ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID 1007

Study Protocol Two-stage pilot system

Plant ICR Number 466

PWS Name NJ-American Water Co. – Short Hills

City, State, Zip Haddon Heights, HJ 08035

General Comments:

1. This utility was only required to conduct a bench study; however, they opted to perform a six month pilot-scale study to develop more representative design information.

2. This study ran from 11/3/97 through 4/10/98. An experimental summary is listed in Table 5 of the Summary Report.

3. A 1 ppm chloramine solution was fed to the membrane system during the last four weeks of the study (from hour 2586 to the end of the study) to control suspected biological fouling. The chloramine feed was turned off and the chloramines were flushed from the system, prior to water quality sampling events.

4. Problems encountered during the study, an operational log and observations, and significant fouling events and discussion are given in Section 4 of the Summary Report. Also listed in Section 4 is a summary of the significant results.

5. Cost information and analyses are given in Section 4 of the Summary Report.

6. The report indicates that the utility is considering one of two possible upgrades to the existing plant: 1.) dissolved air flotation followed by ozone and deep bed GAC contactors; or 2.) microfiltration.

Water Quality Comments:

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

2. During SDS testing, the following conditions were used: incubation time between 5.6 and 6.9 hours, pH between 6.7 and 7.3, incubation temperature between 9 and 11^{o}C, and free residual between 0.3 and 2.7 mg/L. The variability in free residual may be due in part to the use of a

target chlorine dose rather than a target residual, as discussed on page 38 of the Summary Report.

3. The full-scale plant uses water from a reservoir system feed by the Canoe Brook and the Passaic River. After about 1100 hours of operation, pumping from the Canoe Brook increased and this resulted in an increase in raw water UV-254, as shown in Figure 8.

Productivity Comments:

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

2. Increased pumping from the Canoe Brook after 1100 hours also resulted in an increased rate of membrane fouling.

3. The membrane was cleaned using two different cleaning solutions. The first two membrane cleanings were performed using a 2% citric acid solution; the last two cleanings were performed using 1% AFT Filterpure TF. A summary of the cleaning events is shown in Table 11 of the Summary Report.

4. Suspected fouling mechanisms include oxidation of manganese or iron resulting in rapid but reversible fouling, biological fouling (which was effectively controlled by chloramines in the last four weeks of the study), and organic fouling.

5. During data analysis conducted by EPA, the calculated sustained system specific flux and flux were 0.190 $\pm$ 0.012 gfd/psi and 14.66 $\pm$ 1.10 gfd, respectively. This was based on a period of stable performance starting after 1100 hours thorough the end of the study. The corresponding projected cleaning interval was 74 $\pm$ 48 days.

New Jersey American Water Company | **Pilot-Scale Membrane Treatment Study Summary** | **Session:** 1

ICR Information

ID / ICR#:	NJ0712001 / 466
ICR Contact:	Kevin Dixon
Phone No.:	(609) 764-4902
Period:	11/3/97 - 1/25/98 (83 days)

Membrane Information

Manufacturer:	Desal Systems
Trade Name:	DS-5/DL grade
Membrane Model:	HL4040FF
MWCO:	150-300 Daltons
Element Size:	4" x 40"
Element Area:	90.0 ft^2
Design Flux:	12.0 gfd
Mfr. NDP:	38.7 psi
Mfr. $MTC_{w:}$	0.310 (gfd/psi)
Mfr. Temp:	25.0 ^oC
Maximum Flow:	18.0 gpm
Minimum Flow:	4.0 gpm
Total Width :	16.0 ft
Feed Spacer Thickness:	0.0023 ft
840 Element Area	350.0 ft^2
840 Purchase Price:	$650

