

21 November 2006

Technical Memorandum No. 17

To: Bob Castle, MMWD

From: Todd Reynolds, Kennedy/Jenks  
Val Frenkel, Kennedy/Jenks

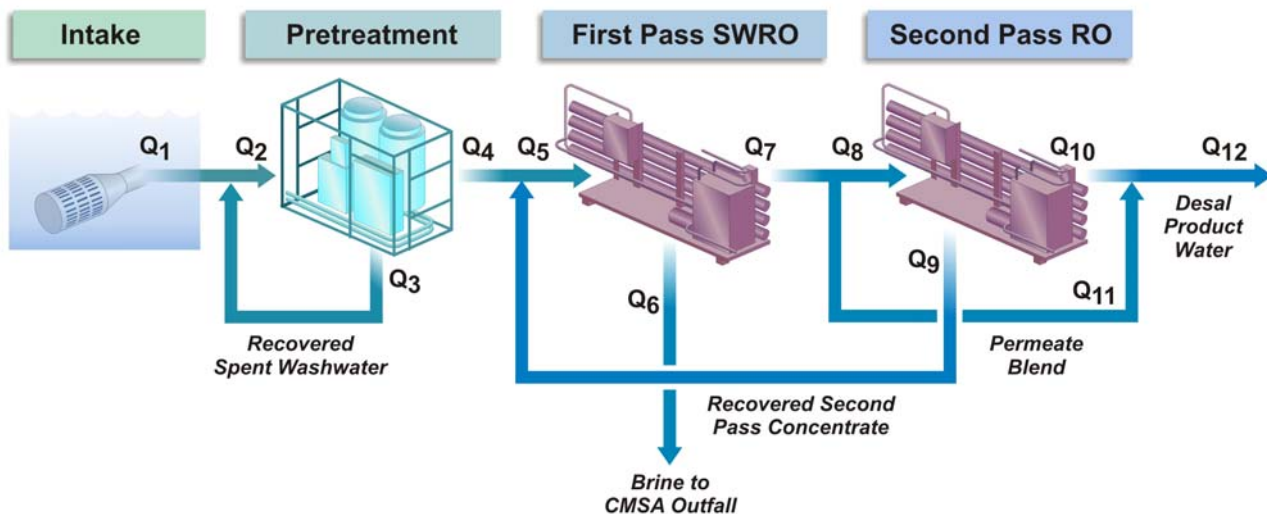
Reviewed: Jim Lozier, CH2M Hill

Subject: Compiled Full Scale Facility Design Criteria  
MMWD Seawater Desalination Pilot Plant Program  
K/J 0468029

This technical memorandum compiles the design criteria for a full-scale SWRO facility as presented in Sections 8 and 9 of the Marin Municipal Water District (MMWD) Seawater Desalination Pilot Program Engineering Report. Descriptions of the processes are presented in Sections 8 and 9 of the report.

Figure 1 shows a simplified process flow schematic of the desalination facility to present the flows required through the plant to produce the required finished water capacity. The flow schematic shows the intake, pretreatment, first pass SWRO and second pass RO processes and the associated waste and recycled water streams. These processes are described in more detail in Sections 8 and 9 of the report.

Figure 1: Desalination Facility Simplified Process Flow Schematic



Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 2 of 16

Table 1 below presents the maximum flow rates for the proposed full scale desalination facility corresponding to the labeled points (Q1, Q2, etc.) in Figure 8.1 for a 5, 10 and 15 MGD facility.

