

# ICR TREATMENT STUDY ANALYSIS

## Base Analysis and Data Review Comments

<b>Treatment Study ID</b>	4006
<b>Study Protocol</b>	Pilot-Scale Membrane Study
<b>Plant ICR Number</b>	685
<b>PWS Name</b>	Fairfax County Water Authority
<b>City, State, Zip</b>	Herndon, VA 20170

### General Comments:

1. This study was grandfathered into the ICR, and therefore does not meet all of the specific requirements listed in the ICR and rule-by-reference manuals. This single element study (study ID 4006) was conducted in conjunction with a pilot-scale study (study ID 4005). Both studies were conducted during the period of September 1995 through June 1996.
2. During this single element study, the FilmTec NF70 was evaluated over a six-month period between January and June of 1996.
3. Conventional filtration, acid addition and scale control served as pretreatment to the nanofiltration system.

### Water Quality Comments:

1. SDS conditions are summarized in Table 7 of the Summary Report. With the exception of SDS incubation temperature, the target SDS conditions remained constant over the study: free chlorine residual of 1.0 mg/L, at a pH of 7.5 and a 72 hour incubation time. The incubation temperature ranged from 11°C to 19°C.
2. The following parameters were not measured during this study: calcium hardness, ammonia, and TOX.
3. Seven water quality outliers were identified and removed prior to base analysis.

### Productivity Comments:

1. The nanofiltration membrane was cleaned using a 0.5% NaOH solution heated to 40°C. Cleanings were performed after a 20% decline in the temperature-normalized specific flux.

2. During the study, the rate of fouling was observed to vary inversely with the flux rate, i.e., lower fluxes lead to longer cleaning intervals. The average rate of specific flux decline calculated during EPA data analysis, over the entire study, was  $-6.36 \times 10^{-3}$  gfd/psi/day  $\pm 2.44 \times 10^{-3}$  gfd/psi/day. The average rate of specific flux decline based on the Summary Report was  $-8.27 \times 10^{-3}$  gfd/psi/day  $\pm 4.99 \times 10^{-3}$  gfd/psi/day.

## ICR Information

ID / ICR#: VA6059501 / 685  
 ICR Contact: Ms. Jeanne Bailey  
 Phone No.: 703-404-5048  
 Period: 1/5/96 - 2/26/96 (52 days)

## Membrane Information

<b>Manufacturer:</b> FilmTec Corp.	<b>Mfr. MTC<sub>w</sub>:</b> 0.357 (gfd/psi)
<b>Trade Name:</b> FilmTec NF70	<b>Mfr. Temp:</b> 25.0 °C
<b>Membrane Model:</b> NF70-4040	<b>Max Flow:</b> 16.0 gpm
<b>MWCO:</b> 200 Daltons	<b>Min Flow:</b> 4.0 gpm
<b>Element Size:</b> 4" x 40"	<b>Total Width :</b> 12.0 ft
<b>Element Area:</b> 72.2 ft <sup>2</sup>	<b>Feed Sp Thickness:</b> 0.0028 ft
<b>Design Flux:</b> 25.0 gfd	<b>840 Element Area</b> 400.0 ft <sup>2</sup>
<b>Mfr. NDP:</b> 70.0 psi	<b>840 Purchase Price:</b> \$600

## Design Parameters

<b>Norm Temp:</b> 17.9 °C	<b>Recycle Ratio:</b> 4.98
<b>Temp Norm MTC-w:</b> 0.290 TavGC	<b>Manuf rep Re<sub>JTDS</sub>:</b> 70%
<b>Design Recovery:</b> 0.75	<b>TDS<sub>F</sub>:</b> 105.0 mg/L
<b>Design Flux:</b> 15.0 gfd	

## Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	6.2	0.2	3	6.0 - 6.4	6.0	0.1	2	5.9 - 6.0	6.1	0.3	2	5.9 - 6.3
Temp	8.5	0.5	3	8.0 - 9.0	8.5	0.5	3	8.0 - 9.0	8.5	0.5	3	8.0 - 9.0
Alk	11	1	2	10 - 12	4	5	2	0 - 7	12	3	2	10 - 14
<b>TDS</b>	<b>119</b>	<b>16</b>	<b>3</b>	<b>102 - 133</b>	<b>29</b>	<b>4</b>	<b>3</b>	<b>27 - 33</b>	<b>160</b>	<b>20</b>	<b>3</b>	<b>138 - 178</b>
TotHard	55	8	2	49 - 61	3	4	2	0 - 6	74	16	2	62 - 85
CaHard	NA	NA	0	0 - 0	NA	NA	0	0 - 0	NA	NA	0	0 - 0
Turb	0.29	0.12	3	0.18 - 0.42	0.08	0.02	3	0.06 - 0.09	0.25	0.12	3	0.15 - 0.38
Amm	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0
<b>TOC</b>	<b>2.0</b>	<b>0.3</b>	<b>3</b>	<b>1.8 - 2.4</b>	<b>0.3</b>	<b>0.0</b>	<b>3</b>	<b>0.3 - 0.3</b>	<b>2.7</b>	<b>0.0</b>	<b>2</b>	<b>2.7 - 2.7</b>
UV254	0.032	0.0	3	0.024 - 0.039	0.005	0.0	3	0.005 - 0.005	0.047	0.0	3	0.038 - 0.056
SUVA	1.58	0.23	3	1.33 - 1.78	1.80	0.00	3	1.80 - 1.80	NA	NA	2	NA
Bromide	30	0	3	30 - 30	NA	NA	0	0 - 0				
TOX	NA	NA	0	0 - 0	NA	NA	0	0 - 0				
CHCl3	34.3	8.1	3	26.6 - 42.8	2.6	1.0	3	1.8 - 3.7	<b>Mass Balance</b>			
BDCM	7.3	1.4	3	5.9 - 8.7	0.5	0.9	3	0.0 - 1.5	<b>Closure Errors (%)</b>			
DBCM	0.9	0.8	3	0.0 - 1.5	0.0	0.0	3	0.0 - 0.0	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	1	-3	n/a
<b>THM4</b>	<b>42.5</b>	<b>6.8</b>	<b>3</b>	<b>35.3 - 48.7</b>	<b>3.1</b>	<b>1.8</b>	<b>3</b>	<b>1.8 - 5.2</b>	TDS	3	-1	1
MCAA	2.0	1.7	3	0.0 - 3.0	0.0	0.0	3	0.0 - 0.0	TotHard	1	-2	n/a
DCAA	18.0	4.6	3	14.0 - 23.0	1.0	0.0	3	1.0 - 1.0	CaHard	0	n/a	n/a
TCAA	20.7	7.0	3	14.0 - 28.0	0.3	0.6	3	0.0 - 1.0	Turb	3	-57	5
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	0.3	0.6	3	0.0 - 1.0	0.0	0.0	3	0.0 - 0.0	TOC	0	n/a	n/a
BCAA	2.0	1.7	3	0.0 - 3.0	0.3	0.6	3	0.0 - 1.0	UV254	0	n/a	n/a
TBAA	NA	NA	0	NA	NA	NA	0	NA	<b>Comments:</b>			
CDBAA	NA	NA	0	NA	NA	NA	0	NA				
DCBAA	NA	NA	0	NA	NA	NA	0	NA	TDS	70	-6	5
<b>HAA5</b>	<b>41.0</b>	<b>12.5</b>	<b>3</b>	<b>31.0 - 55.0</b>	<b>1.3</b>	<b>0.6</b>	<b>3</b>	<b>1.0 - 2.0</b>				
<b>HAA6</b>	<b>43.0</b>	<b>13.7</b>	<b>3</b>	<b>31.0 - 58.0</b>	<b>1.7</b>	<b>0.6</b>	<b>3</b>	<b>1.0 - 2.0</b>				
<b>HAA9</b>	<b>NA</b>	<b>NA</b>	<b>0</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>0</b>	<b>NA</b>				

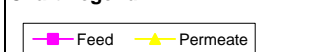
## SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.79	0.16	6	0.63 - 1.08
Temp (°C)	11.0	0.0	6	11.0 - 11.0
pH (unit)	7.5	0.0	6	7.5 - 7.5
Time (hr)	72.0	0.0	6	72.0 - 72.0

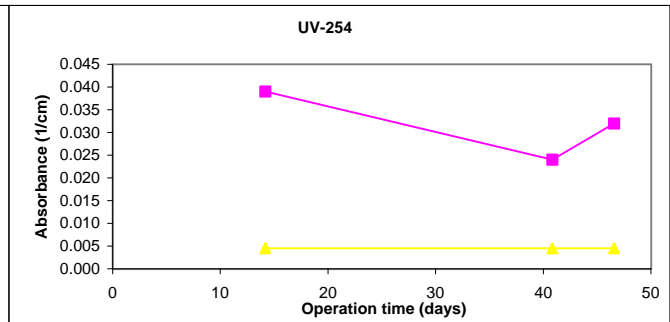
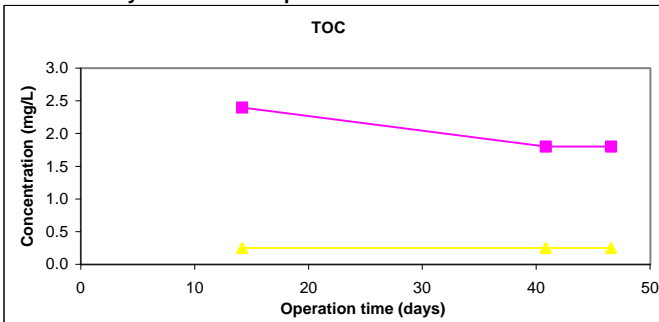
## Pretreatment Information

Process	Description	Scale
Flocculation	Single stage, 20.5 min design detention	Full-scale
Sedimentation	3.15 hr design HDT, upflow rate=0.37 g	Full-scale
Dual media filtration	Anthracite/sand	Pilot-scale
Cartridge filtration	5 micron nominal size exclusion	Pilot-scale
Sulfuric acid addition	pH = 6.0	Pilot-scale

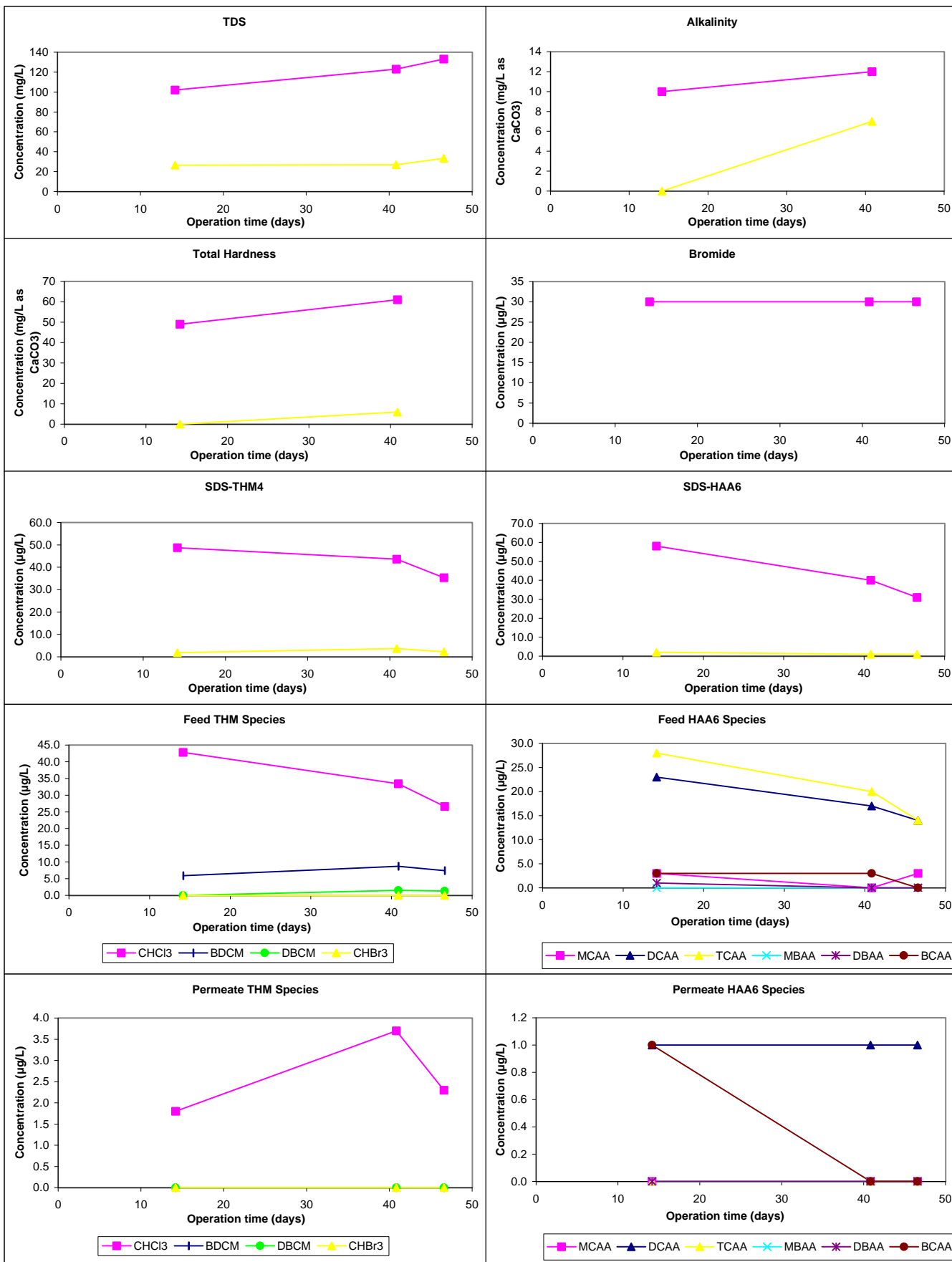
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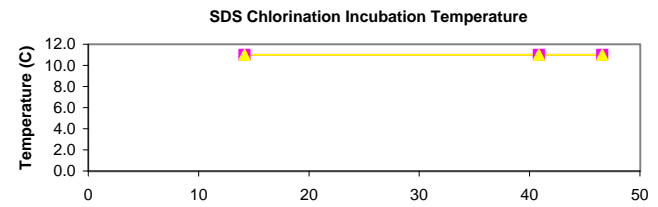
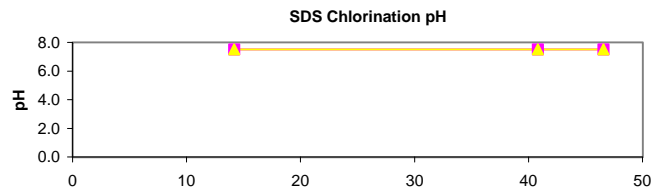
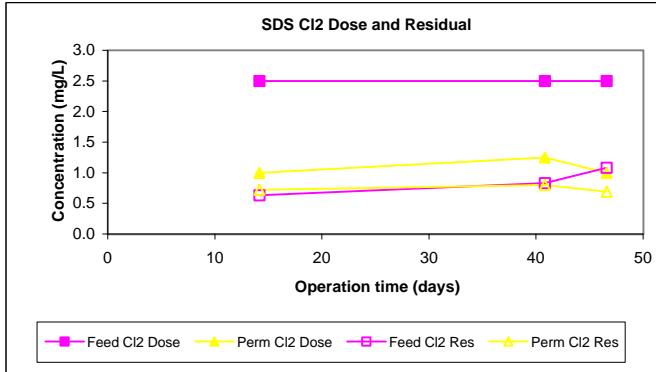
## Water Quality Parameter Graphs



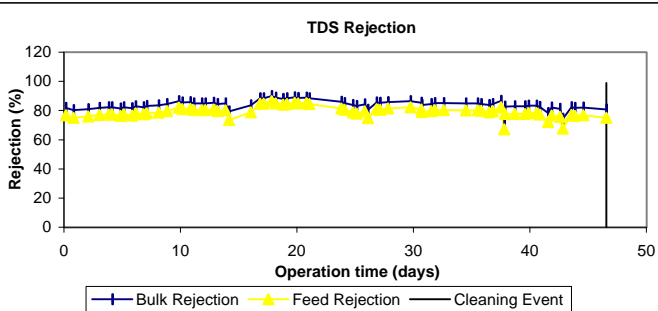
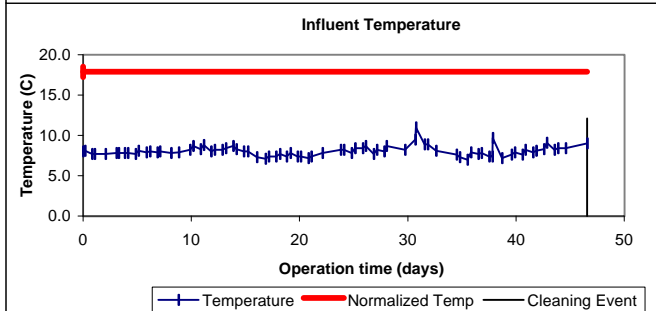
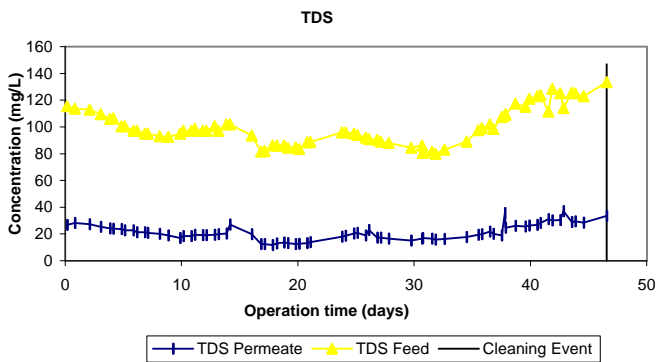
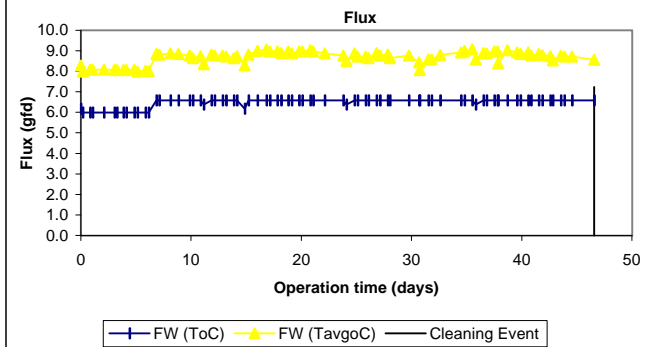
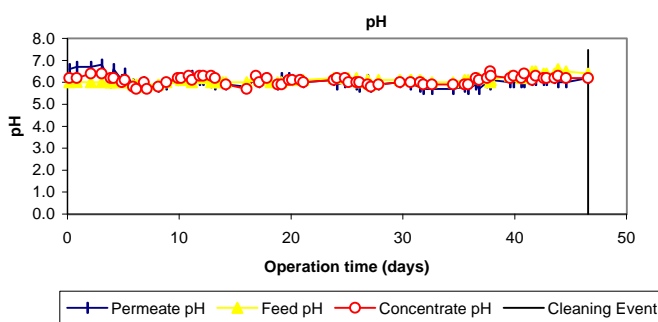
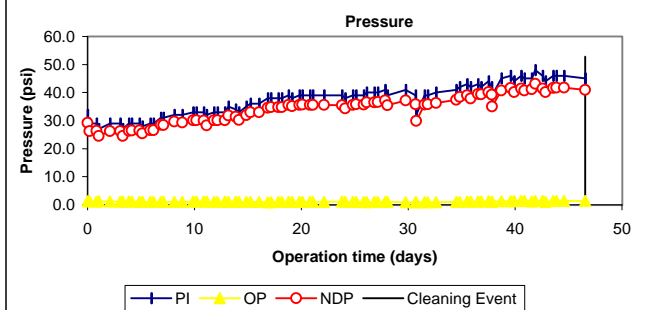
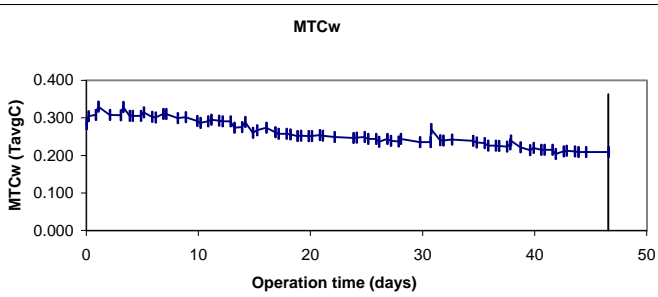
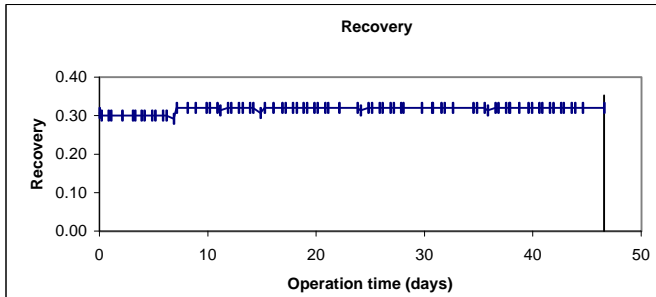
## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: VA6059501 / 685  
 ICR Contact: Ms. Jeanne Bailey  
 Phone No.: 703-404-5048  
 Period: 2/26/96 - 3/15/97 (383 days)

## Membrane Information

<b>Manufacturer:</b> FilmTec Corp.	<b>Mfr. MTC<sub>w</sub>:</b> 0.357 (gfd/psi)
<b>Trade Name:</b> FilmTec NF70	<b>Mfr. Temp:</b> 25.0 °C
<b>Membrane Model:</b> NF70-4040	<b>Max Flow:</b> 16.0 gpm
<b>MWCO:</b> 200 Daltons	<b>Min Flow:</b> 4.0 gpm
<b>Element Size:</b> 4" x 40"	<b>Total Width :</b> 12.0 ft
<b>Element Area:</b> 72.2 ft <sup>2</sup>	<b>Feed Sp Thickness:</b> 0.0028 ft
<b>Design Flux:</b> 25.0 gfd	<b>840 Element Area</b> 400.0 ft <sup>2</sup>
<b>Mfr. NDP:</b> 70.0 psi	<b>840 Purchase Price:</b> \$600

## Design Parameters

<b>Norm Temp:</b> 17.9 °C	<b>Recycle Ratio:</b> 4.98
<b>Temp Norm MTC-w:</b> 0.290 TavGC	<b>Manuf rep Re<sub>JTDS</sub>:</b> 70%
<b>Design Recovery:</b> 0.75	<b>TDS<sub>F</sub>:</b> 105.0 mg/L
<b>Design Flux:</b> 15.0 gfd	

## Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	6.2	0.1	5	6.0 - 6.4	5.8	0.3	5	5.3 - 6.1	6.2	0.1	5	6.1 - 6.3
Temp	12.1	2.0	5	10.0 - 14.5	12.1	2.0	5	10.0 - 14.5	12.1	2.0	5	10.0 - 14.5
Alk	11	2	5	9 - 13	1	2	4	0 - 4	26	8	4	14 - 32
<b>TDS</b>	<b>123</b>	<b>20</b>	<b>5</b>	<b>88 - 139</b>	<b>42</b>	<b>26</b>	<b>5</b>	<b>15 - 85</b>	<b>257</b>	<b>65</b>	<b>5</b>	<b>145 - 308</b>
TotHard	63	4	5	56 - 66	11	6	4	6 - 16	159	41	5	90 - 200
CaHard	NA	NA	0	0 - 0	NA	NA	0	0 - 0	NA	NA	0	0 - 0
Turb	0.14	0.05	5	0.11 - 0.22	0.08	0.01	5	0.07 - 0.10	0.16	0.03	5	0.13 - 0.19
Amm	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0
<b>TOC</b>	<b>2.3</b>	<b>0.4</b>	<b>5</b>	<b>1.9 - 2.9</b>	<b>0.3</b>	<b>0.0</b>	<b>5</b>	<b>0.3 - 0.3</b>	<b>5.8</b>	<b>0.3</b>	<b>3</b>	<b>5.4 - 6.0</b>
UV254	0.038	0.0	4	0.033 - 0.041	0.008	0.0	4	0.005 - 0.013	0.090	0.0	4	0.079 - 0.105
SUVA	NA	NA	4	NA	NA	NA	4	NA	NA	NA	3	NA
Bromide	30	0	5	30 - 30	NA	NA	0	0 - 0				
TOX	NA	NA	0	0 - 0	NA	NA	0	0 - 0				
CHCl3	40.3	12.5	5	32.2 - 62.2	4.3	2.9	5	1.7 - 8.6	<b>Mass Balance</b>			
BDCM	8.3	1.0	5	7.5 - 9.9	1.3	1.4	5	0.0 - 3.2	<b>Closure Errors (%)</b>			
DBCM	0.4	0.5	5	0.0 - 1.0	0.2	0.4	5	0.0 - 1.0	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	0	n/a	n/a
<b>THM4</b>	<b>49.0</b>	<b>12.4</b>	<b>5</b>	<b>41.0 - 71.0</b>	<b>5.8</b>	<b>3.8</b>	<b>5</b>	<b>1.7 - 11.8</b>	TDS	5	-26	24
MCAA	1.0	1.4	5	0.0 - 3.0	0.0	0.0	4	0.0 - 0.0	TotHard	4	-21	21
DCAA	31.0	22.4	5	19.0 - 71.0	1.8	1.3	4	0.0 - 3.0	CaHard	0	n/a	n/a
TCAA	20.8	2.9	5	16.0 - 23.0	0.8	0.5	4	0.0 - 1.0	Turb	5	-81	65
MBAA	0.0	0.0	5	0.0 - 0.0	0.5	1.0	4	0.0 - 2.0	Amm	0	n/a	n/a
DBAA	0.8	1.3	5	0.0 - 3.0	0.0	0.0	4	0.0 - 0.0	TOC	0	n/a	n/a
BCAA	3.6	1.1	5	2.0 - 5.0	0.5	0.6	4	0.0 - 1.0	UV254	2	-24	9
TBAA	NA	NA	0	NA	NA	NA	0	NA	TDS <sub>t</sub>	69	-33	23
CDBAA	NA	NA	0	NA	NA	NA	0	NA	<b>Comments:</b>			
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
<b>HAA5</b>	<b>53.6</b>	<b>20.4</b>	<b>5</b>	<b>43.0 - 90.0</b>	<b>3.0</b>	<b>0.8</b>	<b>4</b>	<b>2.0 - 4.0</b>				
<b>HAA6</b>	<b>57.2</b>	<b>20.6</b>	<b>5</b>	<b>47.0 - 94.0</b>	<b>3.5</b>	<b>1.0</b>	<b>4</b>	<b>3.0 - 5.0</b>				
<b>HAA9</b>	<b>NA</b>	<b>NA</b>	<b>0</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>0</b>	<b>NA</b>				

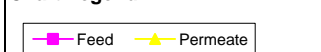
## SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.75	0.13	10	0.55 - 1.00
Temp (°C)	12.6	3.4	10	11.0 - 19.0
pH (unit)	7.5	0.0	10	7.5 - 7.5
Time (hr)	72.0	0.0	10	72.0 - 72.0

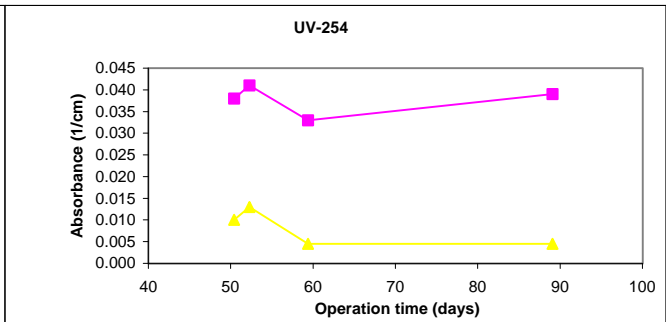
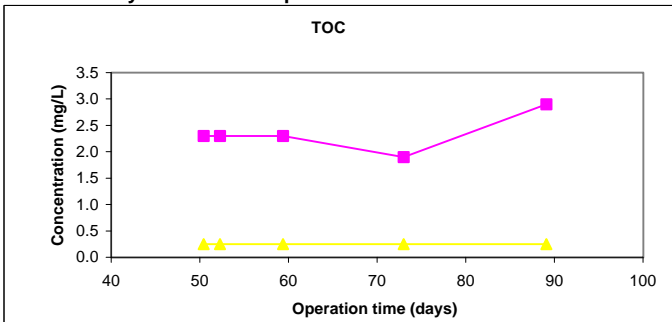
## Pretreatment Information

Process	Description	Scale
Flocculation	Single stage, 20.5 min design detention	Full-scale
Sedimentation	3.15 hr design HDT, upflow rate=0.37 g	Full-scale
Dual media filtration	Anthracite/sand	Pilot-scale
Cartridge filtration	5 micron nominal size exclusion	Pilot-scale
Sulfuric acid addition	pH = 6.0	Pilot-scale

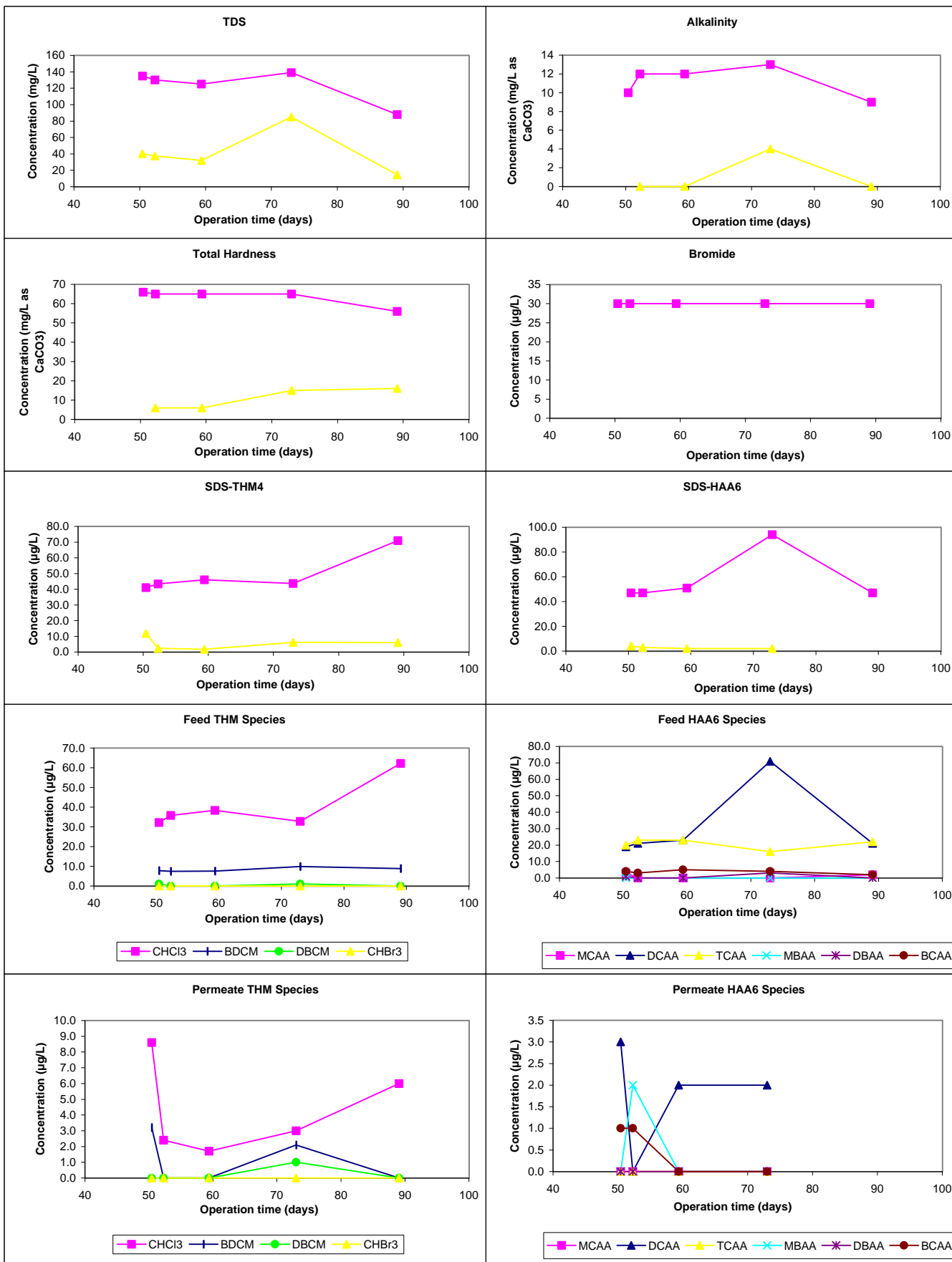
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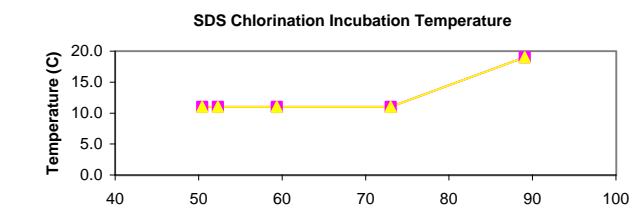
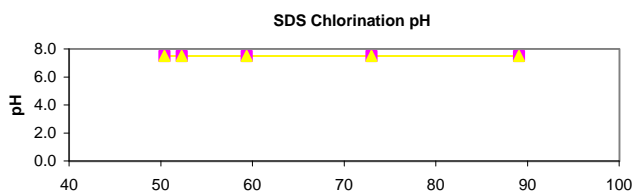
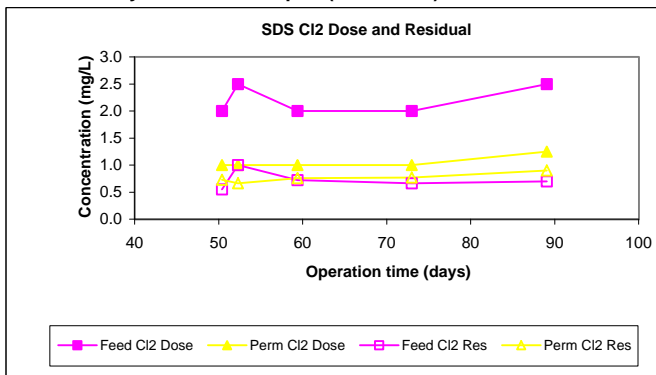
## Water Quality Parameter Graphs



