

ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID 1065

Study Protocol GAC bench-scale treatment study

Plant ICR Number 220

PWS Name City of San Diego Water Utilities

City, State, Zip La Mesa, CA 91942

General comments:

1. This study examined DBP precursor removal using Calgon F-300 8x30 GAC. A 10 and 20 minute EBCT was examined. During the fifth quarter of testing only, a free-chlorine residual based test was used. Average SDS conditions were a 45-hour free chlorine residual of 0.6 mg/L, 25°C, and pH 7.5. However, several residuals for the 10 minute EBCT run were below 0.1 mg/L, especially towards the end of the run. The average free chlorine residual for the 10 minute EBCT run effluent samples was 0.40 mg/L, while that for the 20 minute EBCT run effluent samples was 0.85 mg/L.
2. During the first four quarters of testing, all SDS chlorination tests were based on the use of chloramines to provide a combined chlorine residual. Due to the lack of a free chlorine residual, DBP yields were low, and the DBP data produced during the four quarters should not be included in further data analysis with the treatment studies. A fifth quarter of testing was conducted using a free chlorine residual during SDS testing.
3. As discussed in the Summary Report, during the first four quarters of testing, the RSSCTs were operated only during normal working hours. Therefore, the RSSCTs were shut off for significant amounts of time. For example, during the first quarter, the total operation time for the 10 minute EBCT contactor was 359 days full-scale days. However, when stoppage time is taken into account, the total run time was 73 full-scale days, 20 percent of the total operation time. It is unknown whether the extended downtime periods impacted DBP precursor breakthrough. Therefore, the DBP precursor data obtained should not be utilized in further treatment study data analysis.
4. Due to the high average bromide level in the GAC influent during the fifth quarter (256 µg/L) formed DBP speciation shifted towards more brominated species. This bromide level is consistent with that measured during the first four quarters of testing.

Outlier Data:

One outlier removed.

Cell: A1

Comment: 1065-SAS.xls 2/21/00 09:10

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

Cell: C10

Comment: 1065-10-05 - Run 1 (DCAA) 2/21/00 08:59

Original value (CoefA0) = -1.61 New value = -0.4223

Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: D10

Comment: 1065-10-05 - Run 1 (DCAA) 2/21/00 08:59

Original value (CoefAf) = 4.83 New value = 2.9593

Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: E10

Comment: 1065-10-05 - Run 1 (DCAA) 2/21/00 08:59

Original value (CoefB) = 842.7548 New value = 3223.1249

Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: F10

Comment: 1065-10-05 - Run 1 (DCAA) 2/21/00 08:59

Original value (CoefD) = 0.4175 New value = 0.5019

Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: J10

Comment: 1065-10-05 - Run 1 (DCAA) 2/21/00 08:59

Original value (S) = 0 New value = 0

Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: C15

Comment: 1065-10-05 - Run 1 (MBAA) 2/21/00 09:00

Original value (CoefA0) = 0 New value = -0.1791

Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: D15

Comment: 1065-10-05 - Run 1 (MBAA) 2/21/00 09:00

Original value (CoefAf) = 0 New value = 1.8026

Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: E15

Comment: 1065-10-05 - Run 1 (MBAA) 2/21/00 09:00

Original value (CoefB) = 0 New value = 478.1919

Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: F15

Comment: 1065-10-05 - Run 1 (MBAA) 2/21/00 09:00

Original value (CoefD) = 0 New value = 0.2917

Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: J15

Comment: 1065-10-05 - Run 1 (MBAA) 2/21/00 09:00
Original value (S) = 0 New value = 0
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: C18

Comment: 1065-10-05 - Run 1 (TCAA) 2/21/00 09:01
Original value (CoefA0) = 0 New value = -0.4055
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: D18

Comment: 1065-10-05 - Run 1 (TCAA) 2/21/00 09:01
Original value (CoefAf) = 0 New value = 52.7617
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: E18

Comment: 1065-10-05 - Run 1 (TCAA) 2/21/00 09:01
Original value (CoefB) = 0 New value = 357.1548
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: F18

Comment: 1065-10-05 - Run 1 (TCAA) 2/21/00 09:01
Original value (CoefD) = 0 New value = 0.0696
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: J18

Comment: 1065-10-05 - Run 1 (TCAA) 2/21/00 09:01
Original value (S) = 0 New value = 0
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: C95

Comment: 1065-20-05 - Run 2 (CI2-D) 2/21/00 09:04
Original value (CoefA0) = 0.7238 New value = 0.2392
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: D95

Comment: 1065-20-05 - Run 2 (CI2-D) 2/21/00 09:04
Original value (CoefAf) = 1.96 New value = 2.7358
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: E95

Comment: 1065-20-05 - Run 2 (CI2-D) 2/21/00 09:04
Original value (CoefB) = 10 New value = 20.0944
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: F95

Comment: 1065-20-05 - Run 2 (CI2-D) 2/21/00 09:04
Original value (CoefD) = 0.174 New value = 0.0657
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: J95

Comment: 1065-20-05 - Run 2 (CI2-D) 2/21/00 09:04
Original value (S) = 0 New value = 0
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: C98

Comment: 1065-20-05 - Run 2 (DCAA) 2/21/00 09:03
Original value (CoefA0) = 0 New value = -0.2192
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: D98

Comment: 1065-20-05 - Run 2 (DCAA) 2/21/00 09:03
Original value (CoefAf) = 0 New value = 2.7474
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: E98

Comment: 1065-20-05 - Run 2 (DCAA) 2/21/00 09:03
Original value (CoefB) = 0 New value = 257.3084
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: F98

Comment: 1065-20-05 - Run 2 (DCAA) 2/21/00 09:03
Original value (CoefD) = 0 New value = 0.1701
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: J98

Comment: 1065-20-05 - Run 2 (DCAA) 2/21/00 09:03
Original value (S) = 0 New value = 0
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: C103

Comment: 1065-20-05 - Run 2 (MBAA) 2/21/00 08:56
Original value (CoefA0) = 0 New value = 1.42
Fewer than 6 points above MRL. Step function applied.

Cell: D103

Comment: 1065-20-05 - Run 2 (MBAA) 2/21/00 08:56
Original value (CoefAf) = 0 New value = 0
Fewer than 6 points above MRL. Step function applied.

Cell: E103

Comment: 1065-20-05 - Run 2 (MBAA) 2/21/00 08:56
Original value (CoefB) = 0 New value = 0
Fewer than 6 points above MRL. Step function applied.

Cell: F103

Comment: 1065-20-05 - Run 2 (MBAA) 2/21/00 08:56
Original value (CoefD) = 0 New value = 0
Fewer than 6 points above MRL. Step function applied.

Cell: J103

Comment: 1065-20-05 - Run 2 (MBAA) 2/21/00 08:56

Original value (S) = 0 New value = 0
Fewer than 6 points above MRL. Step function applied.

Cell: K103

Comment: 1065-20-05 - Run 2 (MBAA) 2/21/00 08:56
Original value (t0) = 0 New value = 38.9185
Fewer than 6 points above MRL. Step function applied.

Cell: C110

Comment: 1065-20-05 - Run 2 (TSUVA) 2/21/00 09:02
Original value (CoefA0) = -0.3567 New value = 1.0045
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: D110

Comment: 1065-20-05 - Run 2 (TSUVA) 2/21/00 09:02
Original value (CoefAf) = 3.7079 New value = 0.2775
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: E110

Comment: 1065-20-05 - Run 2 (TSUVA) 2/21/00 09:02
Original value (CoefB) = 1.505 New value = 19.9304
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: F110

Comment: 1065-20-05 - Run 2 (TSUVA) 2/21/00 09:02
Original value (CoefD) = 0.0222 New value = 0.1887
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: J110

Comment: 1065-20-05 - Run 2 (TSUVA) 2/21/00 09:02
Original value (S) = 0 New value = 0
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

ICR Information

ID / ICR#: CA3710020 / 220
 ICR Contact: Michael Williams
 Phone No.: (619) 668-3260
 Period: 5/21/98 - 6/30/98 (40 B-S days)

Design Information

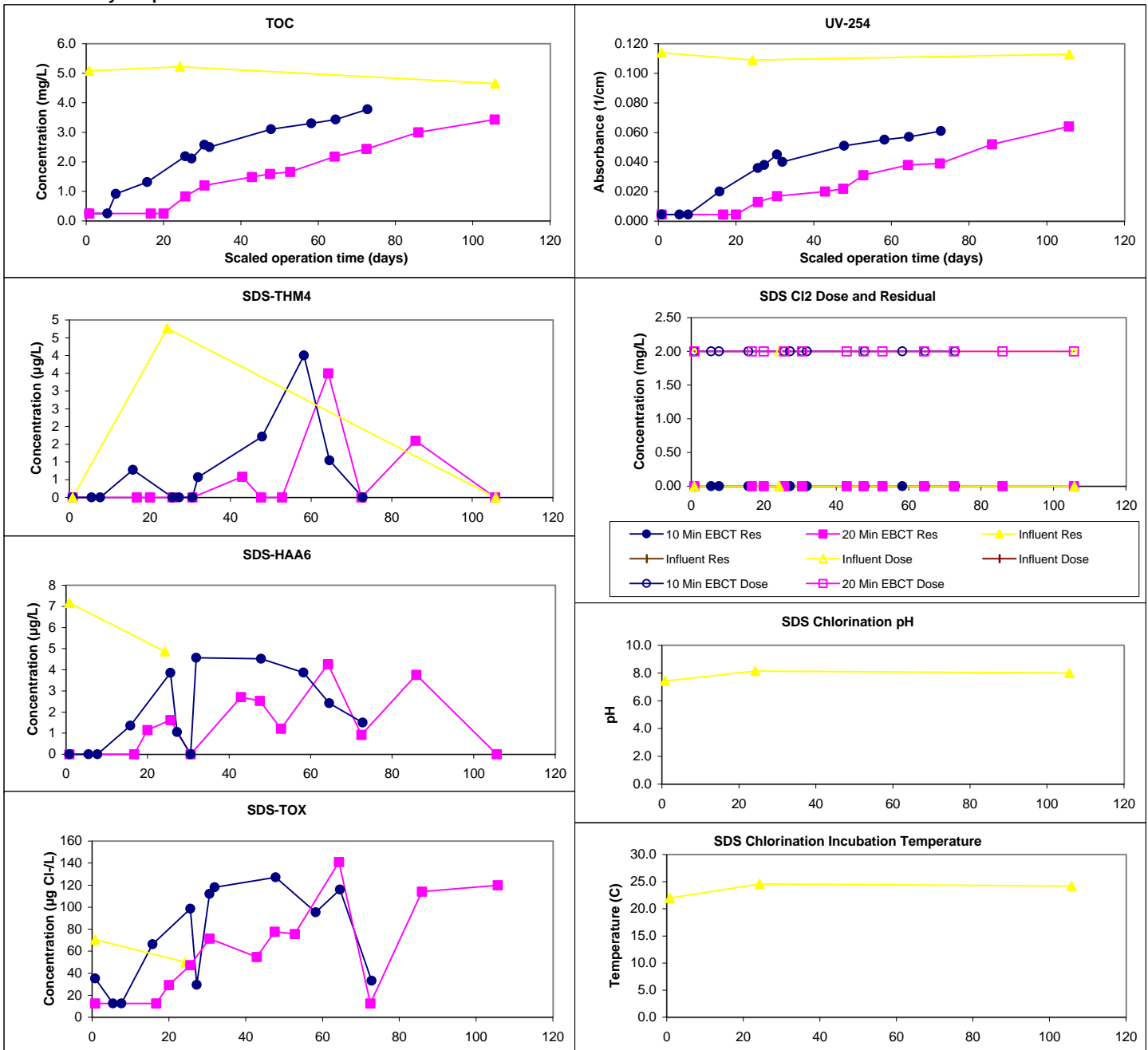
Design TOC: 5.5 mg/L
 Col Diameter: 15.0 mm
 Min Reynolds#: 0.50
 Full-Scale Temp: 20.3 C

Full-Scale GAC Size: 8x30 Bituminous
 Bench-Scale GAC Size: 100x200
 Scaling Factor: 13.16
 Meas Dry Bed Density: 0.50 g/cm3

