

ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID	4211
Study Protocol	Single-Element Bench-Scale Membrane Study
Plant ICR Number	283
PWS Name	City of Melbourne Water System
City, State, Zip	Melbourne, FL 32934

General Comments:

1. This study was grandfathered into the ICR, and therefore does not meet all of the specific requirements listed in the ICR and rule-by-reference manuals. This single-element study (study ID 4211) was conducted in conjunction with two pilot-scale studies (study IDs 4011 and 4111). This study was part of a larger study conducted by the University of Central Florida for the USEPA Risk Reduction Engineering Laboratory, published in a report entitled *“Reduction of Disinfection By-Product Precursors by Nanofiltration”* in April 1992 (EPA/600/SR-92/023).
2. The Osmonics Desal DK4040F (formerly known as the Desal DS5) was evaluated during this study, using a surface water source with an average TOC of 20 mg/L. Due to the nature of this raw water source, advanced membrane pretreatment was used, consisting of microfiltration followed by pH adjustment and cartridge filtration. A schematic of this integrated membrane system is shown in Figure 2 of the Summary Report (Part 3).
3. This system was operated from August through October 1990.
4. Section 1 of the Summary Report (Part 3) lists the significant conclusions and recommendations from this study.
5. Cost information is provided in Section 4 and Tables 15 and 16 of the Summary Report (Part 3).

Water Quality Comments:

1. Nine water quality outliers were identified and removed prior to base analysis.
2. The reported target SDS conditions during this study were to dose and incubate the samples at 22°C, for 96 hours at a pH of 7.6, with a target residual of 0.2 mg/L. However, the

chlorination procedure was more like the Formation Potential test, than a SDS test, since only a measurable residual (i.e., above 0.2 mg/L) after 96 hours was necessary for DBPs to be analyzed from that sample. No measured residuals were reported during this study – only the presence of a residual.

3. The following parameters were not measured during this study: ammonia, UV_{254} , bromide, and BCAA (thus HAA6).

Productivity Comments:

1. Six productivity outliers were identified and removed prior to base analysis.
2. This membrane system was operated between 10 and 15 gfd, at recoveries ranging from 45 to 65%. The experimental design for this study (denoted as the AC-DS5) is listed in Table 7 (Part 3).
3. The membrane system was cleaned at the end of each operational cycle, using a phosphate detergent and NaOH solution.
4. During productivity analysis, the average slope and cleaning interval were calculated to be -1.89×10^{-3} gfd/psi/day and 23 days, respectively. This is similar to the average slope and cleaning interval calculated by the researchers -2.72×10^{-3} gfd/psi/day and 17 days, respectively
5. During productivity analysis, the average cleaning efficiency exceeded 100%, indicating essentially complete recovery of the flux lost during the operational cycle. The upper bound of 100% was entered for the cleaning efficiency in the database.

ICR Information

ID / ICR#: FL3051447 / 283
 ICR Contact: Mr. Ralph Sigman
 Phone No.: (407) 255-4623
 Period: 8/4/90 - 10/13/90 (70 days)

Membrane Information

Manufacturer: Osmonics Desal
 Trade Name: DS5
 Membrane Model: DK 4040F
 MWCO: 10 - 300 Daltons
 Element Size: 4" x 40"
 Element Area: 90.0 ft²
 Design Flux: 20.0 gfd
 Mfr. NDP: 100.0 psi
 Mfr. MTC_w: 0.200 (gfd/psi)
 Mfr. Temp: 25.0 °C
 Max Flow: 12.0 gpm
 Min Flow: 6.3 gpm
 Total Width: 16.0 ft
 Feed Sp Thickness: 0.0028 ft
 840 Element Area: 350.0 ft²
 840 Purchase Price: \$1,500

Design Parameters

Norm Temp: 24.5 °C
 Temp Norm MTC-w: 0.197 TavGC
 Design Recovery: 0.24
 Design Flux: 15.0 gfd
 Recycle Ratio: 0.02
 Manuf rep Rej_{TDS}: 38%
 TDS_F: 359.0 mg/L

Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	7.7	0.3	3	7.3 - 7.9	7.2	0.9	3	6.3 - 8.0	NA	NA	0	0.0 - 0.0
Temp	29.1	0.9	3	28.3 - 30.0	29.1	0.9	3	28.3 - 30.0	NA	NA	0	0.0 - 0.0
Alk	96	8	2	90 - 102	26	1	2	25 - 26	NA	NA	0	0 - 0
TDS	423	118	3	350 - 560	277	90	3	220 - 380	NA	NA	0	0 - 0
TotHard	150	26	3	130 - 180	69	25	3	54 - 97	NA	NA	0	0 - 0
CaHard	112	26	3	90 - 140	71	18	3	53 - 88	NA	NA	0	0 - 0
Turb	0.16	0.05	3	0.11 - 0.20	0.06	0.05	3	0.00 - 0.09	NA	NA	0	0.00 - 0.00
Amm	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0
TOC	24.3	5.5	3	18.0 - 28.0	0.3	0.0	3	0.3 - 0.3	NA	NA	0	0.0 - 0.0
UV254	NA	NA	0	0.000 - 0.000	NA	NA	0	0.000 - 0.000	NA	NA	0	0.000 - 0.000
SUVA	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	NA
Bromide	NA	NA	0	0 - 0	NA	NA	0	0 - 0	NA	NA	0	0 - 0
TOX	5467	802	3	4700 - 6300	54	7	3	48 - 62	Mass Balance Closure Errors (%)			
CHCl3	1063.3	209.8	3	900.0 - 1300.0	4.0	1.0	3	3.0 - 5.0				
BDCM	153.3	58.6	3	110.0 - 220.0	16.3	17.1	3	5.0 - 36.0	WQP Count Avg SD/RD			
DBCM	12.3	21.4	3	0.0 - 37.0	13.3	9.5	3	6.0 - 24.0	Alk	0	n/a	n/a
CHBr3	0.0	0.0	3	0.0 - 0.0	0.0	0.0	3	0.0 - 0.0	TDS	0	n/a	n/a
THM4	1229.0	210.6	3	1010.0 - 1430.0	33.7	26.7	3	14.0 - 64.0	TotHard	0	n/a	n/a
MCAA	28.7	26.4	3	0.0 - 52.0	3.0	5.2	3	0.0 - 9.0	CaHard	0	n/a	n/a
DCAA	476.7	106.9	3	360.0 - 570.0	1.7	2.9	3	0.0 - 5.0	Turb	0	n/a	n/a
TCAA	776.7	372.1	3	370.0 - 1100.0	1.7	1.5	3	0.0 - 3.0	Amm	0	n/a	n/a
MBAA	1.0	1.7	3	0.0 - 3.0	0.0	0.0	3	0.0 - 0.0	TOC	0	n/a	n/a
DBAA	8.3	11.0	3	2.0 - 21.0	13.3	12.7	3	2.0 - 27.0	UV254	0	n/a	n/a
BCAA	NA	NA	0	NA	NA	NA	0	NA	TDS _t 0 ##### #DIV/0!			
TBAA	NA	NA	0	NA	NA	NA	0	NA				
CDBAA	NA	NA	0	NA	NA	NA	0	NA	Comments:			
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
HAA5	1291.3	472.0	3	788.0 - 1724.0	19.7	16.3	3	2.0 - 34.0				
HAA6	NA	NA	0	NA	NA	NA	0	NA				
HAA9	NA	NA	0	NA	NA	NA	0	NA				

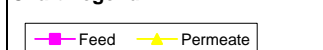
SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.20	0.00	6	0.20 - 0.20
Temp (°C)	22.0	0.0	6	22.0 - 22.0
pH (unit)	7.6	0.0	6	7.6 - 7.6
Time (hr)	96.0	0.0	6	96.0 - 96.0

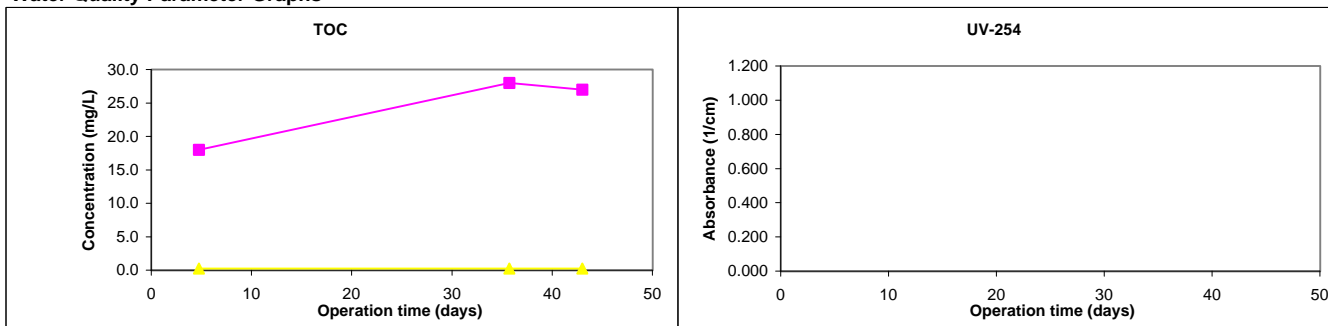
Pretreatment Information

Process	Description	Scale
Microfiltration	Memcor Crossflow Microfilter	Pilot-scale
Acid Feed	Sulfuric acid feed (pH 6)	Pilot-scale
Pre-filtration	Harmsco 5um Cartridge Filter	Pilot-scale

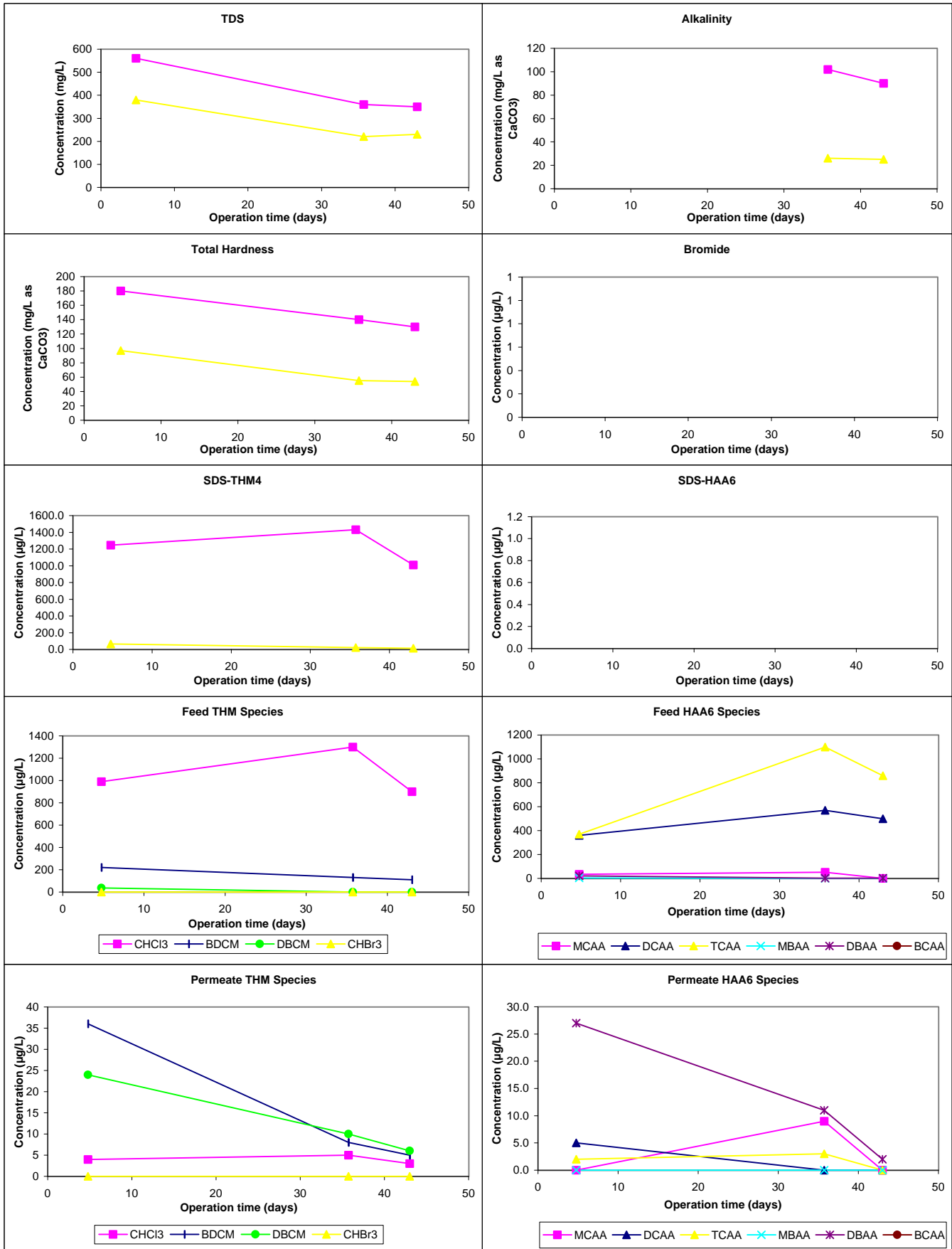
Chart Legend:



