

**ICR Treatment Study Summary Report**

**Evaluation of GAC Performance Using a Pilot Plant  
for Compliance with the Information Collection Rule  
at the E.M. Johnson Water Treatment Plant**

Conducted during the period of April 14, 1998 through March 31, 1999

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E.M. Johnson Water Treatment Plant ICR # 452

Attachments: 2 diskettes containing the Data Collection Spreadsheets

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# Section 1

## Executive Summary and Conclusions and Recommendations

### 1.1 Main Conclusions

- The pretreated pilot study influent water SDS-THM analyses demonstrated that on 27 of the 36 days of sampling the E. M. Johnson plant would be expected to typically not exceed a THM4 limit of < 40 ug/L. All of the SDS-THM analyses on the pretreated pilot study influent water demonstrated THM4 levels to be typically expected to be below a limit of 80 ug/L.
- The pretreated pilot study influent water SDS-HAA analyses demonstrated that on 31 of the 36 days of sampling the E. M. Johnson plant would be expected to typically not exceed an HAA6 limit of < 30 ug/L. All of the SDS-HAA analyses on the pretreated pilot study influent water demonstrated HAA6 levels to be typically expected to be below a limit of 60 ug/L.
- The GAC contactors were able to reduce the SDS-DBP concentrations to levels below the proposed Stage 2 limits of 30 and 40 ug/L for HAA6 and THM4, respectively.
- During this entire study, the SDS-THM4 and SDS-HAA6 contaminant levels in the contactor effluents never exceeded the proposed Stage 2 Rule limits of 30 and 40 ug/L for HAA6 and THM4, respectively.
- The GAC in a contactor with EBCT of 10 minutes would be expected to last for longer than one year and still be able to meet the proposed Stage 2 D/DBP rules.
- Since most of the pretreated influent samples demonstrated SDS-DBP levels below the proposed D/DBP Rule Stage 2 levels, it is possible that use of chloramines in the distribution system during the summer months would enable the plant to meet the Stage 2 levels at a much lower cost than the addition of a GAC contactor.

## Section 2 Background

### 2.1 Location

The E. M. Johnson Water Treatment Plant serves the City of Raleigh and surrounding communities. The state approved rated capacity of the plant is 78 MGD.

### 2.2 Source Water Quality

The E. M. Johnson plant utilizes Falls Lake, a manmade impoundment on the Neuse River, for its raw water source. The raw water has low alkalinity and moderate to high TOC levels that vary seasonally. Typical water quality parameters for the source water are listed in Table 2-1.

### 2.3 Treatment Processes

The Johnson plant is a conventional sedimentation and dual-media (sand/anthracite) filtration plant. A treatment train schematic is shown in Figure 2-1. Potassium permanganate is injected for preoxidation, and ferric sulfate is used as a coagulant. Other chemicals currently added include sodium hydroxide, sodium hypochlorite, ammonia, polymer, fluoride, and polyphosphate. Hypochlorite is used for primary disinfection and chloramines are used as a residual disinfectant in the distribution system. ICR Water Utility Database reports A2 and A3 for the Johnson plant are provided in Appendix A to provide treatment process parameters.

Treatment process upgrades for ozone addition (primary and intermediate) and the replacement of anthracite with GAC for conversion to filter absorbers are under construction and should be completed by summer of 1999.

### 2.4 Finished Water Quality

Table 2-2 lists average finished water quality parameters for water leaving the Johnson WTP and entering the distribution system.

### 2.5 Treatment Challenges

#### DBPs

Chloramines are used as a residual disinfectant to enable the facility to lower the concentrations of disinfection byproducts at the point of use.

**Figure 2-1**  
**Flow Schematic of E.M. Johnson Water Treatment Plant**

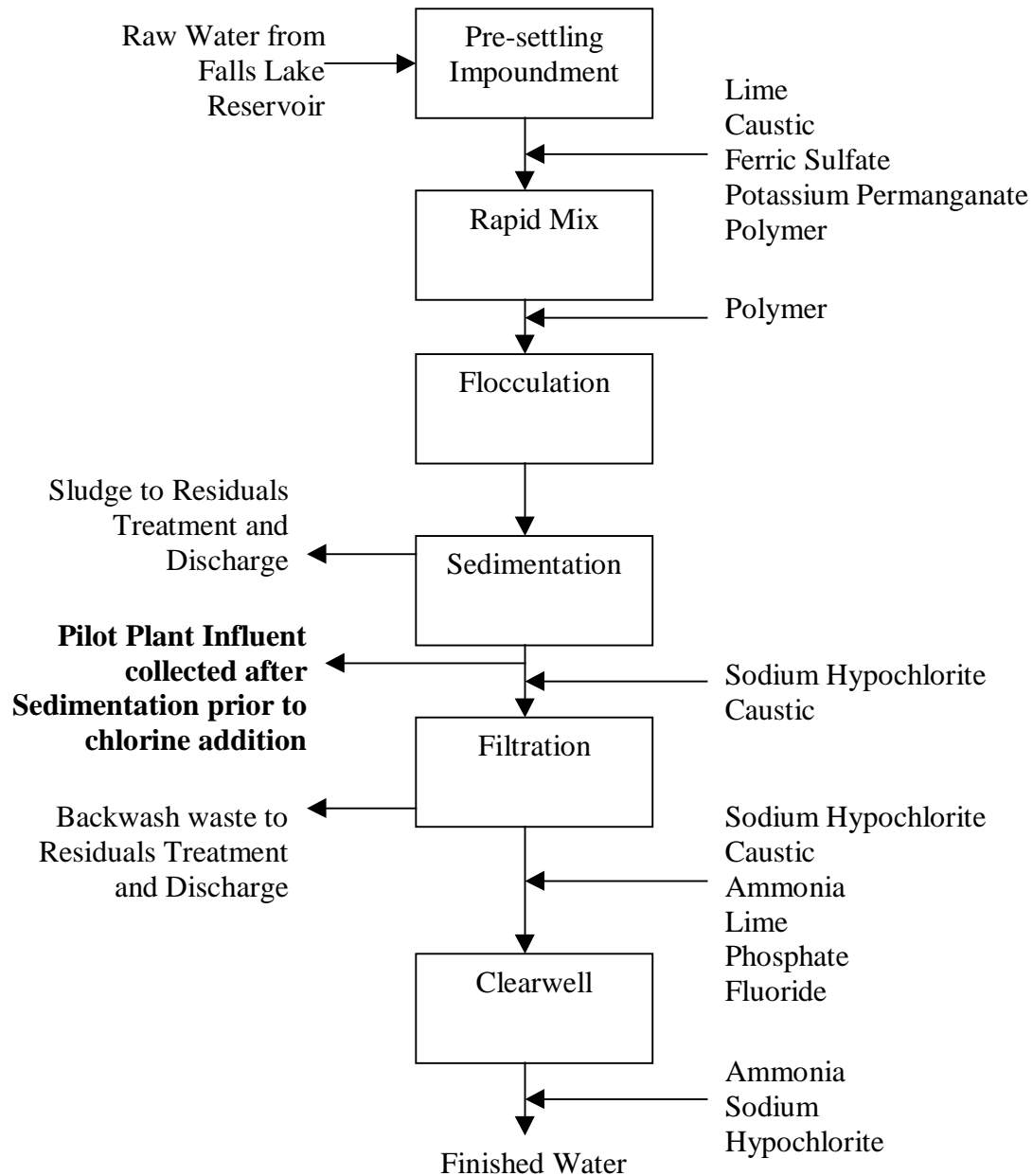


Table 2-1 Tabular Summary of Source Water Quality during 1998 for the E.M. Johnson WTP				
Water Quality Parameter	Average Yearly Value	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
Temperature [°C]	20.6	5.34	28.1	13.4
pH	6.65	0.58	7.42	5.16
Turbidity [ntu]	11.4	6.14	21.7	1.97
Alkalinity (mg/L) as CaCO <sub>3</sub>	21.1	5.76	33	13
CaCO <sub>3</sub>	13.3	2.86	17	8
Total Hardness [mg/L CaCO <sub>3</sub> ]	21.8	4.57	27	14
TOC [mg/L]	4.8	0.95	6.4	3.3
UV254 [cm <sup>-1</sup> ]	0.155	0.093	0.304	0.023
Bromide [ug/L]	31	12	50	<20

Table 2-2 Tabular Summary of Finished Water Quality during 1998 Leaving the E.M. Johnson WTP				
Water Quality Parameter	Average Yearly Value	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
Temperature [°C]	20.7	6.3	28.3	10.4
pH	7.22	0.82	8.19	5.01
Turbidity [ntu]	0.27	0.34	1.33	0.08
TOC [mg/L]	2.11	0.32	2.7	1.6
UV254 [cm <sup>-1</sup> ]	0.042	0.01	0.05	<0.009
Avg Dist System THM4 [ug/L]	32.5	13.8	51.4	20.1
Avg Dist System-HAA5 [ug/L]	29.3	13.7	20.1	16.6



## Section 3

### Materials and Methods

#### 3.1 Pilot-Scale GAC Contactor Set-up

A pilot-scale Granular Activated Carbon (GAC) contactor study was conducted on settled water from the E. M. Johnson Water Treatment Plant (WTP) from 4/14/98 to 3/29/99. Empty bed contact times (EBCT) of 10 minutes and 20 minutes were investigated. The data results are reported in the Data Collection spreadsheet located in Appendix B.

##### 3.1.1 PRETREATMENT PROCESSES

The E.M. Johnson WTP treats raw source water from the Falls Lake Reservoir. The E.M. Johnson plant currently uses conventional sedimentation/filtration treatment processes. Influent water for the pilot study was taken following sedimentation, prior to the addition of chlorine. A schematic of the pretreatment process for the pilot study influent is shown in Figure 3-1.

The full-scale pretreatment processes included ferric sulfate coagulation at dosages between 40 and 50 mg/L as  $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$ ; flocculation and sedimentation. The collected pilot plant influent was further pretreated with pilot-scale ozonation and pilot-scale dual media filtration prior to the GAC contactors. The dual media sand/antracite pilot filtration units were designed to match the full-scale filters currently used at the E.M. Johnson WTP. Three filters were used in series. The filters were backwashed three times a week to prevent clogging.

##### 3.1.2 PILOT PLANT DESIGN

The Pilot Plant design is summarized in Table 3-1 below.

<b>Table 3-1 Experimental Design Summary for Pilot Plant</b>		
<b>Full Scale Pretreatment</b>	Rapid Mix, Sedimentation	
<b>Pilot Scale Pretreatment</b>	Ozonation, Dual Media Filtration	
<b>GAC Contactors</b>	EBCT	10 & 20 minutes
	GAC Column Bed Depths	5.3 ft & 5.3 ft in series
	GAC Column Diameter	6.04 inches
	GAC Media	Calgon Filtrasorb 820 diameter = 1.0 - 1.2 mm
	Water Application Rate	4 gpm/ft <sup>2</sup>
	Water Velocity	0.53 ft/min

Figure 3-1 illustrates the Pilot Plant design. Two GAC contactor columns were run in series with sampling points before (Port A), between (Port B), and after (Port C) the columns, for the influent, EBCT10, and EBCT20 samples, respectively. Each column was more than 8 ft deep to avoid loss of media due to expansion of the bed during backwash. Each column was provided with an overflow pipe to provide pressure relief, piezometers to monitor the pressure, and flow control valves to maintain a constant flow. The pilot filters and GAC columns had backwash capability using non-chlorinated water.

The GAC columns were loaded in accordance with the guidance manual. The amount of GAC that was used was calculated by starting with a GAC sample of 20% more mass than required. This sample was weighed before and after loading the filter. The amount of GAC in the column was taken as the difference between the original sample weight and the weight that remained after filling. The GAC was allowed to become wetted for 24 hours and only the fines were backwashed as discussed in the guidance manual.

### 3.1.3 DEMONSTRATION OF NO TOC LEACHING

The GAC columns and all other materials in contact with the water between influent and effluent sampling ports were composed of PVC as is allowed since the column diameter was greater than 6.00 inches. Prior to the set-up of the pilot filter units, the column and piping was flushed with filtered water and tested to verify that there was no leaching or adsorption of TOC from the parts. During this flushing of the columns without GAC media, the influent TOC concentration was measured to be 2.554 mg/L and the effluent TOC concentration out of column 2 was measured to be 2.514 mg/L, confirming that TOC leaching was not significant.

## 3.2 Sampling

Samples were taken from three sample ports A, B, C, as shown in Figure 3-1.

All samples were taken by Camp Dresser and McKee (CDM) staff and sent to CDM Labs in Cambridge, MA for analysis. Influent water samples (port A) were analyzed for TOC, UV<sub>254</sub>, calcium and total hardness, SDS-DBP's, chlorine demand, bromide, turbidity, alkalinity, and ammonia. GAC effluent water samples (ports B&C) were tested for TOC, UV<sub>254</sub>, SDS-DBP's, chlorine demand, turbidity, and alkalinity. Prior to collection, each sample port was allowed to flow for 2 minutes. CDM laboratories prepared sample containers with the required preservatives. Following sampling, the sample containers were shipped in a cooler overnight to the laboratory.

### 3.3 ANALYTICAL METHODS

The analytical methods used by all labs involved in the Pilot Plant study are summarized in Table 3-2. Additionally Table 3-3 contains contact information for all labs involved in the study.

#### 3.3.1 SIMULATED DISTRIBUTION SYSTEM (SDS) ANALYSES

The SDS conditions for each sample were set to simulate the actual distribution system conditions at the time of sampling. The SDS target temperature was equal to the distribution system temperature at the time of sampling. The free chlorine residual at the end of SDS holding time was approximately equal to 0.8 mg/L, the average residual in the distribution system. The SDS holding time was set at 2 days, the average distribution system residence time.

#### 3.3.2 pH AND TEMPERATURE ANALYSES

pH and temperature measurements were made immediately following sampling by CDM staff using the E.M Johnson WTP laboratory.

**Figure 3-1**  
**Flow Schematic of GAC Columns with Full and Pilot-Scale Pretreatment Processes**

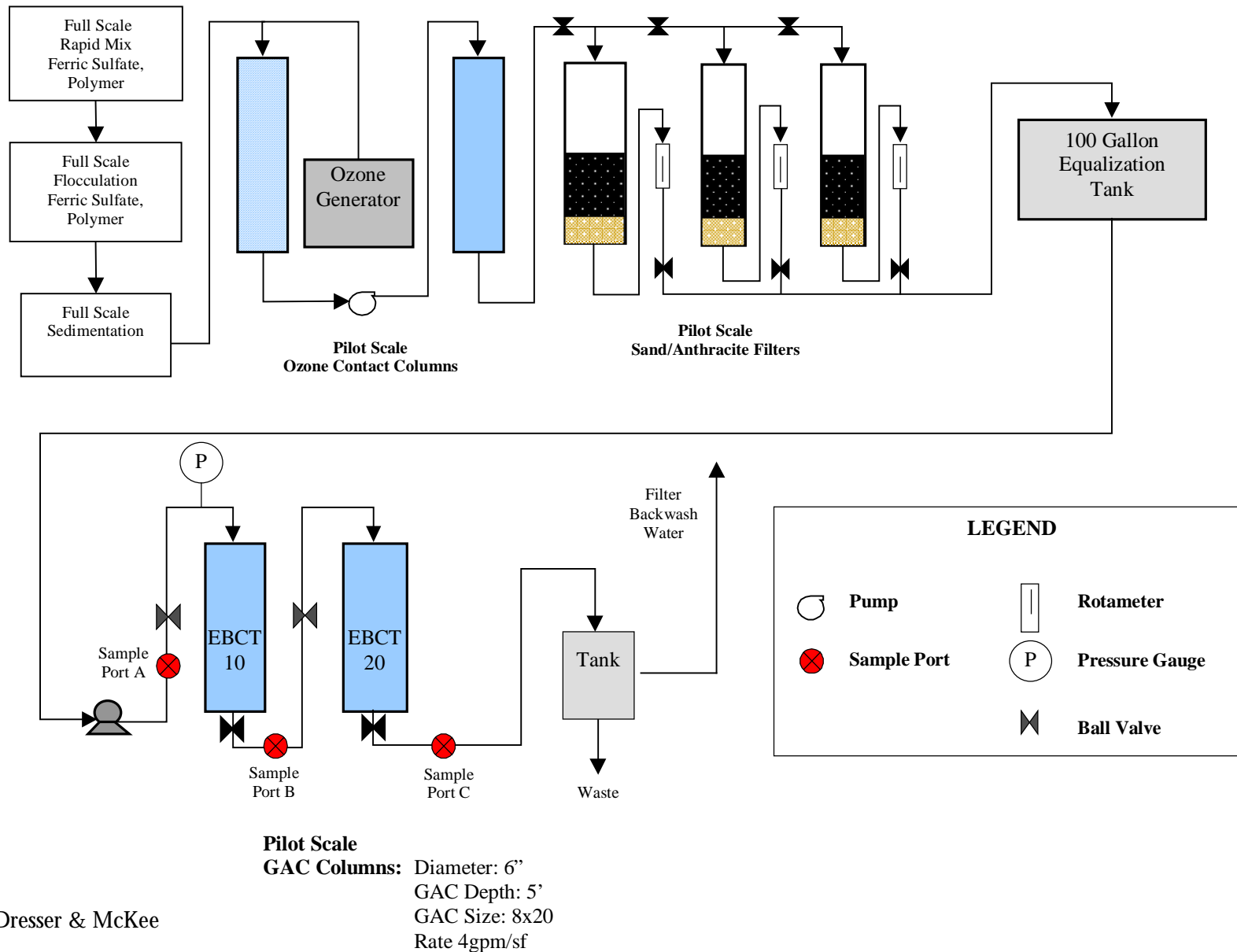


Table 3-2 Summary of Analytical Methods and MRLs Used During Pilot Plant Study						
Analyte	CDM Laboratory		Alpha Analytical		EHL	
	Method	Minimum Reporting Level	Method	Minimum Reporting Level	Method	Minimum Reporting Level
Alkalinity	SM 2320 B	5 mg/L CaCO <sub>3</sub>	EPA 310.1	2.0 mg/L		
Ammonia	SM 4500-NH <sub>3</sub> F	0.10 mg/L NH <sub>3</sub> -N	EPA 350.1	0.07 mg/L		
Bromide	EPA 300A	0.02 mg/L	EPA 300.0	0.05 mg/L	EPA 552.2	0.1 ug/L
Total Hardness	EPA 200.7	3 mg/L CaCO <sub>3</sub>	SM 2340 B	3 mg/L CaCO <sub>3</sub>		
Calcium Hardness	EPA 200.7	3 mg/L CaCO <sub>3</sub>	SM 2340 B	1.25 mg/L CaCO <sub>3</sub>		
Chlorine Residual	SM 4500-Cl D	0.2 mg/L	SM 4500-Cl D	0.05 mg/L		
Chlorine Demand	SM 2350	0.050 mg/L	SM 2350 B	0.1 mg/L		
BCAA, DBAA, DCAA, MBAA, MCAA, TCAA	SM 6251 B	1.0 ug/L for each analyte	SM 6251 B	1.0 ug/L for each analyte	EPA 552.2	0.1 ug/L except for MCAA: 0.2 ug/L
pH	SM 4500-H+ (Elec Method)	N/A	SM 4500-H+ (Elec Method)	N/A		
Temperature	SM 2550 B	N/A	SM 2550 B	N/A		
CHCl <sub>3</sub> , BDCM, DBCM, CHBr <sub>3</sub>	EPA 551.1	1.0 ug/L for each analyte			EPA 552.2	0.1 ug/L
TOC	SM 5310 C	0.50 mg/L	SM 5310 C	0.10 mg/L		
TOX					SM 5320 B	50 ug Cl- /L
Turbidity	SM 2130 B	0.05 ntu	EPA 180.1	0.2 ntu		
UV254	SM 5910	0.005 cm-1	SM 5910 B	0.005 cm-1		

Table 3-3 Summary of Laboratories Conducting Analyses During Pilot Study				
Laboratory	Contact	Dates of Service	Analyses Performed	Comments
E.M. Johnson WTP P.O. Box 590, Raleigh, NC 27602 Tel: (919) 870-2870 Fax: (919) 870-2893	Bill Dowbiggin Camp Dresser & McKee 5400 Glenwood Ave, Suite 300 Raleigh NC 27612 Tel: (919) 787-5620 Fax: (919) 781-5730	4/14/98 - 4/14/99	pH, Temperature	Analyses were performed by CDM staff at the EM Johnson WTP
Camp Dresser & McKee Laboratory, Riverside Technology Ctr, 840 Memorial Dr, Cambridge, MA 02139 Tel: n/a, Fax: n/a ICR Lab ID: MA001*	Jim Occhialini Alpha Analytical Services 8 Walkup Dr, Westborough, MA 01581 Tel: (508) 898-9220 Fax: (508) 898-9193 ICR Lab ID: MA086	4/14/98 - 1/25/99	Alkalinity, Hardness (Total and Calcium), Turbidity, Ammonia, TOC, UV254, SDS-THM, SDS-HAA, SDS-TOX, SDS-Chlorine Demand	CDM Labs was bought by Alpha in Jan 99. J. Occhialini, formerly with CDM Labs was in charge of these analyses for CDM Labs and continues in this role but now works for Alpha Analytical.
Alpha Analytical Services 8 Walkup Dr, Westborough, MA 01581 Tel: (508) 898-9220 Fax: (508) 898-9193 ICR Lab ID: MA086	Jim Occhialini Alpha Analytical Services 8 Walkup Dr, Westborough, MA 01581 Tel: (508) 898-9220 Fax: (508) 898-9193 ICR Lab ID: MA086	1/25/99 - 4/14/99	Alkalinity, Hardness (Total and Calcium), Turbidity, Ammonia, TOC, UV254, SDS-THM, SDS-HAA, SDS-TOX, SDS-Chlorine Demand	
Environmental Health Laboratories 110 S Hill St, South Bend IN 46617-2702 Tel: (219) 233-4777 Fax: (219) 233-3272 ICR Lab ID: IN004	Richard Radcliff Environmental Health Laboratories 110 S Hill St, South Bend IN 46617-2702 Tel: (219) 233-4777 Fax: (219) 233-3272 ICR Lab ID: IN004	4/14/98 - 1/25/99	TOX	Under subcontract with CDM Labs.
Environmental Health Laboratories 110 S Hill St, South Bend IN 46617-2702 Tel: (219) 233-4777 Fax: (219) 233-3272 ICR Lab ID: IN004	Richard Radcliff Environmental Health Laboratories 110 S Hill St, South Bend IN 46617-2702 Tel: (219) 233-4777 Fax: (219) 233-3272 ICR Lab ID: IN004	1/25/99 - 4/14/99	TOX, Bromide, SDS-THM, SDS-HAA	Under subcontract with Alpha Analytical.

## Section 4

# Results and Discussion

### 4.1 Seasonal Variations in Influent Water Quality

There was little seasonal variation in the pretreated pilot study influent water characteristics. Table 4-1 presents a comparison of several influent water parameters between the summer and winter seasons. The influent water temperature was much higher during the summer than the winter.

#### 4.1.1. ORGANIC PARAMETERS

The average TOC levels of the pilot study influent water were slightly higher during the winter than the summer. The average SDS-THM and SDS-HAA levels were lower in the winter than in the summer. However, SDS temperature averaged 28 C in the summer and 13 C in the winter. Thus, the differences in the THM and HAA levels observed at these times could be due to the SDS temperature effects and may not necessarily indicate differences in water quality. The average SDS-TOX levels were higher in the winter than in the summer.

#### 4.1.2. INORGANIC PARAMETERS

The influent water bromide levels were higher during the winter season than during the summer. There is no known explanation for this increase. The increased bromide levels are expected to have affected the amount and speciation of the DBP species during the winter months.

### 4.2 Breakthrough Curves

#### 4.2.1 AGGREGATE ORGANIC CONSTITUENTS

Figure 4-1 shows the TOC breakthrough curves for the EBCT-10 and EBCT-20 minute contactors. TOC breakthrough in the EBCT-10 contactor was observed to start between 100 and 150 days. TOC breakthrough for the EBCT-20 contactor started after approximately 250 days.

Figure 4-2 shows the influent and effluent water UV-254 absorbance curves. Breakthrough of UV-254 absorbance in the EBCT-10 contactor appears to start between 100 and 150 days. For the EBCT-20 minute contactor, measurable UV-254 absorbance levels were observed in the effluent water after 100 days. However, the sharp rise in effluent UV-254 absorbance doesn't occur until after 250 days for the EBCT-20 contactor.

Figure 4-3 shows the chlorine demand curves. Complete breakthrough of chlorine demand occurred after between 150 and 200 days.

#### 4.2.2 DBPs

Figures 4-4 to 4-6 show the influent and contactor effluent curves for SDS-THM4, SDS-HAA6, and SDS-TOX levels. Breakthrough of the SDS-DBP levels for the EBCT-10 minute contactor started about the same time as the breakthrough of the TOC and UV absorbance levels, around 150 days. Measurable levels of SDS-DBP were observed in both the EBCT-10 and EBCT-20 minute contactor after about 100 days. The sharp rise in breakthrough of the SDS-DBP levels for the EBCT-20 minute contactor occurred between 250 and 300 days.

The SDS-THM4 levels in the pretreated influent water were always below the Stage 1 D/DBP Rule level of 80 ug/L and were often below the proposed stage 2 limit of 40 ug/L. The SDS-THM4 levels in both the EBCT-10 and EBCT-20 minute contactors were always below the proposed Stage 2 level of 40 ug/L.

The SDS-HAA6 levels in the pretreated influent water were always below the Stage 1 D/DBP Rule level of 60 ug/L and were often below the proposed stage 2 limit of 30 ug/L. The SDS-HAA6 levels in both the EBCT-10 and EBCT-20 minute contactors were always below the proposed Stage 2 level of 30 ug/L.

## 4.3 Operational Experiences

### 4.3.1 PILOT SYSTEM DOWNTIME

Table 4-2 provides a list of the pilot plant system downtime, including the reason behind and the best estimate of the length for each downtime event. Over the entire project, the pilot plant system had a total accumulated downtime of 12.1 days.

### 4.3.2 BACKWASH FREQUENCY

Table 4-3 provides backwashing dates for GAC Columns 10 and 20 as shown in Figure 3-1. The sand/antracite filters were backwashed every three days by CDM staff: Chitra Parameswar, Patty Quinlivann, Jennifer Chambers, Jean Bailey, and Rob Bharati.

Table 4-3: GAC Backwash Log		
Date	EBCT 10	EBCT 20
4/14/98	X	X
5/26/98	X	X
9/8/98	X	
1/13/99	X	
2/12/99	X	X
2/17/99	X	X
3/1/99	X	X
3/8/99	X	X



Figure 4-1: TOC Breakthrough Curves

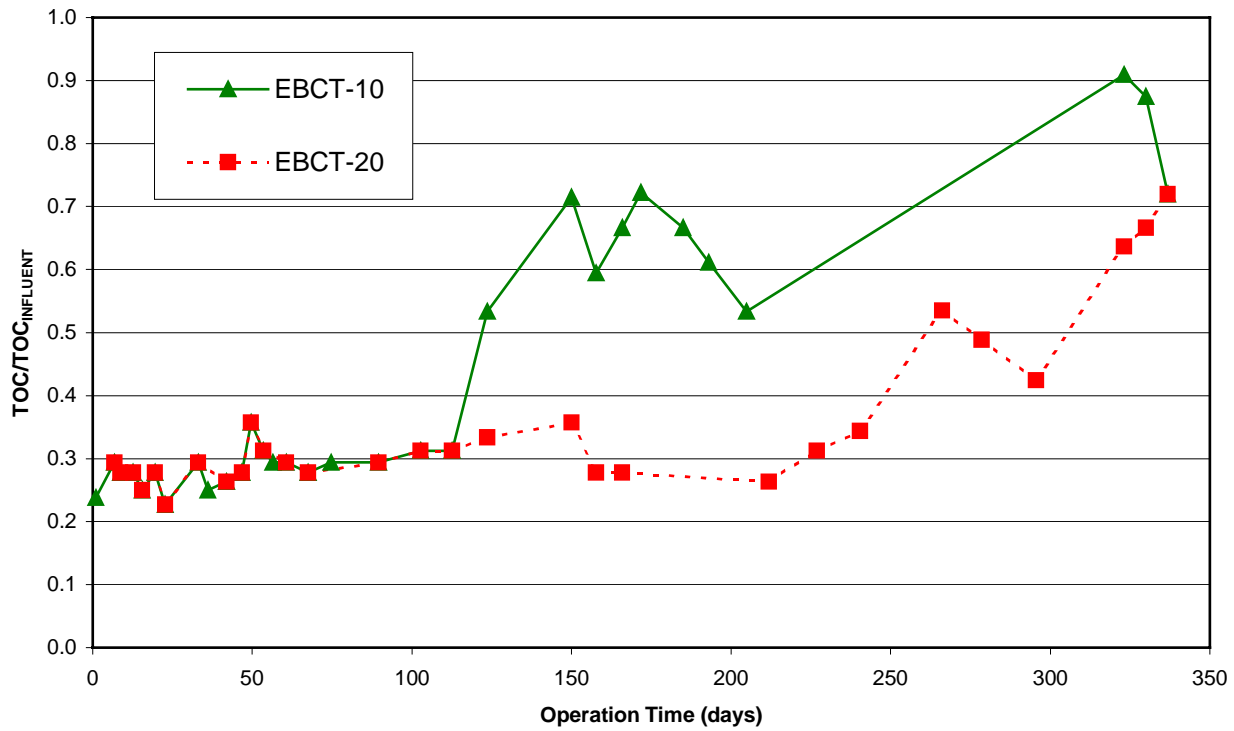


Figure 4-2: UV-254 Absorbance Curves

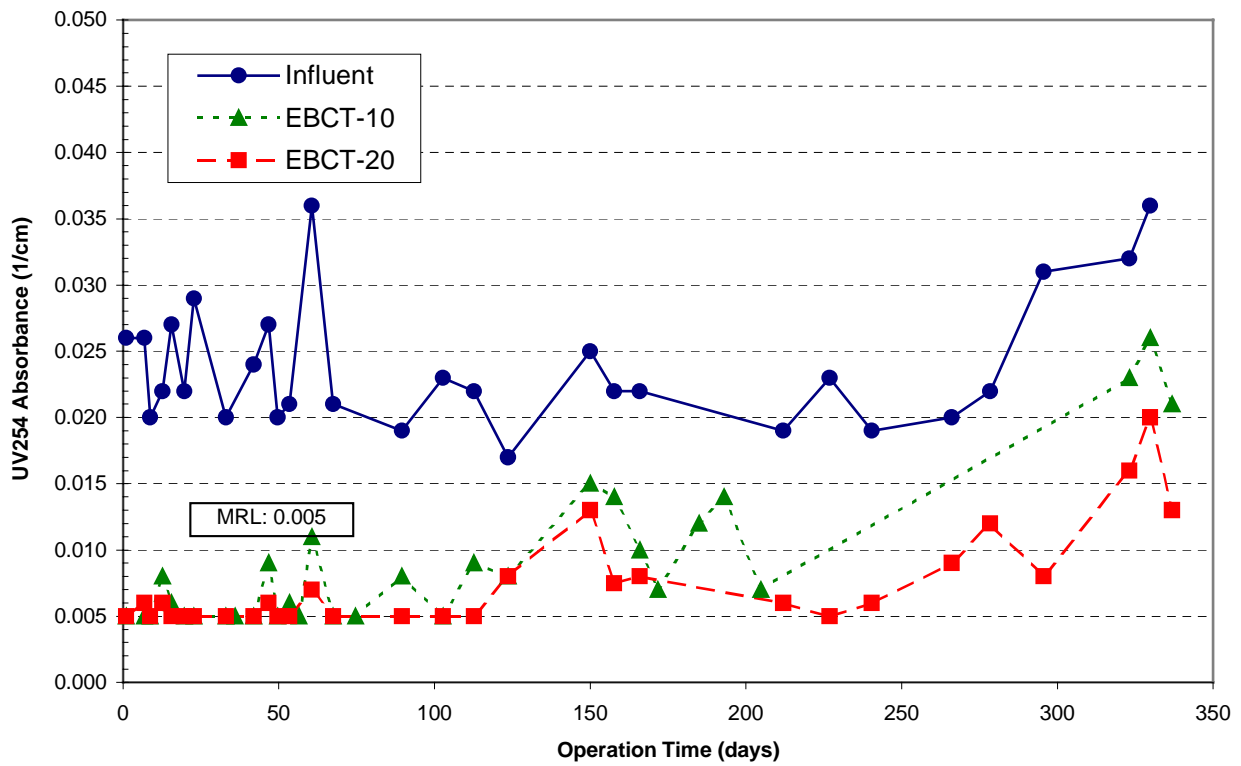


Figure 4-3: Chlorine Demand Curves

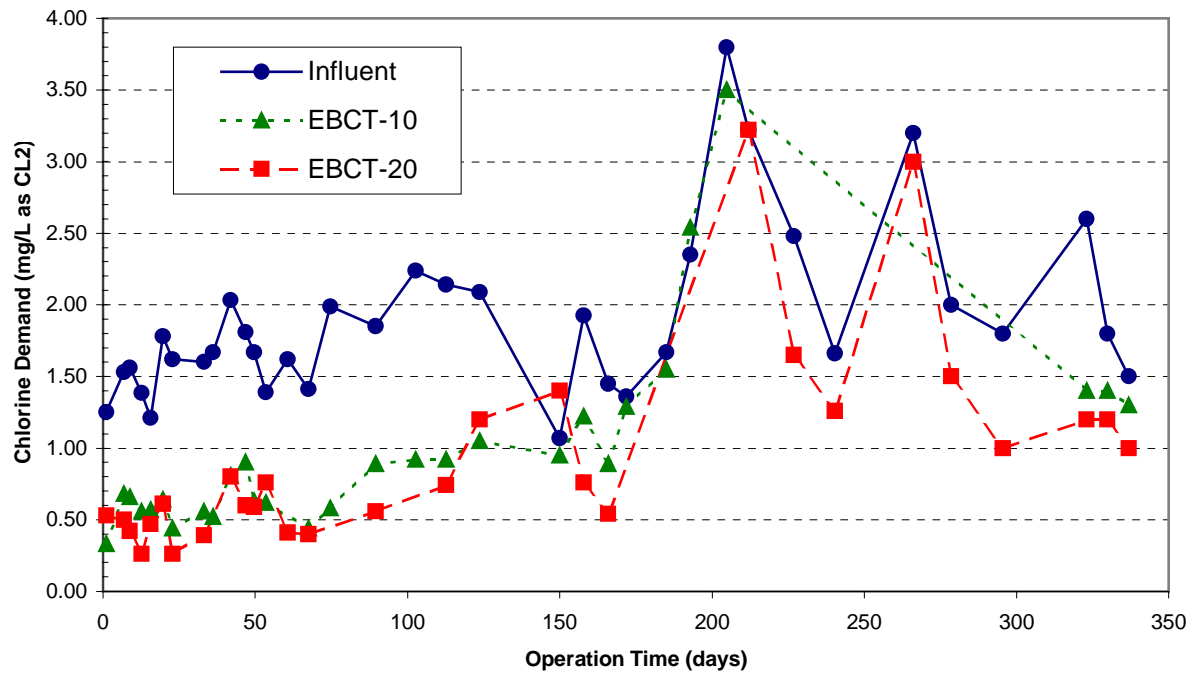


Figure 4-4: Trihalomethanes (THM4) Curves

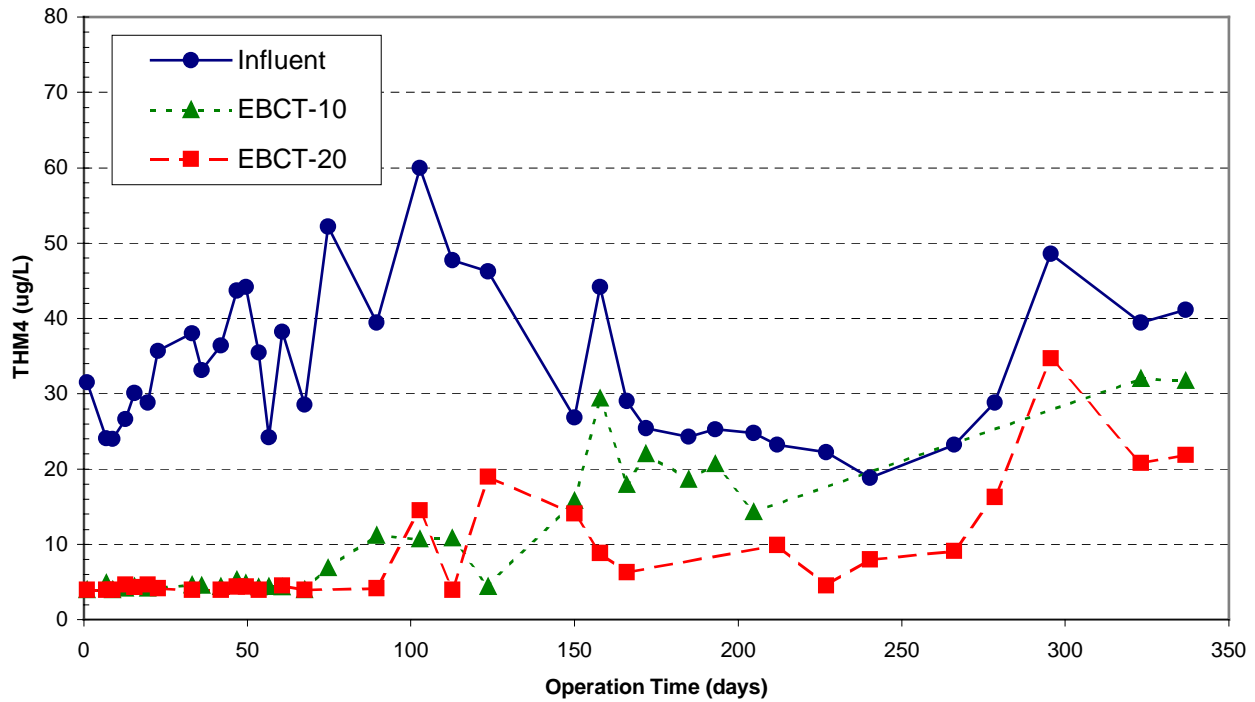


Figure 4-5: Haloacetic Acids (HAA6) Curves

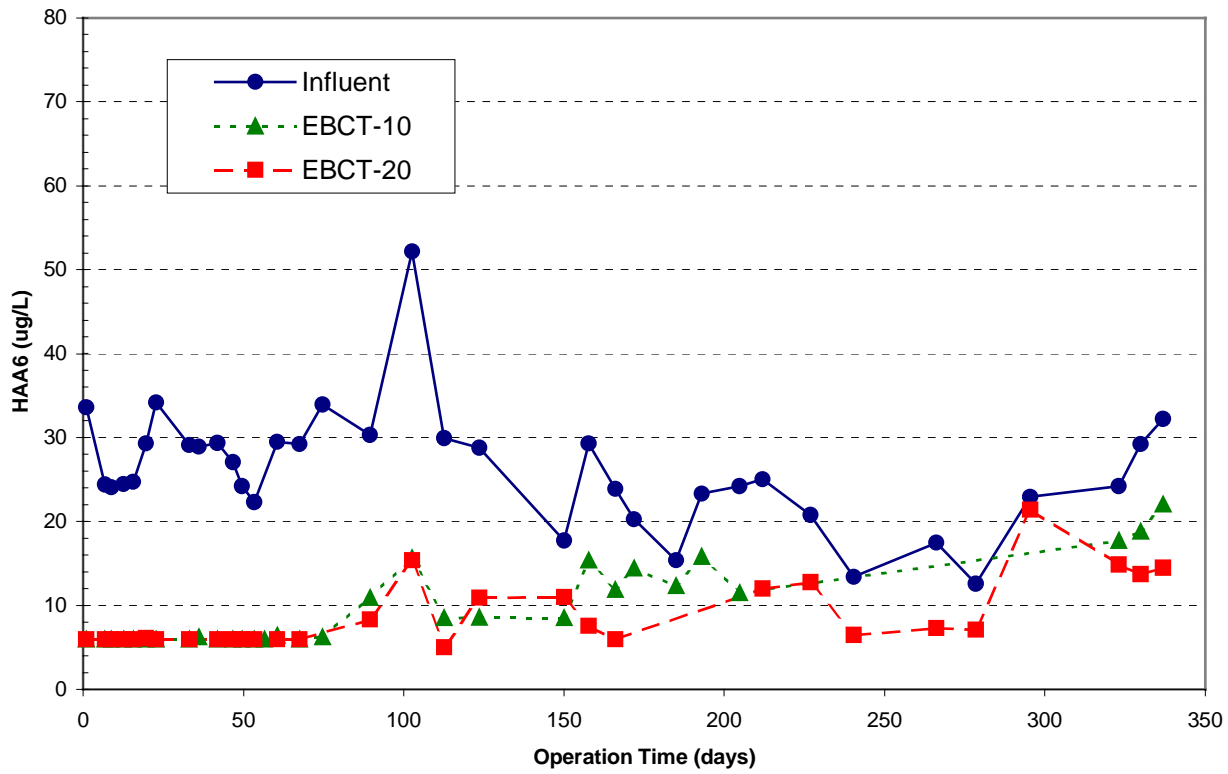
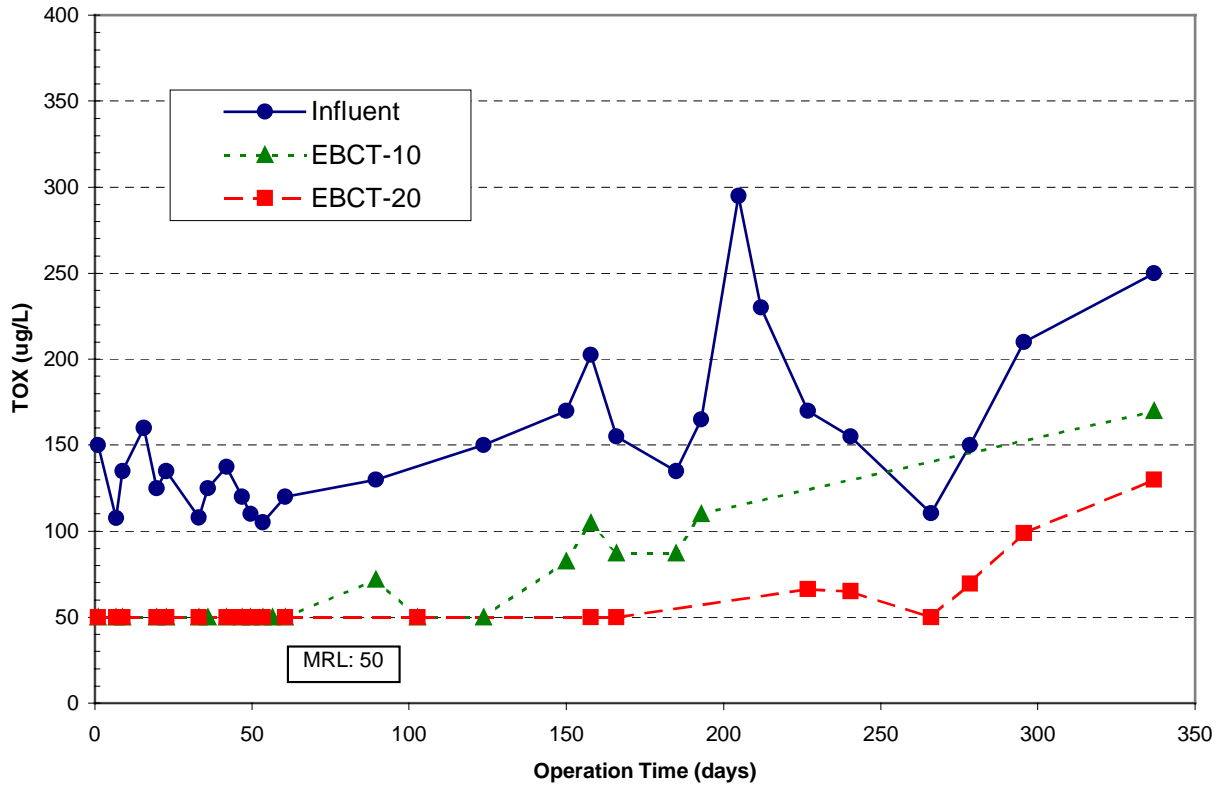


Figure 4-6: Total Organic Halides (TOX) Curves



<b>Table 4-1: GAC Influent Water Quality (Sample Point A)</b>				
<b>Water Quality Parameter</b>	<b>Summer (06/01/98-08/30/98)</b>		<b>Winter (12/01/98-03/29/99)</b>	
	<b>Average</b>	<b>Std Dev</b>	<b>Average</b>	<b>Std Dev</b>
Temperature [°C]	28.0	2.0	15.6	3.1
pH	5.4	0.4	5.6	0.7
Turbidity [ntu]	0.10	0.06	0.06	0.01
Alkalinity [mg/L as CaCO <sub>3</sub> ]	(all BMRL)	(all BMRL)	3.7	2.5
Calcium Hardness [mg/L CaO]	11.8	0.8	16.8	1.8
Total Hardness [mg/L CaCO <sub>3</sub> ]	20.5	1.5	27.4	2.4
TOC [mg/L]	1.65	0.12	1.98	0.369
UV <sub>254</sub> [cm <sup>-1</sup> ]	0.023	0.005	0.027	0.006
SUVA [L/mg-m]	1.4	0.3	1.3	0.1
Bromide [µg/L]	24	2.4	44	4.2
SDS-THM4 [µg/L]	40.9	10.3	31.7	10.8
SDS-HAA5 [µg/L]	26.2	7.6	16.9	6.7
SDS-TOX [µg/L]	124	14.9	186	46.9
SDS-Chlorine Demand [µg/L]	1.82	0.30	2.13	0.58

## Table 4-2: ICR Pilot Study Downtime Log

Date*	Downtime Period	Total Study Downtime	Total Study Downtime	Reason
<i>mm/dd/yy</i>	<i>[hours]</i>	<i>[hours]</i>	<i>[days]</i>	
4/16/98	2	2	0.1	System power failure
4/20/98	8	10	0.4	System power failure
5/12/98	12	22	0.9	System shut down because of ozone
5/25/98	5	27	1.1	System shut down because of construction in full-scale sedimentation basin.
5/29/98	4	31	1.3	Equilization tank went dry because system influent rate was too low.
6/1/98	1	32	1.3	System shut down for backwashing.
6/3/98	4	36	1.5	System power failure
8/9/98	10	46	1.9	Air binding of pump to GAC columns
8/12/98	10	56	2.3	Air binding of pump to GAC columns
9/10/98	20	76	3.2	System shut down for repairs
10/2/98	24	100	4.2	System power failure
12/13/98	35	135	5.6	System power failure
12/24/98	5	140	5.8	System power failure
1/6/99	2	142	5.9	System power failure
1/19/99	30	172	7.2	System shut down because full-scale sedimentation basin was drained.
1/22/99	10	182	7.6	Air binding of pump to GAC columns
1/29/99	10	192	8.0	Air binding of pump to GAC columns
1/31/99	10	202	8.4	Air binding of pump to GAC columns
2/3/99	10	212	8.8	Air binding of pump to GAC columns
2/4/99	24	236	9.8	Air binding of pump to GAC columns
2/5/99	5	241	10.0	Air binding of pump to GAC columns
2/7/99	10	251	10.5	Air binding of pump to GAC columns
2/8/99	5	256	10.7	Air binding of pump to GAC columns
2/10/99	10	266	11.1	Air binding of pump to GAC columns
2/11/99	5	271	11.3	Air binding of pump to GAC columns
2/12/99	5	276	11.5	Air binding of pump to GAC columns
3/1/99	10	286	11.9	Air binding of pump to GAC columns
3/4/99	5	291	12.1	System power failure

\* refers to final date of downtime period

## Section 5

### QA/QC Summary

#### 5.1 QA/QC

The QA/QC information for the laboratory analyses is included in the Treatment Study Summary Report Spreadsheet located in Appendix C.

##### 5.1.1 CDM LABORATORY

CDM Labs was bought by Alpha Analytical Laboratory in January 1999.

##### 5.1.2 ENVIRONMENTAL HEALTH LABORATORY

Environmental Health Laboratory conducted TOX, THM, HAA, and Bromide analyses under subcontract with CDM Laboratory and Alpha Analytical Laboratory.

#### 5.2 Summary of Calibration Procedures

##### 5.2.1 CDM LABORATORY

Calibration for analyses of samples submitted to the CDM laboratory under ICR Bench Study Programs were performed in accordance to the protocols given in the DBP/ICR Analytical Methods Manual [EPA 814-B-96-002] Section 9.0 with the following exception.

From June 1997 through July 1999, the low level calibration check standard for monochloroacetic acid (MCAA) was analyzed at 1.0 ug/L versus the 2.0 ug/L specified in the EPA reference. The expected limits were maintained at 50% - 150% as per the guidance document. As of August 1998 until January 15, 1999 (closure of CDM laboratory) the low level calibration check was analyzed at 2.0 ug/L.

##### 5.2.2 ALPHA ANALYTICAL LABORATORY

The Alpha Analytical Laboratory staff followed the following calibration methods for sample analyses.  $UV_{254}$  analyses were performed as per Method 5910 B with the DBP/ICR Analytical Methods Manual Modifications. The calibration check for TOC analyses was performed according to the DBP/ICR Analytical Method 5310 C. THM calibration was performed per Method 551.1 and HAA calibration was performed per Method 6251 B with the DBP/ICR Analytical Methods Manual Modifications.

### 5.2.3 ENVIRONMENTAL HEALTH LABORATORY

The Environmental Health Laboratory (EHL) staff followed the calibration and quality control procedures as described in Standard Methods 5320 B for the TOX analyses. The EHL laboratory staff followed the calibration and quality control procedures for EPA Method 552.2 as described in the DBP/ICR Analytical Methods Manual for HAA, THM, and Bromide analyses.

# **Appendix A**

## **Plant Design Parameters**

**(Note: Available in hard copy only)**



## A.2 -- Design Plant Parameters

Date: 3/17/99

PWS Name: City of Raleigh

PWS ID: NC0392010

WIDB:

ICR Contact Person: Mr. John Garland

Sampling Period: Design

Design Sampling Start Date: 7/15/97

Design Sampling End Date: 12/31/98

Treatment Plant Name: EM Johnson

ICR Treatment Plant ID: 452

Treatment Plant PWS ID: NC0392010

Treatment Plant Category: CONV

State Approved Plant Capacity (MGD): 78.0

Historical Min. Water Temperature (deg C): 6.0

Installed Sludge Handling Capacity (DPD): 25,000.00

Blending Indicator: N

Water Resource Name: Falls Lake

Water Resource Type: Reservoir/lake

Average Residence Time (Days): 84

Intake Name: Raw Water Intake

Watershed Control: Y

Hydrologic Unit Code:

River Reach:

Latitude (degrees, minutes, seconds): +35°57'0"

Longitude (degrees, minutes, seconds): -78°35'5"

River Reach Miles:

Seq. Sample No. Location Name	Sample Location Type	Sample Loc. No.
-------------------------------------	----------------------------	-----------------------

Hypochlorite Stock

HYP

2

Influent

INF

1

Process Train Name: Main

Process Train Category: CONV

Seq. Sample No. Location Name	Sample Location Type	Sample Loc. No.
1 Reservoir	Other Treatment Process	Surface Area (ft2): Liquid Volume (gal): 150,000,000 Short Circuiting Factor:  Type of Mixer: ME Baffling Type: PR Liquid Volume (gal): 75,038 Short Circuiting Factor: Mean Velocity Gradient (sec-1): 470.0
2 Rapid Mix	Rapid Mix	
3 Flocculation	Flocculation Basin	Type of Mixer: ME Liquid Volume (gal): 1,261,405 Short Circuiting Factor: Baffling Type: AV  Stage Sequence Number: 1 Stage Mean Velocity Gradient (sec-1): 66 Stage Liquid Volume (gal): 630,703  Stage Sequence Number: 2 Stage Mean Velocity Gradient (sec-1): 66 Stage Liquid Volume (gal): 630,703
4 Sedimentation	Sedimentation	6 Surface Area (ft2): 67,500 Liquid Volume (gal): 7,476,050 Baffling Type: PR

Seq. Sample No. Location Name	Sample Location Type	Sample Loc. No.	
			Short Circuiting Factor: Plate Settler Surface Area (ft2): Plate Settler Brand Name: Tube Settler Surface Area (ft2): Tube Settler Brand Name:  Chemical Code: SOY Measurement Formula: NaOCl Dose Rate (mg/L): 2.00  Surface Area (ft2): 10,880 Liquid Volume (gal): 1,632,000 Total Media Depth (in): 49 Depth of GAC (in): Media Type: DUAL Type of Activated Carbon: Minimum Water Depth To Top of Media (ft): 2.8 Depth From Top of Media to Top of Backwash Trough (ft): 2.8
5 Sodium hypochlo	Disinfectant Addition		
6 Filtration	Filtration	8	
7 Sodium hypochlo	Disinfectant Addition		
8 Clearwell	Clearwell	9	Chemical Code: SOY Measurement Formula: NaOCl Dose Rate (mg/L): 5.00  Surface Area (ft2): 108,000 Liquid Volume (gal): 12,000,000 Minimum Liquid Volume (gal): 6,857,144

Seq. Sample No. Location Name	Sample Location Type	Sample Loc. No.
-------------------------------------	----------------------------	-----------------------

9	Anhydrous ammon	Disinfectant Addition	Baffling Type: AV Short Circuiting Factor: Covered Indicator Code: Y
	Finished Water	FIN	Chemical Code: NH3A Measurement Formula: NH3 Dose Rate (mg/L): 1.50

10

End of Report A.2 -Design Plant Parameters

# A.3 -- Design Plant Chemical Parameters

Date: 3/17/99

PWS Name: City of Raleigh

PWS ID: NC0392010

WIDB:

ICR Contact Person: Mr. John Garland

Sampling Period: Design

Sampling Start Date: 7/15/97

Sampling End Date: 12/31/98

Sep. No.	Sample Location Name	Sample Location Type	Sample Location Number	Chemical Name	Measurement Formula	Dose (mg/L)
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Treatment Plant Name: EM Johnson

ICR Treatment Plant ID No: 452

Treatment Plant Category: CONV

Process Train Name: Main

Process Train Category: CONV

1	Reservoir	Other Treatment Process		Potassium permanganate	KMnO4	1.50
2	Rapid Mix	Rapid Mix		Ferric sulfate	FeSO4	46.00
				Sodium hydroxide	NaOH	1.30
				Powdered activated carbon	C	1.90
3	Flocculation	Flocculation Basin		Organic polymer - coagulant aid	EPFLOC 2437 PWG	0.10
4	Sedimentation	Sedimentation		Proprietary		
5	Sodium hypochlo	Disinfectant Addition				

City of Raleigh

Page 1

A.3 -- Design Plant Chemical Parameters 3/17/99

Sep. No.	Sample Location Name	Sample Location Type	Sample Location Number	Chemical Name	Measurement Formula	Dose (mg/L)
6	Filtration	Filtration	8	Sodium hypochlorite	NaOCl	2.00
7	Sodium hypochlo	Disinfectant Addition		Organic polymer - filter aid	POLEZ -675	0.10
				Sodium hydroxide	Proprietary NaOH	0.90
8	Clearwell	Clearwell	9	Sodium hypochlorite	NaOCl	5.00
				Sodium silicate	DABCO 22L	1.50
				Calcium hydroxide	CaOH	19.30
				Hydrofluorosilic acid	H2SiF6	1.00
9	Anhydrous ammon	Disinfectant Addition		Anhydrous ammonia	NH3	1.50

End of Report A.3 --Design Plant Chemical Parameters

## **Appendix B**

### **Data Collection Spreadsheet**

**FIELD-SET 1: RESULTS FROM 1st PILOT-SCALE STUDY (FILE: ICR452.xls)****Field 1-1: PWS And Treatment Plant Data**

PWS Name	City of Raleigh
Public Water System Identification Number	NC 0392-010
Water Industry Data Base Number ( <i>optional</i> )	NA
Official ICR Contact Person	Dale Crisp
Mailing Address	P.O. Box 590 Raleigh, NC 27602
Phone Number	919-890-3400
FAX Number	919-890-3600
E-Mail Address ( <i>optional</i> )	NA
Technical ICR Contact Person	Mr. John Garland
Mailing Address	P.O. Box 590 Raleigh, NC 27602
Phone Number	919-870-2870
FAX Number	919-870-2892
E-Mail Address ( <i>optional</i> )	JGarland@intrstar.net
Plant Name	E.M. Johnson Water Treatment Plant
Treatment Plant Category	CONV
Process Train Name	Conventional Train
ICR Treatment Plant Identification Number	452
PWSID Number of Plant ( <i>if assigned</i> )	NC 0392-010
Historical Minimum Water Temperature (°C)	6.0
Historical Average Water Temperature (°C)	21.1
State Approved Plant Capacity (MGD)	78.0

**Field 1-2: Pilot-Scale GAC Design Parameters****Input Design Parameters**

Carbon manufacturer	Calgon
Carbon trade name	Filtasorb 820
Carbon type	Bituminous
Pilot GAC influent TOC (mg/L)	2.0
Inner diameter of the pilot GAC column, D (mm)	153.9
Manufacturer reported dry bed density, $\rho$ (kg/m <sup>3</sup> )	465.0
Pilot GAC mesh size, upper (US standard mesh)	16
Pilot GAC mesh size, lower (US standard mesh)	20
Flow rate, Q (L/hr)	181.7

**Estimated Run Length**

Bed volumes to 50% TOC breakthrough, BV <sub>50</sub>	8813
Estimated run length, BV <sub>T</sub> (= 2 x BV <sub>50</sub> )	17626

**General Pilot Design Parameters**

Carbon particle diameter, d (mm)	1.015
Column cross-sectional area, A (m <sup>2</sup> )	1.861E-02
Hydraulic loading rate <sup>1</sup> , v (m/hr)	9.76

1: If v is not in the range from 5 to 15 m/hr (2 to 6 gpm/ft<sup>2</sup>) then either Q or D must be adjusted.

**10-Minute EBCT Run**

Empty bed contact time, EBCT (min)	10
Estimated run time, t (days)	122
Pilot column bed length, l (m)	1.63
Mass GAC required, m (kg)	14.080

**20-Minute EBCT Run**

Empty bed contact time, EBCT (min)	20
Estimated run time, t (days)	245
Pilot column bed length, l (m)	3.25
Mass GAC required, m (kg)	28.160



**US Standard Mesh Sizes**

US standard mesh size	Opening (mm)
4	4.750
6	3.350
8	2.360
10	2.000
12	1.680
16	1.180
20	0.850
30	0.600
40	0.425
50	0.300
60	0.250
70	0.210
80	0.180

**Field 1-3: Pretreatment Used Prior To GAC<sup>1</sup>**

Process	Description	Scale
Coagulation	Ferric Sulfate Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·9H <sub>2</sub> O @ 40-50 mg/L	Full Scale
Flocculation	Walking beam flocculators, 0.1-0.2mg/L polymer	Full Scale
Sedimentation	138 Minutes Conventional	Full Scale
Ozonation	Ozone residual 0.1 mg/L	Pilot Scale
Dual media filtration	sand / anthracite	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 GAC run.

Field 1-4: Influent Water Quality For The 10- And 20-Minute, Pilot-Scale GAC Contactors<sup>1</sup>

Group A, 15 influent samples per run

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes 20 minute	Bed volumes ( 10 minute)	pH ---	Turbidity ntu	Alkalinity mg/L as CaCO <sub>3</sub>	Temp. °C	Total Hardness mg/L as CaCO <sub>3</sub>	Calcium Hardness mg/L as CaCO <sub>3</sub>	Ammonia mg NH <sub>3</sub> -N / L	Bromide µg/L	TOC mg/L
START	---	4/14/98	11:00	0.00	0.0	0.0	---	---	---	---	---	---	---	---	---
A-1	N	4/15/98	11:00	24.00	72.0	144.0	6.86	0.06	BMRL	20.3	16.0	9.7	BMRL	NA	2.10
A-2	N	4/21/98	15:30	162.50	487.5	975.0		0.17	BMRL	20.4	16.0	9.5	BMRL	BMRL	1.70
A-3	N	4/23/98	15:00	210.00	630.0	1260.0	6.06	0.05	BMRL	18.7	16.0	9.7	BMRL	BMRL	1.80
Avg-A-4	Y	4/27/98	12:30	303.50	910.5	1821.0	5.73	0.09	BMRL	21.1	16.5	BMRL	BMRL	BMRL	1.80
A-5	N	4/30/98	10:30	373.50	1120.5	2241.0	5.70	0.08	BMRL	20.4	17.0	9.7	BMRL	BMRL	2.00
A-6	N	5/4/98	12:00	471.00	1413.0	2826.0	5.70	0.08	BMRL	21.8	17.0	10.0	BMRL	BMRL	1.80
A-7	N	5/7/98	14:30	545.50	1636.5	3273.0	5.74	0.08	BMRL	22.9	17.0	10.0	BMRL	NA	2.20
A-8	N	5/18/98	10:00	793.00	2379.0	4758.0	5.68	0.09	BMRL	24.7	22.0	13.0	BMRL	NA	1.70
A-9	N	5/21/98	10:00	865.00	2595.0	5190.0	5.74	0.08	BMRL	26.8	22.0	13.0	BMRL	NA	2.00
Avg-A-10	Y	5/27/98	11:00	1005.00	3015.0	6030.0	5.75	0.07	BMRL	26.8	18.0	11.0	BMRL	21.000	1.90
A-11	N	6/1/98	13:00	1122.00	3366.0	6732.0	5.60	0.07	BMRL	28.0	18.0	11.0	BMRL	BMRL	1.80
A-12	N	6/4/98	13:15	1190.25	3570.8	7141.5	5.27	0.06	BMRL	28.4	19.0	12.0	BMRL	BMRL	1.40
A-13	N	6/8/98	10:30	1283.50	3850.5	7701.0	5.34	0.07	BMRL	24.0	19.0	11.0	BMRL	BMRL	1.60
A-14	N	6/11/98	11:00	1356.00	4068.0	8136.0	4.95	0.12	BMRL	25.0	20.0	12.0	BMRL	21.000	1.70
A-15	N	6/15/98	13:00	1454.00	4362.0	8724.0	4.98	0.09	BMRL	28.8	20.0	12.0	BMRL	22.000	1.70
A-16	N	6/22/98	11:15	1620.25	4860.8	9721.5	5.18	0.14	BMRL	29.3	23.0	13.0	BMRL	21.000	1.80
A-17	N	6/29/98	15:15	1792.25	5376.8	10753.5	4.86	0.25	BMRL	31.3	22.0	12.0	BMRL	23.000	1.70
A-18	N	7/14/98	10:45	2147.75	6443.3	12886.5	5.31	BMRL	BMRL	28.3	22.0	13.0	0.11	24.000	1.70
A-19	N	7/27/98	15:00	2464.00	7392.0	14784.0	5.71	0.06	BMRL	28.6	20.0	11.0	BMRL	23.000	1.60
A-20	N	8/6/98	14:00	2703.00	8109.0	16218.0	5.65	BMRL	BMRL	27.9	21.0	11.0	BMRL	28.000	1.60
A-21	N	8/18/98	9:45	2966.75	8900.3	17800.5	6.08	0.06	BMRL	28.4	21.0	12.0	BMRL	26.000	1.50
A-22	N	8/25/98	10:00	3135.00	9405.0	18810.0	NR	NR	NR	NR	NR	NR	NR	NR	NR
A-23	N	9/14/98	14:30	3599.50	10798.5	21597.0	5.84	BMRL	BMRL	28.5	24.0	14.0	0.14	NA	1.40
Avg-A-24	Y	9/22/98	9:00	3786.00	11358.0	22716.0	6.02	0.05	5.0	28.5	27.0	17.0	0.10	31.500	1.80
A-25	N	9/30/98	14:00	3983.00	11949.0	23898.0	5.72	BMRL	BMRL	28.3	26.0	15.0	BMRL	27.000	1.80
A-26	N	10/7/98	10:00	4123.00	12369.0	24738.0	5.64	0.06	BMRL	22.8	27.0	16.0	BMRL	38.000	1.80
A-27	N	10/20/98	13:30	4438.50	13315.5	26631.0	5.60	BMRL	BMRL	23.3	27.0	16.0	BMRL	34.000	2.10
A-28	N	10/28/98	13:30	4630.50	13891.5	27783.0	5.88	0.08	BMRL	21.3	28.0	17.0	0.10	NA	1.80
A-29	N	11/9/98	10:30	4915.50	14746.5	29493.0	6.30	0.09	6.4	21.2	28.0	17.0	0.18	35.000	1.80
A-30	N	11/16/98	13:00	5086.00	15258.0	30516.0	5.54	0.09	BMRL	19.4	27.0	16.0	0.25	37.000	1.90

**Group A, 15 influent samples per run**

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:hh	Bed volumes 20 minute	Bed volumes ( 10 minute)	pH ---	Turbidity ntu	Alkalinity mg/L as CaCO <sub>3</sub>	Temp. °C	Total Hardness mg/L as CaCO <sub>3</sub>	Calcium Hardness mg/L as CaCO <sub>3</sub>	Ammonia mg NH <sub>3</sub> -N / L	Bromide µg/L	TOC mg/L
A-31	N	12/1/98	12:00	5445.00	16335.0	32670.0	6.07	0.06	BMRL	22.9	27.0	16.0	0.14	40.000	1.60
A-32	N	12/16/98	10:30	5768.50	17305.5	34611.0	5.62	0.05	BMRL	15.7	27.0	16.0	0.11	43.000	1.60
A-33	N	1/11/99	11:00	6386.00	19158.0	38316.0	6.09	BMRL	7.4	15.9	30.0	19.3	0.19	44.000	1.70
A-34	N	1/25/99	12:00	6683.00	20049.0	40098.0	5.43	BMRL	3.0	14.2	31.0	19.5	0.13	50.000	1.70
A-35	N	2/15/99	11:00	7092.00	21276.0	42552.0	6.80	BMRL	BMRL	12.7	29.0	18.0	0.09		2.10
A-36	N	3/15/99	15:00	7753.00	23259.0	46518.0	5.20	BMRL	2.0	13.9	26.0	16.0	NA	BMRL	2.20
A-37	N	3/22/99	11:00	7917.00	23751.0	47502.0	4.80	BMRL	2.4	14.5	25.0	15.4	0.08	BMRL	2.40
A-38	N	3/29/99	10:30	8084.50	24253.5	48507.0	4.93	BMRL	BMRL	14.9	24.0	14.6	BMRL	BMRL	2.50

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.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results for the primary and duplicate analyses below.

**Group D, 3 duplicate influent samples per run**

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:hh	Bed volumes 20 minute	Bed volumes ( 10 minute)	pH ---	Turbidity ntu	Alkalinity mg/L as CaCO <sub>3</sub>	Temp. °C	Total Hardness mg/L as CaCO <sub>3</sub>	Calcium Hardness mg/L as CaCO <sub>3</sub>	Ammonia mg NH <sub>3</sub> -N / L	Bromide µg/L	TOC mg/L
A4	Primary	4/27/98	12:30	303.50	910.5	1821.0	5.73	0.09	BMRL	21.1	16.0	BMRL	BMRL	BMRL	1.80
D-A4	Duplicate	4/27/98	12:30	303.50	910.5	1821.0	5.73	0.09	BMRL	21.1	17.0	BMRL	NR	BMRL	1.80
Avg-A4	Average	---	---	---	---	---	5.73	0.09	BMRL	21.1	16.5	BMRL	BMRL	BMRL	1.80
RPD-A4	RPD	---	---	---	---	---	0.00	0.00	BMRL	0.00	6.06	BMRL	BMRL	BMRL	0.00
A10	Primary	5/27/98	11:00	1005.00	3015.0	6030.0	5.75	0.06	BMRL	26.8	18.0	11.0	BMRL	BMRL	1.90
D-A10	Duplicate	5/27/98	11:00	1005.00	3015.0	6030.0	5.75	0.07	BMRL	26.8	18.0	11.0	BMRL	21.000	1.90
Avg-A10	Average	---	---	---	---	---	5.75	0.07	BMRL	26.8	18.0	11.0	BMRL	21.000	1.90
RPD-A10	RPD	---	---	---	---	---	0.00	15.38	BMRL	0.00	0.00	0.00	BMRL	BMRL	0.00
A24	Primary	9/22/98	9:00	3786.00	11358.0	22716.0	6.02	0.05	5.0	28.5	29.0	19.0	0.10	32.000	1.80
D-A24	Duplicate	9/22/98	9:00	3786.00	11358.0	22716.0	6.02	0.05	5.0	28.5	25.0	15.0	0.10	31.000	1.80
Avg-A24	Average	---	---	---	---	---	6.02	0.05	5.0	28.5	27.0	17.0	0.10	31.500	1.80
RPD-A24	RPD	---	---	---	---	---	0.00	0.00	0.00	0.00	14.81	23.53	0.00	3.175	0.00

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.

Field 1-4: Influent Water Quality For The 10- And 20-Minute, Pilot-Scale GAC Contactors (continued)

UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBC µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
0.026	1.24	2.10	0.85	1.25	18.3	7.50	48.0	160.00	25.00	4.50	BMRL	BMRL	29.50	3.80
0.026	1.53	2.25	0.72	1.53	19.6	7.50	48.0	65.00	18.00	4.10	BMRL	BMRL	22.10	3.70
0.020	1.11	2.25	0.69	1.56	19.1	7.50	48.0	150.00	18.00	4.00	BMRL	BMRL	22.00	3.70
0.022	1.22	2.25	0.87	1.39	19.6	7.50	48.0	NR	20.00	4.65	BMRL	BMRL	24.65	2.55
0.027	1.35	1.70	0.49	1.21	20.7	7.50	48.0	130.00	23.00	5.10	BMRL	BMRL	28.10	3.40
0.022	1.22	2.50	0.72	1.78	21.5	7.50	48.0	130.00	22.00	4.80	BMRL	BMRL	26.80	4.60
0.029	1.32	2.50	0.88	1.62	22.2	7.50	48.0	140.00	28.00	5.70	BMRL	BMRL	33.70	3.20
0.020	1.18	2.50	0.90	1.60	23.3	7.50	48.0	120.00	29.00	6.80	1.20	BMRL	37.00	2.90
0.022	1.10	2.50	0.83	1.67	25.1	7.50	48.0	130.00	25.00	6.00	1.10	BMRL	32.10	3.60
0.024	1.26	2.50	0.47	2.04	25.8	7.50	48.0	150.00	27.50	1.30	6.60	BMRL	35.40	3.35
0.027	1.50	2.60	0.79	1.81	27.0	7.50	48.0	120.00	33.00	8.00	1.70	BMRL	42.70	3.50
0.020	1.43	2.60	0.93	1.67	27.5	7.50	48.0	110.00	33.00	8.40	1.80	BMRL	43.20	3.30
0.021	1.31	2.50	1.11	1.39	25.1	7.50	48.0	110.00	26.00	7.00	1.50	BMRL	34.50	3.20
0.022	1.29	2.50	NR	NR	25.4	7.50	48.0	NA	17.00	5.00	1.20	BMRL	23.20	NA
0.036	2.12	2.50	0.88	1.62	27.5	7.50	48.0	120.00	28.00	7.50	1.70	BMRL	37.20	3.40
0.021	1.17	2.40	0.99	1.41	29.2	7.50	48.0	180.00	20.00	6.20	1.30	BMRL	27.50	4.10
0.025	1.47	2.30	0.31	1.99	30.9	7.50	48.0	160.00	39.00	10.00	1.70	1.50	52.20	3.20
0.019	1.12	2.80	0.95	1.85	29.2	7.50	48.0	130.00	27.00	8.90	2.50	BMRL	38.40	4.80
0.023	1.44	2.70	0.46	2.24	30.1	7.50	48.0	NR	46.00	11.00	2.00	BMRL	59.00	5.00
0.022	1.38	2.80	0.66	2.14	28.5	7.50	48.0	130.00	33.00	11.00	2.70	BMRL	46.70	4.30
0.017	1.13	3.00	0.91	2.09	29.5	7.50	48.0	150.00	31.00	11.00	3.20	BMRL	45.20	6.60
NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.025	1.79	2.00	0.93	1.07	27.9	7.50	48.0	170.00	15.00	7.40	3.40	BMRL	25.80	3.80
0.022	1.22	3.28	1.35	1.93	27.9	7.50	48.0	202.50	28.00	11.00	4.15	BMRL	43.15	4.40
0.019	1.06	2.80	1.35	1.45	27.0	7.50	48.0	150.00	17.00	7.80	3.20	BMRL	28.00	4.90
NR	NR	2.05	0.69	1.36	24.2	7.50	48.0	NR	14.00	7.20	3.20	BMRL	24.40	3.60
0.021	1.00	2.00	0.33	1.67	22.8	7.50	48.0	140.00	13.00	6.90	3.40	BMRL	23.30	3.10
0.023	1.28	3.00	0.65	2.35	20.6	7.50	48.0	170.00	14.00	7.00	3.30	BMRL	24.30	5.80
0.022	1.22	5.00	1.20	3.80	17.3	7.50	48.0	280.00	14.00	6.70	3.10	BMRL	23.80	7.20
0.019	1.00	4.50	1.28	3.22	17.0	7.50	48.0	220.00	12.00	6.80	3.40	BMRL	22.20	7.72

Field 1-4: Influent Water Quality For The 10- And 20-Minute, Pilot-Scale GAC Contactors (continued)

UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L
0.023	1.19	3.25	0.77	2.48	16.5	7.50	48.0	170.00	12.00	6.50	2.70	BMRL	21.20	2.60
0.019	1.19	2.75	1.09	1.66	13.5	7.50	48.0	160.00	9.10	6.00	2.70	BMRL	17.80	2.30
0.020	1.18	4.40	1.20	3.20	11.0	7.50	48.0	130.00	10.00	7.80	4.40	BMRL	22.20	BMRL
0.022	1.29	2.87	0.87	2.00	12.0	7.50	48.0	150.00	12.00	10.00	5.80	BMRL	27.80	BMRL
0.031	1.48	2.67	0.87	1.80	11.9	7.50	48.0	210.00	30.00	13.00	4.60	BMRL	47.60	BMRL
0.032	1.45	3.80	1.20	2.60	11.0	7.50	48.0	210.00	27.00	8.00	2.80	BMRL	37.80	BMRL
0.036	1.50	2.74	0.94	1.80	13.0	7.50	48.0	230.00	28.00	8.60	2.20	BMRL	2.20	BMRL
0.031	1.24	1.74	0.24	1.50	14.0	7.50	48.0	250.00	29.00	8.90	2.20	BMRL	2.20	1.26

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.

Group D, 3 duplicate influent samples per run (continued)

UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L
0.022	1.22	2.25	0.91	1.34	19.6	7.50	48.0	NR	20.00	4.90	BMRL	BMRL	0.00	1.90
0.022	1.22	2.25	0.82	1.43	19.6	7.50	48.0	NR	20.00	4.40	BMRL	BMRL	0.00	3.20
0.022	1.22	2.25	0.87	1.39	19.6	7.50	48.0	NR	20.00	4.65	BMRL	BMRL	0.00	2.55
0.00	0.00	0.00	10.40	6.50	0.00	0.00	0.00	NR	0.00	10.75	BMRL	BMRL	0.00	50.98
0.025	1.32	2.50	0.72	1.78	25.8	7.50	48.0	145.00	27.00	1.30	6.60	BMRL	24.90	3.50
0.023	1.21	2.50	0.21	2.29	25.8	7.50	48.0	130.00	28.00	1.30	6.60	BMRL	24.40	3.20
0.024	1.26	2.50	0.47	2.04	25.8	7.50	48.0	137.50	27.50	1.30	6.60	BMRL	24.65	3.35
8.33	8.33	0.00	109.68	25.06	0.00	0.00	0.00	10.91	3.64	0.00	0.00	BMRL	2.03	8.96
0.021	1.17	3.65	1.63	2.02	27.9	7.50	48.0	195.00	29.00	11.00	4.20	BMRL	34.90	4.90
0.023	1.28	2.90	1.07	1.83	27.9	7.50	48.0	210.00	27.00	11.00	4.10	BMRL	35.90	3.90
0.022	1.22	3.28	1.35	1.93	27.9	7.50	48.0	202.50	28.00	11.00	4.15	BMRL	35.40	4.40
9.09	9.09	22.90	41.48	9.87	0.00	0.00	0.00	7.41	7.14	0.00	2.41	BMRL	2.82	22.73

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.

Field 1-4: Influent Water Quality For The 10- And 20-Minute, Pilot-Scale GAC Contactors (continued)

SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
---	---	---	---	---	---	---	---	---	---
12.00	14.00	BMRL	BMRL	1.80	NA	NA	NA	29.80	31.60
8.80	8.30	BMRL	BMRL	1.60	NA	NA	NA	20.80	22.40
8.80	8.00	BMRL	BMRL	1.60	NA	NA	NA	20.50	22.10
11.50	6.95	BMRL	BMRL	1.45	NA	NA	NA	21.00	22.45
10.00	7.60	BMRL	BMRL	1.70	NA	NA	NA	21.00	22.70
11.00	10.00	BMRL	BMRL	1.70	NA	NA	NA	25.60	27.30
12.00	15.00	BMRL	BMRL	2.00	NA	NA	NA	30.20	32.20
12.00	10.00	BMRL	BMRL	2.20	NA	NA	NA	24.90	27.10
12.00	9.00	BMRL	BMRL	2.30	NA	NA	NA	24.60	26.90
12.00	9.75	BMRL	BMRL	2.25	NA	NA	NA	25.10	27.35
11.00	8.50	BMRL	BMRL	2.10	NA	NA	NA	23.00	25.10
9.90	6.70	BMRL	BMRL	2.30	NA	NA	NA	19.90	22.20
8.40	6.80	BMRL	BMRL	1.90	NA	NA	NA	18.40	20.30
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12.00	9.70	BMRL	BMRL	2.40	NA	NA	NA	25.10	27.50
11.00	10.00	BMRL	BMRL	2.10	NA	NA	NA	25.10	27.20
14.00	12.00	BMRL	BMRL	2.70	NA	NA	NA	29.20	31.90
13.00	7.80	BMRL	BMRL	2.70	NA	NA	NA	25.60	28.30
18.00	23.00	BMRL	BMRL	4.20	NA	NA	NA	46.00	50.20
10.00	11.00	BMRL	BMRL	2.60	NA	NA	NA	25.30	27.90
10.00	7.70	BMRL	BMRL	2.50	NA	NA	NA	24.30	26.80
NR	NR	NR	NR	NR	NA	NA	NA	NR	NR
5.30	4.30	BMRL	BMRL	2.30	NA	NA	NA	13.40	15.70
10.95	7.85	BMRL	BMRL	4.10	NA	NA	NA	23.20	27.30
8.20	5.60	BMRL	BMRL	3.20	NA	NA	NA	18.70	21.90
7.40	4.40	BMRL	BMRL	2.90	NA	NA	NA	15.40	18.30
4.50	3.50	BMRL	BMRL	2.30	NA	NA	NA	11.10	13.40
6.20	6.70	BMRL	BMRL	2.60	NA	NA	NA	18.70	21.30
6.80	6.20	BMRL	BMRL	2.00	NA	NA	NA	20.20	22.20
6.75	6.05	BMRL	BMRL	2.52	NA	NA	NA	20.52	23.04

**Field 1-4: Influent Water Quality For The 10- And 20-Minute, Pilot-Scale GAC Contactors**

SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
8.80	5.40	BMRL	BMRL	2.00	NA	NA	NA	16.80	18.80
4.20	3.00	BMRL	BMRL	1.90	NA	NA	NA	9.50	11.40
6.20	4.00	BMRL	2.00	3.30	NA	NA	NA	12.20	15.50
4.44	2.61	BMRL	1.61	1.89	NA	NA	NA	8.66	10.55
9.21	8.06	BMRL	BMRL	2.68	NA	NA	NA	17.27	19.95
9.90	8.70	BMRL	BMRL	2.58	NA	NA	NA	18.60	21.18
10.90	11.10	BMRL	2.61	2.61	NA	NA	NA	24.61	27.22
13.70	12.50	BMRL	BMRL	2.73	NA	NA	NA	27.46	30.19

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.

**Group D, 3 duplicate influent samples per run (continued)**

SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
11.00	6.90	BMRL	BMRL	1.50	NA	NA	NA	19.80	21.30
12.00	7.00	BMRL	BMRL	1.40	NA	NA	NA	22.20	23.60
11.50	6.95	BMRL	BMRL	1.45	NA	NA	NA	21.00	22.45
8.70	1.44	BMRL	BMRL	6.90	NA	NA	NA	11.43	10.24
12.00	9.50	BMRL	BMRL	2.20	NA	NA	NA	25.00	27.20
12.00	10.00	BMRL	BMRL	2.30	NA	NA	NA	25.20	27.50
12.00	9.75	BMRL	BMRL	2.25	NA	NA	NA	25.10	27.35
0.00	5.13	BMRL	BMRL	4.44	NA	NA	NA	0.80	1.10
12.00	8.40	BMRL	BMRL	4.10	NA	NA	NA	25.30	29.40
9.90	7.30	BMRL	BMRL	4.10	NA	NA	NA	21.10	25.20
10.95	7.85	BMRL	BMRL	4.10	NA	NA	NA	23.20	27.30
19.18	14.01	BMRL	BMRL	0.00	NA	NA	NA	18.10	15.38

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.

Field 1-5: Effluent Water Quality For The 10-Minute, Pilot-Scale GAC Contactor<sup>1</sup>

Group B, 15 effluent samples per run

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes (10 minute)	pH ---	Turbidity ntu	Temp. °C	Ammonia mg NH <sub>3</sub> -N / L	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L
START	---	4/14/98	11:00	0.00	0.0	---	---	---	---	---	---	---	---
B-1	N	4/15/98	11:00	24.00	144.0	9.24	0.08	20.3	BMRL	BMRL	BMRL	BMRL	1.00
B-2	N	4/21/98	15:30	162.50	975.0	6.71	0.07	20.4	BMRL	BMRL	0.005	BMRL	1.60
B-3	N	4/23/98	15:00	210.00	1260.0	6.34	0.05	19.1	BMRL	BMRL	0.005	BMRL	1.60
Avg-B-4	Y	4/27/98	12:30	303.50	1821.0	5.78	0.07	21.4	BMRL	BMRL	0.008	BMRL	1.60
B-5	N	4/30/98	10:30	373.50	2241.0	5.72	0.11	20.2	BMRL	BMRL	0.006	BMRL	1.50
B-6	N	5/4/98	12:00	471.00	2826.0	5.70	0.07	22.6	BMRL	BMRL	BMRL	BMRL	1.65
B-7	N	5/7/98	14:30	545.50	3273.0	5.78	0.06	23.7	BMRL	BMRL	BMRL	BMRL	1.40
B-8	N	5/18/98	10:00	793.00	4758.0	5.48	0.09	24.9	BMRL	BMRL	BMRL	BMRL	1.20
B-9	N	5/21/98	10:00	865.00	5190.0	5.72	0.09	27.3	BMRL	BMRL	BMRL	BMRL	1.20
Avg-B-10	Y	5/27/98	11:00	1005.00	6030.0	5.73	0.06	26.9	BMRL	BMRL	BMRL	BMRL	1.30
B-11	N	6/1/98	13:00	1122.00	6732.0	5.54	0.07	28.2	BMRL	BMRL	0.009	BMRL	1.50
B-12	N	6/4/98	13:15	1190.25	7141.5	5.38	0.06	28.3	BMRL	BMRL	BMRL	BMRL	1.50
B-13	N	6/8/98	10:30	1283.50	7701.0	5.60	0.07	23.2	BMRL	BMRL	0.006	BMRL	1.40
B-14	N	6/11/98	11:00	1356.00	8136.0	5.11	0.07	24.8	BMRL	BMRL	BMRL	BMRL	1.40
B-15	N	6/15/98	13:00	1454.00	8724.0	4.93	0.10	29.0	BMRL	BMRL	0.011	BMRL	1.40
B-16	N	6/22/98	11:15	1620.25	9721.5	5.08	0.08	29.5	BMRL	BMRL	BMRL	BMRL	1.40
B-17	N	6/29/98	15:15	1792.25	10753.5	4.98	0.14	31.4	NA	BMRL	BMRL	BMRL	1.30
B-18	N	7/14/98	10:45	2147.75	12886.5	5.48	BMRL	27.5	NA	BMRL	0.008	BMRL	1.90
B-19	N	7/27/98	15:00	2464.00	14784.0	5.58	0.06	28.1	NA	BMRL	BMRL	BMRL	1.90
B-20	N	8/6/98	14:00	2703.00	16218.0	5.40	BMRL	27.7	NA	BMRL	0.009	BMRL	1.90
B-21	N	8/18/98	9:45	2966.75	17800.5	5.92	0.05	28.1	NA	0.80	0.008	1.00	1.70
B-22	N	8/25/98	10:00	3135.00	18810.0	NR	NR	NR	NA	NR	NR	NR	NR
B-23	N	9/14/98	14:30	3599.50	21597.0	5.74	BMRL	28.3	NA	1.00	0.015	1.50	2.30
Avg-B-24	Y	9/22/98	9:00	3786.00	22716.0	5.90	0.05	26.4	NA	1.07	0.014	1.31	2.43
B-25	N	9/30/98	14:00	3983.00	23898.0	5.68	BMRL	27.2	NA	1.20	0.010	0.83	2.20
B-26	N	10/7/98	10:00	4123.00	24738.0	5.58	0.22	22.4	NA	1.30	0.007	0.54	2.40
B-27	N	10/20/98	13:30	4438.50	26631.0	5.66	BMRL	22.3	NA	1.40	0.012	0.86	2.00
B-28	N	10/28/98	13:30	4630.50	27783.0	6.06	0.06	21.2	NA	1.10	0.014	1.27	3.00
B-29	N	11/9/98	10:30	4915.50	29493.0	NA	NA	NA	NA	NA	NA	NA	NA
B-30	N	11/16/98	13:00	5086.00	30516.0	NA	NA	NA	NA	NA	NA	NA	NA



**Group B, 15 effluent samples per run**

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh.hh	Bed volumes (10 minute)	pH ---	Turbidity ntu	Temp. °C	Ammonia mg NH <sub>3</sub> -N / L	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L
B-31	N	12/1/98	12:00	5445.00	32670.0	NA	NA	NA	NA	NA	NA	NA	NA
B-32	N	12/16/98	10:30	5803.50	34821.0	NA	NA	NA	NA	NA	NA	NA	NA
B-33	N	1/11/99	11:00	6428.00	38568.0	NA	NA	NA	NA	NA	NA	NA	NA
B-34	N	1/25/99	12:00	6765.00	40590.0	NA	NA	NA	NA	NA	NA	NA	NA
B-35	N	2/15/99	11:00	7268.00	43608.0	NA	NA	NA	NA	NA	NA	NA	NA
B-36	N	3/15/99	15:00	7753.00	46518.0	5.25	BMRL	14.7	NA	2.00	0.023	1.15	2.40
B-37	N	3/22/99	11:00	7917.00	47502.0	5.03	BMRL	14.6	NA	2.10	0.026	1.24	1.54
B-38	N	3/29/99	10:30	8084.50	48507.0	5.05	BMRL	15.2	NA	1.80	0.021	1.17	1.93

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.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, enter the results for the primary and duplicate analyses below.

**Group D, 3 duplicate effluent [10-minute] samples per run**

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh.hh	Bed volumes (10 minute)	pH ---	Turbidity ntu	Temp. °C	Ammonia mg NH <sub>3</sub> -N / L	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L
B4	Primary	4/27/98	12:30	303.50	1821.0	5.78	0.07	21.4	BMRL	BMRL	0.008	BMRL	1.60
D-B4	Duplicate	4/27/98	12:30	303.50	1821.0	5.78	0.06	21.4	BMRL	BMRL	BMRL	BMRL	1.60
Avg-B4	Average	---	---	---	---	5.78	0.07	21.4	BMRL	BMRL	0.008	BMRL	1.60
RPD-B4	RPD	---	---	---	---	0.00	15.38	0.00	BMRL	BMRL	BMRL	BMRL	0.00
B10	Primary	5/27/98	11:00	1005.00	6030.0	5.73	0.05	26.9	BMRL	BMRL	BMRL	BMRL	1.30
D-B10	Duplicate	5/27/98	11:00	1005.00	6030.0	5.73	0.06	26.9	BMRL	BMRL	BMRL	BMRL	1.30
Avg-B10	Average	---	---	---	---	5.73	0.06	26.9	BMRL	BMRL	BMRL	BMRL	1.30
RPD-B10	RPD	---	---	---	---	0.00	18.18	0.00	BMRL	BMRL	BMRL	BMRL	0.00
B24	Primary	9/22/98	9:00	3786.00	22716.0	5.90	0.05	26.4	NA	1.20	0.014	1.17	2.45
D-B24	Duplicate	9/22/98	9:00	3786.00	22716.0	5.90	0.05	26.4	NA	0.94	0.014	1.49	2.40
Avg-B24	Average	---	---	---	---	5.90	0.05	26.4	NA	1.07	0.014	1.31	2.43
RPD-B24	RPD	---	---	---	---	0.00	0.00	0.00	NA	24.30	0.00	24.66	2.06

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.

Field 1-5: Effluent Water Quality For The 10-Minute, Pilot-Scale GAC Contactor (continued)

SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS <i>CHCl3</i> µg/L	SDS <i>BDCM</i> µg/L	SDS <i>DBC</i> µg/L	SDS <i>CHBr3</i> µg/L	SDS THM4 µg/L	SDS <i>MCAA</i> * µg/L
---	---	---	---	---	---	---	---	---	---	---	---
0.67	0.33	18.3	7.50	48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL
0.92	0.68	19.6	7.50	48.0	BMRL	1.90	BMRL	BMRL	BMRL	1.90	BMRL
0.94	0.66	19.1	7.50	48.0	BMRL	1.00	BMRL	BMRL	BMRL	1.00	BMRL
1.04	0.56	19.6	7.50	48.0	NR	1.20	BMRL	BMRL	BMRL	1.20	BMRL
0.93	0.57	20.7	7.50	48.0	NR	1.40	BMRL	BMRL	BMRL	1.40	BMRL
1.01	0.64	21.5	7.50	48.0	BMRL	1.20	BMRL	BMRL	BMRL	1.20	BMRL
0.96	0.44	22.2	7.50	48.0	BMRL	NR	NR	NR	NR	NR	BMRL
0.64	0.56	23.3	7.50	48.0	BMRL	1.60	BMRL	BMRL	BMRL	1.60	BMRL
0.68	0.52	25.1	7.50	48.0	BMRL	1.50	BMRL	BMRL	BMRL	1.50	BMRL
0.49	0.81	25.8	7.50	48.0	BMRL	1.40	BMRL	BMRL	BMRL	1.40	BMRL
0.60	0.90	27.0	7.50	48.0	BMRL	2.10	1.20	BMRL	BMRL	3.30	BMRL
0.87	0.63	27.5	7.50	48.0	BMRL	1.80	1.00	BMRL	BMRL	2.80	BMRL
0.78	0.62	25.1	7.50	48.0	BMRL	1.30	BMRL	BMRL	BMRL	1.30	BMRL
NR	NR	25.4	7.50	48.0	BMRL	1.40	BMRL	BMRL	BMRL	1.40	BMRL
NR	NR	27.5	7.50	48.0	BMRL	1.30	BMRL	BMRL	BMRL	1.30	BMRL
0.96	0.44	29.2	7.50	48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL
0.72	0.58	30.9	7.50	48.0	BMRL	1.90	1.80	1.40	1.80	6.90	BMRL
1.01	0.89	29.2	7.50	48.0	72.00	4.10	4.00	2.10	BMRL	10.20	3.10
0.98	0.92	30.1	7.50	48.0	BMRL	2.80	4.90	2.00	BMRL	9.70	8.10
0.98	0.92	28.5	7.50	48.0	BMRL	3.80	3.60	2.40	BMRL	9.80	1.80
0.65	1.05	29.5	7.50	48.0	BMRL	1.30	1.10	BMRL	BMRL	2.40	3.20
NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.00	NR
1.35	0.95	27.9	7.50	48.0	81.00	6.40	5.30	3.10	BMRL	14.80	1.80
1.21	1.22	27.9	7.50	48.0	95.50	13.00	9.85	5.50	BMRL	28.35	2.05
1.31	0.89	27.0	7.50	48.0	95.00	7.30	6.00	3.60	BMRL	16.90	2.10
1.11	1.29	24.2	7.50	48.0	100.00	10.00	7.10	3.90	BMRL	21.00	2.40
0.45	1.55	22.8	7.50	48.0	90.00	7.80	6.00	3.80	BMRL	17.60	2.10
0.46	2.54	20.6	7.50	48.0	110.00	9.60	6.40	3.70	BMRL	19.70	3.40
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

**Field 1-5: Effluent Water Quality For The 10-Minute, Pilot-Scale GAC Contactor (continued)**

SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.00	1.40	11.0	7.50	48.0	160.00	19.00	8.30	3.70	BMRL	31.00	BMRL
0.14	1.40	13.0	7.50	48.0	140.00	26.00	8.90	2.80	BMRL	37.70	BMRL
0.63	1.30	14.0	7.50	48.0	170.00	20.00	7.90	2.80	BMRL	30.70	BMRL

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.

**Group D, 3 duplicate effluent [10-minute] samples per run (continued)**

SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L
1.03	0.57	19.6	7.50	48.0	NR	1.20	BMRL	BMRL	BMRL	1.20	BMRL
1.05	0.55	19.6	7.50	48.0	NR	1.20	BMRL	BMRL	BMRL	1.20	BMRL
1.04	0.56	19.6	7.50	48.0	NR	1.20	BMRL	BMRL	BMRL	1.20	BMRL
1.92	3.57	0.00	0.00	0.00	NR	0.00	BMRL	BMRL	BMRL	0.00	BMRL
0.31	0.99	25.8	7.50	48.0	BMRL	1.40	BMRL	BMRL	BMRL	1.40	BMRL
0.67	0.63	25.8	7.50	48.0	BMRL	1.40	BMRL	BMRL	BMRL	1.40	BMRL
0.49	0.81	25.8	7.50	48.0	BMRL	1.40	BMRL	BMRL	BMRL	1.40	BMRL
73.47	44.44	0.00	0.00	0.00	BMRL	0.00	BMRL	BMRL	BMRL	0.00	BMRL
1.20	1.25	27.9	7.50	48.0	110.00	12.00	8.70	4.80	BMRL	25.50	2.20
1.21	1.19	27.9	7.50	48.0	99.50	14.00	11.00	6.20	BMRL	31.20	1.90
1.21	1.22	27.9	7.50	48.0	104.75	13.00	9.85	5.50	BMRL	28.35	2.05
0.83	4.92	0.00	0.00	0.00	10.02	15.38	23.35	25.45	BMRL	20.11	14.63

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.

Field 1-5: Effluent Water Quality For The 10-Minute, Pilot-Scale GAC Contactor (continued)

SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
---	---	---	---	---	---	---	---	---	---
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
1.20	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	1.20	1.20
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
1.40	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	1.40	1.40
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
1.20	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	1.20	1.20
3.20	1.20	BMRL	BMRL	1.40	NA	NA	NA	7.50	8.90
1.80	2.60	BMRL	BMRL	1.10	NA	NA	NA	12.50	13.60
1.90	1.80	BMRL	BMRL	BMRL	NA	NA	NA	5.50	5.50
1.00	1.40	BMRL	BMRL	BMRL	NA	NA	NA	5.60	5.60
NR	NR	NR	NR	NR	NA	NA	NA	NR	NR
BMRL	2.00	BMRL	BMRL	1.70	NA	NA	NA	3.80	5.50
4.85	3.25	BMRL	BMRL	3.25	NA	NA	NA	10.15	13.40
3.30	2.20	BMRL	BMRL	2.30	NA	NA	NA	7.60	9.90
4.50	2.80	BMRL	BMRL	2.70	NA	NA	NA	9.70	12.40
3.40	2.50	BMRL	BMRL	2.30	NA	NA	NA	8.00	10.30
3.70	4.40	BMRL	BMRL	2.30	NA	NA	NA	11.50	13.80
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

**Field 1-5: Effluent Water Quality For The 10-Minute, Pilot-Scale GAC Contactor (continued)**

SDS <i>DCAA*</i> µg/L	SDS <i>TCAA*</i> µg/L	SDS <i>MBAA*</i> µg/L	SDS <i>DBAA*</i> µg/L	SDS <i>BCAA*</i> µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.89	5.56	BMRL	BMRL	2.25	NA	NA	NA	12.45	14.70
5.29	4.07	BMRL	BMRL	2.54	NA	NA	NA	9.36	11.90
8.92	7.80	BMRL	BMRL	2.31	NA	NA	NA	16.72	19.03

**Group D, 3 duplicate effluent [10-minute] samples per run (continued)**

SDS <i>DCAA*</i> µg/L	SDS <i>TCAA*</i> µg/L	SDS <i>MBAA*</i> µg/L	SDS <i>DBAA*</i> µg/L	SDS <i>BCAA*</i> µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
4.60	3.50	BMRL	BMRL	3.40	NA	NA	NA	10.30	13.70
5.10	3.00	BMRL	BMRL	3.10	NA	NA	NA	10.00	13.10
4.85	3.25	BMRL	BMRL	3.25	NA	NA	NA	10.15	13.40
10.31	15.38	BMRL	BMRL	9.23	NA	NA	NA	2.96	4.48

**Field 1-6: Effluent Water Quality For The 20-Minute, Pilot-Scale GAC Contactor<sup>1</sup>**

**Group C, 15 effluent samples per run**

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes (20 minute)	pH ---	Turbidity ntu	Temp. °C	Ammonia mg NH <sub>3</sub> -N / L	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L
START	---	4/14/98	11:00	0.00	0.0	---	---	---	---	---	---	---	---
C-1	N	4/15/98	11:00	24.00	72.0	10.14	0.10	20.6	BMRL	NA	BMRL	BMRL	1.00
C-2	N	4/21/98	15:30	162.50	487.5	7.56	0.07	20.6	BMRL	BMRL	0.006	BMRL	1.30
C-3	N	4/23/98	15:00	210.00	630.0	6.80	BMRL	19.7	BMRL	BMRL	0.005	BMRL	1.30
Avg-C-4	Y	4/27/98	12:30	303.50	910.5	5.88	BMRL	21.3	BMRL	BMRL	0.006	BMRL	1.30
C-5	N	4/30/98	10:30	373.50	1120.5	5.87	0.06	20.4	BMRL	BMRL	BMRL	BMRL	1.20
C-6	N	5/4/98	12:00	471.00	1413.0	5.65	0.06	22.6	BMRL	BMRL	BMRL	BMRL	1.60
C-7	N	5/7/98	14:30	545.50	1636.5	5.70	0.05	23.8	BMRL	BMRL	0.005	BMRL	1.30
C-8	N	5/18/98	10:00	793.00	2379.0	5.43	0.06	25.0	BMRL	BMRL	BMRL	BMRL	1.00
C-9	N	5/21/98	10:00	865.00	2595.0	NA	NA	NA	NA	NA	NA	NA	NA
Avg-C-10	Y	5/27/98	11:00	1005.00	3015.0	5.57	0.06	27.1	BMRL	BMRL	BMRL	BMRL	1.20
C-11	N	6/1/98	13:00	1122.00	3366.0	5.38	0.05	28.2	BMRL	BMRL	0.006	BMRL	1.40
C-12	N	6/4/98	13:15	1190.25	3570.8	5.27	0.08	28.2	BMRL	BMRL	BMRL	BMRL	1.40
C-13	N	6/8/98	10:30	1283.50	3850.5	5.58	0.10	22.8	BMRL	BMRL	0.005	BMRL	1.20
C-14	N	6/11/98	11:00	1356.00	4068.0	NA	NA	NA	NA	NA	NA	NA	NA
C-15	N	6/15/98	13:00	1454.00	4362.0	5.00	0.08	28.6	BMRL	BMRL	0.007	BMRL	1.30
C-16	N	6/22/98	11:15	1620.25	4860.8	4.82	0.07	29.5	BMRL	BMRL	0.005	BMRL	1.10
C-17	N	6/29/98	15:15	1792.25	5376.8	NA	NA	NA	NA	NA	NA	NA	NA
C-18	N	7/14/98	10:45	2147.75	6443.3	5.56	BMRL	27.7	NA	BMRL	BMRL	BMRL	1.50
C-19	N	7/27/98	15:00	2464.00	7392.0	5.51	BMRL	27.7	NA	BMRL	BMRL	BMRL	1.40
C-20	N	8/6/98	14:00	2703.00	8109.0	5.32	BMRL	27.5	NA	BMRL	BMRL	BMRL	1.50
C-21	N	8/18/98	9:45	2966.75	8900.3	5.75	BMRL	27.7	NA	BMRL	0.008	BMRL	1.50
C-22	N	8/25/98	10:00	3135.00	9405.0	NR	NR	NR	NA	NR	NR	NR	NR
C-23	N	9/14/98	14:30	3599.50	10798.5	5.62	0.07	28.0	NA	BMRL	0.013	BMRL	2.30
Avg-C-24	Y	9/22/98	9:00	3786.00	11358.0	5.84	BMRL	26.0	NA	BMRL	0.008	BMRL	2.13
C-25	N	9/30/98	14:00	3983.00	11949.0	5.62	BMRL	25.8	NA	BMRL	0.008	BMRL	1.80
C-26	N	10/7/98	10:00	4123.00	12369.0	NA	NA	NA	NA	NA	NA	BMRL	NA
C-27	N	10/20/98	13:30	4438.50	13315.5	NA	NA	NA	NA	NA	NA	BMRL	NA
C-28	N	10/28/98	13:30	4630.50	13891.5	NA	NA	NA	NA	NA	NA	BMRL	NA
C-29	N	11/9/98	10:30	4915.50	14746.5	6.28	BMRL	20.9	NA	0.96	0.007	0.73	4.80
C-30	N	11/16/98	13:00	5086.00	15258.0	5.72	BMRL	19.8	NA	BMRL	0.006	BMRL	4.50

**Group C, 15 effluent samples per run**

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh.hh	Bed volumes (20 minute)	pH ---	Turbidity ntu	Temp. °C	Ammonia mg NH <sub>3</sub> -N / L	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L
C-31	N	12/1/98	12:00	5445.00	16335.0	5.67	BMRL	22.4	NA	BMRL	BMRL	BMRL	2.70
C-32	N	12/16/98	10:30	5768.50	17305.5	5.75	0.06	16.0	NA	0.55	0.006	1.09	2.50
C-33	N	1/11/99	11:00	6386.00	19158.0	5.84	BMRL	14.9	NA	0.91	0.009	0.99	3.70
C-34	N	1/25/99	12:00	6683.00	20049.0	5.49	BMRL	15.2	0.1	0.83	0.012	1.45	2.09
C-35	N	2/15/99	11:00	7092.00	21276.0	6.36	BMRL	14.0	NA	0.89	0.008	0.90	1.62
C-36	N	3/15/99	15:00	7753.00	23259.0	5.14	BMRL	15.1	NA	1.40	0.016	1.14	1.92
C-37	N	3/22/99	11:00	7917.00	23751.0	4.89	0.25	14.9	NA	1.60	0.020	1.25	1.95
C-38	N	3/29/99	10:30	8084.50	24253.5	5.10	BMRL	15.7	NA	1.80	0.013	0.72	1.82

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.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results for the primary and duplicate analyses below.

**Group D, 3 duplicate effluent [20-minute] samples per run**

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh.hh	Bed volumes (20 minute)	pH ---	Turbidity ntu	Temp. °C	Ammonia mg NH <sub>3</sub> -N / L	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L
C4	Primary	4/27/98	12:00	313.00	939.0	5.88	BMRL	21.3	BMRL	BMRL	0.005	BMRL	1.30
D-C4	Duplicate	4/27/98	12:00	313.00	939.0	5.88	BMRL	21.3	BMRL	BMRL	0.007	BMRL	1.30
Avg-C4	Average	---	---	---	---	5.88	BMRL	21.3	BMRL	BMRL	0.006	BMRL	1.30
RPD-C4	RPD	---	---	---	---	0.00	BMRL	0.00	BMRL	BMRL	33.33	BMRL	0.00
C10	Primary	5/27/98	11:00	1032.00	3096.0	5.57	0.06	27.1	BMRL	BMRL	BMRL	BMRL	1.20
D-C10	Duplicate	5/27/98	11:00	1032.00	3096.0	5.57	0.06	27.1	BMRL	BMRL	BMRL	BMRL	1.20
Avg-C10	Average	---	---	---	---	5.57	0.06	27.1	BMRL	BMRL	BMRL	BMRL	1.20
RPD-C10	RPD	---	---	---	---	0.00	0.00	0.00	BMRL	BMRL	BMRL	BMRL	0.00
C24	Primary	9/22/98	9:00	3862.00	11586.0	5.84	BMRL	26.0	NA	BMRL	0.006	BMRL	2.25
D-C24	Duplicate	9/22/98	9:00	3862.00	11586.0	5.84	BMRL	26.0	NA	BMRL	0.009	BMRL	2.00
Avg-C24	Average	---	---	---	---	5.84	BMRL	26.0	NA	BMRL	0.008	BMRL	2.13
RPD-C24	RPD	---	---	---	---	0.00	BMRL	0.00	NA	BMRL	40.00	BMRL	11.76

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.

Field 1-6: Effluent Water Quality For The 20-Minute, Pilot-Scale GAC Contactor (continued)

SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L
---	---	---	---	---	---	---	---	---	---	---	---	---
0.47	0.53	18.3	7.50	48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL
0.80	0.50	19.6	7.50	48.0	BMRL	1.00	BMRL	BMRL	BMRL	1.00	BMRL	BMRL
0.88	0.42	19.1	7.50	48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL
1.04	0.26	19.60	7.50	48.0	NR	1.70	BMRL	BMRL	BMRL	1.70	BMRL	BMRL
0.73	0.47	20.7	7.50	48.0	NR	1.30	BMRL	BMRL	BMRL	1.30	BMRL	BMRL
0.99	0.61	21.5	7.50	48.0	BMRL	1.70	BMRL	BMRL	BMRL	1.70	BMRL	1.10
1.04	0.26	22.2	7.50	48.0	BMRL	1.20	BMRL	BMRL	BMRL	1.20	BMRL	BMRL
0.61	0.39	23.3	7.50	48.0	BMRL	1.00	BMRL	BMRL	BMRL	1.00	BMRL	BMRL
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.40	0.80	25.80	7.50	48.0	BMRL	1.00	BMRL	BMRL	BMRL	1.00	BMRL	BMRL
0.80	0.60	27.0	7.50	48.0	BMRL	1.40	BMRL	BMRL	BMRL	1.40	BMRL	BMRL
0.81	0.59	27.5	7.50	48.0	BMRL	1.40	BMRL	BMRL	BMRL	1.40	BMRL	BMRL
0.44	0.76	25.1	7.50	48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.89	0.41	27.5	7.50	48.0	BMRL	1.50	BMRL	BMRL	BMRL	1.50	BMRL	1.00
0.70	0.40	29.2	7.50	48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.94	0.56	29.2	7.50	48.0	NR	1.20	1.00	BMRL	BMRL	2.20	2.80	1.50
0.46	0.94	30.1	7.50	48.0	BMRL	5.70	4.60	3.20	BMRL	13.50	4.00	3.40
0.76	0.74	28.5	7.50	48.0	BMRL	1.00	BMRL	BMRL	BMRL	1.00	1.00	BMRL
0.30	1.20	29.5	7.50	48.0	NR	7.10	6.90	4.00	BMRL	18.00	2.90	2.60
NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.90	1.40	27.9	7.50	48.0	NR	5.60	4.40	3.10	BMRL	13.10	BMRL	2.90
1.37	0.76	27.90	7.50	48.0	BMRL	2.70	3.00	2.15	BMRL	7.85	BMRL	2.10
1.26	0.54	27.0	7.50	48.0	BMRL	1.50	2.00	1.80	BMRL	5.30	2.50	1.00
NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.30	3.50	17.3	7.50	48.0	290.00	5.20	4.80	3.30	BMRL	13.30	1.80	3.60
1.28	3.22	17.0	7.50	48.0	NR	4.20	2.90	1.80	BMRL	8.90	2.10	3.70



**Field 1-6: Effluent Water Quality For The 20-Minute, Pilot-Scale GAC Contactor (continued)**

SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L
1.05	1.65	16.5	7.50	48.0	45.00	1.40	1.10	BMRL	BMRL	2.50	4.00	3.70
1.24	1.26	13.5	7.50	48.0	69.00	2.90	2.50	1.60	BMRL	7.00	BMRL	1.50
0.70	3.00	11.0	7.50	48.0	41.00	2.80	3.10	2.20	BMRL	8.10	BMRL	1.80
0.59	1.50	12.0	7.50	48.0	71.00	4.30	5.60	5.40	1.70	17.00	BMRL	1.61
0.62	1.00	11.9	7.50	48.0	98.00	16.00	12.00	5.70	BMRL	33.70	1.22	9.74
0.72	1.20	11.0	7.50	48.0	100.00	10.00	6.30	3.50	BMRL	19.80	BMRL	5.29
0.75	1.20	13.0	7.50	48.0	120.00	12.00	6.90	3.30	BMRL	22.20	BMRL	4.93
0.82	1.00	14.0	7.50	48.0	130.00	11.00	6.60	3.30	BMRL	20.90	BMRL	5.29

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.

**Group D, 3 duplicate effluent [20-minute] samples per run (continued)**

SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L
1.04	0.26	19.6	7.50	48.0	BMRL	1.70	BMRL	BMRL	BMRL	1.70	BMRL	BMRL
1.04	0.26	19.6	7.50	48.0	NR	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL
1.04	0.26	19.6	7.50	48.0	NR	1.70	BMRL	BMRL	BMRL	1.70	BMRL	BMRL
0.00	0.00	0.00	0.00	0.00	NR	BMRL	BMRL	BMRL	BMRL	100.00	BMRL	BMRL
0.56	0.64	25.8	7.50	48.0	BMRL	1.00	BMRL	BMRL	BMRL	1.00	BMRL	BMRL
0.24	0.96	25.8	7.50	48.0	BMRL	1.00	BMRL	BMRL	BMRL	1.00	BMRL	BMRL
0.40	0.80	25.8	7.50	48.0	BMRL	1.00	BMRL	BMRL	BMRL	1.00	BMRL	BMRL
80.00	40.00	0.00	0.00	0.00	BMRL	0.00	BMRL	BMRL	BMRL	0.00	BMRL	BMRL
1.51	0.74	27.9	7.50	48.0	30.00	2.70	2.90	2.00	BMRL	7.60	BMRL	2.20
1.22	0.78	27.9	7.50	48.0	25.00	2.70	3.10	2.30	BMRL	8.10	BMRL	2.00
1.37	0.76	27.9	7.50	48.0	27.50	2.70	3.00	2.15	BMRL	7.85	BMRL	2.10
21.25	5.26	0.00	0.00	0.00	18.18	0.00	6.67	13.95	BMRL	6.37	BMRL	9.52

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.

Field 1-6: Effluent Water Quality For The 20-Minute, Pilot-Scale GAC Contactor (continued)

SDS <i>TCAA</i> * µg/L	SDS <i>MBAA</i> * µg/L	SDS <i>DBAA</i> * µg/L	SDS <i>BCAA</i> * µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
---	---	---	---	---	---	---	---	---
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	1.10	1.10
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
NA	NA	NA	NA	NA	NA	NA	NA	NA
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
NA	NA	NA	NA	NA	NA	NA	NA	NA
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	1.00	1.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
NA	NA	NA	NA	NA	NA	NA	NA	NA
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	4.30	4.30
4.30	BMRL	BMRL	1.70	NA	NA	NA	11.70	13.40
1.00	BMRL	BMRL	BMRL	NA	NA	NA	2.00	2.00
2.00	BMRL	BMRL	1.40	NA	NA	NA	7.50	8.90
NR	NR	NR	NR	NA	NA	NA	NR	NR
3.60	BMRL	BMRL	1.50	NA	NA	NA	6.50	8.00
1.20	BMRL	BMRL	1.25	NA	NA	NA	3.30	4.55
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	3.50	3.50
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
2.70	BMRL	BMRL	1.40	NA	NA	NA	8.10	9.50
3.10	BMRL	BMRL	1.10	NA	NA	NA	8.90	10.00

**Field 1-6: Effluent Water Quality For The 20-Minute, Pilot-Scale GAC Contactor (continued)**

SDS <i>TCAA*</i> µg/L	SDS <i>MBAA*</i> µg/L	SDS <i>DBAA*</i> µg/L	SDS <i>BCAA*</i> µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
1.10	BMRL	BMRL	2.00	NA	NA	NA	8.80	10.80
1.00	BMRL	BMRL	1.00	NA	NA	NA	2.50	3.50
BMRL	BMRL	BMRL	1.50	NA	NA	NA	1.80	3.30
1.13	BMRL	1.30	1.10	NA	NA	NA	4.04	5.14
1.21	BMRL	1.53	6.74	NA	NA	NA	13.70	20.44
4.07	BMRL	BMRL	2.54	NA	NA	NA	9.36	11.90
3.61	BMRL	BMRL	2.19	NA	NA	NA	8.54	10.73
3.98	BMRL	BMRL	2.20	NA	NA	NA	9.27	11.47

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.

**Group D, 3 duplicate effluent [20-minute] samples per run (continued)**

SDS <i>TCAA*</i> µg/L	SDS <i>MBAA*</i> µg/L	SDS <i>DBAA*</i> µg/L	SDS <i>BCAA*</i> µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
BMRL	BMRL	BMRL	BMRL	NA	NA	NA	0.00	0.00
1.10	BMRL	BMRL	1.20	NA	NA	NA	3.30	4.50
1.30	BMRL	BMRL	1.30	NA	NA	NA	3.30	4.60
1.20	BMRL	BMRL	1.25	NA	NA	NA	3.30	4.55
16.67	BMRL	BMRL	8.00	NA	NA	NA	0.00	2.20

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.

**Field 1-7: GAC Cost Parameters**

<b>Cost Parameter</b>	<b>Parameter value</b>
Capital Recovery Interest Rate (%)	7.8
Capital Recovery Period (years)	20
Overhead & Profit Factor (% of construction costs)	10
Special Sitework Factor (% of construction costs)	5
Construction Contingencies (% of construction costs)	10
Engineering Fee Factor (% of construction costs)	10
1998 ENR Construction Cost Index (CCI base year 1913)	78.8
1998 Producers Price Index (PPI base year 1982 = 100)	131.3
Labor Rate + Fringe (\$/work-hour)	22
Labor Overhead Factor (% of labor)	6
Electric Rate (\$/kW-h)	0.08
Fuel Oil Rate (\$/gal)	0.55
Natural Gas Rate (\$/ft <sup>3</sup> )	0.007
Current Process Water Rate (\$/1000 gal)	0.40
Modifications to Existing Plant (% of construction costs)	20

## **Appendix C**

### **Treatment Study Summary Report Spreadsheet**

QA/QC Summary (FILE: TSSUMRPT.xls)

**Miscellaneous Information**

PWSID NC0392010  
Plant ICR # 452

**Full-Scale Plant Information**

Item	Result
Primary Disinfectant	Free Cl2
Residual Disinfectant	Chloramines
Source Type	Reservoir
Source Name	Falls Lake

**Laboratory Information**

Item	ICR ID or Abbrev	Lab Name	Lab Type	Lab City	Lab State
Lab #1	MA001	Camp Dresser & McKee Labora	Consultant	Cambridge	MA
Lab #2	MA086	Alpha Analytical Services	Commercial	Westborough	MA
Lab #3	IN004	Environmental Health Laborator	Commercial	South Bend	IN
Lab #4	EMJ	EM Johnson WTP	Utility	Raleigh	NC

**Batch Sampling Dates for Quarterly Bench-Scale Testing**

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

**1998 Flow and Population Information**

Source	Flow (mgd)	Population Served
Total Population Served		250000
Surface Water	41	41
Ground Water	0	0
Purchased Finished Water	0	0
<b>Total</b>	<b>41</b>	

# QA/QC Summary (FILE: TSSUMRPT.xls)

## Full-Scale Water Quality Data

### Full-Scale Influent Water Quality Data

Item	Units	Average	Std Dev	Min	Max	Count
Temperature	C	20.6	5.34	13.4	28.1	12
pH	Unit	6.65	0.58	5.16	7.42	12
Turbidity	ntu	11.4	6.14	1.97	21.7	12
Alkalinity	mg/L as CaCO <sub>3</sub>	21.1	5.76	13	33	12
Total Hardness	mg/L as CaCO <sub>3</sub>	21.8	4.57	14	27	12
Calcium Hardness	mg/L as CaCO <sub>3</sub>	13.3	2.86	8	17	12
TOC	mg/L	4.8	0.95	3.3	6.4	12
UV <sub>254</sub>	1/cm	0.155	0.093	0.023	0.304	12
Bromide	µg/L	0.031	0.012	<0.02	0.05	12
TSUVA*	L/(mg*m)	NR	NR	NR	NR	12

\*TSUVA = [UV<sub>254</sub> (1/m)] / [TOC (mg/L)]. Summary information for TSUVA should only be calculated from TSUVA values with paired TOC and UV<sub>254</sub> measurements

### Full-Scale Finished Water Quality Data

Item	Units	Average	Std Dev	Min	Max	Count
Temperature	C	20.7	6.3	10.4	28.3	12
pH	unit	7.22	0.82	5.01	8.19	12
Turbidity	ntu	0.27	0.34	0.08	1.33	12
TOC	mg/L	2.11	0.32	1.6	2.7	12
UV <sub>254</sub>	1/cm	0.042	0.01	<0.009	0.05	12
DS-THM4	µg/L	32.5	13.8	20.1	51.4	12
DS-HAA5	µg/L	29.3	13.7	16.6	40.1	12
DS-HAA6	µg/L	NR	NR	NR	NR	12

QA/QC Summary

QA/QC Data - Sheet 1											Percentiles		
Analyte Identification	Units	Laboratory Identification	Start Service Date	End Service Date	Method	MRL	Count	Average	Std Dev		25th	50th	75th
pH	unit	EMJ	4/14/98	4/14/99	SM4500-H+								
Temperature	C	EMJ	4/14/98	4/14/99	SM2550B								
Alkalinity	mg/L as CaCO <sub>3</sub>	MA001	4/14/98	1/25/99	SM2320B	5							
Ammonia	mg NH <sub>3</sub> -N/L	MA001	4/14/98	1/25/99	SM4500-NH <sub>3</sub>	0.1							
Calcium Hardness	mg/L as CaCO <sub>3</sub>	MA001	4/14/98	1/25/99	EPA200.7	3							
SDS-Cl <sub>2</sub> Residual	mg/L	MA001	4/14/98	1/25/99	SM 4500-Cl I	0.2							
Total Hardness	mg/L as CaCO <sub>3</sub>	MA001	4/14/98	1/25/99	EPA200.7	3							
Turbidity	ntu	MA001	4/14/98	1/25/99	SM2130B	0.05							
Bromide	µg/L	MA001	4/14/98	9/22/98	EPA300A	20	RPE of Analytical Duplicates:	1	4.76%	NR	NR	NR	NR
							% Recovery for Lab Fortified Matrix:	17	104%	6.3	100%	103%	105%
							% Recovery for PE Samples:	5	101%	5.08%	98%	99%	105%
UV <sub>254</sub>	1/cm	MA001	4/14/98	1/25/99	SM5910	0.005	RPE of Analytical Duplicates:	58	6.41%	9.39%	0.00%	3.77%	7.55%
							% Recovery for Lab Fortified Matrix:	82	99%	8.1%	95%	99%	102%
							% Recovery for PE Samples:	6	95%	8.48%	96%	97%	98%
TOC	mg/L	MA001	4/14/98	1/25/99	SM5310C	0.5	RPE of Analytical Duplicates:	46	6.65%	7.47%	0%	6.07%	8.90%
							% Recovery for Lab Fortified Matrix:	32	101%	5.9%	97%	100%	104%
							% Recovery for PE Samples:	6	90%	39.1%	100%	103%	109%
SDS-TOX	µg Cl-/L	IN004	4/14/98	8/18/98	SM5320B	50	RPE of Analytical Duplicates:	20	15.33%	19.86%	0%	8.00%	22.22%
							% Recovery for Lab Fortified Matrix:	34	91%	7.79%	85.05%	91.40%	94.85%
							% Recovery for PE Samples:	4	75.07%	5.43%	73.49%	76.88%	78.47%
SDS-CHCl <sub>3</sub>	µg/L	MA001	4/14/98	1/25/99	EPA551.1	1	RPE of Analytical Duplicates:	5	4.82%	4.06%	3.45%	4.00%	5.56%
							% Recovery for Lab Fortified Matrix:	27	94%	6.6%	91%	97%	98%
							% Recovery for PE Samples:	12	92%	15.3%	84%	90%	102%
SDS-BDCM	µg/L	MA001	4/14/98	1/25/99	EPA551.1	1	RPE of Analytical Duplicates:	5	3.70%	2.10%	2.44%	2.94%	5%
							% Recovery for Lab Fortified Matrix:	27	97%	6.6%	96%	99%	101%
							% Recovery for PE Samples:	12	97%	9.64%	90%	96%	102%
SDS-DBCM	µg/L	MA001	4/14/98	1/25/99	EPA551.1	1	RPE of Analytical Duplicates:	3	3.03%	5.25%	0%	0%	4.55%



QA/QC Summary

SDS-CHBr <sub>3</sub>	µg/L	MA001	4/14/98	1/25/99	EPA551.1	1	% Recovery for Lab Fortified Matrix:	27	99%	6.6%	97%	101%	104%
							% Recovery for PE Samples:	12	98%	10.3%	93%	98%	106%
							RPE of Analytical Duplicates:	0	NR	NR	NR	NR	NR
THM4	µg/L	MA001	4/14/98	1/25/99	EPA551.1	1	% Recovery for Lab Fortified Matrix:	27	104%	5.9%	104%	106%	108%
							% Recovery for PE Samples:	10	108%	12.2%	98%	103%	116%
							Avg RPE of Indiv Anal Dupl:	5	4.25%	2.81%	2.13%	5.28%	6.59%
SDS-MCAA	µg/L	MA001	4/14/98	1/11/99	SM6251B	1	Avg % Recov for Indiv Lab Fort Matrix:	27	99%	6.2%	97%	101%	102%
							Avg % Recov for Indiv PE Samples:	10	95%	11.2%	89%	94%	102%
							RPE of Analytical Duplicates:	13	5.87%	4.88%	2.70%	5.56%	6.90%
SDS-DCAA	µg/L	MA001	4/14/98	1/11/99	SM6251B	1	% Recovery for Lab Fortified Matrix:	24	104%	8.7%	99%	103%	109%
							% Recovery for PE Samples:	8	85%	14.3%	78%	88%	91%
							RPE of Analytical Duplicates:	13	6.23%	6.12%	0.00%	6.45%	8.33%
SDS-TCAA	µg/L	MA001	4/14/98	1/11/99	SM6251B	1	% Recovery for Lab Fortified Matrix:	24	104%	8.4%	99%	106%	109%
							% Recovery for PE Samples:	8	91%	8.22%	85%	91%	97%
							RPE of Analytical Duplicates:	13	3.34%	4.18%	1.05%	1.79%	3.09%
SDS-MBAA	µg/L	MA001	4/14/98	1/11/99	SM6251B	1	% Recovery for Lab Fortified Matrix:	24	107%	9.9%	100%	103%	115%
							% Recovery for PE Samples:	8	82%	16.1%	74%	81%	90%
							RPE of Analytical Duplicates:	0	NR	NR	NR	NR	NR
SDS-DBAA	µg/L	MA001	4/14/98	1/11/99	SM6251B	1	% Recovery for Lab Fortified Matrix:	24	101%	8.2%	96%	103%	107%
							% Recovery for PE Samples:	7	78%	16.2%	74%	80%	88%
							RPE of Analytical Duplicates:	0	NR	NR	NR	NR	NR
SDS-BCAA	µg/L	MA001	4/14/98	1/11/99	SM6251B	1	% Recovery for Lab Fortified Matrix:	24	97%	10.4%	90%	98%	105%
							% Recovery for PE Samples:	8	79%	10.1%	69%	78%	87%
							RPE of Analytical Duplicates:	13	8.05%	4.83%	4.55%	7.69%	11.76%
SDS-TBAA	µg/L						% Recovery for Lab Fortified Matrix:	24	101%	9.4%	92%	99%	108%
							% Recovery for PE Samples:	8	78%	8.06%	76%	79%	83%
							RPE of Analytical Duplicates:						
SDS-CDBAA	µg/L						% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
							RPE of Analytical Duplicates:						
SDS-DCBAA	µg/L						% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
							RPE of Analytical Duplicates:						
HAA5	µg/L	MA001	4/14/98	1/11/99	SM6251B	1	Avg RPE of Indiv Anal Dupl:	13	5.15%	3.36%	2.78%	3.85%	5.48%
							Avg % Recov for Indiv Lab Fort Matrix:	24	103%	6.6%	99%	102%	108%
							Avg % Recov for Indiv PE Samples:	7	82%	8.62%	78%	79%	87%
HAA6	µg/L	MA001	4/14/98	1/25/99	SM6251B	1	Avg RPE of Indiv Anal Dupl:	13	5.87%	3.29%	3.50%	5.12%	6.59%
							Avg % Recov for Indiv Lab Fort Matrix:	24	102%	6.9%	98%	101%	109%
							Avg % Recov for Indiv PE Samples:	7	82%	7.90%	77%	79%	86%
HAA9	µg/L						Avg RPE of Indiv Anal Dupl:						
							Avg % Recov for Indiv Lab Fort Matrix:						

QA/QC Summary

QA/QC Data - Sheet 2											Percentiles		
Analyte Identification	Units	Laboratory Identification	Start Service Date	End Service Date	Method	MRL	Count	Average	Std Dev		25th	50th	75th
pH	unit												
Temperature	C												
Alkalinity	mg/L as CaCO <sub>3</sub>	MA086	1/25/99	4/14/99	EPA310.1	2							
Ammonia	mg NH <sub>3</sub> -N/L	MA086	1/25/99	4/14/99	EPA350.1	0.7							
Calcium Hardness	mg/L as CaCO <sub>3</sub>	MA086	1/25/99	4/14/99	SM2340B	1.25							
SDS-Cl <sub>2</sub> Residual	mg/L	MA086	1/25/99	4/14/99	SM4500-Cl-D	0.05							
Total Hardness	mg/L as CaCO <sub>3</sub>	MA086	1/25/99	4/14/99	SM2340B	3							
Turbidity	ntu	MA086	1/25/99	4/14/99	EPA180.1	0.2							
Bromide	µg/L	MA086	1/25/99	4/14/99	EPA300.0	50	RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:	1 5	0 NR 112% NA	NR 4.47% NA	NR 110% NA	NR 110% NA	NR 110% NA
UV <sub>254</sub>	1/cm	MA086	1/25/99	4/14/99	SM5910B	0.005	RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:	14 5	6.0% 100% NA	1238.0% 11.00% NA	0% 89% NA	0% 100% NA	5.9% 111% NA
TOC	mg/L	MA086	1/25/99	4/14/99	EPA415.1	0.1	RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:	5 6	3.40% 108% NA	3.21% 4.08% NA	0% 110% NA	5.00% 110% NA	5.00% 110% NA
SDS-TOX	µg Cl-/L	IN004	8/18/98	4/14/99	EPA300A	25	RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:	34 5 4	10.40% 91.82% 75.07%	19.55% 6.40% 5.43%	0% 90.20% 73.49%	4.72% 92.50% 76.88%	9.15% 96.80% 78.47%
SDS-CHCl <sub>3</sub>	µg/L	IN004	1/25/99	4/14/99	EPA551.1	1	RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:	5 5 4	60.96% 187% 96.75%	36.03% 152.53% 3.59%	64.29% 120% 93.89%	65.00% 123% 96.90%	85.00% 154% 99.77%
SDS-BDCM	µg/L	IN004	1/25/99	4/14/99	EPA551.1	1	RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:	5 5 4	44.26% 103.20% 100.95%	34.99% 40.94% 1.56%	26.74% 97% 99.83%	37.18% 120% 100.88%	68.35% 120% 102.00%
SDS-DBCM	µg/L	IN004	1/25/99	4/14/99	EPA551.1	1	RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix:	5 5	41.88% 109.40%	31.07% 24.95%	31.82% 91%	35.71% 118%	59.09% 119%

QA/QC Summary

SDS-CHBr <sub>3</sub>	µg/L	IN004	1/25/99	4/14/99	EPA551.1	1	% Recovery for PE Samples:	4	98.61%	4.02%	95.70%	97.79%	100.69%
							RPE of Analytical Duplicates:	5	NR	NR	NR	NR	NR
							% Recovery for Lab Fortified Matrix:	5	107.60%	14.10%	96%	115%	119%
THM4	µg/L	IN004	1/25/99	4/14/99	EPA551.1		% Recovery for PE Samples:	4	99.28%	1.11%	99.00%	99.73%	100.00%
							Avg RPE of Indiv Anal Dupl:	4	49.03%	2.62%	29.28%	37.18%	76.68%
							Avg % Recov for Indiv Lab Fort Matrix:	4	127%	63.90%	94.80%	119%	129%
							Avg % Recov for Indiv PE Samples:	4	99.07%	1.02%	98.69%	98.92%	99.31%
SDS-MCAA	µg/L	MA086	1/25/99	4/14/99	SM6251B	1	RPE of Analytical Duplicates:	0	NR	NR	NR	NR	NR
							% Recovery for Lab Fortified Matrix:	6	96%	7.50%	94%	98%	100%
							% Recovery for PE Samples:	NA	NA	NA	NA	NA	NA
SDS-DCAA	µg/L	MA086	1/25/99	4/14/99	SM6251B	1	RPE of Analytical Duplicates:	3	5.67%	1.53%	5.00%	6.00%	6.50%
							% Recovery for Lab Fortified Matrix:	6	95%	12.20%	86%	98%	103%
							% Recovery for PE Samples:	NA	NA	NA	NA	NA	NA
SDS-TCAA	µg/L	MA086	1/25/99	4/14/99	SM6251B	1	RPE of Analytical Duplicates:	3	4.33%	0.58%	4.00%	4.00%	4.50%
							% Recovery for Lab Fortified Matrix:	6	114%	8.94%	110%	115%	117%
							% Recovery for PE Samples:	NA	NA	NA	NA	NA	NA
SDS-MBAA	µg/L	MA086	1/25/99	4/14/99	SM6251B	1	RPE of Analytical Duplicates:	0	NR	NR	NR	NR	NR
							% Recovery for Lab Fortified Matrix:	6	108%	7.23%	101%	108%	114%
							% Recovery for PE Samples:	NA	NA	NA	NA	NA	NA
SDS-DBAA	µg/L	MA086	1/25/99	4/14/99	SM6251B	1	RPE of Analytical Duplicates:	0	NR	NR	NR	NR	NR
							% Recovery for Lab Fortified Matrix:	6	105%	8.62%	104%	105%	108%
							% Recovery for PE Samples:	NA	NA	NA	NA	NA	NA
SDS-BCAA	µg/L	MA086	1/25/99	4/14/99	SM6251B	1	RPE of Analytical Duplicates:	3	8.67%	3.21%	7.50%	10.00%	10.50%
							% Recovery for Lab Fortified Matrix:	6	104%	11.30%	101%	104%	112%
							% Recovery for PE Samples:	NA	NA	NA	NA	NA	NA
SDS-TBAA	µg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
SDS-CDBAA	µg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
SDS-DCBAA	µg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
HAA5	µg/L	MA086	1/25/99	4/14/99	SM6251B		Avg RPE of Indiv Anal Dupl:	3	3.49%	1.70%	2.68%	3.64%	4.37%
							Avg % Recov for Indiv Lab Fort Matrix:	6	103%	5.34%	101%	103%	107%
							Avg % Recov for Indiv PE Samples:	NA	NA	NA	NA	NA	NA
HAA6	µg/L	MA086	1/25/99	4/14/99	SM6251B		Avg RPE of Indiv Anal Dupl:	3	3.85%	1.51%	3.25%	4.35%	4.70%
							Avg % Recov for Indiv Lab Fort Matrix:	6	103%	5.69%	100%	102%	108%
								NA	NA	NA	NA	NA	NA
HAA9	µg/L						Avg RPE of Indiv Anal Dupl:						
							Avg % Recov for Indiv Lab Fort Matrix:						

QA/QC Summary

QA/QC Data - Sheet 3													
Analyte Identification	Units	Laboratory Identification	Start Service Date	End Service Date	Method	MRL		Count	Average	Std Dev	Percentiles		
											25th	50th	75th
pH	unit												
Temperature	C												
Alkalinity	mg/L as CaCO <sub>3</sub>												
Ammonia	mg NH <sub>3</sub> -N/L												
Calcium Hardness	mg/L as CaCO <sub>3</sub>												
SDS-Cl <sub>2</sub> Residual	mg/L												
Total Hardness	mg/L as CaCO <sub>3</sub>												
Turbidity	ntu												
Bromide	µg/L	IN004	9/22/98	1/25/99	EPA552.2	20	RPE of Analytical Duplicates:	9	188.48%	214.91%	35.29%	77.14%	443.75%
							% Recovery for Lab Fortified Matrix:	11	101.94%	5.74%	97.05%	102.20%	104.75%
							% Recovery for PE Samples:	4	96.50%	4.43%	93.96%	96.91%	99.45%
UV <sub>254</sub>	1/cm						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
TOC	mg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
SDS-TOX	µg Cl-/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
SDS-CHCl <sub>3</sub>	µg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
SDS-BDCM	µg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
SDS-DBCM	µg/L						RPE of Analytical Duplicates:						
							% Recovery for PE Samples:						

QA/QC Summary

SDS-CHBr <sub>3</sub>	µg/L						% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
							RPE of Analytical Duplicates:						
THM4	µg/L						% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
							Avg RPE of Indiv Anal Dupl:						
							Avg % Recov for Indiv Lab Fort Matrix:						
							Avg % Recov for Indiv PE Samples:						
SDS-MCAA	µg/L	IN004	1/11/99	1/25/99	EPA552.2	0.2	RPE of Analytical Duplicates:	1	NR	NR	NR	NR	NR
							% Recovery for Lab Fortified Matrix:	1	74.80%	NA	74.80%	74.80%	74.80%
							% Recovery for PE Samples:	4	94.56%	10.91%	86.55%	91.93%	99.94%
SDS-DCAA	µg/L	IN004	1/11/99	1/25/99	EPA552.2	0.1	RPE of Analytical Duplicates:	2	100%	0%	100%	100%	100%
							% Recovery for Lab Fortified Matrix:	1	121%	NA	121.03%	121.03%	121.03%
							% Recovery for PE Samples:	4	85.99%	9.95%	84.36%	90.22%	91.85%
SDS-TCAA	µg/L	IN004	1/11/99	1/25/99	EPA552.2	0.1	RPE of Analytical Duplicates:	1	100%	NA	100%	100%	100%
							% Recovery for Lab Fortified Matrix:	1	87.10%	NA	87.12%	87.12%	87.12%
							% Recovery for PE Samples:	4	87.85%	10.09%	82.87%	85.09%	90.07%
SDS-MBAA	µg/L	IN004	1/11/99	1/25/99	EPA552.2	0.1	RPE of Analytical Duplicates:	1	NR	NR	NR	NR	NR
							% Recovery for Lab Fortified Matrix:	1	99.90%	NA	99.91%	99.91%	99.91%
							% Recovery for PE Samples:	4	83.78%	11.46%	80.23%	86.91%	90.47%
SDS-DBAA	µg/L	IN004	1/11/99	1/25/99	EPA552.2	0.1	RPE of Analytical Duplicates:	1	100%	NA	100%	100%	100%
							% Recovery for Lab Fortified Matrix:	1	102.70%	NA	102.69%	102.69%	102.69%
							% Recovery for PE Samples:	4	82.17%	14.92%	73.88%	82.36%	90.66%
SDS-BCAA	µg/L	IN004	1/11/99	1/25/99	EPA552.2	0.1	RPE of Analytical Duplicates:	2	60%	56.57%	40%	40%	40%
							% Recovery for Lab Fortified Matrix:	1	102.20%	NA	102.18%	102.18%	102.18%
							% Recovery for PE Samples:	4	77.75%	13.60%	72.66%	78%	83.10%
SDS-TBAA	µg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:	NOTE:	NR = All samples and duplicates were BMRL.				
							% Recovery for PE Samples:						
SDS-CDBAA	µg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
SDS-DCBAA	µg/L						RPE of Analytical Duplicates:						
							% Recovery for Lab Fortified Matrix:						
							% Recovery for PE Samples:						
HAA5	µg/L	IN004	1/11/99	1/25/99	EPA552.2		Avg RPE of Indiv Anal Dupl:	6	90%	NA	55%	100%	100%
							Avg % Recov for Indiv Lab Fort Matrix:	6	98%	NA	90.32%	101.05%	95.77%
							Avg % Recov for Indiv PE Samples:	4	87.96%	9.59%	87%	92.06%	93.02%
HAA6	µg/L						Avg RPE of Indiv Anal Dupl:						
							Avg % Recov for Indiv Lab Fort Matrix:						
HAA9	µg/L						Avg RPE of Indiv Anal Dupl:						
							Avg % Recov for Indiv Lab Fort Matrix:						