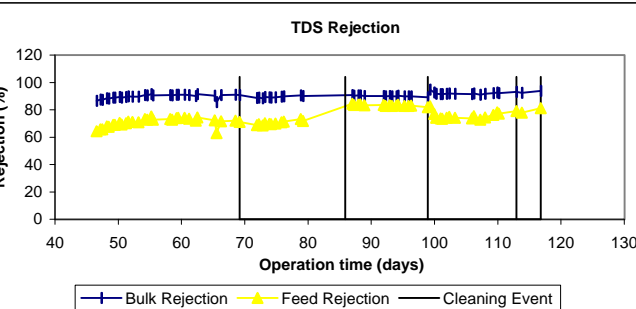
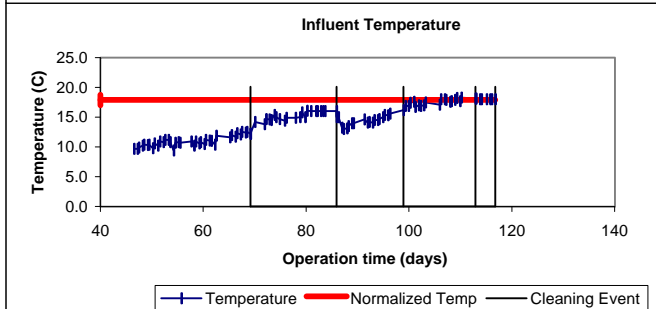
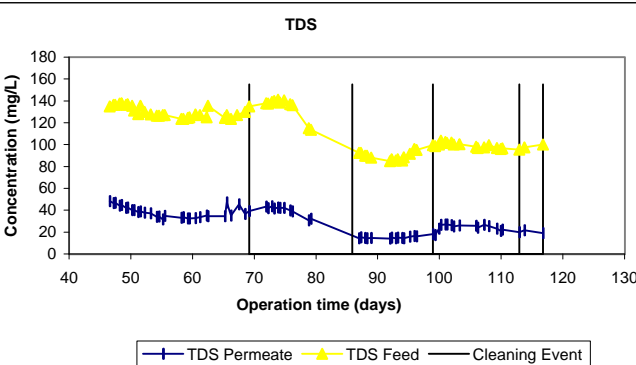
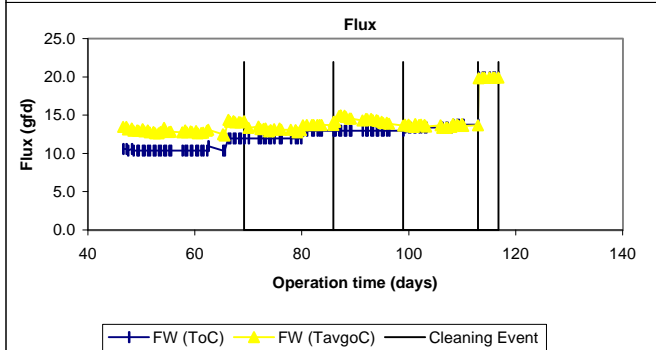
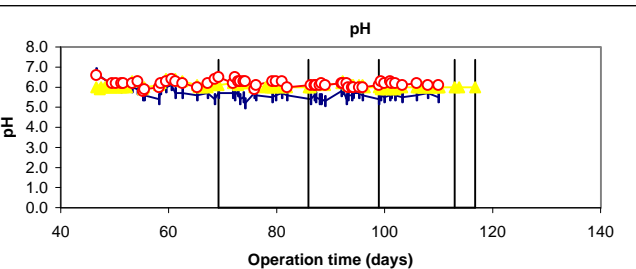
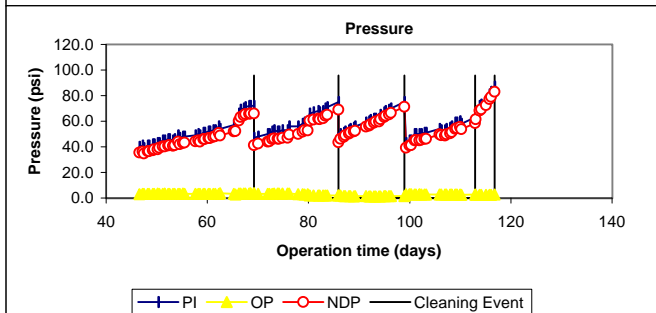
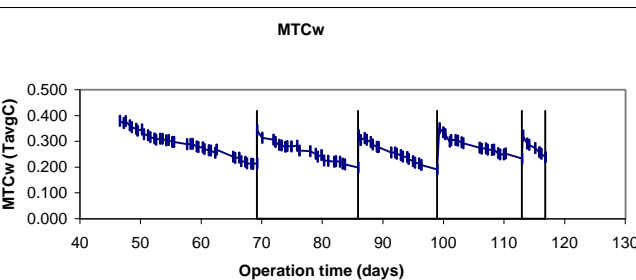
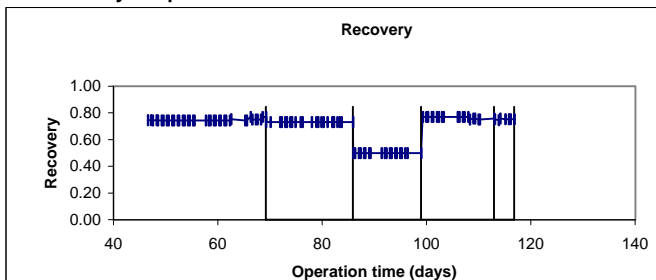
## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs





## ICR Information

ID / ICR#: VA6059501 / 685  
 ICR Contact: Ms. Jeanne Bailey  
 Phone No.: 703-404-5048  
 Period: 5/10/96 - 5/22/09 (4760 days)

## Membrane Information

Manufacturer: FilmTec Corp. Mfr. MTC<sub>w</sub>: 0.357 (gfd/psi)  
 Trade Name: FilmTec NF70 Mfr. Temp: 25.0 °C  
 Membrane Model: NF70-4040 Max Flow: 16.0 gpm  
 MWCO: 200 Daltons Min Flow: 4.0 gpm  
 Element Size: 4" x 40" Total Width: 12.0 ft  
 Element Area: 72.2 ft<sup>2</sup> Feed Sp Thickness: 0.0028 ft  
 Design Flux: 25.0 gfd 840 Element Area: 400.0 ft<sup>2</sup>  
 Mfr. NDP: 70.0 psi 840 Purchase Price: \$600

## Design Parameters

Norm Temp: 17.9 °C Recycle Ratio: 4.98  
 Temp Norm MTC-w: 0.290 TavGC Manuf rep Rej<sub>TDS</sub>: 70%  
 Design Recovery: 0.75 TDS<sub>F</sub>: 105.0 mg/L  
 Design Flux: 15.0 gfd

## Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	6.3	NA	1	6.3 - 6.3	5.9	NA	1	5.9 - 5.9	6.2	NA	1	6.2 - 6.2
Temp	14.0	NA	1	14.0 - 14.0	14.0	NA	1	14.0 - 14.0	14.0	NA	1	14.0 - 14.0
Alk	9	NA	1	9 - 9	0	NA	1	0 - 0	14	NA	1	14 - 14
<b>TDS</b>	<b>85</b>	<b>NA</b>	<b>1</b>	<b>85 - 85</b>	<b>15</b>	<b>NA</b>	<b>1</b>	<b>15 - 15</b>	<b>144</b>	<b>NA</b>	<b>1</b>	<b>144 - 144</b>
TotHard	56	NA	1	56 - 56	16	NA	1	16 - 16	90	NA	1	90 - 90
CaHard	NA	NA	0	0 - 0	NA	NA	0	0 - 0	NA	NA	0	0 - 0
Turb	0.16	NA	1	0.16 - 0.16	0.10	NA	1	0.10 - 0.10	0.15	NA	1	0.15 - 0.15
Amm	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0
<b>TOC</b>	<b>2.8</b>	<b>NA</b>	<b>1</b>	<b>2.8 - 2.8</b>	<b>0.3</b>	<b>NA</b>	<b>1</b>	<b>0.3 - 0.3</b>	<b>5.1</b>	<b>NA</b>	<b>1</b>	<b>5.1 - 5.1</b>
UV254	0.049	NA	1	0.049 - 0.049	0.005	NA	1	0.005 - 0.005	0.090	NA	1	0.090 - 0.090
SUVA	1.75	NA	1	1.75 - 1.75	1.80	NA	1	1.80 - 1.80	1.76	NA	1	1.76 - 1.76
Bromide	<b>30</b>	<b>NA</b>	<b>1</b>	<b>30 - 30</b>	<b>NA</b>	<b>NA</b>	<b>0</b>	<b>0 - 0</b>				
<b>TOX</b>	<b>NA</b>	<b>NA</b>	<b>0</b>	<b>0 - 0</b>	<b>NA</b>	<b>NA</b>	<b>0</b>	<b>0 - 0</b>				
CHCl3	78.9	NA	1	78.9 - 78.9	3.4	NA	1	3.4 - 3.4	<b>Mass Balance</b>			
BDCM	8.2	NA	1	8.2 - 8.2	1.1	NA	1	1.1 - 1.1	<b>Closure Errors (%)</b>			
DBCM	0.0	NA	1	0.0 - 0.0	0.0	NA	1	0.0 - 0.0	WQP	Count	Avg	SD/RD
CHBr3	0.0	NA	1	0.0 - 0.0	0.0	NA	1	0.0 - 0.0	Alk	0	n/a	n/a
<b>THM4</b>	<b>87.1</b>	<b>NA</b>	<b>1</b>	<b>87.1 - 87.1</b>	<b>4.5</b>	<b>NA</b>	<b>1</b>	<b>4.5 - 4.5</b>	TDS	1	-8	n/a
MCAA	5.0	NA	1	5.0 - 5.0	0.0	NA	1	0.0 - 0.0	TotHard	1	-7	n/a
DCAA	45.0	NA	1	45.0 - 45.0	1.0	NA	1	1.0 - 1.0	CaHard	0	n/a	n/a
TCAA	50.0	NA	1	50.0 - 50.0	1.0	NA	1	1.0 - 1.0	Turb	1	-47	n/a
MBAA	0.0	NA	1	0.0 - 0.0	0.0	NA	1	0.0 - 0.0	Amm	0	n/a	n/a
DBAA	1.0	NA	1	1.0 - 1.0	0.0	NA	1	0.0 - 0.0	TOC	0	n/a	n/a
BCAA	3.0	NA	1	3.0 - 3.0	0.0	NA	1	0.0 - 0.0	UV254	0	n/a	n/a
TBAA	NA	NA	0	NA	NA	NA	0	NA	<b>Comments:</b>			
CDBAA	NA	NA	0	NA	NA	NA	0	NA				
DCBAA	NA	NA	0	NA	NA	NA	0	NA	TDS	12	-5	11
<b>HAA5</b>	<b>101.0</b>	<b>NA</b>	<b>1</b>	<b>101.0 - 101.0</b>	<b>2.0</b>	<b>NA</b>	<b>1</b>	<b>2.0 - 2.0</b>				
<b>HAA6</b>	<b>104.0</b>	<b>NA</b>	<b>1</b>	<b>104.0 - 104.0</b>	<b>2.0</b>	<b>NA</b>	<b>1</b>	<b>2.0 - 2.0</b>				
<b>HAA9</b>	<b>NA</b>	<b>NA</b>	<b>0</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>0</b>	<b>NA</b>				

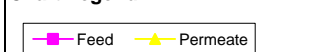
## SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.89	0.02	2	0.87 - 0.90
Temp (°C)	19.0	0.0	2	19.0 - 19.0
pH (unit)	7.5	0.0	2	7.5 - 7.5
Time (hr)	72.0	0.0	2	72.0 - 72.0

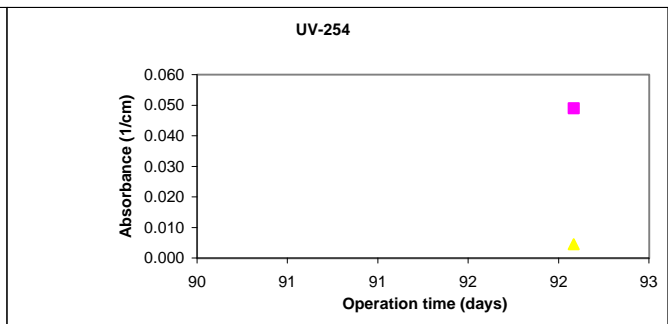
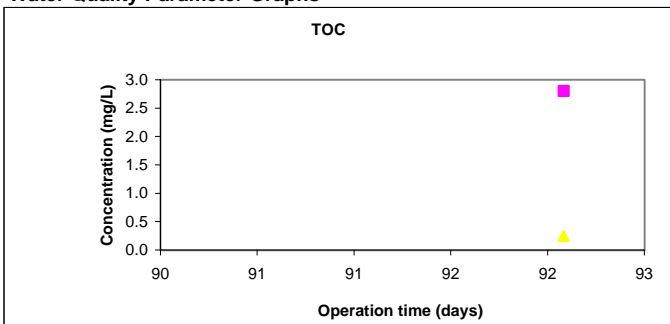
## Pretreatment Information

Process	Description	Scale
Flocculation	Single stage, 20.5 min design detention	Full-scale
Sedimentation	3.15 hr design HDT, upflow rate=0.37 g	Full-scale
Dual media filtration	Anthracite/sand	Pilot-scale
Cartridge filtration	5 micron nominal size exclusion	Pilot-scale
Sulfuric acid addition	pH = 6.0	Pilot-scale

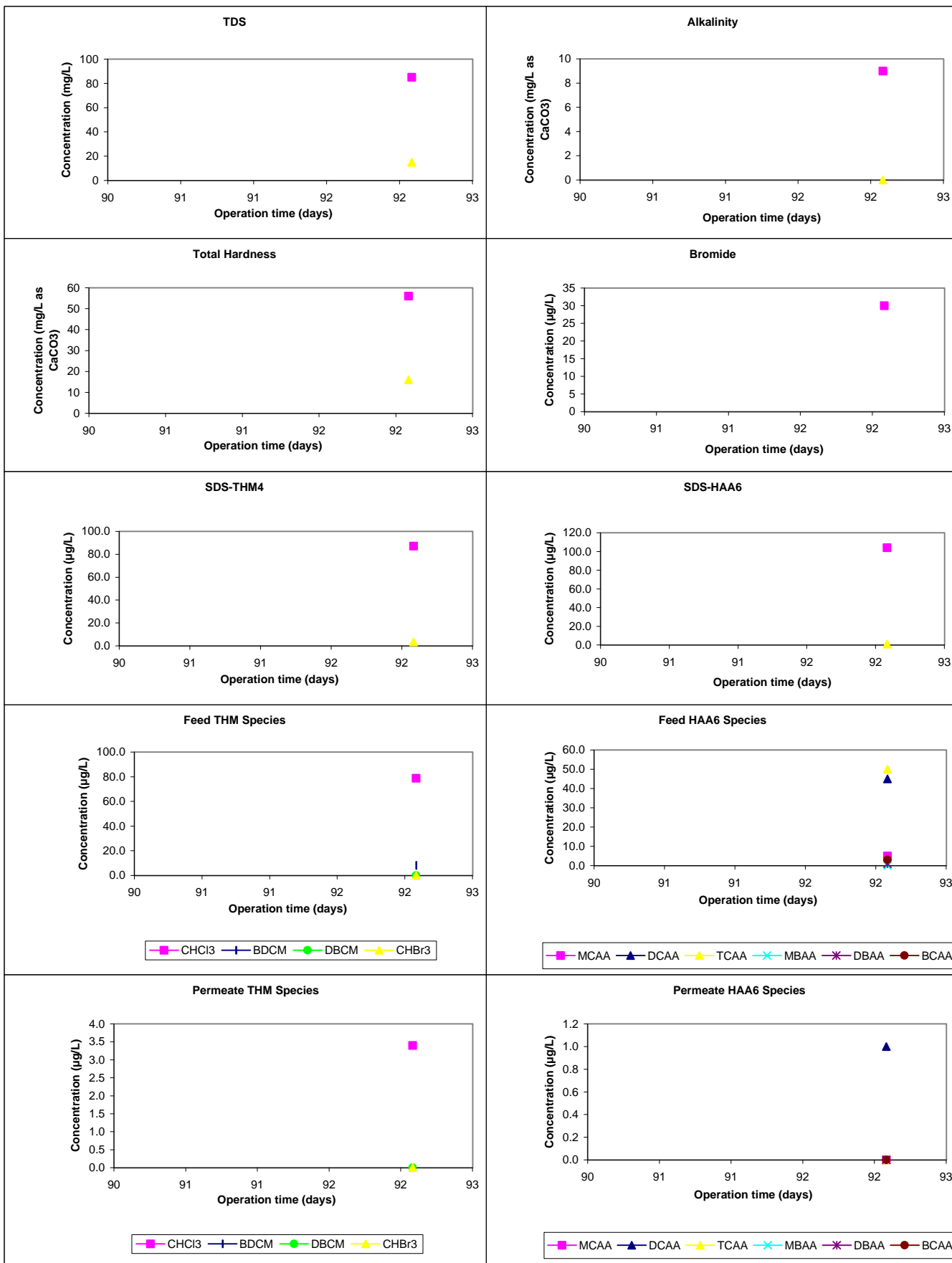
## Chart Legend:



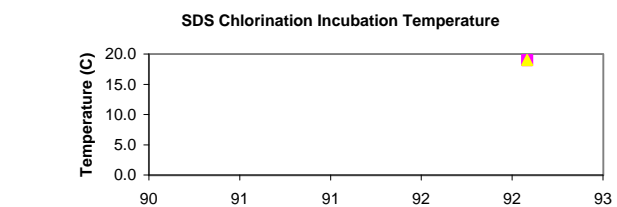
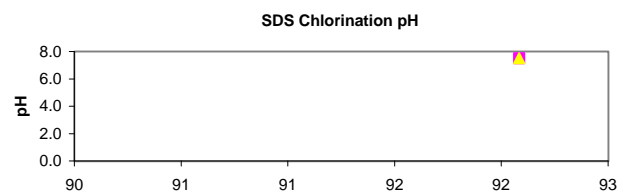
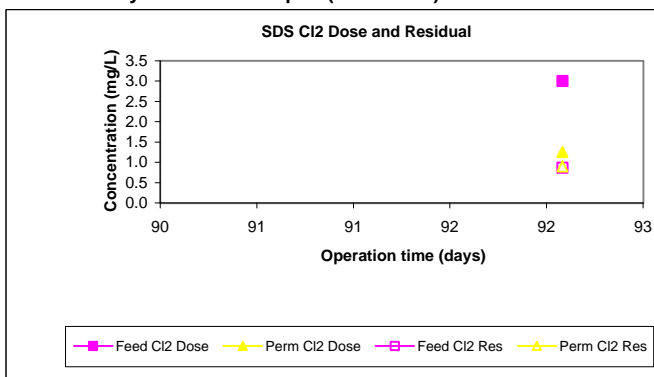
## Water Quality Parameter Graphs



## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs