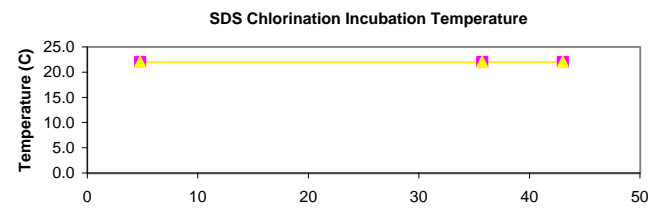
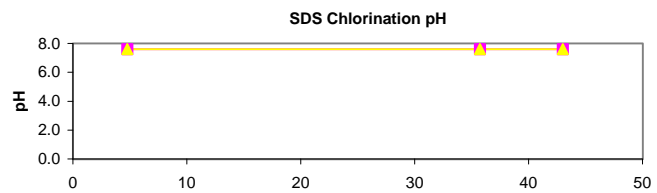
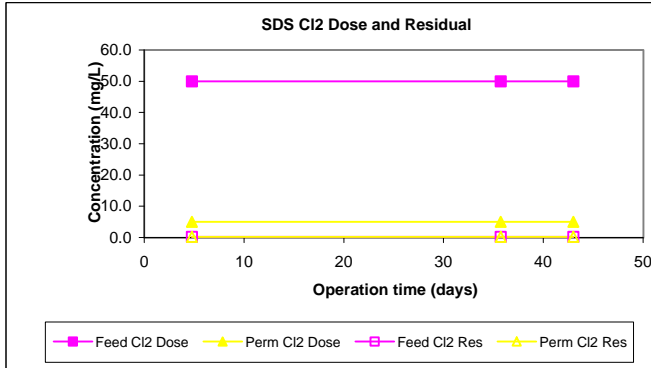
Water Quality Parameter Graphs



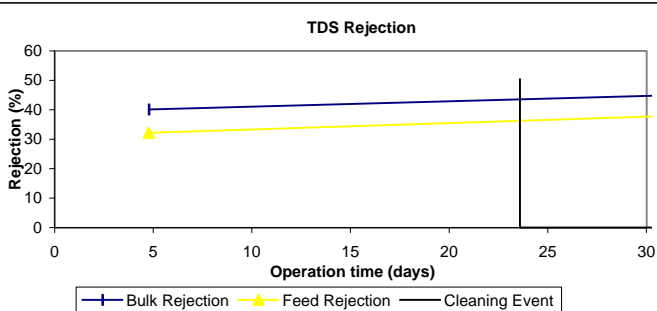
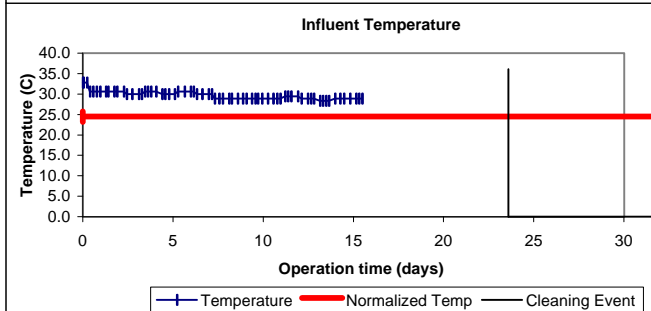
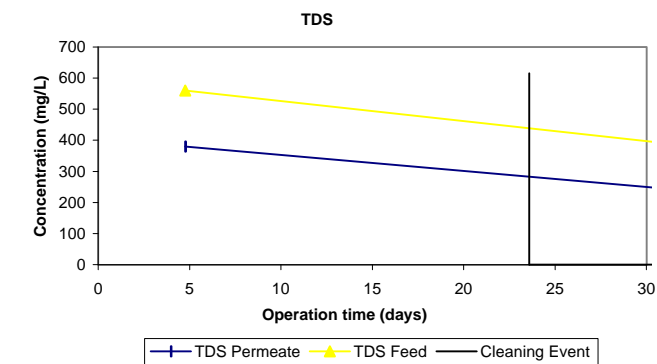
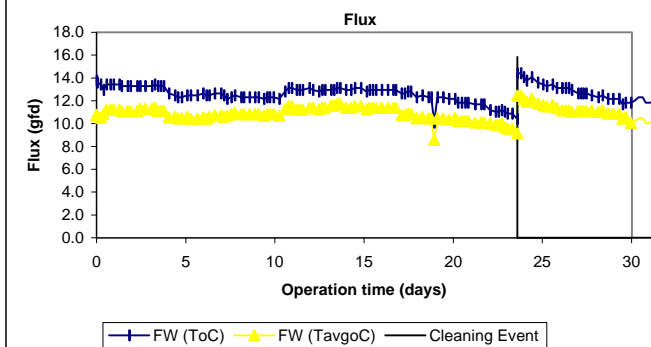
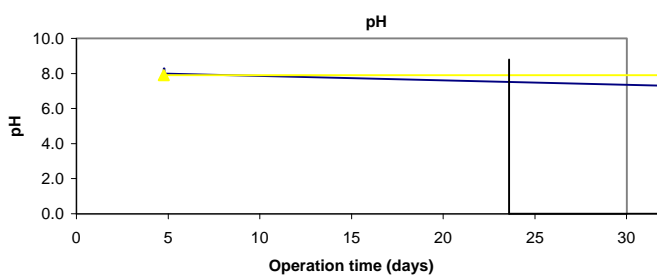
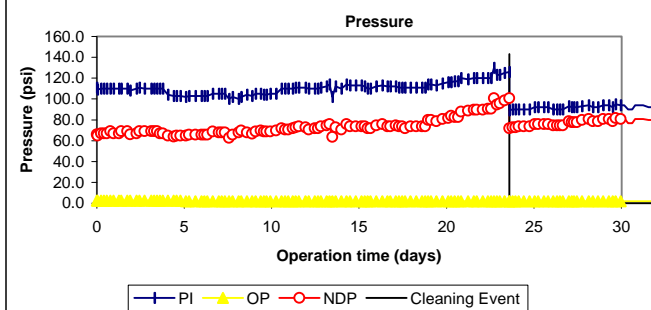
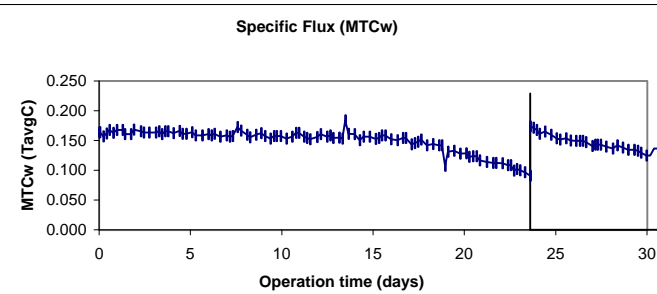
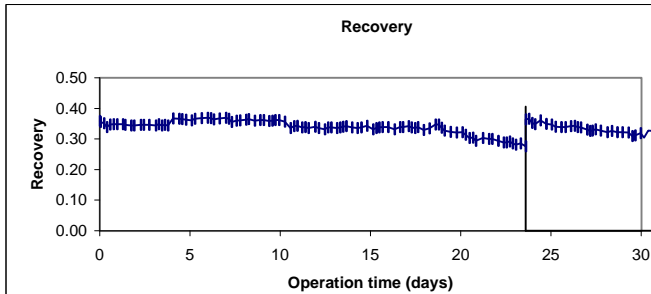
Water Quality Parameter Graphs (Continued)



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL3051447 / 283
 ICR Contact: Mr. Ralph Sigman
 Phone No.: (407) 255-4623
 Period: 10/14/90 - 12/23/90 (70 days)

Membrane Information

Manufacturer: Osmonics Desal
 Trade Name: DS5
 Membrane Model: DK 4040F
 MWCO: 10 - 300 Daltons
 Element Size: 4" x 40"
 Element Area: 90.0 ft²
 Design Flux: 20.0 gfd
 Mfr. NDP: 100.0 psi

Mfr. MTC_w: 0.200 (gfd/psi)
 Mfr. Temp: 25.0 °C
 Max Flow: 12.0 gpm
 Min Flow: 6.3 gpm
 Total Width: 16.0 ft
 Feed Sp Thickness: 0.0028 ft
 840 Element Area: 350.0 ft²
 840 Purchase Price: \$1,500

Design Parameters

Norm Temp: 24.5 °C
 Temp Norm MTC-w: 0.197 TavGC
 Design Recovery: 0.25
 Design Flux: 15.0 gfd

Recycle Ratio: 0.07
 Manuf rep Rej_{TDS}: 38%
 TDS_F: 359.0 mg/L

Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	7.8	0.2	2	7.6 - 7.9	6.7	0.2	2	6.5 - 6.8	NA	NA	0	0.0 - 0.0
Temp	21.4	0.4	2	21.1 - 21.7	21.4	0.4	2	21.1 - 21.7	NA	NA	0	0.0 - 0.0
Alk	89	4	2	86 - 91	35	23	2	18 - 51	NA	NA	0	0 - 0
TDS	340	NA	1	340 - 340	210	NA	1	210 - 210	NA	NA	0	0 - 0
TotHard	125	7	2	120 - 130	56	14	2	46 - 66	NA	NA	0	0 - 0
CaHard	96	4	2	93 - 98	52	13	2	43 - 61	NA	NA	0	0 - 0
Turb	0.21	0.10	2	0.14 - 0.28	0.32	0.45	2	0.00 - 0.64	NA	NA	0	0.00 - 0.00
Amm	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0
TOC	25.5	2.1	2	24.0 - 27.0	0.3	0.0	2	0.3 - 0.3	NA	NA	0	0.0 - 0.0
UV254	NA	NA	0	0.000 - 0.000	NA	NA	0	0.000 - 0.000	NA	NA	0	0.000 - 0.000
SUVA	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	NA
Bromide	NA	NA	0	0 - 0	NA	NA	0	0 - 0	NA	NA	0	NA
TOX	581.0	157.0	2	470.0 - 692.0	42	11	2	34 - 50	Mass Balance Closure Errors (%)			
CHCl3	835.0	176.8	2	710.0 - 960.0	3.0	1.4	2	2.0 - 4.0				
BDCM	127.5	34.6	2	103.0 - 152.0	9.5	7.8	2	4.0 - 15.0	WQP Count Avg SD/RD			
DBCM	3.0	4.2	2	0.0 - 6.0	7.5	2.1	2	6.0 - 9.0	Alk	0	n/a	n/a
CHBr3	0.0	0.0	2	0.0 - 0.0	1.5	2.1	2	0.0 - 3.0	TDS	0	n/a	n/a
THM4	965.5	207.2	2	819.0 - 1112.0	21.5	9.2	2	15.0 - 28.0	TotHard	0	n/a	n/a
MCAA	15.0	21.2	2	0.0 - 30.0	0.0	0.0	2	0.0 - 0.0	CaHard	0	n/a	n/a
DCAA	535.0	35.4	2	510.0 - 560.0	3.0	1.4	2	2.0 - 4.0	Turb	0	n/a	n/a
TCAA	1030.0	99.0	2	960.0 - 1100.0	0.0	0.0	2	0.0 - 0.0	Amm	0	n/a	n/a
MBAA	0.0	0.0	2	0.0 - 0.0	0.0	0.0	2	0.0 - 0.0	TOC	0	n/a	n/a
DBAA	1.5	2.1	2	0.0 - 3.0	2.0	0.0	2	2.0 - 2.0	UV254	0	n/a	n/a
BCAA	NA	NA	0	NA	NA	NA	0	NA	TDS _t 0 ##### #DIV/0!			
TBAA	NA	NA	0	NA	NA	NA	0	NA				
CDBAA	NA	NA	0	NA	NA	NA	0	NA	Comments:			
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
HAA5	1581.5	111.0	2	1503.0 - 1660.0	5.0	1.4	2	4.0 - 6.0				
HAA6	NA	NA	0	NA	NA	NA	0	NA				
HAA9	NA	NA	0	NA	NA	NA	0	NA				

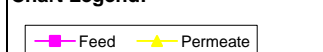
SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.20	0.00	4	0.20 - 0.20
Temp (°C)	22.0	0.0	4	22.0 - 22.0
pH (unit)	7.6	0.0	4	7.6 - 7.6
Time (hr)	96.0	0.0	4	96.0 - 96.0

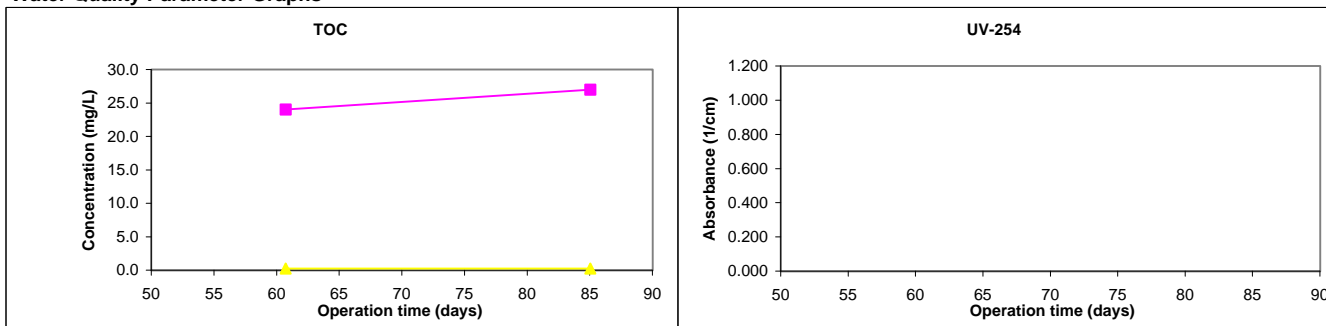
Pretreatment Information

Process	Description	Scale
Microfiltration	Memcor Crossflow Microfilter	Pilot-scale
Acid Feed	Sulfuric acid feed (pH 6)	Pilot-scale
Pre-filtration	Harmsco 5um Cartridge Filter	Pilot-scale

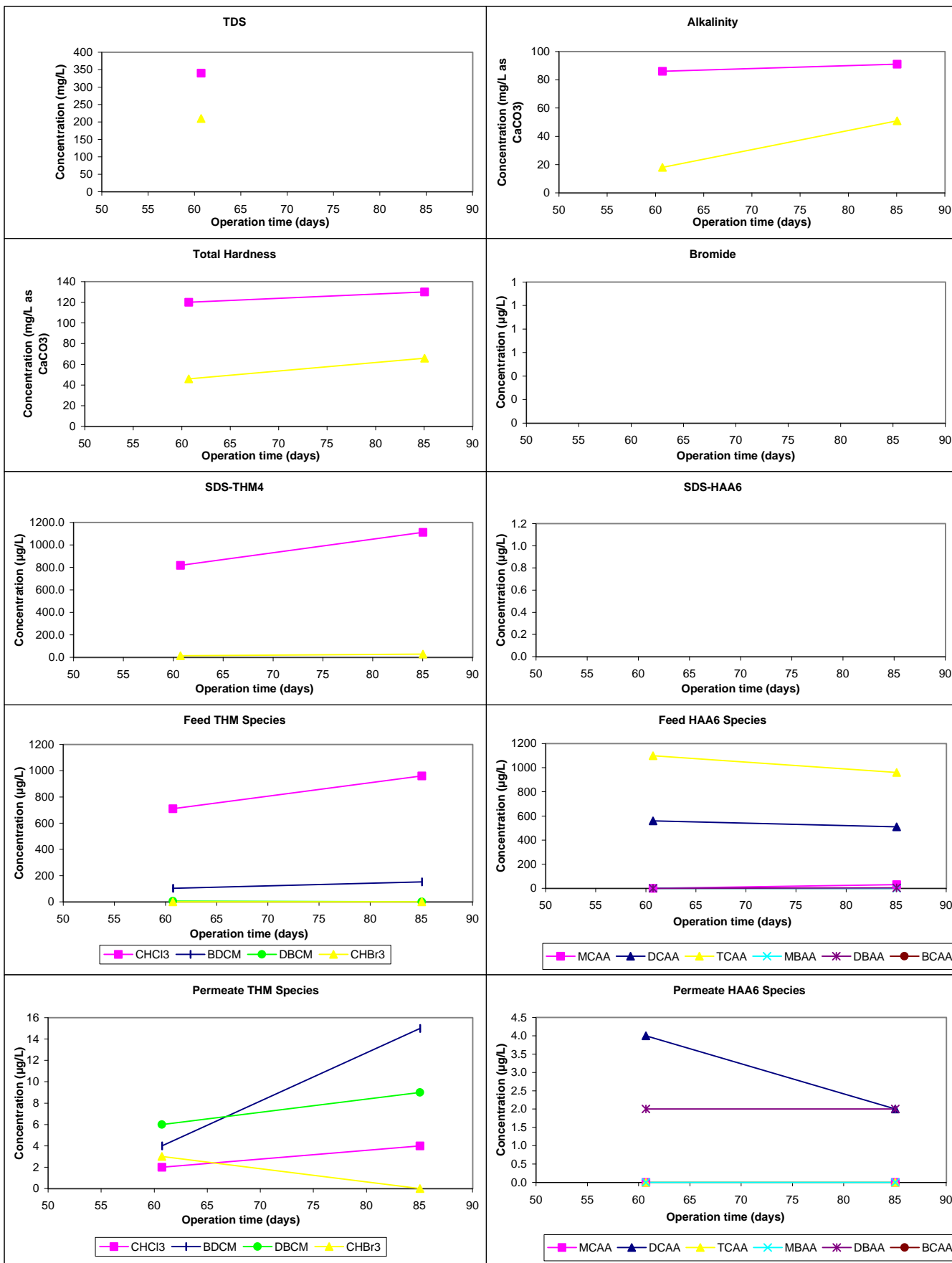
Chart Legend:



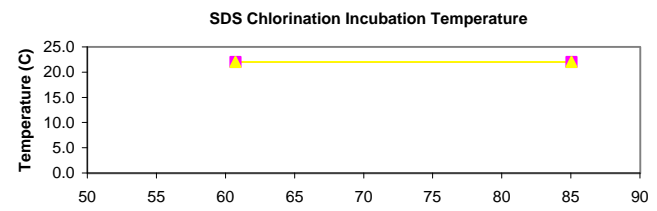
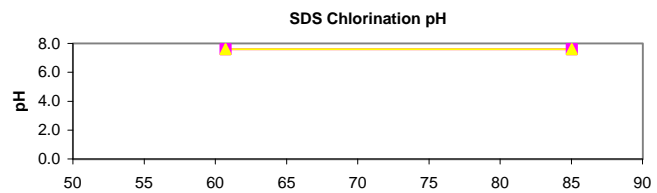
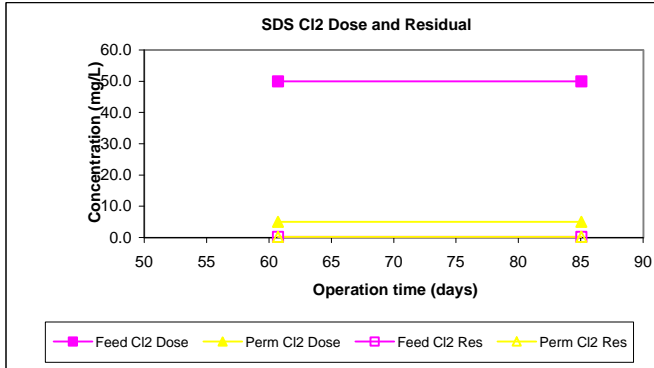
Water Quality Parameter Graphs



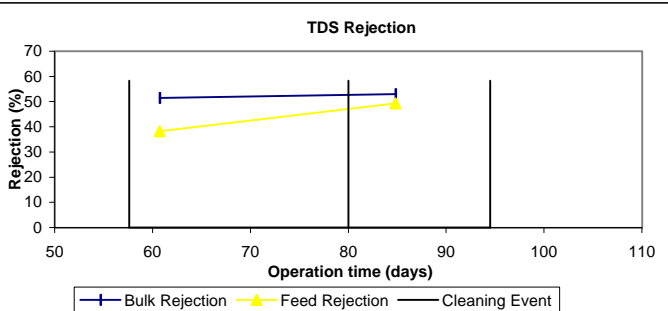
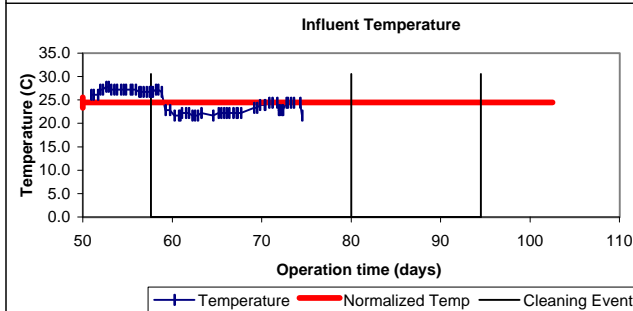
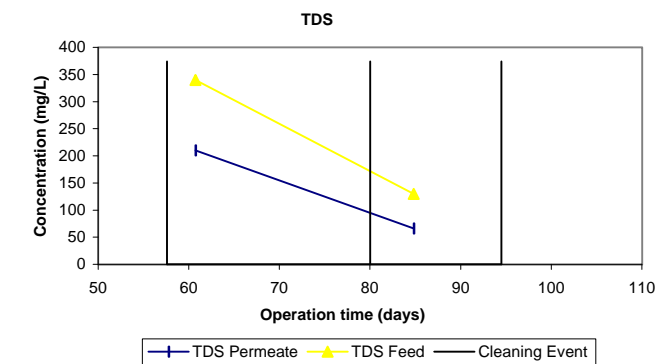
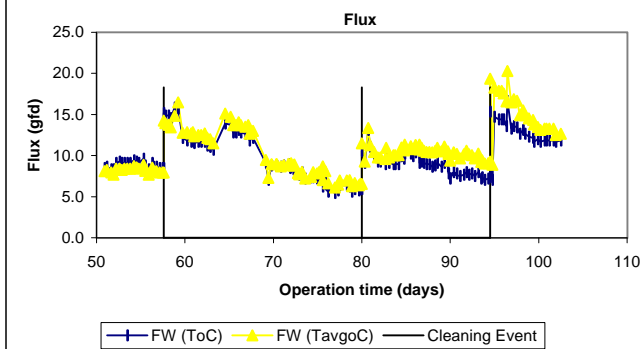
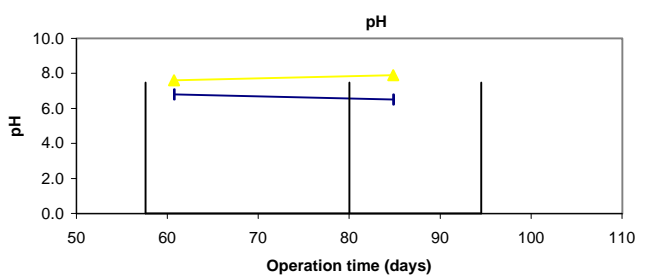
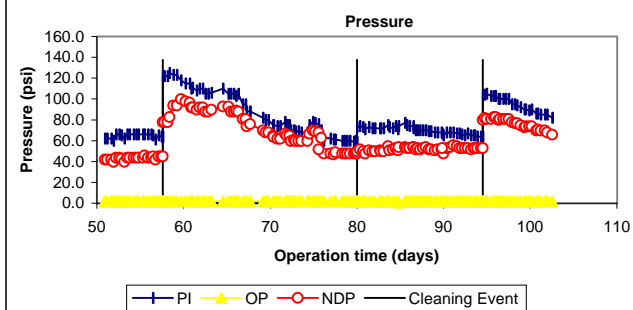
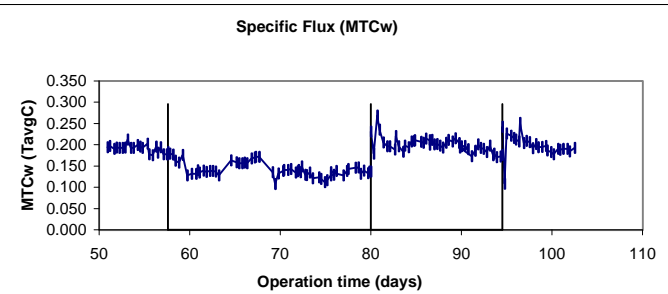
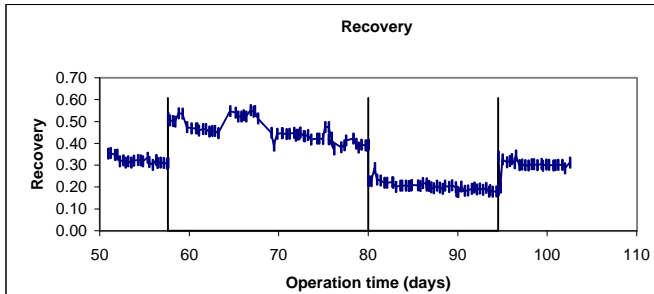
Water Quality Parameter Graphs (Continued)



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL3051447 / 283
 ICR Contact: Mr. Ralph Sigman
 Phone No.: (407) 255-4623
 Period: 12/24/90 - 1/27/91 (34 days)

Membrane Information

Manufacturer: Osmonics Desal
 Trade Name: DS5
 Membrane Model: DK 4040F
 MWCO: 10 - 300 Daltons
 Element Size: 4" x 40"
 Element Area: 90.0 ft²
 Design Flux: 20.0 gfd
 Mfr. NDP: 100.0 psi
 Mfr. MTC_w: 0.200 (gfd/psi)
 Mfr. Temp: 25.0 °C
 Max Flow: 12.0 gpm
 Min Flow: 6.3 gpm
 Total Width: 16.0 ft
 Feed Sp Thickness: 0.0028 ft
 840 Element Area: 350.0 ft²
 840 Purchase Price: \$1,500

Design Parameters

Norm Temp: 24.5 °C
 Temp Norm MTC-w: 0.197 TavGC
 Design Recovery: 0.25
 Design Flux: 15.0 gfd
 Recycle Ratio: 0.07
 Manuf rep Rej_{TDS}: 38%
 TDS_F: 359.0 mg/L

Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	7.9	0.1	2	7.8 - 7.9	6.1	NA	1	6.1 - 6.1	NA	NA	0	0.0 - 0.0
Temp	20.0	1.6	2	18.9 - 21.1	20.0	1.6	2	18.9 - 21.1	NA	NA	0	0.0 - 0.0
Alk	85	5	2	81 - 88	25	NA	1	25 - 25	NA	NA	0	0 - 0
TDS	385	21	2	370 - 400	260	NA	1	260 - 260	NA	NA	0	0 - 0
TotHard	130	14	2	120 - 140	38	48	2	4 - 72	NA	NA	0	0 - 0
CaHard	95	7	2	90 - 100	27	28	2	7 - 47	NA	NA	0	0 - 0
Turb	0.14	0.01	2	0.13 - 0.14	0.03	0.04	2	0.00 - 0.06	NA	NA	0	0.00 - 0.00
Amm	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0
TOC	26.5	0.7	2	26.0 - 27.0	0.5	0.0	2	0.5 - 0.5	NA	NA	0	0.0 - 0.0
UV254	NA	NA	0	0.000 - 0.000	NA	NA	0	0.000 - 0.000	NA	NA	0	0.000 - 0.000
SUVA	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	NA
Bromide	NA	NA	0	0 - 0	NA	NA	0	0 - 0				
TOX	3550	354	2	3300 - 3800	37	34	2	13 - 61				
CHCl3	630.0	99.0	2	560.0 - 700.0	2.5	3.5	2	0.0 - 5.0	Mass Balance			
BDCM	110.5	20.5	2	96.0 - 125.0	7.5	6.4	2	3.0 - 12.0	Closure Errors (%)			
DBCM	9.0	2.8	2	7.0 - 11.0	18.5	12.0	2	10.0 - 27.0	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	2	0.0 - 0.0	21.0	14.1	2	11.0 - 31.0	Alk	0	n/a	n/a
THM4	749.5	122.3	2	663.0 - 836.0	49.5	36.1	2	24.0 - 75.0	TDS	0	n/a	n/a
MCAA	13.0	4.2	2	10.0 - 16.0	2.5	3.5	2	0.0 - 5.0	TotHard	0	n/a	n/a
DCAA	320.0	141.4	2	220.0 - 420.0	1.5	0.7	2	1.0 - 2.0	CaHard	0	n/a	n/a
TCAA	670.0	311.1	2	450.0 - 890.0	0.5	0.7	2	0.0 - 1.0	Turb	0	n/a	n/a
MBAA	0.0	0.0	2	0.0 - 0.0	0.0	0.0	2	0.0 - 0.0	Amm	0	n/a	n/a
DBAA	3.0	4.2	2	0.0 - 6.0	5.5	2.1	2	4.0 - 7.0	TOC	0	n/a	n/a
BCAA	NA	NA	0	NA	NA	NA	0	NA	UV254	0	n/a	n/a
TBAA	NA	NA	0	NA	NA	NA	0	NA				
CDBAA	NA	NA	0	NA	NA	NA	0	NA	TDS _t	0	#####	#DIV/0!
DCBAA	NA	NA	0	NA	NA	NA	0	NA	Comments:			
HAA5	1006.0	461.0	2	680.0 - 1332.0	10.0	7.1	2	5.0 - 15.0				
HAA6	NA	NA	0	NA	NA	NA	0	NA				
HAA9	NA	NA	0	NA	NA	NA	0	NA				

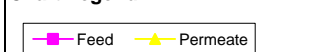
SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.20	0.00	4	0.20 - 0.20
Temp (°C)	22.0	0.0	4	22.0 - 22.0
pH (unit)	7.6	0.0	4	7.6 - 7.6
Time (hr)	96.0	0.0	4	96.0 - 96.0

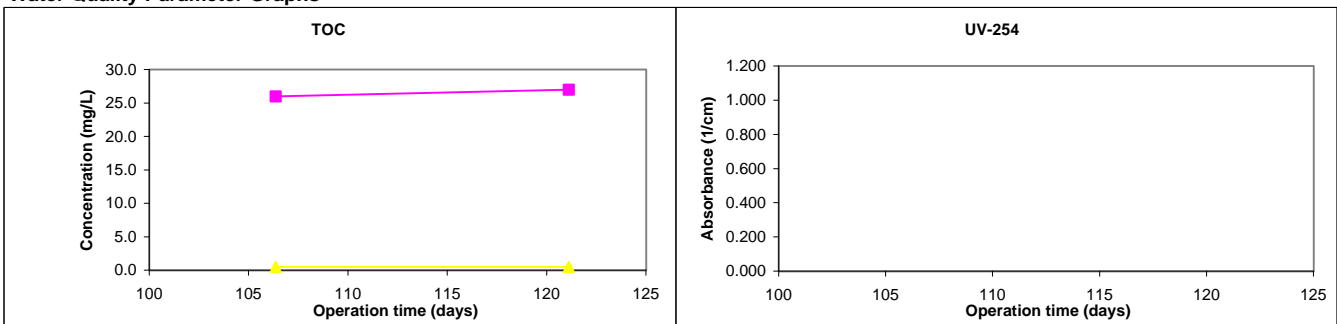
Pretreatment Information

Process	Description	Scale
Acid Feed	Sulfuric acid feed (pH 6)	Pilot-scale
Pre-filtration	Harmsco 5um Cartridge Filter	Pilot-scale

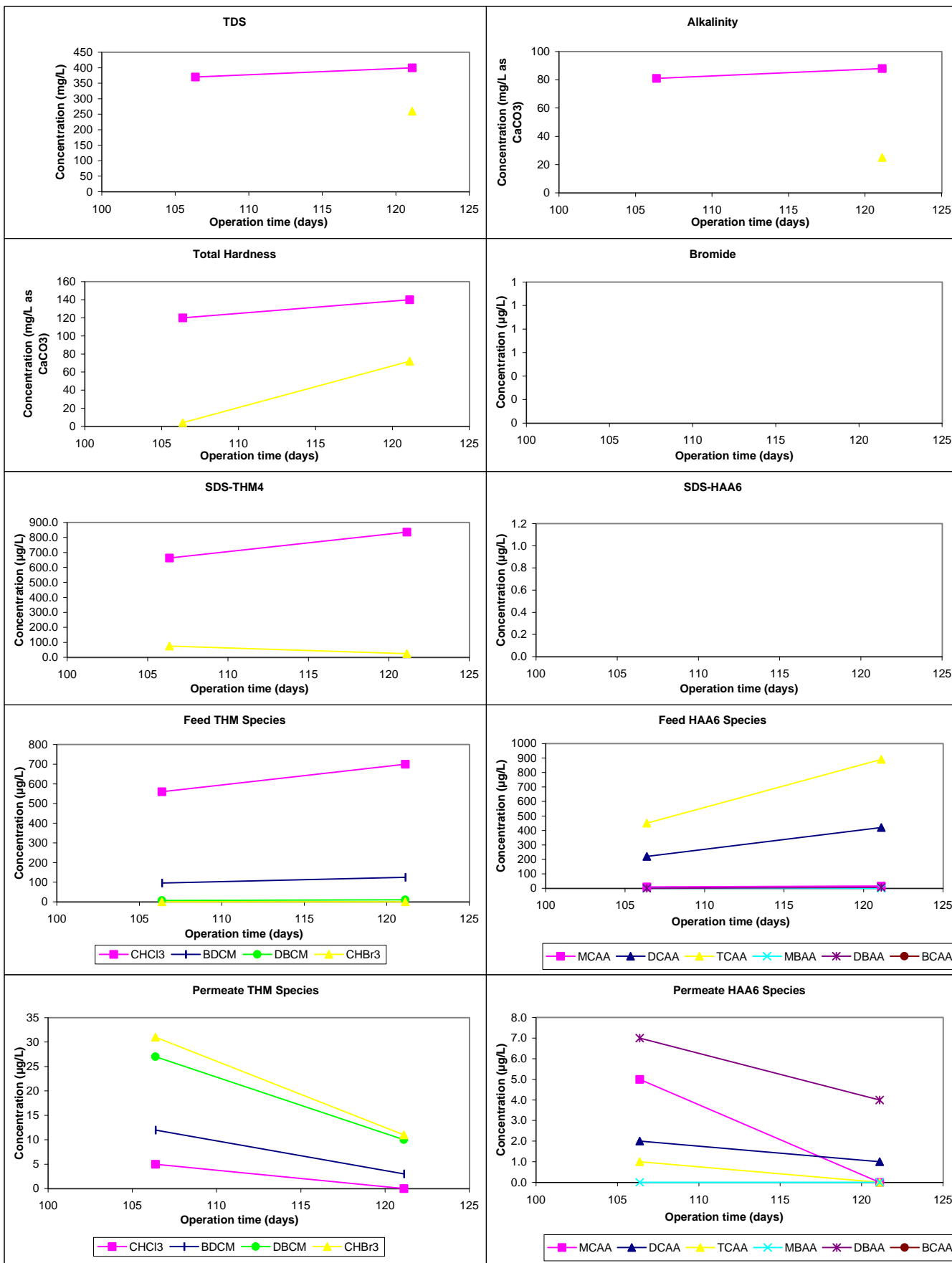
Chart Legend:



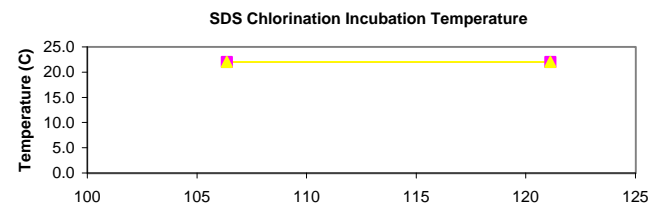
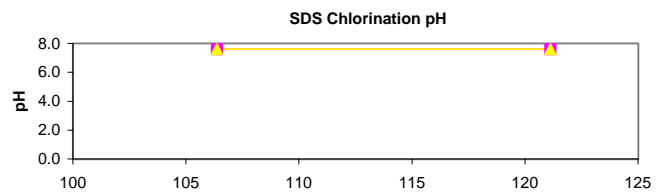
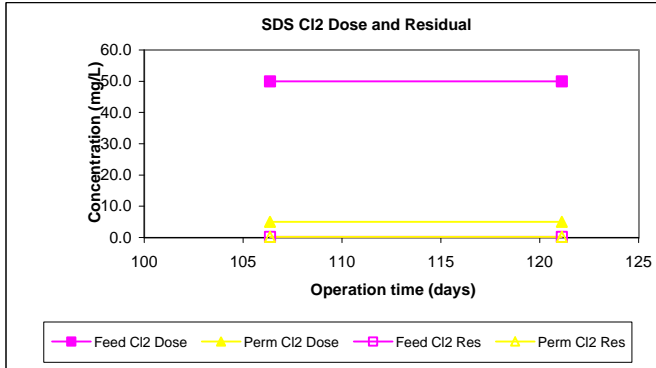
Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



Water Quality Parameter Graphs (Continued)



Productivity Graphs