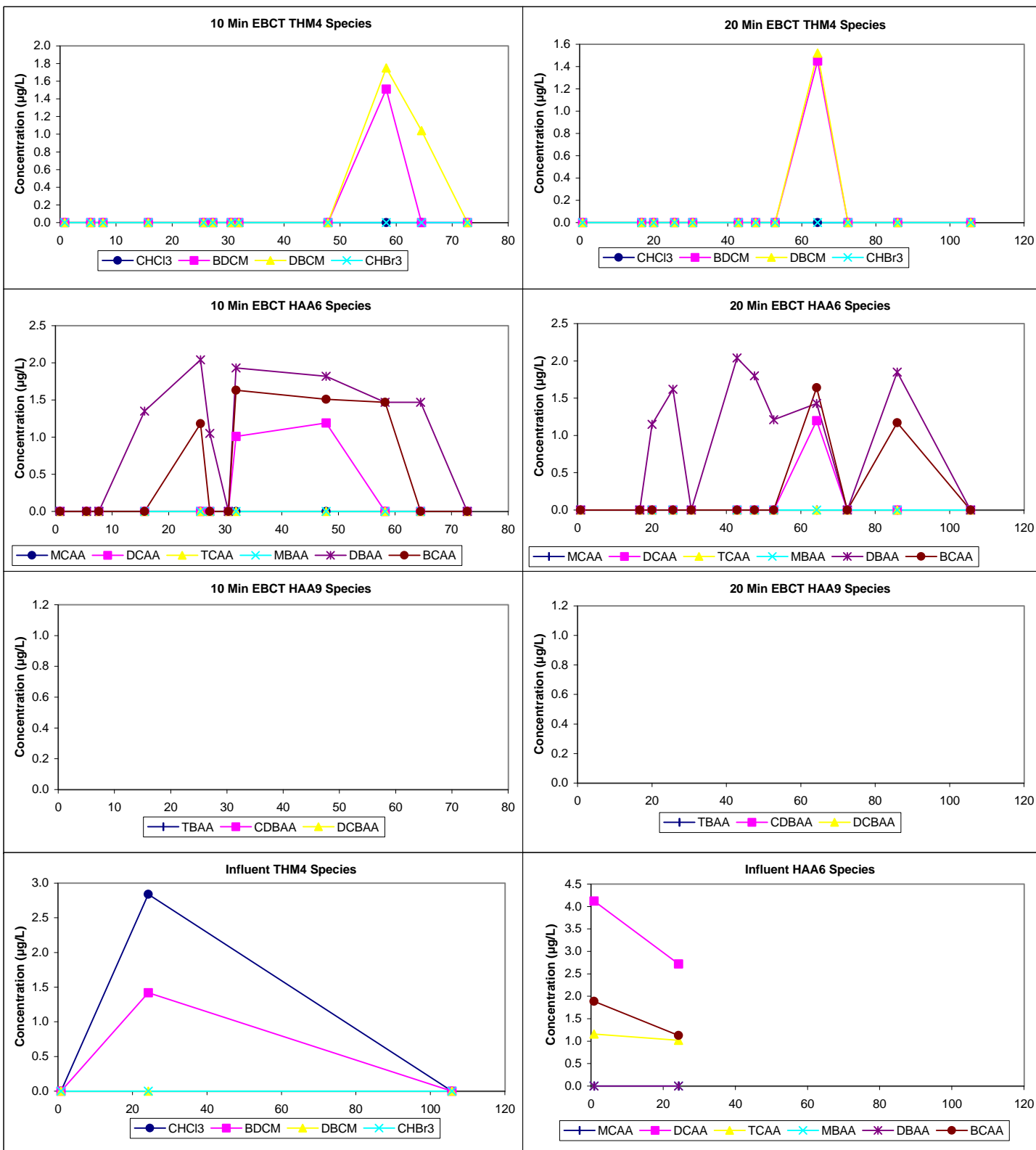
Water Quality Summary

	Influent				Influent									
Influent	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max		Mean	SD	Count	Min/Max	
TOC	5.0	0.3	3	4.7 - 5.2					Res (27)	0.00	0.00	27	0.00 - 0.00	
pH	7.8	0.4	3	7.3 - 8.1					Temp	23.6	1.4	3	22.0 - 24.6	
UV254	0.112	0.003	3	0.109 - 0.114					pH	7.9	0.4	3	7.4 - 8.1	
SUVA	2.25	0.17	3	2.09 - 2.43					Time	45.0	0.0	27	45.0 - 45.0	
Bromide	265	1	2	264 - 265					Comments:					
SDS-TOX	60	20	2	50 - 71										
SDS-THM4	2	3	3	0 - 5										
SDS-HAA6	6	2	2	5 - 7					<div><div><div></div><div>10 Min EBCT</div></div><div><div></div><div>20 Min EBCT</div></div><div><div></div><div>Influent</div></div><div><div></div><div>Influent</div></div></div> <div>Chart Legend:</div>					
Effluent	10 Min EBCT (27 B-S days)				20 Min EBCT (40 B-S days)									
Effluent pH	7.9	0.2	12	7.6 - 8.3	7.9	0.2	12	7.5 - 8.3						
Effluent Temp	24.0	0.8	12	22.0 - 24.7	24.2	1.0	12	22.0 - 26.2						

Water Quality Graphs



Water Quality Graphs (Continued)



ICR Information

ID / ICR#: CA3710020 / 220
 ICR Contact: Michael Williams
 Phone No.: (619) 668-3260
 Period: 8/17/98 - 9/17/98 (30 B-S days)

Design Information

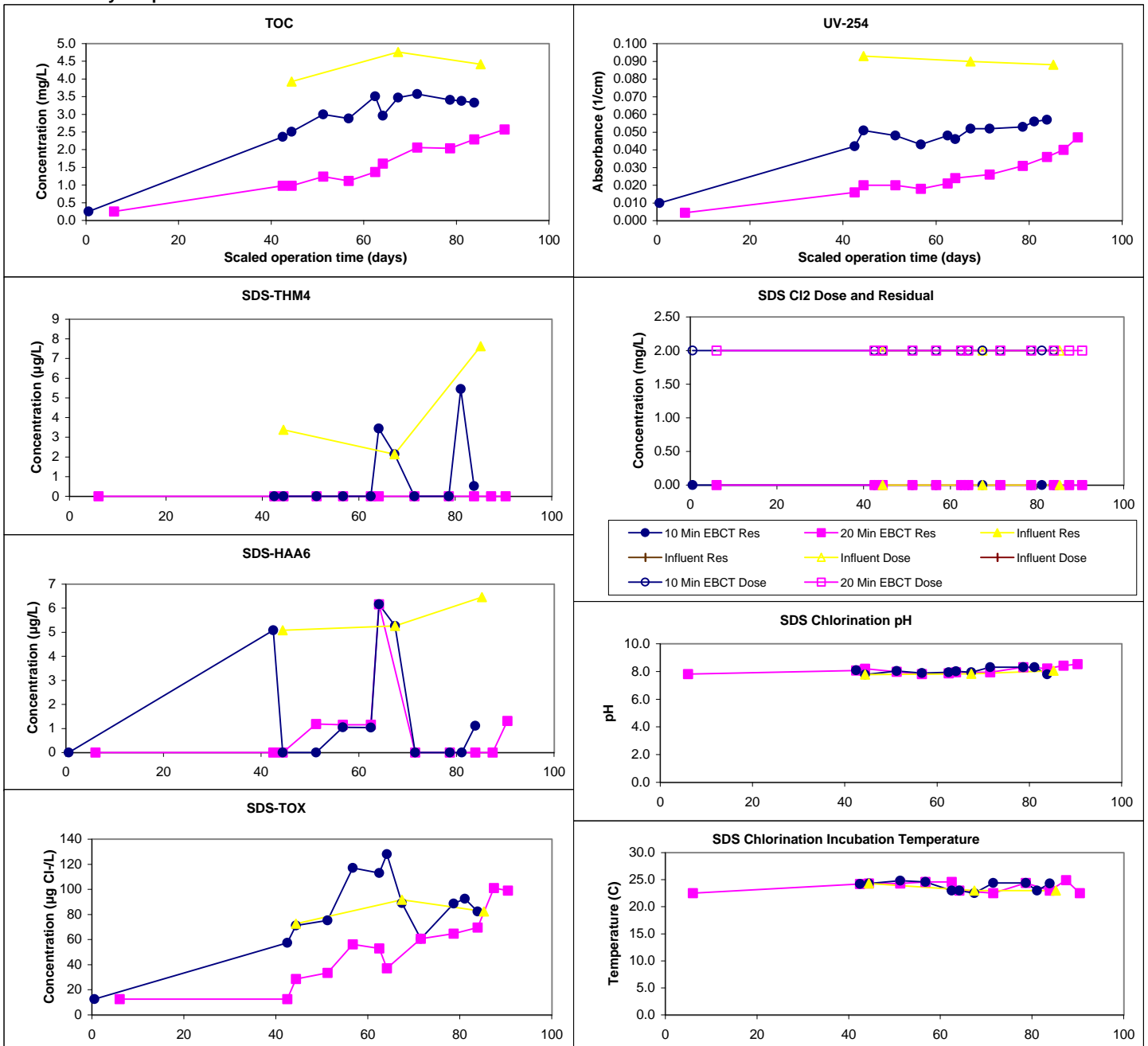
Design TOC: 5.5 mg/L
 Col Diameter: 15.0 mm
 Min Reynolds#: 0.50
 Full-Scale Temp: 20.3 C

Full-Scale GAC Size: 8x30 Bituminous
 Bench-Scale GAC Size: 100x200
 Scaling Factor: 13.16
 Meas Dry Bed Density: 0.50 g/cm3