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 3 of 16

Table 1: Full Scale Desalination Facility Design Flow Rates

PLANT FLOW RATES AND RECOVERIES	Unit	Figure Flow			
		Location	5-MGD	10-MGD	15-MGD
Maximum Drought Product Water Flow	MGD		5	10	15
Average Dry Period Product Water Flow	MGD		4	8	12
Minimum Product Water Flow	MGD		1	1	2
Average Pretreatment System Recovery	%		95	95	95
First Pass SWRO Recovery	%		50	50	52
Second Pass RO Recovery	%		90	90	90
Maximum Desal Facility Feed Water Flow	MGD	Q1	10.4	20.7	29.9
Pretreatment Feed Water Flow	MGD	Q2	10.9	21.7	31.4
Pretreatment Recycled Water Flow	MGD	Q3	0.5	1	1.5
Pretreatment Filtrate Flow	MGD	Q4	10.4	20.7	29.9
First Pass SWRO Feed Water Flow	MGD	Q5	10.8	21.4	31
First Pass SWRO Brine Flow	MGD	Q6	5.4	10.7	14.9
First Pass SWRO Permeate Flow	MGD	Q7	5.4	10.7	16.1
Second Pass RO Feed Water Flow	MGD	Q8	3.7	7.3	11.1
Second Pass RO Concentrate Recycle	MGD	Q9	0.4	0.7	1.1
Second Pass RO Permeate Flow	MGD	Q10	3.3	6.6	10
First Pass Permeate Blend Flow	MGD	Q11	1.7	3.4	5
Desalination Facility Product Water Flow	MGD	Q12	5	10	15

Full Scale Facility Design Criteria

The preliminary design criteria presented in Table 2 below are based on constructing a full scale desalination facility with an initial production capacity of 5 MGD or 10 MGD, and the ability to expand to 15 MGD. The preliminary design criteria for a 5 MGD facility that would not be expanded (5 MGD Non-Exp.) are also shown. The design criteria for expansion assumes that in some cases, certain systems such as the intake and source water pipelines, would be sized and constructed for the full 15 MGD capacity during an initial 5 MGD phase of the facility. For these components it is generally less expensive for the overall project to install a single larger pipe, than to construct parallel pipes during expansion. MMWD is also considering an approach that would call for initial construction of a 5 MGD facility that could be rapidly expanded to 10 MGD in a period of approximately 12 months, in response to a severe drought. The approach to construction of a desalination plant necessary to permit rapid expansion are discussed in Section 10 of the report.

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 4 of 16

Table 2: Full Scale SWRO Facility Design Criteria

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>INTAKE SCREENS</b>					
Maximum Source Water Flow	MGD	10.4	10.4	20.7	29.9
Number of Intake Screens	number	1	1	2	3
Number of Spare Screens	number	1	1	1	1
Unit Capacity @ Max. Flow	MGD	10.5	10.5	10.5	10.5
Screen Slot Size	inches	0.09	0.09	0.09	0.09
Approach Velocity	fps	<0.33	<0.33	<0.33	<0.33
Screen Material	--	Copper-Nickel	Copper-Nickel	Copper-Nickel	Copper-Nickel
Cleaning Approach	--	Periodic Air-Burst	Periodic Air-Burst	Periodic Air-Burst	Periodic Air-Burst
Air Compressors	number	2	2	2	2
<b>INTAKE PIPELINE</b>					
	<b>Unit</b>				
Maximum Source Water Flow	MGD	10.4	10.4	20.7	29.9
Number of Intake Pipelines	number	1	1	1	1
Pipeline Diameter	inches	24	36	36	36
Approx. Pipeline Length	feet	2500	2500	2500	2500
Flow Velocity at Max Flow per pipe	fps	5.4	2.2	4.4	6.6
Pipeline Material	--	HDPE	HDPE	HDPE	HDPE
Cleaning Approach	--	Shock Chlor./Pigging	Shock Chlor./Pigging	Shock Chlor./Pigging	Shock Chlor./Pigging
<b>INTAKE PUMP STATION</b>					
	<b>Unit</b>				
Maximum Source Water Flow	MGD	10.4	10.4	20.7	29.9
Minimum Source Water Flow	MGD	2	2	2	4
Low Flow Pumps	number	3	3	3	3
Capacity	MGD	5.5	5.5	5.5	5.5
High Flow Pumps	number	0	0	1	2
Capacity	MGD	--	--	11	11
Speed Control	type	VFD	VFD	VFD	VFD
Pump Materials	--	Duplex SS	Duplex SS	Duplex SS	Duplex SS
<b>SOURCE WATER PIPELINE</b>					
	<b>Unit</b>				

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 5 of 16

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
Maximum Source Water Flow	MGD	10.4	10.4	20.7	29.9
Number of Intake Pipelines	number	1	1	1	1
Pipeline Diameter	inches	24	36	36	36
Flow Velocity at Maximum Flow	fps	2.2	2.2	4.4	6.6
Approx. Pipeline Length	feet	5500	5500	5500	5500
Pipeline Material	--	HDPE	HDPE	HDPE	HDPE
Cleaning Approach	--	Shock Chlor./ Pigging	Shock Chlor./ Pigging	Shock Chlor./ Pigging	Shock Chlor./ Pigging

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>CONVENTIONAL RAPID MIX and FLOCCULATION</b>					
Maximum Intake Flow	MGD	10.4	10.4	20.7	29.9
Maximum Recovered Water Flow	MGD	0.5	0.5	1	1.5
Maximum Process Feed Flow	MGD	10.9	10.9	21.7	31.4
Rapid Mix Units/Basins	number	1	1	2	3
Design Coagulant Dose					
Average Dry Season/Algal Bloom	mg/l	12.0	12.0	12.0	12.0
Average Wet Season	mg/l	25.0	25.0	25.0	25.0
Design Coagulant Aid	mg/l	0.5	0.5	0.5	0.5
Flocculation Time	minutes	30	30	30	30
Flocculation Stages (tapered)	number	3	3	3	3
Flocculation Basins	number	1	1	2	3
Capacity per Basin	MGD	11	11	11	11
Basin Materials	--	Coated Concrete	Coated Concrete	Coated Concrete	Coated Concrete
<b>CONVENTIONAL SEDIMENTATION SYSTEM</b>					
Maximum Process Feed Water Flow	MGD	10.9	10.9	21.7	31.4
Sedimentation Basins	number	1	1	2	3
Capacity per Basin	MGD	11	11	11	11
Basin Hydraulic Detention Time	minutes	60	60	60	60
Plate/Tube Settler Overflow Rate (Top of Plates/Tubes)	gpm/ft2	1.5	1.5	1.5	1.5
Basin Materials	--	Coated Concrete	Coated Concrete	Coated Concrete	Coated Concrete

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 6 of 16

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>CONVENTIONAL FILTRATION SYSTEM</b>					
Maximum Process Feed Water Flow	MGD	10.9	10.9	21.7	31.4
Filter Basins	number	3	3	6	9
Redundant Filter Basin	number	1	1	1	1
Capacity per Basin	MGD	3.7	3.7	3.7	3.7
Design Filtration Rate (Dry Season)	gpm/ft2	4	4	4	4
<b>Design Deep Bed Filter Media</b>					
Antracite Media	inches	36	36	36	36
Silica Sand Media	inches	24	24	24	24
Garnet Media	inches	12	12	12	12
Basin Materials	--	Coated Concrete	Coated Concrete	Coated Concrete	Coated Concrete
Backwash Source	--	Filtered Source	Filtered Source	Filtered Source	Filtered Source
Design Backwash Frequency (Dry Season- /Wet Season)	hrs	48/24	48/24	48/24	48/24
<b>CONVENTIONAL FILTRATE TANK</b>					
Maximum Process Feed Flow	MGD	10.9	10.9	21.7	31.4
Conventional BW Supply Volume	gal	280,000	280,000	560,000	560,000
SWRO Feed Pump Operational Volume 5 - minutes @ max flow	gal	40,000	40,000	80,000	120,000
Total Tank Operational Volume	gallons	320,500	320,500	641,000	680,000
Number of Tanks	number	1	1	2	2
Capacity of Tanks	gallons	350,000	350,000	700,000	700,000

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>CONVENTIONAL SOLIDS RESIDUALS HANDLING SYSTEM</b>					
<b>Summer Pretreatment Design Conditions</b>					
Maximum Pretreatment Design Flow	MGD	10.9	10.9	21.7	31.4
Average Influent Turbidity	NTU	9.0	9.0	9.0	9.0
<b>Winter Pretreatment Design Conditions</b>					
Maximum Pretreatment Design Flow	MGD	8.60	8.60	8.60	21.60

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 7 of 16

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
Average Influent Turbidity	NTU	42.0	42.0	42.0	42.0
<b>Conventional System Solids Loading</b>					
Summer Pretreatment Design Conditions					
Dry Season Design Backwash Frequency	hrs	48	48	48	48
Filter Backwash Volume	gpd	210,000	210,000	420,000	630,000
Sedimentation Basin Blowdown Volume	gpd	43,000	43,000	86,300	130,000
Filter to Waste Volume	gpd	121,000	121,000	242,000	363,000
Total Backwash-related Volume	gpd	374,000	374,000	748,300	1,123,000
Ferric Chloride Dose	mg/l	12.0	12.0	12.0	12.0
Filter Polymer Aid Dose	mg/l	0.5	0.5	0.5	0.5
Total Suspended Solids	mg/l	19.4	19.4	19.4	19.4
Conventional Pretreatment Solids	lb/d	1,880	1,880	3,740	5,620
Wet Solids at 2.5%	gal/d, 7d/wk	9,000	9,000	18,000	27,000
Winter Pretreatment Design Conditions					
Wet Season Design Backwash Frequency	hrs	24	24	24	24
Filter Backwash Volume	gpd	420,000	420,000	560,000	1,120,000
Sedimentation Basin Blowdown Volume	gpd	105,700	105,700	111,300	273,000
Filter to Waste Volume	gpd	242,000	242,000	323,000	645,000
Total Backwash-related Volume	gpd	767,700	767,700	994,300	2,038,000
Ferric Chloride Dose	mg/l	25	25	25	25
Filter Polymer Aid Dose	mg/l	0.5	0.5	0.5	0.5
Total Suspended Solids	mg/l	67.1	67.1	67.1	67.1
Conventional Pretreatment Solids	lb/d	4,820	4,820	4,820	12,090
Wet Solids at 2.5%	gal/d, 7d/wk	23,000	23,000	23,000	57,000
<b>Equalization Basins – Conventional System</b>					
Washwater EQ Basin					
Number of Basins	number	2	2	2	3
Volume per Basin	gal	150,000	150,000	150,000	150,000
EQ Basin Volume	gal	300,000	300,000	300,000	450,000
Filter to Waste EQ Basin					
Number of Basins	number	1	1	1	1

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 8 of 16

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
Volume per Basin	gal	160,000	160,000	160,000	160,000
<b>Conventional Expected Wet Tons of Dewatered Residuals</b>					
Dewatered Solids at 25% - Summer	tons/d	4.7	4.7	9.4	14.1
Dewatered Solids at 25% - Winter	tons/d	12.1	12.1	12.1	30.2

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>MF/UF SOURCE WATER STRAINER</b>					
Maximum Intake Flow	MGD	10.4	10.4	20.7	29.9
Maximum Recovered Water Flow	MGD	0.5	0.5	1	1.5
Maximum Process Feed Flow	MGD	10.9	10.9	21.7	31.4
Nominal Particle Size Removal	microns	100	100	100	100
Process Units	number	5	5	10	15
Capacity, each	MGD	2.2	2.2	2.2	2.2
Backwash Source	--	Filtered Source	Filtered Source	Filtered Source	Filtered Source
Approx. Backwash Volume per unit wash	gal	2,400	2,400	2,400	2,400
Approx. Total Backwash Volume	gpd	29,000	29,000	57,750	86,750
Strainer Materials	--	Plastic	Plastic	Plastic	Plastic
<b>MF/UF RAPID MIX and Coagulation</b>	<b>Unit</b>				
Maximum Process Feed Flow	MGD	10.9	10.9	21.7	31.4
Rapid Mix Units/Basins	number	1	1	2	3
Design Average Coagulant Dose					
MF/UF - Algal Bloom (2 week event)	mg/l	10.0	10.0	10.0	10.0
Coagulation Time	minutes	10	10	10	10
Flocculation Stages (tapered)	number	2	2	2	2
Flocculation Basins	number	1	1	2	3
Capacity per Basin	MGD	11	11	11	11
Basin Materials	--	Coated Concrete	Coated Concrete	Coated Concrete	Coated Concrete
<b>MF/UF FILTRATION SYSTEM</b>	<b>Unit</b>				
Maximum Process Feed Flow	MGD	10.9	10.9	21.7	31.4

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 9 of 16

<b>PROCESS DESCRIPTION</b>	<b>Unit</b>	<b>5-MGD Non-Exp.</b>	<b>5-MGD Exp.</b>	<b>10-MGD Exp.</b>	<b>15-MGD</b>
Membrane Classification	--	MF/UF	MF/UF	MF/UF	MF/UF
Membrane Material	--	PVDF	PVDF	PVDF	PVDF
MF/UF Filter Basins	number	2	2	4	6
Redundant Filter Basin	number	1	1	1	1
Reserve Capacity per Basin	%	25	25	25	25
Capacity per Basin	MGD	5.5	5.5	5.5	5.5
MF Design Flux Rate - (Dry Season - 3 Basin)	gfd	33	33	33	33
MF Design Flux Rate - (Dry Season - High TOC -4 Basins)	gfd	25	25	25	25
UF Design Flux Rate - (Dry Season -3 Basins)	gfd	33	33	33	33
UF Design Flux Rate - (Dry Season - High TOC -4 Basins)	gfd	25	25	25	25
Basin Materials	--	coated concrete	coated concrete	coated concrete	coated concrete
Backwash Source	--	MF/UF Filtrate	MF/UF Filtrate	MF/UF Filtrate	MF/UF Filtrate
Design System Recovery (Dry Season/High TOC - Wet Season)	%	95/93	95/93	95/93	95/93
Design Chemical Wash Frequency	per day	1	1	1	1
Design CIP Frequency (Dry Season)	days	45	45	45	45
Design CIP Frequency (High TOC/Wet Season)	days	30	30	30	30
<b>MF/UF FILTRATE TANK</b>	<b>Unit</b>				
Maximum Process Feed Flow	MGD	10.9	10.9	21.7	31.4
MF/UF BW Supply Volume	gal	5,000	5,000	10,000	15,000
Strainer BW Supply Volume	gal	2,500	2,500	5,000	7,500
SWRO Feed Pump Operational Volume 5 -minutes @ max flow	gal	40,500	40,500	80,000	121,000
Total Tank Operational Volume	gallons	48,000	48,000	95,000	143,500
Number of Tanks	number	1	1	2	2
Capacity of Tanks	gallons	50,000	75,000	150,000	150,000

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 10 of 16

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>MF/UF SOLIDS RESIDUALS HANDLING SYSTEM</b>					
<b>Summer Pretreatment Design Conditions</b>					
Maximum Pretreatment Design Flow	MGD	10.9	10.9	21.7	31.4
Average Influent Turbidity	NTU	9.0	9.0	9.0	9.0
<b>Winter Pretreatment Design Conditions</b>					
Maximum Pretreatment Design Flow	MGD	8.60	8.60	8.60	21.60
Average Influent Turbidity	NTU	42.0	42.0	42.0	42.0
<b>MF/UF System Solids Loading</b>					
Summer Pretreatment Design Conditions					
System Recovery	percent	95%	95%	95%	95%
Ferric Chloride Dose	mg/l	0	0	0	0
Pretreatment TSS	mg/l	11.7	11.7	11.7	11.7
Pretreatment Solids	lb/d	1,140	1,140	2,260	3,390
Backwash Volume					
Strainer	gpd	29,000	29,000	58,000	87,000
MF/UF Unit	gpd	795,000	795,000	1,583,000	2,378,000
Total Backwash Volume	gpd	824,000	824,000	1,641,000	2,465,000
MF/UF Residuals Coagulant Dose (Ferric Chloride)	mg/l	25	25	25	25
MF/UF Residuals Coagulant TSS	mg/l	12.0	12.0	12.0	12.0
MF/UF Residuals Coagulant Solids	lb/d	83	83	165	247
MF/UF Pretreatment Solids	lb/d	1,223	1,223	2,425	3,637
Wet Solids at 2.5%	gal/d, 7d/wk	5,200	5,200	11,000	16,000
<b>Winter Pretreatment Design Conditions</b>					
System Recovery	percent	93%	93%	93%	93%
Ferric Chloride Dose (Periodic)	mg/l	10	10	10	10
Pretreatment TSS	mg/l	59.4	59.4	59.4	59.4
Pretreatment Solids	lb/d	4,260	4,260	4,260	10,710
Backwash Volume					
Strainer	gpd	22,000	22,000	22,000	54,000
MF/UF Unit	gpd	602,000	602,000	602,000	1,512,000
Total Backwash Volume	gpd	624,000	624,000	624,000	1,566,000

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 11 of 16

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
MF/UF Residuals Coagulant Dose (Ferric Chloride)	mg/l	15	15	15	15
MF/UF Residuals Coagulant TSS	mg/l	7.2	7.2	7.2	7.2
MF/UF Residuals Coagulant Solids	lb/d	37.5	37.5	37.5	94.0
MF/UF Pretreatment Solids	lb/d	4,298	4,298	4,298	10,804
Wet Solids at 2.5%	lb/d	20,000	20,000	20,000	52,000
<b>Equalization Basins – MF/UF Pretreatment</b>					
Washwater EQ Basin					
Number of Basins	number	2	2	2	3
Volume per Basin	gal	50,000	50,000	50,000	50,000
EQ Volume	gal	100,000	100,000	100,000	150,000
<b>MF/UF Expected Wet Tons of Dewatered Residuals</b>					
Dewatered Solids @ 25% - Summer	tons/d	3.1	3.1	6.1	9.1
Dewatered Solids @ 25% - Winter	tons/d	10.7	10.7	10.7	27.0

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>SWRO BOOSTER PUMPS</b>					
Maximum Pretreatment Filtrate Flow	MGD	10.4	10.4	20.7	29.9
2 <sup>nd</sup> Pass RO Concentrate Recycle	MGD	0.4	0.4	0.7	1.1
Maximum SWRO Feed Flow	MGD	10.8	10.8	21.4	31
Minimum Feed Water Flow	MGD	2.0	2.0	2.0	4.0
Low Flow Pumps	number	3	3	3	3
Capacity	MGD	5.5	5.5	5.5	5.5
High Flow Pumps	number	0	0	1	2
Capacity	MGD	--	--	11	11
Speed Control	type	VFD	VFD	VFD	VFD
Pump Materials	--	Duplex SS	Duplex SS	Duplex SS	Duplex SS
<b>CARTRIDGE FILTRATION SYSTEM</b>					
Maximum Process Feed Flow	MGD	10.8	10.8	21.4	31
Nominal Filter Rating	micron	5	5	5	5
Cartridge Filter Housings	number	4	4	8	12

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 12 of 16

<b>PROCESS DESCRIPTION</b>	<b>Unit</b>	<b>5-MGD Non-Exp.</b>	<b>5-MGD Exp.</b>	<b>10-MGD Exp.</b>	<b>15-MGD</b>
Redundant Filter Housing	number	1	1	1	1
Design Capacity (each)	MGD	2.7	2.7	2.7	2.7
Housing Materials	--	FRP	FRP	FRP	FRP
<b>SWRO HP PUMPS AND ENERGY RECOVERY</b>					
	<b>Unit</b>				
Maximum Process Feed Flow	MGD	10.8	10.8	21.4	31
Minimum Feed Water Flow	MGD	2.0	2.0	2.0	4.0
HP SWRO Feed Pumps	number	2	2	3	4
Approx. Capacity (Permeate)	MGD	5.4	5.4	5.4	5.4
Approx. Maximum Pressure	psi	1080	1080	1080	1080
Speed Control	type	VFD	VFD	VFD	VFD
Pump Materials	--	Duplex SS	Duplex SS	Duplex SS	Duplex SS
Energy Recovery Process	type	Pressure Exchanger	Pressure Exchanger	Pressure Exchanger	Pressure Exchanger
Energy Recovery Booster Pumps	number	2	2	3	4
Approx. Capacity (brine flow)	MGD	5.4	5.4	5.4	5.4
Approx. Maximum Pressure	psi	75	75	75	75
Speed Control	type	VFD	VFD	VFD	VFD
Pump Materials	--	Duplex SS	Duplex SS	Duplex SS	Duplex SS
<b>FIRST PASS SWRO MEMBRANE SYSTEM</b>					
	<b>Unit</b>				
Maximum Process Feed Flow	MGD	10.8	10.8	21.4	31
Maximum SWRO Permeate Flow	MGD	5.4	5.4	10.7	16.1
SWRO Process Skids	number	3	3	3/2	3/2
Permeate Capacity per Skid - maximum	MGD	1.8	1.8	1.8/2.7	1.8/2.7
Permeate Capacity per Skid - minimum	MGD	1	1	1 / 2.5	1 / 2.5
Design Flux Rate	gfd	9	9	9	9
Design Recovery - Max. Drought Salinity	%	50	50	50	52
SWRO Membrane Array	--	Single Stage	Single Stage	Single Stage	Single Stage
SWRO Membrane Material	--	TFC	TFC	TFC	TFC
SWRO Membrane Element Diameter	inches	8	8	8	8
SWRO Membrane Elements per Vessel	number	7	7	7	7
Average Antiscalant Dose	mg/l	1.5	1.5	1.5	1.5
Average Bisulfite Dose	mg/l	1.5	1.5	1.5	1.5
SWRO Brine Flow at Max Production and Design Recovery	MGD	5.4	5.4	10.7	14.9

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 13 of 16

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>FIRST PASS PERMEATE TANK</b>					
Maximum Process Feed Flow to 2nd Pass RO - Design Drought Salinity	MGD	3.7	3.7	7.3	11.0
Approx. Volume to Flush SWRO Skid on Shutdown	gallons	5,000	5,000	10,000	10,000
BWRO Feed Pump Operational Volume 5 -minutes @ max flow	gallons	12,800	12,800	25,700	38,500
Total Tank Operational Volume	gallons	17,800	17,800	35,700	48,500
Number of Tanks	number	1	1	2	2
Capacity of Tank	gallons	20,000	25,000	25,000	25,000

SECOND PASS RO MEMBRANE SYSTEM	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
Maximum Process Feed Flow to 2nd Pass RO - Design Drought Salinity	MGD	3.7	3.7	7.3	11.0
BWRO Process Skids	number	2	2	2/1	2/2
Design Flux Rate	gfd	16	16	16	16
Design Recovery - Max. Drought Salinity	%	90	90	90	90
Permeate Capacity per Skid - maximum	MGD	1.7	1.7	1.7/3.3	1.7/3.3
BWRO Membrane Array	--	2 Stage	2 Stage	2 Stage	2 Stage
BWRO Membrane Material	--	TFC	TFC	TFC	TFC
BWRO Membrane Element Diameter	inches	8	8	8	8
BWRO Membrane Elements per Vessel	number	7	7	7	7
Average Sodium Hydroxide Dose	mg/l	2.5	2.5	2.5	2.5
Average Antiscalant Dose	mg/l	1.5	1.5	1.5	1.5
BWRO Concentrate Recycle Flow	MGD	0.4	0.4	0.7	1.1

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>POST TREATMENT SYSTEM</b>					
Maximum SWRO Permeate Blend Flow	MGD	1.7	1.7	3.4	5
Maximum Second Pass RO Permeate Flow	MGD	3.3	3.3	6.6	10
Maximum Process Feed Flow	MGD	5	5	10	15
Design Finished Water pH Range	mg/l	7.8 - 8.2	7.8 - 8.2	7.8 - 8.2	7.8 - 8.2
Design Finished Water Hardness Range	mg/l	60 - 80	60 - 80	60 - 80	60 - 80

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 14 of 16

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
Design Finished Water Alkalinity Range	mg/l	60 - 80	60 - 80	60 - 80	60 - 80
Design CO <sub>2</sub> Dose	mg/l	75	75	75	75
Design CO <sub>2</sub> Addition Rate	ppd	3,130	3,130	6,260	9,380
CO <sub>2</sub> Storage and Feeder Units	number	1	1	2	3
CO <sub>2</sub> Storage Capacity (each)	pounds	100,000	100,000	100,000	100,000
Design Lime/Calcite Dose	mg/l	65	65	65	65
Design Lime/Calcite Addition Rate	ppd	2,710	2,710	5,420	8,130
Lime/Calcite Storage and Feed Beds	number	1	1	2	3
Lime/Calcite Storage Capacity (each)	pounds	100,000	100,000	100,000	100,000
Avg. Zinc Orthophosphate Dose (as P)	mg/l	1.1	1.1	1.1	1.1
<b>DISINFECTION SYSTEM</b>					
Maximum Process Feed Flow	MGD	5	5	10	15
DHS Multi-Barrier Minimum Inactivation Requirement	log	0.5-log <i>Giardia</i> /2-log virus	0.5-log <i>Giardia</i> /2-log virus	0.5-log <i>Giardia</i> /2-log virus	0.5-log <i>Giardia</i> /2-log virus
CT Design Temperature -pH combinations	--	10°C - 8.5 pH units	10°C - 8.5 pH units	10°C - 8.5 pH units	10°C - 8.5 pH units
CT Design Free Chlorine Residual	mg/l	2	2	2	2
Free Chlorine CT for 0.5-log <i>Giardia</i> inactivation	mg/L-min	33.0	33.0	33.0	33.0
Free Chlorine CT for 2 log <i>virus</i> inactivation	mg/L-min	3.0	3.0	3.0	3.0
<b>Disinfection Reservoir (Chlorine Contact Tank)</b>					
Design Reservoir Hydraulic Efficiency (T <sub>10</sub> /T)	--	0.5	0.5	0.5	0.5
Required Reservoir CT Volume at max. flow	gallons	120,000	120,000	240,000	360,000
Distribution Pump Operational Control Volume - 5 minutes @ max flow	gallons	17,500	17,500	35,000	52,500
Total Reservoir Volume	gallons	137,500	137,500	275,000	412,500
Number of Reservoirs	number	1	1	2	2
Reservoir Volume, each	gallons	150,000	200,000	400,000	400,000
<b>DISTRIBUTION BOOSTER PUMPS</b>					
Maximum Process Feed Flow	MGD	5	5	10	15
Minimum Feed Water Flow	MGD	2	2	2	2
Approx. Pump Discharge Pressure	psi	100	100	100	100

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 15 of 16

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
Low Flow Pumps	number	3	3	3	3
Capacity	MGD	2.5	2.5	2.5	2.5
High Flow Pumps	number	0	0	1	2
Capacity	MGD	--	--	5	5
Speed Control	type	VFD	VFD	VFD	VFD

PROCESS DESCRIPTION	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>Gravity Thickener System</b>					
Gravity Thickeners	number	1	1	1	2
Redundant Gravity Thickeners	number	1	1	1	1
Capacity per Unit	gpm	1,500	1,500	1,500	1,500
Solids Loading per unit (Winter Season)	ppd/SF	2.5	2.5	2.5	3.0
Hydraulic Loading per unit (Summer Season)	gpd/SF	820	820	820	630
Basin Diameter	ft	50	50	50	50
Side Water Depth	ft	16	16	16	16
Gravity Thickener Feed Pumps	number	2	2	2	3
Gravity Thickener Feed Pump Capacity	gpm	1,500	1,500	1,500	1,500
<b>Centrifuge Dewatering System</b>					
Centrifuge Units	number	1	1	1	2
Redundant Units	number	1	1	1	1
Capacity per Unit	gpm	80	80	80	80
Centrifuge Feed Pumps	number	2	2	2	3
Centrifuge Feed Pump Capacity	gpm	80	80	80	80
Average Centrate flow rate	gpm	10	10	20	30
Minimum Dewatered Sludge Concentration	percent	25%	25%	25%	25%

Process Description	Unit	5-MGD Non-Exp.	5-MGD Exp.	10-MGD Exp.	15-MGD
<b>Brine Pump Station</b>					
Brine Flowrate at Max Capacity and Design Recovery	MGD	5.4	5.4	10.7	14.9
Approx. Pump Discharge Pressure	psi	10	10	10	10
Brine Pumps	number	1	1	2	3
Redundant Brine Pumps	number	1	1	1	1
Capacity	MGD	5.5	5.5	5.5	5.5

Technical Memorandum No. 17

Compiled Full Scale SWRO Design Criteria

21 November 2006

Page 16 of 16

<b>Process Description</b>	<b>Unit</b>	<b>5-MGD Non-Exp.</b>	<b>5-MGD Exp.</b>	<b>10-MGD Exp.</b>	<b>15-MGD</b>
Speed Control	type	VFD	VFD	VFD	VFD
<b>Brine Pipeline</b>					
Number of Brine Pipelines	number	1	1	1	1
Pipeline Diameter	inches	18	24	24	24
Flow Velocity at Maximum Flow	fps	5	2.8	5.4	7.4
Approx. Pipeline Length	feet	2,000	2,000	2,000	2,000
Pipeline Material	--	HDPE	HDPE	HDPE	HDPE