

ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID	1017
Study Protocol	Membrane Pilot-Scale treatment study
Plant ICR Number	302
PWS Name	Miami Dade Water and Sewer Department
City, State, Zip	Coral Gables, FL 33146

General Comments:

1. The plant currently uses air stripping to remove vinyl chloride and THMs formed during a short contact time with free chlorine. This process does not effectively remove HAAs formed during contact with chlorine.
2. The organization of data in the Data Collection Spreadsheets is summarized in Table 3-8 of the Summary Report.
3. A three stage pilot system, designed as a 2-1-1 array, was used during this study. In the first and second stage, 4-inch diameter elements were used (Fluid Systems TFC 4921S); while in the third stage 2.5-inch diameter elements were used (Fluid Systems SC 2540S). The two different membrane models are reported as being very similar in characteristics, although the SC is somewhat looser. A booster pump was used to increase the pressure of the concentrate stream from Stage 2 as it entered Stage 3.
4. In November of 1997, it was determined that some of the membrane modules had severe damage. Seven of the twenty-four membrane elements were replaced at this time.
5. Based on water quality considerations, it would be feasible to blend nanofiltration permeate with lime softened water. However, the area around the Hialeah and Preston plants is built-up leaving little room for expansion. There is space to construct a nanofiltration facility at the Northwest Wellfield. Two possible methods identified for concentrate disposal include deep well injection and discharge to brackish/saline tidewater.
6. In section 4.5 of the Summary Report, capital and O&M costs are estimated for three different alternatives involving nanofiltration technology.

Water Quality Comments:

1. 11 water quality outliers were removed from this study prior to base analysis.
2. In January 1998, the feed water was changed from the composite plant influent (from the entire wellfield), to a single dedicated well. This resulted in some changes in feed water quality (see alkalinity and hardness plots in Figures 4-10 and 4-11 of the Summary Report).
3. Note that the water quality data from this study was segregated based on this change in influent water. The first TSSRunID contains a summary of water quality data when the composite influent served as the source while the second TSSRunID summarizes the water quality data obtained when the single well served as the source.
4. During SDS testing, the free chlorine residual ranged from 0.3 to 1.9 mg/L, the incubation temperature ranged from 23 to 27°C, the pH ranged from 5.5 to 6.9, and the incubation time was 48 hours for the first 12 weeks and was changed to 9 hours from week 14 (10/22/97) through the end of the study.
5. A site-specific calibration was used to convert conductivity readings to TDS concentrations for each stream in the pilot system. The average correlation parameters are listed in Table 3-7 of the Summary Report.
6. This utility reported some permeate bromide concentrations that were below the reported MRL in the SRSS.

Productivity Comments:

1. 0 productivity outliers were removed from this study.
2. Due to the use of inter-stage pumping between stages 2 and 3, it is necessary to conduct productivity analysis on a stage-by-stage basis.
3. During the first five months of the study, feed water for the membrane system was obtained from the composite raw water main entering the plant. Several severe fouling episodes occurred during this five month period due to precipitation of iron hydroxide (see Section 4.1 of the Summary Report). It is hypothesized that this occurred when air entered the feed water at the wellheads. To mitigate this problem, a single well was dedicated to the pilot system from January 1998 through the final seven months of the study. No major fouling event occurred after this change was made.
4. During productivity analysis, cleaning intervals were projected to exceed two years in the system and all three individual stages. This analysis was performed on the productivity data in the period of stable performance – after the single well was used as the influent source for the study. In the Summary Report, the consultant projected a cleaning interval of six to eight months based on the productivity data gathered prior to the use of a dedicated well – when problems with iron hydroxide fouling were occurring. However, an important fouling mitigation strategy would be well rehabilitation to minimize the entrainment of oxygen.

Based on this consideration, it was felt that the use of productivity data during operation with the dedicated well was appropriate. Since the projected cleaning interval exceeded one-year, the upper bound of 365 days was used as the cleaning interval for all three stages. This upper-bound of one year serves as the minimum cleaning frequency necessary to mitigate problems beyond flux loss that can result from membrane fouling.

5. All membrane cleanings were performed with a solution adjusted to $\text{pH} = 2.5$ with citric acid.

ICR Information

ID / ICR#: FL 4130871 / 302
 ICR Contact: Mr. Tom Segars
 Phone No.: (305) 888-2522
 Period: 7/7/97 - 9/5/97 (60 days)

Membrane Information

Manufacturer: Fluid Systems
 Trade Name: TFC-S
 Membrane Model: TFC 4921S
 MWCO: 300 Daltons
 Element Size: 4" x 40"
 Element Area: 78.0 ft²
 Design Flux: 20.5 gfd
 Mfr. NDP: 70.0 psi
 Mfr. MTC_w: 0.293 (gfd/psi)
 Mfr. Temp: 25.0 °C
 Maximum Flow: 10.0 gpm
 Minimum Flow: 6.5 gpm
 Total Width : 13.2 ft
 Feed Spacer Thickness: 0.0026 ft
 840 Element Area 330.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 26.0 °C
 Temp Norm MTC-w: 0.302 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 15.0 gfd
 # of Elem in P.V.: 6
 # Pres Ves in Stg 1: 2
 # Pres Ves in Stg 2: 1
 Pres Ves in Stg 3: 1
 Design Flux: 15.0 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 8.9 psi
 Osmotic P Stage 2: 13.4 psi
 Osmotic P Stage 3: 18.6 psi

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)					
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max		
pH	7.1	0.1	3	7.0 - 7.2	6.3	0.1	3	6.2 - 6.4	7.5	0.1	3	7.4 - 7.7		
Temp	25.0	0.6	3	24.4 - 25.5	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0		
Alk	207	12	3	198 - 221	28	3	3	26 - 31	896	117	3	764 - 988		
TDS	382	4	3	379 - 386	69	3	3	67 - 73	1402	118	3	1266 - 1477		
TotHard	227	6	3	221 - 233	20	3	3	18 - 23	1034	95	3	926 - 1100		
CaHard	196	8	3	187 - 201	18	1	3	17 - 19	907	93	3	801 - 972		
Turb	0.11	0.0	3	0.09 - 0.12	0.01	0.0	3	0.00 - 0.02	26.67	6.7	3	19.00 - 31.00		
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0		
TOC	19.5	4.4	3	15.0 - 23.8	0.9	0.6	3	0.3 - 1.5	71.0	9.1	3	60.7 - 77.9		
UV254	0.539	0.1	3	0.458 - 0.669	0.012	0.0	3	0.011 - 0.013	0.924	0.0	3	0.900 - 0.943		
SUVA	2.86	0.81	3	1.92 - 3.38	2.18	1.93	3	0.88 - 4.40	1.31	0.15	3	1.21 - 1.48		
Bromide	170	10	3	159 - 180	38	4	3	34 - 41						
TOX	NA	NA	0	0 - 0	13	NA	1	13 - 13						
CHCl3	NA	NA	0	NA	2.7	NA	1	2.7 - 2.7	Mass Balance					
BDCM	NA	NA	0	NA	2.9	NA	1	2.9 - 2.9	Closure Errors (%)					
DBCM	NA	NA	0	NA	0.0	NA	1	0.0 - 0.0	WQP	Count	Avg	SD/RD		
CHBr3	NA	NA	0	NA	0.0	NA	1	0.0 - 0.0	Alk	3	-19	23		
THM4	NA	NA	0	NA	5.6	NA	1	5.6 - 5.6	TDS	3	-33	24		
MCAA	NA	NA	0	NA	0.0	NA	1	0.0 - 0.0	TotHard	3	-17	20		
DCAA	NA	NA	0	NA	1.9	NA	1	1.9 - 1.9	CaHard	3	-15	19		
TCAA	NA	NA	0	NA	2.5	NA	1	2.5 - 2.5	Turb	2	98	1		
MBAA	NA	NA	0	NA	0.0	NA	1	0.0 - 0.0	Amm	0	n/a	n/a		
DBAA	NA	NA	0	NA	1.1	NA	1	1.1 - 1.1	TOC	3	-52	35		
BCAA	NA	NA	0	NA	2.0	NA	1	2.0 - 2.0	UV254	3	-229	96		
TBAA	NA	NA	0	NA	0.0	NA	1	0.0 - 0.0	TDS _t	98	17	9		
CDBAA	NA	NA	0	NA	2.5	NA	1	2.5 - 2.5	Comments:					
DCBAA	NA	NA	0	NA	4.2	NA	1	4.2 - 4.2						
HAA5	NA	NA	0	NA	5.5	NA	1	5.5 - 5.5						
HAA6	NA	NA	0	NA	7.5	NA	1	7.5 - 7.5						
HAA9	NA	NA	0	NA	14.2	NA	1	14.2 - 14.2						
SDS Conditions					Pretreatment Information									
WQP	Avg	SD	Count	Min - Max	Process		Description				Scale			
Res (0)	0.64	#DIV/0!	1	0.64 - 0.64	Antiscalant Addition		King Lee Pre-treat 100 (2 mg/L dose)				Pilot Scale			
Temp (°C)	23.0	#DIV/0!	1	23.0 - 23.0	Sulfuric Acid Addition		pH ~ 6.75 (85 mg/L dose)				Pilot Scale			
pH (unit)	6.5	#DIV/0!	1	6.5 - 6.5	Cartridge Filtration		5 um exclusion size				Pilot Scale			
Time (hr)	48.0	#DIV/0!	1	48.0 - 48.0										

Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	0.0%	0.3%	Sys Conc - Stg 3 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	-3.9%	11.6%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Stg 2 Conc - Stg 3 Inf	-89.1%	15.1%	Stg 2 Conc - Stg 3 Inf	5.8%	17.7%	Stg 2 Conc - Stg 3 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Per	-19.3%	2.1%	Sys Perm - Avg Stg Perm	-32.2%	16.8%

Stage Summary

	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.53	0.04	3	0.49 - 0.57					
pH	7.1	7.5	7.1	0.1	3	7.0 - 7.2	6.3	6.2	0.1	3	6.1 - 6.4
Temp	25.0	NA	25.3	0.4	2	25.0 - 25.5	NA	NA	NA	0	0.0 - 0.0
Alk	207	896	207	12	3	198 - 221	28	21	2	3	19 - 22
TDS	382	1402	382	4	3	379 - 386	69	58	11	3	51 - 71
TotHard	227	1034	227	6	3	221 - 233	20	13	2	3	12 - 16
CaHard	196	907	196	8	3	187 - 201	18	12	0	3	12 - 12
Turb	0.11	26.67	0.11	0	3	0.09 - 0.12	0.01	0.07	0.07	3	0 - 0
TOC	19.5	71.0	19.5	4.4	3	15.0 - 23.8	0.9	0.6	0.6	3	0.3 - 1.3
UV254	0.539	0.924	0.539	0.114	3	0.458 - 0.669	0.012	0.016	0.002	3	0.014 - 0.017
SUVA	2.86	1.31	2.86	0.81	3	1.92 - 3.38	2.18	4.76	3.19	3	1.09 - 6.80

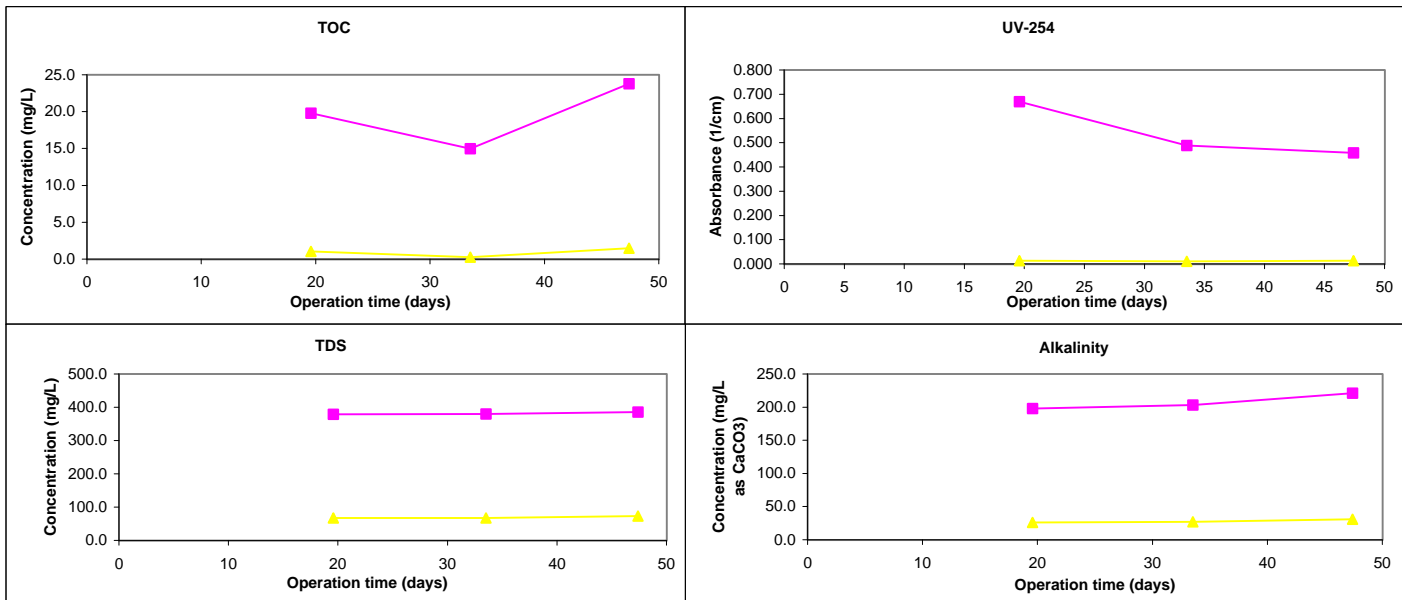
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.38	0.03	3	0.36 - 0.41					
pH	7.1	7.5	7.3	0.1	3	7.2 - 7.5	6.3	6.5	0.1	3	6.4 - 6.7
Temp	25.0	NA	NA	NA	0	0.0 - 0.0	NA	NA	NA	0	0.0 - 0.0
Alk	207	896	415	29	3	387 - 444	28	57	5	3	54 - 62
TDS	382	1402	713	14	3	697 - 722	69	128	7	3	123 - 136
TotHard	227	1034	464	14	3	448 - 476	20	45	6	3	42 - 52
CaHard	196	907	405	15	3	387 - 415	18	40	4	3	37 - 44
Turb	0.11	26.67	2.76	1	3	1.78 - 4.10	0.01	0.01	0.01	3	0 - 0
TOC	19.5	71.0	26.3	6.3	3	19.8 - 32.4	0.9	1.6	0.8	3	0.7 - 2.3
UV254	0.539	0.924	0.788	0.103	3	0.669 - 0.850	0.012	0.027	0.009	3	0.019 - 0.037
SUVA	2.86	1.31	3.06	0.39	3.00	2.62 - 3.38	2.18	1.91	0.71	3.00	1.38 - 2.71

	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.41	0.03	3	0.38 - 0.44					
pH	7.1	7.5	7.4	0.1	3	7.3 - 7.5	6.3	6.5	0.2	3.0	6.3 - 6.7
Temp	25.0	NA	25.7	0.4	2	25.4 - 26.0	NA	NA	NA	0	0.0 - 0.0
Alk	207	896	575	53	3	515 - 618	28	38	5	3	34 - 44
TDS	382	1402	946	52	3	887 - 986	69	99	13	3	89 - 114
TotHard	227	1034	646	47	3	592 - 678	20	25	7	3	19 - 32
CaHard	196	907	567	44	3	518 - 603	18	22	6	3	18 - 28
Turb	0.11	26.67	10.83	3	3	8.90 - 13.70	0.01	0.01	0.01	3	0 - 0
TOC	19.5	71.0	45.0	7.3	3	37.2 - 51.8	0.9	0.7	0.5	3	0.3 - 1.2
UV254	0.539	0.924	0.925	0.052	3	0.872 - 0.975	0.012	0.007	0.005	3	0.005 - 0.013
SUVA	2.86	1.31	2.09	0.35	3.00	1.88 - 2.49	2.18	1.35	0.84	3.00	0.38 - 1.86

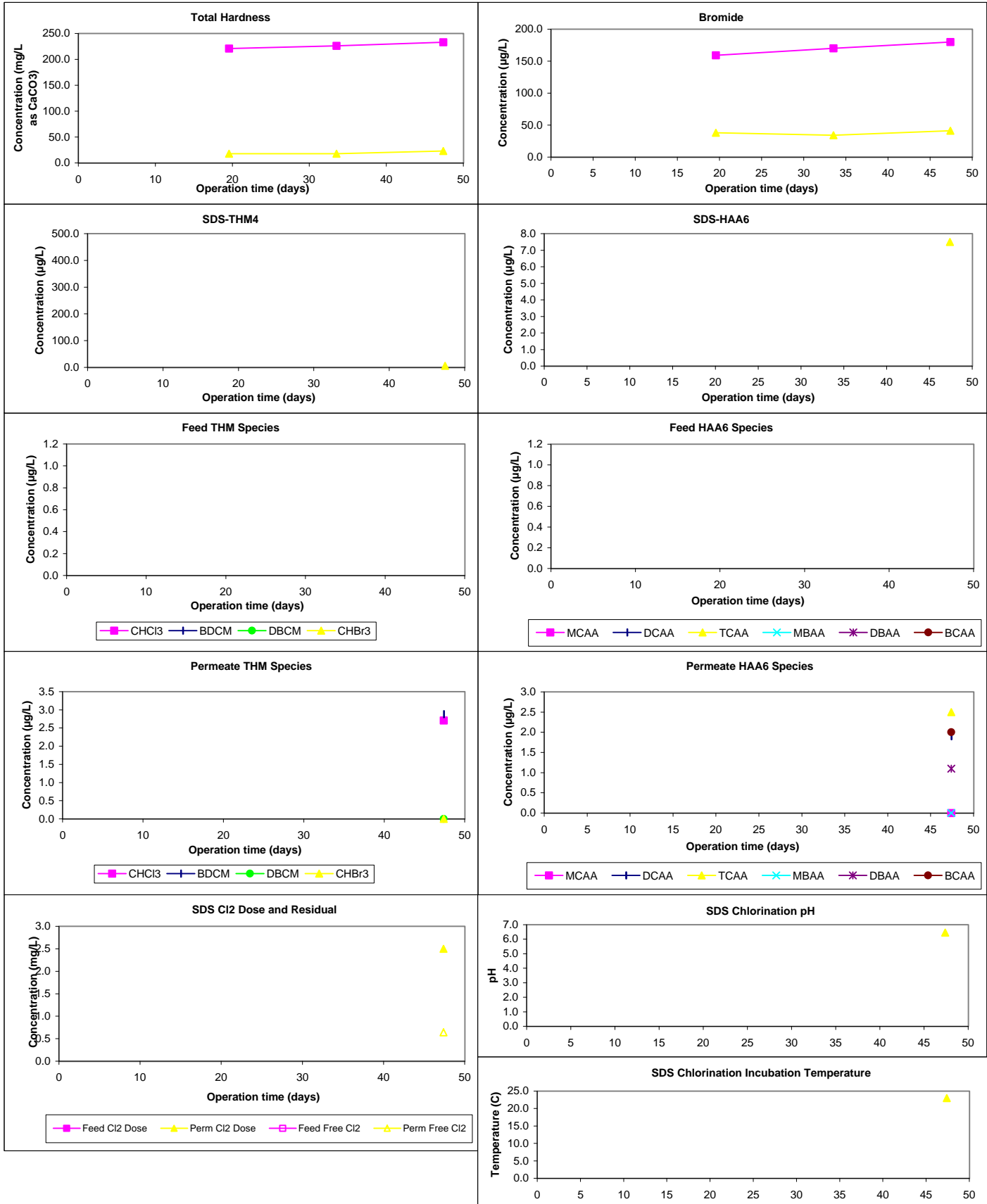
Chart Legend:

■ Feed (System)
▲ Permeate (System)

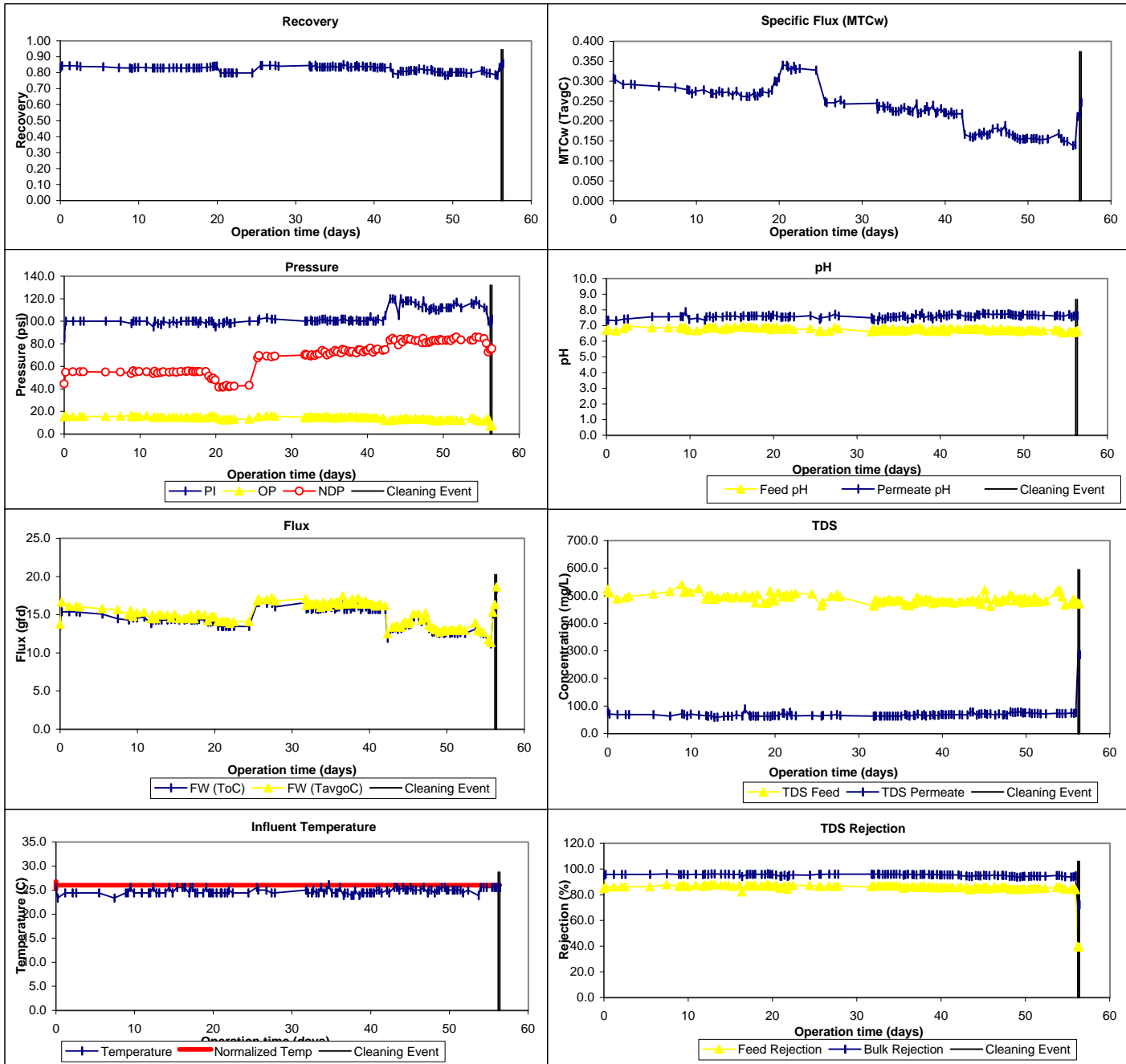
Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL 4130871 / 302
 ICR Contact: Mr. Tom Segars
 Phone No.: (305) 888-2522
 Period: 10/3/97 - 10/26/98 (388 days)

Membrane Information

Manufacturer: Fluid Systems
 Trade Name: TFC-S
 Membrane Model: TFC 4921S
 MWCO: 300 Daltons
 Element Size: 4" x 40"
 Element Area: 78.0 ft²
 Design Flux: 20.5 gfd
 Mfr. NDP: 70.0 psi
 Mfr. MTC_w: 0.293 (gfd/psi)
 Mfr. Temp: 25.0 °C
 Maximum Flow: 10.0 gpm
 Minimum Flow: 6.5 gpm
 Total Width : 13.2 ft
 Feed Spacer Thickness: 0.0026 ft
 840 Element Area 330.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 26.0 °C
 Temp Norm MTC-w: 0.302 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 15.0 gfd
 # of Elem in P.V.: 6
 # Pres Ves in Stg 1: 2
 # Pres Ves in Stg 2: 1
 Pres Ves in Stg 3: 1
 Design Flux: 15.0 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 8.9 psi
 Osmotic P Stage 2: 13.4 psi
 Osmotic P Stage 3: 18.6 psi

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)				
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	
pH	6.7	0.3	5	6.5 - 7.1	6.3	0.6	5	5.8 - 7.3	7.1	0.3	5	6.9 - 7.6	
Temp	24.5	0.6	5	23.8 - 25.5	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0	
Alk	156	42	5	116 - 224	35	10	4	21 - 45	652	197	5	492 - 996	
TDS	375	30	5	322 - 398	139	131	5	64 - 371	1287	54	5	1224 - 1353	
TotHard	222	19	5	188 - 235	69	85	5	19 - 222	1030	96	5	923 - 1130	
CaHard	197	10	5	180 - 204	62	63	5	18 - 170	911	93	5	812 - 1024	
Turb	0.17	0.1	5	0.06 - 0.38	0.21	0.4	5	0.00 - 0.94	19.09	11.4	5	0.60 - 31.80	
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0	
TOC	11.1	3.1	5	6.5 - 15.3	0.7	0.3	5	0.3 - 1.1	50.3	14.8	5	31.3 - 68.3	
UV254	0.384	0.1	5	0.214 - 0.573	0.024	0.0	5	0.005 - 0.038	1.135	0.5	5	0.688 - 1.962	
SUVA	3.42	0.22	5	3.20 - 3.76	3.05	1.20	5	1.80 - 4.93	2.40	1.16	5	1.25 - 4.03	
Bromide	142	37	5	78 - 170	54	29	5	17 - 97					
TOX	743	294	5	335 - 1160	39	26	5	13 - 66					
CHCl3	81.2	42.1	5	35.8 - 145.0	2.1	1.4	5	0.0 - 3.3	Mass Balance Closure Errors (%)				
BDCM	27.8	5.2	5	19.0 - 31.5	2.1	1.6	5	0.0 - 3.9					
DBCM	4.1	2.9	5	0.0 - 7.5	1.5	1.1	5	0.0 - 3.1	WQP	Count	Avg	SD/RD	
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	4	-10	10	
THM4	113.0	45.3	5	57.9 - 175.6	5.7	4.0	5	0.0 - 10.3	TDS	5	-16	48	
MCAA	4.5	2.6	5	0.0 - 6.6	0.0	0.0	5	0.0 - 0.0	TotHard	5	10	37	
DCAA	42.0	14.6	5	22.0 - 62.0	2.3	1.7	5	0.0 - 4.7	CaHard	5	10	29	
TCAA	91.2	34.1	5	39.0 - 120.0	2.7	1.8	5	1.1 - 5.7	Turb	4	103	8	
MBAA	1.0	0.6	5	0.0 - 1.5	0.0	0.0	5	0.0 - 0.0	Amm	0	n/a	n/a	
DBAA	1.7	0.4	5	1.2 - 2.2	1.0	0.6	5	0.0 - 1.4	TOC	5	-19	14	
BCAA	11.5	2.7	5	6.7 - 13.0	1.8	1.2	5	0.0 - 3.1	UV254	5	-101	91	
TBAA	0.0	0.0	3	0.0 - 0.0	0.0	0.0	3	0.0 - 0.0					
CDBAA	4.0	1.2	4	2.6 - 5.4	1.2	1.3	4	0.0 - 2.5	TDS _t	85	10	12	
DCBAA	29.2	7.0	5	18.0 - 36.0	2.6	1.7	5	0.0 - 4.5	Comments:				
HAA5	140.4	50.8	5	62.2 - 191.6	6.0	3.7	5	1.1 - 11.5					
HAA6	152.0	53.3	5	68.9 - 204.6	7.7	4.8	5	1.1 - 14.6					
HAA9	185.2	83.1	3	89.5 - 238.5	12.5	10.4	3	1.1 - 21.6					
SDS Conditions					Pretreatment Information								
WQP	Avg	SD	Count	Min - Max	Process		Description					Scale	
Res (0)	0.96	0.44	10	0.25 - 1.91	Antiscalant Addition		King Lee Pre-treat 100 (2 mg/L dose)					Pilot Scale	
Temp (°C)	24.4	1.2	10	23.0 - 26.0	Sulfuric Acid Addition		pH ~ 6.75 (85 mg/L dose)					Pilot Scale	
pH (unit)	6.6	0.7	10	5.9 - 8.2	Cartridge Filtration		5 um exclusion size					Pilot Scale	
Time (hr)	16.8	16.4	10	9.0 - 48.0									

Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	1.7%	4.5%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	3.1%	1.5%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Stg 2 Conc - Stg 3 Inf	-104.3%	20.0%	Stg 2 Conc - Stg 3 Inf	-4.6%	2.2%	Stg 2 Conc - Stg 3 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Per	-19.1%	7.4%	Sys Perm - Avg Stg Perm	-7.1%	9.1%

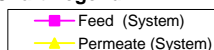
Stage Summary

	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.58	0.13	5	0.50 - 0.81					
pH	6.7	7.1	6.7	0.3	5	6.5 - 7.1	6.3	6.1	0.4	5	5.9 - 6.7
Temp	24.5	NA	24.5	0.6	5	23.8 - 25.5	NA	NA	NA	0	0.0 - 0.0
Alk	156	652	156	42	5	116 - 224	35	32	9	5	21 - 46
TDS	375	1287	375	30	5	322 - 398	139	78	11	5	62 - 88
TotHard	222	1030	222	19	5	188 - 235	69	29	7	5	19 - 39
CaHard	197	911	197	10	5	180 - 204	62	25	6	5	18 - 35
Turb	0.17	19.09	0.17	0	5	0.06 - 0.38	0.21	0.11	0.20	5	0 - 0
TOC	11.1	50.3	11.1	3.1	5	6.5 - 15.3	0.7	0.6	0.2	5	0.3 - 0.9
UV254	0.384	1.135	0.384	0.129	5	0.214 - 0.573	0.024	0.017	0.010	5	0.005 - 0.031
SUVA	3.42	2.40	3.42	0.22	5	3.20 - 3.76	3.05	2.52	0.66	5	1.80 - 3.60

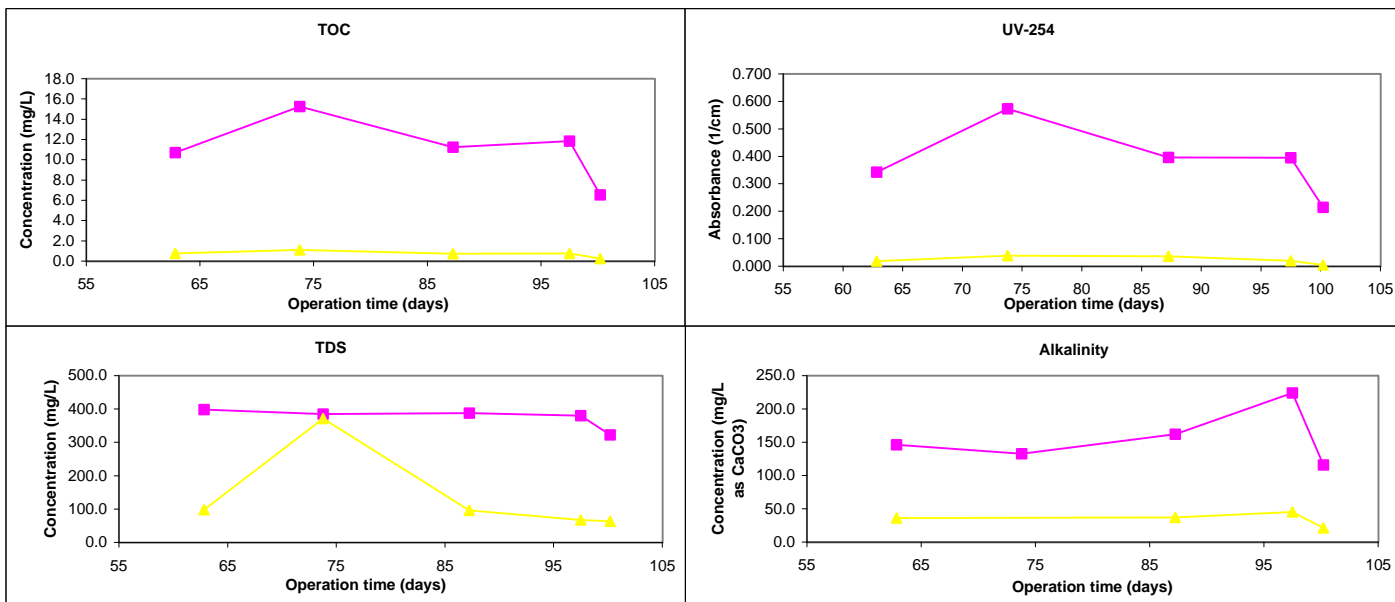
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.36	0.08	5	0.29 - 0.48					
pH	6.7	7.1	6.9	0.3	5	6.7 - 7.4	6.3	6.2	0.4	5	5.8 - 6.7
Temp	24.5	NA	NA	NA	0	0.0 - 0.0	NA	NA	NA	0	0.0 - 0.0
Alk	156	652	287	92	5	213 - 444	35	50	18	5	19 - 67
TDS	375	1287	656	48	5	573 - 697	139	132	47	5	55 - 181
TotHard	222	1030	452	46	5	384 - 505	69	43	20	5	11 - 58
CaHard	197	911	390	27	5	359 - 425	62	41	17	5	11 - 52
Turb	0.17	19.09	0.45	0	5	0.12 - 1.24	0.21	0.07	0.09	5	0 - 0
TOC	11.1	50.3	22.1	6.7	5	12.1 - 31.0	0.7	0.9	0.5	5	0.3 - 1.5
UV254	0.384	1.135	0.701	0.163	5	0.456 - 0.857	0.024	0.029	0.021	5	0.005 - 0.058
SUVA	3.42	2.40	3.26	0.41	5.00	2.77 - 3.76	3.05	2.73	0.77	5.00	1.80 - 3.84

	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.41	0.04	5	0.37 - 0.45					
pH	6.7	7.1	7.0	0.3	5	6.8 - 7.5	6.3	6.0	0.3	5.0	5.8 - 6.5
Temp	24.5	NA	24.8	1.4	5	22.6 - 26.0	NA	NA	NA	0	0.0 - 0.0
Alk	156	652	404	136	5	299 - 639	35	29	11	5	21 - 47
TDS	375	1287	871	49	5	835 - 950	139	85	18	5	71 - 114
TotHard	222	1030	638	51	5	568 - 700	69	20	8	5	14 - 32
CaHard	197	911	562	67	5	500 - 668	62	17	6	5	12 - 24
Turb	0.17	19.09	4.11	6	5	0.45 - 14.03	0.21	0.01	0.01	5	0 - 0
TOC	11.1	50.3	30.7	8.1	5	20.9 - 41.3	0.7	0.3	0.0	5	0.3 - 0.3
UV254	0.384	1.135	0.930	0.196	5	0.709 - 1.209	0.024	0.005	0.000	5	0.005 - 0.005
SUVA	3.42	2.40	3.12	0.67	5.00	2.08 - 3.86	3.05	1.80	0.00	5.00	1.80 - 1.80

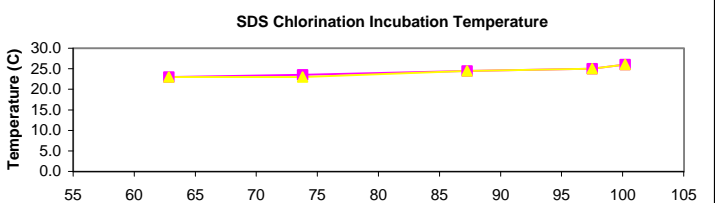
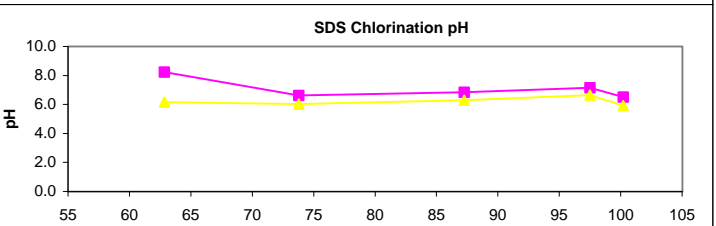
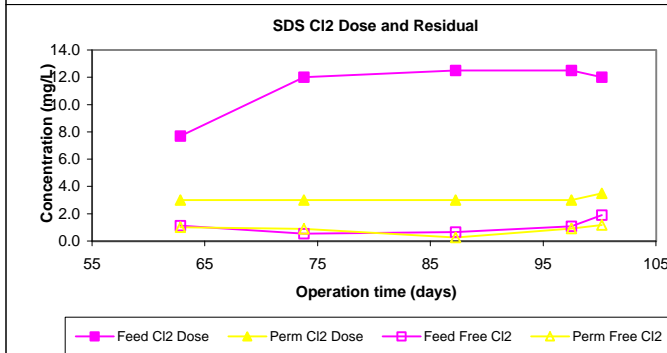
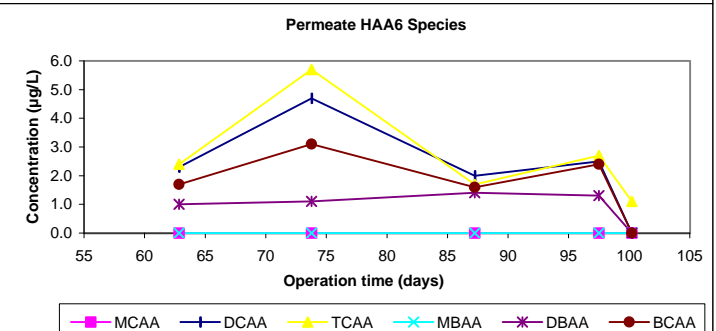
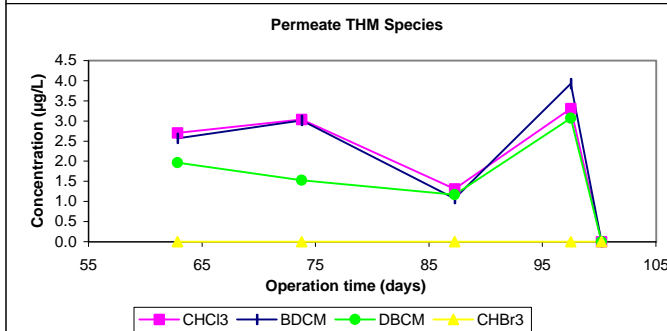
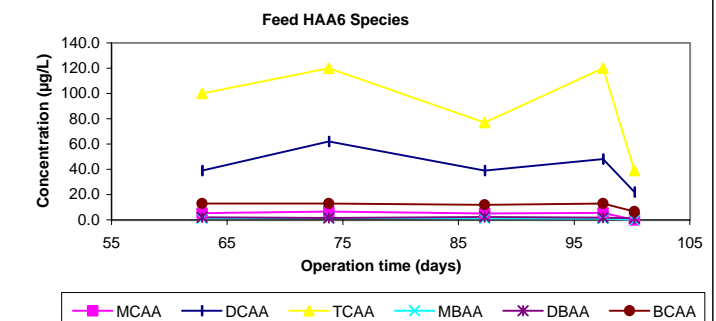
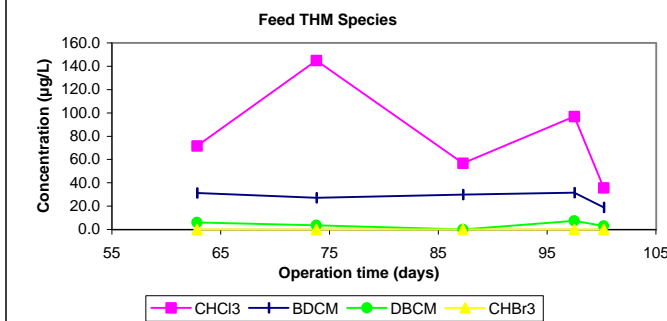
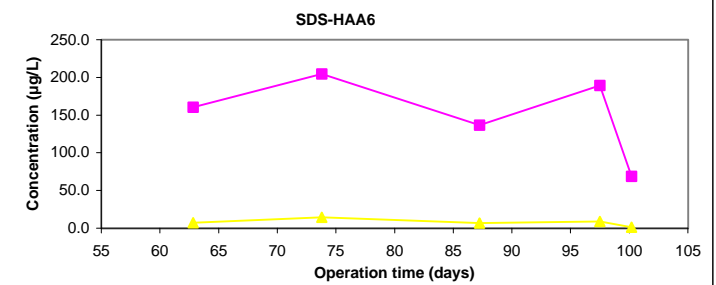
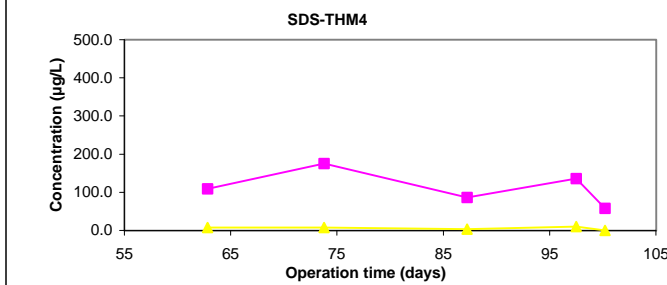
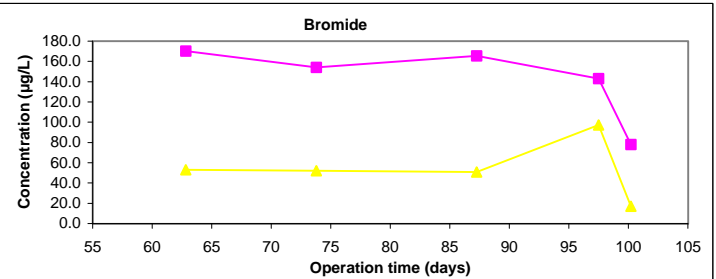
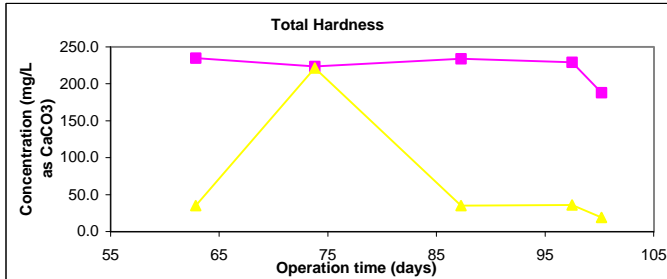
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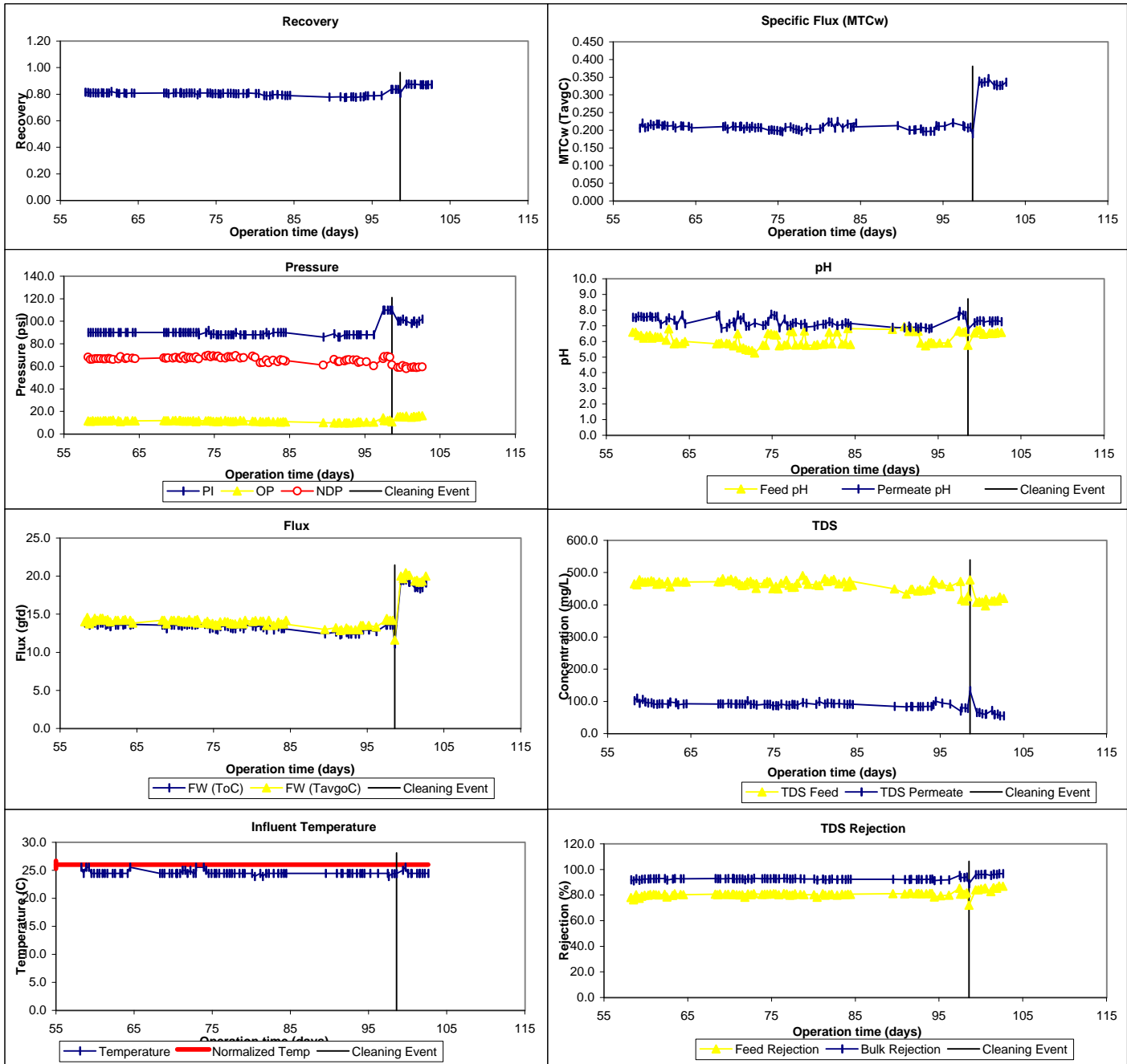
Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL 4130871 / 302
 ICR Contact: Mr. Tom Segars
 Phone No.: (305) 888-2522
 Period: 1/17/98 - 3/27/98 (69 days)

Membrane Information

Manufacturer: Fluid Systems
 Trade Name: TFC-S
 Membrane Model: TFC 4921S
 MWCO: 300 Daltons
 Element Size: 4" x 40"
 Element Area: 78.0 ft²
 Design Flux: 20.5 gfd
 Mfr. NDP: 70.0 psi
 Mfr. MTC_w: 0.293 (gfd/psi)
 Mfr. Temp: 25.0 °C
 Maximum Flow: 10.0 gpm
 Minimum Flow: 6.5 gpm
 Total Width : 13.2 ft
 Feed Spacer Thickness: 0.0026 ft
 840 Element Area 330.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 26.0 °C
 Temp Norm MTC-w: 0.302 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 15.0 gfd
 # of Elem in P.V.: 6
 # Pres Ves in Stg 1: 2
 # Pres Ves in Stg 2: 1
 Pres Ves in Stg 3: 1
 Design Flux: 15.0 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 8.9 psi
 Osmotic P Stage 2: 13.4 psi
 Osmotic P Stage 3: 18.6 psi

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)																																											
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max																																								
pH	6.5	0.1	5	6.5 - 6.6	5.7	0.0	5	5.6 - 5.7	7.1	0.1	5	7.0 - 7.2																																								
Temp	24.1	0.5	5	23.2 - 24.4	22.7	1.4	3	21.1 - 23.5	24.7	0.8	3	23.8 - 25.3																																								
Alk	117	9	5	107 - 126	16	0	5	15 - 16	598	55	5	533 - 674																																								
TDS	338	8	5	329 - 347	36	2	5	34 - 38	1387	34	5	1346 - 1434																																								
TotHard	196	5	5	192 - 205	11	1	5	10 - 11	1113	43	5	1058 - 1160																																								
CaHard	182	2	5	180 - 184	10	1	5	9 - 10	1037	42	5	1003 - 1105																																								
Turb	0.04	0.0	5	0.03 - 0.06	0.00	0.0	5	0.00 - 0.01	32.20	5.0	5	27.00 - 38.00																																								
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0																																								
TOC	5.7	0.6	5	5.1 - 6.7	0.3	0.0	5	0.3 - 0.3	31.8	1.6	5	30.8 - 34.7																																								
UV254	0.215	0.0	5	0.209 - 0.223	0.005	0.0	5	0.005 - 0.005	1.153	0.1	5	1.073 - 1.210																																								
SUVA	3.78	0.33	5	3.31 - 4.14	1.80	0.00	5	1.80 - 1.80	3.63	0.20	5	3.40 - 3.85																																								
Bromide	78	13	5	67 - 98	11	3	5	6 - 14	<div>Mass Balance</div> <div>Closure Errors (%)</div> <table><tr><td>WQP</td><td>Count</td><td>Avg</td><td>SD/RD</td></tr><tr><td>Alk</td><td>5</td><td>-14</td><td>5</td></tr><tr><td>TDS</td><td>5</td><td>-47</td><td>4</td></tr><tr><td>TotHard</td><td>5</td><td>-11</td><td>7</td></tr><tr><td>CaHard</td><td>5</td><td>-10</td><td>5</td></tr><tr><td>Turb</td><td>1</td><td>99</td><td>n/a</td></tr><tr><td>Amm</td><td>0</td><td>n/a</td><td>n/a</td></tr><tr><td>TOC</td><td>5</td><td>-16</td><td>11</td></tr><tr><td>UV254</td><td>5</td><td>-23</td><td>6</td></tr><tr><td>TDS_t</td><td>98</td><td>-2</td><td>6</td></tr></table> <div>Comments:</div>				WQP	Count	Avg	SD/RD	Alk	5	-14	5	TDS	5	-47	4	TotHard	5	-11	7	CaHard	5	-10	5	Turb	1	99	n/a	Amm	0	n/a	n/a	TOC	5	-16	11	UV254	5	-23	6	TDS _t	98	-2	6
WQP	Count	Avg	SD/RD																																																	
Alk	5	-14	5																																																	
TDS	5	-47	4																																																	
TotHard	5	-11	7																																																	
CaHard	5	-10	5																																																	
Turb	1	99	n/a																																																	
Amm	0	n/a	n/a																																																	
TOC	5	-16	11																																																	
UV254	5	-23	6																																																	
TDS _t	98	-2	6																																																	
TOX	346	47	5	280 - 390	13	0	4	13 - 13																																												
CHCl3	31.0	5.7	5	27.2 - 40.6	0.0	0.0	4	0.0 - 0.0																																												
BDCM	12.0	3.4	5	7.7 - 16.6	0.0	0.0	4	0.0 - 0.0																																												
DBCM	3.0	0.3	5	2.6 - 3.3	0.0	0.0	4	0.0 - 0.0																																												
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	4	0.0 - 0.0																																												
THM4	46.0	8.9	5	38.1 - 60.4	0.0	0.0	4	0.0 - 0.0																																												
MCAA	0.9	1.3	5	0.0 - 2.4	0.0	0.0	4	0.0 - 0.0																																												
DCAA	18.7	2.7	5	16.0 - 23.0	0.0	0.0	4	0.0 - 0.0																																												
TCAA	28.9	8.5	5	21.0 - 42.0	0.0	0.0	4	0.0 - 0.0																																												
MBAA	0.5	0.7	5	0.0 - 1.4	0.0	0.0	4	0.0 - 0.0																																												
DBAA	0.9	0.5	5	0.0 - 1.3	0.0	0.0	4	0.0 - 0.0																																												
BCAA	6.0	0.7	5	5.4 - 7.0	0.0	0.0	4	0.0 - 0.0																																												
TBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	4	0.0 - 0.0																																												
CDBAA	1.7	1.6	5	0.0 - 3.5	0.0	0.0	4	0.0 - 0.0																																												
DCBAA	10.6	3.9	5	7.3 - 17.0	0.3	0.5	4	0.0 - 1.0																																												
HAA5	49.9	12.3	5	38.0 - 69.7	0.0	0.0	4	0.0 - 0.0																																												
HAA6	55.9	12.9	5	43.4 - 76.7	0.0	0.0	4	0.0 - 0.0																																												
HAA9	68.2	18.2	5	50.7 - 97.2	0.3	0.5	4	0.0 - 1.0																																												
SDS Conditions					Pretreatment Information																																															
WQP	Avg	SD	Count	Min - Max	Process		Description			Scale																																										
Res (0)	0.76	0.44	9	0.20 - 1.67	Antiscalant Addition		King Lee Pre-treat 100 (2 mg/L dose)			Pilot Scale																																										
Temp (°C)	24.1	1.1	9	23.0 - 26.0	Sulfuric Acid Addition		pH ~ 6.75 (85 mg/L dose)			Pilot Scale																																										
pH (unit)	6.3	0.4	9	5.7 - 6.7	Cartridge Filtration		5 um exclusion size			Pilot Scale																																										
Time (hr)	9.0	0.0	9	9.0 - 9.0																																																

Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	3.0%	0.8%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Stg 2 Conc - Stg 3 Inf	-60.2%	3.8%	Stg 2 Conc - Stg 3 Inf	-5.7%	1.5%	Stg 2 Conc - Stg 3 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Per	-16.4%	0.4%	Sys Perm - Avg Stg Perm	-20.6%	10.0%

Stage Summary

	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.51	0.00	5	0.50 - 0.51					
pH	6.5	7.1	6.5	0.1	5	6.5 - 6.6	5.7	5.8	0.0	5	5.8 - 5.9
Temp	24.1	24.7	24.1	0.5	5	23.2 - 24.4	22.7	24.0	0.5	3	23.5 - 24.4
Alk	117	598	117	9	5	107 - 126	16	14	3	5	10 - 16
TDS	338	1387	339	8	5	330 - 347	36	34	2	5	31 - 37
TotHard	196	1113	196	5	5	192 - 205	11	12	1	5	10 - 14
CaHard	182	1037	182	2	5	180 - 184	10	10	2	5	8 - 12
Turb	0.04	32.20	0.04	0	5	0.03 - 0.06	0.00	0.02	0.01	5	0 - 0
TOC	5.7	31.8	5.8	0.6	5	5.1 - 6.7	0.3	0.3	0.0	5	0.3 - 0.3
UV254	0.215	1.153	0.216	0.006	5	0.209 - 0.223	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	3.78	3.63	3.76	0.34	5	3.31 - 4.14	1.80	1.80	0.00	5	1.80 - 1.80

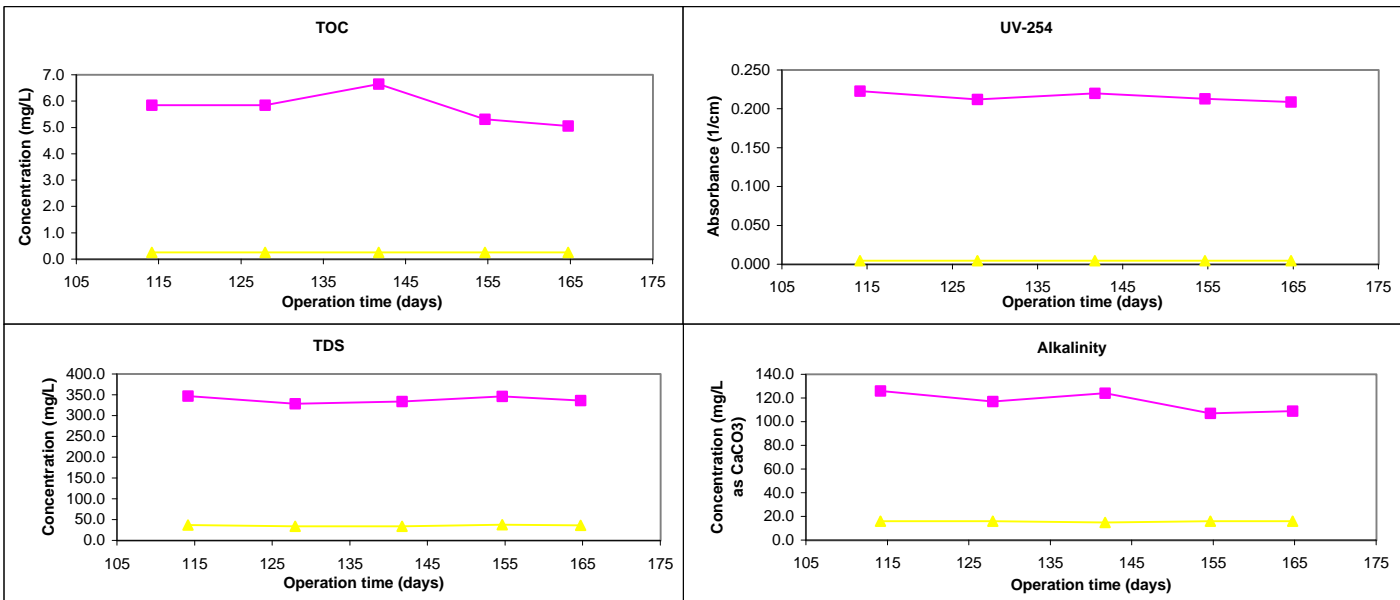
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.48	0.01	5	0.47 - 0.49					
pH	6.5	7.1	6.8	0.1	5	6.6 - 6.9	5.7	5.8	0.1	5	5.8 - 5.9
Temp	24.1	24.7	24.4	0.4	3	24.0 - 24.8	22.7	23.6	0.5	3	23.1 - 24.0
Alk	117	598	223	18	5	201 - 245	16	19	3	5	18 - 24
TDS	338	1387	622	19	5	611 - 656	36	42	4	5	38 - 48
TotHard	196	1113	396	15	5	380 - 422	11	12	4	5	9 - 18
CaHard	182	1037	378	18	5	355 - 404	10	11	3	5	8 - 16
Turb	0.04	32.20	0.14	0	5	0.09 - 0.31	0.00	0.04	0.02	5	0 - 0
TOC	5.7	31.8	11.5	1.3	5	10.1 - 12.9	0.3	0.3	0.0	5	0.3 - 0.3
UV254	0.215	1.153	0.461	0.008	5	0.453 - 0.473	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	3.78	3.63	4.05	0.47	5.00	3.56 - 4.57	1.80	1.80	0.00	5.00	1.80 - 1.80

	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.42	0.00	5	0.41 - 0.42					
pH	6.5	7.1	7.0	0.1	5	6.9 - 7.0	5.7	6.0	0.1	5.0	5.9 - 6.1
Temp	24.1	24.7	24.6	0.3	5	24.2 - 24.8	22.7	24.3	0.3	3	24.0 - 24.5
Alk	117	598	400	41	5	355 - 445	16	27	3	5	23 - 30
TDS	338	1387	1033	49	5	989 - 1109	36	72	7	5	66 - 82
TotHard	196	1113	729	26	5	697 - 757	11	19	3	5	16 - 23
CaHard	182	1037	692	28	5	661 - 730	10	17	3	5	15 - 21
Turb	0.04	32.20	8.90	7	5	0.22 - 19.02	0.00	0.01	0.01	5	0 - 0
TOC	5.7	31.8	19.1	1.7	5	17.6 - 21.7	0.3	0.3	0.0	5	0.3 - 0.3
UV254	0.215	1.153	0.716	0.018	5	0.704 - 0.747	0.005	0.007	0.006	5	0.005 - 0.018
SUVA	3.78	3.63	3.78	0.32	5.00	3.24 - 4.06	1.80	2.88	2.41	5.00	1.80 - 7.20

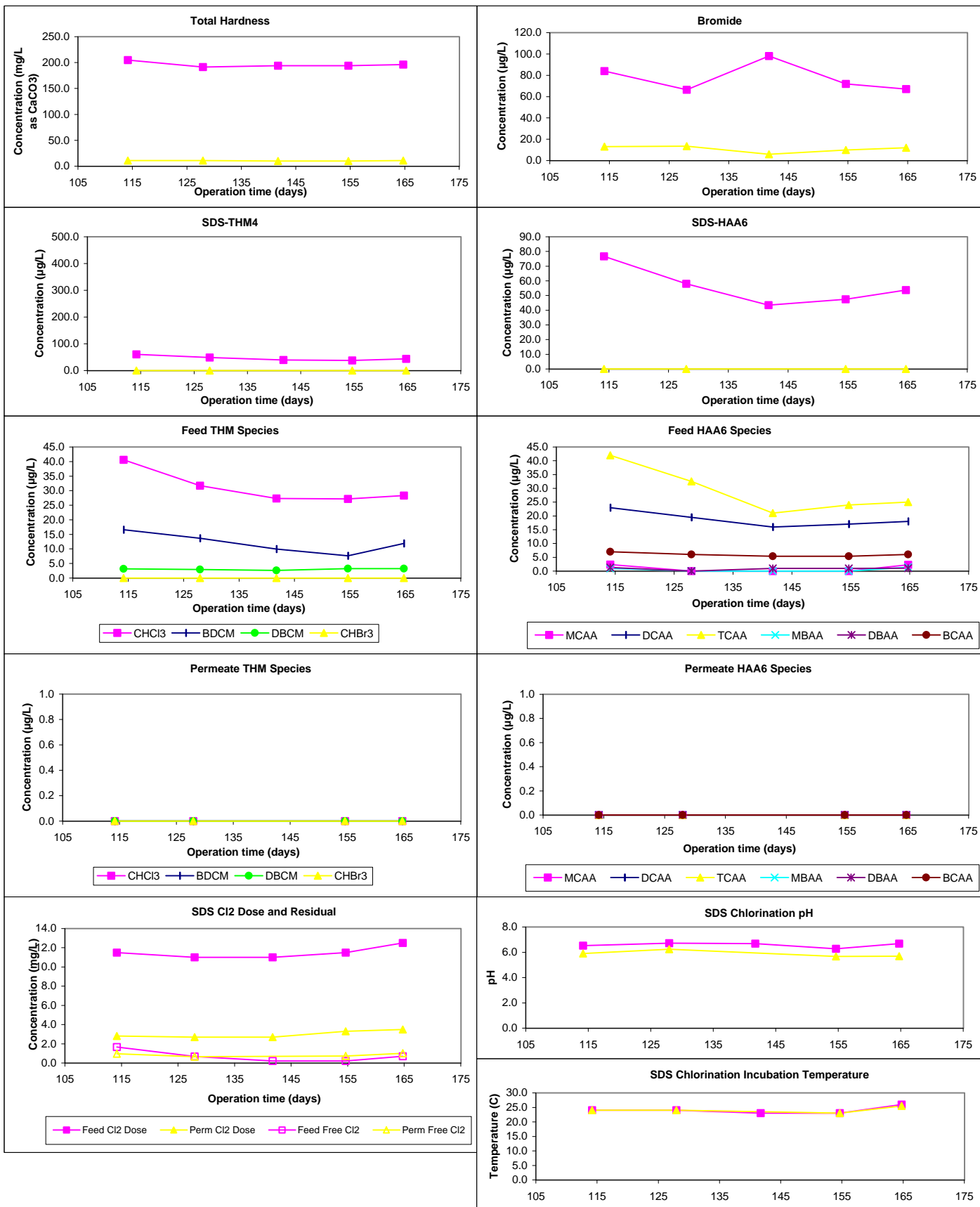
Chart Legend:

- Feed (System)
- ▲ Permeate (System)

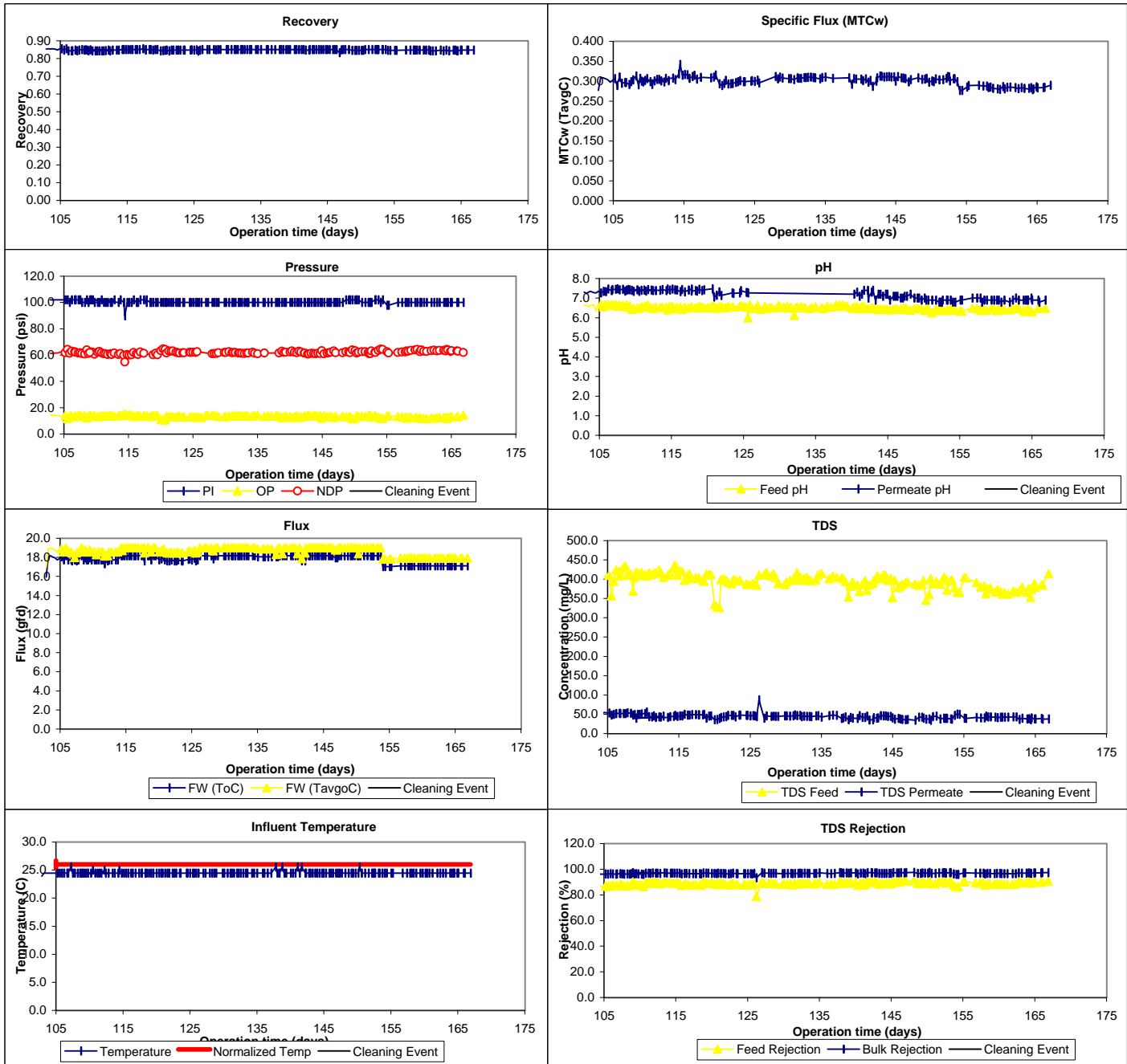
Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL 4130871 / 302
 ICR Contact: Mr. Tom Segars
 Phone No.: (305) 888-2522
 Period: 3/28/98 - 6/5/98 (69 days)

Membrane Information

Manufacturer: Fluid Systems
 Trade Name: TFC-S
 Membrane Model: TFC 4921S
 MWCO: 300 Daltons
 Element Size: 4" x 40"
 Element Area: 78.0 ft²
 Design Flux: 20.5 gfd
 Mfr. NDP: 70.0 psi
 Mfr. MTC_w: 0.293 (gfd/psi)
 Mfr. Temp: 25.0 °C
 Maximum Flow: 10.0 gpm
 Minimum Flow: 6.5 gpm
 Total Width : 13.2 ft
 Feed Spacer Thickness: 0.0026 ft
 840 Element Area 330.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 26.0 °C
 Temp Norm MTC-w: 0.302 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 15.0 gfd
 # of Elem in P.V.: 6
 # Pres Ves in Stg 1: 2
 # Pres Ves in Stg 2: 1
 Pres Ves in Stg 3: 1
 Design Flux: 15.0 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 8.9 psi
 Osmotic P Stage 2: 13.4 psi
 Osmotic P Stage 3: 18.6 psi

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)			
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	6.6	0.1	5	6.4 - 6.8	5.8	0.1	5	5.6 - 5.9	7.2	0.1	5	7.0 - 7.4
Temp	24.6	1.6	4	23.4 - 26.9	25.0	1.3	4	23.7 - 26.4	25.5	1.0	4	24.7 - 27.0
Alk	130	16	5	109 - 142	17	1	5	16 - 18	677	93	5	561 - 793
TDS	328	10	5	311 - 337	36	1	5	35 - 38	1377	44	5	1306 - 1422
TotHard	195	4	5	190 - 200	12	1	5	11 - 13	1093	72	5	974 - 1154
CaHard	184	3	5	179 - 188	10	1	5	9 - 12	1006	77	5	903 - 1086
Turb	0.07	0.0	5	0.04 - 0.10	0.03	0.0	5	0.00 - 0.11	34.91	4.1	5	29.53 - 40.00
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0
TOC	5.5	0.2	5	5.4 - 5.8	0.3	0.1	5	0.3 - 0.5	32.4	3.3	5	29.5 - 36.7
UV254	0.224	0.0	5	0.208 - 0.238	0.005	0.0	5	0.005 - 0.005	1.173	0.1	5	1.096 - 1.266
SUVA	4.05	0.16	5	3.76 - 4.19	1.61	0.42	5	0.87 - 1.80	3.65	0.36	5	3.30 - 4.19
Bromide	67	18	5	34 - 78	16	8	5	6 - 28				
TOX	375	48	5	315 - 425	17	9	5	13 - 33				
CHCl3	49.6	5.7	5	44.0 - 56.1	0.8	1.8	5	0.0 - 3.9	Mass Balance Closure Errors (%)			
BDCM	17.9	3.0	5	14.0 - 20.9	0.0	0.0	5	0.0 - 0.0				
DBCM	3.9	0.8	5	2.8 - 5.1	0.0	0.0	5	0.0 - 0.0	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	5	-7	3
THM4	71.4	8.1	5	62.8 - 80.3	0.8	1.8	5	0.0 - 3.9	TDS	5	-36	6
MCAA	3.1	1.0	5	2.3 - 4.8	0.0	0.0	5	0.0 - 0.0	TotHard	5	-7	5
DCAA	20.4	1.1	5	19.0 - 22.0	0.0	0.0	5	0.0 - 0.0	CaHard	5	-10	7
TCAA	37.0	5.2	5	34.0 - 46.0	0.0	0.0	5	0.0 - 0.0	Turb	4	99	1
MBAA	0.3	0.6	5	0.0 - 1.4	0.0	0.0	5	0.0 - 0.0	Amm	0	n/a	n/a
DBAA	1.1	0.2	5	1.0 - 1.4	0.0	0.0	5	0.0 - 0.0	TOC	5	-2	10
BCAA	7.4	0.4	5	6.9 - 7.9	0.0	0.0	5	0.0 - 0.0	UV254	4	-20	7
TBAA	0.0	0.0	4	0.0 - 0.0	0.0	0.0	4	0.0 - 0.0	TDS			
CDBAA	3.3	0.5	5	2.5 - 3.9	0.0	0.0	5	0.0 - 0.0				
DCBAA	15.7	3.1	5	12.5 - 20.0	0.2	0.4	5	0.0 - 1.0	99	-32	13	
HAA5	61.9	7.0	5	56.5 - 74.0	0.0	0.0	5	0.0 - 0.0	Comments:			
HAA6	69.3	7.3	5	63.4 - 81.9	0.0	0.0	5	0.0 - 0.0				
HAA9	89.7	11.1	4	79.6 - 105.5	0.3	0.5	4	0.0 - 1.0				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description			Scale		
Res (0)	0.98	0.36	10	0.70 - 1.90	Antiscalant Addition		King Lee Pre-treat 100 (2 mg/L dose)			Pilot Scale		
Temp (°C)	25.4	1.3	10	24.0 - 27.0	Sulfuric Acid Addition		pH ~ 6.75 (85 mg/L dose)			Pilot Scale		
pH (unit)	6.2	0.5	10	5.5 - 6.9	Cartridge Filtration		5 um exclusion size			Pilot Scale		
Time (hr)	9.0	0.0	10	9.0 - 9.0								

Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	2.3%	1.3%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Stg 2 Conc - Stg 3 Inf	-65.1%	2.9%	Stg 2 Conc - Stg 3 Inf	-4.4%	2.5%	Stg 2 Conc - Stg 3 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Per	-16.6%	0.6%	Sys Perm - Avg Stg Perm	-21.1%	8.1%

Stage Summary

	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.51	0.01	5	0.50 - 0.53					
pH	6.6	7.2	6.6	0.1	5	6.4 - 6.8	5.8	5.9	0.1	5	5.8 - 6.1
Temp	24.6	25.5	24.6	1.6	4	23.4 - 26.9	25.0	24.6	1.4	4	23.1 - 26.5
Alk	130	677	130	16	5	109 - 142	17	16	1	5	15 - 17
TDS	328	1377	329	10	5	311 - 337	36	34	2	5	32 - 37
TotHard	195	1093	195	4	5	190 - 200	12	12	2	5	11 - 14
CaHard	184	1006	184	3	5	179 - 188	10	10	1	5	10 - 11
Turb	0.07	34.91	0.07	0	5	0.04 - 0.10	0.03	0.03	0.01	5	0 - 0
TOC	5.5	32.4	5.5	0.2	5	5.4 - 5.8	0.3	0.3	0.1	5	0.3 - 0.6
UV254	0.224	1.173	0.224	0.011	5	0.208 - 0.238	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	4.05	3.65	4.06	0.17	5	3.76 - 4.19	1.61	1.60	0.45	5	0.80 - 1.80

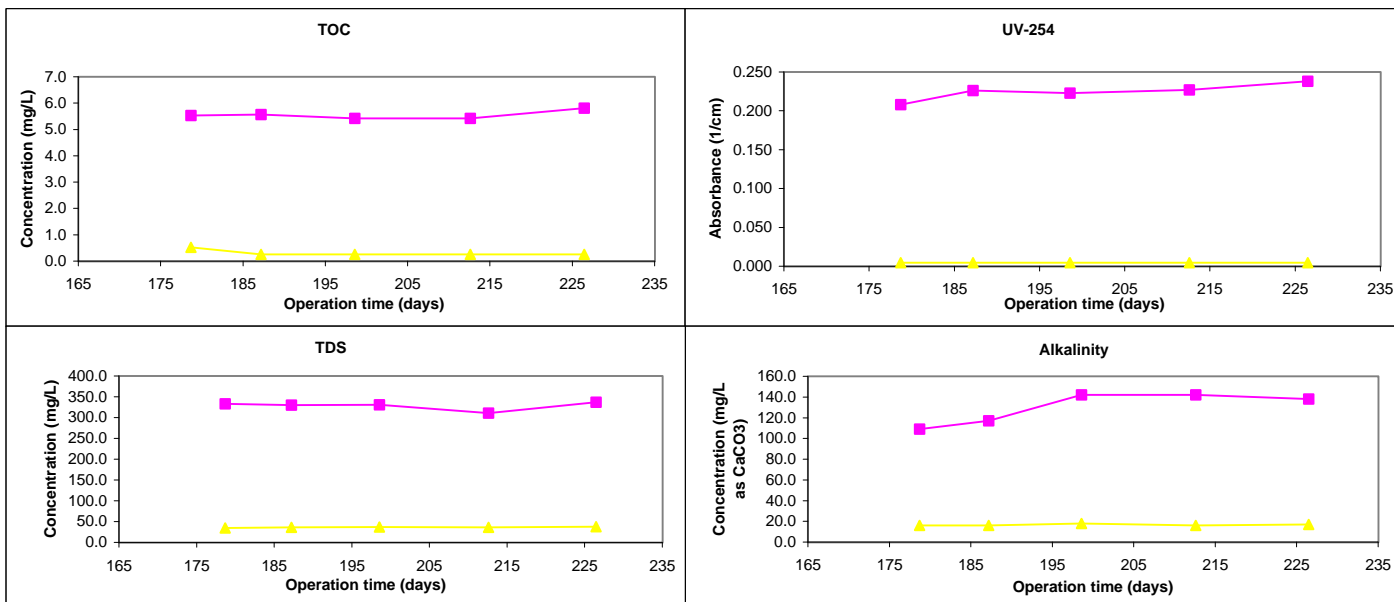
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.48	0.02	5	0.47 - 0.52					
pH	6.6	7.2	6.8	0.1	5	6.6 - 7.0	5.8	5.9	0.1	5	5.8 - 6.0
Temp	24.6	25.5	25.0	1.2	4	24.0 - 26.5	25.0	24.7	1.3	4	23.3 - 26.4
Alk	130	677	256	37	5	209 - 294	17	19	1	5	17 - 20
TDS	328	1377	614	19	5	592 - 640	36	42	3	5	38 - 45
TotHard	195	1093	399	17	5	376 - 416	12	11	1	5	10 - 13
CaHard	184	1006	373	6	5	364 - 380	10	10	1	5	9 - 11
Turb	0.07	34.91	0.86	1	5	0.11 - 1.60	0.03	0.02	0.01	5	0 - 0
TOC	5.5	32.4	11.9	1.0	5	10.9 - 13.4	0.3	0.3	0.0	5	0.3 - 0.3
UV254	0.224	1.173	0.475	0.019	5	0.458 - 0.502	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	4.05	3.65	4.01	0.23	5.00	3.76 - 4.22	1.61	1.80	0.00	5.00	1.80 - 1.80

	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.37	0.11	5	0.18 - 0.42					
pH	6.6	7.2	7.1	0.2	5	6.8 - 7.2	5.8	6.0	0.2	5.0	5.8 - 6.2
Temp	24.6	25.5	25.1	1.2	4	24.0 - 26.4	25.0	25.6	1.0	4	24.7 - 26.9
Alk	130	677	451	72	5	342 - 506	17	30	10	5	20 - 46
TDS	328	1377	1014	41	5	966 - 1067	36	74	19	5	55 - 105
TotHard	195	1093	712	38	5	672 - 759	12	21	10	5	14 - 38
CaHard	184	1006	605	148	5	341 - 700	10	19	8	5	12 - 33
Turb	0.07	34.91	12.79	7	5	2.03 - 20.00	0.03	0.02	0.01	5	0 - 0
TOC	5.5	32.4	20.5	1.8	5	18.5 - 23.4	0.3	0.3	0.1	5	0.3 - 0.5
UV254	0.224	1.173	0.732	0.023	5	0.700 - 0.759	0.005	0.006	0.003	5	0.005 - 0.012
SUVA	4.05	3.65	3.58	0.21	5.00	3.25 - 3.78	1.61	2.22	1.49	5.00	0.90 - 4.80

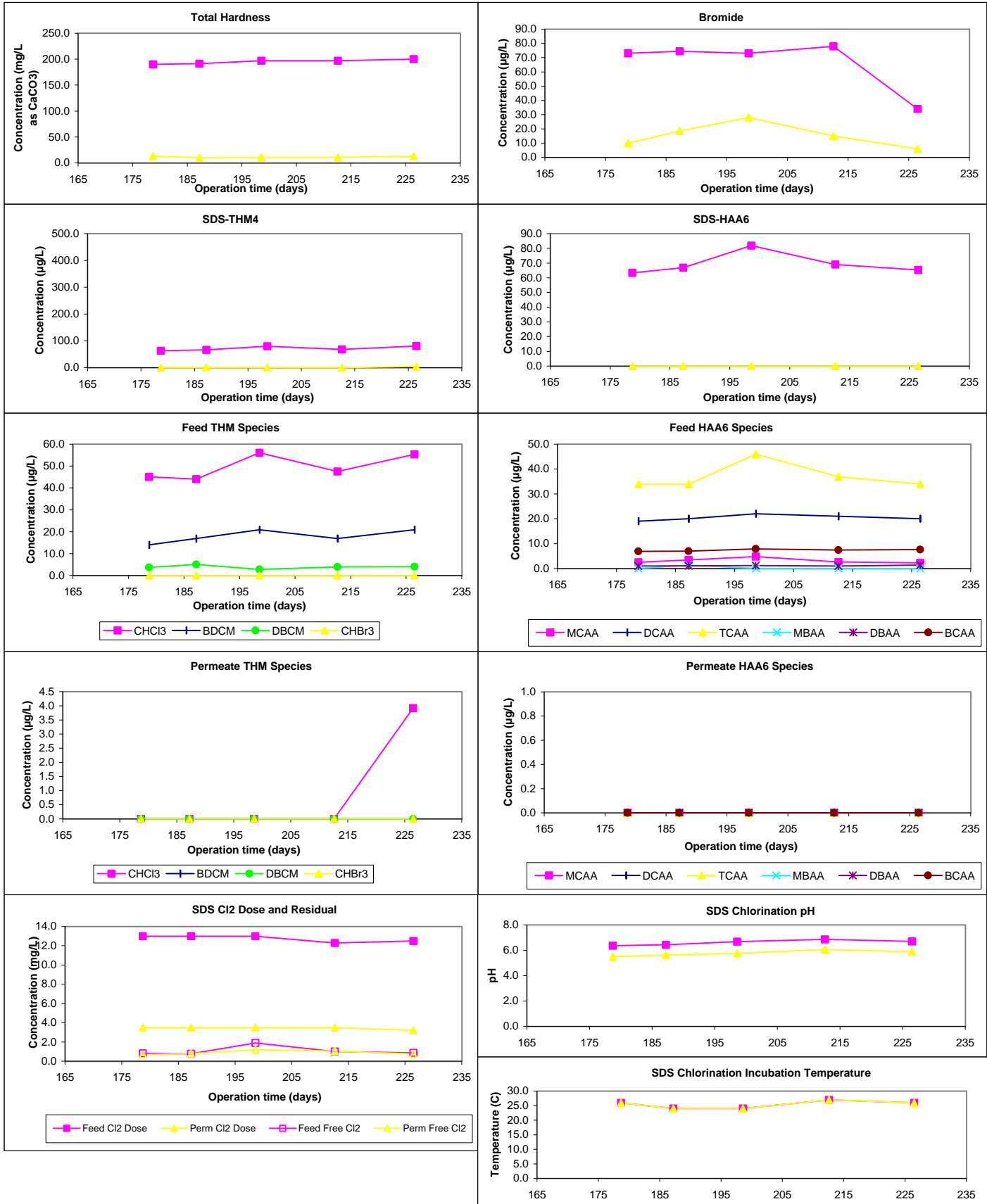
Chart Legend:

- Feed (System)
- Permeate (System)

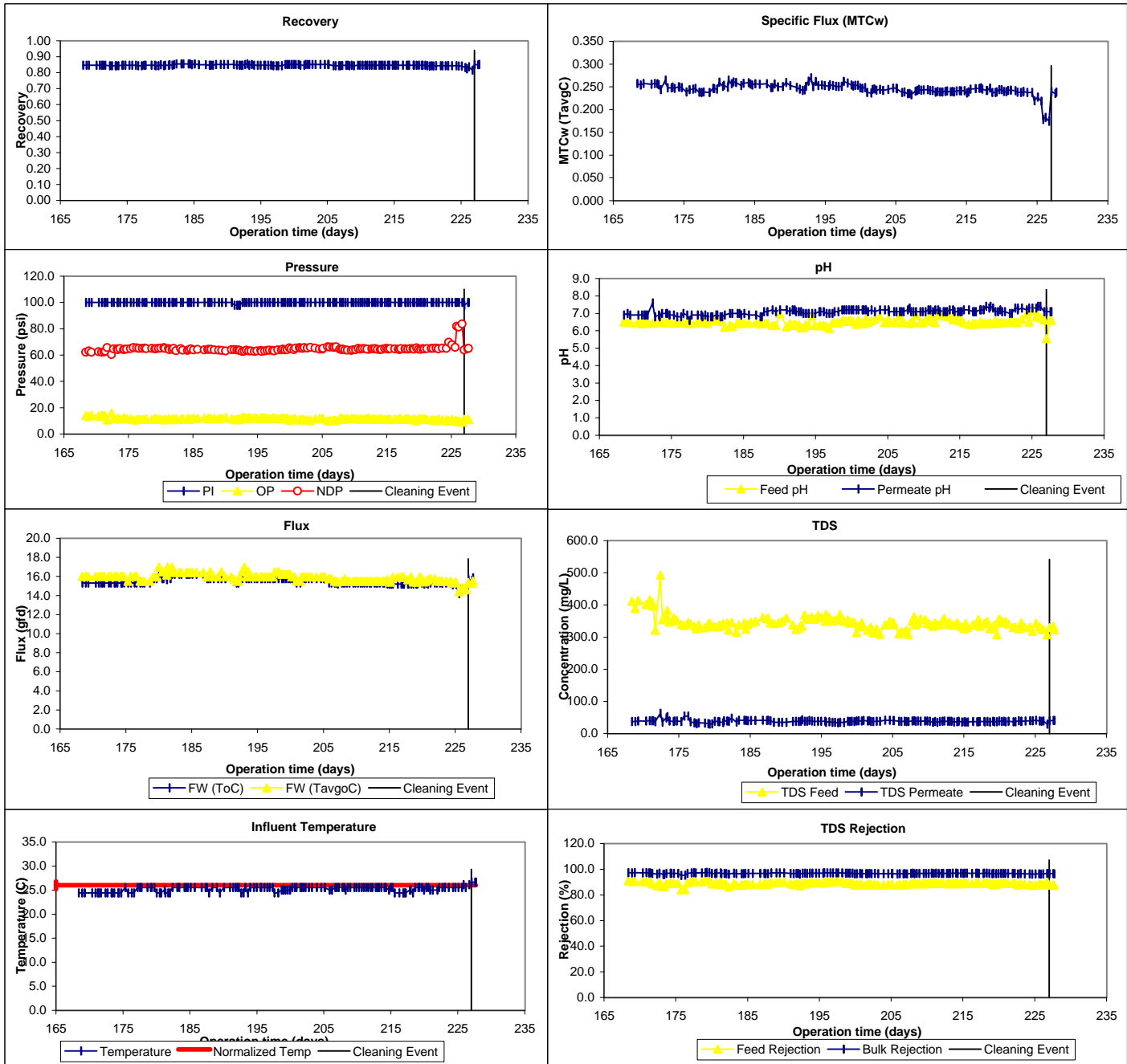
Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL 4130871 / 302
 ICR Contact: Mr. Tom Segars
 Phone No.: (305) 888-2522
 Period: 6/6/98 - 8/14/98 (69 days)

Membrane Information

Manufacturer: Fluid Systems
 Trade Name: TFC-S
 Membrane Model: TFC 4921S
 MWCO: 300 Daltons
 Element Size: 4" x 40"
 Element Area: 78.0 ft²
 Design Flux: 20.5 gfd
 Mfr. NDP: 70.0 psi
 Mfr. MTC_w: 0.293 (gfd/psi)
 Mfr. Temp: 25.0 °C
 Maximum Flow: 10.0 gpm
 Minimum Flow: 6.5 gpm
 Total Width : 13.2 ft
 Feed Spacer Thickness: 0.0026 ft
 840 Element Area 330.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 26.0 °C
 Temp Norm MTC-w: 0.302 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 15.0 gfd
 # of Elem in P.V.: 6
 # Pres Ves in Stg 1: 2
 # Pres Ves in Stg 2: 1
 Pres Ves in Stg 3: 1
 Design Flux: 15.0 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 8.9 psi
 Osmotic P Stage 2: 13.4 psi
 Osmotic P Stage 3: 18.6 psi

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)				
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	
pH	6.6	0.1	5	6.5 - 6.8	5.8	0.1	5	5.7 - 6.0	7.1	0.2	5	7.0 - 7.3	
Temp	25.4	1.1	5	23.6 - 26.4	25.4	1.1	5	24.1 - 27.1	26.3	0.7	5	25.5 - 27.2	
Alk	128	15	5	114 - 146	17	0	5	17 - 17	604	99	4	538 - 751	
TDS	328	3	5	324 - 333	37	2	5	35 - 39	1360	35	5	1322 - 1410	
TotHard	196	4	5	193 - 201	12	1	5	10 - 13	1065	48	5	996 - 1121	
CaHard	184	4	5	180 - 189	10	1	5	9 - 12	1025	45	5	965 - 1079	
Turb	0.05	0.0	5	0.04 - 0.07	0.01	0.0	5	0.00 - 0.02	34.40	2.1	5	32.00 - 37.05	
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0	
TOC	4.8	1.6	5	1.9 - 5.7	0.3	0.0	5	0.3 - 0.3	30.6	2.7	5	28.6 - 35.3	
UV254	0.220	0.0	5	0.205 - 0.230	0.005	0.0	5	0.005 - 0.005	1.132	0.1	5	1.044 - 1.226	
SUVA	5.42	3.04	5	3.87 - 10.85	1.80	0.00	5	1.80 - 1.80	3.73	0.50	5	3.06 - 4.29	
Bromide	31	19	5	12 - 57	10	3	5	7 - 16					
TOX	337	58	5	235 - 380	13	0	5	13 - 13					
CHCl3	38.6	5.8	5	33.8 - 47.5	0.0	0.0	5	0.0 - 0.0	Mass Balance Closure Errors (%)				
BDCM	14.4	2.3	5	12.7 - 18.4	0.0	0.0	5	0.0 - 0.0					
DBCM	3.2	0.3	5	2.8 - 3.6	0.0	0.0	5	0.0 - 0.0	WQP	Count	Avg	SD/RD	
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	4	-18	4	
THM4	56.2	7.9	5	50.9 - 69.5	0.0	0.0	5	0.0 - 0.0	TDS	5	-41	3	
MCAA	1.0	1.4	5	0.0 - 2.8	0.0	0.0	5	0.0 - 0.0	TotHard	5	-13	5	
DCAA	20.3	2.7	5	17.0 - 23.0	0.0	0.0	5	0.0 - 0.0	CaHard	5	-10	6	
TCAA	32.0	5.4	5	25.0 - 38.0	0.0	0.0	5	0.0 - 0.0	Turb	3	99	0	
MBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Amm	0	n/a	n/a	
DBAA	1.2	0.1	5	1.1 - 1.3	0.0	0.0	5	0.0 - 0.0	TOC	5	0	39	
BCAA	6.8	0.4	5	6.5 - 7.4	0.0	0.0	5	0.0 - 0.0	UV254	4	-27	8	
TBAA	0.0	0.0	3	0.0 - 0.0	0.0	0.0	4	0.0 - 0.0	TDS _t	99	-104	36	
CDBAA	2.0	1.1	5	0.0 - 2.7	0.0	0.0	5	0.0 - 0.0					
DCBAA	12.4	2.1	5	10.0 - 15.0	0.0	0.0	5	0.0 - 0.0	Comments:				
HAA5	54.5	9.0	5	43.3 - 65.0	0.0	0.0	5	0.0 - 0.0					
HAA6	61.4	9.3	5	49.8 - 72.0	0.0	0.0	5	0.0 - 0.0					
HAA9	77.2	15.3	3	59.8 - 88.5	0.0	0.0	4	0.0 - 0.0					
SDS Conditions					Pretreatment Information								
WQP	Avg	SD	Count	Min - Max	Process	Description						Scale	
Res (0)	0.82	0.22	10	0.30 - 1.09	Antiscalant Addition	King Lee Pre-treat 100 (2 mg/L dose)						Pilot Scale	
Temp (°C)	25.4	0.8	10	25.0 - 27.0	Sulfuric Acid Addition	pH ~ 6.75 (85 mg/L dose)						Pilot Scale	
pH (unit)	6.3	0.4	10	5.7 - 6.8	Cartridge Filtration	5 um exclusion size						Pilot Scale	
Time (hr)	9.0	0.0	10	9.0 - 9.0									

Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	-35.4%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	2.3%	1.1%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Stg 2 Conc - Stg 3 Inf	-63.2%	11.0%	Stg 2 Conc - Stg 3 Inf	-4.4%	2.1%	Stg 2 Conc - Stg 3 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Per	-16.7%	0.4%	Sys Perm - Avg Stg Perm	-17.2%	15.7%

Stage Summary

	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.54	0.07	5	0.51 - 0.67					
pH	6.6	7.1	6.6	0.1	5	6.5 - 6.8	5.8	5.9	0.1	5	5.8 - 6.1
Temp	25.4	26.3	25.4	1.1	5	23.6 - 26.4	25.4	25.8	0.9	5	24.8 - 26.9
Alk	128	604	128	15	5	114 - 146	17	17	2	5	16 - 19
TDS	328	1360	328	3	5	324 - 333	37	36	3	5	32 - 40
TotHard	196	1065	196	4	5	193 - 201	12	12	1	5	10 - 13
CaHard	184	1025	184	4	5	180 - 189	10	10	1	5	9 - 12
Turb	0.05	34.40	0.05	0	5	0.04 - 0.07	0.01	0.03	0.01	5	0 - 0
TOC	4.8	30.6	4.8	1.7	5	1.9 - 5.8	0.3	0.3	0.0	5	0.3 - 0.3
UV254	0.220	1.132	0.220	0.010	5	0.205 - 0.230	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	5.42	3.73	5.40	3.05	5	3.79 - 10.85	1.80	1.80	0.00	5	1.80 - 1.80

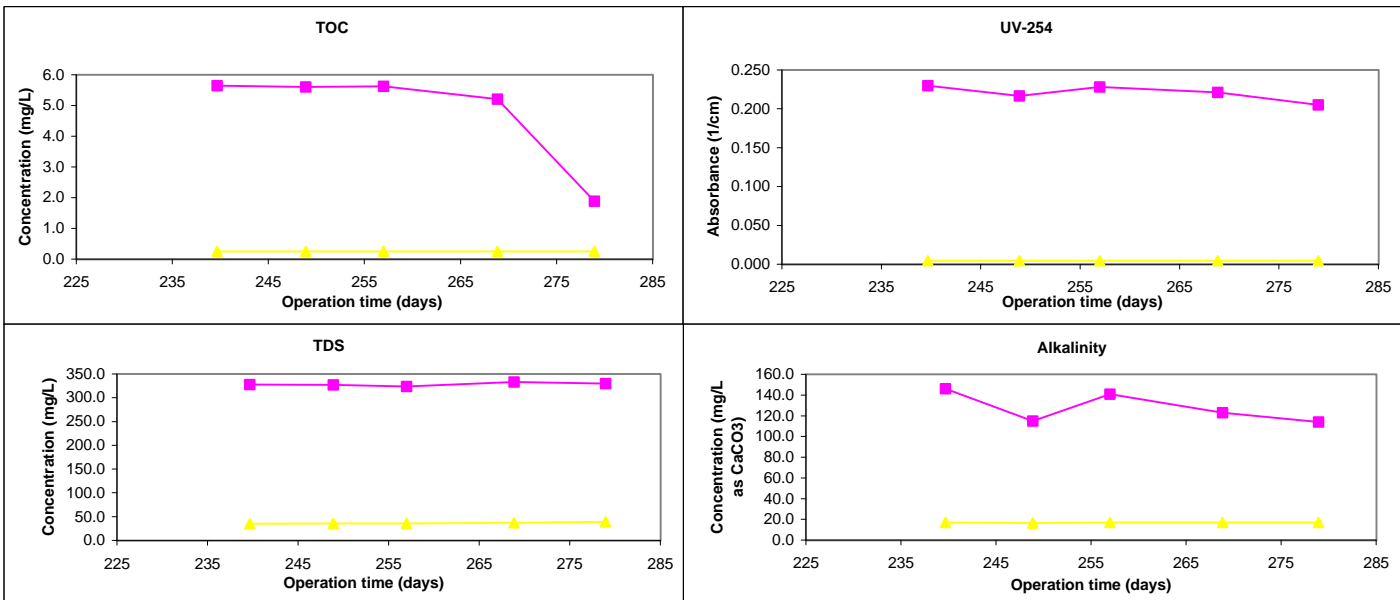
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.46	0.01	5	0.45 - 0.46					
pH	6.6	7.1	6.8	0.1	5	6.7 - 7.0	5.8	5.9	0.1	5	5.8 - 6.1
Temp	25.4	26.3	25.9	1.0	5	24.7 - 27.1	25.4	25.5	0.9	5	24.6 - 27.0
Alk	128	604	255	56	5	203 - 335	17	21	2	5	19 - 25
TDS	328	1360	604	5	5	598 - 612	37	42	1	5	41 - 44
TotHard	196	1065	395	14	5	377 - 414	12	12	1	5	11 - 13
CaHard	184	1025	375	17	5	349 - 390	10	11	1	5	9 - 12
Turb	0.05	34.40	1.24	2	5	0.14 - 3.10	0.01	0.01	0.01	5	0 - 0
TOC	4.8	30.6	11.1	0.8	5	10.0 - 11.8	0.3	0.6	0.9	5	0.3 - 2.2
UV254	0.220	1.132	0.473	0.007	5	0.464 - 0.481	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	5.42	3.73	4.26	0.36	5.00	3.97 - 4.81	1.80	1.48	0.71	5.00	0.21 - 1.80

	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.42	0.00	5	0.42 - 0.42					
pH	6.6	7.1	7.0	0.2	5	6.9 - 7.2	5.8	6.0	0.1	5.0	5.9 - 6.1
Temp	25.4	26.3	26.1	0.9	5	25.1 - 27.2	25.4	26.2	0.8	5	25.3 - 27.2
Alk	128	604	423	79	5	345 - 508	17	24	5	5	17 - 29
TDS	328	1360	1008	46	5	963 - 1081	37	63	8	5	50 - 68
TotHard	196	1065	697	25	5	671 - 725	12	18	1	5	17 - 19
CaHard	184	1025	647	31	5	605 - 678	10	16	1	5	15 - 18
Turb	0.05	34.40	13.07	6	5	7.75 - 19.10	0.01	0.02	0.01	5	0 - 0
TOC	4.8	30.6	19.2	0.8	5	18.4 - 20.4	0.3	0.3	0.0	5	0.3 - 0.3
UV254	0.220	1.132	0.693	0.026	5	0.669 - 0.736	0.005	0.008	0.007	5	0.005 - 0.020
SUVA	5.42	3.73	3.62	0.07	5.00	3.50 - 3.68	1.80	3.04	2.77	5.00	1.80 - 8.00

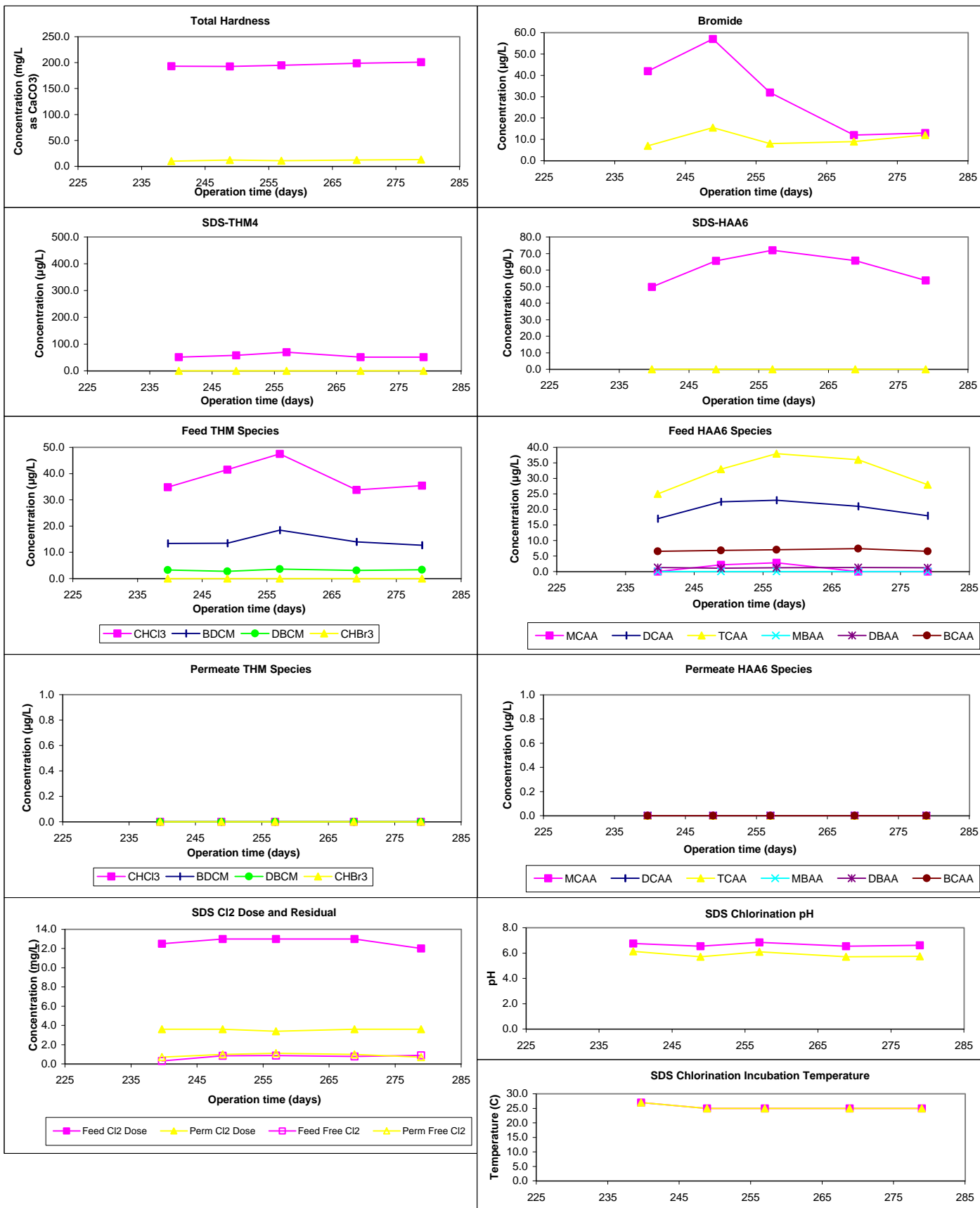
Chart Legend:

- Feed (System)
- ▲ Permeate (System)

Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs

