

# ICR TREATMENT STUDY ANALYSIS

## Base Analysis and Data Review Comments

<b>Treatment Study ID</b>	3006
<b>Study Protocol</b>	GAC pilot-scale treatment study
<b>Plant ICR Number</b>	630
<b>PWS Name</b>	City of Houston
<b>City, State, Zip</b>	Houston, TX 77015

These are general comments that do not need to be responded to directly.

### Major comments:

1. As explained in the Summary Report, chloramines were present in the source water to the pilot study. The source water (Trinity River) was located 12 miles away from the treatment plant and transported there by a pipeline. Chloramination at the raw water intake is practiced to prevent the attachment of Asiatic clams and biogrowth (page 9 of the Summary Report). Permission was obtained from the USEPA to utilize this pre-chloraminated source water since the costs of obtaining disinfectant-free water were prohibitive. Sampling was performed on the GAC influent and effluent to quantify any DBPs formed due to pre-disinfection. The total chlorine was also monitored in the raw water (Table 4 of the Summary Report). The median total chlorine residual was 0.2 mg/L. The maximum total chlorine residual was 1.8 mg/L. Results of instantaneous DBP monitoring are summarized in Table 16 of the Summary Report and in Cells N59:DX64 of the Data Collection Spreadsheets. In general, measured DBP levels were low. Instantaneous DBPs accounted for 0 to 20 percent of the formed DBPs after SDS chlorination. GAC influent instantaneous chloroform ranged from 0.6 to 4.4 µg/L, the highest THM analyte measured. The only HAA compound measured above the MRL in the GAC influent was BCAA, with reported values between BMRL and 2.5 µg/L. TOX in the GAC influent was reported between BMRL and 31 µg/L as Cl<sup>-</sup>. Some HAA compounds not detected above the MRL in the GAC influent were measured in the GAC effluent to both contactors. For example, at 2,450 hours of operation, 4.7 µg/L of instantaneous DCAA was measured in the 20 minute EBCT contactor effluent. This compares to a SDS-DCAA measurement of 12.6 µg/L for the same sample.

### General Comments:

1. As explained on page 20 of the Summary Report, source water quality historically is relatively stable. However, during operation of the pilot plant (May through October, 1998)

the area experienced unusual weather patterns attributed to the El Niño effect. During the first two-thirds of the study, the area experienced a severe drought, which yielded lower source water TOC levels than normal. During the last one-third of the study, several rainstorms destabilized the watershed, resulting in a large increase in the source water TOC concentration. As shown clearly in Figure 1 in the Summary Report, a source water TOC spike occurred near the end of the study.

2. Although Table 11 of the Summary Report lists a target SDS incubation temperature of 25°C, ambient distribution system temperature was used for SDS incubation, as described on page 17 of the Summary Report. The SDS incubation temperature ranged from 21 to 30°C.
3. The relative performance of the breakthrough of SDS-THM4 and SDS-TOX in the 10 minute EBCT contactor as compared to the 20 minute EBCT contactor was similar to that observed for TOC: run times to any point in breakthrough are typically about doubled for the 20 minute EBCT run. Therefore, on a throughput basis (normalized by EBCT) the two runs performed similarly. For SDS-HAA6, however, the 10 minute EBCT contactor outperformed the 20 minute EBCT contactor on a throughput basis (normalized by EBCT).

### **Outlier Data:**

No outliers removed.

**Cell:** A1

**Comment:** 3006-SAS.xls 2/12/00 16:46

All curve fits reviewed and approved. See below for log of refit datasets.

**Cell:** C4

**Comment:** 3006-10-01 - Run 1 (CDBAA) 2/12/00 16:37

Original value (CoefA0) = 99999 New value = -2.4884

Fewer than 6 points above MRL. Data was fit to peak curve by iterative curve fit procedure.

**Cell:** D4

**Comment:** 3006-10-01 - Run 1 (CDBAA) 2/12/00 16:37

Original value (CoefAf) = 99999 New value = 1583.007

Fewer than 6 points above MRL. Data was fit to peak curve by iterative curve fit procedure.

**Cell:** E4

**Comment:** 3006-10-01 - Run 1 (CDBAA) 2/12/00 16:37

Original value (CoefB) = 99999 New value = 1833.0371

Fewer than 6 points above MRL. Data was fit to peak curve by iterative curve fit procedure.

**Cell:** F4

**Comment:** 3006-10-01 - Run 1 (CDBAA) 2/12/00 16:37

Original value (CoefD) = 99999 New value = 0.0443

Fewer than 6 points above MRL. Data was fit to peak curve by iterative curve fit procedure.

**Cell:** J4

**Comment:** 3006-10-01 - Run 1 (CDBAA) 2/12/00 16:37

Original value (S) = 0 New value = -0.0893

Fewer than 6 points above MRL. Data was fit to peak curve by iterative curve fit procedure.

**Cell:** C5

**Comment:** 3006-10-01 - Run 1 (CHBr3) 2/12/00 16:35

Original value (CoefA0) = 0 New value = -0.1116

Poor peak curve fit. Data was refit by iterative curve fit procedure.

**Cell:** D5

**Comment:** 3006-10-01 - Run 1 (CHBr3) 2/12/00 16:35

Original value (CoefAf) = 12.4679 New value = 31.4019

Poor peak curve fit. Data was refit by iterative curve fit procedure.

**Cell:** E5

**Comment:** 3006-10-01 - Run 1 (CHBr3) 2/12/00 16:35

Original value (CoefB) = 10 New value = 33.7881

Poor peak curve fit. Data was refit by iterative curve fit procedure.

**Cell:** F5

**Comment:** 3006-10-01 - Run 1 (CHBr3) 2/12/00 16:35

Original value (CoefD) = 0.15 New value = 0.1487

Poor peak curve fit. Data was refit by iterative curve fit procedure.

**Cell:** J5

**Comment:** 3006-10-01 - Run 1 (CHBr3) 2/12/00 16:35  
Original value (S) = 0 New value = -0.0709  
Poor peak curve fit. Data was refit by iterative curve fit procedure.

**Cell:** C11

**Comment:** 3006-10-01 - Run 1 (DCBAA) 2/12/00 16:32  
Original value (CoefA0) = 99999 New value = -0.022  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** D11

**Comment:** 3006-10-01 - Run 1 (DCBAA) 2/12/00 16:32  
Original value (CoefAf) = 99999 New value = 5.9145  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** E11

**Comment:** 3006-10-01 - Run 1 (DCBAA) 2/12/00 16:32  
Original value (CoefB) = 99999 New value = 248.3185  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** F11

**Comment:** 3006-10-01 - Run 1 (DCBAA) 2/12/00 16:32  
Original value (CoefD) = 99999 New value = 0.1448  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** J11

**Comment:** 3006-10-01 - Run 1 (DCBAA) 2/12/00 16:32  
Original value (S) = 0 New value = 0  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** C14

**Comment:** 3006-10-01 - Run 1 (HAA9) 2/12/00 16:34  
Original value (CoefA0) = 99999 New value = -0.514  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** D14

**Comment:** 3006-10-01 - Run 1 (HAA9) 2/12/00 16:34  
Original value (CoefAf) = 99999 New value = 47.3779  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** E14

**Comment:** 3006-10-01 - Run 1 (HAA9) 2/12/00 16:34  
Original value (CoefB) = 99999 New value = 120.1687  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** F14

**Comment:** 3006-10-01 - Run 1 (HAA9) 2/12/00 16:34  
Original value (CoefD) = 99999 New value = 0.1291  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** J14

**Comment:** 3006-10-01 - Run 1 (HAA9) 2/12/00 16:34  
Original value (S) = 0 New value = 0  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** C15

**Comment:** 3006-10-01 - Run 1 (MBAA) 2/12/00 16:30  
Original value (CoefA0) = 0 New value = 0  
Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** D15

**Comment:** 3006-10-01 - Run 1 (MBAA) 2/12/00 16:30  
Original value (CoefAf) = 0 New value = 3.95  
Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** E15

**Comment:** 3006-10-01 - Run 1 (MBAA) 2/12/00 16:30  
Original value (CoefB) = 0 New value = 0  
Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** F15

**Comment:** 3006-10-01 - Run 1 (MBAA) 2/12/00 16:30  
Original value (CoefD) = 0 New value = 0  
Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** J15

**Comment:** 3006-10-01 - Run 1 (MBAA) 2/12/00 16:30  
Original value (S) = 0 New value = -0.1703  
Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** C17

**Comment:** 3006-10-01 - Run 1 (TBAA) 2/12/00 16:39  
Original value (CoefA0) = 99999 New value = 0.644  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** D17

**Comment:** 3006-10-01 - Run 1 (TBAA) 2/12/00 16:39  
Original value (CoefAf) = 99999 New value = 6.2836  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** E17

**Comment:** 3006-10-01 - Run 1 (TBAA) 2/12/00 16:39  
Original value (CoefB) = 99999 New value = 7299.3545  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** F17

**Comment:** 3006-10-01 - Run 1 (TBAA) 2/12/00 16:39  
Original value (CoefD) = 99999 New value = 0.2258  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** J17

**Comment:** 3006-10-01 - Run 1 (TBAA) 2/12/00 16:39

Original value (S) = 0 New value = 0  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** C92

**Comment:** 3006-20-01 - Run 2 (CDBAA) 2/12/00 16:27  
Original value (CoefA0) = 99999 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** D92

**Comment:** 3006-20-01 - Run 2 (CDBAA) 2/12/00 16:27  
Original value (CoefAf) = 99999 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** E92

**Comment:** 3006-20-01 - Run 2 (CDBAA) 2/12/00 16:27  
Original value (CoefB) = 99999 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** F92

**Comment:** 3006-20-01 - Run 2 (CDBAA) 2/12/00 16:27  
Original value (CoefD) = 99999 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** J92

**Comment:** 3006-20-01 - Run 2 (CDBAA) 2/12/00 16:27  
Original value (S) = 0 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** K92

**Comment:** 3006-20-01 - Run 2 (CDBAA) 2/12/00 16:27  
Original value (t0) = 0 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** C99

**Comment:** 3006-20-01 - Run 2 (DCBAA) 2/12/00 16:25  
Original value (CoefA0) = 99999 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** D99

**Comment:** 3006-20-01 - Run 2 (DCBAA) 2/12/00 16:25  
Original value (CoefAf) = 99999 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** E99

**Comment:** 3006-20-01 - Run 2 (DCBAA) 2/12/00 16:25  
Original value (CoefB) = 99999 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** F99

**Comment:** 3006-20-01 - Run 2 (DCBAA) 2/12/00 16:25  
Original value (CoefD) = 99999 New value = 0

Fewer than 6 points above MRL. Step function applied.

**Cell:** J99

**Comment:** 3006-20-01 - Run 2 (DCBAA) 2/12/00 16:25  
Original value (S) = 0 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** K99

**Comment:** 3006-20-01 - Run 2 (DCBAA) 2/12/00 16:25  
Original value (t0) = 0 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** C102

**Comment:** 3006-20-01 - Run 2 (HAA9) 2/12/00 16:41  
Original value (CoefA0) = 99999 New value = -0.8263  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** D102

**Comment:** 3006-20-01 - Run 2 (HAA9) 2/12/00 16:41  
Original value (CoefAf) = 99999 New value = 36.3754  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** E102

**Comment:** 3006-20-01 - Run 2 (HAA9) 2/12/00 16:41  
Original value (CoefB) = 99999 New value = 63.8749  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** F102

**Comment:** 3006-20-01 - Run 2 (HAA9) 2/12/00 16:41  
Original value (CoefD) = 99999 New value = 0.074  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** J102

**Comment:** 3006-20-01 - Run 2 (HAA9) 2/12/00 16:41  
Original value (S) = 0 New value = 0  
Fewer than 6 points. Logistic function (type 1) applied.

**Cell:** C103

**Comment:** 3006-20-01 - Run 2 (MBAA) 2/12/00 16:40  
Original value (CoefA0) = 0 New value = 0  
Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** D103

**Comment:** 3006-20-01 - Run 2 (MBAA) 2/12/00 16:40  
Original value (CoefAf) = 0 New value = 6.83  
Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** E103

**Comment:** 3006-20-01 - Run 2 (MBAA) 2/12/00 16:40  
Original value (CoefB) = 0 New value = 0  
Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** F103

**Comment:** 3006-20-01 - Run 2 (MBAA) 2/12/00 16:40

Original value (CoefD) = 0 New value = 0

Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** J103

**Comment:** 3006-20-01 - Run 2 (MBAA) 2/12/00 16:40

Original value (S) = 0 New value = -0.7606

Fewer than 6 points above MRL. Peak curve/step function combination applied.

**Cell:** C104

**Comment:** 3006-20-01 - Run 2 (MCAA) 2/12/00 16:27

Original value (CoefA0) = 0 New value = 3.635

Fewer than 6 points above MRL. Step function applied.

**Cell:** D104

**Comment:** 3006-20-01 - Run 2 (MCAA) 2/12/00 16:27

Original value (CoefAf) = 0 New value = 0

Fewer than 6 points above MRL. Step function applied.

**Cell:** E104

**Comment:** 3006-20-01 - Run 2 (MCAA) 2/12/00 16:27

Original value (CoefB) = 0 New value = 0

Fewer than 6 points above MRL. Step function applied.

**Cell:** F104

**Comment:** 3006-20-01 - Run 2 (MCAA) 2/12/00 16:27

Original value (CoefD) = 0 New value = 0

Fewer than 6 points above MRL. Step function applied.

**Cell:** J104

**Comment:** 3006-20-01 - Run 2 (MCAA) 2/12/00 16:27

Original value (S) = 0 New value = 0

Fewer than 6 points above MRL. Step function applied.

**Cell:** K104

**Comment:** 3006-20-01 - Run 2 (MCAA) 2/12/00 16:27

Original value (t0) = 0 New value = 149.0417

Fewer than 6 points above MRL. Step function applied.

**Cell:** C105

**Comment:** 3006-20-01 - Run 2 (TBAA) 2/12/00 16:28

Original value (CoefA0) = 99999 New value = 5.195

Fewer than 6 points above MRL. Step function applied.

**Cell:** D105

**Comment:** 3006-20-01 - Run 2 (TBAA) 2/12/00 16:28

Original value (CoefAf) = 99999 New value = 0

Fewer than 6 points above MRL. Step function applied.

**Cell:** E105



**Comment:** 3006-20-01 - Run 2 (TBAA) 2/12/00 16:28  
Original value (CoefB) = 99999 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** F105

**Comment:** 3006-20-01 - Run 2 (TBAA) 2/12/00 16:28  
Original value (CoefD) = 99999 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** J105

**Comment:** 3006-20-01 - Run 2 (TBAA) 2/12/00 16:28  
Original value (S) = 0 New value = 0  
Fewer than 6 points above MRL. Step function applied.

**Cell:** K105

**Comment:** 3006-20-01 - Run 2 (TBAA) 2/12/00 16:28  
Original value (t0) = 0 New value = 53  
Fewer than 6 points above MRL. Step function applied.

## ICR Information

ID / ICR#: TX1010013 / 630  
 ICR Contact: Jim Greenlee  
 Phone No.: (713) 451-9910  
 Period: 4/14/98 - 10/5/98 (174 days)

## Design Information

Design TOC: 4 mg/L  
 Col Diameter: 101.6 mm

Full-Scale GAC Size: 8x30 US Std Mesh  
 Full-Scale particle dia.: 1.480 mm  
 Meas Dry Bed Density: 479.4 kg/m3

## Water Quality Summary

Influent	Mean	SD	Count	Min/Max
TOC	3.3	0.2	18	2.8 - 3.6
pH	7.2	0.2	18	6.9 - 7.6
UV254	0.063	0.007	18	0.046 - 0.073
SUVA	1.94	0.26	18	1.3 - 2.3
Bromide	126	24	18	109 - 179
SDS-TOX	262	39	18	185 - 355
SDS-THM4	89	14	16	55 - 106
SDS-HAA6	71	21	18	41 - 106
Ammonia	0.10	0.04	18	0.04 - 0.20

## Cumulative SDS Conditions

	Mean	SD	Count	Min/Max
Res (0)	0.79	0.13	51	0.55 - 1.00
Temp	25.5	2.0	51	21.1 - 30.0
pH	8.1	0.1	51	7.9 - 8.3
Time	18.0	0.1	51	18.0 - 18.5

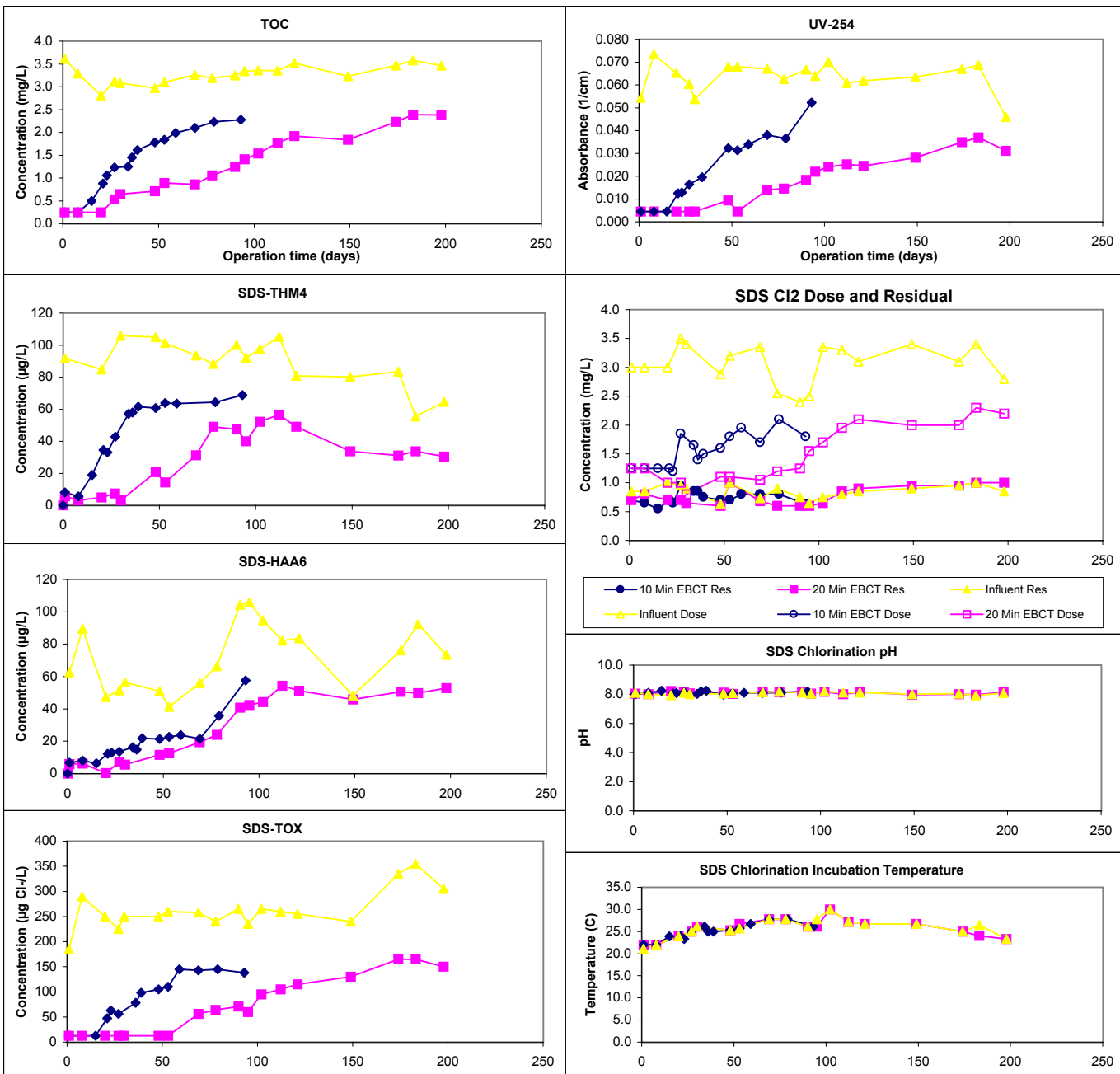
## Comments:

## Chart Legend:

10 Min EBCT  
 20 Min EBCT  
 Influent

Effluent	10 Min EBCT	20 Min EBCT
Effluent pH	7.3	7.3
Effluent Temp	25.3	26.6

## Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)