Design Parameters

Norm Temp:	16.0 ^oC
Temp Norm MTC-w:	0.238 gfd/psi
Design Recovery:	0.90
Avg Sys Flux F_w:	12.0 gfd
# of Elem in P.V.:	6
# Pres Ves in Stg 1:	2
# Pres Ves in Stg 2:	1
Pres Ves in Stg 3:	NA
Design Flux:	12.0 gfd
Recycle Ratio:	0.19
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	7.5	0.1	3	7.4 - 7.5	7.2	0.1	3	7.1 - 7.3	8.1	0.2	3	7.9 - 8.3
Temp	7.3	3.0	2	5.2 - 9.4	8.1	1.6	2	7.0 - 9.2	7.1	NA	1	7.1 - 7.1
Alk	36	1	5	34 - 38	17	1	5	16 - 18	190	25	5	148 - 214
TDS	**180**	**23**	**5**	**162 - 206**	**90**	**22**	**5**	**60 - 111**	**750**	**116**	**5**	**601 - 877**
TotHard	71	4	5	65 - 75	22	2	5	20 - 24	451	86	5	322 - 536
CaHard	47	3	5	42 - 51	17	1	5	16 - 18	273	37	5	216 - 315
Turb	0.05	0.0	5	0.02 - 0.08	0.03	0.0	5	0.02 - 0.04	0.13	0.0	5	0.08 - 0.19
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0
TOC	**4.3**	**0.4**	**5**	**3.8 - 4.7**	**0.3**	**0.0**	**5**	**0.3 - 0.3**	**36.8**	**5.3**	**5**	**32.1 - 44.1**
UV254	0.105	0.0	5	0.088 - 0.140	0.005	0.0	5	0.005 - 0.005	0.908	0.3	5	0.678 - 1.355
SUVA	2.43	0.37	5	2.00 - 2.97	1.80	0.00	5	1.80 - 1.80	2.43	0.37	5	2.11 - 3.07
Bromide	**40**	**2**	**5**	**38 - 42**	**39**	**3**	**5**	**35 - 42**				
TOX	**326**	**56**	**5**	**275 - 392**	**13**	**0**	**5**	**13 - 13**				
CHCl3	46.5	12.5	5	33.9 - 66.1	0.0	0.0	5	0.0 - 0.0				
BDCM	8.0	1.7	5	6.2 - 10.3	0.0	0.0	5	0.0 - 0.0				
DBCM	1.1	0.7	5	0.0 - 1.6	0.0	0.0	5	0.0 - 0.0				
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0				
THM4	**55.6**	**10.4**	**5**	**45.8 - 72.3**	**0.0**	**0.0**	**5**	**0.0 - 0.0**				
MCAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0				
DCAA	20.4	8.1	5	13.5 - 30.1	0.0	0.0	5	0.0 - 0.0				
TCAA	24.6	4.0	5	20.5 - 30.0	0.0	0.0	5	0.0 - 0.0				
MBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0				
DBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0				
BCAA	3.1	0.4	5	2.6 - 3.6	0.0	0.0	5	0.0 - 0.0				
TBAA	NA	NA	0	NA	NA	NA	0	NA				
CDBAA	NA	NA	0	NA	NA	NA	0	NA				
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
HAA5	**45.1**	**11.8**	**5**	**35.7 - 60.1**	**0.0**	**0.0**	**5**	**0.0 - 0.0**				
HAA6	**48.1**	**12.2**	**5**	**38.6 - 63.6**	**0.0**	**0.0**	**5**	**0.0 - 0.0**				
HAA9	**NA**	**NA**	**0**	**NA**	**NA**	**NA**	**0**	**NA**				

Mass Balance Closure Errors (%)

WQP	Count	Avg	SD/RD
Alk	5	-14	16
TDS	5	-40	30
TotHard	5	-21	19
CaHard	5	-22	22
Turb	5	-33	146
Amm	0	n/a	n/a
TOC	0	n/a	n/a
UV254	5	-23	17
TDSt	53	-30	15

Comments:

SDS Conditions

WQP	**Avg**	**SD**	**Count**	**Min - Max**
Res (0)	1.05	0.63	10	0.38 - 2.66
Temp (^oC)	9.0	0.0	10	9.0 - 9.0
pH (unit)	7.1	0.2	10	6.7 - 7.3
Time (hr)	6.1	0.1	10	6.0 - 6.3

Pretreatment Information

Process	**Description**	**Scale**
Microfiltration	Memcor (60M10C) 0.2 mm hollow fiber mem	Pilot-scale
Antiscalant addition	3 mg/L PreTreat Plus (King Lee)	Pilot-scale
Disinfectant	Chloramines (1.07 mg/L residual)	Pilot-Scale

Mass Balance Errors

Pressure	**RPD**	**SD**	**Flow**	**RPD**	**SD**	**TDS**	**RPD**	**SD**
System Inf - Stg 1 Inf	0.2%	1.8%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-39.5%	4.7%
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	0.1%	1.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	9.4%
Sys Perm - Avg Stg Perm	-2.4%	12.5%	Sys Perm - Sum Stg Per	0.0%	0.0%	Sys Perm - Avg Stg Perm	-14.1%	5.2%

New Jersey American Water Company **Pilot-Scale Membrane Treatment Study Summary** **Session:** 1

