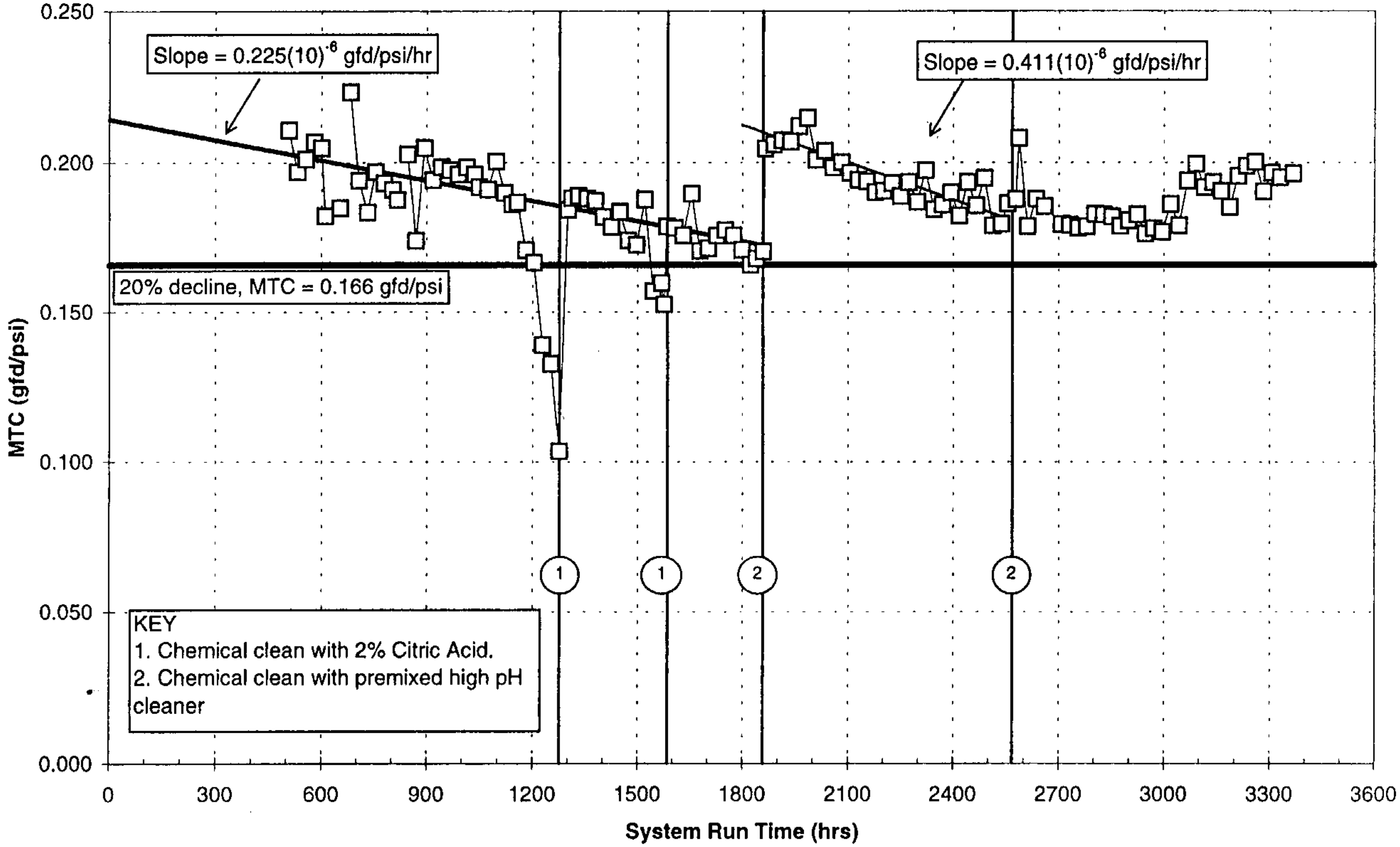
REVIEWED BY: Eva Ibrahim Date: 3/20/98

Eva Ibrahim, Ph.D., Laboratory Manager



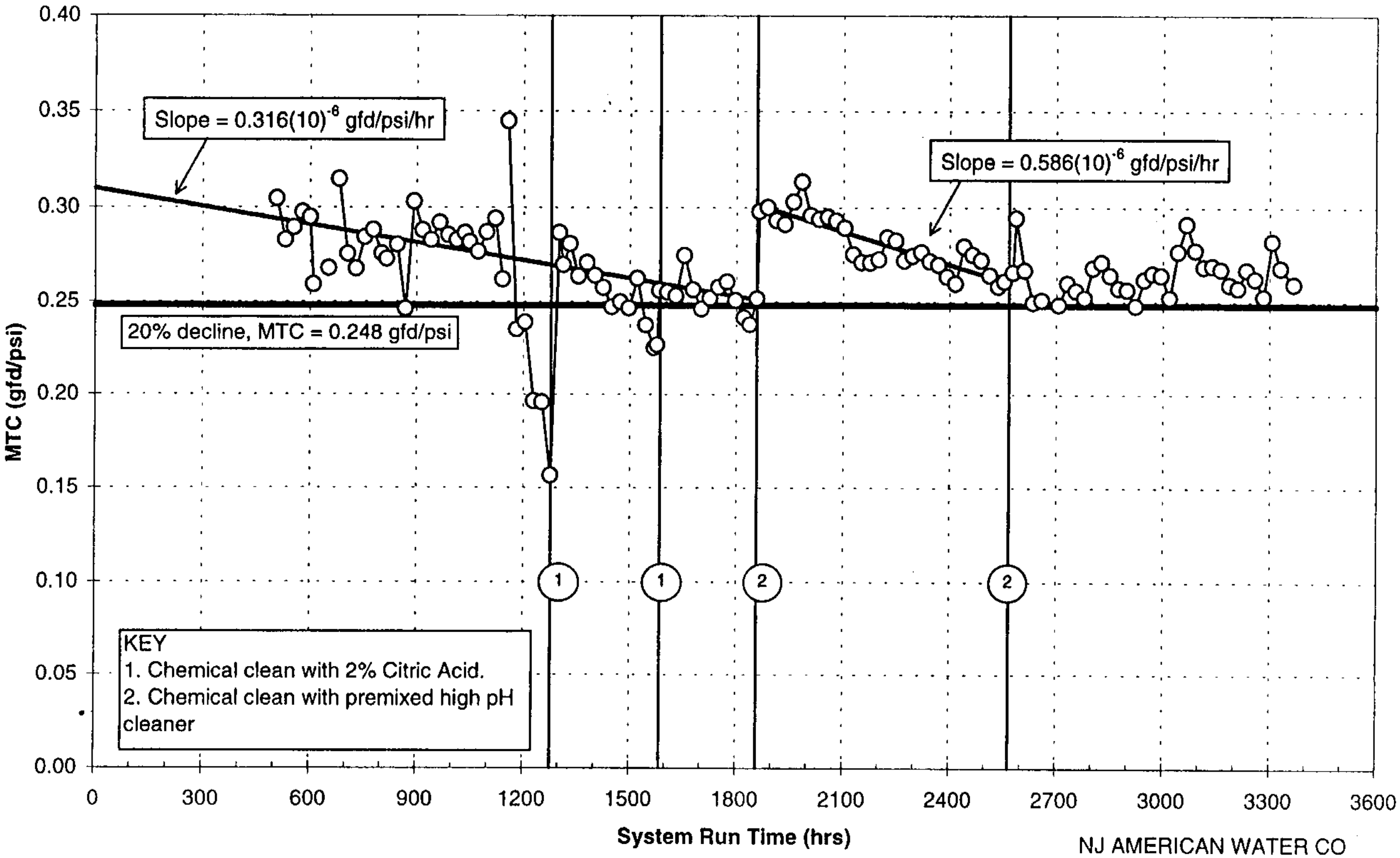
Notes:
System Run Time is same as NF unit.

NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
MICROFILTRATION PRETREATMENT
TRANSMEMBRANE PRESSURE



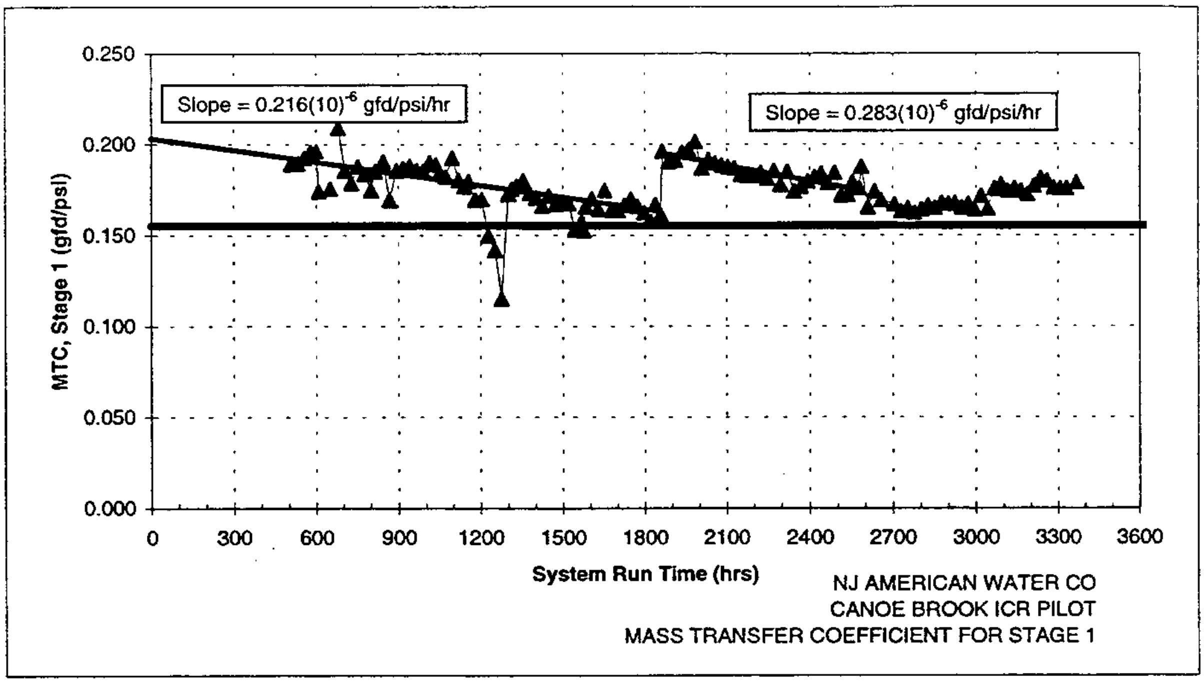
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
NORMALIZED SYSTEM
MASS TRANSFER COEFFICIENT

