

ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID	1078
Study Protocol	3-Stage Pilot System
Plant ICR Number	1080
PWS Name	City of Pompano Beach
City, State, Zip	Pompano Beach, FL 33060

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

General Comments:

1. Two different Fluid Systems membrane models were evaluated during this study: the 2540 TFCS membrane (4" x 40" elements) in the first and second stages, and the 4921 TFCS membrane (2.5" x 40" elements) in the third stage.
2. No cost information was provided in the Summary Report.

Water Quality Comments:

1. 673 water quality outliers were identified and removed prior to base analysis.
2. Target SDS conditions were to dose samples at a pH of 8.5, incubate at 72 hours at 24.5°C. Initially, both the feed and permeate samples were dosed at 5 mg/L; however, midway through this study these doses were increased to 8.5 mg/L. This latter dose was still not high enough to satisfy the anticipated demand of feed samples, which had reported feed TOC concentrations ranging from 11 to 17 mg/L. Conversely, dosing the permeate samples at 8.5 mg/L resulted in reported free chlorine residuals ranging from 1.5 to 8 mg/L, while the reported permeate TOC concentration ranged from 0.5 to 1.4 mg/L.
3. Due to the inadequate dosing of the feed SDS samples, all feed DBP data was reported as NR. Furthermore, the reported permeate SDS doses and residuals were very inconsistent and outside the expected target conditions. Additionally, the formation of DBPs in the permeate samples was very erratic, making it difficult to determine which permeate DBP data was representative. Thus, the permeate DBP data was also not used during data analysis.
4. Through the end of September (i.e., through quarter 2) there were suspected problems with the TOC analyses, as noted in the Summary Report. As a result, the system feed and

permeate TOC data collected during this time were not used during data analysis. Additionally, the stage samples (i.e., influents and permeates) were very erratic and none of these data were used during data analysis.

Productivity Comments:

1. Twenty-nine productivity outliers were identified and removed prior to base analysis.
2. During EPA data analysis the average system sustained flux and specific flux were 13.26 ± 0.34 gfd and 0.198 ± 0.009 gfd/psi, respectively. Cleaning intervals greater than one year were projected for the system and for the first two stages, and a positive slope, which is physically impossible, was calculated for the third stage. Therefore, the third stage slope was changed to 0 and the projected cleaning intervals were set at 365 days for the system and 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.
3. There were no reported cleaning events during this study.

ICR Information

ID / ICR#: FL4131618 / 1080
 ICR Contact: Gerald Weber
 Phone No.: 954 786-4061
 Period: 5/24/98 - 7/31/98 (68 days)

Membrane Information

Manufacturer: FLUID SYSTEMS CORP.
 Trade Name: FLUID SYSTEMS
 Membrane Model: 2540 TFCS / 4921 TFCS
 MWCO: 200 Daltons
 Element Size: 4" x 40"
 Element Area: 79.0 ft²
 Design Flux: 17.9 gfd
 Mfr. NDP: 80.0 psi
 Mfr. MTC_w: 0.130 (gfd/psi)
 Mfr. Temp: 30.0 °C
 Maximum Flow: 16.0 gpm
 Minimum Flow: 4.0 gpm
 Total Width: 14.4 ft
 Feed Spacer Thickness: 0.0029 ft
 840 Element Area: 330.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 29.0 °C
 Temp Norm MTC-w: 0.126 TavGC
 Design Recovery: 0.82
 Avg Sys Flux F_w: 14.0 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: 14.0 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 2.8 psi
 Osmotic P Stage 2: 5.0 psi
 Osmotic P Stage 3: 9.0 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	5.9	0.2	5	5.7 - 6.1	5.6	0.5	5	5.3 - 6.5	6.3	0.1	5	6.2 - 6.4
Temp	29.0	0.0	5	29.0 - 29.0	29.0	0.0	5	29.0 - 29.0	27.3	3.7	5	20.7 - 29.0
Alk	63	9	5	52 - 72	18	3	5	15 - 22	306	71	5	200 - 400
TDS	294	7	5	285 - 305	37	2	5	34 - 39	1432	117	5	1306 - 1596
TotHard	NA	NA	0	0 - 0	NA	NA	0	0 - 0	NA	NA	0	0 - 0
CaHard	261	6	5	254 - 270	17	6	5	9 - 22	1666	362	5	1460 - 2310
Turb	11.22	22.8	5	0.25 - 52.00	0.35	0.3	5	0.08 - 0.80	14.99	9.4	5	2.06 - 27.50
Amm	0.67	0.03	4	0.63 - 0.69	0.21	0.08	4	0.12 - 0.30	2.20	0.16	4	2.0 - 2.3
TOC	13.4	1.9	5	10.6 - 15.6	1.3	1.5	5	0.3 - 3.1	73.2	15.2	5	57.6 - 90.4
UV254	0.533	0.1	5	0.427 - 0.693	0.024	0.0	5	0.005 - 0.051	2.626	0.1	5	2.400 - 2.740
SUVA	4.03	0.72	5	3.22 - 4.76	5.89	8.35	5	0.68 - 20.40	3.69	0.63	5	2.97 - 4.17
Bromide	10	0	5	10 - 10	10	0	5	10 - 10				
TOX	NA	NA	0	0 - 0	NA	NA	0	0 - 0				
CHCl3	NA	NA	0	NA	12.5	6.5	2	7.8 - 17.1	Mass Balance Closure Errors (%)			
BDCM	NA	NA	0	NA	6.5	3.7	5	2.5 - 11.5				
DBCM	NA	NA	0	NA	3.2	0.8	5	2.1 - 4.3	WQP	Count	Avg	SD/RD
CHBr3	NA	NA	0	NA	0.0	0.0	5	0.0 - 0.0	Alk	5	15	11
THM4	NA	NA	0	NA	20.0	10.7	2	12.4 - 27.5	TDS	5	2	8
MCAA	NA	NA	0	NA	2.9	4.0	5	0.0 - 9.8	TotHard	2	24	6
DCAA	NA	NA	0	NA	15.2	8.9	5	6.2 - 26.1	CaHard	5	20	9
TCAA	NA	NA	0	NA	4.9	4.2	5	1.3 - 11.5	Turb	5	-475	1033
MBAA	NA	NA	0	NA	3.3	4.8	5	0.0 - 10.7	Amm	4	-16	15
DBAA	NA	NA	0	NA	2.9	1.2	5	1.0 - 4.1	TOC	1	9	n/a
BCAA	NA	NA	0	NA	6.5	7.0	5	0.0 - 17.3	UV254	3	-9	25
TBAA	NA	NA	0	NA	0.0	0.0	3	0.0 - 0.0				
CDBAA	NA	NA	0	NA	3.4	3.6	3	0.0 - 7.2	TDS _t	97	4	15
DCBAA	NA	NA	0	NA	0.5	0.9	3	0.0 - 1.6	Comments:			
HAA5	NA	NA	0	NA	29.2	20.1	5	11.6 - 56.9				
HAA6	NA	NA	0	NA	35.7	26.9	5	11.6 - 74.2				
HAA9	NA	NA	0	NA	21.0	8.2	3	11.6 - 26.0				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description		Scale			
Res (5)	0.89	1.18	10	0.00 - 3.68	Cartridge filtration		1 micron		Pilot - scale			
Temp (°C)	23.9	0.5	10	23.0 - 24.5	sulfuric acid addition		pH = 5.7, Dosage= 42 mg/L		Pilot - scale			
pH (unit)	8.6	0.1	10	8.4 - 8.8								
Time (hr)	72.0	0.0	10	72.0 - 72.0								

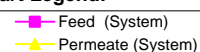
Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	#VALUE!	#VALUE!	System Inf - Stg 1 Inf	0.1%	0.4%
Sys Conc - Stg 3 Conc	-0.1%	0.7%	Sys Conc - Stg 3 Conc	#VALUE!	#VALUE!	Sys Conc - Stg 3 Conc	0.2%	1.1%
Stg 1 Conc - Stg 2 Inf	0.0%	0.1%	Stg 1 Conc - Stg 2 Inf	0.0%	0.1%	Stg 1 Conc - Stg 2 Inf	0.0%	0.1%
Stg 2 Conc - Stg 3 Inf	-0.6%	5.6%	Stg 2 Conc - Stg 3 Inf	-1.7%	6.1%	Stg 2 Conc - Stg 3 Inf	0.5%	5.1%
Sys Perm - Avg Stg Pern	0.4%	4.0%	Sys Perm - Sum Stg Pe	-22.4%	3.7%	Sys Perm - Avg Stg Perm	-168.1%	1.9%

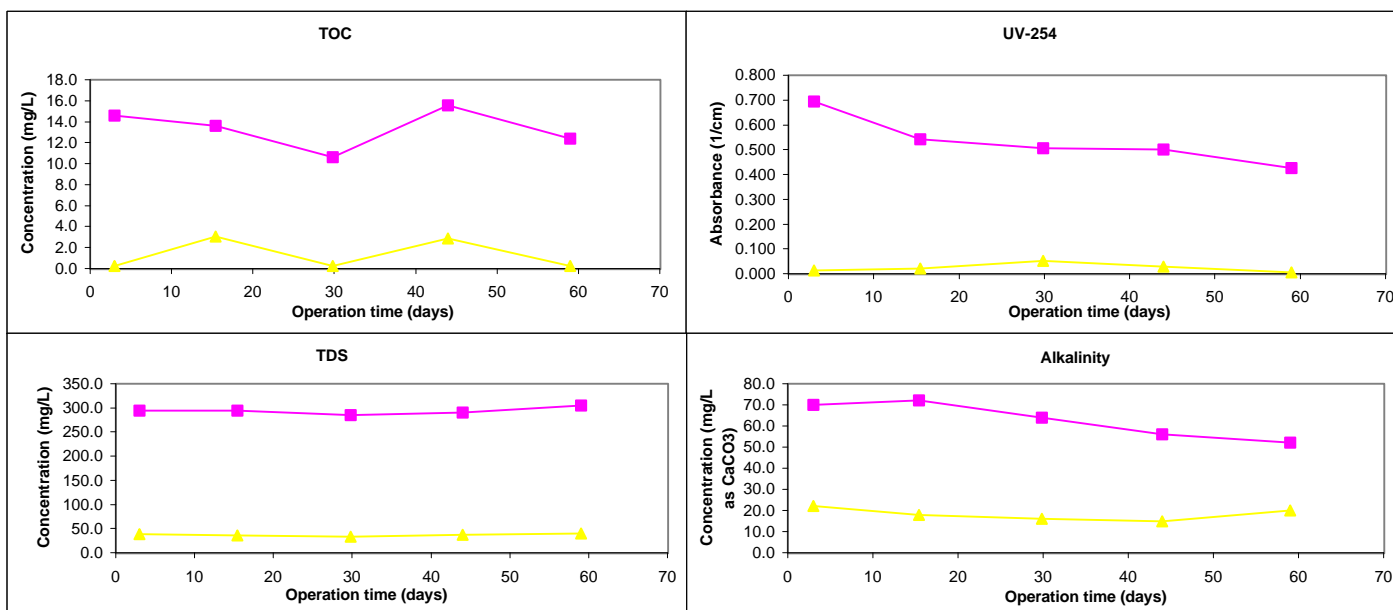
Stage Summary

WQP	Stage 1 Influent						Stage 1 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.49	0.01	5	0.48 - 0.51					
pH	5.9	6.3	5.9	0.2	5	5.7 - 6.1	5.6	5.5	0.2	5	5.3 - 5.9
Temp	29.0	27.3	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	63	306	63	8	5	52 - 72	18	17	6	5	10 - 26
TDS	294	1432	294	7	5	285 - 305	37	18	1	5	17 - 19
TotHard	NA	NA	285	16	5	268 - 304	NA	14	3	5	10 - 18
CaHard	261	1666	262	6	5	254 - 270	17	12	2	5	8 - 14
Turb	11.22	14.99	11.20	23	5	0.25 - 52.00	0.35	0.25	0.15	5	0 - 0
TOC	13.4	73.2	13.9	2.9	5	10.6 - 18.4	1.3	2.6	2.9	5	0.3 - 7.7
UV254	0.533	2.626	0.541	0.097	5	0.427 - 0.693	0.024	0.009	0.005	5	0.005 - 0.015
SUVA	4.03	3.69	3.97	0.81	5	2.92 - 4.76	5.89	1.31	2.18	5	0.19 - 5.20
WQP	Stage 2 Influent						Stage 2 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.49	0.01	5	0.48 - 0.51					
pH	5.9	6.3	6.1	0.2	5	5.9 - 6.3	5.6	5.6	0.2	5	5.3 - 5.8
Temp	29.0	27.3	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	63	306	106	77	5	11 - 222	18	19	1	5	18 - 20
TDS	294	1432	537	26	5	505 - 572	37	32	2	5	29 - 35
TotHard	NA	NA	687	317	5	484 - 1250	NA	20	6	5	14 - 28
CaHard	261	1666	631	290	5	480 - 1150	17	16	5	5	12 - 24
Turb	11.22	14.99	12.86	10	5	5.07 - 30.00	0.35	0.79	1.44	5	0 - 3
TOC	13.4	73.2	23.7	5.2	5	16.6 - 29.0	1.3	5.0	2.8	5	0.3 - 7.5
UV254	0.533	2.626	1.206	0.267	5	1.050 - 1.680	0.024	0.010	0.005	5	0.005 - 0.017
SUVA	4.03	3.69	5.33	1.82	5.00	3.86 - 8.04	5.89	1.46	2.98	5.00	0.06 - 6.80
WQP	Stage 3 Influent						Stage 3 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.25	0.04	5	0.19 - 0.29					
pH	5.9	6.3	6.3	0.1	5	6.2 - 6.4	5.6	5.6	0.1	5.0	5.5 - 5.8
Temp	29.0	27.3	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	63	306	185	40	5	137 - 222	18	33	5	5	28 - 40
TDS	294	1432	925	54	5	865 - 1009	37	127	34	5	98 - 185
TotHard	NA	NA	1085	153	5	885 - 1250	NA	72	9	5	63 - 86
CaHard	261	1666	994	123	5	810 - 1150	17	64	10	5	54 - 76
Turb	11.22	14.99	16.78	12	5	0.52 - 30.00	0.35	8.55	12.55	5	0 - 28
TOC	13.4	73.2	51.9	10.0	5	41.5 - 63.8	1.3	8.1	8.2	5	3.5 - 22.4
UV254	0.533	2.626	1.878	0.251	5	1.660 - 2.280	0.024	0.261	0.389	5	0.051 - 0.948
SUVA	4.03	3.69	3.69	0.57	5.00	2.97 - 4.47	5.89	6.57	11.50	5.00	0.27 - 27.09

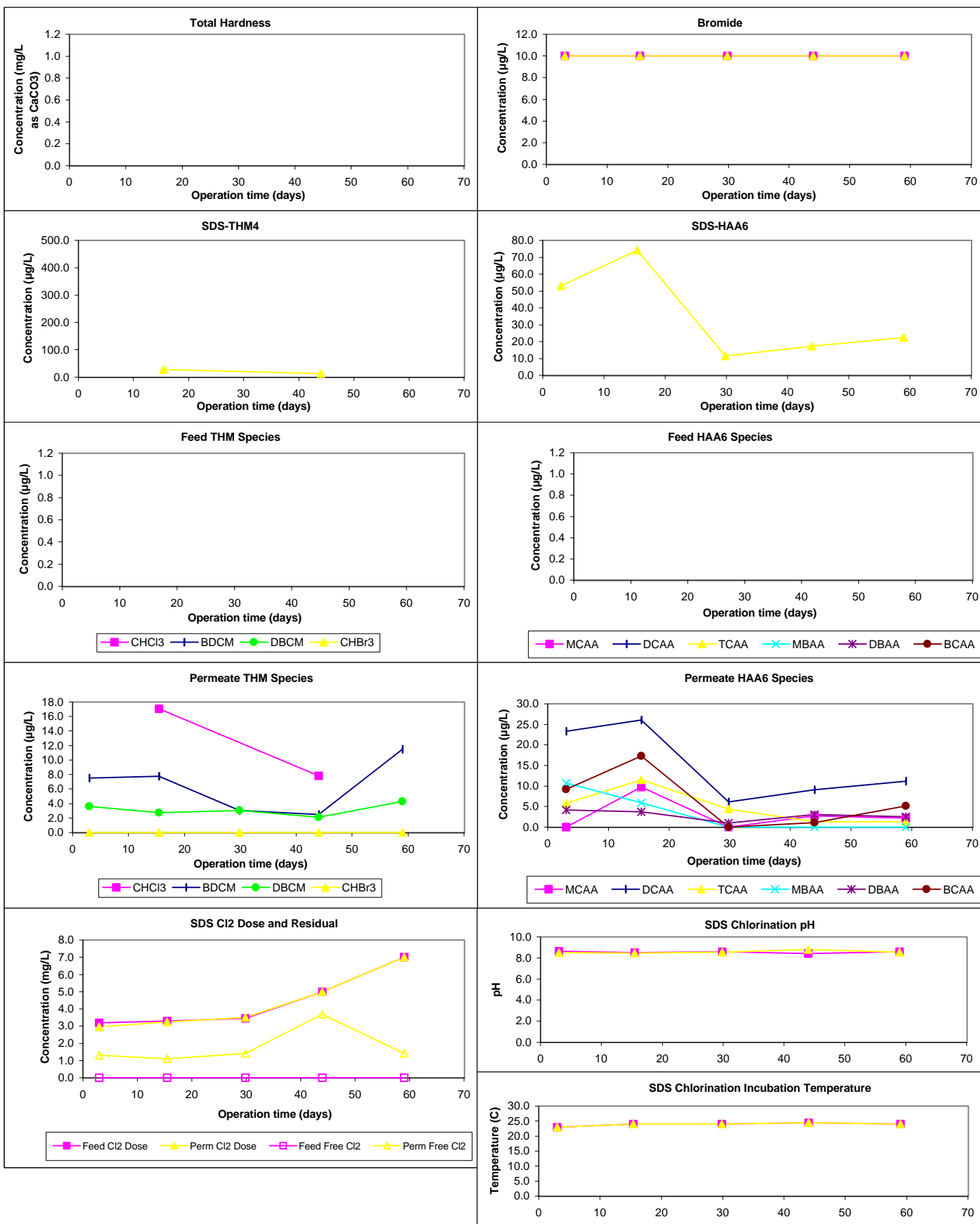
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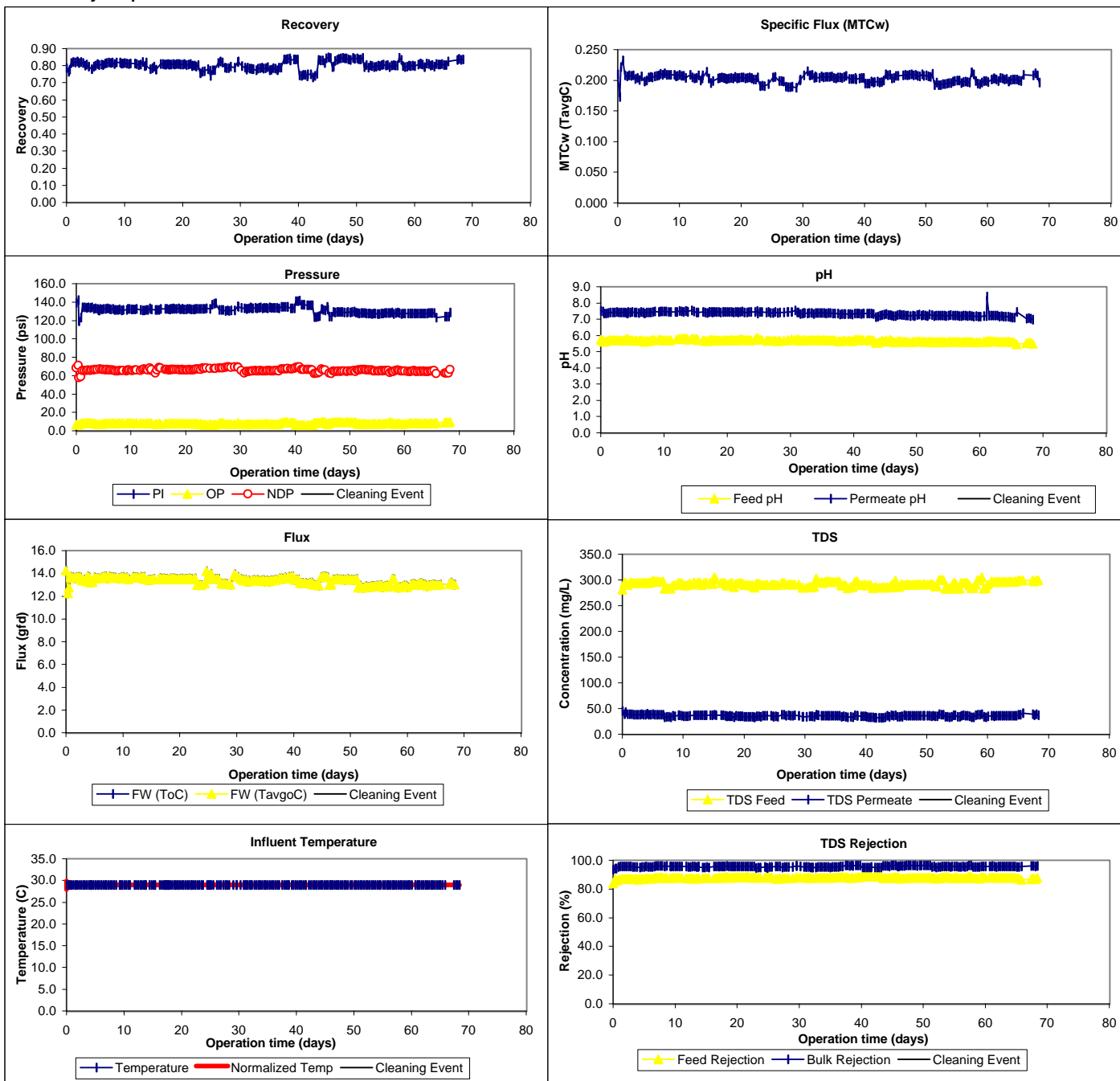
Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL4131618 / 1080
 ICR Contact: Gerald Weber
 Phone No.: 954 786-4061
 Period: 8/1/98 - 10/10/98 (70 days)

Membrane Information

Manufacturer: FLUID SYSTEMS CORP.
 Trade Name: FLUID SYSTEMS
 Membrane Model: 2540 TFCS / 4921 TFCS
 MWCO: 200 Daltons
 Element Size: 4" x 40"
 Element Area: 79.0 ft²
 Design Flux: 17.9 gfd
 Mfr. NDP: 80.0 psi
 Mfr. MTC_w: 0.130 (gfd/psi)
 Mfr. Temp: 30.0 °C
 Maximum Flow: 16.0 gpm
 Minimum Flow: 4.0 gpm
 Total Width : 57.6 ft
 Feed Spacer Thickness: 0.0029 ft
 840 Element Area 330.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 29.0 °C
 Temp Norm MTC-w: 0.126 TavGC
 Design Recovery: 0.80
 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: 2.8 psi
 Osmotic P Stage 2: 5.0 psi
 Osmotic P Stage 3: 9.0 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	5.9	0.3	5	5.6 - 6.4	5.6	0.3	5	5.2 - 6.1	6.2	0.1	5	6.0 - 6.3
Temp	29.0	0.0	5	29.0 - 29.0	29.0	0.0	5	29.0 - 29.0	29.0	0.0	5	29.0 - 29.0
Alk	47	8	5	37 - 58	17	1	5	16 - 18	207	56	4	160 - 286
TDS	296	3	5	292 - 299	35	1	5	33 - 36	1373	116	5	1190 - 1495
TotHard	292	29	5	268 - 340	20	1	5	18 - 22	1665	10	4	1660 - 1680
CaHard	275	28	5	250 - 320	17	1	5	16 - 18	1506	72	4	1400 - 1562
Turb	14.62	27.6	5	1.34 - 64.00	0.66	0.4	5	0.20 - 1.23	58.45	66.3	5	0.20 - 146.00
Amm	0.95	0.30	3	0.75 - 1.30	0.08	0.09	4	0.00 - 0.15	2.93	0.10	4	2.9 - 3.1
TOC	24.1	6.6	5	17.1 - 32.1	4.5	3.6	5	0.3 - 8.5	107.2	28.6	4	92.6 - 150.0
UV254	0.519	0.0	5	0.465 - 0.568	0.015	0.0	5	0.005 - 0.052	2.350	0.6	4	1.850 - 3.150
SUVA	2.29	0.68	5	1.72 - 3.07	1.19	1.66	5	0.05 - 3.85	NA	NA	4	NA
Bromide	10	0	5	10 - 10	10	0	5	10 - 10				
TOX	NA	NA	0	0 - 0	NA	NA	0	0 - 0				
CHCl3	NA	NA	0	NA	16.5	NA	1	16.5 - 16.5	Mass Balance			
BDCM	NA	NA	0	NA	8.4	4.2	5	3.1 - 14.0	Closure Errors (%)			
DBCM	NA	NA	0	NA	1.6	1.6	5	0.0 - 3.8	WQP	Count	Avg	SD/RD
CHBr3	NA	NA	0	NA	0.0	0.0	5	0.0 - 0.0	Alk	4	19	9
THM4	NA	NA	0	NA	22.2	NA	1	22.2 - 22.2	TDS	5	-3	5
MCAA	NA	NA	0	NA	1.1	2.5	5	0.0 - 5.7	TotHard	4	9	13
DCAA	NA	NA	0	NA	10.8	10.1	4	1.4 - 25.2	CaHard	4	5	11
TCAA	NA	NA	0	NA	4.8	3.2	4	1.6 - 9.2	Turb	5	-1197	2192
MBAA	NA	NA	0	NA	0.0	0.0	5	0.0 - 0.0	Amm	1	-8	n/a
DBAA	NA	NA	0	NA	1.5	3.3	5	0.0 - 7.4	TOC	4	19	15
BCAA	NA	NA	0	NA	0.0	0.0	4	0.0 - 0.0	UV254	1	18	n/a
TBAA	NA	NA	0	NA	0.0	0.0	5	0.0 - 0.0				
CDBAA	NA	NA	0	NA	2.2	4.9	5	0.0 - 11.0	TDS _t	99	5	5
DCBAA	NA	NA	0	NA	1.9	2.8	5	0.0 - 6.4	Comments:			
HAA5	NA	NA	0	NA	15.7	13.3	4	2.9 - 34.4				
HAA6	NA	NA	0	NA	15.7	13.3	4	2.9 - 34.4				
HAA9	NA	NA	0	NA	17.3	11.5	4	9.3 - 34.4				
SDS Conditions				Pretreatment Information								
WQP	Avg	SD	Count	Min - Max	Process	Description	Scale					
Res (5)	2.27	3.43	10	0.00 - 8.83	Cartridge filtration	1 micron	Pilot - scale					
Temp (°C)	24.4	0.3	10	24.0 - 24.8	sulfuric acid addition	pH = 5.7, Dosage= 42 mg/L	Pilot - scale					
pH (unit)	8.6	0.3	10	8.0 - 8.9								
Time (hr)	72.0	0.0	10	72.0 - 72.0								

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	#VALUE!	#VALUE!	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	#VALUE!	#VALUE!	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%	8.2%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Stg 2 Conc - Stg 3 Inf	0.0%	0.0%	Stg 2 Conc - Stg 3 Inf	9.0%	16.9%	Stg 2 Conc - Stg 3 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Per	-21.7%	2.4%	Sys Perm - Avg Stg Perm	-170.1%	1.8%

Stage Summary

WQP	Stage 1 Influent						Stage 1 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.49	0.02	5	0.48 - 0.52					
pH	5.9	6.2	5.9	0.3	5	5.6 - 6.4	5.6	5.6	0.3	5	5.2 - 5.9
Temp	29.0	29.0	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	47	207	47	8	5	38 - 58	17	15	1	5	14 - 16
TDS	296	1373	296	3	5	292 - 299	35	19	2	5	17 - 23
TotHard	292	1665	292	29	5	268 - 340	20	17	7	5	12 - 28
CaHard	275	1506	275	27	5	250 - 320	17	14	6	5	8 - 24
Turb	14.62	58.45	1.63	1	5	0.64 - 3.17	0.66	0.27	0.06	5	0 - 0
TOC	24.1	107.2	22.3	6.2	5	17.1 - 32.1	4.5	5.2	4.1	5	0.3 - 8.4
UV254	0.519	2.350	0.509	0.052	5	0.450 - 0.568	0.015	0.066	0.097	5	0.005 - 0.232
SUVA	2.29	NA	2.40	0.60	5	1.77 - 3.07	1.19	2.28	2.59	5	0.05 - 6.42

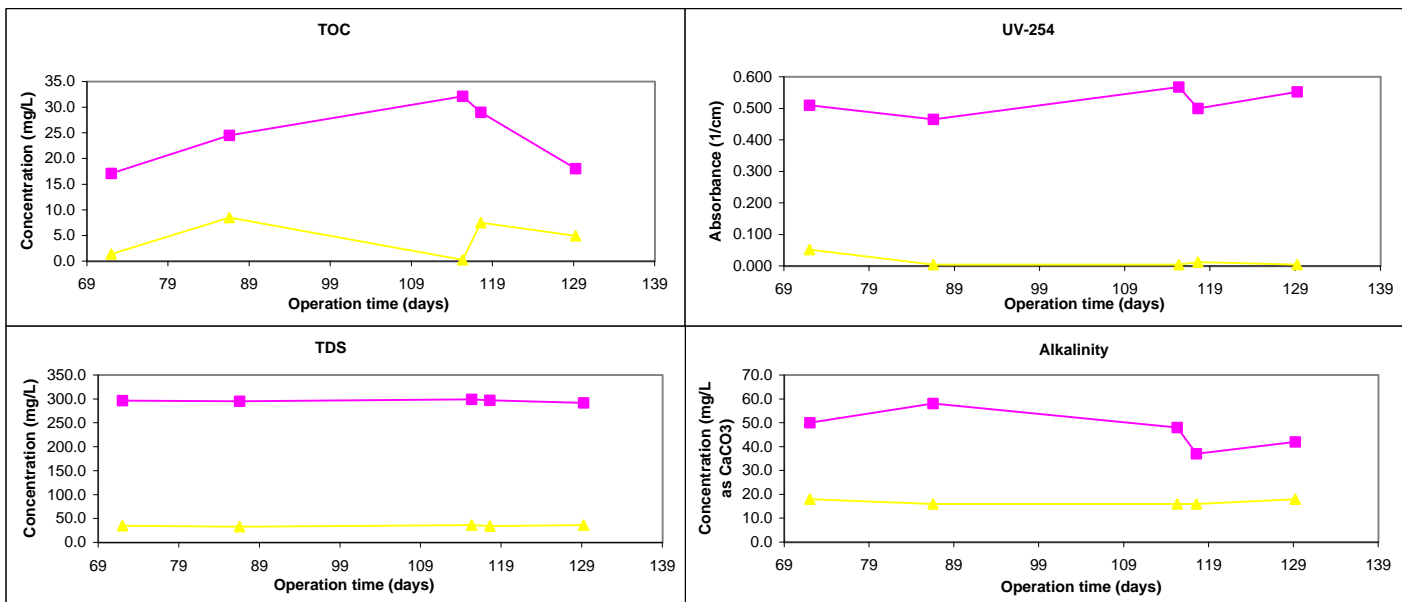
WQP	Stage 2 Influent						Stage 2 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.49	0.02	5	0.48 - 0.52					
pH	5.9	6.2	10.5	10.3	5	5.8 - 29.0	5.6	5.4	0.2	5	5.2 - 5.8
Temp	29.0	29.0	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	47	207	88	17	5	76 - 116	17	18	2	5	16 - 20
TDS	296	1373	536	26	5	504 - 567	35	32	1	5	31 - 34
TotHard	292	1665	560	29	4	520 - 590	20	19	2	5	16 - 22
CaHard	275	1506	502	45	5	430 - 550	17	127	247	5	16 - 569
Turb	14.62	58.45	6.84	3	5	3.28 - 10.80	0.66	0.52	0.26	5	0 - 1
TOC	24.1	107.2	41.9	8.8	5	35.1 - 55.8	4.5	2.7	3.6	5	0.3 - 9.0
UV254	0.519	2.350	1.177	0.312	5	0.816 - 1.680	0.015	0.013	0.008	5	0.005 - 0.024
SUVA	2.29	NA	2.84	0.60	5.00	1.79 - 3.28	1.19	1.21	0.70	5.00	0.05 - 1.80

WQP	Stage 3 Influent						Stage 3 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.26	0.02	5	0.24 - 0.28					
pH	5.9	6.2	6.1	0.1	5	6.0 - 6.3	5.6	5.6	0.1	5.0	5.4 - 5.7
Temp	29.0	29.0	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	47	207	136	16	5	116 - 156	17	27	1	5	25 - 28
TDS	296	1373	931	41	5	870 - 984	35	103	4	5	98 - 108
TotHard	292	1665	1119	93	5	1020 - 1267	20	58	4	5	54 - 64
CaHard	275	1506	1034	49	5	970 - 1094	17	54	4	5	48 - 58
Turb	14.62	58.45	46.42	16	5	24.60 - 63.00	0.66	0.42	0.29	5	0 - 1
TOC	24.1	107.2	63.9	20.8	5	52.5 - 101.0	4.5	4.3	2.9	5	0.3 - 8.3
UV254	0.519	2.350	1.840	0.234	5	1.510 - 2.030	0.015	0.036	0.006	5	0.026 - 0.043
SUVA	2.29	NA	3.12	0.95	5.00	1.50 - 3.71	1.19	3.64	6.47	5.00	0.40 - 15.20

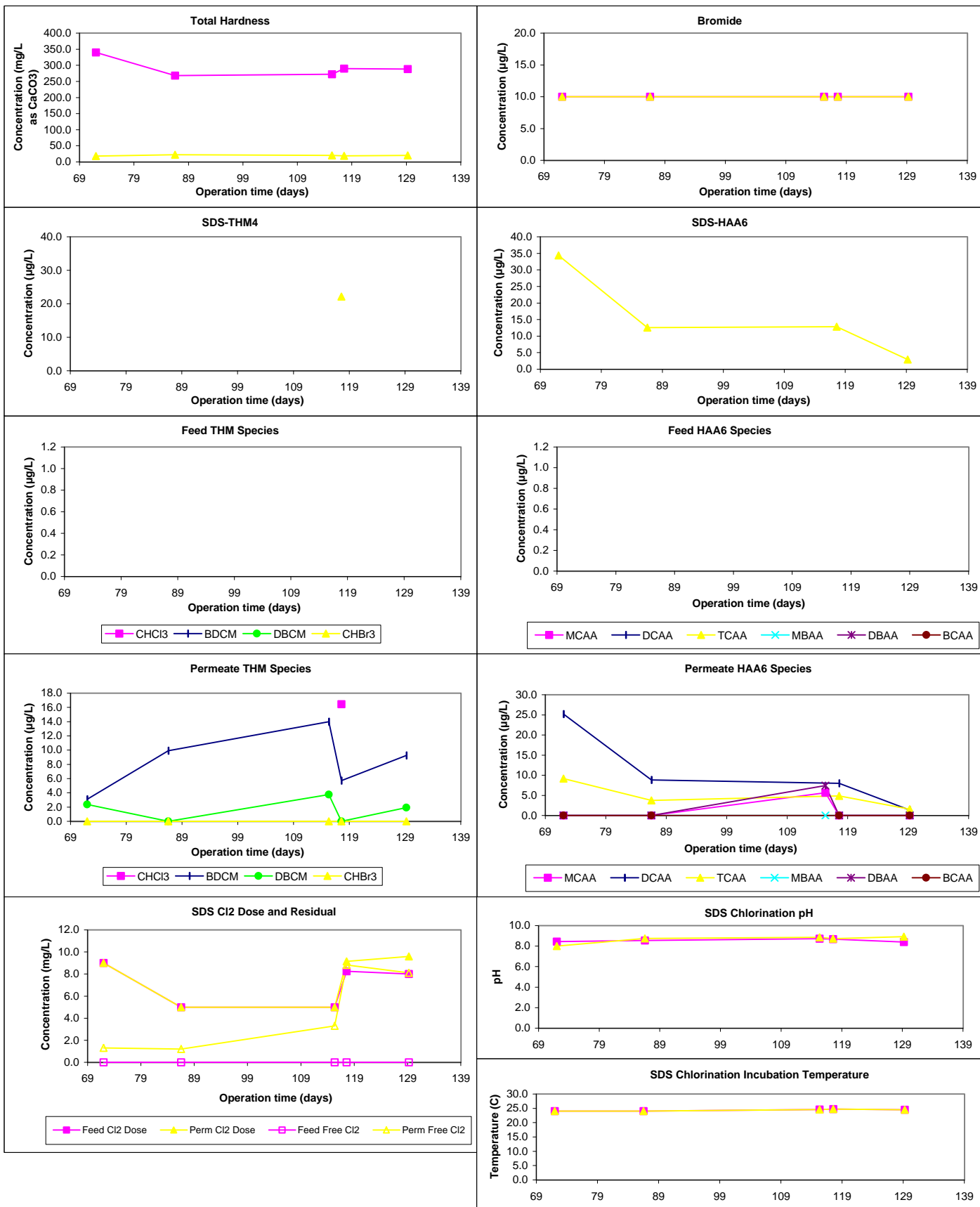
Chart Legend:

- Feed (System)
- ▲ Permeate (System)

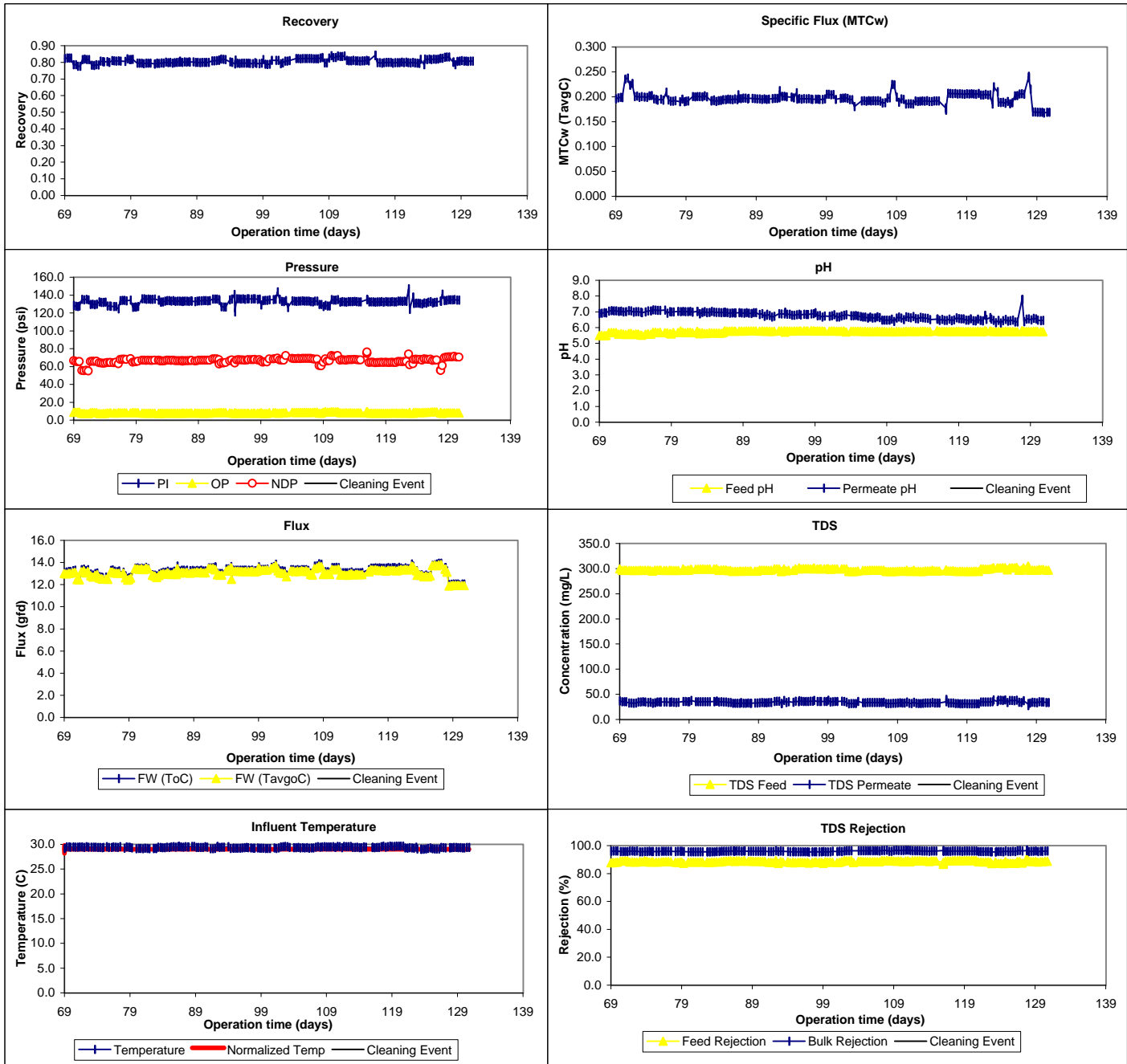
Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL4131618 / 1080
 ICR Contact: Gerald Weber
 Phone No.: 954 786-4061
 Period: 10/11/98 - 12/19/98 (69 days)

Membrane Information

Manufacturer: FLUID SYSTEMS CORP.
 Trade Name: FLUID SYSTEMS
 Membrane Model: 2540 TFCS / 4921 TFCS
 MWCO: 200 Daltons
 Element Size: 4" x 40"
 Element Area: 79.0 ft²
 Design Flux: 17.9 gfd
 Mfr. NDP: 80.0 psi
 Mfr. MTC_w: 0.130 (gfd/psi)
 Mfr. Temp: 30.0 °C
 Maximum Flow: 16.0 gpm
 Minimum Flow: 4.0 gpm
 Total Width : 14.4 ft
 Feed Spacer Thickness: 0.0029 ft
 840 Element Area 330.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 29.0 °C
 Temp Norm MTC-w: 0.126 TavGC
 Design Recovery: 0.80
 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: 2.8 psi
 Osmotic P Stage 2: 5.0 psi
 Osmotic P Stage 3: 9.0 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	5.3	0.4	5	4.9 - 5.9	5.2	0.3	5	4.7 - 5.4	5.6	0.6	5	4.7 - 6.1
Temp	29.0	0.0	5	29.0 - 29.0	29.0	0.0	5	29.0 - 29.0	29.0	0.0	5	29.0 - 29.0
Alk	36	12	4	26 - 50	16	3	5	14 - 20	150	48	5	68 - 186
TDS	324	22	5	295 - 353	40	5	5	35 - 47	1350	76	5	1260 - 1470
TotHard	295	13	5	280 - 310	16	2	5	14 - 18	1656	151	5	1400 - 1760
CaHard	280	15	5	256 - 296	15	2	5	14 - 18	1460	209	5	1100 - 1620
Turb	1.46	0.7	5	0.73 - 2.45	0.27	0.1	5	0.17 - 0.36	21.94	5.7	5	11.70 - 24.70
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0
TOC	14.6	2.1	3	12.3 - 16.6	NA	NA	0	0.0 - 0.0	78.2	9.6	5	68.9 - 92.6
UV254	0.465	0.0	4	0.424 - 0.495	0.005	0.0	5	0.005 - 0.005	2.370	0.4	5	1.880 - 2.640
SUVA	NA	NA	2	NA	NA	NA	0	NA	3.07	0.64	5	2.49 - 3.83
Bromide	10	0	5	10 - 10	10	0	5	10 - 10				
TOX	NA	NA	0	0 - 0	NA	NA	0	0 - 0				
CHCl3	NA	NA	0	NA	25.2	0.7	2	24.7 - 25.7	Mass Balance			
BDCM	NA	NA	0	NA	10.0	1.1	5	8.1 - 10.9	Closure Errors (%)			
DBCM	NA	NA	0	NA	4.5	1.0	5	2.9 - 5.8	WQP	Count	Avg	SD/RD
CHBr3	NA	NA	0	NA	0.0	0.0	5	0.0 - 0.0	Alk	5	30	43
THM4	NA	NA	0	NA	41.1	1.8	2	39.9 - 42.4	TDS	5	-14	14
MCAA	NA	NA	0	NA	2.1	4.7	5	0.0 - 10.4	TotHard	5	10	10
DCAA	NA	NA	0	NA	5.9	0.4	4	5.2 - 6.1	CaHard	5	2	17
TCAA	NA	NA	0	NA	2.3	0.9	4	1.3 - 3.6	Turb	5	69	13
MBAA	NA	NA	0	NA	1.5	3.4	5	0.0 - 7.7	Amm	0	n/a	n/a
DBAA	NA	NA	0	NA	0.5	1.2	5	0.0 - 2.7	TOC	2	74	2
BCAA	NA	NA	0	NA	0.9	1.2	5	0.0 - 2.6	UV254	1	79	n/a
TBAA	NA	NA	0	NA	0.0	0.0	5	0.0 - 0.0				
CDBAA	NA	NA	0	NA	0.0	0.0	5	0.0 - 0.0	TDS _t	98	-8	6
DCBAA	2.6	NA	1	2.6 - 2.6	0.0	0.0	5	0.0 - 0.0	Comments:			
HAA5	NA	NA	0	NA	8.0	0.6	3	7.2 - 8.3				
HAA6	NA	NA	0	NA	8.0	0.6	3	7.2 - 8.3				
HAA9	NA	NA	0	NA	8.0	0.6	3	7.2 - 8.3				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process	Description	Scale					
Res (5)	2.66	2.85	10	0.00 - 6.47	Cartridge filtration	1 micron	Pilot - scale					
Temp (°C)	25.0	0.0	10	25.0 - 25.0	sulfuric acid addition	pH = 5.7, Dosage= 42 mg/L	Pilot - scale					
pH (unit)	8.8	0.2	10	8.6 - 9.1								
Time (hr)	72.0	0.0	10	72.0 - 72.0								

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	#VALUE!	#VALUE!	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	#VALUE!	#VALUE!	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	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Stg 2 Conc - Stg 3 Inf	#REF!	#REF!	Stg 2 Conc - Stg 3 Inf	-2.5%	11.5%	Stg 2 Conc - Stg 3 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Per	-21.2%	2.1%	Sys Perm - Avg Stg Perm	-171.2%	1.6%

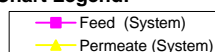
Stage Summary

WQP	Stage 1 Influent						Stage 1 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.50	0.03	5	0.46 - 0.53					
pH	5.3	5.6	5.3	0.4	5	4.9 - 5.9	5.2	5.1	0.2	5	4.9 - 5.4
Temp	29.0	29.0	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	36	150	32	14	5	14 - 50	16	16	3	5	12 - 18
TDS	324	1350	324	22	5	295 - 353	40	27	8	5	23 - 42
TotHard	295	1656	297	13	5	280 - 310	16	15	3	5	12 - 18
CaHard	280	1460	282	16	5	256 - 296	15	13	3	5	10 - 16
Turb	1.46	21.94	1.57	1	5	0.73 - 2.45	0.27	0.33	0.13	5	0 - 0
TOC	14.6	78.2	30.4	22.0	5	14.9 - 68.0	NA	9.2	8.7	5	2.2 - 21.7
UV254	0.465	2.370	0.418	0.120	4	0.240 - 0.495	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	NA	3.07	NA	NA	4	NA	NA	0.11	0.08	5	0.02 - 0.20

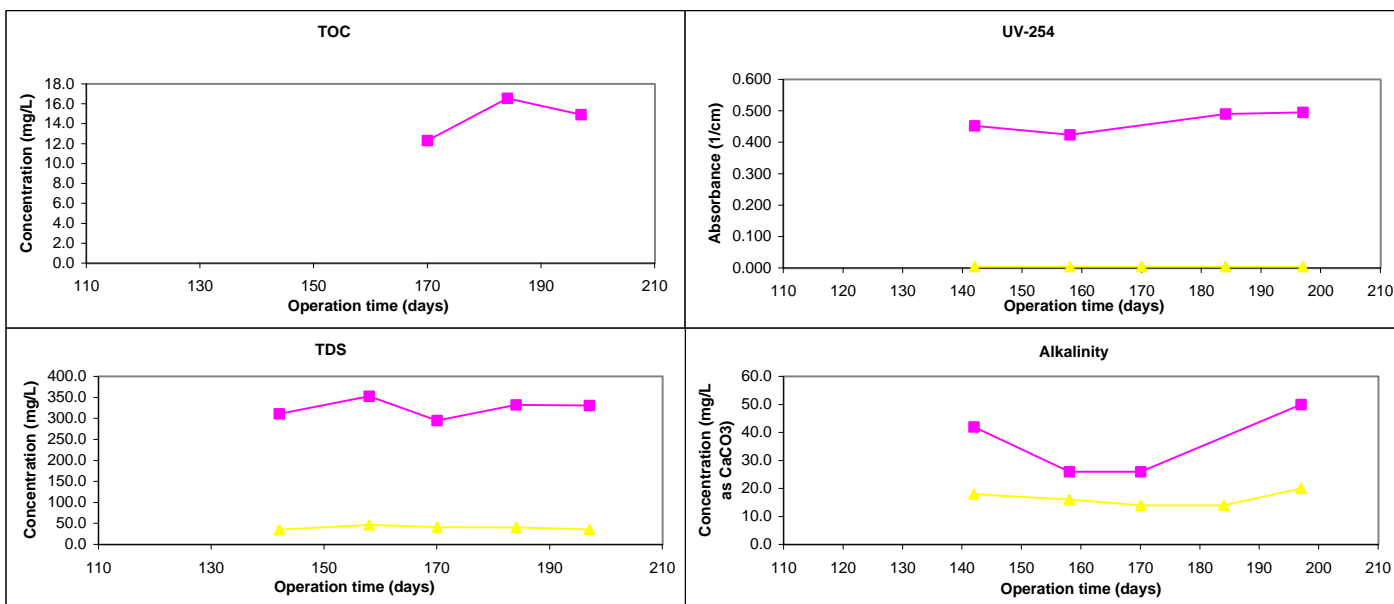
WQP	Stage 2 Influent						Stage 2 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			16.24	23.77	5	0.47 - 54.00					
pH	5.3	5.6	5.6	0.3	5	5.3 - 5.9	5.2	5.0	0.2	5	4.7 - 5.2
Temp	29.0	29.0	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	36	150	58	14	5	38 - 76	16	17	3	5	13 - 20
TDS	324	1350	565	58	5	500 - 649	40	39	5	5	35 - 47
TotHard	295	1656	660	226	5	500 - 1060	16	16	2	5	14 - 18
CaHard	280	1460	614	190	5	480 - 950	15	15	2	5	13 - 18
Turb	1.46	21.94	14.63	21	5	2.43 - 52.60	0.27	0.32	0.19	5	0 - 1
TOC	14.6	78.2	26.5	1.2	5	25.6 - 28.5	NA	8.3	6.3	5	0.8 - 17.7
UV254	0.465	2.370	0.863	0.091	5	0.708 - 0.931	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	NA	3.07	3.26	0.38	5.00	2.69 - 3.62	NA	0.15	0.23	5.00	0.03 - 0.56

WQP	Stage 3 Influent						Stage 3 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			2.85	5.75	5	0.26 - 13.13					
pH	5.3	5.6	5.6	0.3	5	5.1 - 6.0	5.2	5.2	0.2	5.0	5.0 - 5.4
Temp	29.0	29.0	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	36	150	78	49	5	26 - 130	16	22	6	5	13 - 29
TDS	324	1350	981	76	5	890 - 1099	40	107	10	5	97 - 124
TotHard	295	1656	776	421	5	140 - 1120	16	55	12	5	44 - 76
CaHard	280	1460	724	398	5	128 - 1080	15	52	10	5	42 - 69
Turb	1.46	21.94	20.72	31	5	1.12 - 75.10	0.27	0.31	0.08	5	0 - 0
TOC	14.6	78.2	55.4	9.2	5	48.7 - 71.5	NA	5.1	4.7	5	1.0 - 13.2
UV254	0.465	2.370	1.668	0.204	5	1.430 - 1.870	0.005	0.024	0.010	5	0.014 - 0.041
SUVA	NA	3.07	3.07	0.61	5.00	2.45 - 3.74	NA	0.74	0.59	5.00	0.31 - 1.76

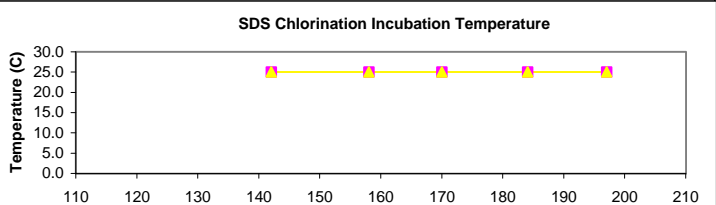
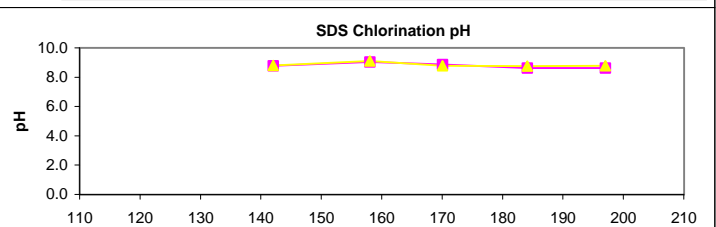
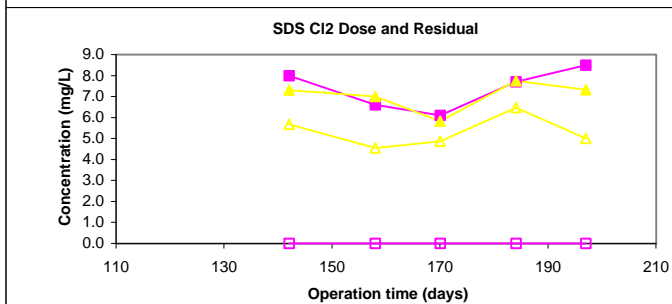
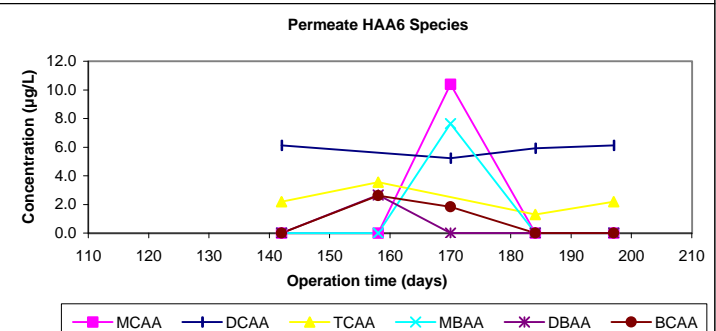
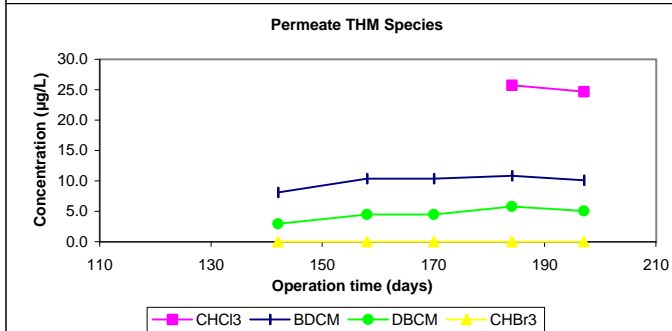
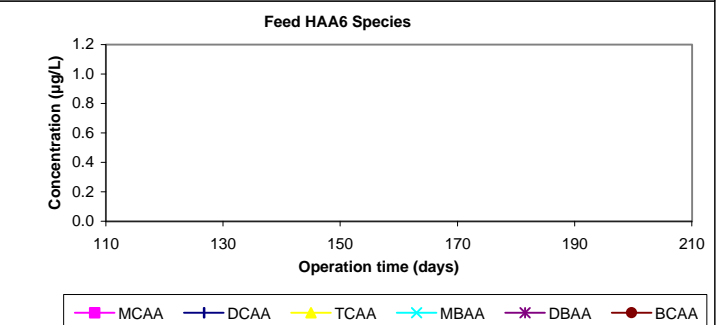
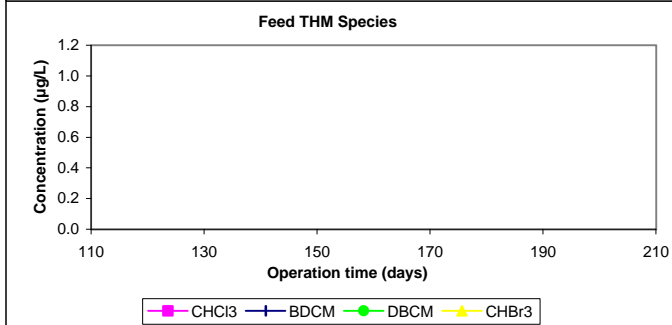
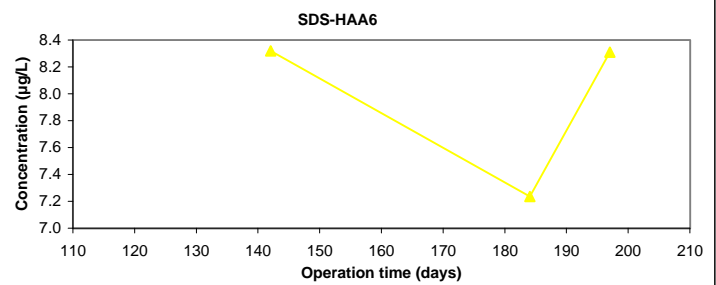
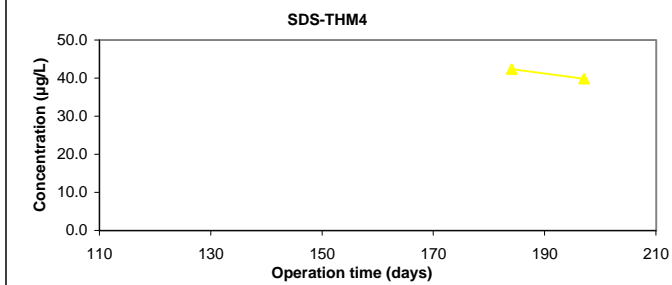
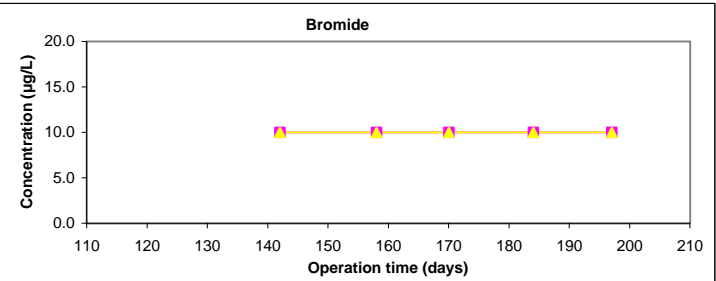
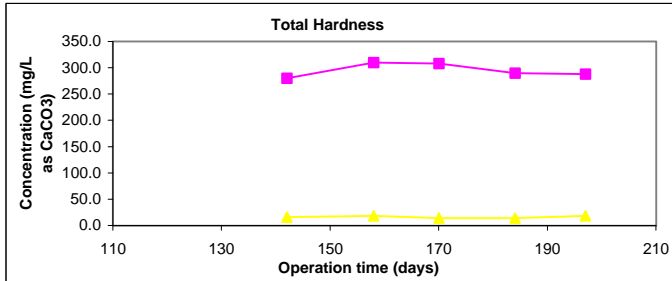
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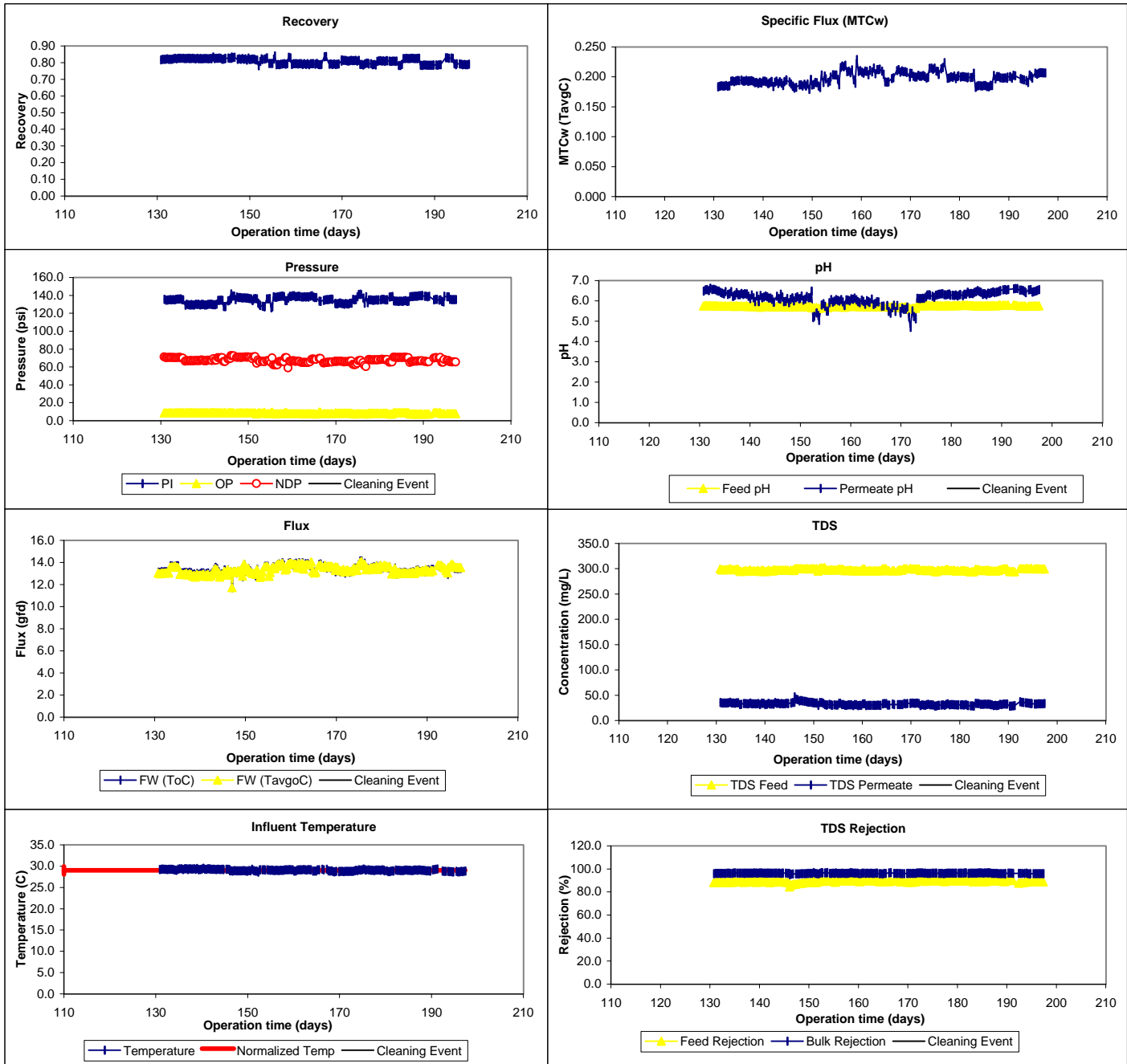
Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL4131618 / 1080
 ICR Contact: Gerald Weber
 Phone No.: 954 786-4061
 Period: 12/20/98 - 3/6/99 (76 days)

Membrane Information

Manufacturer: FLUID SYSTEMS CORP.
 Trade Name: FLUID SYSTEMS
 Membrane Model: 2540 TFCS / 4921 TFCS
 MWCO: 200 Daltons
 Element Size: 4" x 40"
 Element Area: 79.0 ft²
 Design Flux: 17.9 gfd
 Mfr. NDP: 80.0 psi
 Mfr. MTC_w: 0.130 (gfd/psi)
 Mfr. Temp: 30.0 °C
 Maximum Flow: 16.0 gpm
 Minimum Flow: 4.0 gpm
 Total Width : 14.4 ft
 Feed Spacer Thickness: 0.0029 ft
 840 Element Area 330.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 29.0 °C
 Temp Norm MTC-w: 0.126 TavGC
 Design Recovery: 0.80
 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: 2.8 psi
 Osmotic P Stage 2: 5.0 psi
 Osmotic P Stage 3: 9.0 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	5.6	0.2	5	5.3 - 6.0	5.1	0.4	5	4.7 - 5.7	5.6	0.5	5	4.9 - 6.1
Temp	29.0	0.0	5	29.0 - 29.0	29.0	0.0	5	29.0 - 29.0	29.0	0.0	5	29.0 - 29.0
Alk	48	8	4	36 - 54	17	3	4	12 - 20	120	58	5	32 - 160
TDS	366	27	4	326 - 384	36	2	5	33 - 39	1318	123	5	1160 - 1500
TotHard	312	22	5	288 - 340	17	2	5	14 - 20	1428	240	5	1240 - 1700
CaHard	298	22	5	276 - 328	16	2	5	14 - 18	1272	179	5	1100 - 1500
Turb	2.27	2.2	5	0.14 - 6.08	0.38	0.4	5	0.07 - 0.93	41.70	17.1	5	26.00 - 63.00
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0
TOC	13.2	2.4	3	10.9 - 15.7	0.6	0.6	3	0.3 - 1.4	127.8	58.2	5	75.7 - 191.0
UV254	0.538	0.0	3	0.501 - 0.581	0.008	0.0	5	0.005 - 0.015	2.708	0.2	5	2.570 - 3.130
SUVA	NA	NA	2	NA	NA	NA	3	NA	2.51	1.11	5	1.37 - 3.73
Bromide	10	0	2	10 - 10	10	0	5	10 - 10				
TOX	NA	NA	0	0 - 0	NA	NA	0	0 - 0				
CHCl3	NA	NA	0	NA	29.1	4.7	5	25.4 - 37.4	Mass Balance			
BDCM	NA	NA	0	NA	13.3	3.5	5	9.4 - 16.7	Closure Errors (%)			
DBCM	NA	NA	0	NA	6.0	4.9	5	0.0 - 11.8	WQP	Count	Avg	SD/RD
CHBr3	NA	NA	0	NA	0.2	0.5	5	0.0 - 1.0	Alk	4	-26	29
THM4	NA	NA	0	NA	48.6	9.2	5	37.5 - 58.2	TDS	4	-31	11
MCAA	NA	NA	0	NA	0.5	1.1	5	0.0 - 2.6	TotHard	5	-7	6
DCAA	NA	NA	0	NA	4.6	2.0	4	2.6 - 6.6	CaHard	5	-14	6
TCAA	NA	NA	0	NA	7.8	12.1	4	1.0 - 26.0	Turb	5	75	19
MBAA	NA	NA	0	NA	0.0	0.0	5	0.0 - 0.0	Amm	0	n/a	n/a
DBAA	NA	NA	0	NA	0.5	1.0	5	0.0 - 2.3	TOC	2	44	30
BCAA	NA	NA	0	NA	3.9	5.0	5	0.0 - 11.0	UV254	2	5	1
TBAA	NA	NA	0	NA	0.0	0.0	5	0.0 - 0.0	TDS _t	99	3	5
CDBAA	NA	NA	0	NA	3.2	6.0	5	0.0 - 13.9	Comments:			
DCBAA	NA	NA	0	NA	3.3	7.3	5	0.0 - 16.3				
HAA5	NA	NA	0	NA	12.4	10.9	4	4.3 - 28.6				
HAA6	NA	NA	0	NA	15.5	16.2	4	4.3 - 39.6				
HAA9	NA	NA	0	NA	18.9	23.1	4	4.3 - 53.5				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process	Description					Scale	
Res (2)	4.52	3.85	7	0.00 - 8.00	Cartridge filtration	1 micron					Pilot - scale	
Temp (°C)	24.8	0.4	10	24.0 - 25.0	sulfuric acid addition	pH = 5.7, Dosage= 42 mg/L					Pilot - scale	
pH (unit)	8.7	0.1	4	8.5 - 8.8								
Time (hr)	72.0	0.0	10	72.0 - 72.0								

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	#VALUE!	#VALUE!	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 3 Conc	0.0%	0.0%	Sys Conc - Stg 3 Conc	#VALUE!	#VALUE!	Sys Conc - Stg 3 Conc	#REF!	#REF!
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Stg 2 Conc - Stg 3 Inf	0.0%	0.0%	Stg 2 Conc - Stg 3 Inf	-2.6%	10.3%	Stg 2 Conc - Stg 3 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Per	-22.0%	2.0%	Sys Perm - Avg Stg Perm	-171.5%	2.3%

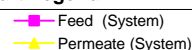
Stage Summary

	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			NA	NA	5	NA					
pH	5.6	5.6	5.7	0.2	5	5.5 - 6.0	5.1	5.0	0.5	5	4.7 - 5.8
Temp	29.0	29.0	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	48	120	74	50	5	36 - 160	17	15	2	5	14 - 18
TDS	366	1318	967	1209	4	326 - 2780	36	29	3	5	26 - 33
TotHard	312	1428	502	413	5	288 - 1240	17	13	4	5	10 - 18
CaHard	298	1272	463	357	5	276 - 1100	16	12	2	5	10 - 16
Turb	2.27	41.70	7.09	11	5	0.14 - 26.00	0.38	0.34	0.16	5	0 - 0
TOC	13.2	127.8	52.5	78.4	5	4.8 - 191.0	0.6	4.3	5.5	5	0.3 - 13.9
UV254	0.538	2.708	1.060	1.040	4	0.508 - 2.620	0.008	0.005	0.000	5	0.005 - 0.005
SUVA	NA	2.51	NA	NA	4	NA	NA	0.50	0.73	5	0.03 - 1.80

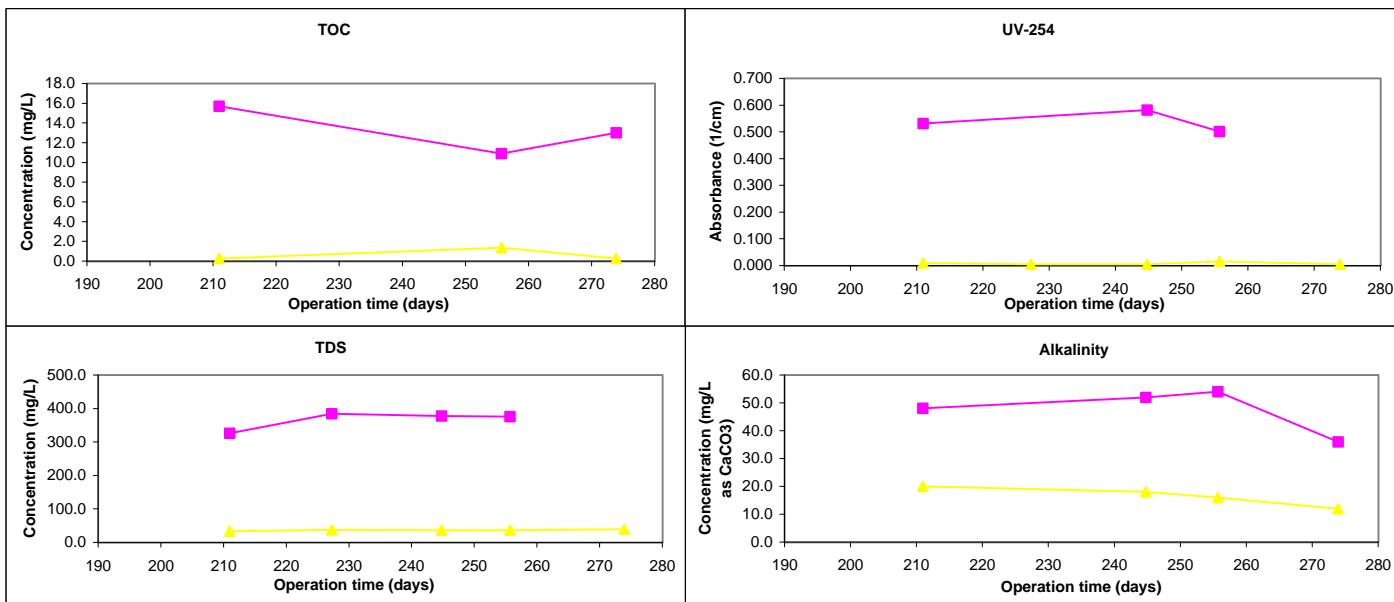
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			NA	NA	5	NA					
pH	5.6	5.6	5.5	0.5	5	5.0 - 6.2	5.1	5.0	0.3	5	4.8 - 5.6
Temp	29.0	29.0	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	48	120	76	42	5	20 - 116	17	18	2	5	16 - 20
TDS	366	1318	772	235	5	561 - 1050	36	40	11	5	32 - 58
TotHard	312	1428	764	227	5	550 - 1010	17	21	3	5	18 - 24
CaHard	298	1272	710	238	5	520 - 970	16	18	1	5	16 - 18
Turb	2.27	41.70	18.27	22	5	0.55 - 41.80	0.38	0.40	0.39	5	0 - 1
TOC	13.2	127.8	50.9	19.6	5	30.0 - 71.5	0.6	4.1	6.0	5	1.2 - 14.8
UV254	0.538	2.708	1.108	0.112	5	0.982 - 1.220	0.008	0.011	0.011	5	0.005 - 0.030
SUVA	NA	2.51	2.42	0.85	5.00	1.71 - 3.70	NA	0.61	0.79	5.00	0.06 - 2.00

	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			NA	NA	5	NA					
pH	5.6	5.6	5.8	0.5	5	4.9 - 6.3	5.1	5.2	0.3	5.0	5.0 - 5.8
Temp	29.0	29.0	29.0	0.0	5	29.0 - 29.0	29.0	29.0	0.0	5	29.0 - 29.0
Alk	48	120	100	45	5	32 - 132	17	26	4	5	18 - 28
TDS	366	1318	1015	66	5	931 - 1110	36	83	46	5	26 - 122
TotHard	312	1428	1014	30	5	980 - 1050	17	50	15	5	28 - 70
CaHard	298	1272	956	55	5	880 - 1020	16	50	16	5	26 - 68
Turb	2.27	41.70	27.26	2	5	25.20 - 30.80	0.38	0.37	0.26	5	0 - 1
TOC	13.2	127.8	107.1	62.7	5	50.6 - 175.0	0.6	15.5	9.8	5	1.5 - 28.6
UV254	0.538	2.708	2.120	0.287	5	1.720 - 2.330	0.008	0.056	0.051	5	0.005 - 0.110
SUVA	NA	2.51	2.50	1.20	5.00	1.33 - 3.98	NA	0.73	0.87	5.00	0.02 - 2.20

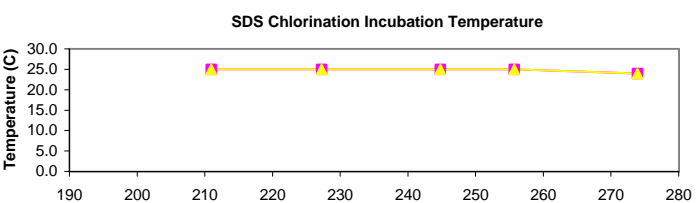
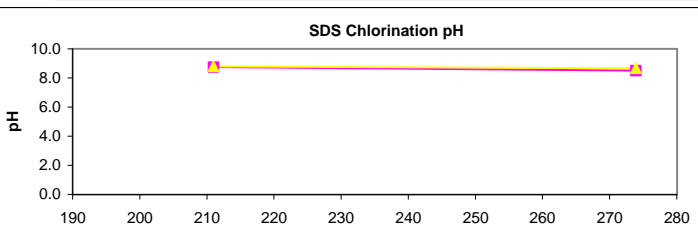
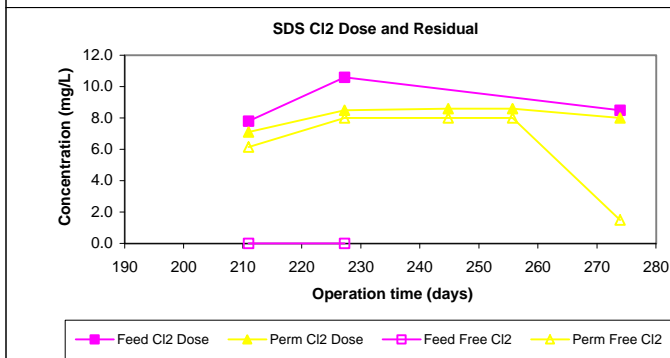
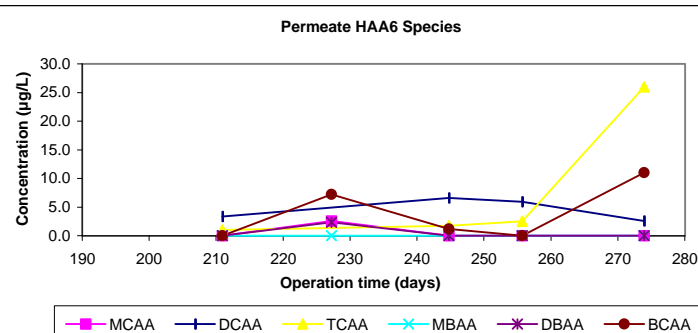
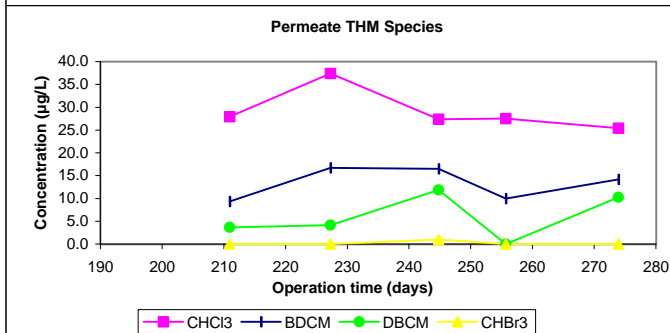
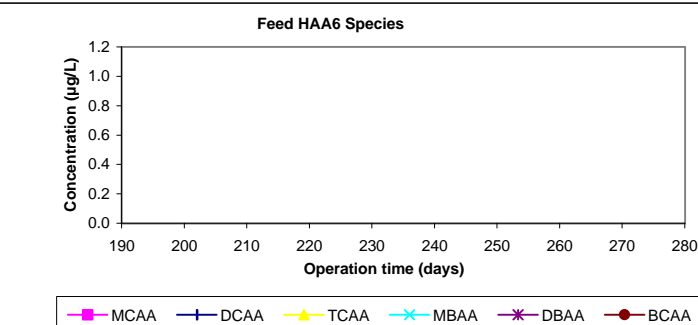
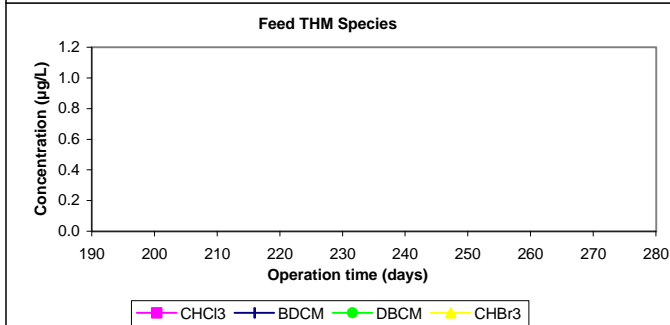
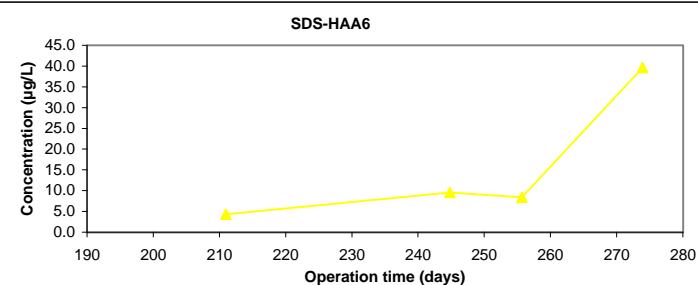
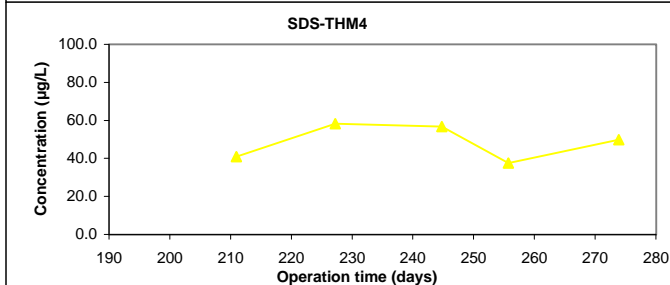
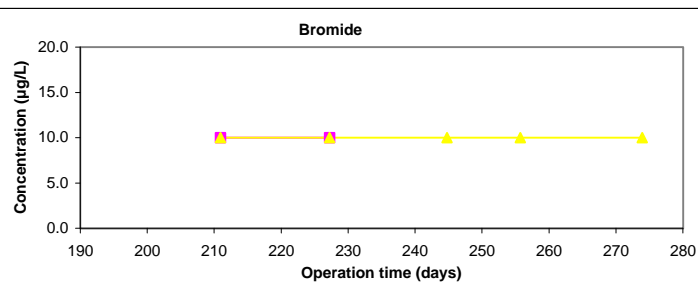
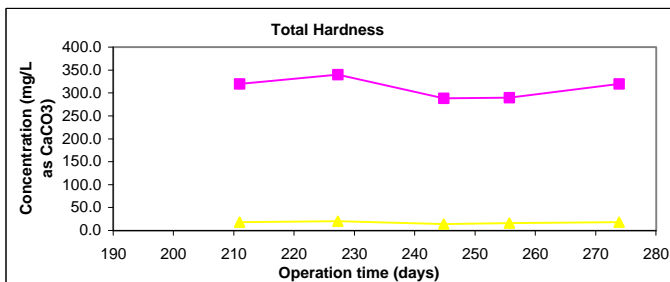
Chart Legend:



Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs

