ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID 4011

Study Protocol Two-Stage Pilot-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 pilot-scale study (study ID 4011) was conducted in conjunction with a pilot-scale study (study ID 4111) and a single-element study (study ID 4211). 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 TriSep TS80 TSA (formerly known as the Dupont A15S) 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 needed. The resulting integrated membrane system included the following pretreatments: coagulation, sedimentation, rapid sand filtration, pH reduction, and microfiltration. A schematic of the integrated membrane system, including the 4-2 staged array nanofiltration system, is shown in Figure 2 of the Summary Report (Part 1)

3. This system was operated from July 1990 through February 1991; however, treatment study data was only collected during the first 185 days of operation, resulting in seven sets of water quality data.

4. Section 1 of the Summary Report (Part 1) 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 1).

Water Quality Comments:

1. Three 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 similar to a 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. Twenty productivity ouliers 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-A15S) is listed in Table 7 (Part 1).

3. The membrane system was cleaned every 2 to 4 weeks, as needed, with a phosphate detergent and NaOH solution.

4. New membranes were installed after 73 days of operation, resulting in an ~ 80% increase in the temperature normalized MTCw. Due to this significant change in performance, only productivity data from the period of operation with the new membranes was considered during this analysis.

5. During productivity analysis, the average slope and cleaning interval were calculated to be -2.49×10^{-3} gfd/psi/day and 35 days, respectively. This slope is similar to the average slope and reported by the researchers: -3.63×10^{-3} gfd/psi/day (the cleaning interval calculated from this slope is 29 days).

City of Melbourne Water System | **Pilot-Scale Membrane Treatment Study Summary** | **Session:** 1

ICR Information

ID / ICR#:	FL3051447 / 283
ICR Contact:	Mr. Ralph Sigman
Phone No.:	(407) 255-4623
Period:	7/4/90 - 8/27/97 (2611 days)

Membrane Information

Manufacturer:	Trisep
Trade Name:	TS80
Membrane Model:	4040 TS80 TSA
MWCO:	200 - 300 Daltons
Element Size:	4" X 40"
Element Area:	92.0 ft^2
Design Flux:	22.7 gfd
Mfr. NDP:	105.0 psi
Mfr. MTC_W:	0.216 (gfd/psi)
Mfr. Temp:	25.0 ^oC
Maximum Flow:	20.0 gpm
Minimum Flow:	7.0 gpm
Total Width :	14.0 ft
Feed Spacer Thickness:	0.0023 ft
840 Element Area	360.0 ft^2
840 Purchase Price:	750 - 900

Design Parameters

Norm Temp:	24.5 ^oC
Temp Norm MTC-w:	0.213 TavgC
Design Recovery:	0.65
Avg Sys Flux F_W:	15.0 gfd
# of Elem in P.V.:	3
# Pres Ves in Stg 1:	2
# Pres Ves in Stg 2:	1
Pres Ves in Stg 3:	NA
Design Flux:	15.0 gfd
Recycle Ratio:	0.00
Osmotic P Stage 1:	3.0 psi
Osmotic P Stage 2:	6.0 psi
Osmotic P Stage 3:	NA

Water Quality Summary

	Feed (System)				Permeate (System)				Concentrate (System)			
Summary	**Mean**	**SD**	**Count**	**Min/Max**	**Mean**	**SD**	**Count**	**Min/Max**	**Mean**	**SD**	**Count**	**Min/Max**
pH	6.3	0.8	2	5.7 - 6.8	5.9	0.4	2	5.6 - 6.1	5.8	0.1	2	5.7 - 5.9
Temp	28.6	0.4	2	28.3 - 28.9	28.6	0.4	2	28.3 - 28.9	28.6	0.4	2	28.3 - 28.9
Alk	67	13	2	57 - 76	10	8	2	4 - 16	58	1	2	57 - 58
TDS	**530**	**14**	**2**	**520 - 540**	**42**	**5**	**2**	**38 - 45**	**995**	**7**	**2**	**990 - 1000**
TotHard	220	0	2	220 - 220	8	1	2	7 - 9	405	7	2	400 - 410
CaHard	180	14	2	170 - 190	7	1	2	6 - 8	325	7	2	320 - 330
Turb	1.55	1.9	2	0.20 - 2.90	0.23	0.2	2	0.06 - 0.40	0.77	0.2	2	0.63 - 0.90
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0
TOC	**8.4**	**2.3**	**2**	**6.8 - 10.0**	**0.4**	**0.2**	**2**	**0.3 - 0.6**	**18.0**	**1.4**	**2**	**17.0 - 19.0**
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	**1135**	**375**	**2**	**870 - 1400**	**49**	**17**	**2**	**37 - 61**				
CHCl3	180.0	127.3	2	90.0 - 270.0	3.0	4.2	2	0.0 - 6.0	**Mass Balance**			
BDCM	114.5	36.1	2	89.0 - 140.0	4.5	2.1	2	3.0 - 6.0	**Closure Errors (%)**			
DBCM	50.5	6.4	2	46.0 - 55.0	3.0	1.4	2	2.0 - 4.0	WQP	Count	Avg	SD/RD
CHBr3	4.0	5.7	2	0.0 - 8.0	0.0	0.0	2	0.0 - 0.0	Alk	2	-88	26
THM4	**349.0**	**151.3**	**2**	**242.0 - 456.0**	**10.5**	**7.8**	**2**	**5.0 - 16.0**	TDS	2	11	4
MCAA	9.0	1.4	2	8.0 - 10.0	0.0	0.0	2	0.0 - 0.0	TotHard	2	7	3
DCAA	94.5	36.1	2	69.0 - 120.0	3.0	1.4	2	2.0 - 4.0	CaHard	2	6	6
TCAA	105.0	77.8	2	50.0 - 160.0	1.0	1.4	2	0.0 - 2.0	Turb	2	-191	244
MBAA	2.0	0.0	2	2.0 - 2.0	0.0	0.0	2	0.0 - 0.0	Amm	0	n/a	n/a
DBAA	15.0	0.0	2	15.0 - 15.0	4.5	6.4	2	0.0 - 9.0	TOC	1	42	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	TDSt	1	7	#DIV/0!
DCBAA	NA	NA	0	NA	NA	NA	0	NA	**Comments:**			
HAA5	**225.5**	**115.3**	**2**	**144.0 - 307.0**	**8.5**	**9.2**	**2**	**2.0 - 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 (^oC)	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**
Alum Coagulation	Aluminum Sulfate dose: 151.4 mg/L	Full-scale
Sedimentation	Circular Clarifier	Full-scale
Rapid Sand Filtration	Sand/anthracite	Full-scale
Sulfuric Acid Feed	Approx. 85 mg/L to pH 3.5 to 4.5	Pilot-scale
Microfiltration	5um Filter Specialists Bag filter	Pilot-scale

Mass Balance Errors

Pressure	**RPD**	**SD**	**Flow**	**RPD**	**SD**	**TDS**	**RPD**	**SD**
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-0.2%	1.1%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 2 Conc	0.1%	1.4%	Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.6%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	9.7%	4.2%	Sys Perm - Sum Stg Pe	-0.3%	1.8%	Sys Perm - Avg Stg Perm	-18.9%	11.8%

Stage Summary

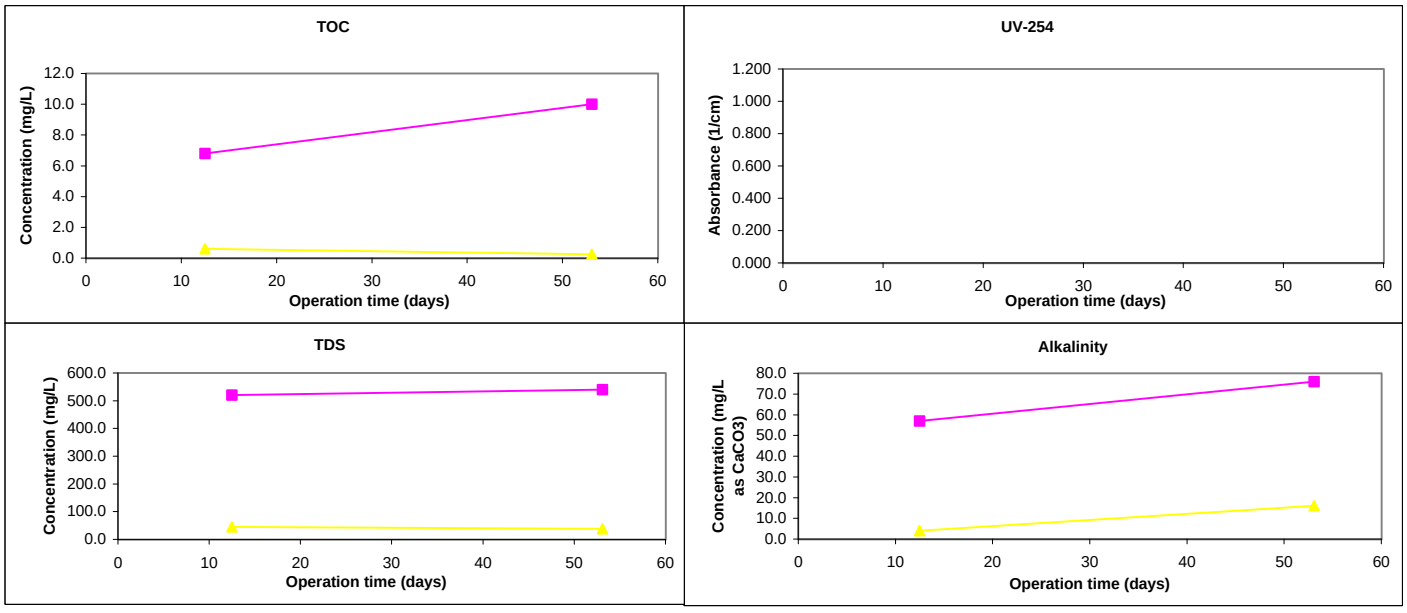
	Stage 1 Influent						Stage 1 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.30**	**0.02**	**2**	**0.28 - 0.31**					
pH	6.3	5.8	6.3	0.8	2	5.7 - 6.8	5.9	6.3	0.8	2	5.7 - 6.8
Temp	28.6	28.6	28.6	0.4	2	28.3 - 28.9	28.6	28.6	0.4	2	28.3 - 28.9
Alk	67	58	67	13	2	57 - 76	10	36	43	2	5 - 66
TDS	**530**	**995**	530	**14**	**2**	**520 - 540**	**42**	**47**	**13**	**2**	**38 - 56**
TotHard	220	405	220	0	2	220 - 220	8	17	13	2	7 - 26
CaHard	180	325	180	14	2	170 - 190	7	27	30	2	5 - 48
Turb	1.55	0.77	1.55	2	2	0.20 - 2.90	0.23	0.29	0.30	2	0 - 1
TOC	**8.4**	**18.0**	8.4	**2.3**	**2**	**6.8 - 10.0**	**0.4**	**0.4**	**0.2**	**2**	**0.3 - 0.5**
UV254	NA	**NA**	NA	NA	0	0.000 - 0.000	NA	NA	NA	0	0.000 - 0.000
SUVA	NA	**NA**	NA	NA	0	NA	NA	NA	NA	0	NA

	Stage 2 Influent						Stage 2 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.23**	**0.01**	**2**	**0.22 - 0.23**					
pH	6.3	5.8	5.4	1.3	2	4.5 - 6.3	5.9	6.2	0.2	2	6.0 - 6.3
Temp	28.6	28.6	28.6	0.4	2	28.3 - 28.9	28.6	28.6	0.4	2	28.3 - 28.9
Alk	67	58	**10**	14	2	0 - 20	10	14	1	2	13 - 15
TDS	**530**	**995**	755	**7**	**2**	**750 - 760**	**42**	**53**	**13**	**2**	**44 - 62**
TotHard	220	405	300	14	2	290 - 310	8	7	1	2	**6 - 8**
CaHard	180	325	260	28	2	240 - 280	7	8	1	2	**7 - 9**
Turb	1.55	0.77	**0.73**	1	2	0.25 - 1.20	0.23	0.45	0.49	2	0 - 1
TOC	**8.4**	**18.0**	12.5	**0.7**	**2**	**12.0 - 13.0**	**0.4**	**0.4**	**0.2**	**2**	**0.3 - 0.5**
UV254	NA	**NA**	NA	NA	0	0.000 - 0.000	NA	NA	NA	0	0.000 - 0.000
SUVA	NA	**NA**	NA	NA	0.00	NA	NA	NA	NA	0.00	NA

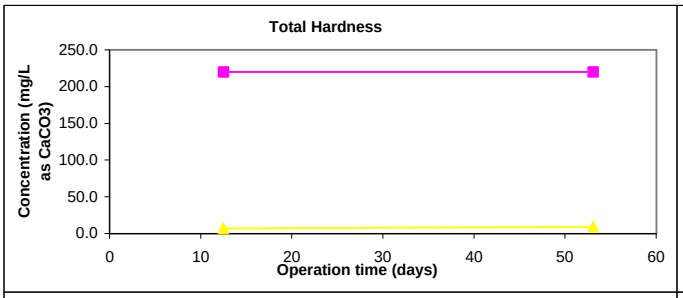
	Stage 3 Influent						Stage 3 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery											
pH											
Temp											
Alk	This	was	**only**	a	two	stage study.					
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

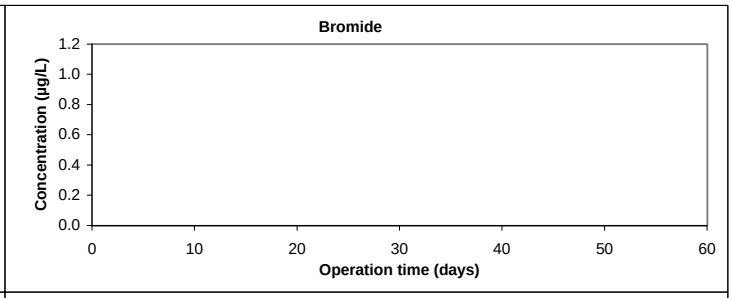
Chart Legend:
Feed (System)
Permeate (System)

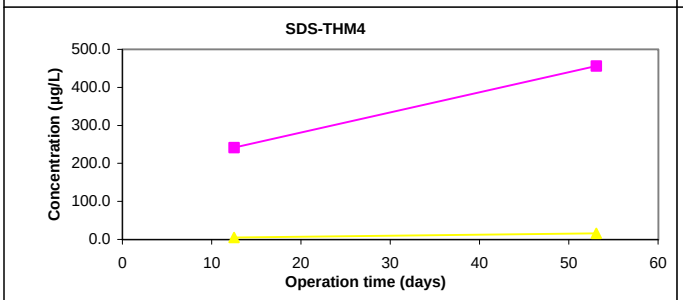
Water Quality Parameter Graphs

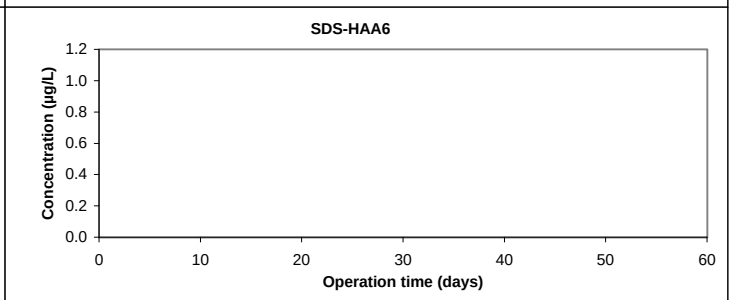


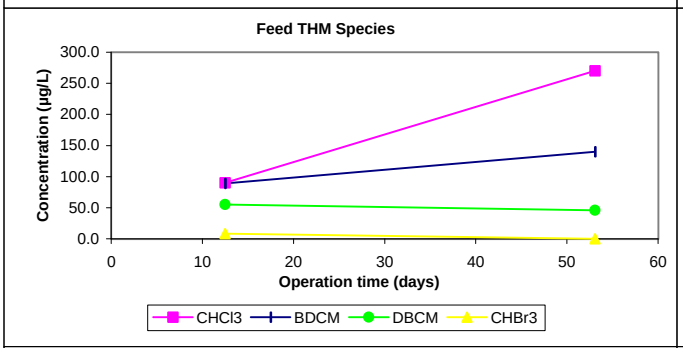
Water Quality Graphs (Continued)

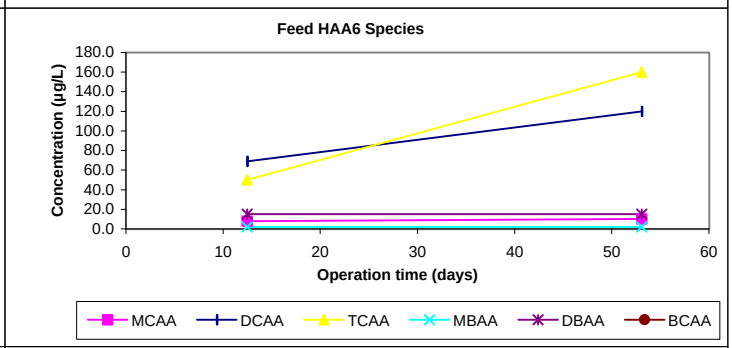


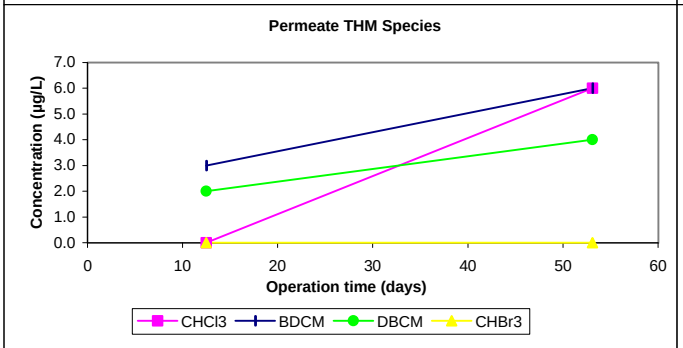


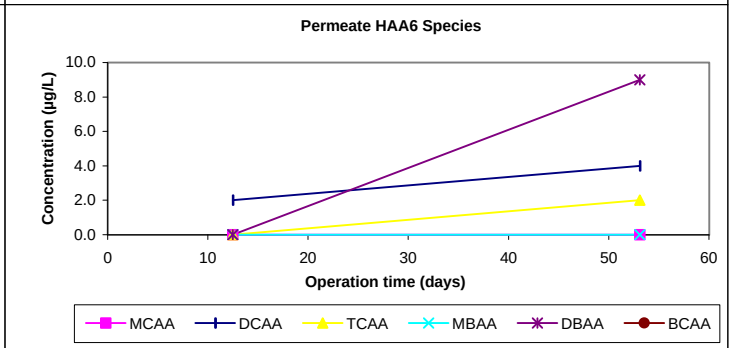


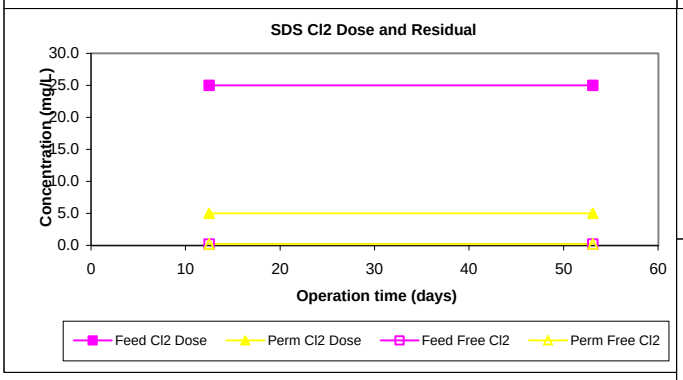


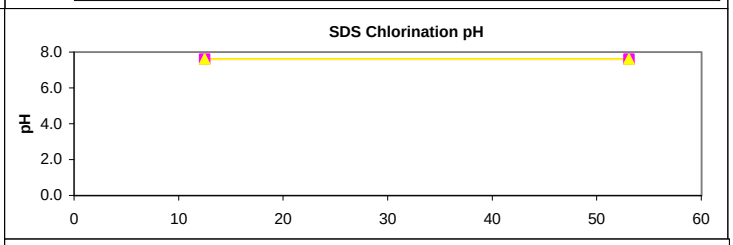


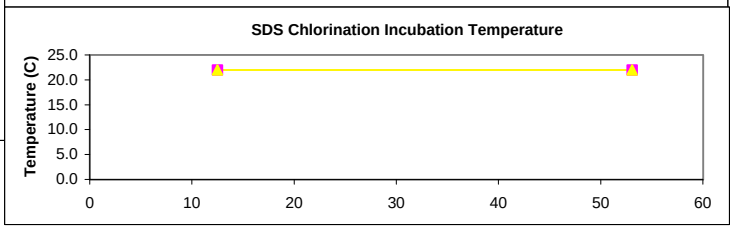




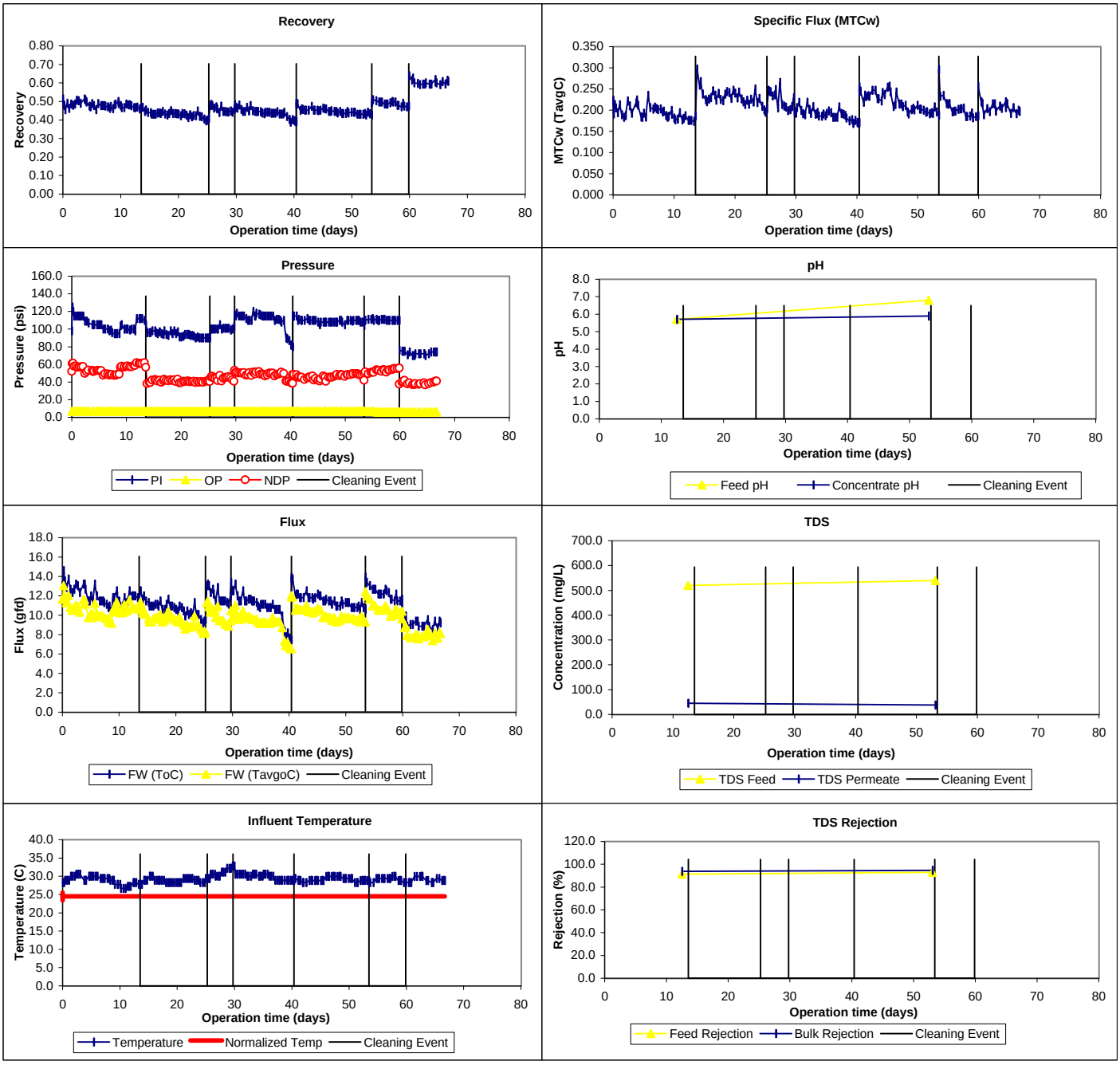








Productivity Graphs



City of Melbourne Water System | **Pilot-Scale Membrane Treatment Study Summary** | **Session:** 2

ICR Information

ID / ICR#:	FL3051447 / 283
ICR Contact:	Mr. Ralph Sigman
Phone No.:	(407) 255-4623
Period:	9/13/90 - 11/21/90 (69 days)

Membrane Information

Manufacturer:	Trisep
Trade Name:	TS80
Membrane Model:	4040 TS80 TSA
MWCO:	200 - 300 Daltons
Element Size:	4" X 40"
Element Area:	92.0 ft^2
Design Flux:	22.7 gfd
Mfr. NDP:	105.0 psi
Mfr. MTC_w:	0.216 (gfd/psi)
Mfr. Temp:	25.0 ^oC
Maximum Flow:	20.0 gpm
Minimum Flow:	7.0 gpm
Total Width :	14.0 ft
Feed Spacer Thickness:	0.0023 ft
840 Element Area	360.0 ft^2
840 Purchase Price:	750 - 900

Design Parameters

Norm Temp:	24.5 ^oC
Temp Norm MTC-w:	0.213 TavgC
Design Recovery:	0.65
Avg Sys Flux F_w:	15.0 gfd
# of Elem in P.V.:	3
# Pres Ves in Stg 1:	2
# Pres Ves in Stg 2:	1
Pres Ves in Stg 3:	NA
Design Flux:	15.0 gfd
Recycle Ratio:	0.00
Osmotic P Stage 1:	3.0 psi
Osmotic P Stage 2:	6.0 psi
Osmotic P Stage 3:	NA

Water Quality Summary

	Feed (System)				Permeate (System)				Concentrate (System)			
Summary	**Mean**	**SD**	**Count**	**Min/Max**	**Mean**	**SD**	**Count**	**Min/Max**	**Mean**	**SD**	**Count**	**Min/Max**
pH	4.5	1.2	3	3.8 - 5.9	4.7	2.0	3	3.5 - 7.0	3.9	1.5	3	2.9 - 5.6
Temp	27.2	2.4	3	24.4 - 28.9	27.2	2.4	3	24.4 - 28.9	27.2	2.4	3	24.4 - 28.9
Alk	75	16	2	63 - 86	0	0	2	0 - 0	3	5	3	0 - 9
TDS	**423**	**72**	**3**	**340 - 470**	**120**	**10**	**3**	**110 - 130**	**970**	**113**	**3**	**900 - 1100**
TotHard	187	15	3	170 - 200	44	41	3	20 - 91	430	62	3	380 - 500
CaHard	144	49	3	92 - 190	39	45	3	7 - 90	353	59	3	310 - 420
Turb	0.17	0.0	3	0.13 - 0.21	0.09	0.2	3	0.00 - 0.27	0.14	0.0	3	0.11 - 0.18
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0
TOC	**7.7**	**0.9**	**3**	**6.7 - 8.4**	**0.3**	**0.0**	**3**	**0.3 - 0.3**	**19.3**	**5.0**	**3**	**14.0 - 24.0**
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	**1267**	**208**	**3**	**1100 - 1500**	**54**	**19**	**3**	**33 - 69**				
CHCl3	246.7	20.8	3	230.0 - 270.0	5.0	1.0	3	4.0 - 6.0	**Mass Balance**			
BDCM	100.7	9.0	3	92.0 - 110.0	9.7	3.8	3	7.0 - 14.0	**Closure Errors (%)**			
DBCM	30.3	3.8	3	26.0 - 33.0	8.0	3.0	3	5.0 - 11.0	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	3	0.0 - 0.0	0.0	0.0	3	0.0 - 0.0	Alk	0	n/a	n/a
THM4	**377.7**	**27.4**	**3**	**348.0 - 402.0**	**22.7**	**7.6**	**3**	**16.0 - 31.0**	TDS	3	12	18
MCAA	7.3	6.4	3	0.0 - 12.0	0.0	0.0	3	0.0 - 0.0	TotHard	3	10	16
DCAA	120.0	17.3	3	110.0 - 140.0	3.3	1.2	3	2.0 - 4.0	CaHard	3	20	43
TCAA	126.7	20.8	3	110.0 - 150.0	1.7	0.6	3	1.0 - 2.0	Turb	1	152	n/a
MBAA	0.0	0.0	3	0.0 - 0.0	0.0	0.0	3	0.0 - 0.0	Amm	0	n/a	n/a
DBAA	10.7	8.6	3	3.0 - 20.0	8.3	6.1	3	3.0 - 15.0	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	TDSt	2	3	11
DCBAA	NA	NA	0	NA	NA	NA	0	NA	**Comments:**			
HAA5	**264.7**	**49.7**	**3**	**233.0 - 322.0**	**13.3**	**7.5**	**3**	**6.0 - 21.0**				
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 (^oC)	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**
Alum Coagulation	Aluminum Sulfate dose: 151.4 mg/L	Full-scale
Sedimentation	Circular Clarifier	Full-scale
Rapid Sand Filtration	Sand/anthracite	Full-scale
Sulfuric Acid Feed	Approx. 85 mg/L to pH 3.5 to 4.5	Pilot-scale
Microfiltration	5um Filter Specialists Bag filter	Pilot-scale

Mass Balance Errors

Pressure	**RPD**	**SD**	**Flow**	**RPD**	**SD**	**TDS**	**RPD**	**SD**
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.5%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.1%	0.6%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	1.5%	1.2%	Sys Perm - Sum Stg Pe	0.0%	1.3%	Sys Perm - Avg Stg Perm	**20.0%**	**17.4%**

Stage Summary

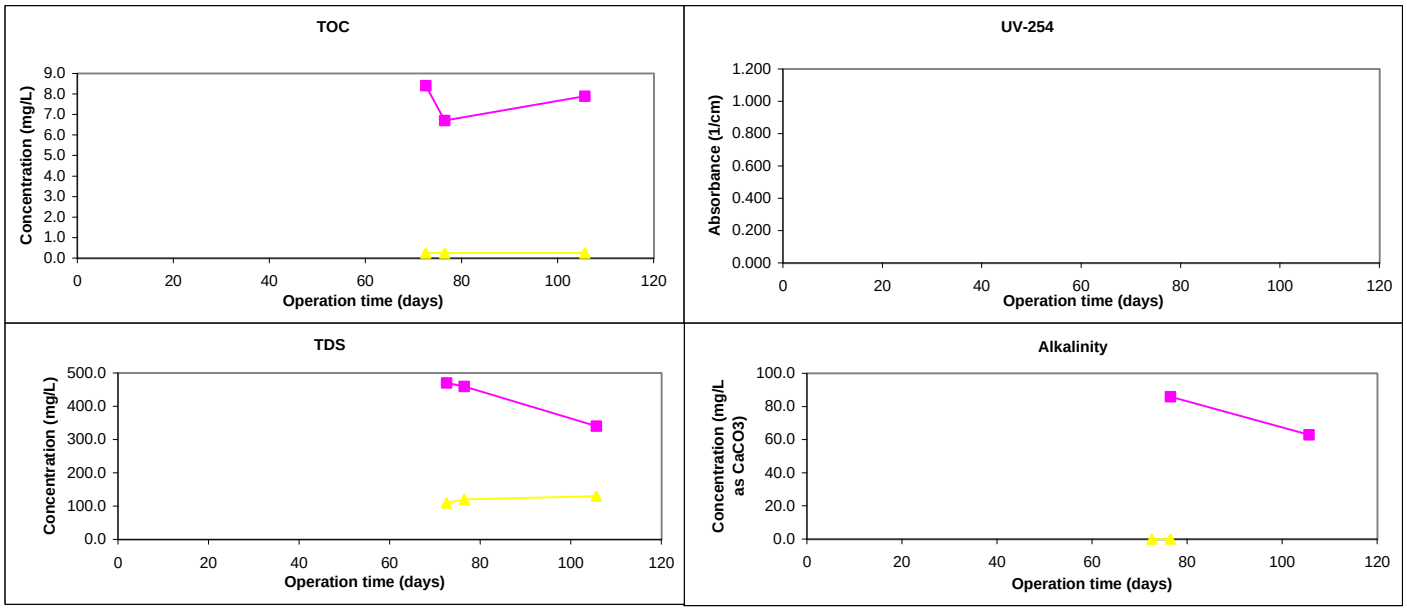
	Stage 1 Influent						Stage 1 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.39**	**0.01**	**3**	**0.38 - 0.40**					
pH	4.5	3.9	4.5	1.2	3	3.8 - 5.9	4.7	4.5	1.2	3	3.8 - 5.9
Temp	27.2	27.2	27.2	2.4	3	24.4 - 28.9	27.2	27.2	2.4	3	24.4 - 28.9
Alk	75	3	75	16	2	63 - 86	0	3	5	3	0 - 8
TDS	**423**	**970**	423	**72**	**3**	**340 - 470**	**120**	**87**	**21**	**3**	**68 - 110**
TotHard	187	430	187	15	3	170 - 200	44	18	5	3	14 - 23
CaHard	144	353	144	49	3	92 - 190	39	12	4	3	7 - 15
Turb	0.17	0.14	0.17	0	3	0.13 - 0.21	0.09	0.00	0.00	3	0 - 0
TOC	**7.7**	**19.3**	7.7	**0.9**	**3**	**6.7 - 8.4**	**0.3**	**0.3**	**0.0**	**3**	**0.3 - 0.3**
UV254	NA	**NA**	NA	NA	0	0.000 - 0.000	NA	NA	NA	0	0.000 - 0.000
SUVA	NA	**NA**	NA	NA	0	NA	NA	NA	NA	0	NA

	Stage 2 Influent						Stage 2 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.32**	**0.02**	**3**	**0.31 - 0.34**					
pH	4.5	3.9	4.2	1.4	3	3.1 - 5.8	4.7	4.4	1.1	3	3.6 - 5.7
Temp	27.2	27.2	27.2	2.4	3	24.4 - 28.9	27.2	27.2	2.4	3	24.4 - 28.9
Alk	75	3	3	6	3	0 - 10	0	2	4	3	0 - 7
TDS	**423**	**970**	677	**55**	**3**	**640 - 740**	**120**	**111**	**19**	**3**	**93 - 130**
TotHard	187	430	287	21	3	270 - 310	44	16	6	3	**9 - 21**
CaHard	144	353	243	49	3	210 - 300	39	15	6	3	**9 - 20**
Turb	0.17	0.14	**0.10**	0	3	0.10 - 0.11	0.09	0.02	0.03	3	0 - 0
TOC	**7.7**	**19.3**	12.0	**1.7**	**3**	**10.0 - 13.0**	**0.3**	**0.3**	**0.0**	**3**	**0.3 - 0.3**
UV254	NA	**NA**	NA	NA	0	0.000 - 0.000	NA	NA	NA	0	0.000 - 0.000
SUVA	NA	**NA**	NA	NA	0.00	NA	NA	NA	NA	0.00	NA

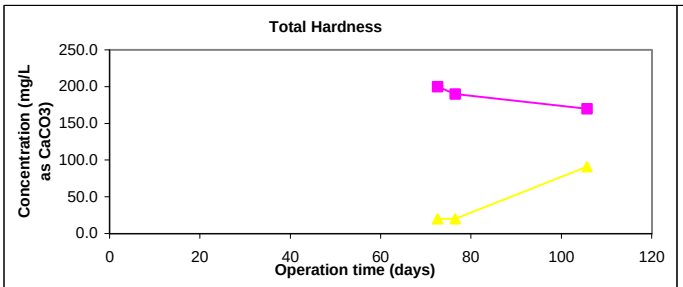
	Stage 3 Influent						Stage 3 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery											
pH											
Temp											
Alk	This	was	**only**	a	two	stage study.					
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

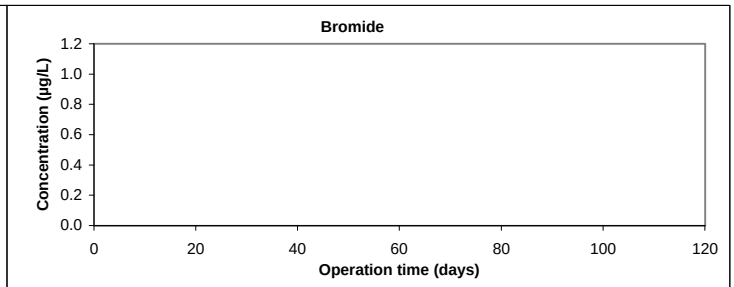
Chart Legend:
Feed (System)
Permeate (System)

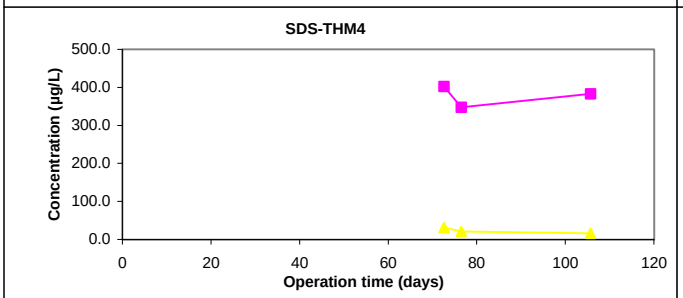
Water Quality Parameter Graphs

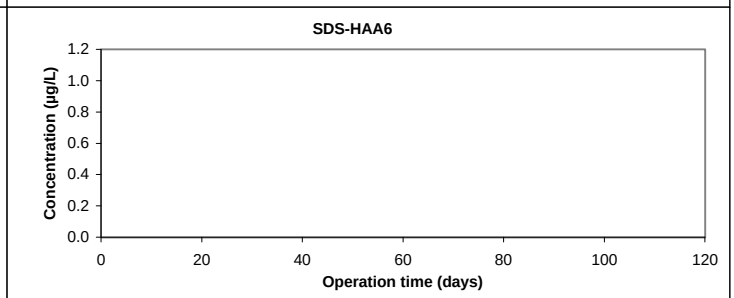


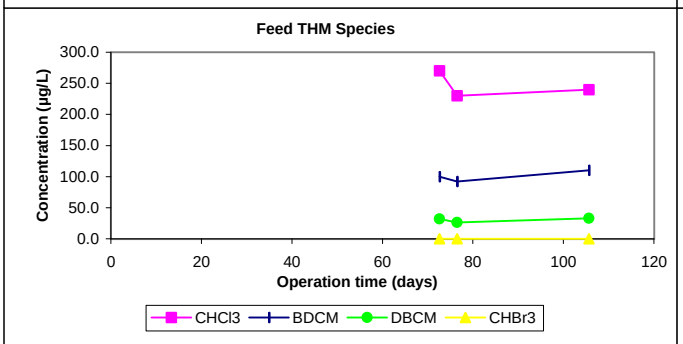
Water Quality Graphs (Continued)

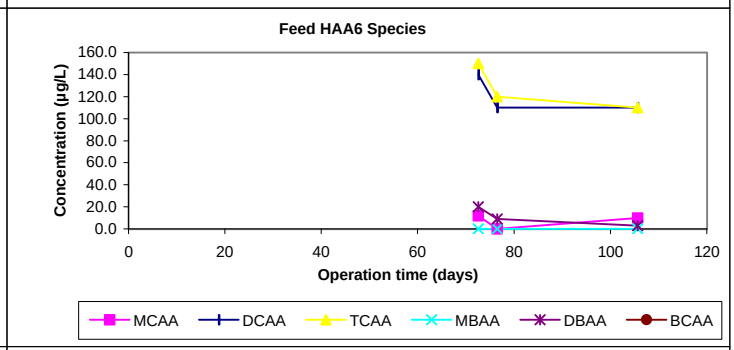


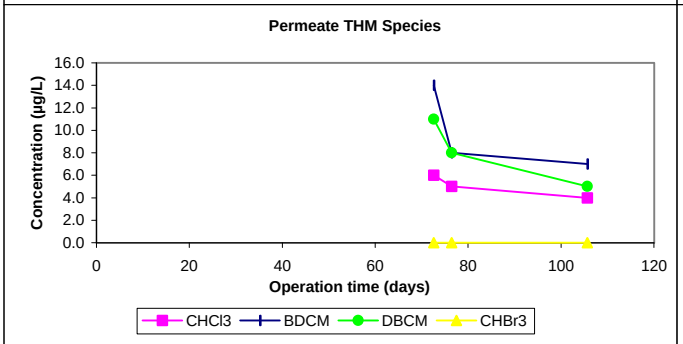


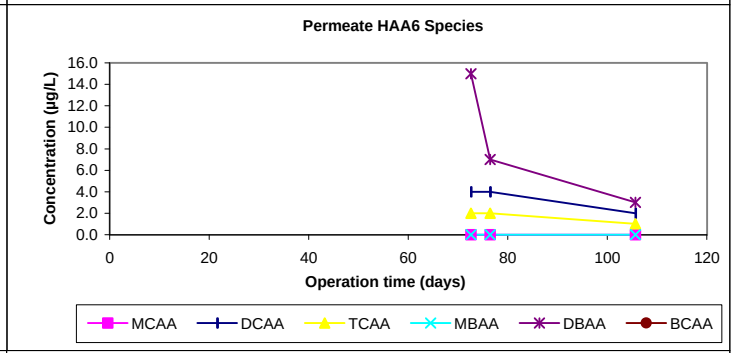


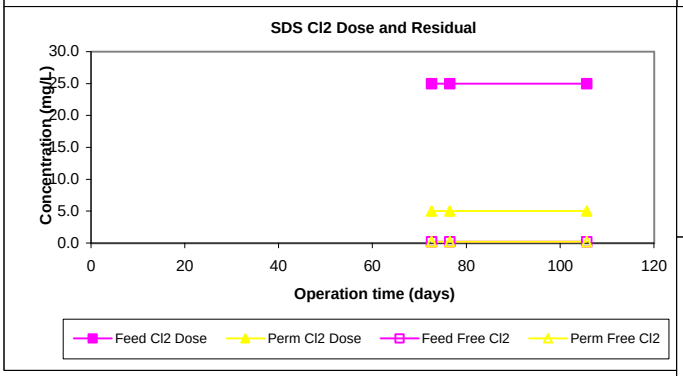


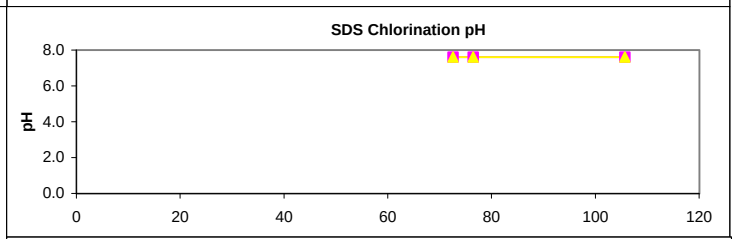


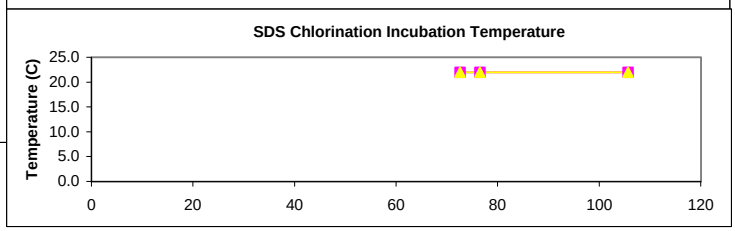




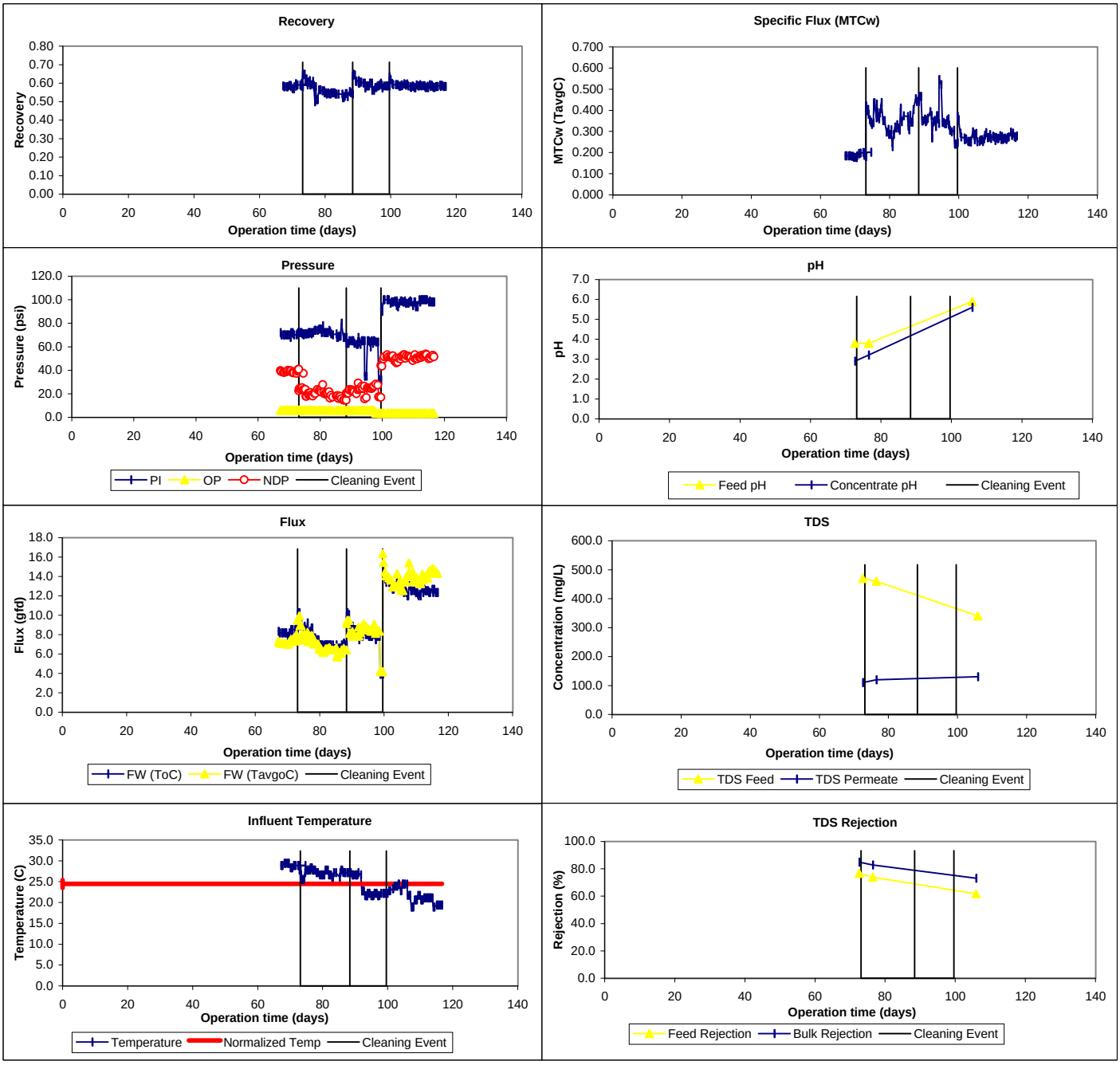








Productivity Graphs



City of Melbourne Water System | **Pilot-Scale Membrane Treatment Study Summary** | **Session:** 3

ICR Information

ID / ICR#:	FL3051447 / 283
ICR Contact:	Mr. Ralph Sigman
Phone No.:	(407) 255-4623
Period:	11/22/90 - 2/2/91 (72 days)

Membrane Information

Manufacturer:	Trisep
Trade Name:	TS80
Membrane Model:	4040 TS80 TSA
MWCO:	200 - 300 Daltons
Element Size:	4" X 40"
Element Area:	92.0 ft^2
Design Flux:	22.7 gfd
Mfr. NDP:	105.0 psi
Mfr. MTC_W:	0.216 (gfd/psi)
Mfr. Temp:	25.0 ^oC
Maximum Flow:	20.0 gpm
Minimum Flow:	7.0 gpm
Total Width :	14.0 ft
Feed Spacer Thickness:	0.0023 ft
840 Element Area	360.0 ft^2
840 Purchase Price:	750 - 900

Design Parameters

Norm Temp:	24.5 ^oC
Temp Norm MTC-w:	0.213 TavgC
Design Recovery:	0.65
Avg Sys Flux F_W:	15.0 gfd
# of Elem in P.V.:	3
# Pres Ves in Stg 1:	2
# Pres Ves in Stg 2:	1
Pres Ves in Stg 3:	NA
Design Flux:	15.0 gfd
Recycle Ratio:	0.00
Osmotic P Stage 1:	3.0 psi
Osmotic P Stage 2:	6.0 psi
Osmotic P Stage 3:	NA

Water Quality Summary

	Feed (System)				Permeate (System)				Concentrate (System)			
Summary	**Mean**	**SD**	**Count**	**Min/Max**	**Mean**	**SD**	**Count**	**Min/Max**	**Mean**	**SD**	**Count**	**Min/Max**
pH	3.3	0.8	2	2.7 - 3.8	3.8	1.1	2	3.0 - 4.6	2.8	0.4	2	2.5 - 3.1
Temp	22.0	1.2	2	21.1 - 22.8	22.0	1.2	2	21.1 - 22.8	22.0	1.2	2	21.1 - 22.8
Alk	NA	NA	0	0 - 0	1	NA	1	1 - 1	0	0	2	0 - 0
TDS	**430**	**42**	**2**	**400 - 460**	**66**	**13**	**2**	**56 - 75**	**650**	**28**	**2**	**630 - 670**
TotHard	185	7	2	180 - 190	17	13	2	8 - 26	285	7	2	280 - 290
CaHard	146	6	2	142 - 150	14	11	2	6 - 22	225	7	2	220 - 230
Turb	0.15	0.0	2	0.11 - 0.18	0.03	0.0	2	0.00 - 0.06	0.06	0.1	2	0.00 - 0.12
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0
TOC	**8.5**	**1.1**	**2**	**7.7 - 9.2**	**0.3**	**0.0**	**2**	**0.3 - 0.3**	**13.0**	**1.4**	**2**	**12.0 - 14.0**
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	**1370**	**99**	**2**	**1300 - 1440**	**65**	**41**	**2**	**36 - 94**				
CHCl3	245.0	21.2	2	230.0 - 260.0	1.5	2.1	2	0.0 - 3.0	**Mass Balance**			
BDCM	125.0	7.1	2	120.0 - 130.0	5.0	1.4	2	4.0 - 6.0	**Closure Errors (%)**			
DBCM	49.0	5.7	2	45.0 - 53.0	9.0	4.2	2	6.0 - 12.0	WQP	Count	Avg	SD/RD
CHBr3	7.5	10.6	2	0.0 - 15.0	9.0	5.7	2	5.0 - 13.0	Alk	0	n/a	n/a
THM4	**426.5**	**2.1**	**2**	**425.0 - 428.0**	**24.5**	**13.4**	**2**	**15.0 - 34.0**	TDS	2	49	47
MCAA	10.0	1.4	2	9.0 - 11.0	8.0	4.2	2	5.0 - 11.0	TotHard	2	47	54
DCAA	114.5	36.1	2	89.0 - 140.0	1.5	0.7	2	1.0 - 2.0	CaHard	2	50	51
TCAA	122.0	39.6	2	94.0 - 150.0	0.0	0.0	2	0.0 - 0.0	Turb	1	56	n/a
MBAA	0.0	0.0	2	0.0 - 0.0	1.0	1.4	2	0.0 - 2.0	Amm	0	n/a	n/a
DBAA	5.5	0.7	2	5.0 - 6.0	2.0	1.4	2	1.0 - 3.0	TOC	1	-5	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	TDSt	1	2	#DIV/0!
DCBAA	NA	NA	0	NA	NA	NA	0	NA	**Comments:**			
HAA5	**252.0**	**76.4**	**2**	**198.0 - 306.0**	**12.5**	**7.8**	**2**	**7.0 - 18.0**				
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 (^oC)	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**
Alum Coagulation	Aluminum Sulfate dose: 151.4 mg/L	Full-scale
Sedimentation	Circular Clarifier	Full-scale
Rapid Sand Filtration	Sand/anthracite	Full-scale
Sulfuric Acid Feed	Approx. 85 mg/L to pH 3.5 to 4.5	Pilot-scale
Microfiltration	5um Filter Specialists Bag filter	Pilot-scale

Mass Balance Errors

Pressure	**RPD**	**SD**	**Flow**	**RPD**	**SD**	**TDS**	**RPD**	**SD**
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.3%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 2 Conc	0.1%	0.6%	Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 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%
Sys Perm - Avg Stg Perm	6.9%	3.3%	Sys Perm - Sum Stg Pe	0.0%	0.8%	Sys Perm - Avg Stg Perm	-25.1%	3.7%

Stage Summary

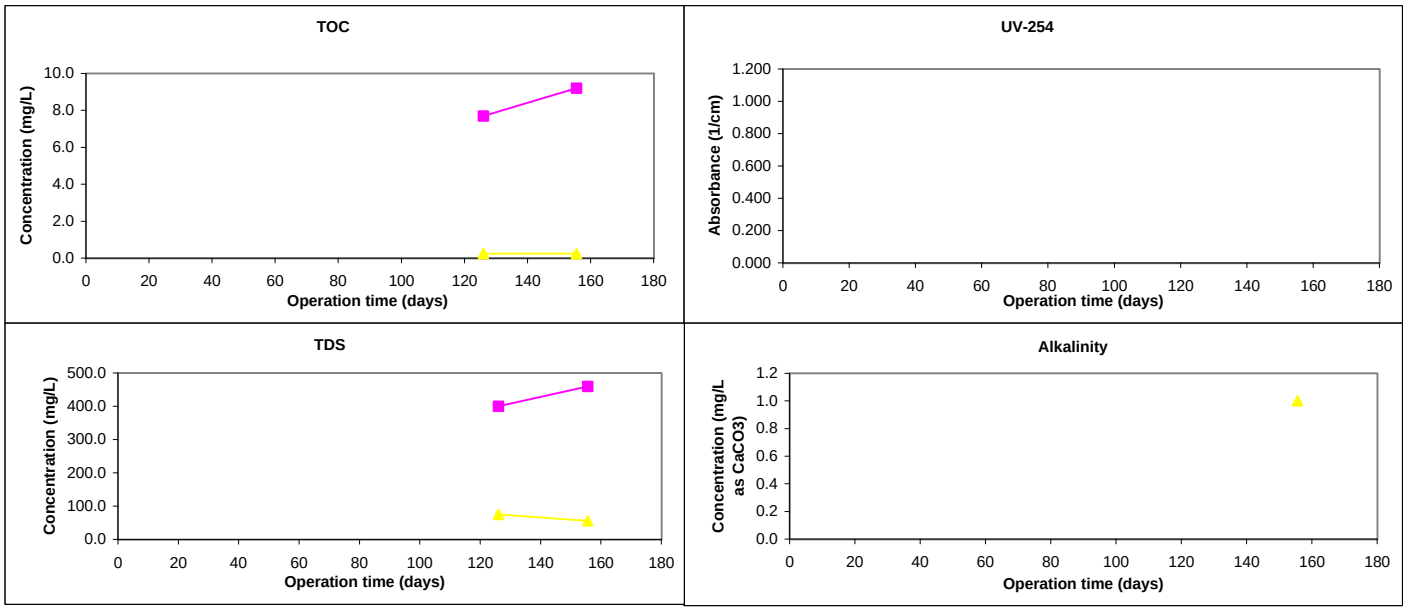
	Stage 1 Influent						Stage 1 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.27**	**0.01**	**2**	**0.26 - 0.27**					
pH	3.3	2.8	3.3	0.8	2	2.7 - 3.8	3.8	3.3	0.8	2	2.7 - 3.8
Temp	22.0	22.0	22.0	1.2	2	21.1 - 22.8	22.0	22.0	1.2	2	21.1 - 22.8
Alk	NA	0	80	NA	1	80 - 80	1	0	0	2	0 - 0
TDS	**430**	**650**	430	**42**	**2**	**400 - 460**	**66**	**57**	**13**	**2**	**48 - 66**
TotHard	185	285	185	7	2	180 - 190	17	13	6	2	8 - 17
CaHard	146	225	146	6	2	142 - 150	14	10	7	2	5 - 15
Turb	0.15	0.06	0.15	0	2	0.11 - 0.18	0.03	0.03	0.04	2	0 - 0
TOC	**8.5**	**13.0**	8.5	**1.1**	**2**	**7.7 - 9.2**	**0.3**	**0.3**	**0.0**	**2**	**0.3 - 0.3**
UV254	NA	**NA**	NA	NA	0	0.000 - 0.000	NA	NA	NA	0	0.000 - 0.000
SUVA	NA	**NA**	NA	NA	0	NA	NA	NA	NA	0	NA

	Stage 2 Influent						Stage 2 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.18**	**0.01**	**2**	**0.17 - 0.19**					
pH	3.3	2.8	2.9	0.5	2	2.5 - 3.2	3.8	3.5	0.3	2	3.3 - 3.7
Temp	22.0	22.0	22.0	1.2	2	21.1 - 22.8	22.0	22.0	1.2	2	21.1 - 22.8
Alk	NA	0	0	0	2	0 - 0	1	0	0	2	0 - 0
TDS	**430**	**650**	555	**21**	**2**	**540 - 570**	**66**	**111**	**41**	**2**	**82 - 140**
TotHard	185	285	235	7	2	230 - 240	17	28	26	2	**9 - 46**
CaHard	146	225	190	14	2	180 - 200	14	26	25	2	**8 - 44**
Turb	0.15	0.06	**0.04**	0	2	0.00 - 0.08	0.03	0.03	0.04	2	0 - 0
TOC	**8.5**	**13.0**	11.0	**1.4**	**2**	**10.0 - 12.0**	**0.3**	**0.3**	**0.0**	**2**	**0.3 - 0.3**
UV254	NA	**NA**	NA	NA	0	0.000 - 0.000	NA	NA	NA	0	0.000 - 0.000
SUVA	NA	**NA**	NA	NA	0.00	NA	NA	NA	NA	0.00	NA

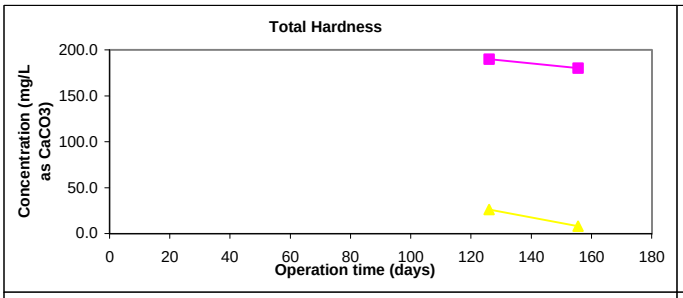
	Stage 3 Influent						Stage 3 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery											
pH											
Temp											
Alk	This	was	**only**	a	two	stage	study.				
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

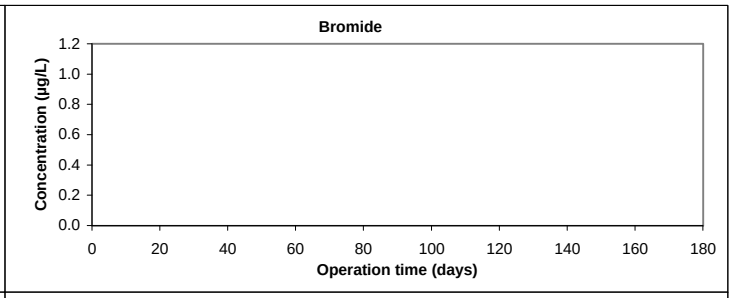
Chart Legend:
Feed (System)
Permeate (System)

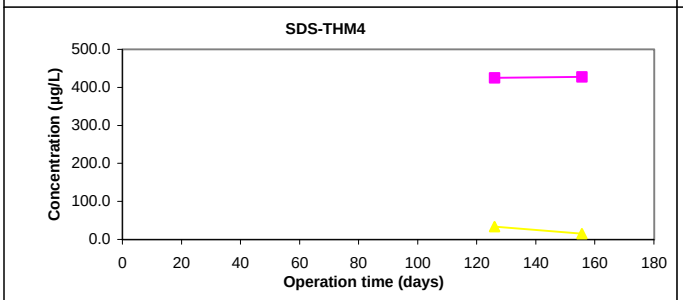
Water Quality Parameter Graphs

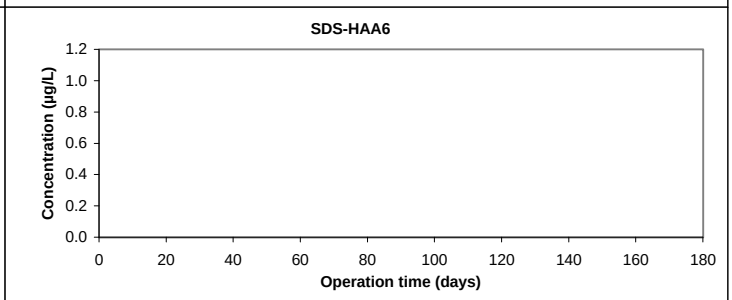


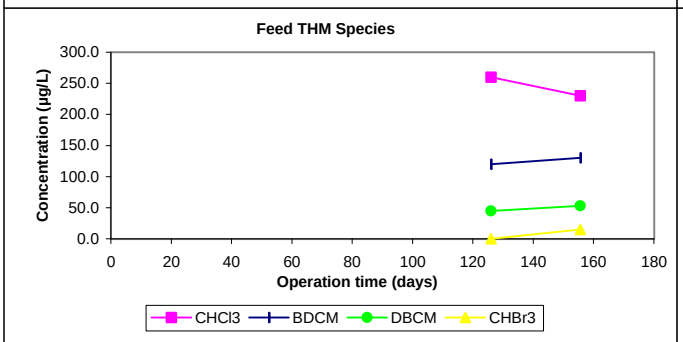
Water Quality Graphs (Continued)

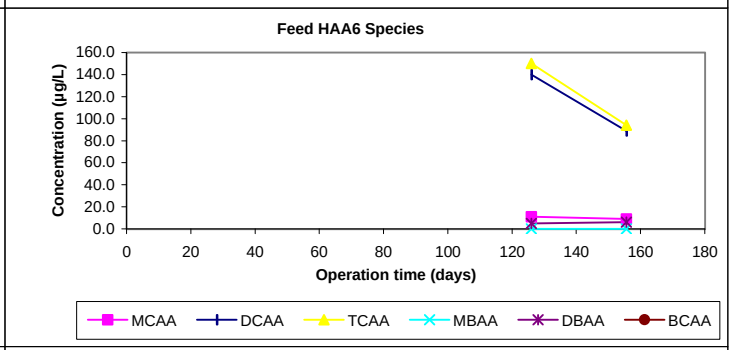


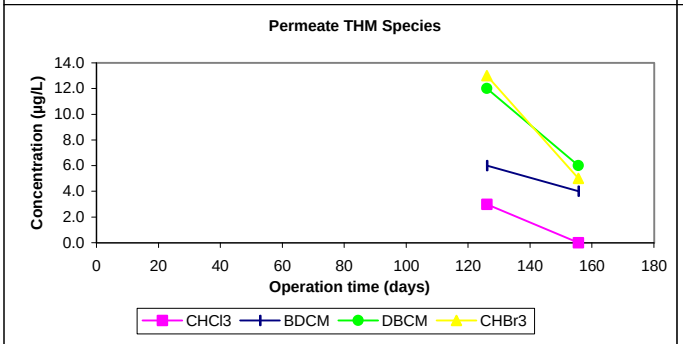


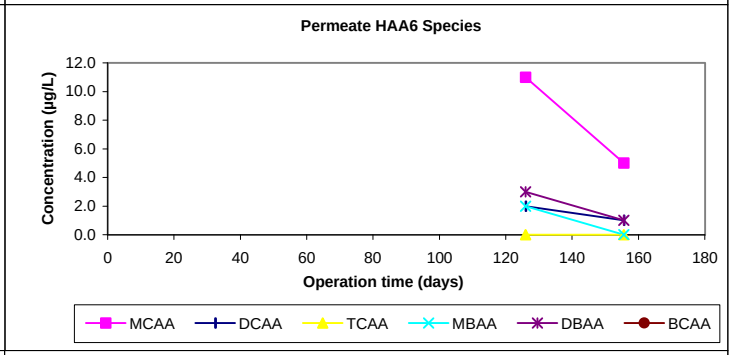


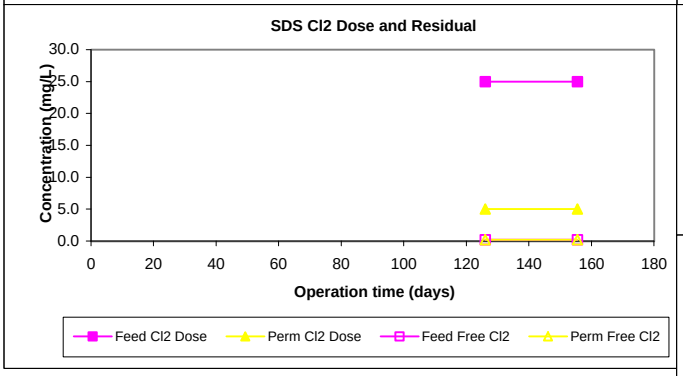


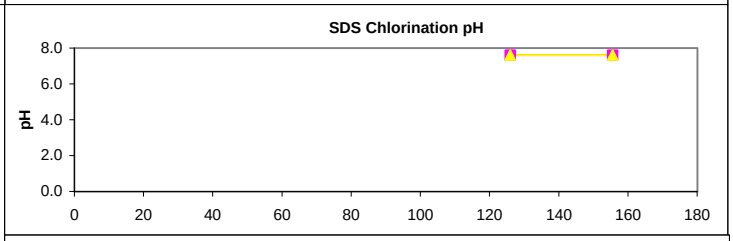


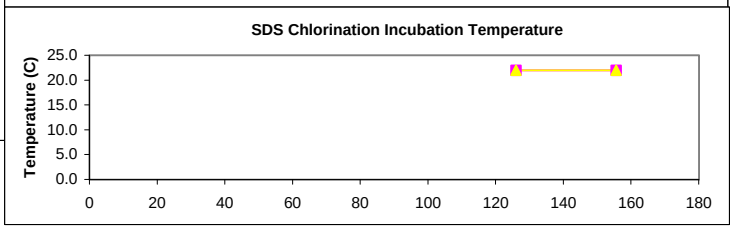












Productivity Graphs