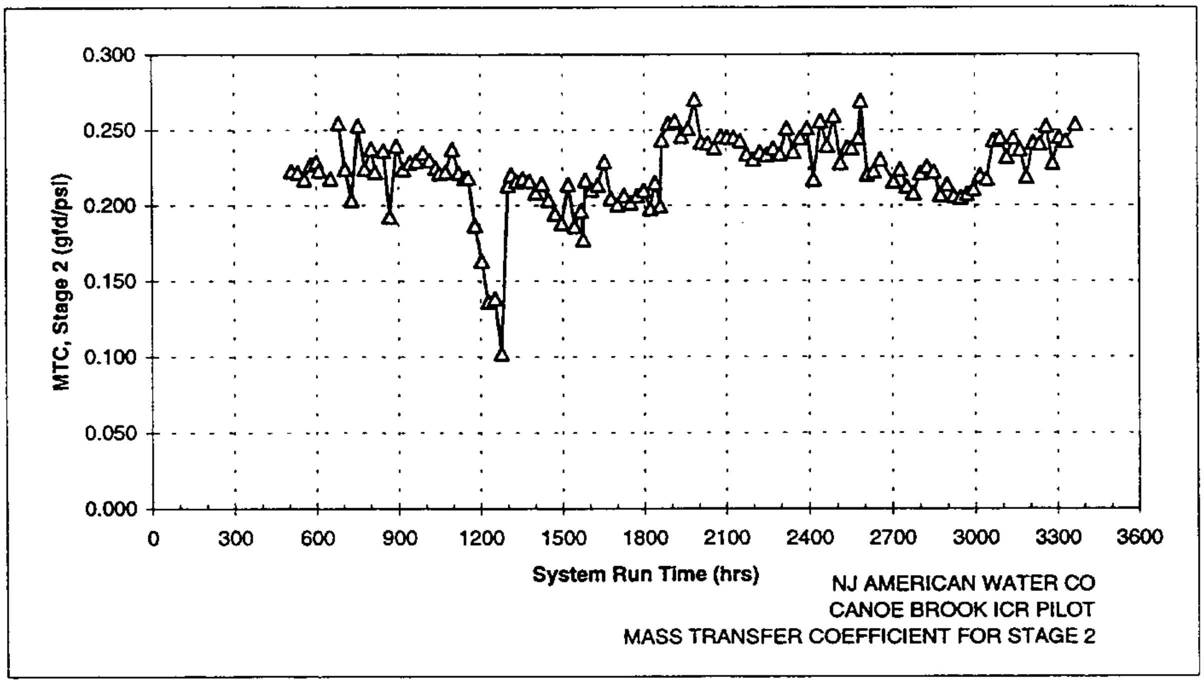
4_10sum.xls[MTC]



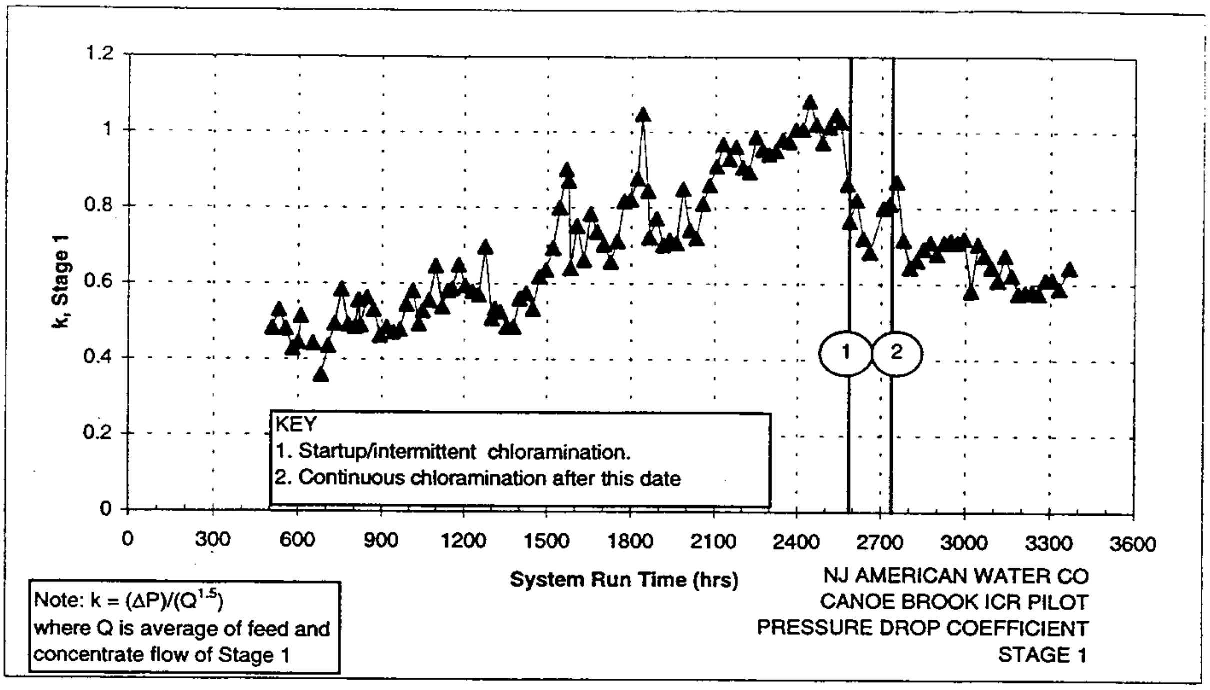
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
MASS TRANSFER COEFFICIENT
NORMALIZED WITH MANUFACTURER'S
TEMPERERATURE CORRECTION FACTOR

4_10sum.xls[MTC wO-D Tc]

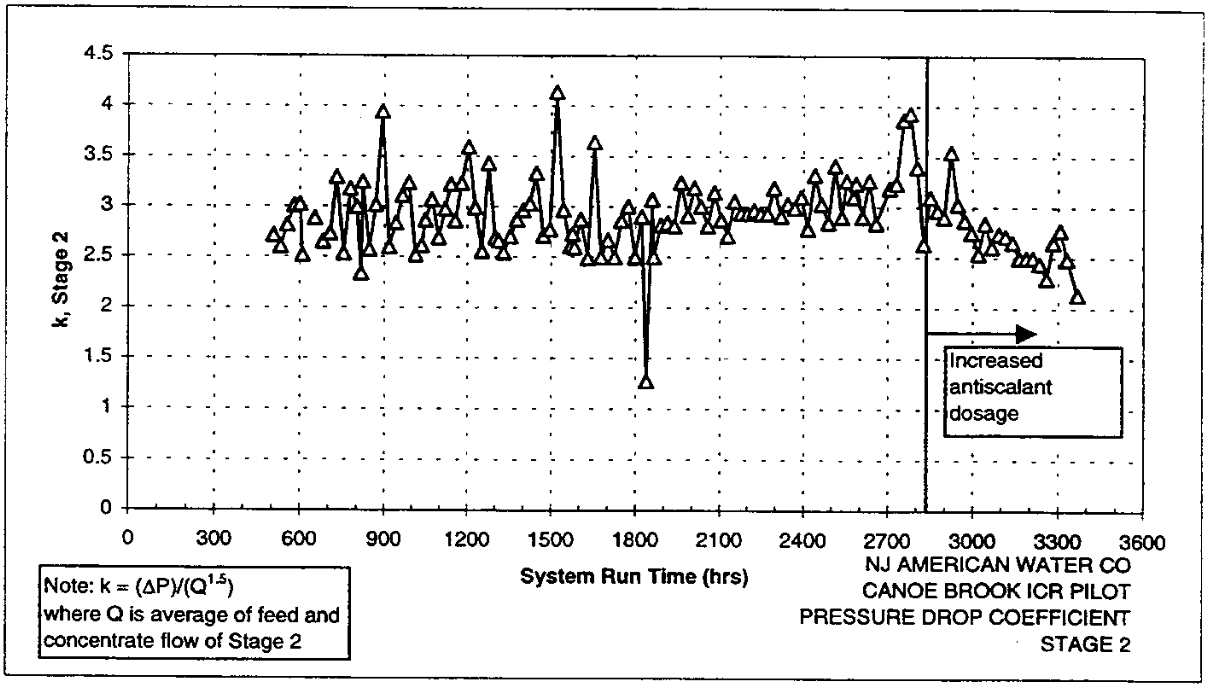




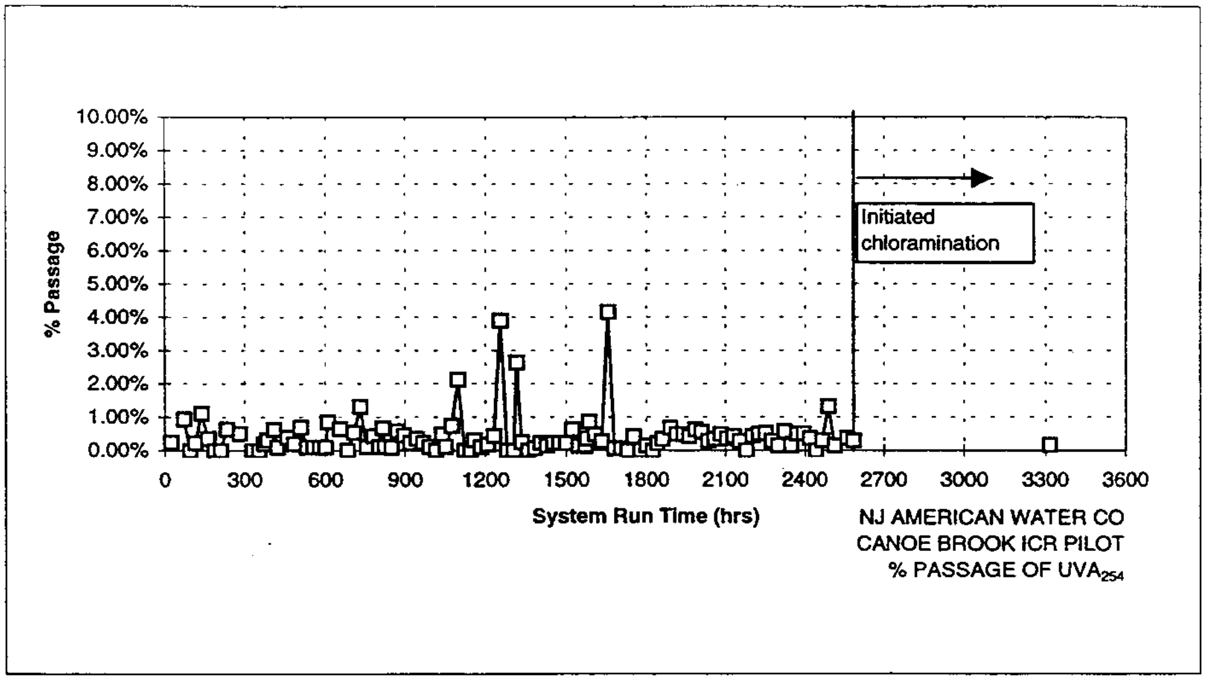
4_10sum.xls[MTC, Stages]