Stage Summary

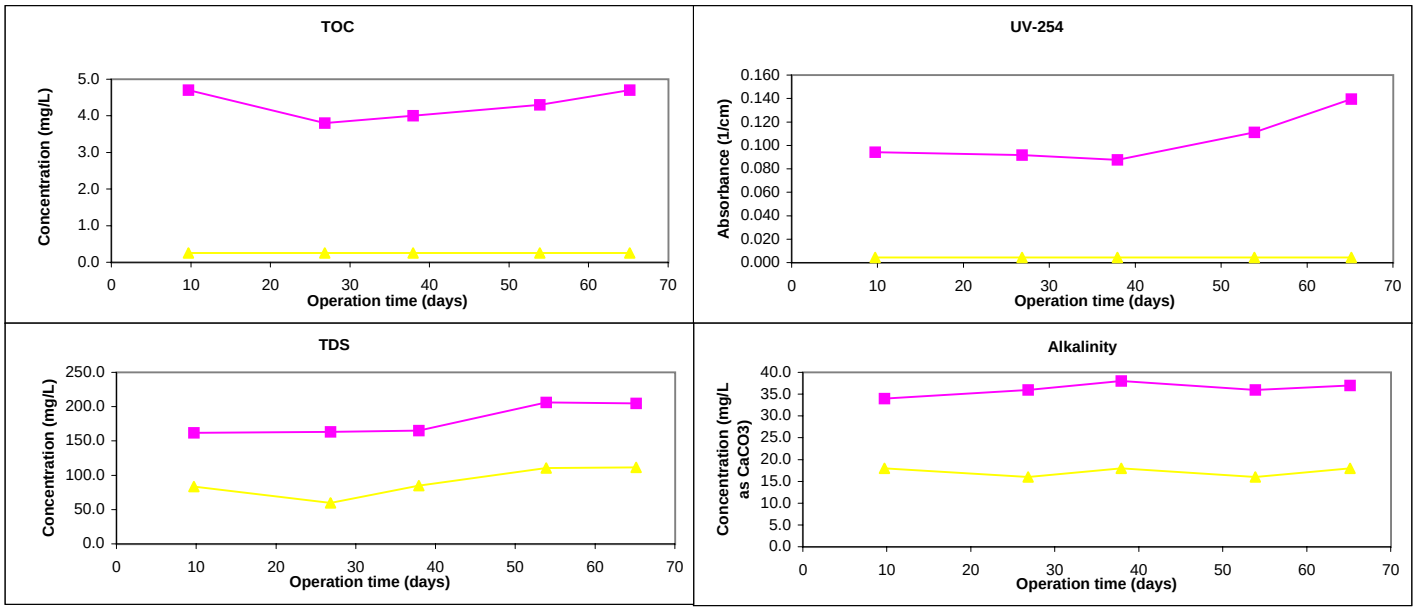
	Stage 1 Influent						Stage 1 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.62**	**0.02**	**5**	**0.60 - 0.64**					
pH	7.5	8.1	7.8	0.2	3	7.7 - 8.1	7.2	6.8	0.1	3	6.7 - 7.0
Temp	7.3	7.1	5.1	NA	1	5.1 - 5.1	8.1	6.4	NA	1	6.4 - 6.4
Alk	36	190	60	2	5	58 - 63	17	14	2	5	12 - 18
TDS	**180**	**750**	268	**34**	**5**	**231 - 305**	**90**	**96**	**15**	**5**	**84 - 115**
TotHard	71	451	133	18	5	108 - 155	22	18	1	5	17 - 20
CaHard	47	273	83	7	5	75 - 95	17	14	1	5	13 - 15
Turb	0.05	0.13	0.08	0	5	0.07 - 0.13	0.03	0.03	0.02	5	0 - 0
TOC	**4.3**	**36.8**	9.4	**1.6**	**5**	**7.0 - 11.3**	**0.3**	**0.3**	**0.0**	**5**	**0.3 - 0.3**
UV254	0.105	**0.908**	0.210	0.108	5	0.049 - 0.343	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	2.43	**2.43**	**2.12**	0.90	5	0.70 - 3.04	1.80	1.80	0.00	5	1.80 - 1.80

	Stage 2 Influent						Stage 2 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.75**	**0.05**	**5**	**0.71 - 0.83**					
pH	7.5	8.1	8.0	0.2	3	7.8 - 8.2	7.2	7.3	0.1	3	7.2 - 7.4
Temp	7.3	7.1	6.9	NA	1	6.9 - 6.9	8.1	6.5	NA	1	6.5 - 6.5
Alk	36	190	117	14	5	92 - 126	17	28	2	5	26 - 31
TDS	**180**	**750**	476	**70**	**5**	**388 - 553**	**90**	**118**	**19**	**5**	**102 - 141**
TotHard	71	451	288	21	3	265 - 307	22	57	38	3	33 - 101
CaHard	47	273	157	23	5	122 - 183	17	26	1	5	26 - 28
Turb	0.05	0.13	0.11	0	5	0.07 - 0.20	0.03	0.03	0.04	5	0 - 0
TOC	**4.3**	**36.8**	20.7	**3.5**	**5**	**16.3 - 24.9**	**0.3**	**0.3**	**0.0**	**5**	**0.3 - 0.3**
UV254	0.105	**0.908**	0.458	0.259	5	0.094 - 0.810	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	2.43	**2.43**	**2.11**	0.97	5.00	0.58 - 3.25	1.80	1.80	0.00	5.00	1.80 - 1.80

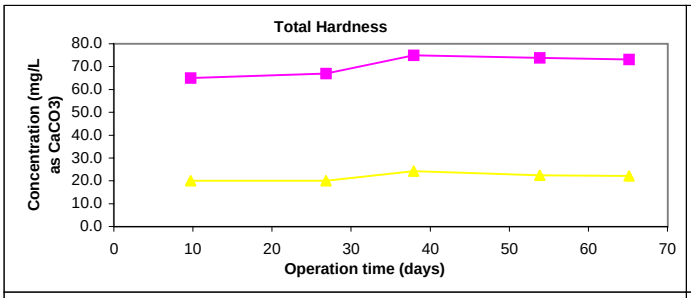
	Stage 3 Influent						Stage 3 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery											
pH											
Temp											
Alk	This	was	**only**	a	two	stage	study.				
TDS											
TotHard											
CaHard			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

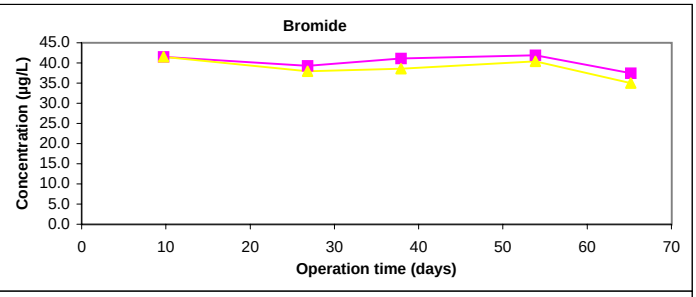
Chart Legend:
- Feed (System)
- Permeate (System)

