ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID 1054

Study Protocol Membrane RBSMT treatment study

Plant ICR Number 294

PWS Name Broward County, District 1A WTP

City, State, Zip Pompano Beach, FL 33069

General Comments:

1. During this bench-scale study, three membranes were evaluated: the Koch-Fluid Systems TFC-SR40, the Hydranautics NTR7450, and the FilmTec NF200B. The SR40 was evaluated over four quarters (Spring, Summer, Fall and Winter); the NF200 was evaluated over three quarters (Spring, Summer and Fall – however the Fall quarter of testing was incomplete); and the NTR7450 was evaluated over two quarters (Fall and Winter – however the Fall quarter of testing was abbreviated). The sampling and testing dates are summarized in Table 5 of the Summary Report.

2. During the third (Fall) quarter of testing, problems were encountered with the performance of the NF200B membrane. Increases in permeate flux were observed as the run progressed, accompanied by an increase in permeate TDS and UV concentrations. This was observed for two different NF200B membrane samples. These problems are summarized on pages 29 and 30 of the Summary Report. The third quarter run with the NF200B membrane was terminated and a new run with the NTR7450 was initiated; however, the NTR7450 was only evaluated at recoveries of 50% and 70% during the third quarter.

3. The only pretreatment applied to this groundwater (Biscayne aquifer) was cartridge filtration. Relatively loose membranes (i.e., low rejection of most inorganic salts) were used during this study. However, these membranes did reject calcium hardness in the range of 25 to 60%, and at high recoveries, this level of rejection may have resulted in concentration factors high enough to cause salt precipitation. Thus, the addition of acid or antiscalant to control inorganic scale formation may have resulted in longer cleaning intervals than those observed during this study.

4. Recovery was very erratic during the fourth quarter of testing (using the NTR7450 membrane).

5. In general, it appears that variability among membrane samples may have impacted the results for all three membranes investigated during this study. Interpretation of these results

should be made by evaluating the performance of a specific membrane over all quarters in which it was tested.

6. During analysis, a temperature of 26°C was used for productivity analysis during all four quarters. The average temperature for this source is reported as 26°C and varies between 25°C and 27°C.

7. No cost information was provided in the Summary Report.

Water Quality Comments:

1. 73 water quality outliers were identified and removed prior to base analysis. Most of these outliers were reported for the 70% recovery runs with the SR40 membrane. The concentrations of most water quality parameters reported during these runs were significantly lower than concentrations reported at other recoveries. The 70% recovery runs are always conducted first, so it is possible that the rejection characteristics of the membrane were not stable during this early period of operation. Water quality data reported for the other three recoveries evaluated (30%, 50% and 70%) was used to assess permeate water quality.

2. Constant SDS conditions were used throughout all four quarters: incubation temperature = 25°C; pH = 9.0; incubation time = 24 hours; and free residual = 1 mg/L. SDS time and temperature reported in the spreadsheet appear to be target values.

3. During testing with the SR40 membrane, a significant increase in permeate THMs, TOX and UV was observed during the third and fourth quarters of testing as compared to the first and second quarters. Corresponding changes in the permeate TOC and HAA levels were not observed.

Productivity Comments:

1. No productivity outliers were identified and removed prior to base analysis.

2. Severe flux loss was observed at 90% recovery during the fourth quarter of the TFC SR40 run. Summary Report indicates that this could be due to inorganic scale formation.

3. The standard membrane cleaning procedure utilized a sodium hydroxide solution (pH ≈ 12, at 40°C). When this cleaner was not effective, a sulfuric acid solutions (pH > 2.5) was also used. Additional information on membrane cleaning is given in Section 3 of the Summary Report.

Broward County Office of Environmental Services - DWRM **RBSMT Membrane Treatment Study Summary (NF200B-400)** **Quarter:** 1

ICR Information

ID / ICR#: 4060167 / 294
ICR Contact: Mr. Jerry Baker
Phone No.: (954) 960-3061
Period: 5/6/98 - 5/13/98 (7 days)

Membrane Information

Manufacturer: FilmTec Corporation
Trade Name: NF200B-400
MWCO: 200-400 Daltons
Mfr. Flux: 21.1 gfd
Mfr. NDP: 71.0 psi
Mfr. MTCw: 0.284 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 400.0 ft²
840 Purchase Price: $800
840 Maximum Flow: 70.0 gpm
840 Minimum Flow: 16.0 gpm
840 Total Width: 70.5 ft
840 Feed Spacer Thickness: 0.0023 ft

Water Qality Summary

Source ->	Feed		Permeate				Concentrate			
Recovery ->	Avg	Diff	0.31	0.52	0.69	0.89	0.31	0.52	0.69	0.89
pH	8.3	0.2	8.4	8.3	8.3	8.3	8.8	8.8	8.7	8.8
Temp	24.0	0.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
Alk	191	25	160	184	177	188	262	284	320	354
TDS	**297**	**3**	**214**	**223**	**223**	**223**	**295**	**357**	**364**	**367**
TotHard	195	5	163	184	195	196	244	292	285	390
CaHard	161	3	144	154	176	182	212	226	262	352
Turb	0.96	0.01	0.09	0.12	0.15	0.13	0.43	0.42	0.42	0.52
Amm	0.00	NA	0.13	0.00	0.00	0.00	NA	NA	NA	0.00
TOC	**14.4**	**NA**	**0.6**	**0.9**	**0.9**	**1.4**	**18.8**	**42.7**	**61.5**	**97.6**
UV254	0.523	0.048	0.016	0.026	0.023	0.038	0.742	1.446	2.270	2.600
SUVA	#N/A	NA	2.67	2.89	2.56	2.71	3.95	3.39	3.69	2.66
Bromide	**140**	**NA**	**120**	**120**	**120**	**120**				
TOX	**1300**	**NA**	**49**	**72**	**76**	**110**				
CHCl3	490.0	NA	3.6	5.4	6.3	13.0				
BDCM	69.0	NA	7.8	13.0	13.0	23.0				
DBCM	7.1	NA	15.0	23.0	23.0	28.0				
CHBr3	0.0	NA	12.0	16.0	14.5	10.0				
THM4	**566.1**	**NA**	**38.4**	**57.4**	**56.8**	**74.0**				
MCAA	8.6	NA	0.0	0.0	0.0	2.2				
DCAA	120.0	NA	2.2	2.3	3.0	4.7				
TCAA	89.0	NA	0.0	0.0	0.0	2.7				
MBAA	1.0	NA	0.0	0.0	0.0	0.0				
DBAA	1.3	NA	4.4	6.3	6.1	6.3				
BCAA	16.0	NA	2.6	3.7	3.9	6.5				
TBAA	0.0	NA	0.0	4.1	0.0	0.0				
CDBAA	0.0	NA	3.0	3.7	4.1	5.2				
DCBAA	12.0	NA	1.6	2.1	2.6	5.0				
HAA5	**219.9**	**NA**	**6.6**	**8.6**	**9.1**	**15.9**				
HAA6	**235.9**	**NA**	**9.2**	**12.3**	**13.0**	**22.4**				
HAA9	**247.9**	**NA**	**13.8**	**22.2**	**19.7**	**32.6**				

Mass Balance Closure Err (%)

WQP	Count	Avg	SD
TDSt	16	0	8
Alk	4	30	7
TDS	4	-47	65
TotHard	4	32	16
CaHard	4	50	38
Turb	4	-618	517
Amm	0	n/a	n/a
TOC	4	7	27
UV254	4	-4	46

Pretreatment Information

Process	Description	Scale
Cartridge filtration	5 micron filter	bench

SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (mg/L) (0)	2.07	0.75	6	1.23 - 3.12
Temp (°C)	25.0	0.0	6	25.0 - 25.0
pH (unit)	8.6	0.1	6	8.5 - 8.7
Time (hr)	24.0	0.0	6	24.0 - 24.0

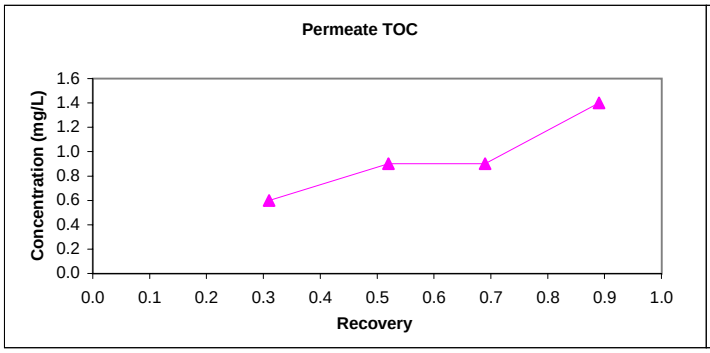
Design Parameters

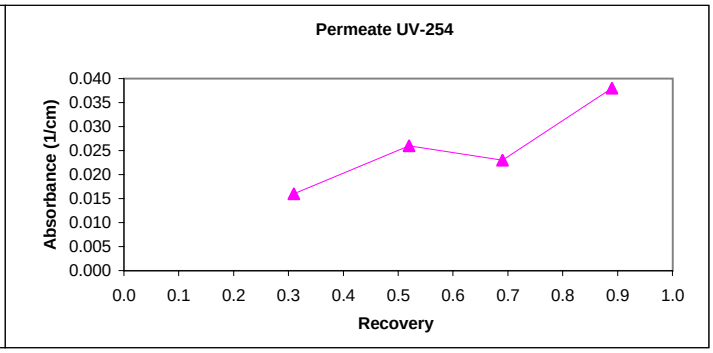
Active memb area: 0.167 ft²
Active width: 0.330 ft
Norm Temp: 24.6 °C
Feed TDS: 300.0 mg/L
Manuf rep TDS rej: 50%
Temp Norm MTC-w: 0.281 gfd/psi

ID#	Recov (dec.)	$F_{W\text{-des}}$ (gfd)
1	0.70	15.0
2	0.90	15.0
3	0.50	15.0
4	0.30	15.0

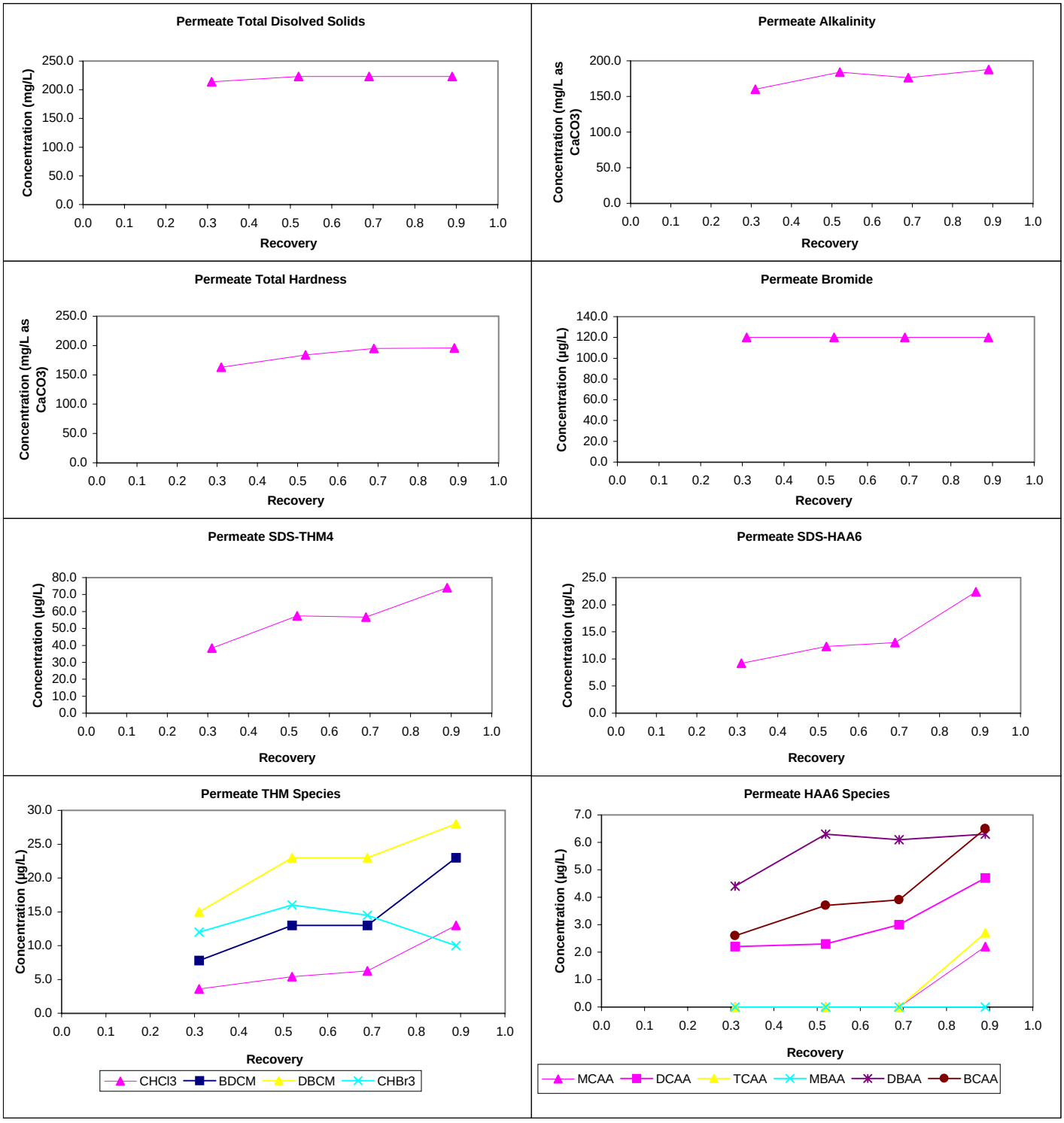
Comments:

Water Quality Parameter Graphs

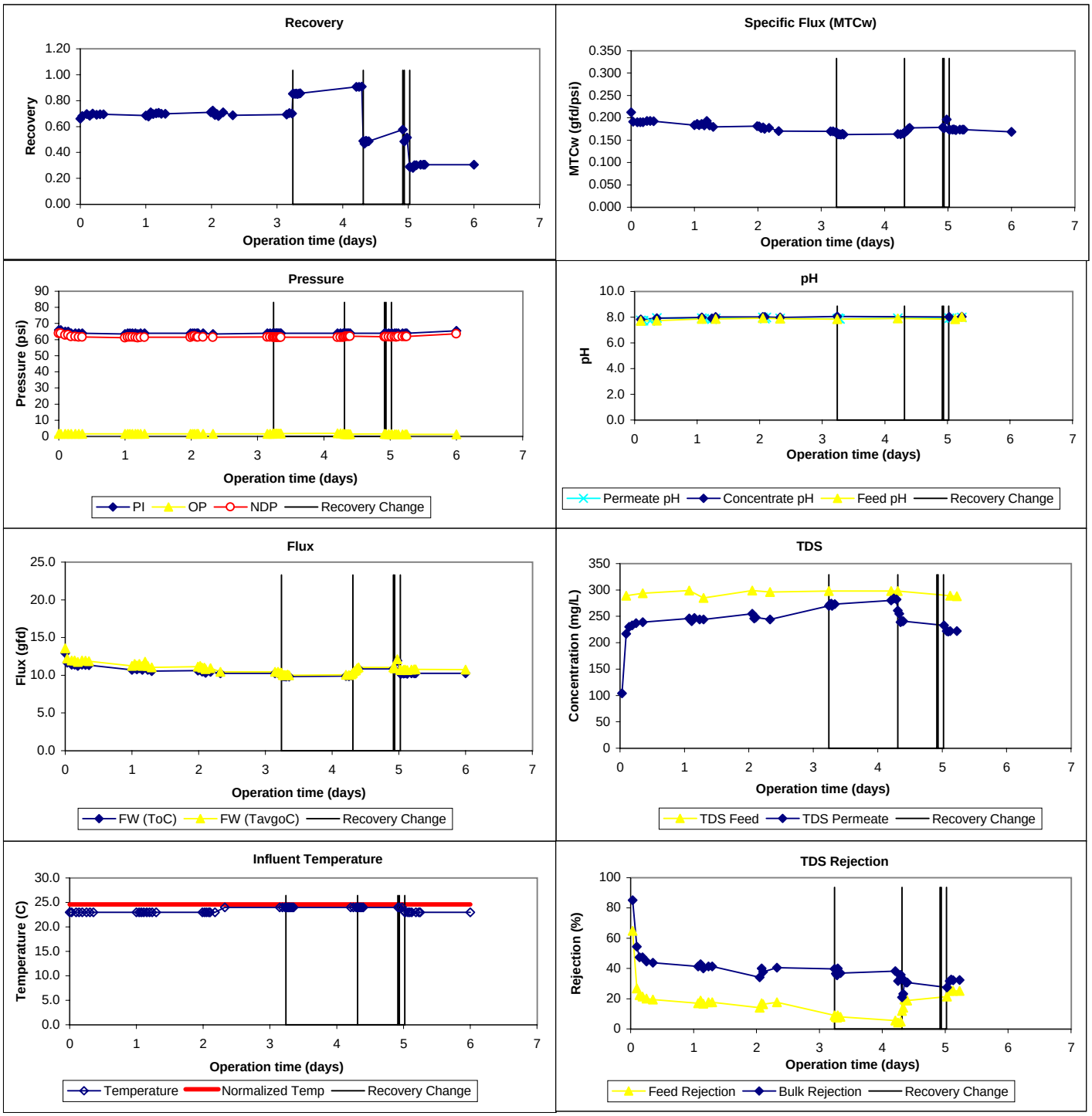




Water Quality Parameter Graphs (Continued)



Productivity Graphs



Broward County Office of Environmental Services - RBSMT Membrane Treatment Study Summary (NF200B-400) **Quarter:** 2

ICR Information

ID / ICR#: 4060167 / 294
ICR Contact: Mr. Jerry Baker
Phone No.: (954) 960-3061
Period: 7/16/98 - 7/22/98 (6 days)

Membrane Information

Manufacturer: FilmTec Corporation
Trade Name: NF200B-400
MWCO: 200-400 Daltons
Mfr. Flux: 21.1 gfd
Mfr. NDP: 71.0 psi
Mfr. MTCw: 0.284 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 400.0 ft²
840 Purchase Price: $800
840 Maximum Flow: 70.0 gpm
840 Minimum Flow: 16.0 gpm
840 Total Width: 70.5 ft
840 Feed Spacer Thickness: 0.0023 ft

Water Qality Summary

Source ->	Feed		Permeate				Concentrate			
Recovery ->	Avg	Diff	0.30	0.50	0.67	0.91	0.30	0.50	0.67	0.91
pH	7.9	0.3	8.3	8.0	7.7	7.5	8.3	8.3	8.4	8.5
Temp	24.0	0.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Alk	205	2	114	118	114	132	151	161	185	199
TDS	**317**	**2**	**250**	**260**	**258**	**288**	**332**	**338**	**381**	**422**
TotHard	299	9	186	208	204	230	314	310	349	430
CaHard	256	4	172	196	191	216	282	302	329	406
Turb	1.26	0.14	0.11	0.07	0.09	0.08	1.51	1.71	0.64	1.83
Amm	0.31	0.17	0.00	0.00	0.00	0.00	NA	NA	NA	NA
TOC	**13.3**	**0.5**	**1.2**	**1.6**	**1.1**	**2.8**	**18.1**	**27.0**	**41.3**	**116.6**
UV254	0.635	0.030	0.042	0.051	0.024	0.106	0.837	1.172	1.520	4.100
SUVA	4.77	0.05	3.50	3.19	2.24	3.79	4.62	4.34	3.68	3.52
Bromide	**150**	**0**	**140**	**150**	**150**	**150**				
TOX	**1435**	**5**	**88**	**115**	**68**	**235**				
CHCl3	480.0	0.0	11.0	18.0	5.9	67.0				
BDCM	53.5	5.5	16.0	21.0	10.1	30.0				
DBCM	5.4	0.0	25.0	27.0	19.0	18.0				
CHBr3	0.0	0.0	16.0	11.0	15.5	2.6				
THM4	**538.9**	**5.5**	**68.0**	**77.0**	**50.5**	**117.6**				
MCAA	10.4	0.6	0.0	0.0	0.0	0.0				
DCAA	130.0	0.0	4.1	8.3	2.3	16.0				
TCAA	103.0	7.0	1.1	2.9	0.0	3.9				
MBAA	0.0	0.0	0.0	0.0	0.0	0.0				
DBAA	1.5	0.0	6.4	6.4	5.4	4.3				
BCAA	16.0	1.0	3.9	5.5	2.8	8.3				
TBAA	0.0	0.0	0.0	0.0	0.0	0.0				
CDBAA	0.0	0.0	0.0	2.0	0.0	0.0				
DCBAA	12.5	1.5	1.2	1.7	0.0	2.3				
HAA5	**244.9**	**6.4**	**11.6**	**17.6**	**7.7**	**24.2**				
HAA6	**260.9**	**7.4**	**15.5**	**23.1**	**10.5**	**32.5**				
HAA9	**273.4**	**8.9**	**16.7**	**26.8**	**10.5**	**34.8**				

Mass Balance Closure Err (%)

WQP	Count	Avg	SD
TDSt	42	-16	28
Alk	4	-156	145
TDS	4	-19	18
TotHard	4	-52	54
CaHard	4	-22	28
Turb	4	-286	304
Amm	0	n/a	n/a
TOC	4	3	6
UV254	4	-20	19

Pretreatment Information

Process	Description	Scale
Cartridge filtration	5 micron filter	bench

SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (mg/L) (0)	1.21	0.40	6	0.59 - 1.80
Temp (°C)	25.0	0.0	6	25.0 - 25.0
pH (unit)	9.1	0.1	6	8.9 - 9.3
Time (hr)	24.0	0.0	6	24.0 - 24.0

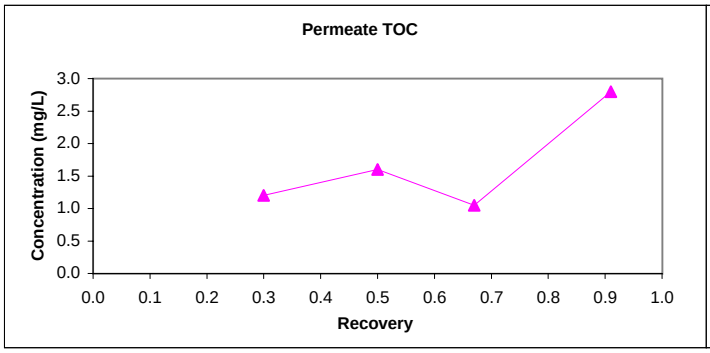
Design Parameters

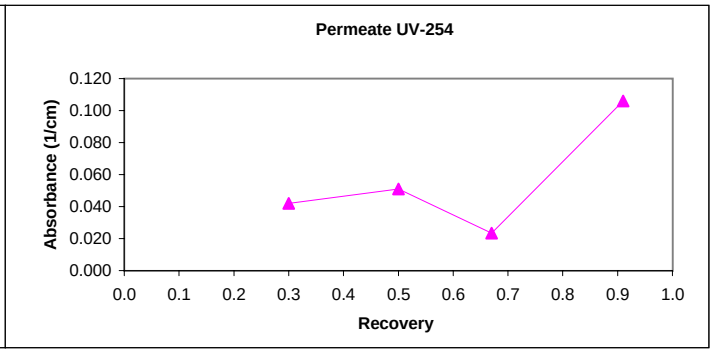
Active memb area: 0.167 ft²
Active width: 0.330 ft
Norm Temp: 24.6 °C
Feed TDS: 300.0 mg/L
Manuf rep TDS rej: 50%
Temp Norm MTC-w: 0.281 gfd/psi

ID#	Recov (dec.)	$F_{W\text{-}des}$ (gfd)
1	0.70	15.0
2	0.90	15.0
3	0.50	15.0
4	0.30	15.0

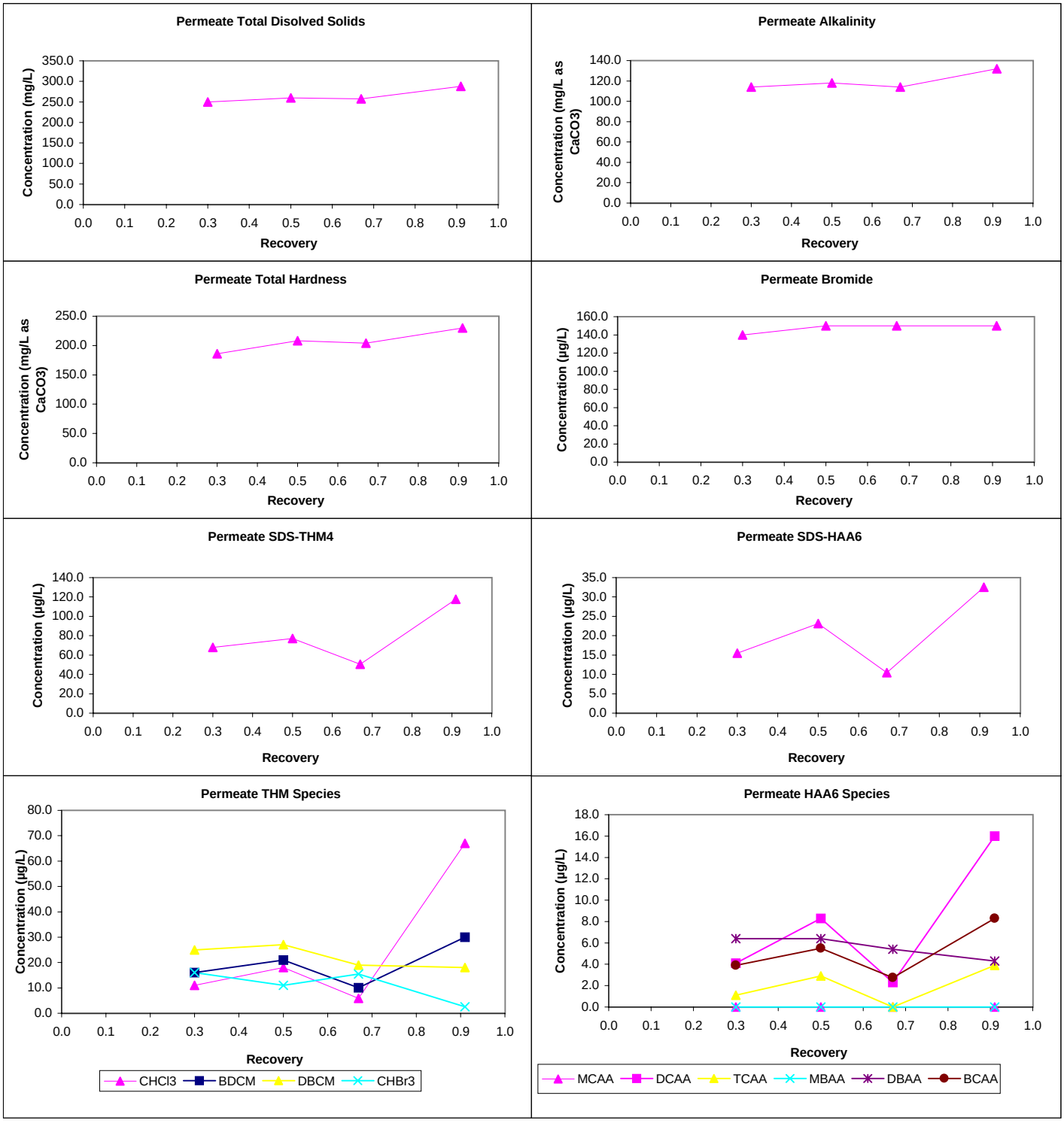
Comments:

Water Quality Parameter Graphs

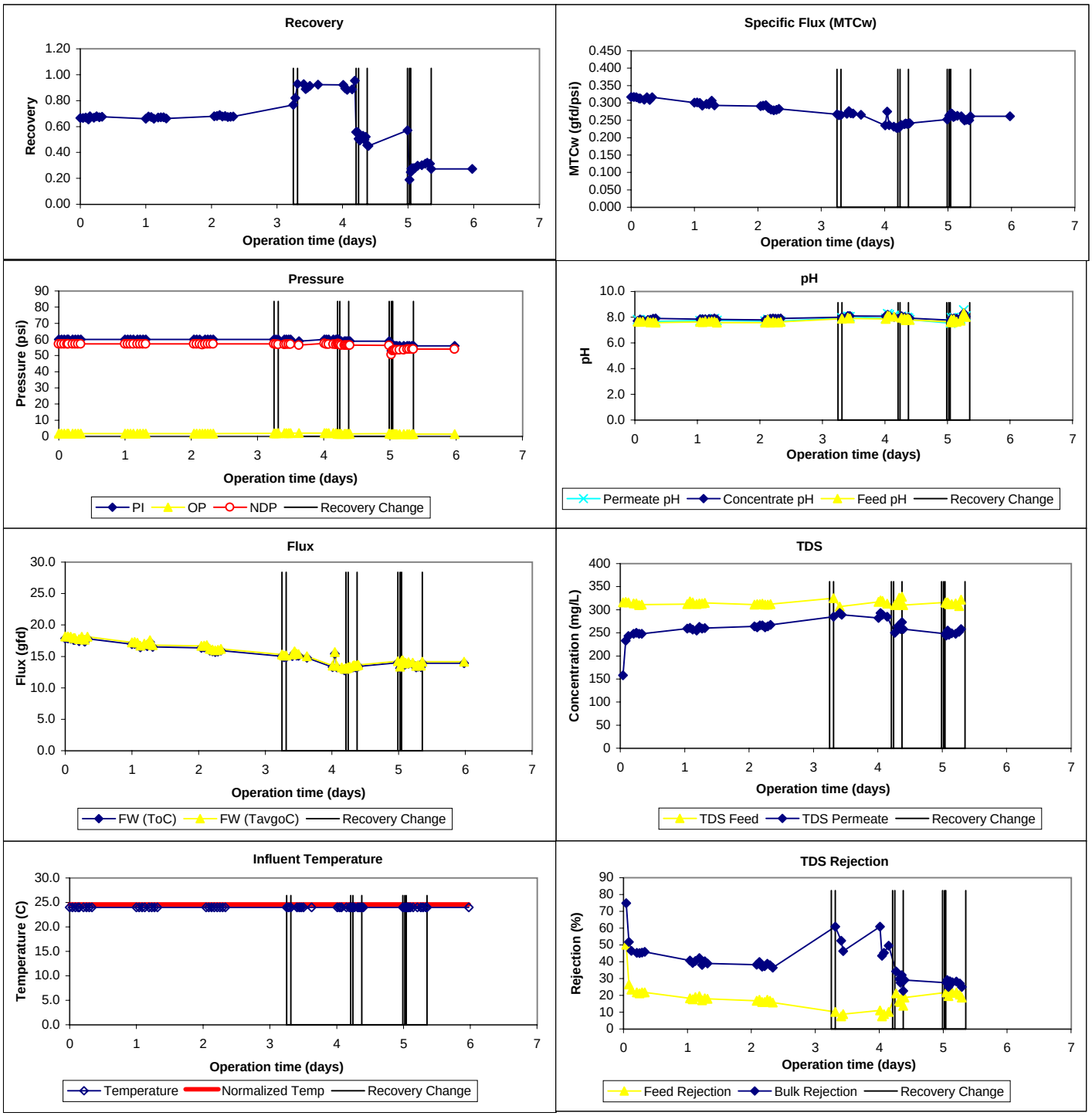




Water Quality Parameter Graphs (Continued)



Productivity Graphs



Broward County Office of Environmental Services - RBSMT Membrane Treatment Study Summary (NF200B-400)

Quarter: 3

ICR Information

ID / ICR#: 4060167 / 294
ICR Contact: Mr. Jerry Baker
Phone No.: (954) 960-3061
Period: 12/1/98 - 12/4/98 (3 days)

Membrane Information

Manufacturer: FilmTec Corporation
Trade Name: NF200B-400
MWCO: 200-400 Daltons
Mfr. Flux: 21.1 gfd
Mfr. NDP: 71.0 psi
Mfr. MTCw: 0.284 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 400.0 ft²
840 Purchase Price: $800
840 Maximum Flow: 70.0 gpm
840 Minimum Flow: 16.0 gpm
840 Total Width: 70.5 ft
840 Feed Spacer Thickness: 0.0023 ft

Water Qality Summary

Source ->	Feed		Permeate				Concentrate				Mass Balance Closure Err (%)			
Recovery ->	Avg	Diff	0.00	0.00	0.73	0.00	0.00	0.00	0.73	0.00	WQP	Count	Avg	SD
pH	8.0	0.4			8.0				8.2		TDSt	30	-16	51
Temp	23.5	0.5			24.0				24.0					
Alk	421	15			NA				NA		Alk	0	n/a	n/a
TDS	**280**	**2**			**244**				**336**		TDS	1	-12	n/a
TotHard	217	3			NA				NA		TotHard	0	n/a	n/a
CaHard	205	1			NA				NA		CaHard	0	n/a	n/a
Turb	0.62	0.26			NA				NA		Turb	0	n/a	n/a
Amm	0.00	0.00			NA				NA		Amm	0	n/a	n/a
TOC	**12.0**	**0.3**			**NA**				**NA**		TOC	0	n/a	n/a
UV254	0.570	0.043			0.273				1.078		UV254	1	-27	n/a
SUVA	4.74	0.24	######	#VALUE!	#N/A	#VALUE!			#######					
Bromide	**140**	**0**			**NA**									
TOX	**1095**	**25**			**NA**									
CHCl3	405.0	45.0			NA									
BDCM	52.0	7.0			NA									
DBCM	5.9	0.6			NA									
CHBr3	0.0	0.0			NA									
THM4	**462.9**	**52.5**	**0.0**	**0.0**	**NA**	**0.0**								
MCAA	5.5	0.1			NA									
DCAA	105.0	5.0			NA									
TCAA	96.5	13.5			NA									
MBAA	0.0	0.0			NA									
DBAA	1.6	0.2			NA									
BCAA	14.5	0.5			NA									
TBAA	0.0	NA			NA									
CDBAA	1.1	1.1			NA									
DCBAA	12.0	0.0			NA									
HAA5	**208.5**	**18.7**	**0.0**	**0.0**	**NA**	**0.0**								
HAA6	**223.0**	**19.2**	**0.0**	**0.0**	**NA**	**0.0**								
HAA9	**215.8**	**NA**	**0.0**	**0.0**	**NA**	**0.0**								

Pretreatment Information

Process	Description	Scale
Cartridge filtration	5 micron filter	bench

SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (mg/L) (0)	1.49	0.68	2	1.01 - 1.97
Temp (°C)	25.0	0.0	2	25.0 - 25.0
pH (unit)	8.9	0.1	2	8.8 - 9.0
Time (hr)	24.0	0.0	2	24.0 - 24.0

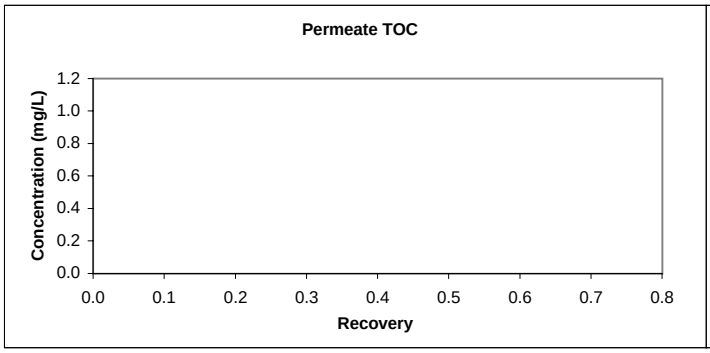
Design Parameters

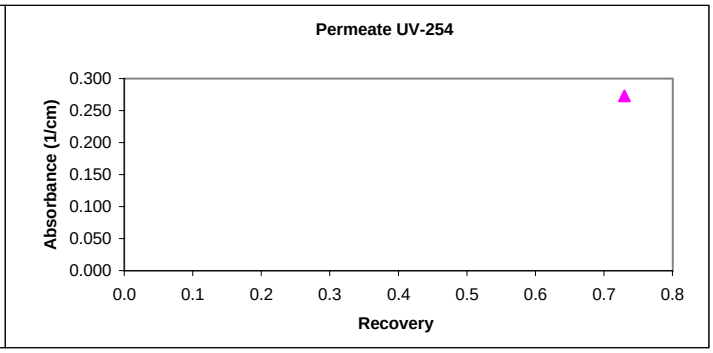
Active memb area: 0.167 ft²
Active width: 0.330 ft
Norm Temp: 24.6 °C
Feed TDS: 300.0 mg/L
Manuf rep TDS rej: 50%
Temp Norm MTC-w: 0.281 gfd/psi

ID#	Recov (dec.)	$F_{W\text{-}des}$ (gfd)
1	0.70	15.0
2	0.90	15.0
3	0.50	15.0
4	0.30	15.0

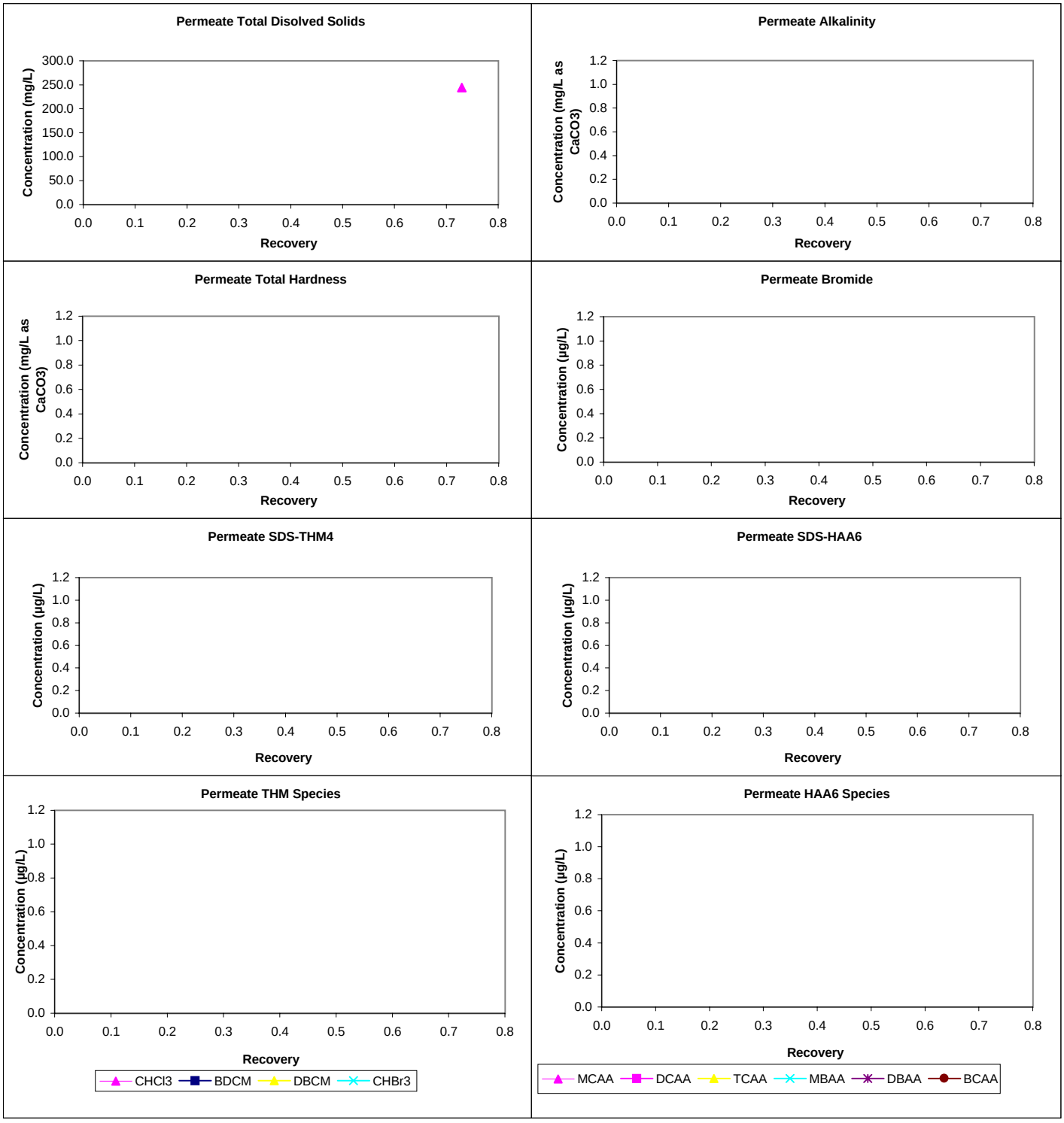
Comments:

Water Quality Parameter Graphs

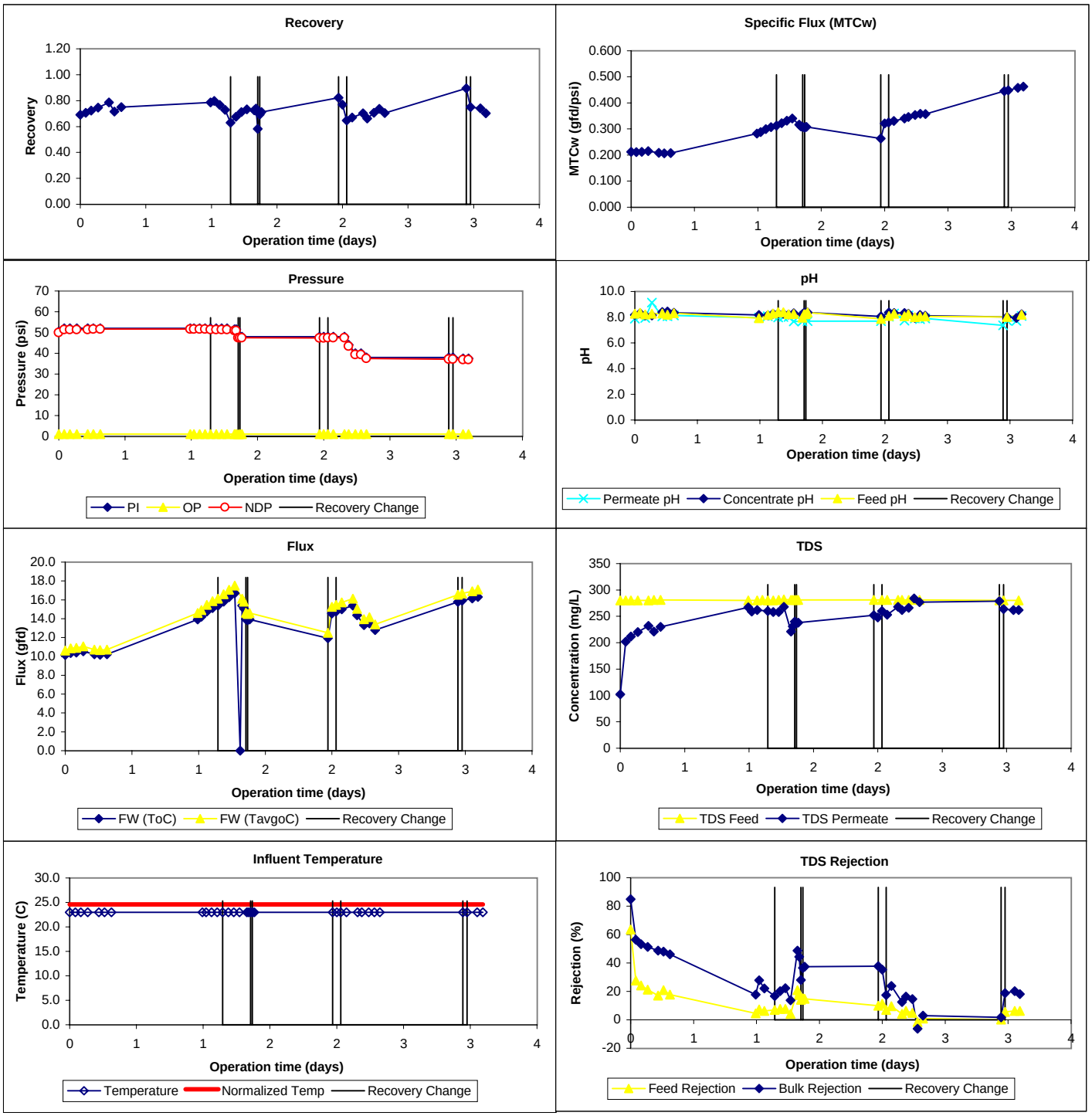




Water Quality Parameter Graphs (Continued)



Productivity Graphs



Broward County Office of Environmental Services (BCOES) **RSSMT Membrane Treatment Study Summary (NTR7450)** **Quarter:** 3

ICR Information

ID / ICR#: 4060167 / 294
ICR Contact: Mr. Jerry Baker
Phone No.: (954) 960-3061
Period: 12/8/98 - 12/10/9 (2 days)

Membrane Information

Manufacturer: Hydranautics Corp., San Diego, CA
Trade Name: NTR7450
MWCO: L,000 Da Daltons
Mfr. Flux: 45.0 gfd
Mfr. NDP: 140.0 psi
Mfr. MTCw: 0.320 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 365.0 ft²
840 Purchase Price: $800
840 Maximum Flow: 75.0 gpm
840 Minimum Flow: 25.0 gpm
840 Total Width: 64.4 ft
840 Feed Spacer Thickness: 0.0023 ft

Water Qality Summary

Source ->	Feed		Permeate				Concentrate				Mass Balance Closure Err (%)			
Recovery ->	Avg	Diff	0.00	0.50	0.72	0.00	0.00	0.50	0.72	0.00	WQP	Count	Avg	SD
pH	8.0	0.4		8.4	8.2			8.2	8.2		TDSt	23	-9	13
Temp	23.5	0.5		23.0	25.0			23.0	25.0					
Alk	421	15		372	364			424	440		Alk	2	-20	9
TDS	**280**	**2**		**262**	**264**			**292**	**300**		TDS	2	-4	2
TotHard	217	3		204	206			236	264		TotHard	2	5	2
CaHard	205	1		174	192			240	246		CaHard	2	2	1
Turb	0.62	0.26		0.12	0.12			0.53	0.57		Turb	2	-175	62
Amm	0.00	0.00		0.00	0.00			NA	NA		Amm	0	n/a	n/a
TOC	**12.0**	**0.3**		**1.9**	**3.0**			**23.5**	**34.9**		TOC	2	3	3
UV254	0.570	0.043		0.050	0.081			1.008	1.574		UV254	2	-12	4
SUVA	4.74	0.24	######	2.63	2.70	#VALUE!		4.29	4.51					
Bromide	**140**	**0**		**140**	**140**									
TOX	**1095**	**25**		**135**	**230**									
CHCl3	405.0	45.0		21.0	49.0									
BDCM	52.0	7.0		23.0	32.0									
DBCM	5.9	0.6		24.0	21.0									
CHBr3	0.0	0.0		9.4	4.5									
THM4	**462.9**	**52.5**	**0.0**	**77.4**	**106.5**	**0.0**								
MCAA	5.5	0.1		0.0	2.1									
DCAA	105.0	5.0		5.8	12.0									
TCAA	96.5	13.5		2.0	5.3									
MBAA	0.0	0.0		0.0	0.0									
DBAA	1.6	0.2		5.7	5.1									
BCAA	14.5	0.5		5.5	8.5									
TBAA	0.0	NA		NR	NA									
CDBAA	1.1	1.1		2.5	2.8									
DCBAA	12.0	0.0		2.7	4.4									
HAA5	**208.5**	**18.7**	**0.0**	**13.5**	**24.5**	**0.0**								
HAA6	**223.0**	**19.2**	**0.0**	**19.0**	**33.0**	**0.0**								
HAA9	**215.8**	**NA**	**0.0**	**NR**	**NA**	**0.0**								

SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (mg/L) (0)	1.24	0.51	4	0.82 - 1.97
Temp (°C)	25.0	0.0	4	25.0 - 25.0
pH (unit)	9.0	0.2	4	8.8 - 9.2
Time (hr)	24.0	0.0	4	24.0 - 24.0

Pretreatment Information

Process	Description	Scale
Cartridge filtration	5 micron filter	bench

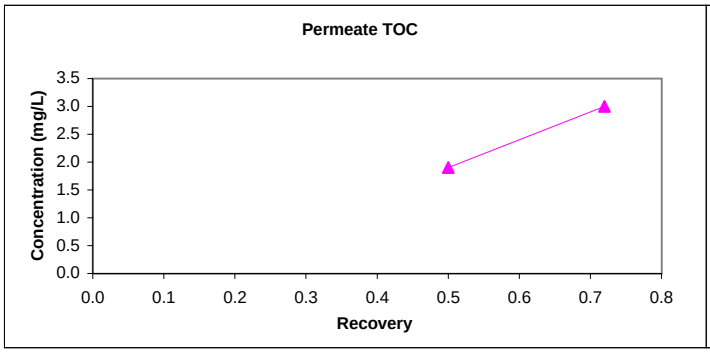
Design Parameters

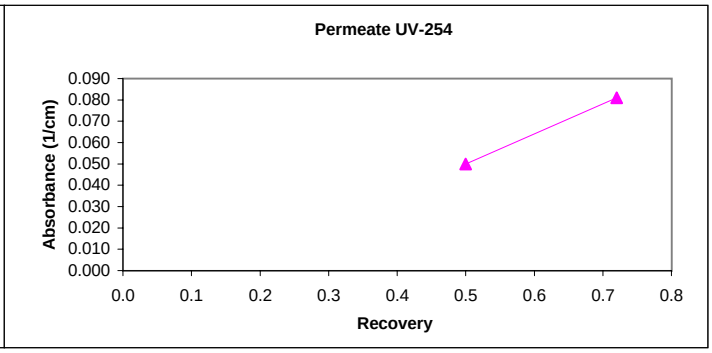
Active memb area: 0.167 ft²
Active width: 0.330 ft
Norm Temp: 24.6 °C
Feed TDS: 300.0 mg/L
Manuf rep TDS rej: 50%
Temp Norm MTC-w: 0.316 gfd/psi

ID#	Recov (dec.)	$F_{W\text{-des}}$ (gfd)
1	0.70	15.0
2	0.90	15.0
3	0.50	15.0
4	0.30	15.0

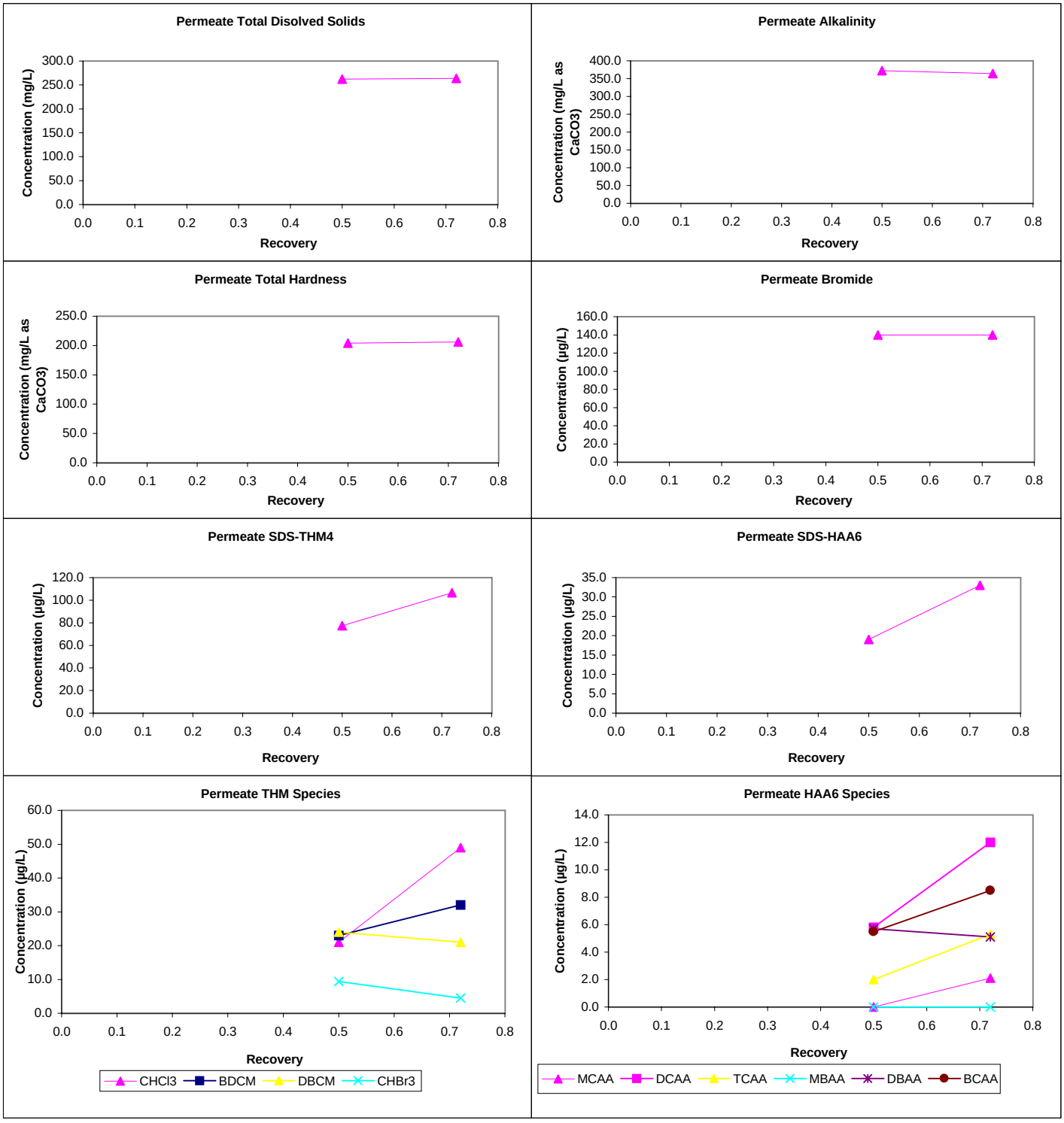
Comments:

Water Quality Parameter Graphs

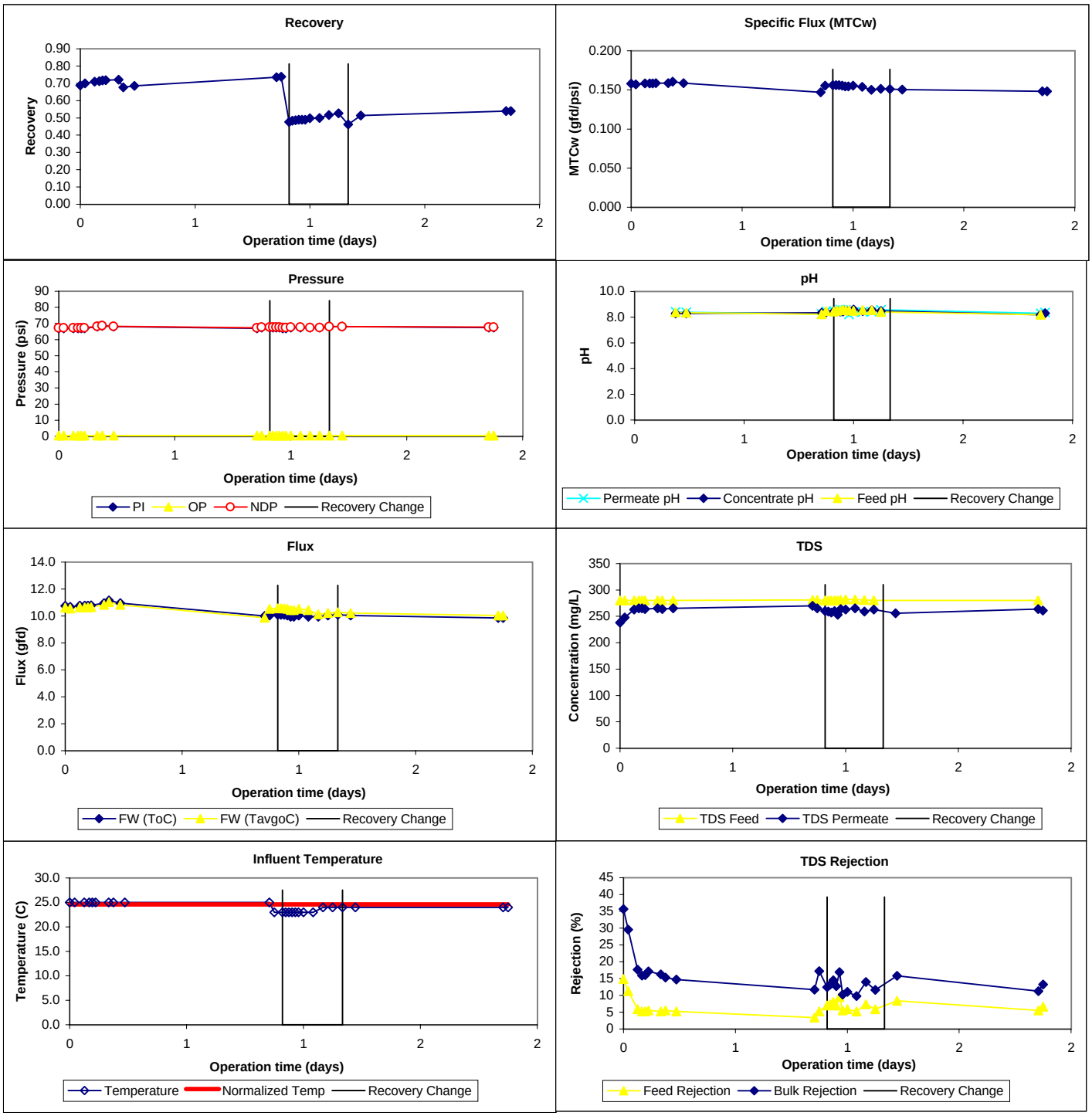




Water Quality Parameter Graphs (Continued)



Productivity Graphs



Broward County Office of Environmental Services, Davie, FL **RSSMT Membrane Treatment Study Summary (NTR7450)** **Quarter:** 4

ICR Information

ID / ICR#: 4060167 / 294
ICR Contact: Mr. Jerry Baker
Phone No.: (954) 960-3061
Period: 4/3/99 - 4/9/99 (6 days)

Membrane Information

Manufacturer: Hydranautics Corp., San Diego, CA
Trade Name: NTR7450
MWCO: L,000 Da Daltons
Mfr. Flux: 45.0 gfd
Mfr. NDP: 140.0 psi
Mfr. MTCw: 0.320 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 365.0 ft²
840 Purchase Price: $800
840 Maximum Flow: 75.0 gpm
840 Minimum Flow: 25.0 gpm
840 Total Width: 64.4 ft
840 Feed Spacer Thickness: 0.0023 ft

Water Qality Summary

Source ->	Feed		Permeate				Concentrate			
Recovery ->	Avg	Diff	0.30	0.50	0.70	0.87	0.30	0.50	0.70	0.87
pH	8.1	0.2	8.0	7.9	8.0	8.1	8.1	8.1	8.0	8.2
Temp	24.0	0.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Alk	348	2	284	298	319	350	352	376	399	492
TDS	**293**	**0**	**271**	**270**	**279**	**293**	**287**	**295**	**303**	**321**
TotHard	295	3	240	246	271	294	286	296	328	386
CaHard	270	2	212	218	233	268	276	278	295	336
Turb	0.26	0.01	0.08	0.09	0.09	0.12	0.28	0.30	0.39	1.18
Amm	0.04	0.04	0.00	0.00	0.00	0.00	NA	NA	NA	NA
TOC	**12.6**	**0.1**	**3.6**	**4.2**	**4.8**	**7.2**	**16.9**	**22.7**	**32.2**	**73.5**
UV254	0.588	0.001	0.106	0.118	0.122	0.203	0.729	0.958	1.360	3.050
SUVA	4.67	0.04	2.94	2.81	2.57	2.82	4.31	4.22	4.22	4.15
Bromide	**140**	**0**	**140**	**140**	**140**	**140**				
TOX	**1665**	**265**	**300**	**335**	**353**	**530**				
CHCl3	475.0	45.0	75.0	81.0	94.5	150.0				
BDCM	59.0	2.0	37.0	38.0	41.0	44.0				
DBCM	5.5	0.2	19.0	18.0	17.5	13.0				
CHBr3	0.0	0.0	2.0	1.5	1.5	0.0				
THM4	**539.5**	**47.1**	**133.0**	**138.5**	**154.5**	**207.0**				
MCAA	11.0	NA	3.1	2.7	3.3	4.0				
DCAA	110.0	NA	18.0	21.0	24.0	37.0				
TCAA	140.0	NA	12.0	15.0	16.5	28.0				
MBAA	0.0	NA	0.0	0.0	0.0	0.0				
DBAA	1.4	NA	3.9	3.8	3.4	2.5				
BCAA	16.0	NA	10.0	11.0	11.0	12.0				
TBAA	0.0	NA	0.0	0.0	0.0	0.0				
CDBAA	2.6	NA	3.8	3.8	3.6	2.7				
DCBAA	19.0	NA	7.6	8.6	8.8	9.2				
HAA5	**262.4**	**NA**	**37.0**	**42.5**	**47.2**	**71.5**				
HAA6	**278.4**	**NA**	**47.0**	**53.5**	**58.2**	**83.5**				
HAA9	**300.0**	**NA**	**58.4**	**65.9**	**70.5**	**95.4**				

SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (mg/L) (0)	0.89	0.25	6	0.55 - 1.20
Temp (°C)	24.0	0.0	6	24.0 - 24.0
pH (unit)	9.0	0.1	6	8.9 - 9.0
Time (hr)	24.0	0.0	6	24.0 - 24.0

Mass Balance Closure Err (%)

WQP	Count	Avg	SD
TDSt	60	-4	7
Alk	4	4	19
TDS	4	-3	8
TotHard	4	-3	17
CaHard	4	-7	16
Turb	4	-31	28
Amm	0	n/a	n/a
TOC	4	13	15
UV254	4	-10	9

Pretreatment Information

Process	Description	Scale
Cartridge filtration	5 micron filter	bench

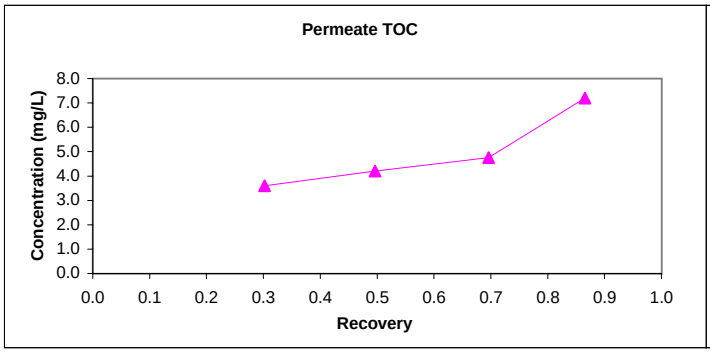
Design Parameters

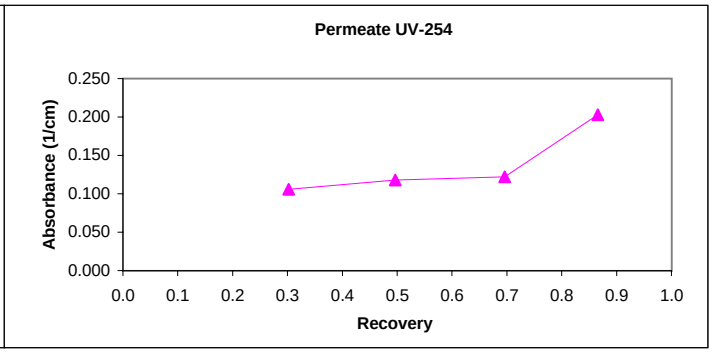
Active memb area: 0.167 ft²
Active width: 0.330 ft
Norm Temp: 24.6 °C
Feed TDS: 300.0 mg/L
Manuf rep TDS rej: 50%
Temp Norm MTC-w: 0.316 gfd/psi

ID#	Recov (dec.)	$F_{W\text{-des}}$ (gfd)
1	0.70	15.0
2	0.90	15.0
3	0.50	15.0
4	0.30	15.0

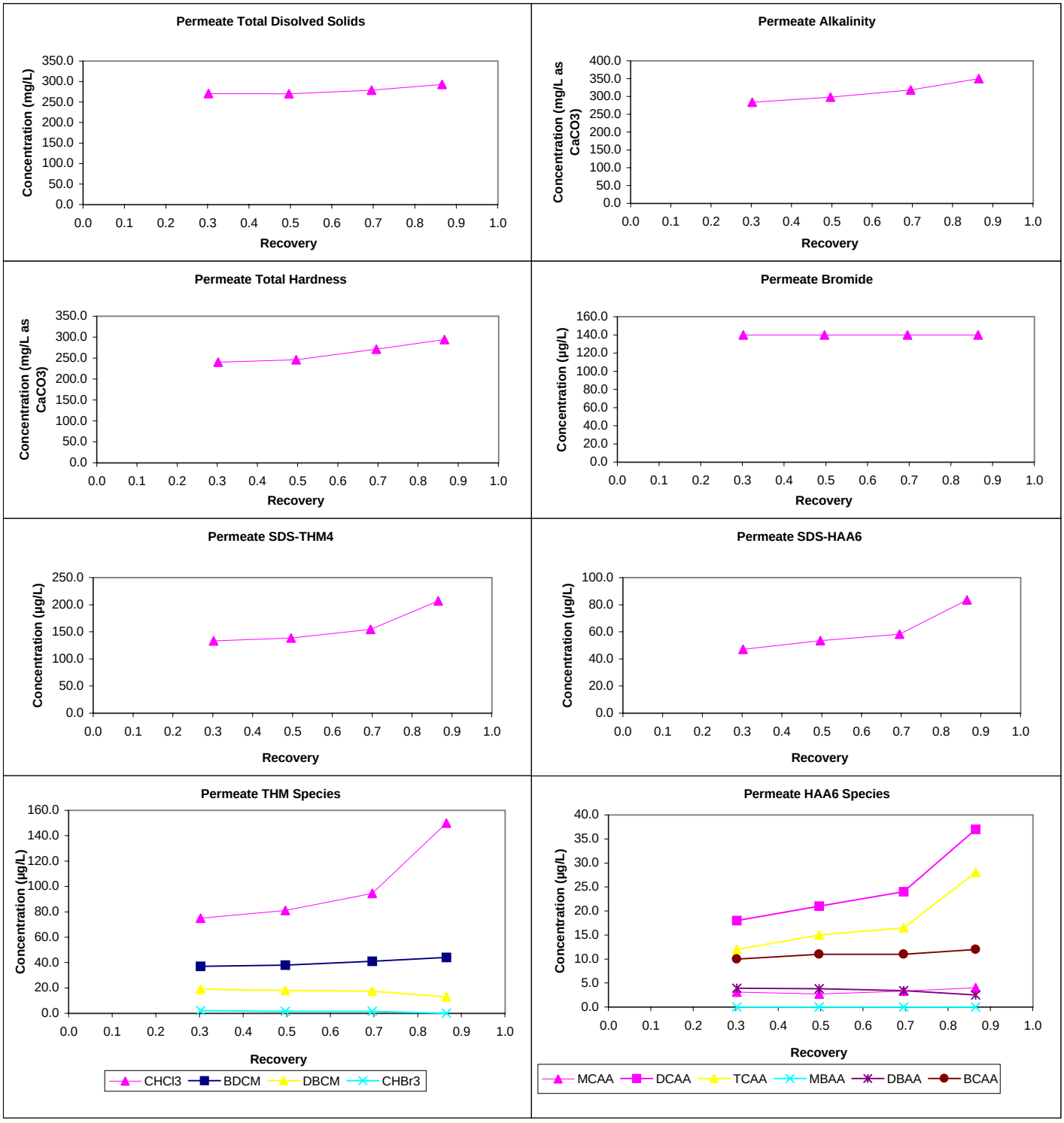
Comments:

Water Quality Parameter Graphs

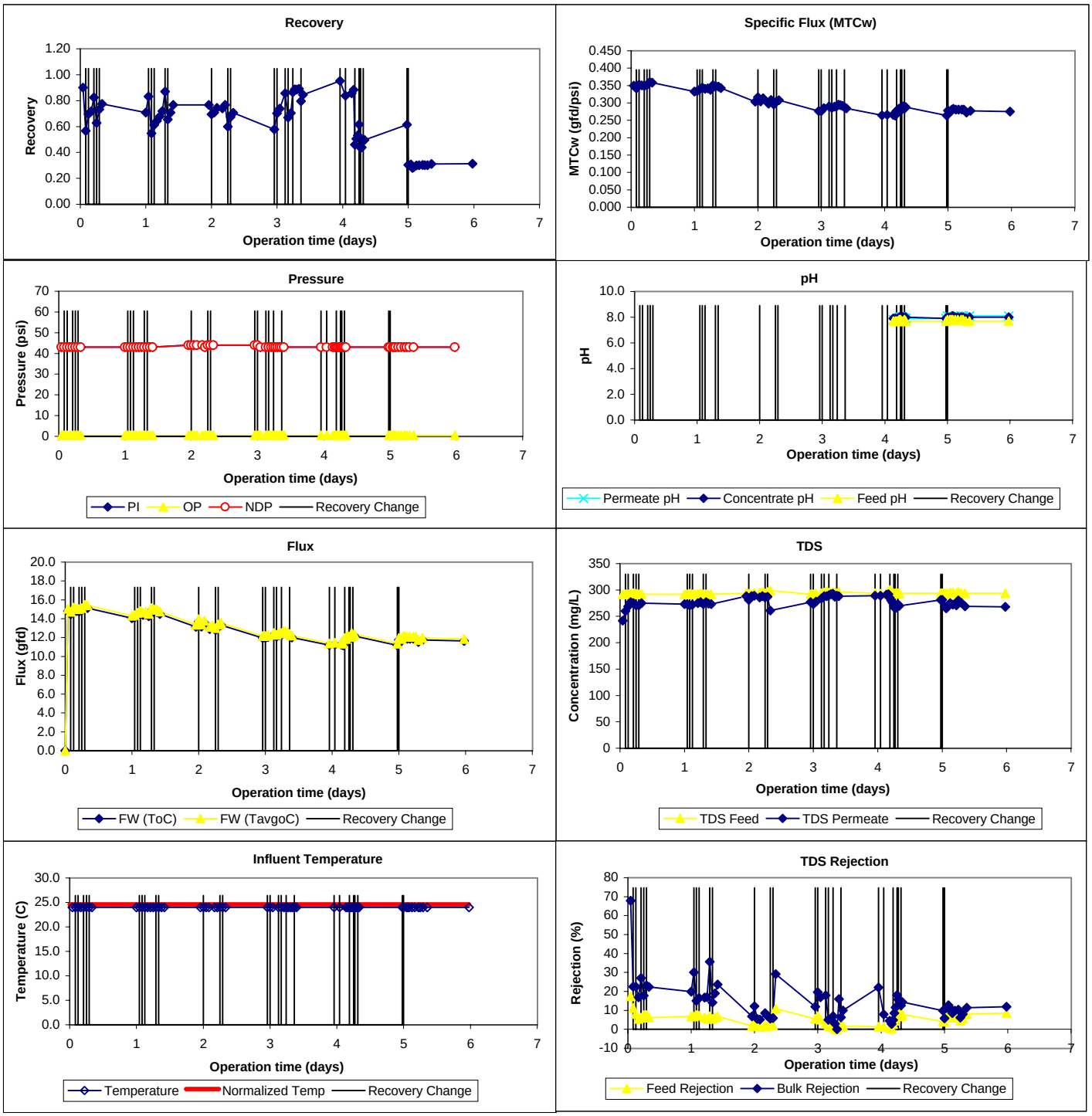




Water Quality Parameter Graphs (Continued)



Productivity Graphs



Broward County Office of Environmental Services, LA WTP

RBSMT Membrane Treatment Study Summary (TFC-SR)

Quarter: 1

ICR Information

ID / ICR#: 4060167 / 294
ICR Contact: Mr. Jerry Baker
Phone No.: (954) 960-3061
Period: 4/29/98 - 5/5/98 (6 days)

Membrane Information

Manufacturer: Fluid Systems
Trade Name: TFC-SR
MWCO: 300 Daltons
Mfr. Flux: 24.0 gfd
Mfr. NDP: 100.0 psi
Mfr. MTCw: 0.240 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 330.0 ft²
840 Purchase Price: N.A.
840 Maximum Flow: 80.0 gpm
840 Minimum Flow: 20.0 gpm
840 Total Width: 58.2 ft
840 Feed Spacer Thickness: 0.0026 ft

Water Qality Summary

Source ->	Feed		Permeate				Concentrate			
Recovery ->	Avg	Diff	0.29	0.50	0.70	0.82	0.29	0.50	0.70	0.82
pH	8.3	0.2	8.4	8.3	8.2	8.2	8.5	8.5	8.4	8.6
Temp	24.0	0.0	23.0	23.0	24.0	24.0	23.0	23.0	24.0	24.0
Alk	191	25	140	190	161	186	242	258	300	330
TDS	**297**	**3**	**204**	**247**	**225**	**260**	**317**	**337**	**389**	**429**
TotHard	195	5	118	176	146	186	268	318	382	458
CaHard	161	3	106	156	133	158	232	234	348	420
Turb	0.96	0.01	0.07	0.07	0.09	0.08	1.18	1.33	1.48	1.80
Amm	0.00	NA	0.08	0.22	0.78	0.39	NA	NA	NA	NA
TOC	**14.4**	**NA**	**0.3**	**0.6**	**0.3**	**1.0**	**19.1**	**25.7**	**45.5**	**105.9**
UV254	0.523	0.048	0.010	0.017	0.005	0.028	0.809	1.132	1.748	3.934
SUVA	#N/A	NA	4.00	2.83	1.80	2.80	4.24	4.40	3.84	3.71
Bromide	**140**	**NA**	**110**	**120**	**130**	**130**				
TOX	**1300**	**NA**	**41**	**59**	**13**	**67**				
CHCl3	490.0	NA	2.9	5.3	2.9	7.9				
BDCM	69.0	NA	5.8	9.4	1.8	9.3				
DBCM	7.1	NA	14.0	18.0	0.0	15.0				
CHBr3	0.0	NA	16.0	17.0	0.0	16.0				
THM4	**566.1**	**NA**	**38.7**	**49.7**	**4.6**	**48.2**				
MCAA	8.6	NA	0.0	0.0	0.0	0.0				
DCAA	120.0	NA	1.0	2.2	1.9	3.2				
TCAA	89.0	NA	0.0	1.0	0.0	1.6				
MBAA	1.0	NA	0.0	0.0	0.0	0.0				
DBAA	1.3	NA	3.8	5.0	0.0	5.2				
BCAA	16.0	NA	1.8	3.1	0.0	3.0				
TBAA	0.0	NA	0.0	0.0	0.0	0.0				
CDBAA	0.0	NA	0.0	0.0	0.0	0.0				
DCBAA	12.0	NA	0.0	1.2	0.0	1.1				
HAA5	**219.9**	**NA**	**4.8**	**8.2**	**1.9**	**10.0**				
HAA6	**235.9**	**NA**	**6.6**	**11.3**	**1.9**	**13.0**				
HAA9	**247.9**	**NA**	**6.6**	**12.5**	**1.9**	**14.1**				

SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (mg/L) (1)	0.79	0.53	6	0.08 - 1.23
Temp (°C)	25.0	0.0	6	25.0 - 25.0
pH (unit)	8.8	0.1	6	8.7 - 8.9
Time (hr)	24.0	0.0	6	24.0 - 24.0

Mass Balance Closure Err (%)

WQP	Count	Avg	SD
TDSt	15	-16	55
Alk	4	22	11
TDS	4	-9	7
TotHard	4	29	15
CaHard	4	36	16
Turb	4	-81	73
Amm	0	n/a	n/a
TOC	2	10	19
UV254	3	16	12

Pretreatment Information

Process	Description	Scale
Cartridge filtration	5 micron filter	bench

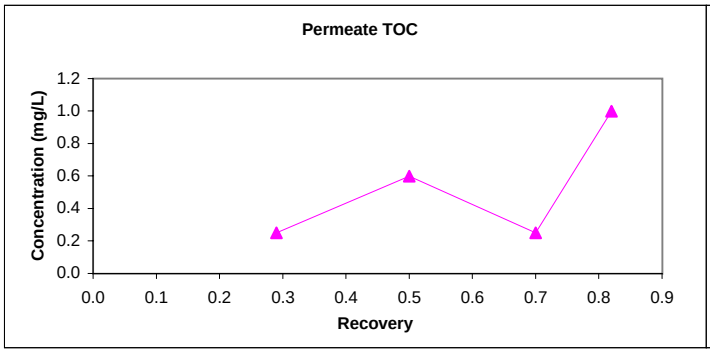
Design Parameters

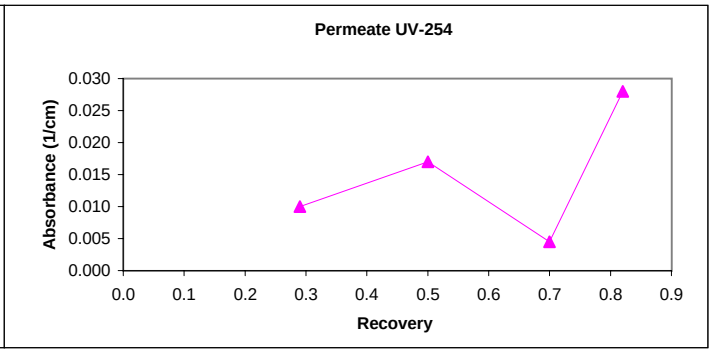
Active memb area: 0.167 ft²
Active width: 0.330 ft
Norm Temp: 24.6 °C
Feed TDS: 300.0 mg/L
Manuf rep TDS rej: 50%
Temp Norm MTC-w: 0.237 gfd/psi

ID#	Recov (dec.)	$F_{W\text{-}des}$ (gfd)
1	0.70	15.0
2	0.90	15.0
3	0.50	15.0
4	0.30	15.0

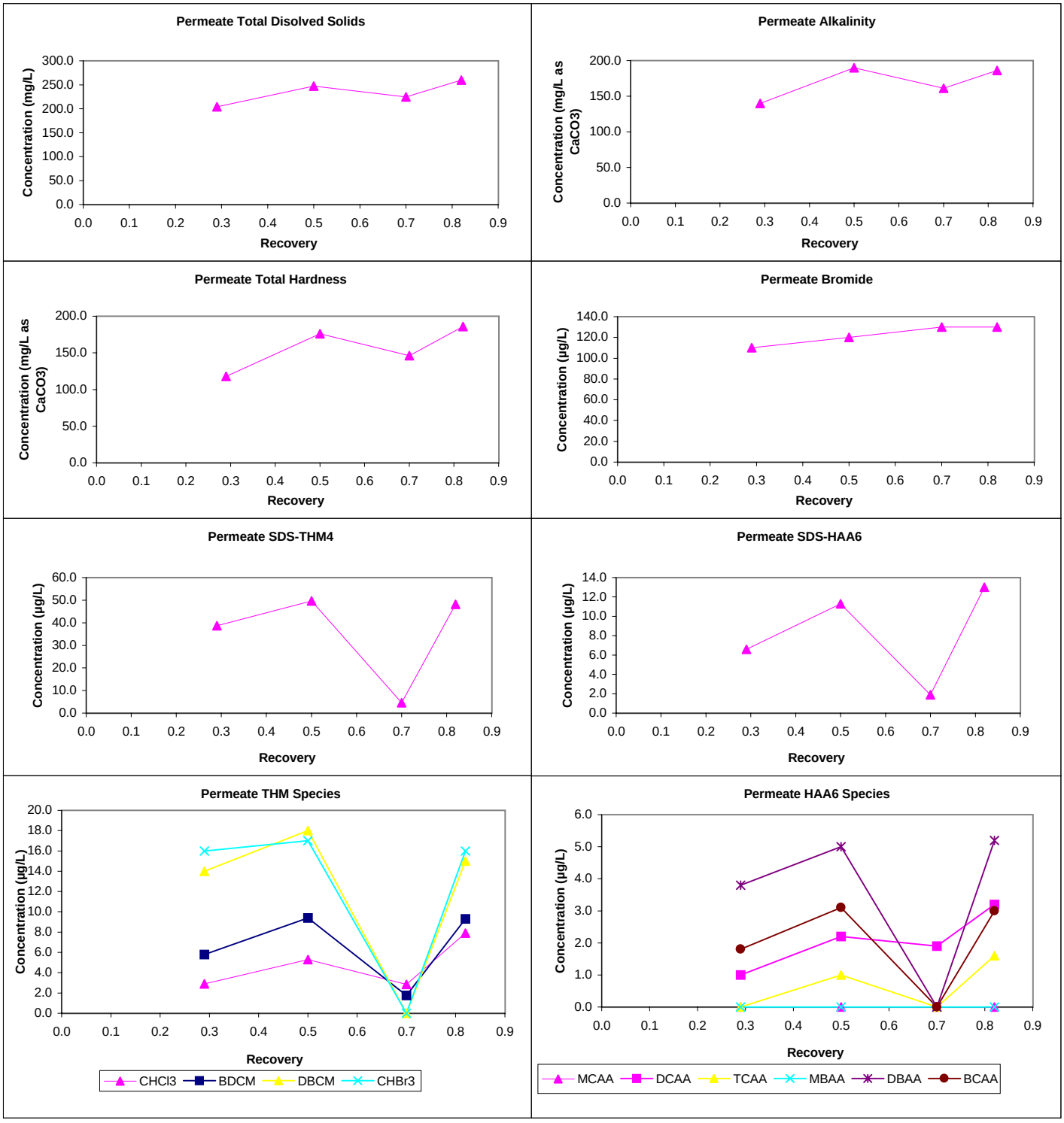
Comments:

Water Quality Parameter Graphs

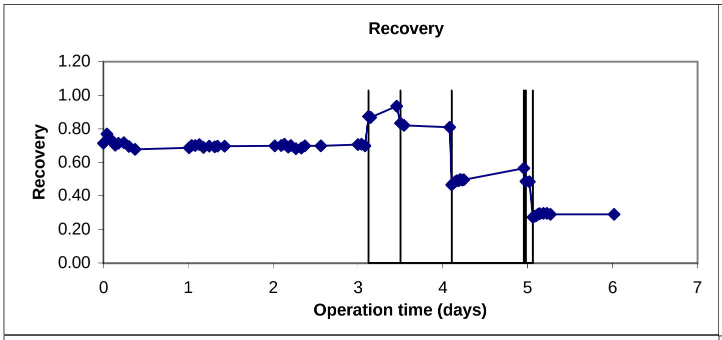


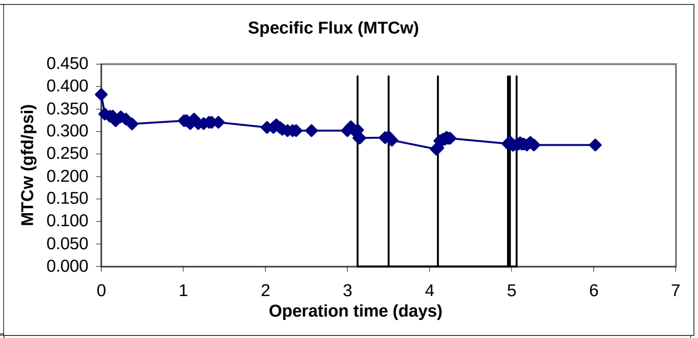


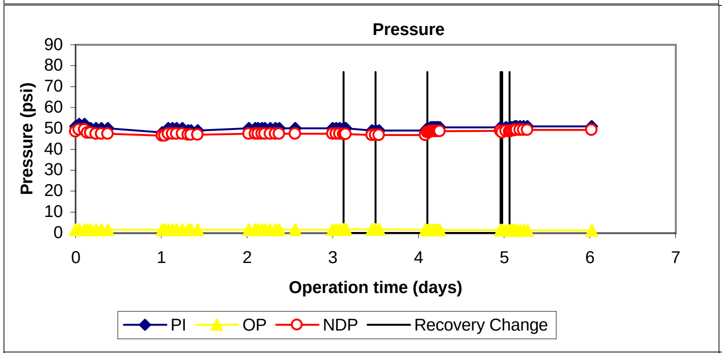
Water Quality Parameter Graphs (Continued)

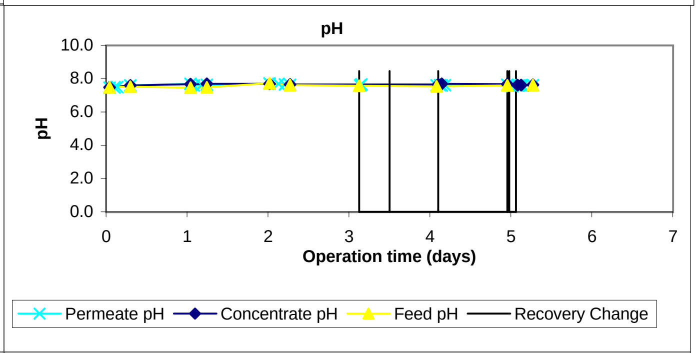


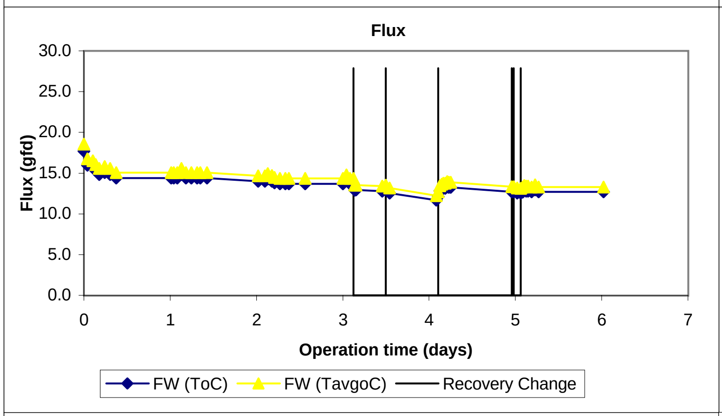
Productivity Graphs

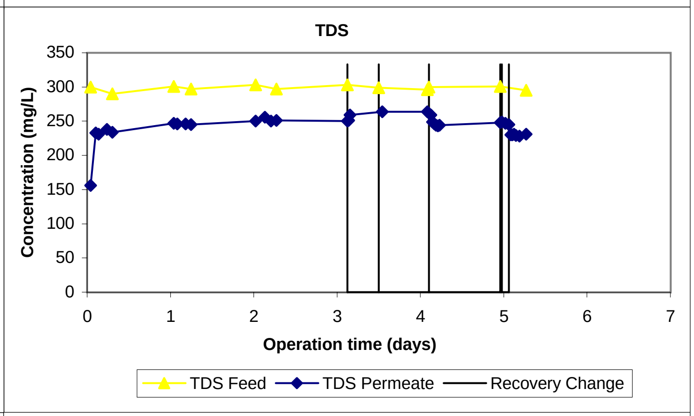


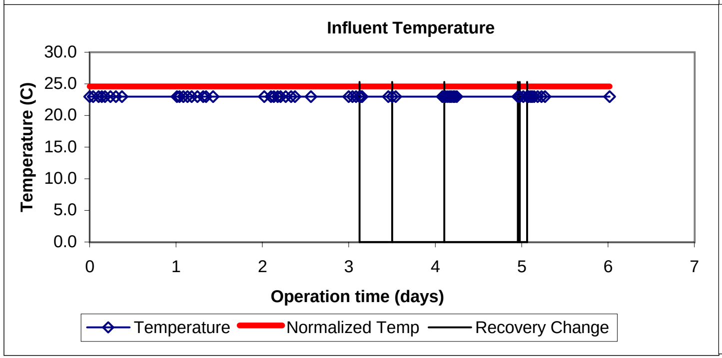


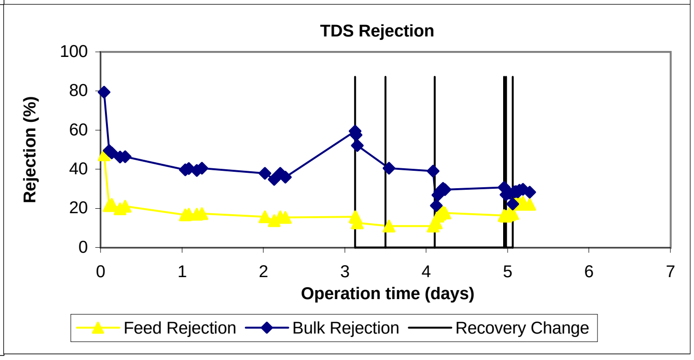












Broward County Office of Environmental Services - Lab Area

RBSMT Membrane Treatment Study Summary (TFC-SR)

Quarter: 2

ICR Information

ID / ICR#: 4060167 / 294
ICR Contact: Mr. Jerry Baker
Phone No.: (954) 960-3061
Period: 7/8/98 - 7/14/98 (6 days)

Membrane Information

Manufacturer: Fluid Systems
Trade Name: TFC-SR
MWCO: 300 Daltons
Mfr. Flux: 24.0 gfd
Mfr. NDP: 100.0 psi
Mfr. MTCw: 0.240 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 330.0 ft²
840 Purchase Price: N.A.
840 Maximum Flow: 80.0 gpm
840 Minimum Flow: 20.0 gpm
840 Total Width: 58.2 ft
840 Feed Spacer Thickness: 0.0026 ft

Water Qality Summary

Source ->	Feed		Permeate				Concentrate			
Recovery ->	Avg	Diff	0.30	0.51	0.69	0.91	0.30	0.51	0.69	0.91
pH	7.9	0.3	7.7	7.7	7.8	7.7	7.7	8.3	8.1	8.3
Temp	24.0	0.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Alk	205	2	157	175	193	188	238	245	270	265
TDS	**317**	**2**	**223**	**246**	**238**	**273**	**333**	**352**	**453**	**486**
TotHard	299	9	162	182	210	270	286	332	508	484
CaHard	256	4	146	158	180	206	280	324	478	462
Turb	1.26	0.14	0.05	0.05	0.05	0.05	0.35	0.38	0.48	1.13
Amm	0.31	0.17	0.00	0.00	1.10	0.20	NA	NA	NA	NA
TOC	**13.3**	**0.5**	**0.3**	**0.9**	**0.3**	**1.1**	**19.5**	**27.0**	**45.0**	**105.0**
UV254	0.635	0.030	0.020	0.016	0.005	0.024	0.877	1.111	1.660	3.620
SUVA	4.77	0.05	8.00	1.78	1.80	2.18	4.50	4.11	3.69	3.45
Bromide	**150**	**0**	**110**	**120**	**120**	**140**				
TOX	**1435**	**5**	**43**	**52**	**13**	**78**				
CHCl3	480.0	0.0	5.1	6.0	3.0	8.2				
BDCM	53.5	5.5	8.0	9.5	0.0	14.0				
DBCM	5.4	0.0	12.0	15.0	0.0	22.0				
CHBr3	0.0	0.0	8.0	9.4	0.0	15.0				
THM4	**538.9**	**5.5**	**33.1**	**39.9**	**3.0**	**59.2**				
MCAA	10.4	0.6	0.0	0.0	0.0	0.0				
DCAA	130.0	0.0	2.5	2.4	3.8	3.4				
TCAA	103.0	7.0	0.0	0.0	0.0	1.1				
MBAA	0.0	0.0	0.0	0.0	0.0	0.0				
DBAA	1.5	0.0	3.0	3.6	0.0	5.3				
BCAA	16.0	1.0	1.2	1.9	0.0	3.5				
TBAA	0.0	0.0	0.0	0.0	0.0	0.0				
CDBAA	0.0	0.0	0.0	0.0	0.0	2.7				
DCBAA	12.5	1.5	1.1	1.4	0.0	1.9				
HAA5	**244.9**	**6.4**	**5.5**	**6.0**	**3.8**	**9.8**				
HAA6	**260.9**	**7.4**	**6.7**	**7.9**	**3.8**	**13.3**				
HAA9	**273.4**	**8.9**	**7.8**	**9.3**	**3.8**	**17.9**				

SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (mg/L) (0)	1.55	0.64	6	0.68 - 2.42
Temp (°C)	25.0	0.0	6	25.0 - 25.0
pH (unit)	9.2	0.3	6	8.9 - 9.5
Time (hr)	24.0	0.0	6	24.0 - 24.0

Mass Balance Closure Err (%)

WQP	Count	Avg	SD
TDSt	54	-8	11
Alk	4	-4	24
TDS	4	-21	24
TotHard	4	-18	14
CaHard	4	-18	33
Turb	4	-693	292
Amm	0	n/a	n/a
TOC	3	-6	21
UV254	3	-35	46

Pretreatment Information

Process	Description	Scale
Cartridge filtration	5 micron filter	bench

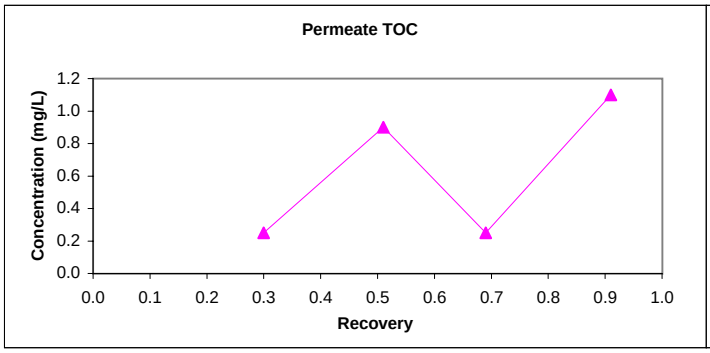
Design Parameters

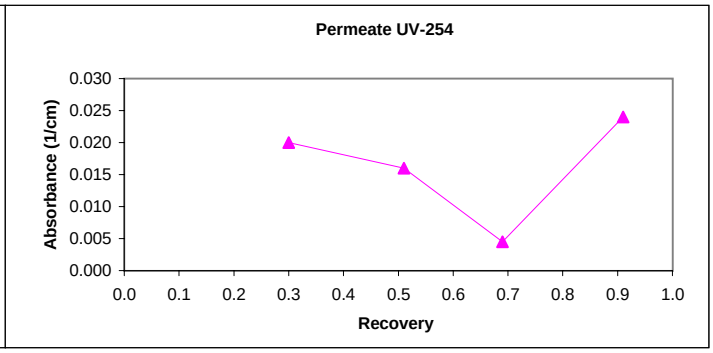
Active memb area: 0.167 ft²
Active width: 0.330 ft
Norm Temp: 24.6 °C
Feed TDS: 300.0 mg/L
Manuf rep TDS rej: 50%
Temp Norm MTC-w: 0.237 gfd/psi

ID#	Recov (dec.)	$F_{W\text{-des}}$ (gfd)
1	0.70	15.0
2	0.90	15.0
3	0.50	15.0
4	0.30	15.0

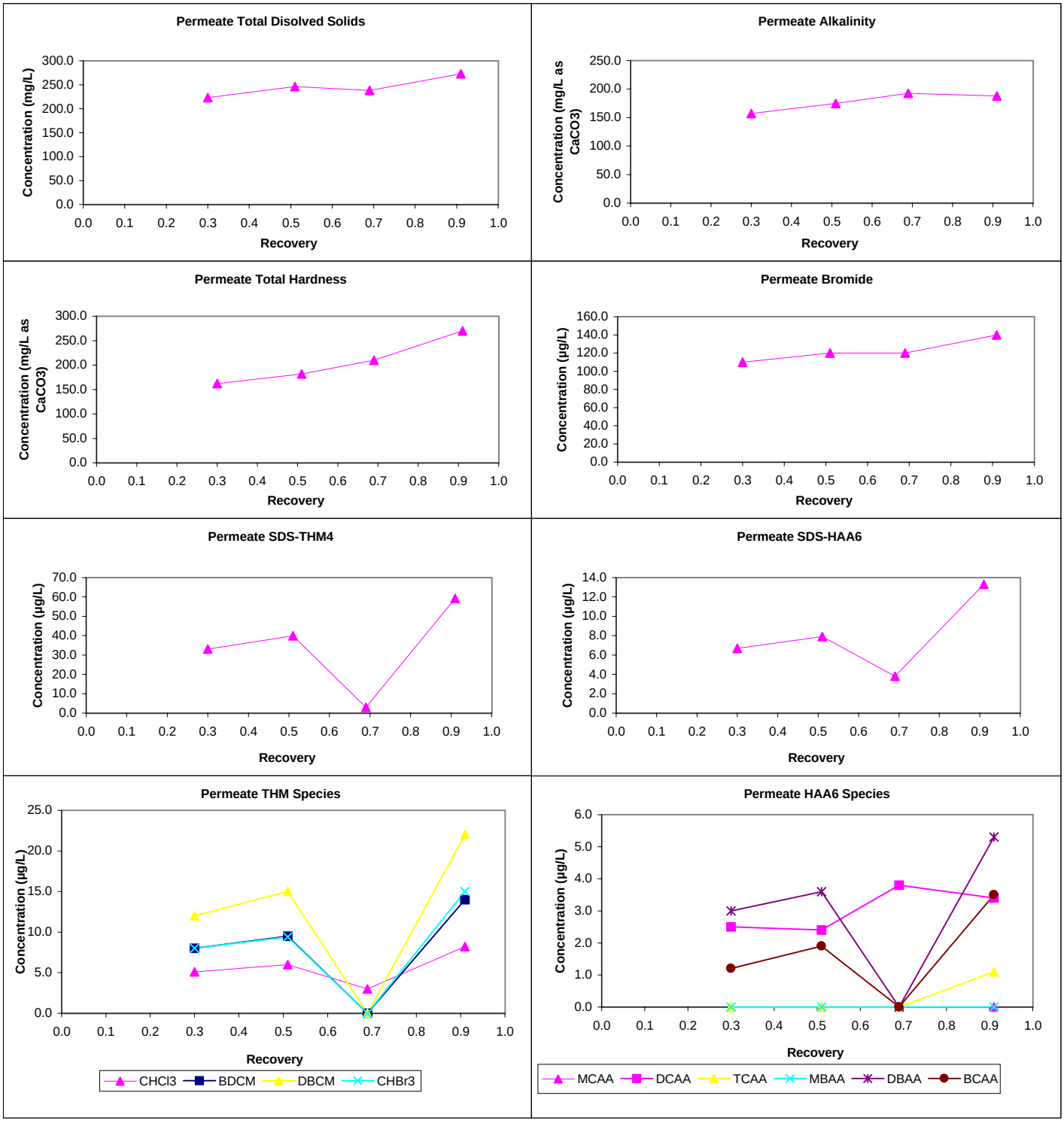
Comments:

Water Quality Parameter Graphs

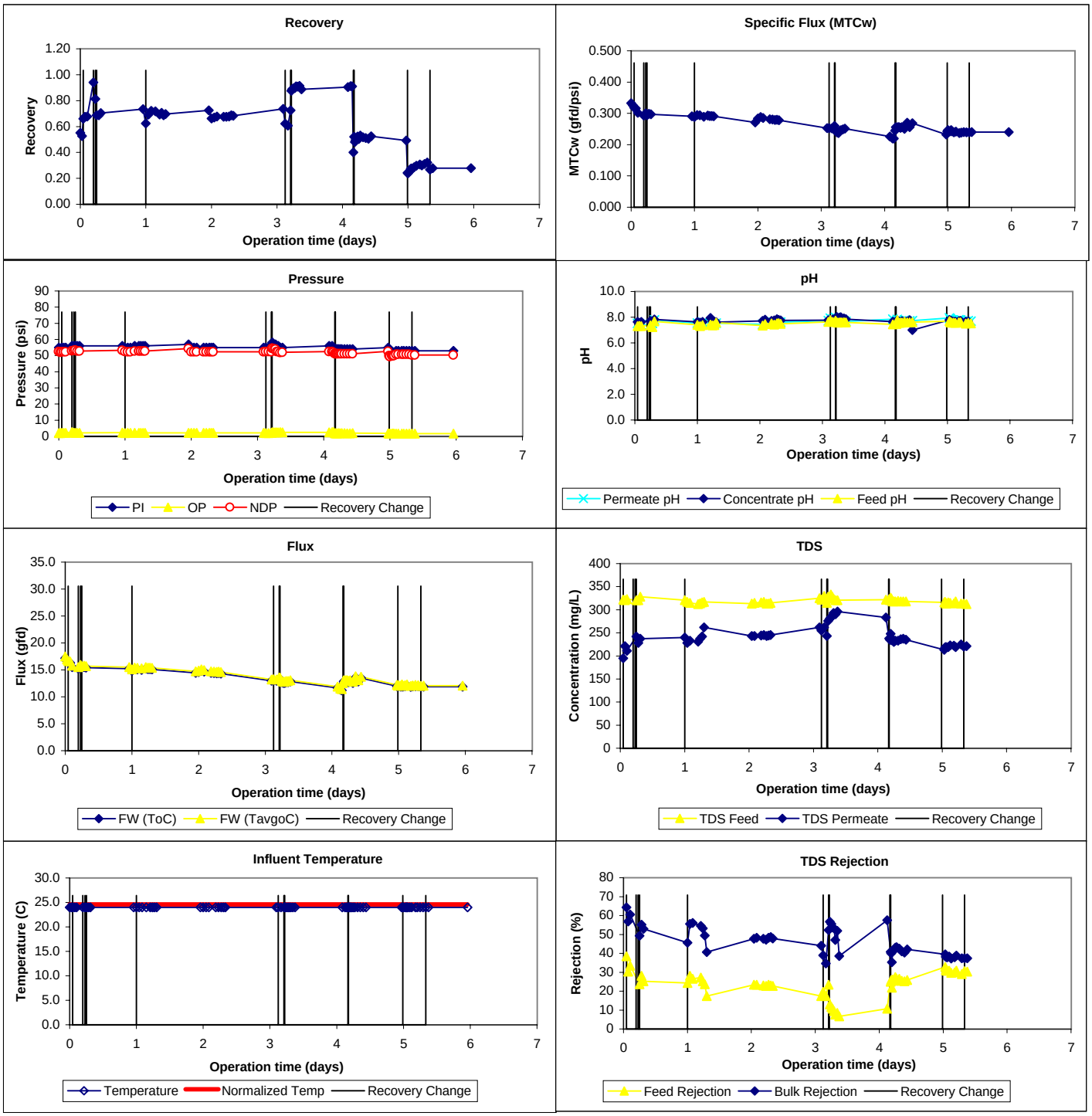




Water Quality Parameter Graphs (Continued)



Productivity Graphs



Broward County Office of Environmental Services - LEA WTP **RBSMT Membrane Treatment Study Summary (TFC-SR)** **Quarter:** 3

ICR Information

ID / ICR#: 4060167 / 294
ICR Contact: Mr. Jerry Baker
Phone No.: (954) 960-3061
Period: 11/10/98 - 11/16 (6 days)

Membrane Information

Manufacturer: Fluid Systems
Trade Name: TFC-SR
MWCO: 300 Daltons
Mfr. Flux: 24.0 gfd
Mfr. NDP: 100.0 psi
Mfr. MTCw: 0.240 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 330.0 ft²
840 Purchase Price: N.A.
840 Maximum Flow: 80.0 gpm
840 Minimum Flow: 20.0 gpm
840 Total Width: 58.2 ft
840 Feed Spacer Thickness: 0.0026 ft

Water Qality Summary

Source ->	Feed		Permeate				Concentrate			
Recovery ->	Avg	Diff	0.30	0.54	0.71	0.90	0.30	0.54	0.71	0.90
pH	8.0	0.4	7.7	7.7	7.7	7.8	8.1	7.6	7.8	8.5
Temp	23.5	0.5	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
Alk	421	15	312	330	321	384	400	506	581	612
TDS	**280**	**2**	**225**	**247**	**232**	**266**	**301**	**347**	**386**	**418**
TotHard	217	3	150	172	158	196	240	308	364	456
CaHard	205	1	142	152	135	164	234	254	345	424
Turb	0.62	0.26	0.08	0.07	0.09	0.10	1.11	1.15	1.00	4.25
Amm	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
TOC	**12.0**	**0.3**	**0.8**	**1.0**	**0.9**	**1.8**	**17.6**	**34.2**	**42.9**	**122.3**
UV254	0.570	0.043	0.034	0.029	0.021	0.065	0.797	1.452	1.745	4.720
SUVA	4.74	0.24	4.25	2.90	2.41	3.61	4.53	4.25	4.07	3.86
Bromide	**140**	**0**	**130**	**130**	**130**	**140**				
TOX	**1095**	**25**	**72**	**85**	**62**	**140**				
CHCl3	405.0	45.0	8.7	12.0	4.9	29.0				
BDCM	52.0	7.0	11.0	15.0	7.6	25.0				
DBCM	5.9	0.6	16.0	21.0	15.5	24.0				
CHBr3	0.0	0.0	13.0	14.0	16.5	8.3				
THM4	**462.9**	**52.5**	**48.7**	**62.0**	**44.5**	**86.3**				
MCAA	5.5	0.1	0.0	0.0	0.0	0.0				
DCAA	105.0	5.0	3.1	3.8	1.9	7.0				
TCAA	96.5	13.5	0.0	0.0	0.0	1.9				
MBAA	0.0	0.0	0.0	0.0	0.0	0.0				
DBAA	1.6	0.2	3.6	4.8	4.2	6.1				
BCAA	14.5	0.5	2.4	2.7	1.7	6.0				
TBAA	0.0	NA	0.0	0.0	0.0	0.0				
CDBAA	1.1	1.1	0.0	0.0	0.0	2.2				
DCBAA	12.0	0.0	1.2	1.4	1.4	2.5				
HAA5	**208.5**	**18.7**	**6.7**	**8.6**	**6.1**	**15.0**				
HAA6	**223.0**	**19.2**	**9.1**	**11.3**	**7.8**	**21.0**				
HAA9	**215.8**	**NA**	**10.3**	**12.7**	**9.1**	**25.7**				

SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (mg/L) (0)	1.76	0.53	6	1.01 - 2.20
Temp (°C)	25.0	0.0	6	25.0 - 25.0
pH (unit)	8.8	0.2	6	8.4 - 9.0
Time (hr)	24.0	0.0	6	24.0 - 24.0

Mass Balance Closure Err (%)

WQP	Count	Avg	SD
TDSt	45	-5	9
Alk	4	-15	8
TDS	4	2	5
TotHard	4	5	7
CaHard	4	-12	16
Turb	4	-27	49
Amm	0	n/a	n/a
TOC	4	14	10
UV254	4	0	12

Pretreatment Information

Process	Description	Scale
Cartridge filtration	5 micron filter	bench

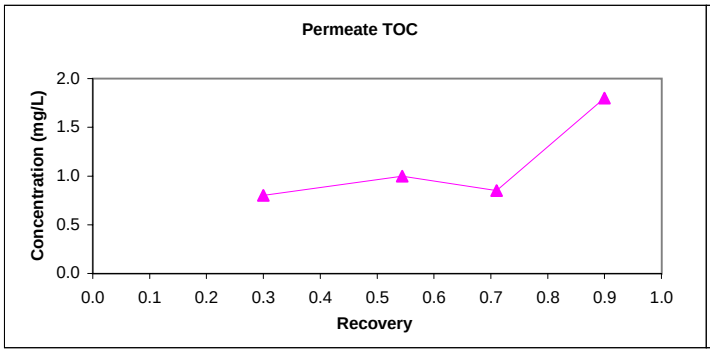
Design Parameters

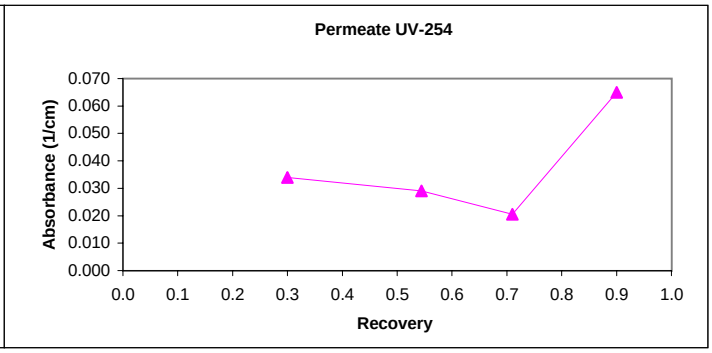
Active memb area: 0.167 ft²
Active width: 0.330 ft
Norm Temp: 24.6 °C
Feed TDS: 300.0 mg/L
Manuf rep TDS rej: 50%
Temp Norm MTC-w: 0.237 gfd/psi

ID#	Recov (dec.)	$F_{W\text{-}des}$ (gfd)
1	0.70	15.0
2	0.90	15.0
3	0.50	15.0
4	0.30	15.0

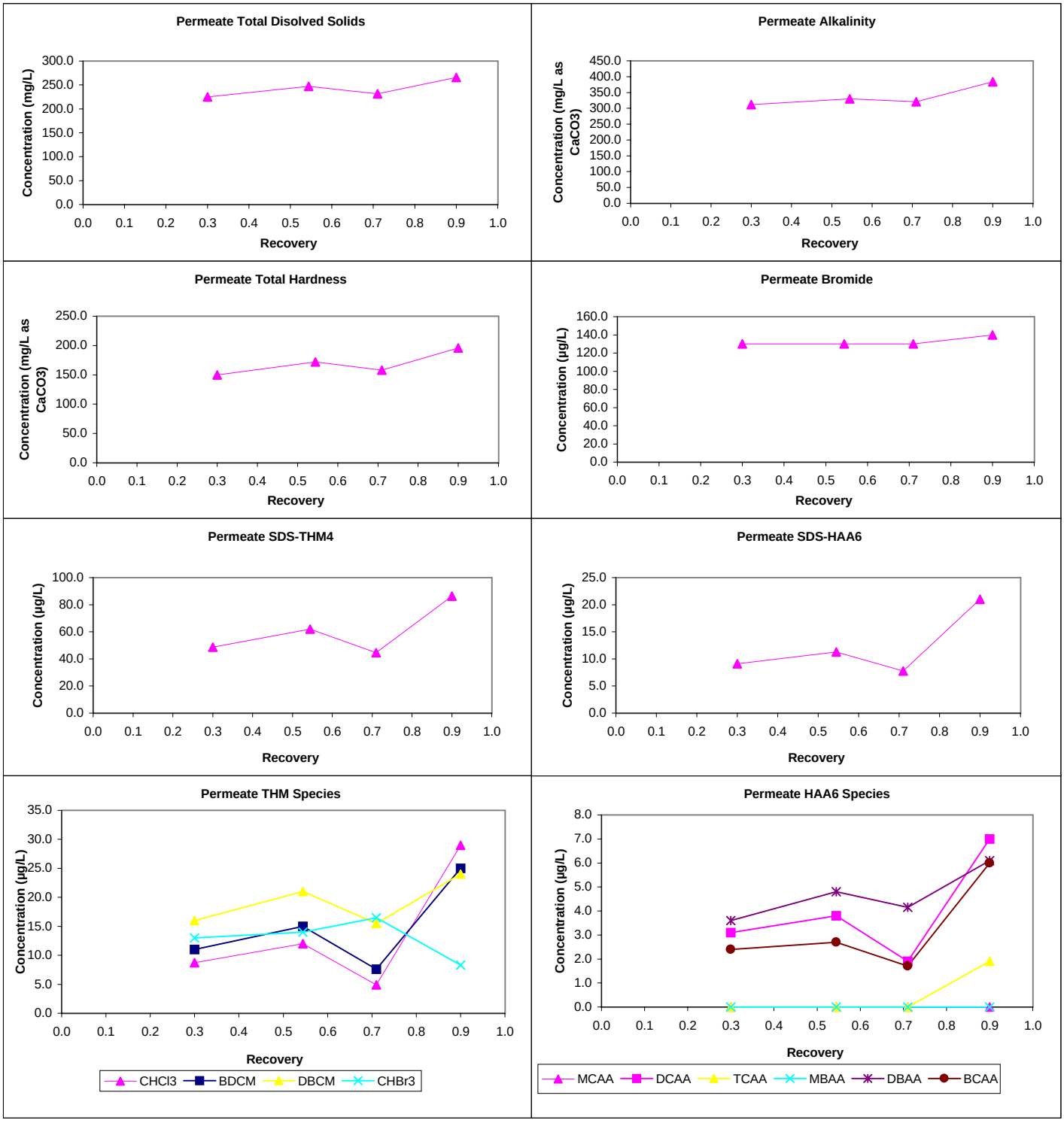
Comments:

Water Quality Parameter Graphs

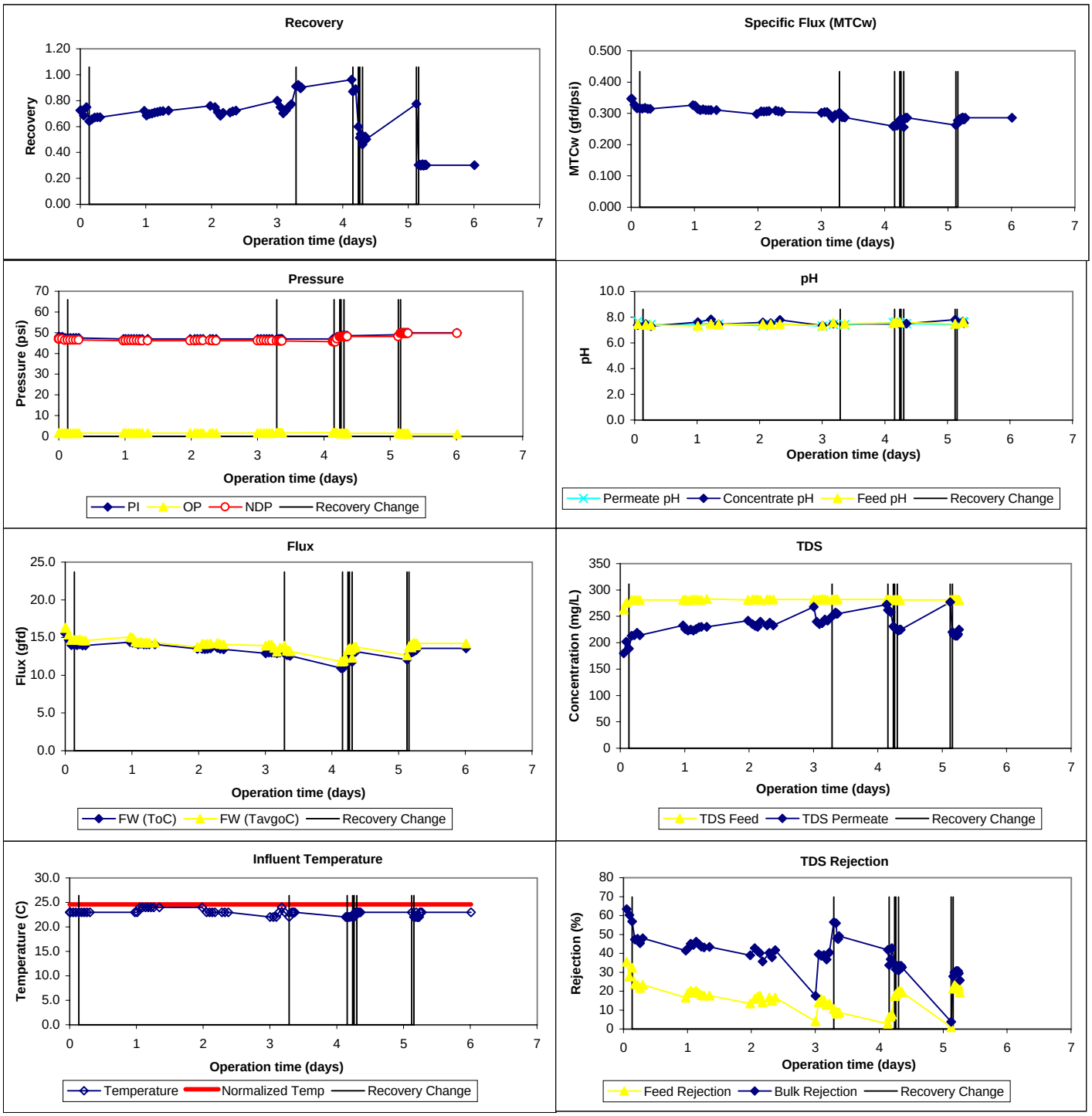




Water Quality Parameter Graphs (Continued)



Productivity Graphs



Broward County Office of Environmental Services, Davie, FL — **RBSMT Membrane Treatment Study Summary (TFC-SR)** — **Quarter:** 4

ICR Information

ID / ICR#: 4060167 / 294
ICR Contact: Mr. Jerry Baker
Phone No.: (954) 960-3061
Period: 3/26/99 - 4/1/99 (6 days)

Membrane Information

Manufacturer: Fluid Systems
Trade Name: TFC-SR
MWCO: 300 Daltons
Mfr. Flux: 24.0 gfd
Mfr. NDP: 100.0 psi
Mfr. MTCw: 0.240 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 330.0 ft²
840 Purchase Price: N.A.
840 Maximum Flow: 80.0 gpm
840 Minimum Flow: 20.0 gpm
840 Total Width: 58.2 ft
840 Feed Spacer Thickness: 0.0026 ft

Water Qality Summary

Source ->	Feed		Permeate				Concentrate			
Recovery ->	Avg	Diff	0.31	0.51	0.71	0.90	0.31	0.51	0.71	0.90
pH	8.1	0.2	8.0	7.9	8.0	7.9	8.0	8.1	8.1	8.2
Temp	24.0	0.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Alk	348	2	136	144	155	292	356	360	435	534
TDS	**293**	**0**	**184**	**198**	**204**	**259**	**339**	**375**	**420**	**443**
TotHard	295	3	134	140	156	224	352	378	508	602
CaHard	270	2	102	116	126	196	318	334	480	566
Turb	0.26	0.01	0.07	0.08	0.09	0.11	0.29	0.30	0.32	0.80
Amm	0.04	0.04	0.00	0.00	0.00	0.00	NA	NA	NA	NA
TOC	**12.6**	**0.1**	**0.7**	**1.0**	**0.8**	**1.6**	**17.9**	**27.9**	**45.5**	**114.4**
UV254	0.588	0.001	0.014	0.018	0.020	0.045	0.717	1.099	1.727	3.094
SUVA	4.67	0.04	2.00	1.80	2.67	2.81	4.01	3.94	3.80	2.70
Bromide	**140**	**0**	**83**	**96**	**100**	**130**				
TOX	**1665**	**265**	**45**	**61**	**65**	**110**				
CHCl3	475.0	45.0	4.9	5.7	4.3	15.0				
BDCM	59.0	2.0	7.7	10.0	8.5	21.0				
DBCM	5.5	0.2	13.0	17.0	15.5	26.0				
CHBr3	0.0	0.0	7.8	8.7	10.1	8.7				
THM4	**539.5**	**47.1**	**33.4**	**41.4**	**38.3**	**70.7**				
MCAA	11.0	NA	0.0	0.0	0.0	0.0				
DCAA	110.0	NA	1.2	2.4	1.8	4.0				
TCAA	140.0	NA	0.0	1.4	0.0	1.9				
MBAA	0.0	NA	0.0	0.0	0.0	0.0				
DBAA	1.4	NA	3.2	3.8	4.0	5.8				
BCAA	16.0	NA	1.9	2.7	2.2	5.2				
TBAA	0.0	NA	NR	NR	NA	NR				
CDBAA	2.6	NA	2.2	2.6	2.4	4.3				
DCBAA	19.0	NA	1.3	1.8	1.6	3.7				
HAA5	**262.4**	**NA**	**4.4**	**7.6**	**5.8**	**11.7**				
HAA6	**278.4**	**NA**	**6.3**	**10.3**	**8.0**	**16.9**				
HAA9	**300.0**	**NA**	**NR**	**NR**	**NA**	**NR**				

SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (mg/L) (0)	1.19	0.39	6	0.71 - 1.66
Temp (°C)	24.0	0.0	6	24.0 - 24.0
pH (unit)	8.9	0.1	6	8.8 - 9.0
Time (hr)	24.0	0.0	6	24.0 - 24.0

Mass Balance Closure Err (%)

WQP	Count	Avg	SD
TDSt	57	-13	50
Alk	4	-57	26
TDS	4	-15	15
TotHard	4	-26	20
CaHard	4	-33	22
Turb	4	-70	43
Amm	0	n/a	n/a
TOC	4	6	5
UV254	4	-29	30

Pretreatment Information

Process	Description	Scale
Cartridge filtration	5 micron filter	bench

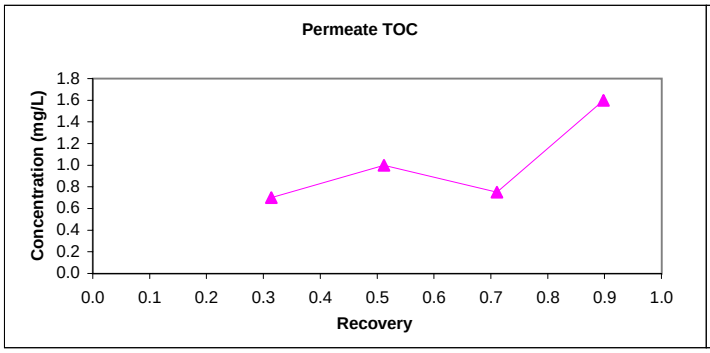
Design Parameters

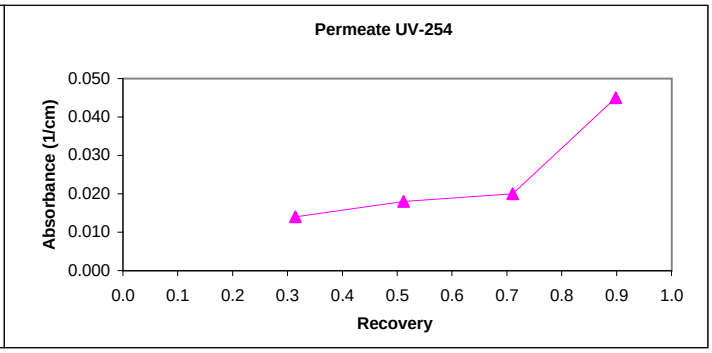
Active memb area: 0.167 ft²
Active width: 0.330 ft
Norm Temp: 24.6 °C
Feed TDS: 300.0 mg/L
Manuf rep TDS rej: 50%
Temp Norm MTC-w: 0.237 gfd/psi

ID#	Recov (dec.)	$F_{W\text{-des}}$ (gfd)
1	0.70	15.0
2	0.90	15.0
3	0.50	15.0
4	0.30	15.0

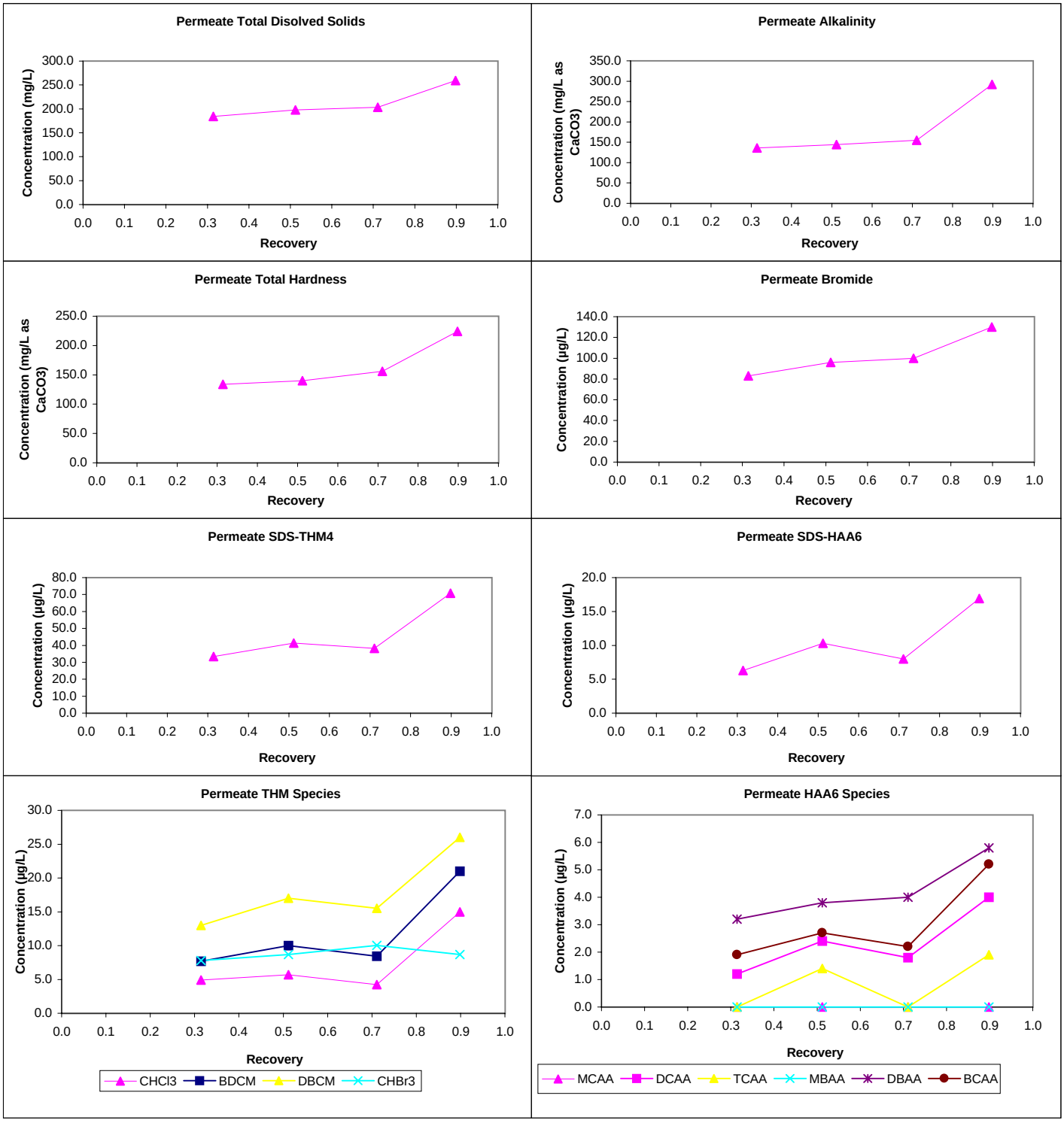
Comments:

Water Quality Parameter Graphs





Water Quality Parameter Graphs (Continued)



Productivity Graphs