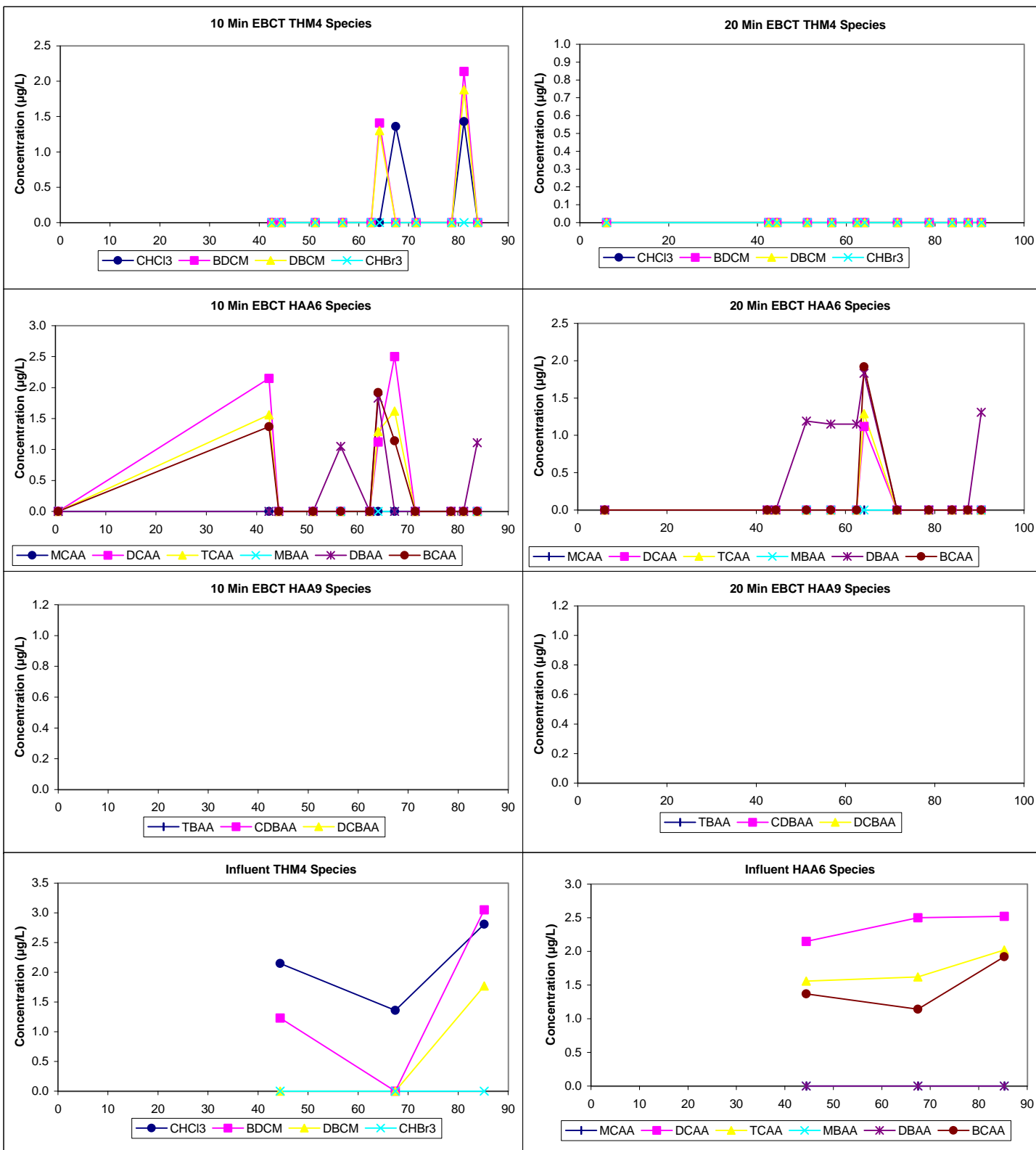
Water Quality Summary

	Influent					Influent									
Influent	Mean	SD/RD	Count	Min/Max		Mean	SD/RD	Count	Min/Max		Mean	SD	Count	Min/Max	
TOC	4.4	0.4	3	3.9 - 4.8						Res (27)	0.00	0.00	27	0.00 - 0.00	
pH	7.5	0.3	3	7.3 - 7.8						Temp	23.8	0.8	26	22.5 - 24.9	
UV254	0.090	0.003	3	0.088 - 0.093						pH	8.0	0.2	26	7.8 - 8.5	
SUVA	2.08	0.25	3	1.89 - 2.37						Time	45.0	0.3	26	44.5 - 46.3	
Bromide	243	3	2	241 - 244						Comments:					
SDS-TOX	82	10	3	73 - 92											
SDS-THM4	4	3	3	2 - 8											
SDS-HAA6	6	1	3	5 - 6						<div><div><div></div><div>10 Min EBCT</div></div><div><div></div><div>20 Min EBCT</div></div><div><div></div><div>Influent</div></div><div><div></div><div>Influent</div></div></div>					
Effluent	10 Min EBCT (24 B-S days)					20 Min EBCT (29 B-S days)									Chart Legend:
Effluent pH	7.6	0.2	12	7.3 - 7.8		7.6	0.3	12	7.3 - 8.2						
Effluent Temp	24.9	0.7	12	23.7 - 26.0		24.6	0.7	12	23.3 - 26.0						

Water Quality Graphs



Water Quality Graphs (Continued)



ICR Information

ID / ICR#: CA3710020 / 220
 ICR Contact: Michael Williams
 Phone No.: (619) 668-3260
 Period: 11/16/98 - 1/11/99 (55 B-S days)

Design Information

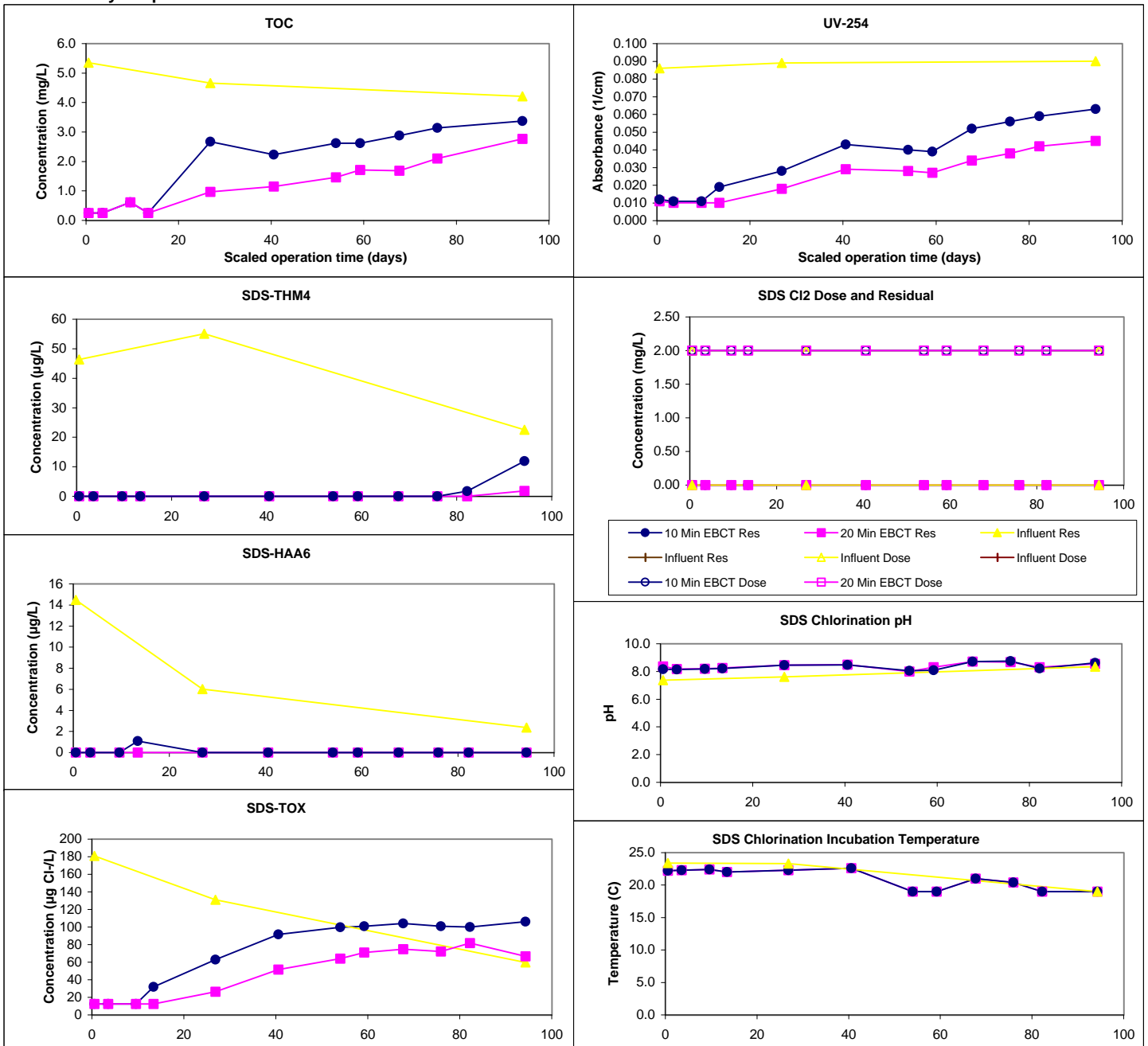
Design TOC: 5.5 mg/L
 Col Diameter: 15.0 mm
 Min Reynolds#: 0.50
 Full-Scale Temp: 20.3 C