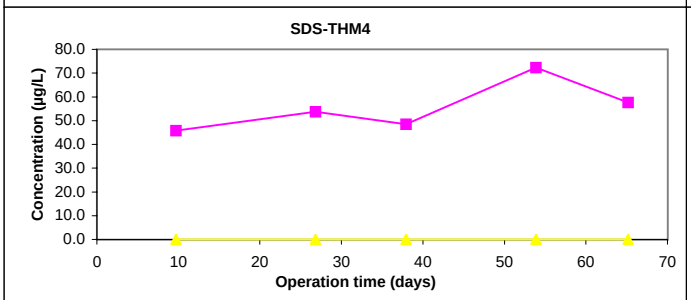
Water Quality Parameter Graphs

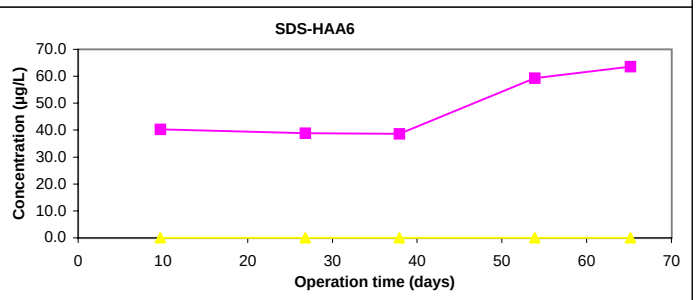


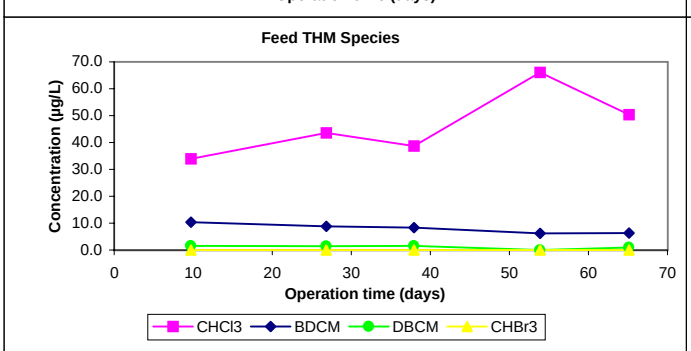
Water Quality Graphs (Continued)