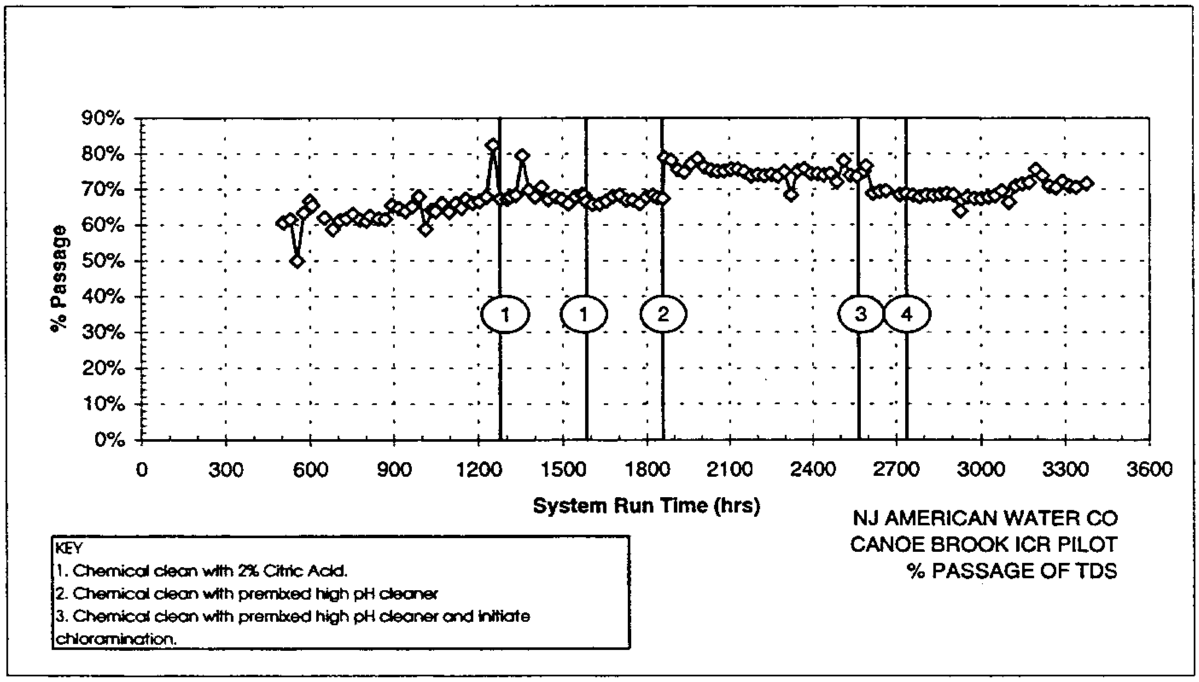


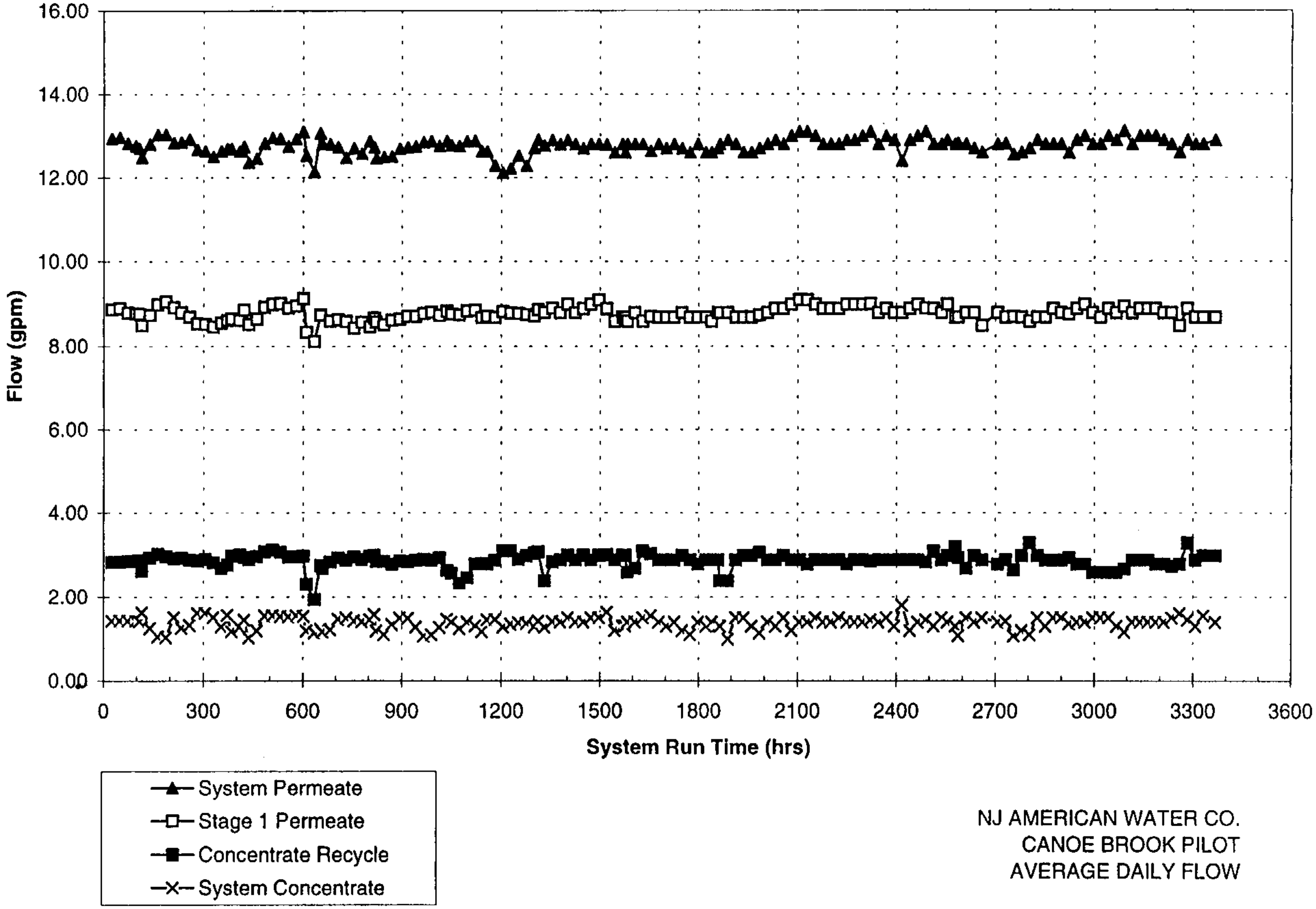
1.2
1
0.8
0.6
0.4
0.2
0
k, Stage 1
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
System Run Time (hrs)
1
2
KEY
1. Startup/intermittent chloramination.
2. Continuous chloramination after this date
Note: $k = (\Delta P)/(Q^{1.5})$
where Q is average of feed and
concentrate flow of Stage 1
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
PRESSURE DROP COEFFICIENT
STAGE 1



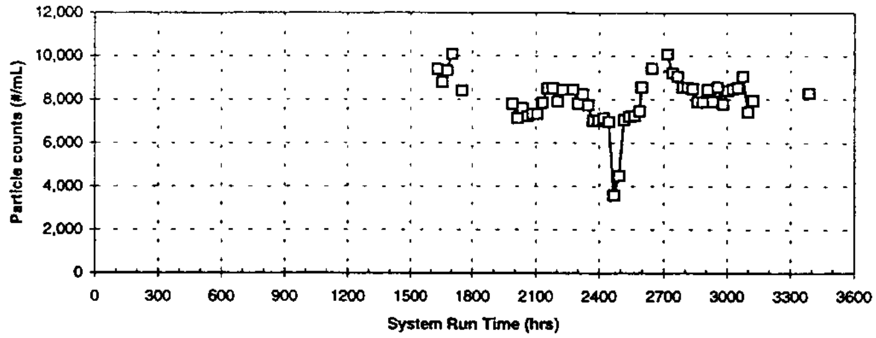
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
k, Stage 2
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
System Run Time (hrs)
Increased
antiscalant
dosage
Note: $k = (\Delta P)/(Q^{1.5})$
where Q is average of feed and
concentrate flow of Stage 2
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
PRESSURE DROP COEFFICIENT
STAGE 2


10.00%
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
% Passage
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
System Run Time (hrs)
Initiated chloramination
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
% PASSAGE OF UVA254

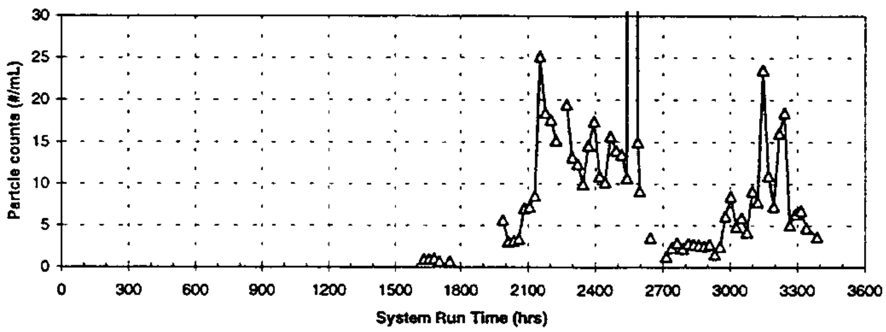

90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Passage
1
1
2
3
4
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
System Run Time (hrs)
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
% PASSAGE OF TDS
KEY
1. Chemical clean with 2% Citric Acid.
2. Chemical clean with premixed high pH cleaner
3. Chemical clean with premixed high pH cleaner and initiate chloramination.



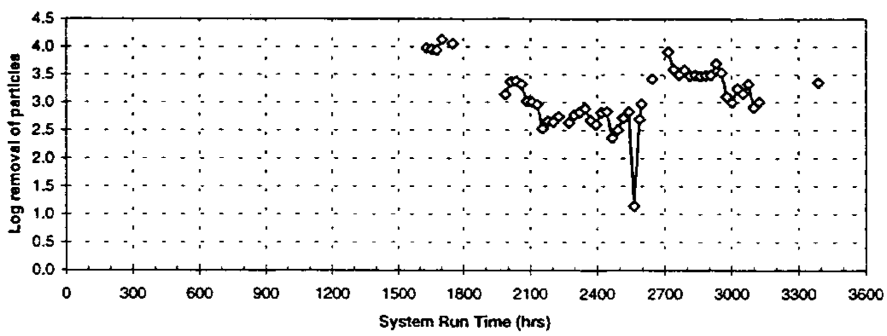
NJ AMERICAN WATER CO.
CANOE BROOK PILOT
AVERAGE DAILY FLOW



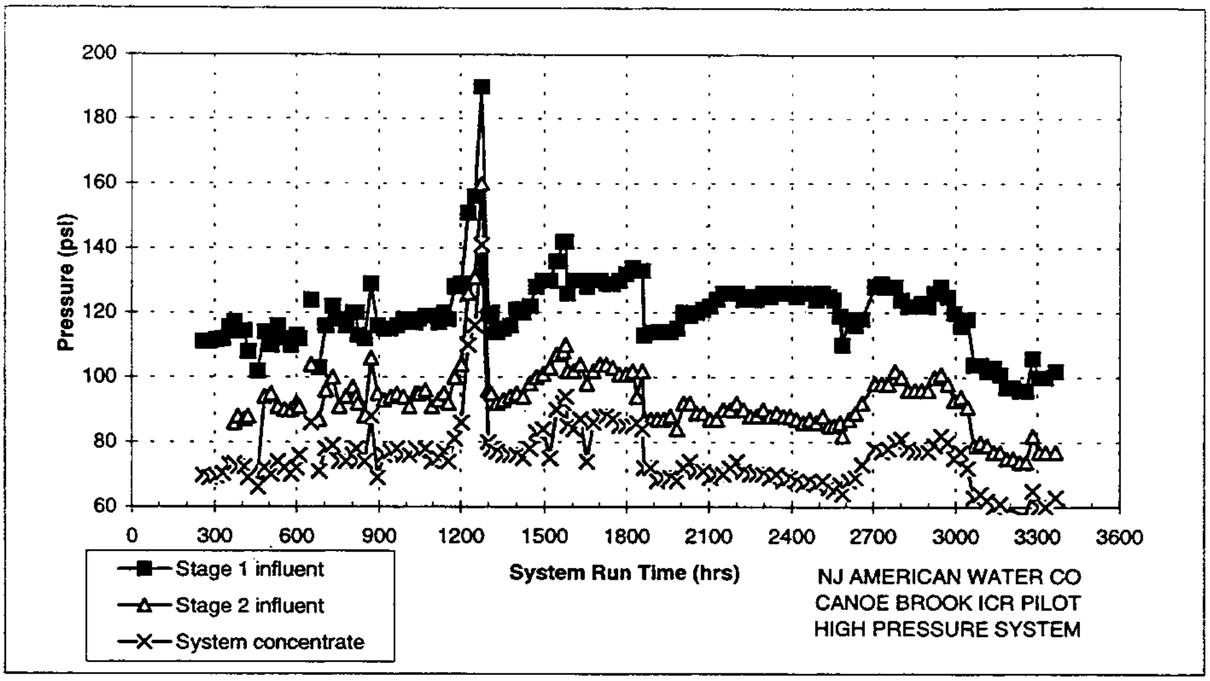
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
MF FEED PARTICLE COUNTS (2-100 µ)



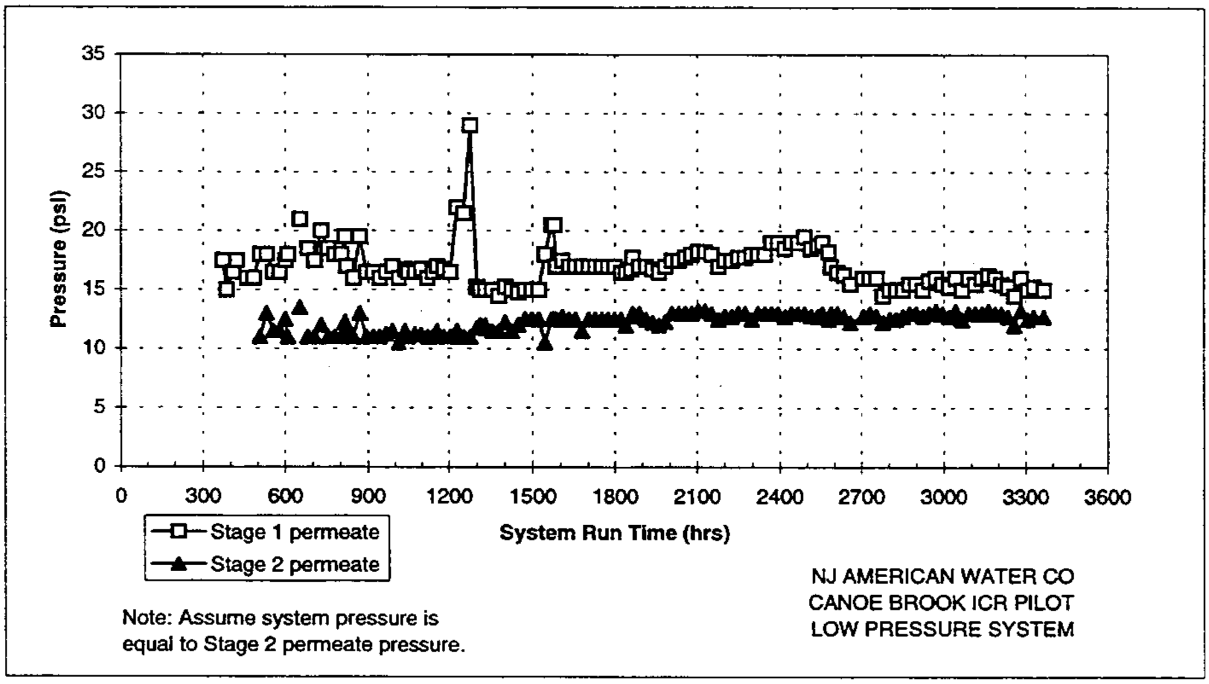
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
MF FILTRATE PARTICLE COUNTS (2-100 µ)



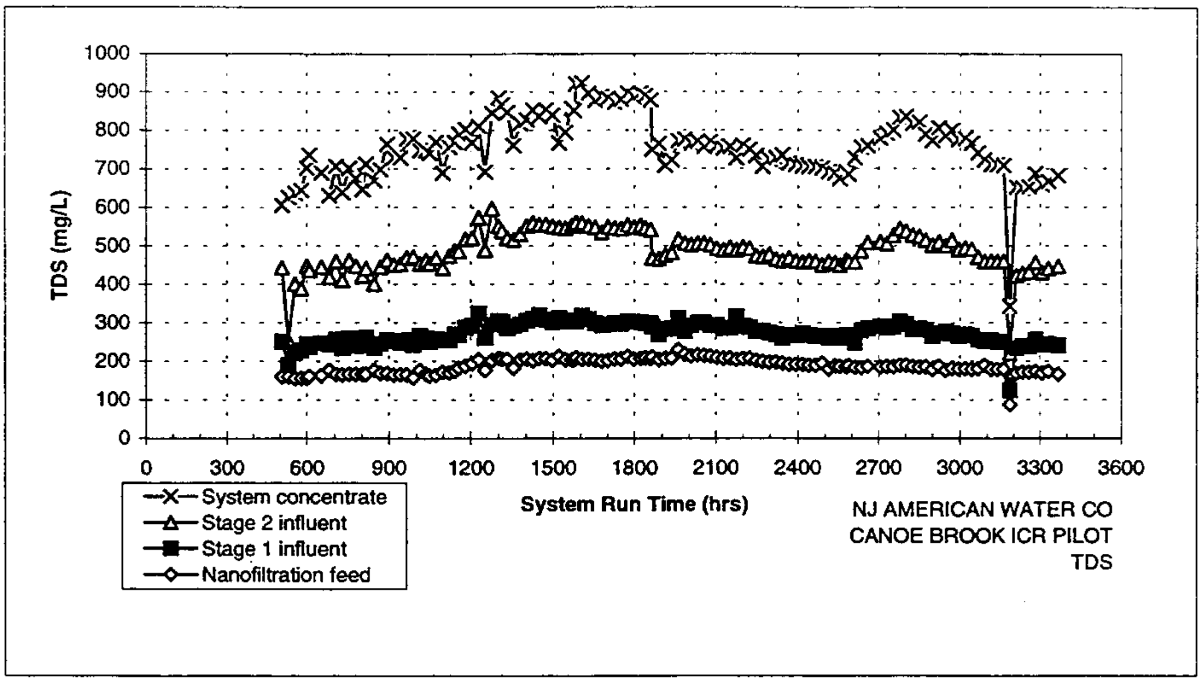
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
LOG REMOVAL OF PARTICLES

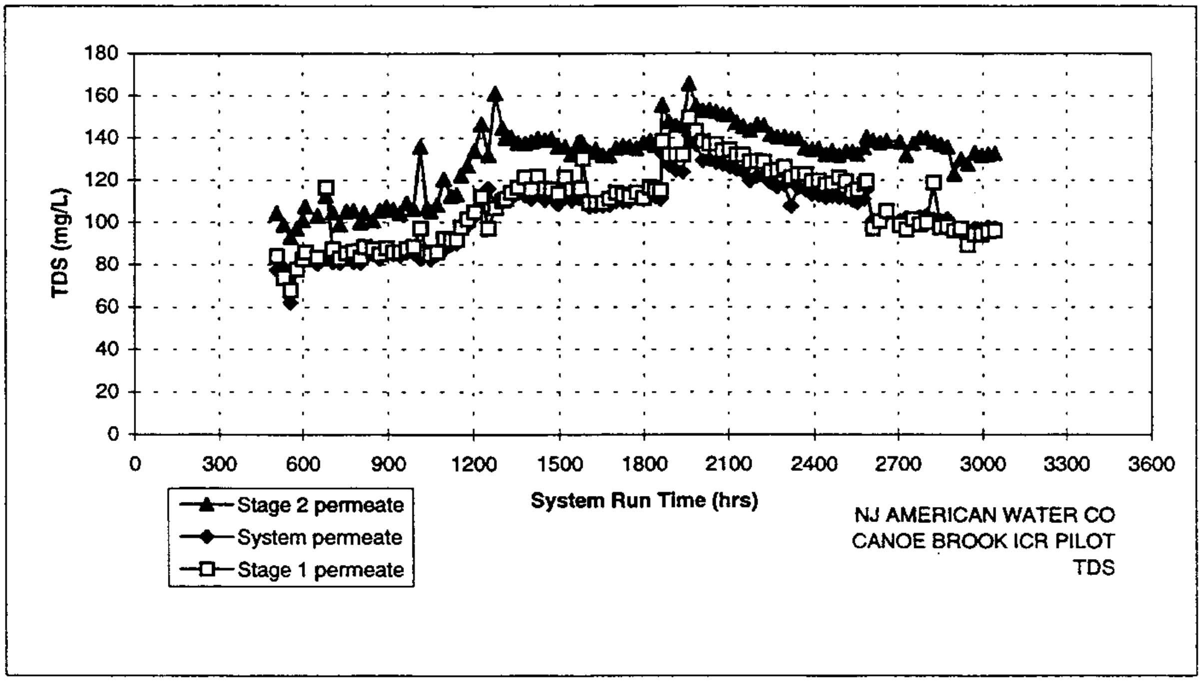


200
180
160
140
120
100
80
60
Pressure (psi)
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
System Run Time (hrs)
Stage 1 influent
Stage 2 influent
System concentrate
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
HIGH PRESSURE SYSTEM

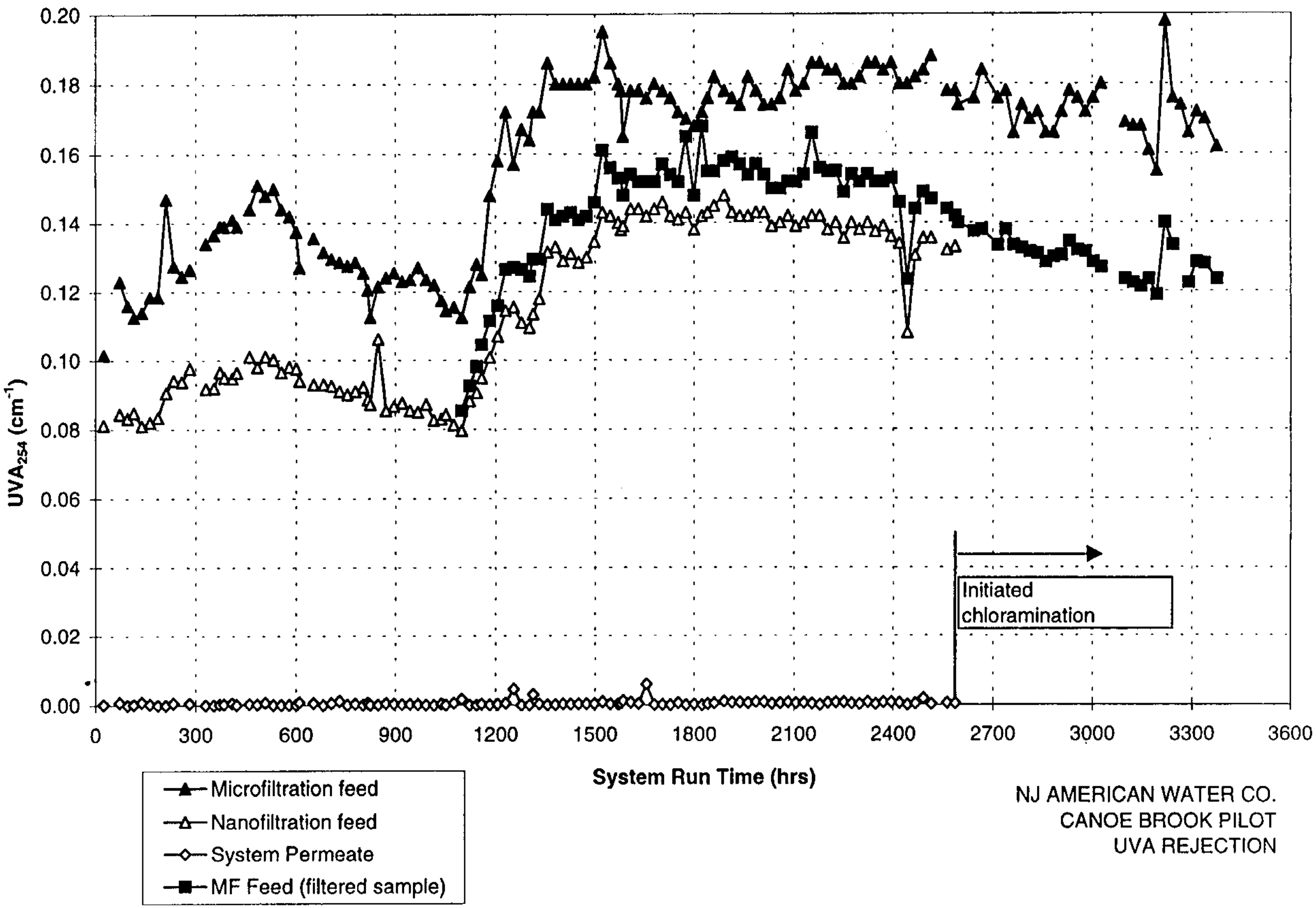


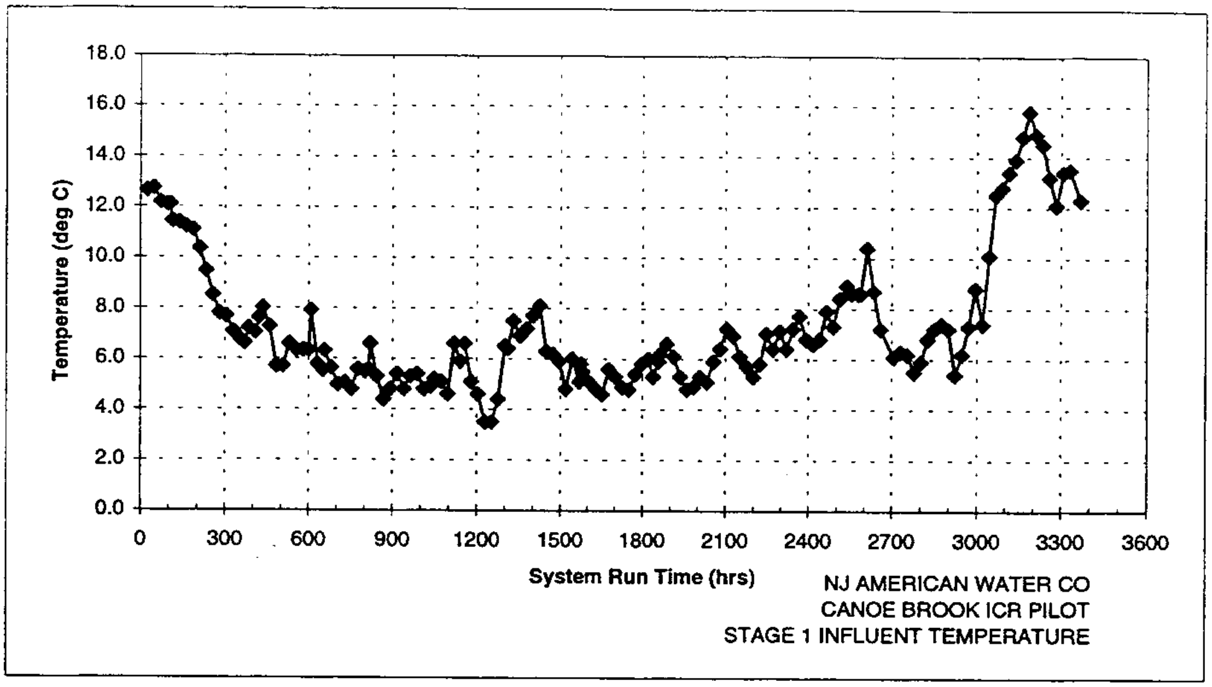
35
30
25
20
15
10
5
0
Pressure (psi)
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
System Run Time (hrs)
Stage 1 permeate
Stage 2 permeate
Note: Assume system pressure is
equal to Stage 2 permeate pressure.
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
LOW PRESSURE SYSTEM

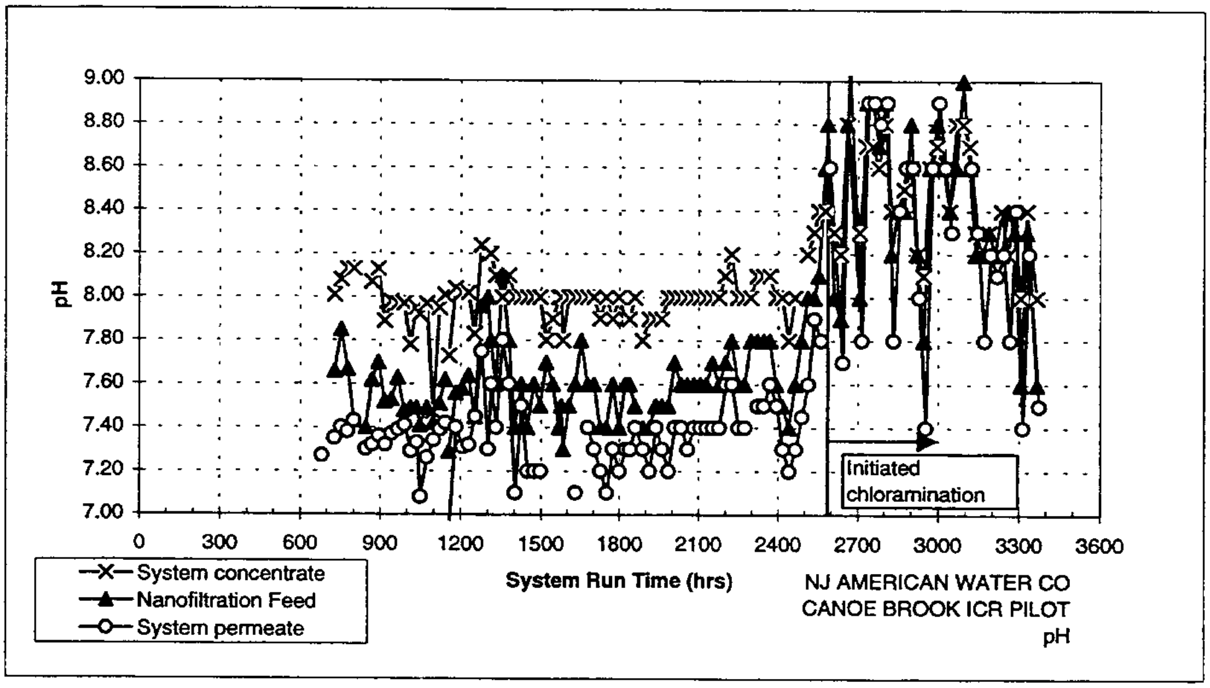




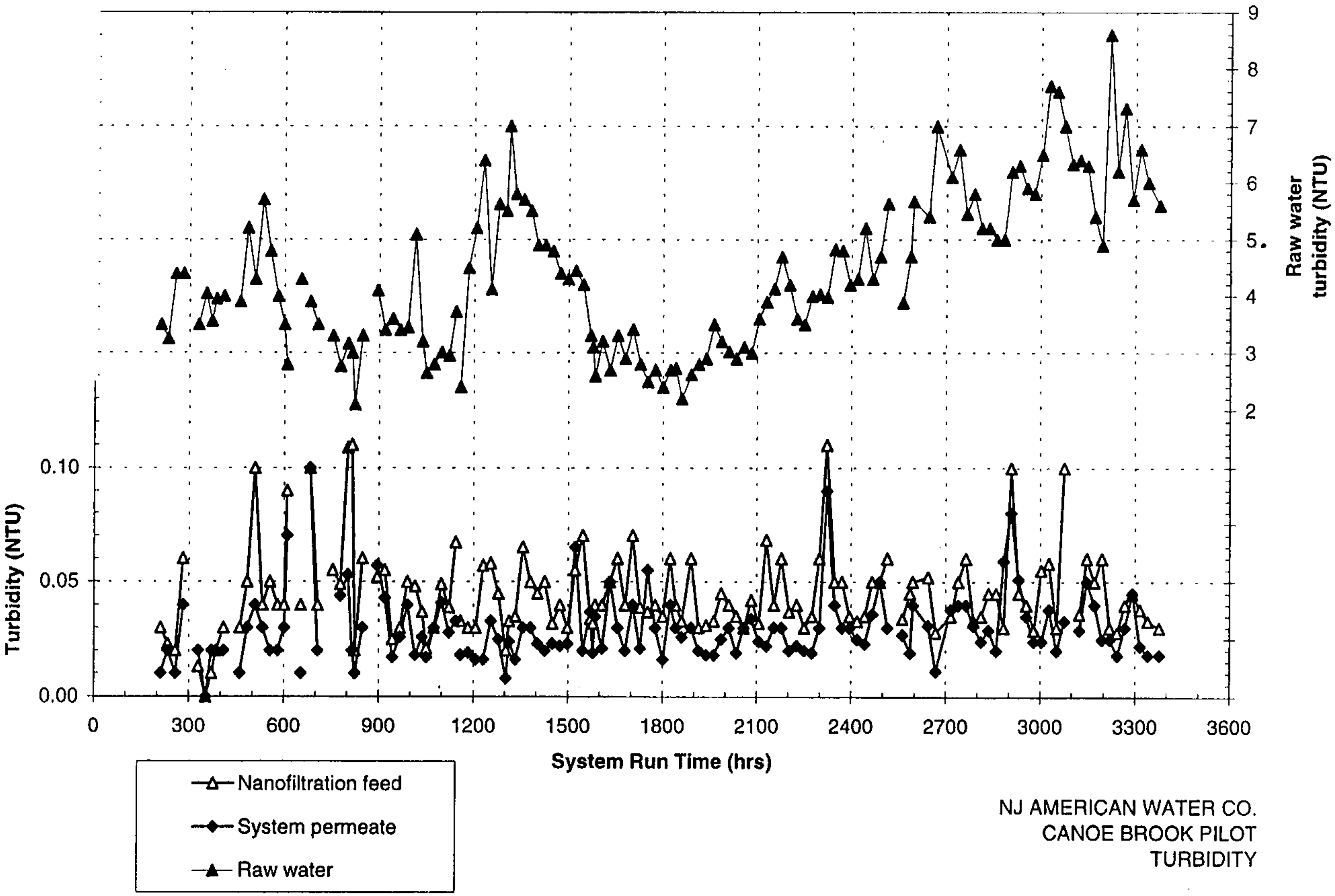
4_10sum.xls[TDS]


0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
UVA254 (cm-1)
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
System Run Time (hrs)
Initiated chloramination
Microfiltration feed
Nanofiltration feed
System Permeate
MF Feed (filtered sample)
NJ AMERICAN WATER CO.
CANOE BROOK PILOT
UVA REJECTION

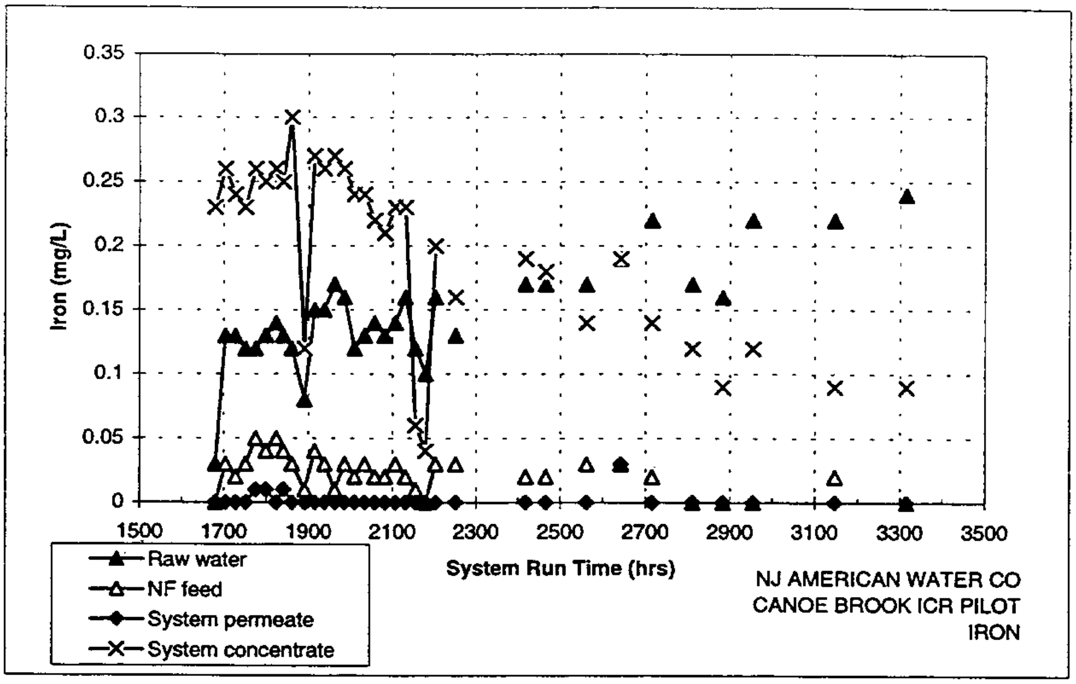




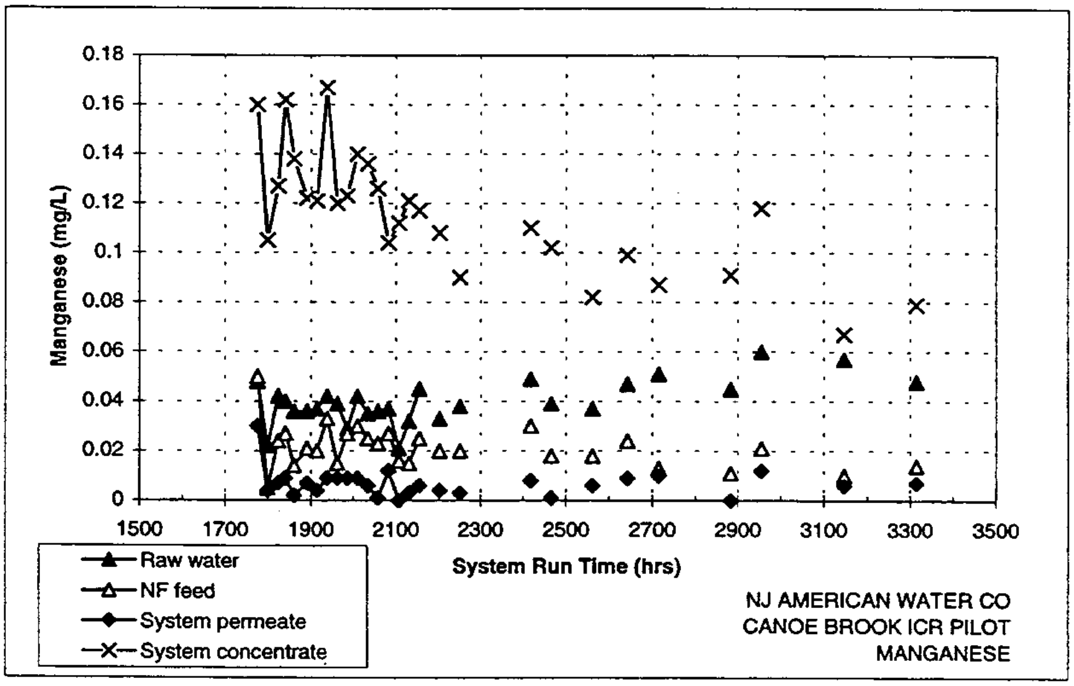
4_10sum.xls[TEMP & pH]



NJ AMERICAN WATER CO.
CANOE BROOK PILOT
TURBIDITY



0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Iron (mg/L)
1500
1700
1900
2100
2300
2500
2700
2900
3100
3300
3500
System Run Time (hrs)
Raw water
NF feed
System permeate
System concentrate
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
IRON



0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Manganese (mg/L)
1500
1700
1900
2100
2300
2500
2700
2900
3100
3300
3500
System Run Time (hrs)
Raw water
NF feed
System permeate
System concentrate
NJ AMERICAN WATER CO
CANOE BROOK ICR PILOT
MANGANESE

New Jersey American Water Company Canoe Brook Station ICR Pilot Week 2 Testing Results								
Date of test: 11/13/97	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	34	34	58	12	92	26	18	154
Total Hardness, mg/L as CaCO3	66	65	108	18	200	34	20	322
Calcium Hardness, mg/L as CaCO3	49	51	75	14	122	26	17	216
UV_{254}, cm^{-1}	0.1275	0.0942	0.19	0.0005	0.4	0.0009	0.0006	0.6775
Conductivity, µS/cm	311	311	424	177	658	263	201	924
Turbidity, ntu	3.21	0.02	0.1	0.02	0.08	0.01	0.02	0.08
Bromide, µg/L		41.5					41.5	
TOC, mg/L	6.0	4.7	9.8	< 0.1	20.1	< 0.1	< 0.1	32.1
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.7					7.3	
Contact pH		7.1					7.1	
Contact temperature, deg C		9					9	
Chlorine dosage, mg/L		2.80					2.80	
Haloacetic Acids, µg/L								
Chloroacetic acid		< 2.0					< 2.0	
Bromoacetic acid		< 1.0					< 1.0	
Dichloroacetic acid		13.5					< 1.0	
Trichloroacetic acid		24.2					< 1.0	
Bromochloroacetic acid		2.6					< 1.0	
Dibromoacetic acid		< 1.0					< 1.0	
Total HAA6		40.3					--	
Trihalomethanes, µg/L								
Chloroform		33.9					< 1.0	
Bromodichloromethane		10.3					< 1.0	
Dibromochloromethane		1.6					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		45.8					--	
Total Organic Halide, µg/L								
TOX Result		300					< 25	
TOX Duplicate		291					< 25	
Chlorine Demand Test Results								
Contact time, hrs		6.15					6.08	
Measured pH		7.1					7.3	
Measured temperature, deg C		9					9	
Chlorine residual, mg/L		1.11					2.66	
Chlorine demand, mg/L		1.69					0.14	

New Jersey American Water Company
Canoe Brook Station ICR Pilot
Week 4 Testing Results

Date of test: 12/3/97	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	40	36	60	15	121.	29	16	188
Total Hardness, mg/L as CaCO3	71	67	126	17	248	33	20	414
Calcium Hardness, mg/L as CaCO3	45	42	82	13	160	26	16	270
UV_{254}, cm^{-1}	0.1355	0.0918	0.2450	0.0005	0.469	0.0003	0.0006	0.755
Conductivity, µS/cm	NA	313	454	172	756	266	194	1061
Turbidity, ntu	4.3	0.08	0.08	0.07	0.20	0.1	0.04	0.14
Bromide, µg/L		39.3					37.9	
TOC, mg/L	4.6	3.8	7.0	< 0.1	16.3	< 0.1	< 0.1	32.8
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.7					7.3	
Contact pH		7.1					7.1	
Contact temperature, deg C		9					9	
Chlorine dosage, mg/L		2.80					1.00	
***Haloacetic Acids*, µg/L**								
Chloroacetic acid		< 2.0					< 2.0	
Bromoacetic acid		< 1.0					< 1.0	
Dichloroacetic acid		14.9					< 1.0	
Trichloroacetic acid		21.2					< 1.0	
Bromochloroacetic acid		2.8					< 1.0	
Dibromoacetic acid		< 1.0					< 1.0	
Total HAA6		38.9					--	
***Trihalomethanes*, µg/L**								
Chloroform		43.6					< 1.0	
Bromodichloromethane		8.8					< 1.0	
Dibromochloromethane		1.4					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		53.8					--	
***Total Organic Halide*, µg/L**								
TOX Result		282					< 25	
TOX Duplicate		279					< 25	
Chlorine Demand Test Results								
Contact time, hrs		6.17					6.17	
Measured pH		7.0					7.1	
Measured temperature, deg C		9					9	
Chlorine residual, mg/L		1.05					0.91	
Chlorine demand, mg/L		1.75					0.09	

Notes:

New Jersey American Water Company Canoe Brook Station ICR Pilot Week 6 Testing Results								
Date of test: 12/17/97	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	38	38	67	24	123	31	18	198
Total Hardness, mg/L as CaCO3	72.5	75.0	135	19.7	265	38.3	24.2	472
Calcium Hardness, mg/L as CaCO3	45.7	47.7	80.4	15.0	153	27.5	18.2	267
UV_{254}, cm^{-1}	0.1230	0.0876	0.2040	0.0001	0.4440	0.0007	0.0002	0.8000
Conductivity, µS/cm	317	317	464	177	765	273	205	1120
TDS, mg/L		165	253	86	451	106	85	728
Conversion, x Conductivity (µS/cm) = TDS (mg/L)		0.521	0.545	0.486	0.590	0.388	0.415	0.650
Turbidity, ntu	3.4	0.055	0.065	0.014	0.068	0.015	0.043	0.120
Bromide, µg/L		41.1					38.6	
TOC, mg/L	4.5	4.0	9.0	< 0.1	18.5	< 0.1	< 0.1	34.6
Iron, mg/L	0.0706	< 0.02					< .02	
Manganese, mg/L	0.015	0.002					< 0.0008	
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.8					7.5	
Contact pH		7.2					7.2	
Contact temperature, deg C		9					9	
Chlorine dosage, mg/L		2.80					1.00	
Haloacetic Acids, µg/L								
Chloroacetic acid		< 2.0					< 2.0	
Bromoacetic acid		< 1.0					< 1.0	
Dichloroacetic acid		15.2					< 1.0	
Trichloroacetic acid		20.5					< 1.0	
Bromochloroacetic acid		2.9					< 1.0	
Dibromoacetic acid		< 1.0					< 1.0	
Total HAA6		38.6					--	
Trihalomethanes, µg/L								
Chloroform		38.7					< 1.0	
Bromodichloromethane		8.3					< 1.0	
Dibromochloromethane		1.5					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		48.5					--	
Total Organic Halide, µg/L								
TOX Result		275					< 25	
TOX Duplicate		265					< 25	
Chlorine Demand Test Results								
Contact time, hrs		6.03					5.97	
Measured pH		7.2					7.2	
Measured temperature, deg C		9					9	
Chlorine residual, mg/L		1.29					0.96	
Chlorine demand, mg/L		1.51					0.04	
Notes:								

New Jersey American Water Company
Canoe Brook Station ICR Pilot
Week 8 Testing Results

Date of test: 1/7/98	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	36	36	63	18	126	26	16	214
Total Hardness, mg/L as CaCO3	72.7	73.9	141	19.0	292	101	22.4	513
Calcium Hardness, mg/L as CaCO3	45.7	45.9	83.4	14.3	168	25.7	17.2	295
UV_{254}, cm^{-1}	0.1640	0.1110	0.265	0.0003	0.543	0.0013	0.0006	0.950
Conductivity, µS/cm	395	396	559	226	920	363	266	1349
Turbidity, ntu	5.0	0.036	0.065	0.025	0.084	0.02	0.02	0.194
Bromide, µg/L		41.9					40.4	
TOC, mg/L	4.9	4.3	9.9	< 0.1	23.5	< 0.1	< 0.1	40.6
Iron, mg/L	0.193	< 0.02					< 0.02	
Manganese, mg/L	0.024	0.0025					< 0.001	
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		8.1					7.7	
Contact pH		7.0					7.0	
Contact temperature, deg C		9					9	
Chlorine dosage, mg/L		2.50					1.00	
Haloacetic Acids, µg/L								
Chloroacetic acid		< 2.0					< 2.0	
Bromoacetic acid		< 1.0					< 1.0	
Dichloroacetic acid		28.4					< 1.0	
Trichloroacetic acid		27.3					< 1.0	
Bromochloroacetic acid		3.6					< 1.0	
Dibromoacetic acid		<1.0					< 1.0	
Total HAA6		59.3					--	
Trihalomethanes, µg/L								
Chloroform		66.1					< 1.0	
Bromodichloromethane		6.2					< 1.0	
Dibromochloromethane		< 1.0					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		72.3					--	
Total Organic Halide, µg/L								
TOX Result		392					< 25	
TOX Duplicate		394					< 25	
Chlorine Demand Test Results								
Contact time, hrs		6					6	
Measured pH		7.0					7.3	
Measured temperature, deg C		9					9	
Chlorine residual, mg/L		0.58					0.90	
Chlorine demand, mg/L		1.92					0.10	

Notes:

New Jersey American Water Company Canoe Brook Station ICR Pilot Week 10 Testing Results								
Date of test: 1/19/98	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	36	36	62	12	124	30	18	200
Total Hardness, mg/L as CaCO3	75	74.5	155	17.9	307	33.4	22.8	536
Calcium Hardness, mg/L as CaCO3	48.2	47.9	94.6	13.9	183	26.5	17.9	315
UV_{254}, cm^{-1}	0.1530	0.1400	0.343	0.0002	0.810	0.0010	0.0005	1.355
Conductivity, µS/cm	396	393	560	238	938	355	269	1318
Turbidity, ntu	3.3	0.034	0.08	0.026	0.110	0.030	0.037	0.110
pH	7.6	7.4	7.7	6.9	7.9	7.3	7.1	8.0
Temperature, deg C		5.0	5.1	6.7	6.9	6.4	6.9	7.1
Bromide, µg/L		38					35	
TOC, mg/L	5.2	4.7	11.3	< 0.1	24.9	< 0.1	< 0.1	44.1
Iron, mg/L	0.108	< 0.05					< 0.05	
Manganese, mg/L	0.0159	< 0.005					< 0.005	
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.5					7.3	
Contact pH		7.1					7.1	
Contact temperature, deg C		9					9	
Chlorine dosage, mg/L		2.50					1.00	
Haloacetic Acids, µg/L								
Chloroacetic acid		< 2.0					< 2.0	
Bromoacetic acid		< 1.0					< 1.0	
Dichloroacetic acid		27.5					< 1.0	
Trichloroacetic acid		26.5					< 1.0	
Bromochloroacetic acid		3.2					< 1.0	
Dibromoacetic acid		< 1.0					< 1.0	
Total HAA6		57.2					--	
Trihalomethanes, µg/L								
Chloroform		48.4					< 1.0	
Bromodichloromethane		6.0					< 1.0	
Dibromochloromethane		1.0					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		55.4					--	
Total Organic Halide, µg/L								
TOX Result		387					< 25	
TOX Duplicate		396					< 25	
Chlorine Demand Test Results								
Contact time, hrs		6.00					6.00	
Measured pH		6.4					7.0	
Measured temperature, deg C		9					9	
Chlorine residual, mg/L		0.26					0.63	
Chlorine demand, mg/L		2.24					0.37	
Notes:								

New Jersey American Water Company Canoe Brook Station ICR Pilot Week 10 Duplicate Test Results								
Date of test: 1/19/98	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	38	38	64	14	126	30	18	203
Total Hardness, mg/L as CaCO3	71.3	71.7	150	17.1	287	32.5	21.5	508
Calcium Hardness, mg/L as CaCO3	45.4	46.2	91.6	13.3	171	25.7	16.9	300
UV_{254}, cm^{-1}	0.1530	0.1390	0.353	0.0004	0.780	0.0008	0.0007	1.460
Conductivity, µS/cm	394	393	562	235	936	353	268	1315
Turbidity, ntu	3.2	0.035	0.11	0.019	0.10	0.018	0.021	0.18
pH	7.5	7.4	7.7	7.0	7.9	7.3	7.1	8.0
Temperature, deg C	4.4	5.4	5.5	6.1	6.9	6.5	7.0	6.9
Bromide, µg/L		37					35	
TOC, mg/L	5.2	4.7	11.8	< 0.1	25.6	< 0.1	< 0.1	44.6
Iron, mg/L	0.108	< 0.05					< 0.05	
Manganese, mg/L	0.0151	< 0.005					< 0.005	
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.5					7.2	
Contact pH		7.0					7.0	
Contact temperature, deg C		9					9	
Chlorine dosage, mg/L		2.50					1.00	
Haloacetic Acids, µg/L								
Chloroacetic acid		< 2.0					< 2.0	
Bromoacetic acid		< 1.0					< 1.0	
Dichloroacetic acid		32.7					< 1.0	
Trichloroacetic acid		33.5					< 1.0	
Bromochloroacetic acid		3.7					< 1.0	
Dibromoacetic acid		< 1.0					< 1.0	
Total HAA6		69.9					--	
Trihalomethanes, µg/L								
Chloroform		52.4					< 1.0	
Bromodichloromethane		6.6					< 1.0	
Dibromochloromethane		1.0					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		60					--	
Total Organic Halide, µg/L								
TOX Result		373					< 25	
TOX Duplicate		389					< 25	
Chlorine Demand Test Results								
Contact time, hrs		6.00					6.00	
Measured pH		7.0					6.9	
Measured temperature, deg C		9					9	
Chlorine residual, mg/L		0.5					0.71	
Chlorine demand, mg/L		2.00					0.29	

Notes:

New Jersey American Water Company
Canoe Brook Station ICR Pilot
Week 12 Testing Results

Date of test: 2/4/98	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	36	36	56	17	101	34	23	154
Total Hardness, mg/L as CaCO3	75.3	74.0	132	31.6	235	50.4	38.3	78
Calcium Hardness, mg/L as CaCO3	47.9	46.7	79.9	22.6	134	36.7	28.2	49.4
UV_{254}, cm^{-1}	0.1590	0.1430	0.366	0.0004	0.795	0.0011	0.0007	1.520
Conductivity, µS/cm	398	399	520	272	807	376	301	1091
Turbidity, ntu	2.8	0.03	0.05	0.016	0.10	0.018	0.020	0.130
pH	7.4	7.4	7.6	7.0	7.8	7.3	7.2	7.9
Temperature, deg C		5.3	6.1	6.3	6.7	6.4	6.6	6.7
Bromide, µg/L		42					38	
TOC, mg/L	5.4	5.0	11.2	< 0.01	24.6	< 0.01	< 0.01	43.8
Iron, mg/L	0.14	< 0.05					< 0.05	
Manganese, mg/L	0.016	0.007					< 0.005	
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.5					7.4	
Contact pH		7.1					7.1	
Contact temperature, deg C		9					9	
Chlorine dosage, mg/L		2.70					1.00	
Haloacetic Acids, µg/L								
Chloroacetic acid		< 2.0					< 2.0	
Bromoacetic acid		< 1.0					< 1.0	
Dichloroacetic acid		29.6					< 1.0	
Trichloroacetic acid		32.8					< 1.0	
Bromochloroacetic acid		3.0					< 1.0	
Dibromoacetic acid		< 1.0					< 1.0	
Total HAA6		65.4					< 1.0	
Trihalomethanes, µg/L								
Chloroform		60.8					< 1.0	
Bromodichloromethane		6.0					< 1.0	
Dibromochloromethane		< 1.0					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		66.8					--	
Total Organic Halide, µg/L								
TOX Result		446					< 25	
TOX Duplicate		452					< 25	
Chlorine Demand Test Results								
Contact time, hrs		6.93					6.82	
Measured pH		7.0					7.1	
Measured temperature, deg C		9					9	
Chlorine residual, mg/L		0.27					0.78	
Chlorine demand, mg/L		2.43					0.22	

Notes:

New Jersey American Water Company Canoe Brook Station ICR Pilot Week 14 Testing Results								
Date of test: 2/18/98	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	36	35	58	16	105	33	21	168
Total Hardness, mg/L as CaCO3	75.8	74.1	132	28.1	250	46.9	35.6	447
Calcium Hardness, mg/L as CaCO3	47.9	46.7	77.7	20.5	144	34.2	26.2	255
UV_{254}, cm^{-1}	0.1490	0.1355	0.353	0.0007	0.790	0.0012	0.0007	1.380
Conductivity, µS/cm	387	385	510	256	804	365	287	1129
TDS, mg/L	220	212	304	122	489	198	156	760
Turbidity, ntu	3.5	0.03	0.075	0.016	0.10	0.020	0.020	0.160
pH	7.7	7.6	7.8	7.3	8.0	7.5	7.4	8.0
Temperature, deg C		6.2	7.0	7.1	7.2	7.2	7.7	7.8
Bromide, µg/L		39					37	
TOC, mg/L	5.2	4.6	10.7	< 0.1	22.6	< 0.1	< 0.1	42.7
Iron, mg/L	0.234	0.0497					0.0228	0.154
Manganese, mg/L	0.023	0.0032					0.0014	0.0212
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.7					7.5	
Contact pH		7.2					7.2	
Contact temperature, deg C		10					10	
Chlorine dosage, mg/L		2.80					1.00	
Haloacetic Acids, µg/L								
Chloroacetic acid		1.3					< 1.0	
Bromoacetic acid		< 0.5					< 0.5	
Dichloroacetic acid		28.3					< 0.5	
Trichloroacetic acid		37.8					< 0.5	
Bromochloroacetic acid		3.0					< 0.5	
Dibromoacetic acid		< 0.5					< 0.5	
Total HAA6		70.4					--	
Trihalomethanes, µg/L								
Chloroform		69.2					< 1.0	
Bromodichloromethane		7.3					< 1.0	
Dibromochloromethane		< 1.0					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		76.5					--	
Total Organic Halide, µg/L								
TOX Result		440					< 50	
TOX Duplicate		439					< 50	
Chlorine Demand Test Results								
Contact time, hrs		6.58					6.42	
Measured pH		7.0					7.1	
Measured temperature, deg C		11					11	
Chlorine residual, mg/L		0.45					0.69	
Chlorine demand, mg/L		2.35					0.31	

Notes:
Chlorine Demand and Simulated Distribution System Samples were not analyzed until May 4, 1998. Samples were stored at 4 deg C for entire holding time.

New Jersey American Water Company
Canoe Brook Station ICR Pilot
Week 16 Testing Results

Date of test: 3/3/98	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	35	35	55	15	104	31	20	154
Total Hardness, mg/L as CaCO3	65.7	63.5	114	25.5	215	42.6	30.5	359
Calcium Hardness, mg/L as CaCO3	41.4	40.7	67.9	18.7	124	30.7	22.0	201
UV_{254}, cm^{-1}	0.1440	0.1320	0.328	0.0004	0.775	0.0008	0.0005	1.43
Conductivity, µS/cm	359	358	479	238	784	341	264	1038
Turbidity, ntu	3.88	0.034	0.078	0.034	0.092	0.026	0.027	0.142
pH	8.2	8.0	8.2	7.6	8.2	7.8	7.8	8.4
Temperature, deg C		8.1	8.6	9.4	9.8	9.5	9.4	9.8
Bromide, µg/L		38					35	
TOC, mg/L	5.0	4.5	11.1	< 0.1	22.9	< 0.1	< 0.1	40.6
Iron, mg/L	0.149	< 0.0211					< 0.0210	0.0518
Manganese, mg/L	0.0192	< 0.0011					< 0.0011	0.0025
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		8					7.9	
Contact pH		7.1					7.2	
Contact temperature, deg C		10					10	
Chlorine dosage, mg/L		2.80					1.00	
Haloacetic Acids, µg/L								
Chloroacetic acid		1.5					< 1.0	
Bromoacetic acid		< 0.5					< 0.5	
Dichloroacetic acid		28.4					< 0.5	
Trichloroacetic acid		37.6					< 0.5	
Bromochloroacetic acid		2.6					< 0.5	
Dibromoacetic acid		< 0.5					< 0.5	
Total HAA6		70.1					--	
Trihalomethanes, µg/L								
Chloroform		68.1					< 1.0	
Bromodichloromethane		6.9					< 1.0	
Dibromochloromethane		< 1.0					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		75.0					--	
Total Organic Halide, µg/L								
TOX Result		435					< 50	
TOX Duplicate		417					< 50	
Chlorine Demand Test Results								
Contact time, hrs		6.23					6.15	
Measured pH		7.0					7.2	
Measured temperature, deg C		11					11	
Chlorine residual, mg/L		0.74					0.90	
Chlorine demand, mg/L		2.06					0.10	

Notes:
Chlorine Demand and Simulated Distribution System Samples were not analyzed until May 4, 1998. Samples were stored at 4 deg C for entire holding time.

New Jersey American Water Company
Canoe Brook Station ICR Pilot
Week 18 Testing Results

Date of test: 3/23/98	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	36	36	66	12	127	29	18	200
Total Hardness, mg/L as CaCO3	67.9	66.4	130	21.2	242	44.5	29.7	403
Calcium Hardness, mg/L as CaCO3	42.4	41.7	79.2	14.2	146	31.0	20.2	238
UV_{254}, cm^{-1}	0.1320	0.1210	0.339	0.0003	0.710	0.0011	0.0007	1.31
Conductivity, µS/cm	338	338	509	184	849	329	229	1210
Turbidity, ntu	5.9	0.04	0.05	0.014	0.075	0.039	0.035	0.12
pH	8.0	7.8	8.0	7.2	8.1	7.6	7.4	8.1
Temperature, deg C		6.3	6.2	6.8	7.1	7.0	7.2	7.4
Bromide, µg/L		33					32	
TOC, mg/L	5.0	4.2	11.5	< 0.1	22.6	< 0.1	< 0.1	40.6
Iron, mg/L	0.334	0.0279					< .0210	0.0936
Manganese, mg/L	0.0249	< 0.001					< 0.001	0.0068
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.9					7.6	
Contact pH		7.1					7.1	
Contact temperature, deg C		10					10	
Chlorine dosage, mg/L		2.80					1.00	
Haloacetic Acids, µg/L								
Chloroacetic acid		1.9					< 1.0	
Bromoacetic acid		< 0.5					< 0.5	
Dichloroacetic acid		30.1					< 0.5	
Trichloroacetic acid		37					< 0.5	
Bromochloroacetic acid		3.2					< 0.5	
Dibromoacetic acid		< 0.5					< 0.5	
Total HAA6		72.2					--	
Trihalomethanes, µg/L								
Chloroform		66.5					< 0.5	
Bromodichloromethane		6.8					< 0.5	
Dibromochloromethane		0.8					< 0.5	
Bromoform		< 0.5					< 0.5	
Total THM4		74.1					--	
Total Organic Halide, µg/L								
TOX Result		409					< 50	
TOX Duplicate		392					< 50	
Chlorine Demand Test Results								
Contact time, hrs		5.67					5.60	
Measured pH		7.1					7.1	
Measured temperature, deg C		10					10	
Chlorine residual, mg/L		0.98					0.93	
Chlorine demand, mg/L		1.82					0.07	

Notes:

New Jersey American Water Company Canoe Brook Station ICR Pilot Week 20 Testing Results								
Date of test: 4/7/98	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	35	35	57	15	103	33	20	165
Total Hardness, mg/L as CaCO3	46.6	53.9	93.4	22.0	161	42.0	23.2	277
Calcium Hardness, mg/L as CaCO3	29.7	34.2	57.7	14.5	97.6	28.5	15.4	167
UV_{254}, cm^{-1}	0.1285	0.1190	0.298	0.0001	0.663	0.0013	0.0002	1.20
Conductivity, µS/cm	326	326	446	193	731	323	231	1013
Turbidity, ntu	6.6	0.038	0.05	0.027	0.07	0.03	0.022	0.14
pH	7.8	7.6	7.8	7.2	8.0	7.5	7.4	8.0
Temperature, deg C		13.4	13.7	14.3	14.8	14.6	14.6	14.7
Bromide, µg/L		32					37	
TOC, mg/L	5.1	4.4	9.4	< 0.1	20.5	< 0.1	< 0.1	36.9
Iron, mg/L	0.152	< 0.0178					< 0.0178	0.0412
Manganese, mg/L	0.031	0.0037					0.0015	0.0219
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.7					7.5	
Contact pH		7.1					7.1	
Contact temperature, deg C		10					10	
Chlorine dosage, mg/L		2.80					1.00	
***Haloacetic Acids*, µg/L**								
Chloroacetic acid		1.5					< 1.0	
Bromoacetic acid		< 0.5					< 0.5	
Dichloroacetic acid		26.4					< 0.5	
Trichloroacetic acid		34.9					< 0.5	
Bromochloroacetic acid		2.8					< 0.5	
Dibromoacetic acid		< 0.5					< 0.5	
Total HAA6		65.6					--	
***Trihalomethanes*, µg/L**								
Chloroform		63.9					< 1.0	
Bromodichloromethane		7.6					< 1.0	
Dibromochloromethane		< 1.0					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		71.5					--	
***Total Organic Halide*, µg/L**								
TOX Result		385					< 50	
TOX Duplicate		380					< 50	
Chlorine Demand Test Results								
Contact time, hrs		6.68					6.53	
Measured pH		7.2					7.3	
Measured temperature, deg C		10					10	
Chlorine residual, mg/L		0.9					0.98	
Chlorine demand, mg/L		1.90					0.02	
Notes:								

New Jersey American Water Company
Canoe Brook Station ICR Pilot
Week 20 Duplicate Test Results

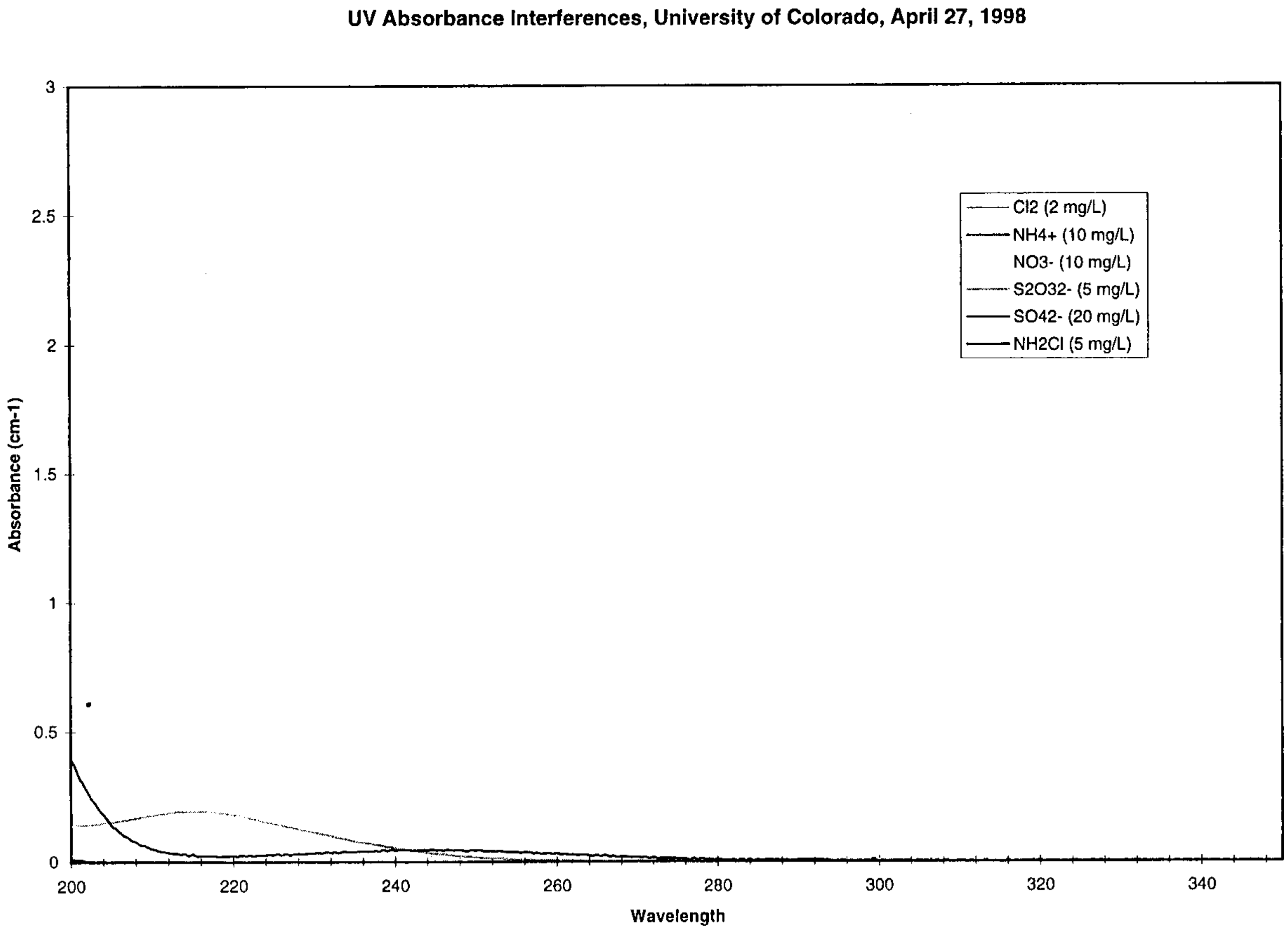
Date of test: 4/7/98	Sample Location							
		#3	#4	#12	#11	#13	#15	#14
Parameter	Raw water/ MF Feed Water	NF Feed/ Cartridge Filtered	Stage 1 Influent	Stage 1 Permeate	Stage 2 Influent	Stage 2 Permeate	System Permeate	System Concentrate
Alkalinity, mg/L as $CaCO_3$	35	34	56	14	104	31	18	157
Total Hardness, mg/L as CaCO3	50.8	53.8	88.5	21.3	165	41.6	27.5	278
Calcium Hardness, mg/L as CaCO3	31.5	33.7	53.9	14.2	100	28.5	18.5	166
UV_{254}, cm^{-1}	0.1290	0.1180	0.287	0.0002	0.648	0.0008	0.0003	1.20
Conductivity, µS/cm	325	324	444	193	723	324	230	1010
Turbidity, ntu	6.1	0.025	0.05	0.018	0.10	0.035	0.025	0.13
pH	7.8	7.6	7.8	7.5	8.0	7.5	7.4	8.0
Bromide, µg/L		34					34	
TOC, mg/L	4.8	4.2	9.8	< 0.1	21.9	< 0.1	< 0.1	37.6
Iron, mg/L	0.257	< 0.0178					< 0.0178	0.0415
Manganese, mg/L	0.0431	0.0036					0.0016	0.0222
SDS-HAA/THM Formation Potential Test Conditions								
Target contact time, hrs		6					6	
Initial pH		7.7					7.5	
Contact pH		7.1					7.1	
Contact temperature, deg C		10					10	
Chlorine dosage, mg/L		2.80					1.00	
Haloacetic Acids, µg/L								
Chloroacetic acid		1.6					< 1.0	
Bromoacetic acid		< 0.5					< 0.5	
Dichloroacetic acid		27.2					< 0.5	
Trichloroacetic acid		36.1					< 0.5	
Bromochloroacetic acid		2.9					< 0.5	
Dibromoacetic acid		< 0.5					< 0.5	
Total HAA6		67.8					--	
Trihalomethanes, µg/L								
Chloroform		65.4					< 1.0	
Bromodichloromethane		7.4					< 1.0	
Dibromochloromethane		< 1.0					< 1.0	
Bromoform		< 1.0					< 1.0	
Total THM4		72.8					--	
Total Organic Halide, µg/L								
TOX Result		400					< 50	
TOX Duplicate		401					< 50	
Chlorine Demand Test Results								
Contact time, hrs		6.37					6.27	
Measured pH		7.1					7.3	
Measured temperature, deg C		10					10	
Chlorine residual, mg/L		0.89					0.98	
Chlorine demand, mg/L		1.91					0.02	

Notes:

Appendix E

UVA_{254} Study Results from the University of Colorado

Chart1


UV Absorbance Interferences, University of Colorado, April 27, 1998
3
2.5
2
1.5
1
0.5
0
Absorbance (cm-1)
200
220
240
260
280
300
320
340
Wavelength
Cl2 (2 mg/L)
NH4+ (10 mg/L)
NO3- (10 mg/L)
S2O32- (5 mg/L)
SO42- (20 mg/L)
NH2Cl (5 mg/L)

UV Absorbance Interferences, University of Colorado, April 27, 1998