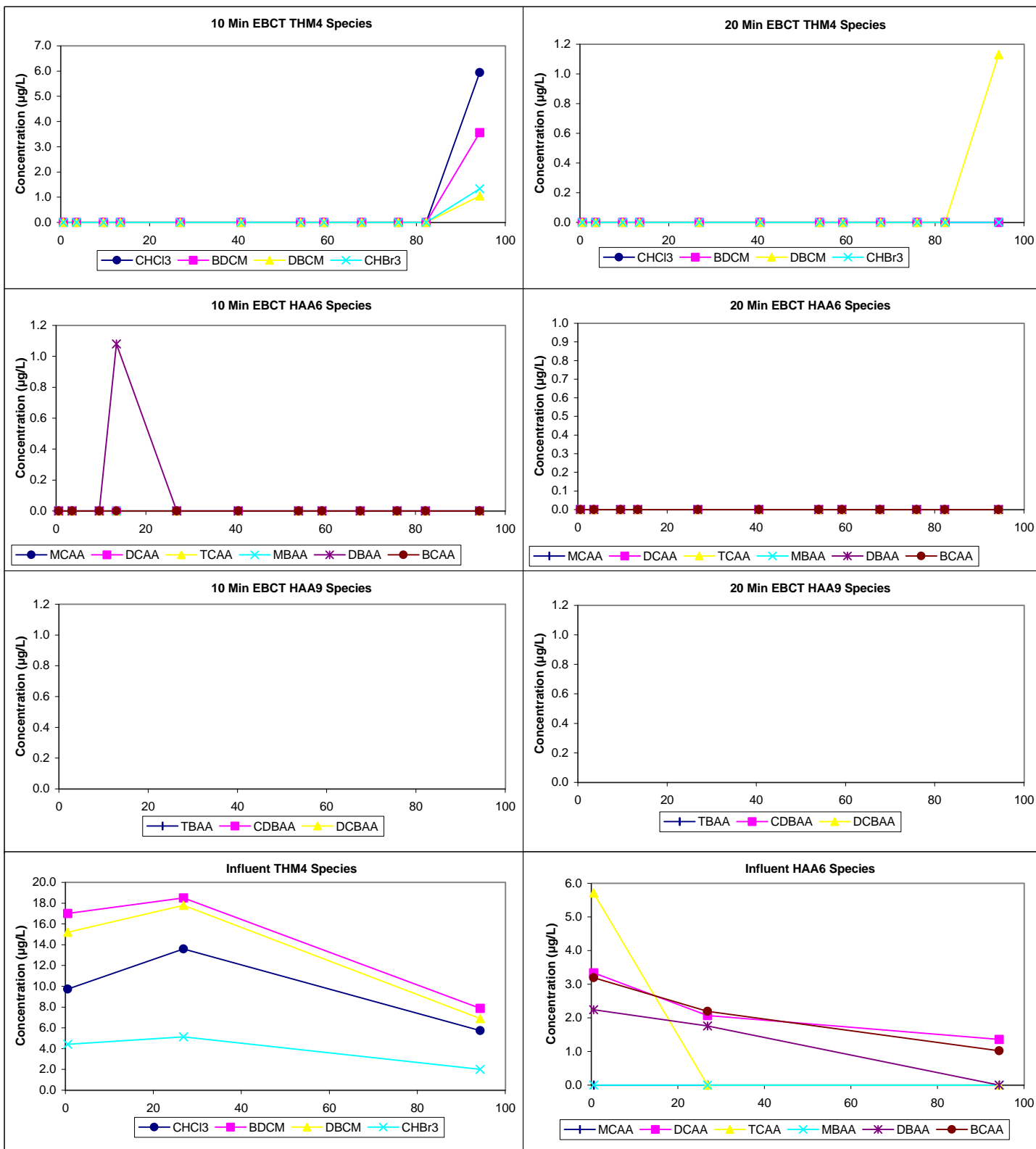
Full-Scale GAC Size: 8x30 Bituminous
 Bench-Scale GAC Size: 100x200
 Scaling Factor: 13.16
 Meas Dry Bed Density: 0.50 g/cm3

Water Quality Summary

	Influent				Influent								
Influent	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max		Mean	SD	Count	Min/Max
TOC	4.7	0.6	3	4.2 - 5.4					Res (27)	0.00	0.00	27	0.00 - 0.00
pH	7.8	0.5	3	7.4 - 8.4					Temp	21.0	1.6	27	19.0 - 23.4
UV254	0.088	0.002	3	0.086 - 0.090					pH	8.3	0.3	27	7.4 - 8.8
SUVA	1.89	0.27	3	1.61 - 2.14					Time	45.7	1.4	27	44.8 - 49.0
Bromide	169	58	2	140 - 198					Comments:				
SDS-TOX	124	61	3	60 - 181									
SDS-THM4	41	17	3	23 - 55									
SDS-HAA6	8	6	3	2 - 14									
Effluent	10 Min EBCT (56 B-S days)				20 Min EBCT (56 B-S days)				Chart Legend:				
Effluent pH	7.8	0.3	12	7.3 - 8.4	8.4	0.2	12	8.0 - 8.7		● 10 Min EBCT ■ 20 Min EBCT			
Effluent Temp	23.7	0.4	12	23.0 - 24.4	23.7	0.4	12	23.0 - 24.4		▲ Influent ✕ Influent			

Water Quality Graphs





ICR Information

ID / ICR#: CA3710020 / 220
 ICR Contact: Michael Williams
 Phone No.: (619) 668-3260
 Period: 2/8/99 - 3/26/99 (46 B-S days)

Design Information

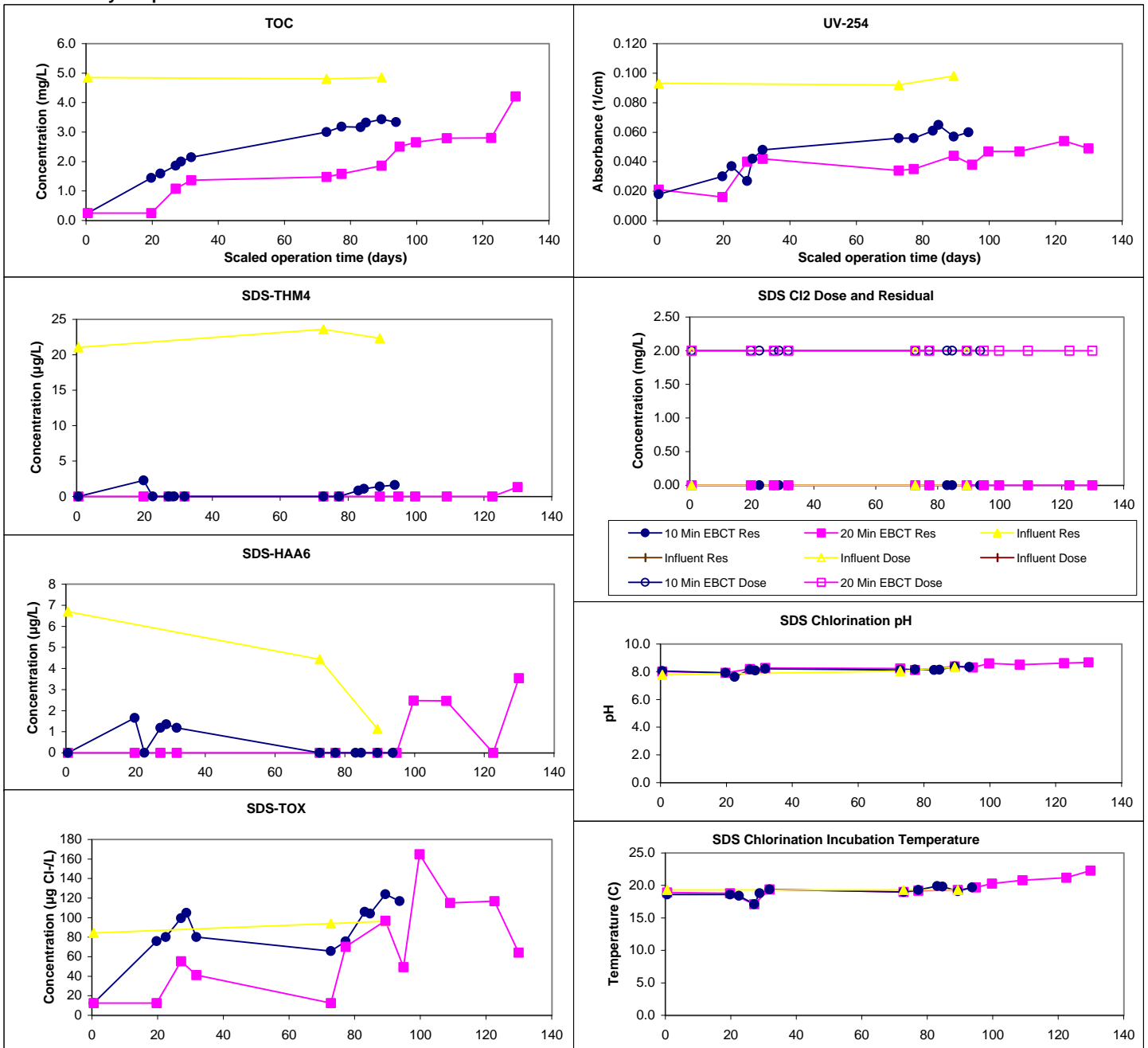
Design TOC: 5.5 mg/L
 Col Diameter: 15.0 mm
 Min Reynolds#: 0.50
 Full-Scale Temp: 20.3 C

Full-Scale GAC Size: 8x30 Bituminous
 Bench-Scale GAC Size: 100x200
 Scaling Factor: 13.16
 Meas Dry Bed Density: 0.50 g/cm3

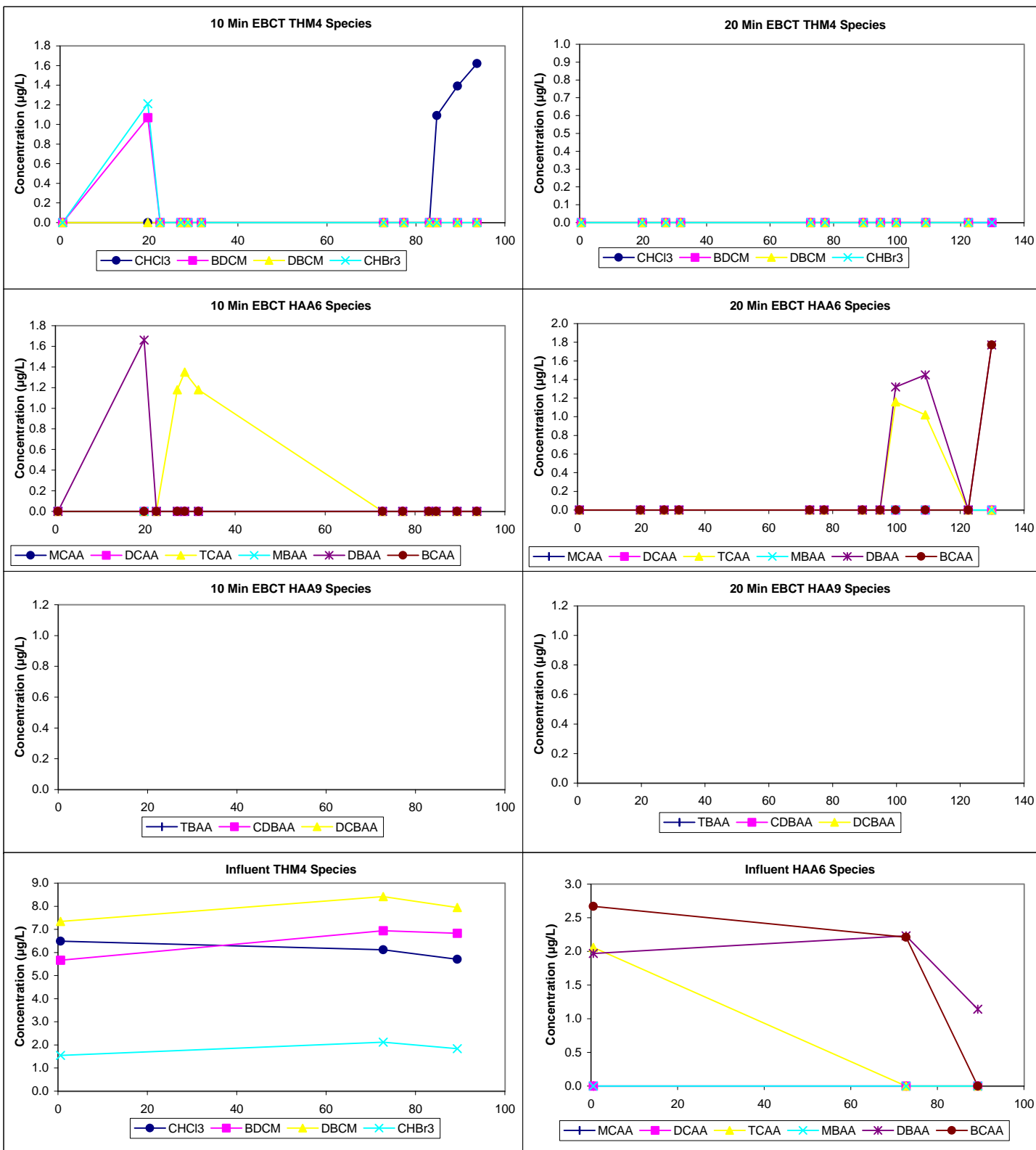
Water Quality Summary

	Influent				Influent								
Influent	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max		Mean	SD	Count	Min/Max
TOC	4.8	0.0	3	4.8 - 4.9					Res (27)	0.00	0.00	27	0.00 - 0.00
pH	7.5	0.1	3	7.5 - 7.7					Temp	19.3	1.1	27	17.1 - 22.3
UV254	0.094	0.003	3	0.092 - 0.098					pH	8.2	0.2	27	7.6 - 8.7
SUVA	1.95	0.06	3	1.91 - 2.02					Time	45.1	0.3	26	45.0 - 46.0
Bromide	229	0	2	229 - 229					Comments:				
SDS-TOX	91	6	3	84 - 96									
SDS-THM4	22	1	3	21 - 24									
SDS-HAA6	4	3	3	1 - 7									
Effluent	10 Min EBCT (22 B-S days)				20 Min EBCT (46 B-S days)				Chart Legend:				
Effluent pH	7.7	0.2	12	7.5 - 8.0	7.8	0.2	12	7.5 - 8.2					
Effluent Temp	23.6	0.6	12	22.7 - 24.3	24.2	1.3	12	22.4 - 26.2					

Water Quality Graphs



Water Quality Graphs (Continued)



ICR Information

ID / ICR#: CA3710020 / 220
 ICR Contact: Michael Williams
 Phone No.: (619) 668-3260
 Period: 7/13/99 - 7/19/99 (6 B-S days)

Design Information

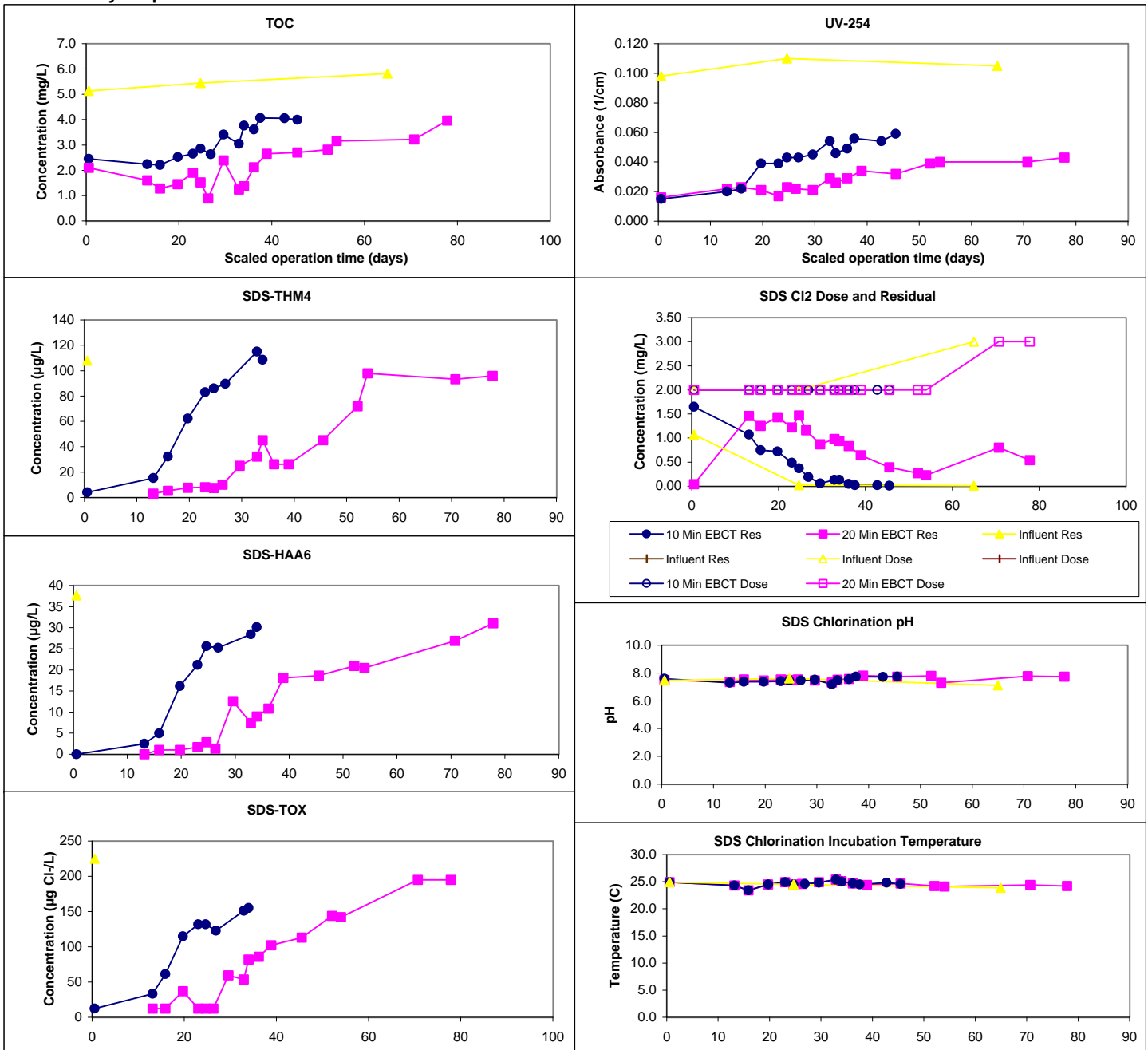
Design TOC: 5.5 mg/L
 Col Diameter: 15.0 mm
 Min Reynolds#: 0.50
 Full-Scale Temp: 20.3 C

Full-Scale GAC Size: 8x30 Bituminous
 Bench-Scale GAC Size: 100x200
 Scaling Factor: 13.16
 Meas Dry Bed Density: 0.50 g/cm3

Water Quality Summary

	Influent				Influent								
Influent	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max		Mean	SD	Count	Min/Max
TOC	5.5	0.3	3	5.1 - 5.8					Res (8)	0.63	0.53	33	0.01 - 1.65
pH	7.4	0.3	3	7.1 - 7.6					Temp	24.6	0.4	34	23.4 - 25.4
UV254	0.104	0.006	3	0.098 - 0.110					pH	7.5	0.2	34	7.1 - 7.8
SUVA	1.91	0.11	3	1.80 - 2.02					Time	45.0	0.0	34	45.0 - 45.0
Bromide	256	13	2	249 - 262					Comments:				
SDS-TOX	225	0	1	225 - 225									
SDS-THM4	108	0	1	108 - 108									
SDS-HAA6	38	0	1	38 - 38									
Effluent	10 Min EBCT (3 B-S days)				20 Min EBCT (6 B-S days)				Chart Legend: <div><div>● 10 Min EBCT</div><div>■ 20 Min EBCT</div><div>▲ Influent</div><div>✕ Influent</div></div>				
Effluent pH	7.2	0.1	14	7.0 - 7.4	7.4	0.2	17	7.0 - 7.6					
Effluent Temp	24.5	0.5	14	23.5 - 25.2	24.5	0.4	17	23.6 - 25.2					

Water Quality Graphs



Water Quality Graphs (Continued)