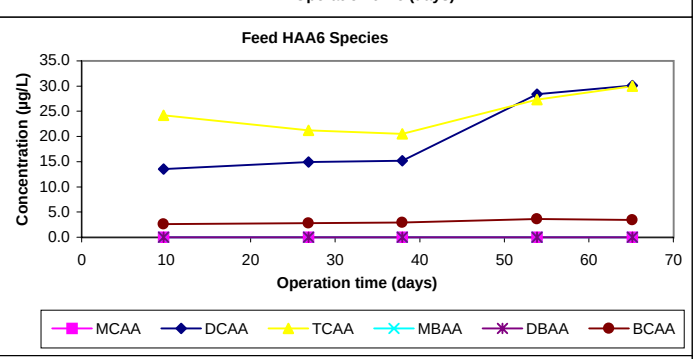


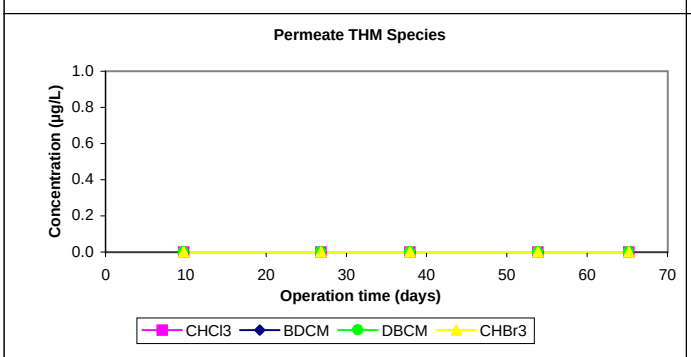


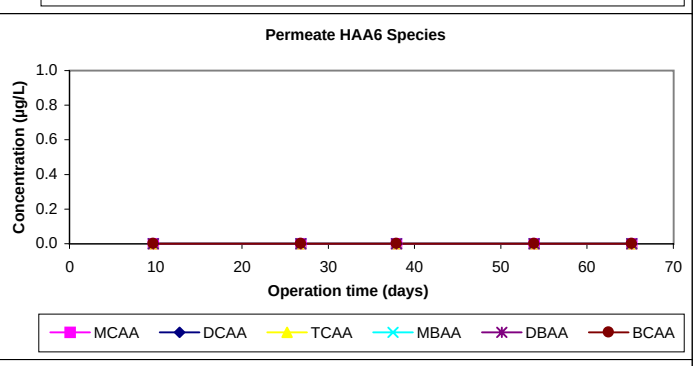


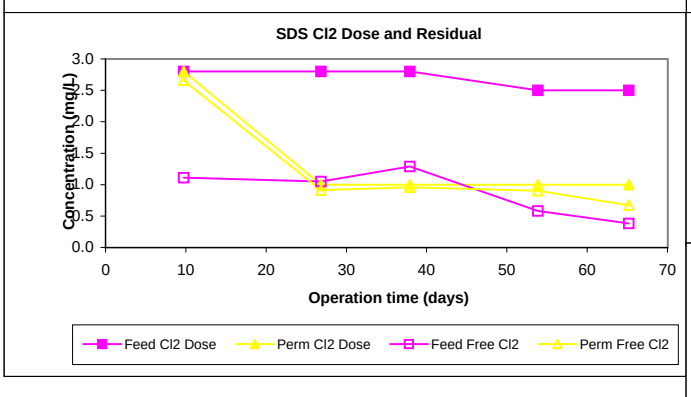


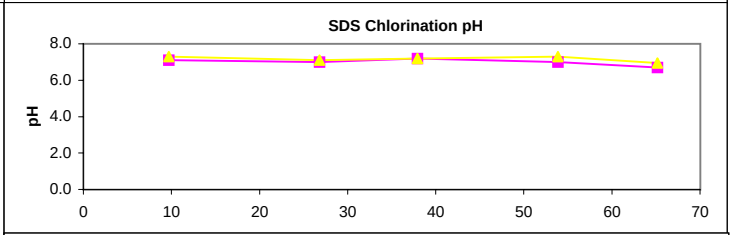


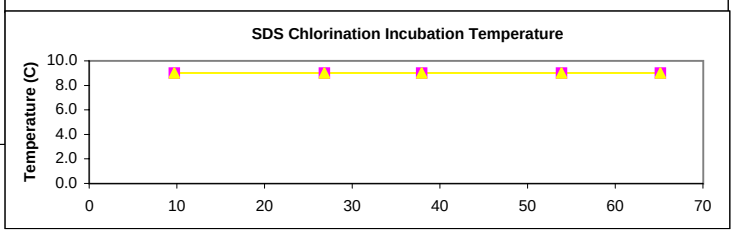




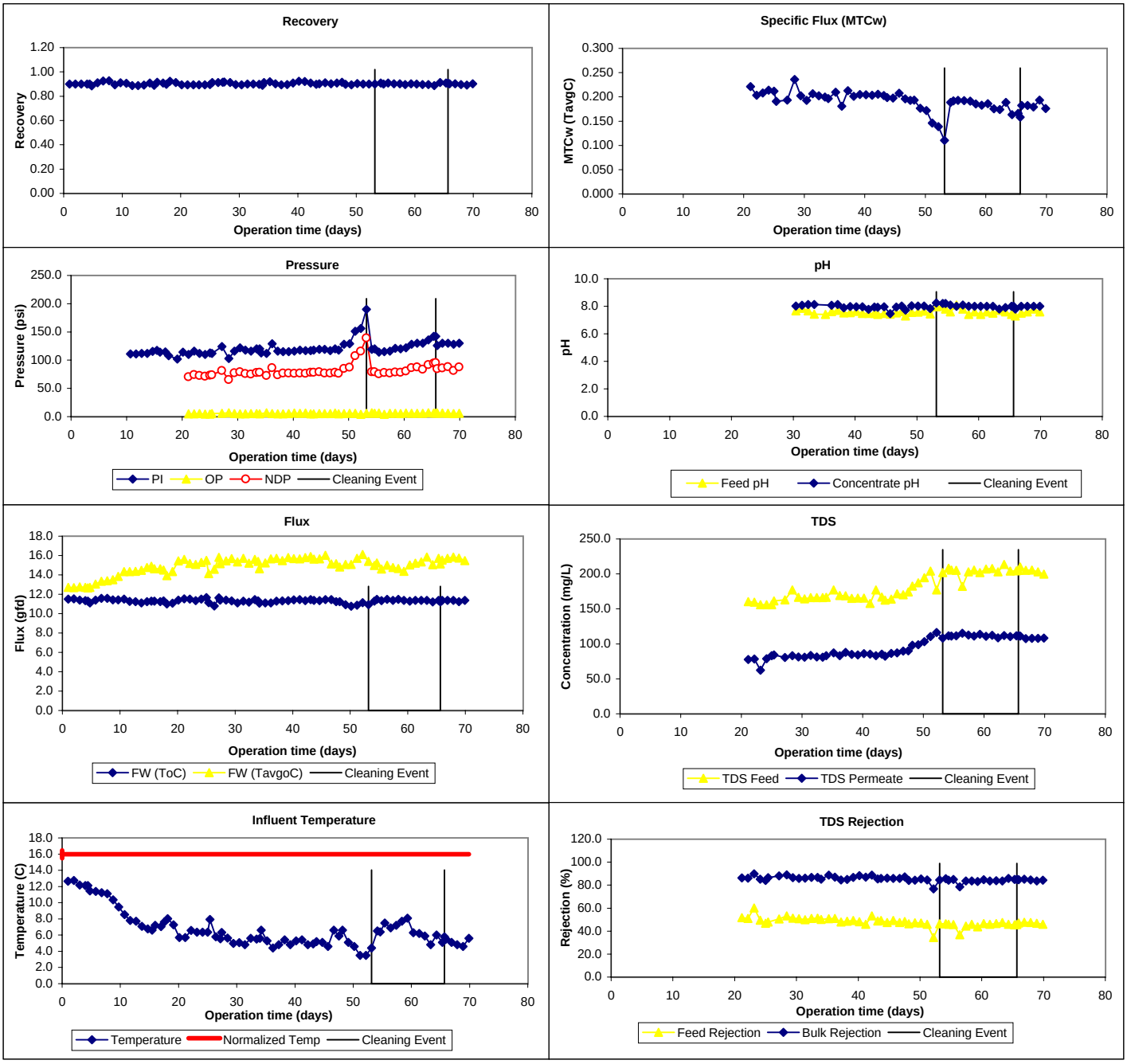








Productivity Graphs



New Jersey American Water Company | **Pilot-Scale Membrane Treatment Study Summary** | **Session:** 2

ICR Information

ID / ICR#:	NJ0712001 / 466
ICR Contact:	Kevin Dixon
Phone No.:	(609) 764-4902
Period:	1/26/98 - 4/10/98 (74 days)

Membrane Information

Manufacturer:	Desal Systems
Trade Name:	DS-5/DL grade
Membrane Model:	HL4040FF
MWCO:	150-300 Daltons
Element Size:	4" x 40"
Element Area:	90.0 ft^2
Design Flux:	12.0 gfd
Mfr. NDP:	38.7 psi
Mfr. MTC_w:	0.310 (gfd/psi)
Mfr. Temp:	25.0 °C
Maximum Flow:	18.0 gpm
Minimum Flow:	4.0 gpm
Total Width :	16.0 ft
Feed Spacer Thickness:	0.0023 ft
840 Element Area	350.0 ft^2
840 Purchase Price:	$650

Design Parameters

Norm Temp:	16.0 °C
Temp Norm MTC-w:	0.238 gfd/psi
Design Recovery:	0.90
Avg Sys Flux F_w:	12.0 gfd
# of Elem in P.V.:	6
# Pres Ves in Stg 1:	2
# Pres Ves in Stg 2:	1
Pres Ves in Stg 3:	NA
Design Flux:	12.0 gfd
Recycle Ratio:	0.19
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	7.6	0.4	5	7.0 - 8.0	7.4	0.2	5	7.2 - 7.8	8.1	0.2	5	7.9 - 8.4
Temp	8.1	3.1	5	5.3 - 13.4	9.1	3.2	5	6.6 - 14.6	9.3	3.2	5	6.7 - 14.7
Alk	35	1	5	35 - 36	20	2	5	18 - 23	168	19	5	154 - 200
TDS	**188**	**16**	**5**	**170 - 208**	**109**	**13**	**5**	**95 - 125**	**713**	**51**	**5**	**658 - 787**
TotHard	66	8	5	54 - 74	32	5	5	25 - 38	313	146	5	78 - 447
CaHard	42	5	5	34 - 47	23	5	5	17 - 28	182	82	5	49 - 255
Turb	0.03	0.0	5	0.03 - 0.04	0.03	0.0	5	0.02 - 0.04	0.14	0.0	5	0.12 - 0.16
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0
TOC	**4.5**	**0.3**	**5**	**4.2 - 5.0**	**0.3**	**0.0**	**5**	**0.3 - 0.3**	**40.9**	**2.6**	**5**	**36.9 - 43.8**
UV254	0.130	0.0	5	0.119 - 0.143	0.005	0.0	5	0.005 - 0.005	1.367	0.1	5	1.200 - 1.520
SUVA	2.88	0.08	5	2.76 - 2.95	1.80	0.00	5	1.80 - 1.80	3.34	0.15	5	3.21 - 3.52
Bromide	**37**	**4**	**5**	**33 - 42**	**36**	**2**	**5**	**32 - 38**				
TOX	**425**	**23**	**5**	**393 - 446**	**13**	**0**	**5**	**13 - 13**				
CHCl3	65.9	3.3	5	60.8 - 69.2	0.0	0.0	5	0.0 - 0.0				
BDCM	6.9	0.6	5	6.0 - 7.5	0.0	0.0	5	0.0 - 0.0				
DBCM	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0				
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0				
THM4	**72.8**	**3.7**	**5**	**66.8 - 76.5**	**0.0**	**0.0**	**5**	**0.0 - 0.0**				
MCAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0				
DCAA	28.6	1.3	5	26.8 - 30.1	0.0	0.0	5	0.0 - 0.0				
TCAA	36.1	2.1	5	32.8 - 37.8	0.0	0.0	5	0.0 - 0.0				
MBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0				
DBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0				
BCAA	2.9	0.2	5	2.6 - 3.2	0.0	0.0	5	0.0 - 0.0				
TBAA	NA	NA	0	NA	NA	NA	0	NA				
CDBAA	NA	NA	0	NA	NA	NA	0	NA				
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
HAA5	**64.8**	**2.3**	**5**	**62.3 - 67.1**	**0.0**	**0.0**	**5**	**0.0 - 0.0**				
HAA6	**67.7**	**2.3**	**5**	**65.2 - 70.3**	**0.0**	**0.0**	**5**	**0.0 - 0.0**				
HAA9	**NA**	**NA**	**0**	**NA**	**NA**	**NA**	**0**	**NA**				

Mass Balance Closure Errors (%)

WQP	Count	Avg	SD/RD
Alk	5	-3	8
TDS	5	-29	7
TotHard	5	-83	170
CaHard	5	-69	138
Turb	5	11	29
Amm	0	n/a	n/a
TOC	0	n/a	n/a
UV254	5	3	7
TDSt	70	-29	12

Comments:

SDS Conditions

WQP	**Avg**	**SD**	**Count**	**Min - Max**
Res (0)	0.76	0.24	10	0.27 - 0.98
Temp (°C)	10.2	0.8	10	9.0 - 11.0
pH (unit)	7.1	0.1	10	7.0 - 7.3
Time (hr)	6.3	0.4	10	5.6 - 6.9

Pretreatment Information

Process	**Description**	**Scale**
Microfiltration	Memcor (60M10C) 0.2 mm hollow fiber mei	Pilot-scale
Antiscalant addition	3 mg/L PreTreat Plus (King Lee)	Pilot-scale
Disinfectant	Chloramines (1.07 mg/L residual)	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%	0.0%	System Inf - Stg 1 Inf	-35.5%	4.6%
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	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Pei	0.0%	0.0%	Sys Perm - Avg Stg Perm	-13.5%	2.8%

Stage Summary

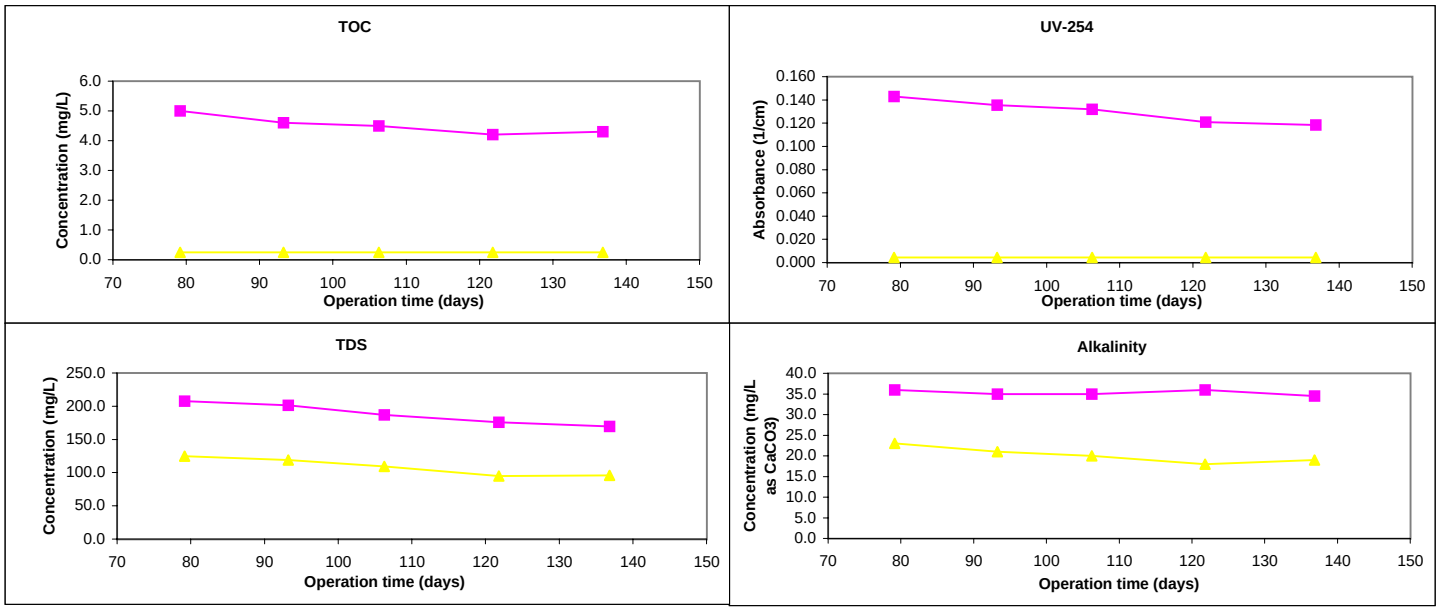
	Stage 1 Influent						Stage 1 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.62**	**0.01**	**5**	**0.61 - 0.63**					
pH	7.6	8.1	7.9	0.2	5	7.6 - 8.2	7.4	7.3	0.2	5	7.0 - 7.6
Temp	8.1	9.3	8.3	3.2	5	6.1 - 13.7	9.1	8.8	3.3	5	6.3 - 14.3
Alk	35	168	58	4	5	55 - 66	20	15	2	5	12 - 17
TDS	**188**	**713**	269	**17**	**5**	**243 - 284**	**109**	**111**	**19**	**5**	**89 - 132**
TotHard	66	313	120	17	5	93 - 132	32	26	4	5	21 - 32
CaHard	42	182	72	10	5	58 - 80	23	18	4	5	14 - 23
Turb	0.03	0.14	0.06	0	5	0.05 - 0.08	0.03	0.02	0.01	5	0 - 0
TOC	**4.5**	**40.9**	10.8	**0.8**	**5**	**9.4 - 11.5**	**0.3**	**0.3**	**0.0**	**5**	**0.3 - 0.3**
UV254	0.130	**1.367**	0.337	0.026	5	0.298 - 0.366	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	2.88	**3.34**	3.13	0.17	5	2.95 - 3.30	1.80	1.80	0.00	5	1.80 - 1.80

	Stage 2 Influent						Stage 2 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.74**	**0.01**	**5**	**0.73 - 0.76**					
pH	7.6	8.1	8.0	0.1	5	7.8 - 8.2	7.4	7.5	0.2	5	7.3 - 7.8
Temp	8.1	9.3	9.1	3.4	5	6.7 - 14.8	9.1	8.9	3.4	5	6.4 - 14.6
Alk	35	168	108	11	5	101 - 127	20	32	2	5	29 - 34
TDS	**188**	**713**	466	**27**	**5**	**431 - 501**	**109**	**135**	**9**	**5**	**125 - 146**
TotHard	66	313	221	36	5	161 - 250	32	45	3	5	42 - 50
CaHard	42	182	129	20	5	98 - 146	23	32	3	5	29 - 37
Turb	0.03	0.14	0.09	0	5	0.07 - 0.10	0.03	0.03	0.01	5	0 - 0
TOC	**4.5**	**40.9**	22.6	**1.5**	**5**	**20.5 - 24.6**	**0.3**	**0.3**	**0.0**	**5**	**0.3 - 0.3**
UV254	0.130	**1.367**	0.747	0.058	5	0.663 - 0.795	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	2.88	**3.34**	3.30	0.14	5.00	3.14 - 3.50	1.80	1.80	0.00	5.00	1.80 - 1.80

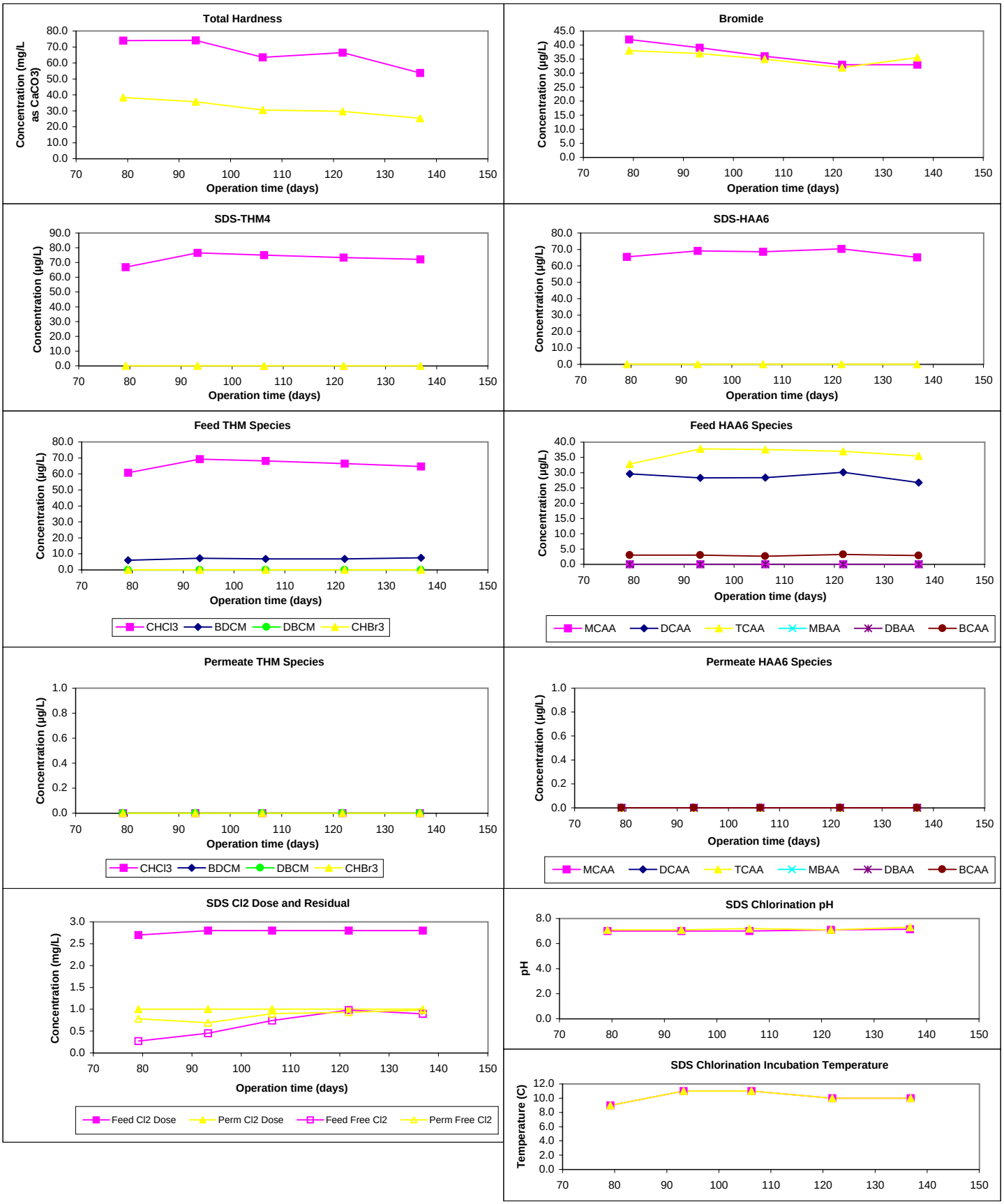
	Stage 3 Influent						Stage 3 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery											
pH											
Temp											
Alk	This	was	**only**	a	two	stage	study.				
TDS											
TotHard											
CaHard			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

Chart Legend:
Feed (System)
Permeate (System)

Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs